Kenya National Biodiversity Threat Assessment

Direct Human Threats Impacting Kenya's Biodiversity

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The report was prepared by Masumi S. Gudka for IUCN – BIODEV2030

Contents

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Biodiversity Threat Assessment Contributors and Assessors

Dr Abdullahi Hussein Ali	Hirola Conservation Programme
Dr Beryl Bwong	National Museums of Kenya
Cyrus Mageria	Ministry of Environment and Forestry
Dr Darcy Ogada	The Peregrine Fund
Don Turner	Nature Kenya Bird Committee
Ebenezer Amadi	Kenya Private Sector Alliance
Elizabeth Mueni	Kenya Fisheries Service
Eunice Robai	African Network for Animal Welfare
Fleur Ngweno	Nature Kenya
Dr Gladys Okemwa	Kenya Marine and Fisheries Research Institute
Jagi Gakunju	Wajee Nature Park
Janes Spilsbury	The Kenya Marine Mammal Network
Jenni Choma	Marine Education Centre
Juliet Furaha	Kenya Marine and Fisheries Research Institute
Dr Margaret Otieno	Wildlife Clubs of Kenya
Dr Melita Samoilys	Coastal Oceans Research and Development – Indian Ocean (CORDIO)
Michael Mwangombe	The Kenya Marine Mammal Network
Mishal Gudka	Coastal Oceans Research and Development – Indian Ocean (CORDIO)
Munira Ayonge	The Nature Conservancy

Dr Nina Wambiji	Kenya Marine and Fisheries Research Institute
Dr Patrick Malonza	National Museums of Kenya
Paul Gacheru	Nature Kenya
Dr Paula Kahumbu	WildlifeDirect
Dr Sharon Kahara	Humboldt State University
Sidney Shema	Kenya Bird Map
Dr Simon Musila	National Museums of Kenya
Stephen Manegene	Kenya Wildlife Service
Stephen Spawls	City College Norwich
Dr Tom Butynski	Lolldaiga Hills Research Programme
Dr Yvonne De Jong	Lolldaiga Hills Research Programme
Zarek Cockar	Nature Kenya Bird Committee

Abbreviations and Acronyms

AZE	Alliance for Zero Extinction
CBD	Convention on Biological Diversity
CMP	Conservation Measures Partnership
CR	Critically Endangered
DD	Data Deficient
EbTAT	Expert-based Threat Assessment Tool
EN	Endangered
GESIP	Green Economy Strategy and Implementation Plan
HWC	Human Wildlife Conflict
IBA	Important Bird Areas
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
KFS	Kenya Forest Service
KWS	Kenya Wildlife Service
LAPSSET	Lamu Port, South Sudan, Ethiopia Transport Corridor
LC	Least Concern
LMMAs	Locally Managed Marine Area
MoEF	Ministry of Environment and Forestry
NA	Not Assessed
NBSAP	National Biodiversity Strategy and Action Plan
NEMA	National Environmental Management Agency
NT	Near Threatened
PA	Protected Area

RLI	Red List Index
RLTS	Red List of Threatened Species
STAR	Species, Threat Abatement, and Restoration
STAT	Simplified Threat Assessment Tool
UNESCO	UN Economic, Social, and Cultural Organisation
WDPA	World Database on Protected Areas

Executive Summary

Introduction

Recent scientific knowledge points to the acceleration of the loss and decline of biodiversity and ecosystem services, predicting that one million plant and animal species are threatened with extinction (IPBES, 2019). The unprecedented degradation of ecosystem health weakens livelihoods, food security, health, and quality of life worldwide, while also posing economic and financial risks. In Africa, the loss of natural capital will weaken the resilience of the most vulnerable human populations, significantly impacting economies and societies. The foundation of Kenya's national economic wealth is driven primarily by agriculture and tourism which rely heavily on its natural resources that must be conserved.

The BIODEV2030 initiative aims to accelerate the mainstreaming of biodiversity into economic sectors which are key to biodiversity (BIO-) and development (-DEV), to 'bend the curve' of biodiversity decline and promote more sustainable and resilient economies. Kenya is one of 16 pilot countries[1] involved to set voluntary national and sectoral commitments to help reduce pressures on biodiversity by facilitating national dialogue involving stakeholders from two economic sectors.

In the context of BIODEV2030 project, the purpose of this study is to provide a scientific overview and assessment of sectoral threats to biodiversity at the national level in Kenya, based on existing reports, scientific data, and interviews of experts and national representatives. The national analysis is complemented by case studies at county level in areas of high biodiversity. In addition, a calculation of the scores of the new metric called "Species Threat Abatement and Restoration" (STAR) provides useful insights for assessing the potential of both threat reduction and restoration of natural habitats to stop biodiversity decline in Kenya.

Using a combination of published literature and expert opinion, this study examines the status and trends of biodiversity, and assesses the severity of direct threats on mammal, amphibian, bird, and fish vertebrate classes and on coral reef ecosystems.

Methodology, Results & Analyses

Kenya has 73 identified KBA sites (Figure 10) of which 67 are IBAs (Gacheru et al., 2019) and 6 are AZEs, with a further 47 potential KBA sites. Since 1980, there has been a 7.5% increase in the coverage of KBAs within protected areas (PAs) in Kenya (IBAT, 2020). Over 400 official PAs occur in

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[1] 16 Pilot Countries include: Kenya, Burkina Faso, Benin, Senegal, Guinea Conakry, Mozambique, Ethiopia, Fiji, (under the mandate of IUCN) and Cameroon, Congo, Gabon, Guyana, Madagascar, Tunisia, Uganda, and Vietnam (under WWF).

Kenya and include forest reserves, terrestrial and marine national parks and reserves, as well as community conserved areas.

Despite the increase in coverage of KBAs within PAs and a large number of PAs in Kenya, species are continuing to decline. The survival probability for birds, mammals, amphibians, corals, and cycads in Kenya was determined using the IUCN Red List Index (RLI) which showed a downward trend from 1993 to 2020. This suggests that species within these five groups have a declining survival probability.

Mammal species richness in Kenya is comparatively high for Africa with 390 to 405 species described (MEWNR 2015; Musila et al., 2019; IUCN Red List, 2020; IBAT, 2020). Of these, mammal species assessed using the IUCN Red List of Threatened Species show that 41 are threatened (IBAT, 2020), while 91 species are experiencing declines in their global populations (IUCN Red List, 2020). The number of bird species (including migrants and vagrants) described in Kenya ranges from 1121 to 1187 (Lapage 2018, 2019 & 2020; IUCN Red List, 2020). Population trends (at the global level) for 698 bird species occurring in Kenya are either stable or increasing, however populations of 354 species, or approximately 32%, are on the decline. With more than 40 threatened (6 CR; 16 EN; 26 VU) bird species (IUCN Red List, 2020), Kenya is an important country for avian conservation at both national and global levels (Fanshawe and Bennun, 1991). Kenya has between 111 to 115 species of amphibians (IUCN Red List, 2020; AmphibiaWeb, 2020) of which 11 are threatened with extinction. Global populations of at least eight frogs and one toad that occur in Kenya are declining, however global population trends of majority of amphibian species found in Kenya are not known (IUCN Red List, 2020). Marine and freshwater fish in Kenya belong in three classes Actinopterygii, Chondrichthyes, and Sarcopterygii (IUCN Red List, 2020) and include roughly 1058 species (FishBase, 2019). According to data extracted from the IUCN Red List (2020), for freshwater and marine fish assessed and occurring in Kenya, global populations of 8 species were increasing, 96 were decreasing, and 232 were stable. However, population trends of the majority were unknown. A total of 42 species (CR: 30 and EN: 12) were highly threatened with extinction.

To determine what direct threats from human sources (anthropogenic) were impacting these species groups and to what extent, the STAR Metric and threat assessment survey tool were used.

The STAR score calculated for mammals, birds and amphibians for Kenya is 16,791, where the threat abatement score is 56% and the restoration score is 44% of the national STAR score. Kenya contributes 0.29% of the global STAR score, ranked at number 35 out of 195 countries. This high score as well as the red list index confirms that biodiversity is at risk in Kenya.

Annual & Perennial Non-timber Crops had the highest STAR threat abatement score of 2,722, closely followed by Logging & Wood Harvesting with a score of 1,897. These scores indicate the abatement of those two threats present the greatest potential benefit for species conservation.

These results were complimented through expert assessments using two different specialised assessment tools to capture threat severity data and better represent aquatic (Marine and Freshwater) biodiversity. IUCN and the Conservation Measures Partnership (CMP) developed a comprehensive, standardised, and globally applicable classification system of direct threats that is consistent with IUCN Red List of Threatened Species (IUCN Red List) and Key Biodiversity Areas (KBAs). Direct threats were based on this IUCN-CMP Threat Classification System[2]. Fifteen expert assessors[3] identified a total of 64 direct threats (level-two and level-three of the Classification System) to biodiversity in Kenya ranking 18 as 'Very High' impact and 22 as 'High' impact. Eighteen threats were considered to be priorities for conservation action.

An additional nine assessors representing government institutions, private sector, and NGOs identified a total of 32 (level-two) direct threats impacting biodiversity in Kenya. **Out of the 32 threats, four were considered to be top threats**, such that assessors perceived these threats to have the greatest impact on biodiversity in Kenya. **Hunting & Collecting Terrestrial Animals** was reported by 100% of assessors and also the most frequently reported threat perceived as having the greatest impact on biodiversity in Kenya. **Housing & Urban Areas** and **Annual & Perennial Non-timber Crops** closely followed as most frequently reported direct threats. The fourth one is **Roads & Railroads.**

Conclusion & Recommendations

This study set out to identify threats with the greatest impact on biodiversity in Kenya and the economic sectors driving them. Differences in threats and their impacts were found between terrestrial and aquatic (marine and freshwater) biodiversity. Based on the study findings, Annual & Perennial Non-timber Crops and Hunting & Collecting Terrestrial Animals had the greatest impact on terrestrial biodiversity, while climate related Habitat Shifting & Alteration had the greatest impact on aquatic, particularly marine biodiversity, followed by Oil & Gas Drilling and Fishing & Harvesting Aquatic Resources. **The economic sectors driving these threats were identified as agriculture, forestry, energy, and fisheries**.

The study findings showed that several high impact threats with equally high threat abatement scores were linked either directly or indirectly to agricultural activities, of which crop farming was most prominent.

[2] The full IUCN-CMP Threat Classification System Version 3.2 can be retrieved here: https://www.iucnredlist.org/resources/threat-classification-scheme

[3] who are known authorities in Kenya on the selected biological targets (Coral Reefs, Mammals, Birds, Amphibians, and Fish)

Non-timber Crop Farming and Logging & Wood Harvesting had the two highest STAR threat abatement scores. When also considering the intricate links between agricultural (crop) expansion, effluents, logging, and wood harvesting, the potential to reduce species declines is multiplied significantly by focusing on synergies between the agriculture and forestry sectors.

Although Climate related Habitat Shifting & Alteration was the greatest threat to marine biodiversity, due to the challenges with tackling Climate Change, threats from Oil & Gas Drilling and Fishing & Harvesting Aquatic Resources were considered more appropriate for abatement. However, since threats to marine biodiversity from fishing and harvesting were more immediate, the potential to abate threats are better demonstrated through the fisheries sector.

Therefore, to effectively conserve terrestrial, marine, and freshwater biodiversity in Kenya, it is recommended that the agriculture, forestry, and fisheries sectors are prioritised for engagement when setting voluntary commitments through BIODEV2030.

The BIODEV2030 Initiative, using the key conclusion and recommendations of this assessment, could support the Government of Kenya to secure a high-level political commitment to stop biodiversity loss associated with key economic sectors in order to prepare for and adopt an ambitious Post 2020 Global Biodiversity Framework. It could also support key stakeholders to secure a robust voluntary commitment to stop biodiversity decline between 2020 and 2030 from actors in the key economic sector.

1. Introduction

Recent scientific knowledge points to the acceleration of the loss and decline of biodiversity and ecosystem services since 2010, with a more than ever plausible risk of mass extinction of species in the next few decades if urgent measures are not taken globally. The 2019 Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment of Biodiversity and Ecosystem Services Report (IPBES 2019) predicts that one million plant and animal species are threatened with extinction. The health of the ecosystems on which we and all other species depend is degrading today at an unprecedented rate. This situation weakens livelihoods, food security, health, and quality of life worldwide and poses economic and financial risks.

In Africa, it is anticipated that the accelerated loss of biodiversity and ecosystem services will have significant consequences on economies and society in general. In particular, the increasing exposure of populations to disasters and the consequences linked to the loss of natural capital which forms the basis of subsistence and resilience for the most vulnerable populations. Kenya's natural resources are the foundation of the national economic wealth, by their contribution to the tourism sector and to agriculture.

1.1 BIODEV2030: Mainstreaming Biodiversity into Key Economic Sectors

The BIODEV2030 initiative aims to accelerate the mainstreaming of biodiversity into economic sectors which are key to biodiversity (BIO-) and development (-DEV), to 'bend the curve' of biodiversity decline and promote more sustainable and resilient economies. BIODEV2030 empowers 16[4] pilot countries with diverse ecological, economic, political and institutional contexts, to catalyse voluntary national and sectoral commitments for biodiversity to reduce pressures on biodiversity over the next decade. The project is Funded by the French Development Agency (AFD), coordinated by Expertise France, and implemented by International Union for Conservation of Nature (IUCN) and World Wildlife Fund (WWF)-France in 8 countries each. The two-year project intends to foster ambitious commitments based on scientific assessments and clear accountability mechanisms that bring about change. It will strive to create the conditions for a national dialogue involving stakeholders of at least two economic sectors, identified by national representatives as strategic and relevant to each country's biodiversity and development. The multi-stakeholder dialogue shall catalyse concrete national and sectoral voluntary commitments over the next decade.

[4] 16 Pilot Countries include: Kenya, Burkina Faso, Benin, Senegal, Guinea Conakry, Mozambique, Ethiopia, Fiji, (under the mandate of IUCN) and Cameroon, Congo, Gabon, Guyana, Madagascar, Tunisia, Uganda, and Vietnam (under WWF).

The voluntary contributions will be a big step towards building ambitious common goals aimed at halting the decline in biodiversity by 2030 and restoring biodiversity by 2050. They shall also demonstrate the effectiveness of voluntary commitments as an approach to tackle biodiversity loss and support the achievement of National Biodiversity Strategies and Action Plans (NBSAPs) – and possibly Nationally Determined Contributions (NDCs[5]). The IUCN World Conservation Congress in January 2021 in Marseille (France) and the 15th meeting of the Conference of the Parties (COP15) to the Convention on Biological Diversity (CBD), in May 2021 in Kunming, China, will offer many opportunities to showcase successful experiences, share and discuss best practices, and present initiatives from "champion" countries, with the aim of inspiring an even broader mobilization. The project will therefore bring valuable inputs to the discussions of the Post2020 Global Framework for Biodiversity, to be adopted at CBD COP15 in Kunming.

In addition, the BIODEV2030 Initiative and recommendations from this report could support the Government of Kenya to secure high level political commitment from the Head of State to halt biodiversity decline in Kenya by setting robust voluntary commitments. These voluntary commitments should focus on stopping biodiversity loss between 2020 and 2030 from key economic sectors threatening biodiversity in Kenya, as well as negotiate the best possible outcomes for the Post 2020 Global Biodiversity Framework in CBD COP 15.

1.2 BIODEV2030: Supporting Kenya Vision 2030

Situated on the East African coast and on the equator, Kenya's geography supports abundant and varied wildlife of high intrinsic and economic value. The country is transforming politically and economically after 50 years of independence marked by mixed political and economic performance. Notwithstanding recent significant political, structural, and economic reforms that have driven sustained growth, the country still faces considerable challenges including generating economic growth that is more inclusive to reduce poverty more effectively[6].

Kenya is an economic, financial, and transport hub for East Africa, and the region's second largest economy after Ethiopia. Since 2014, Kenya has been ranked as a lower middle-income country[7]. While economic activity faltered following the 2008 global economic recession, growth resumed in the last five years reaching 5.9% in 2019, placing Kenya as one of the fastest growing economies in Sub-Saharan Africa[8]. Looking ahead, medium-term gross GDP is expected to rise to 6.0% in 2020 underpinned by private consumption, a pick-up in industrial activity and strong performance in the

[5] Nationally Determined Contributions, CO2 emission targets under UNFCCC
[6] African Development Bank Group Country Strategy Paper for Kenya 2014-2018. February 2014.
[7] https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html Accessed December 2019
[8] https://www.worldbank.org/en/country/kenya/overview. Accessed December 2019

services sector. Growth will also be driven by ongoing key investment to support implementation of "the Big Four Development agenda"[9].

In 2017, Kenya launched a Green Economy Strategy and Implementation Plan (GESIP) designed to support a globally competitive low carbon development path through promoting economic resilience and resource efficiency, sustainable management of natural resources, development of sustainable infrastructure, and providing support for social inclusion[10].

Kenya Vision 2030[11]

Launched in 2008, Kenya's long term development blue print, Vision 2030 aims to transform the country into an industrialized middle income country offering a high quality of life to its citizens. The three key pillars of this vision are:

- a sustained average economic growth rate of 10% p.a.
- just, cohesive, and equitable social development in a clean and secure environment
- an issue-based, people-centred, results-oriented, and accountable democracy.

The Vision is being implemented through successive five-year medium-term plans. The Third Medium Term Plan (MTP III) 2018-2022 is designed to achieve the Big Four initiatives of the current administration ("Big Four" or B4): Industrialization, Manufacturing and Agro-processing; Affordable Housing; Food and Nutrition Security; and Universal Health Coverage.

Although the environment does not feature in Vision 2030 as a pillar, environmental considerations are contained in the social and economic pillars as it emphasizes the need to conserve natural resources to support economic growth. The Kenyan Government has put in place a wide range of policy, institutional and legislative frameworks to address the major causes of environmental degradation and negative impacts on ecosystems emanating from industrial and economic development programmes. For forests, the goal is to increase area under forest (forest cover) to 10% by 2022 and sustainably manage natural forest resources for environmental protection and enhanced economic growth[12].

[9] https://www.worldbank.org/en/country/kenya/overview. Accessed December 2019
[10] Green Economy Strategy and Implementation Plan – Kenya 2016-2030. Government of Kenya http://www.environment.go.ke/wp-content/uploads/2018/08/GESIP_Final23032017.pdf
[11] Third Medium Term Plan 2018 – 2022. *Transforming Lives: Advancing socio-economic development through the "Big Four"* Accessed December 2019
[12] National strategy for achieving and maintaining over 10% tree cover by 2022. Ministry of Environment and Forestry. May, 2019.

1.3 Purpose of the Assessment

In the context of BIODEV2030 project, the purpose of this study is to provide a scientific overview and assessment of sectoral threats to biodiversity at the national level in Kenya, based on existing reports, scientific data and interviews of experts and national representatives. The national analysis is complemented by the case studies at county level in areas of high biodiversity.

The results of this study shall inform national authorities and key stakeholders to prioritise engagement of two economic sectors with the greatest impact on biodiversity in Kenya, on which the project should focus its efforts in the multi-stakeholder dialogue phase, with the aim to reduce pressures by 2030.

In-person meetings were held between 9th – 11th March with key project stakeholders including: IUCN Members, Ministry of Environment and Forestry, French Development Agency, the French Embassy, and the Kenya Private Sector Alliance (KEPSA). The BIODEV2030 project team also attended the drafting workshop in preparation for the 6th national report to the United Nations Convention on Biological Diversity (CBD Drafting Workshop) 9th to 13th March 2020.

The study depicts Kenya's biodiversity status and trends in Chapter One, based on available literature and expert knowledge. The biodiversity overview of Kenya presented in Chapter One helps prioritize the biological targets and stressors to be analysed in the threat assessment detailed in Chapter Two. The threat assessment was conducted both at a national level and for two counties which included Taita Taveta and Nyandarua Counties.

The study therefore produces a baseline, which will serve as a foundation both for the BIODEV2030 project and to inform national decision-making in terms of biodiversity management.

2. Methodology

2.1 Conceptual Framework and Definitions

The Convention on Biological Diversity (CBD) defines 'biological diversity' as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems" (CBD, 2006).

The CBD national profile for Kenya[13] calls for an urgent re-assessment of biodiversity to ascertain the current status in Kenya, stating that existing ones are outdated. This study is therefore addressing a relevant and urgent need to support national biodiversity conservation goals. Both the CBD post-2020 agenda and UN Sustainable Development Goals have a mandate to facilitate global action on biodiversity conservation which depend on ecosystem assessment (Keith et al.,2020).

Through a biodiversity threat assessment of Kenya, we intend to identify direct threats with the greatest impact on biodiversity and the economic sectors driving them for prioritisation in engagement through the BIODEV2030 Project.

For a threat assessment to be conducted, the biological targets (species, communities, and/or ecosystems) and stressors (attributes of a conservation target's ecology that are impaired directly or indirectly by human activities) must first be identified (Salafsky et al., 2008).

Using a combination of published literature and expert opinion, this study examines the status and trends of biodiversity and assesses the severity of direct threats on mammal, amphibian, bird, and fish vertebrate classes and coral reef ecosystems. These are hereafter referred to as biological targets. These biological targets were selected based on their usefulness as surrogates of biodiversity and indicators of ecological health and integrity (Hilty and Merenlender 2000, Lindenmayer et al., 2015; Tyrell et al., 2019). In addition, they are widely studied with accessible data to determine status and trends. While it is recognised that plants are important surrogates for biodiversity, local information on their status & trends was limited, and none of the plant experts contacted for the EbTAT participated in the assessment therefore mentions of plants were limited in the report.

Expert opinion is used to determine the severity of threats on biological targets. Systematic surveys involving multiple experts to gather knowledge are used to assess evidence, especially where empirical data is lacking and uncertainty is high. Using expert opinion can help fill data gaps by making available knowledge that would be otherwise inaccessible.

[13] Link to the webpage calling for biodiversity re-assessments https://www.cbd.int/countries/profile/?country=ke

In literature to date, ‘threats’ have been frequently communicated as a combination of drivers, stressors, direct and indirect threats, without clear distinctions being made. Often habitat loss is reported as a major threat, however, communicated in this way it is difficult to pinpoint the actual source of the stress and, by extension, determine the economic activity/activities impeding the biological target. It was therefore important to adopt the IUCN-CMP classification system[14] which clearly identifies the source of stress (Salafsky et al., 2008). Using a universal language, conservation can build a common database to share ideas, set priorities, and allocate resources (Salafsky et al., 2008).

2.1.1 Conceptual Framework

The simplified conceptual model (Figure 1) used for the purpose of this study is adapted from the DPSIR (Drivers, Pressures, State, Impact, and Response) model. This study focuses specifically on the state of biodiversity and on the threats affecting this state. The threats to biodiversity have natural (volcanic eruptions, earthquakes, etc.) and anthropogenic (human) sources (Residential & Commercial Development, Agriculture & Aquaculture, Biological Resource Use, etc.). For the purpose of this study, we are focusing on human sources of threats affecting biodiversity status.

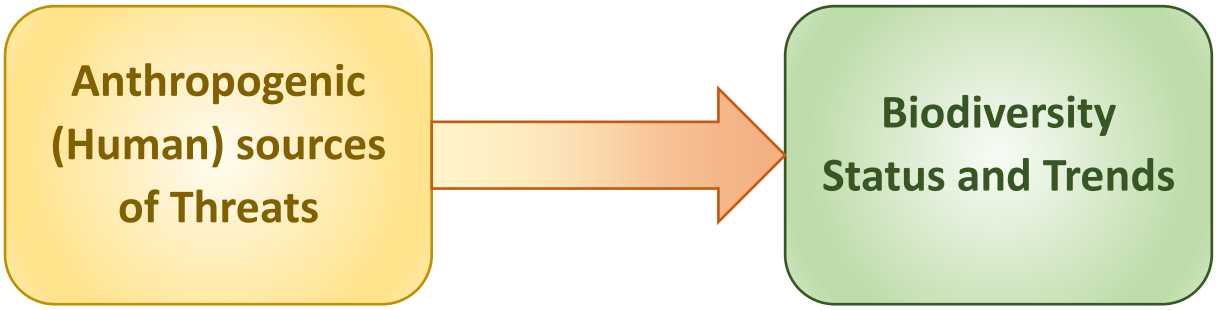

Figure 1: Conceptual framework used for this assessment – adapted from DPSIR model

[14] The IUCN-CMP Threat Classification System can be retrieved here: https://www.iucnredlist.org/resources/threat-classification-scheme

2.2 Data Collection

A preliminary scoping and feasibility exercise was conducted to determine the availability, type, and quality of online data and information to facilitate the desk-based study. Peer-reviewed scientific journals, government reports, global and national datasets, and experts relevant to the study were consulted as the foundation for developing the study methodology.

2.2.1 Biodiversity Status and Trends

A review of relevant published and grey literature was carried out to gather data and information on status and trends of selected biological targets. Field guides, checklists (e.g. Musila et al., 2019 for mammals), peer-reviewed articles, national and county government reports, and global databases (e.g. IUCN Red List of Threatened Species) were all used to compile this section. The IUCN Red List website (IUCN Red List, 2020) was used for data on global species population trends, sizes, and conservation threat status.

2.2.2 Biodiversity Threat Assessment – National Level

To determine threats and their severity impacting biodiversity at the national level in Kenya, the STAR Metric and two expert knowledge-based survey tools (specifically designed for this study) were adopted. These three complimentary methods were used collectively to enhance the richness of threat information. Each one adopted the same threat classification system. The survey tools were designed to capture expert knowledge to address some limitations in the STAR Metric, while also fostering a more collaborative and participatory assessment process. At this stage of its development, one of the main limitations of the STAR metric is the focus on only mammal, bird, and amphibian taxonomic groups. While they are useful surrogates for the terrestrial realm, these taxonomic groups may provide a limited representation of biodiversity restricted to marine and freshwater realms. The only representation of biodiversity within the STAR Metric for the marine realm is through marine mammals and birds, and for the freshwater realm is through amphibians and water birds. Therefore, relying on the STAR Metric alone may not provide an accurate picture of threats impacting marine and freshwater biodiversity, thus survey tools were incorporated into the study methodology.

A. Threat Classification System

Following Salafsky et al., 2008, threats were defined as “the proximate human activities or processes that have caused, are causing, or may cause the destruction, and/or impairment of biodiversity targets (e.g. unsustainable fishing or logging).”

To standardise the threat assessment, a universal language (lexicon) the IUCN–CMP Classification of Direct Threats Version 3.2 (Salafsky et al., 2008), was adopted in this study. This ensured a consistency and comparability with the IUCN Red List of Threatened Species 2020[15] (IUCN RLTS), Key Biodiversity Areas (KBA), and BirdLife's Important Bird Areas (IBA), which all use the same classificiation system (Schultze et al., 2017).

The classification system is hierarchical and structured with three different levels from coarse to fine scale. The first level lists 12 general threat categories (e.g., threat "2. Agriculture and Aquaculture"), subdivided into 45 second-level threat types (e.g., threat "2.1 Annual & Perennial Non-Timber Crops" & "2.2 Wood & Pulp Plantations"). These are further subdivided into third-level threat types (e.g., "2.1.1 Shifting Agriculture") (Salafsky et al., 2008).The classifications are designed to be comprehensive, consistent, and exclusive for the first and second levels. However, the third level is at a much finer scale containing mainly illustrative examples rather than comprehensive listings of threats (Salafsky et al., 2008).

B. Species Threat Abatement and Restoration (STAR)

The STAR Metric measures the contribution that countries, economic sectors, or projects can make within a geographical area to reduce species extinction risk by two factors: either mitigating existing risk factors or assessing contributions of habitat restoration. At this stage of development, STAR uses global species range and threat data for mammal, bird, and amphibian taxonomic groups from the IUCN Red List of Threatened Species to calculate STAR scores. In the near future, other taxonomic groups, such as reptiles, fishes, plants will be included into the computation of the metric. STAR operates on the principle that any change in threats, positive or negative, will lead to changes in the risk of species extinction. STAR measures the potential '*conservation gain*' for species that could be achieved through action taken within a geographical area (site, landscape, corporate footprint, country levels).

STAR considers two complementary site-based actions for species conservation types of action:

1. Threat abatement (stabilization): actions preventing further deterioration in species survival probability (i.e. to prevent further decline in Red List Index).
2. Threat restoration (reversal): actions contributing to the improvement of species survival probability (i.e. to increase Red List Index).

The total STAR score for a site is the sum of the threat abatement and restoration score, which is calculated as:

$$\text{STAR Threat Abatement Score} = \sum (Pc_{\text{Sp}} \times W_{\text{Sp}} \times R_{\text{SpT}})$$

[15] IUCN 2020: The IUCN Red List of Threatened Species Version 2020. http://iucnredlist.org downloaded on 2nd April 2020.

STAR Restoration Score = ∑ (Pr_{Sp} x W_{Sp} x R_{SpT} x M_{Sp})

STAR Total Score = STAR Threat Abatement Score+ STAR restoration Score

Where:

•Pc_{Sp} is the current extent of Area of Habitat (AOH) for species, *Sp* at the site, expressed as a percentage of the total global AOH that was historically available for the species; The historical AOH refers to 1992.

•W_{Sp} is the Red List category weighting of species *Sp* (NT=1, VU=2, EN=3, CR=4).

•R_{SpT} is the relative contribution of threat *T* to the extinction risk of species *Sp*;

•Pr_{Sp} is the extent of restorable AOH (i.e. AOH that has been lost) for species *Sp* at the site, expressed as a percentage of the total global AOH that was historically available for the species.

•M_{Sp} is a multiplier appropriate to the habitat at location i to discount restoration scores. We used a global multiplier of 0.29 based on the median rate of recovery from a global meta-analysis.

STAR threat abatement scores indicate which threats have a high impact on species groups and thereby reveal which threats have the highest potential to make significant contributions to improving species survival if abated. They also only demonstrate the current impact of a threat on biodiversity (mammals, birds, and amphibians) and cannot predict the future impact. To do so, it would be necessary to forecast the changes in threats due for instance to a given development project or a specific land use change. The restoration score indicates the potential contribution from site-based restoration of a habitat could make to improving species survival. An important condition of the restoration component is that for restoration scores to be realised, relevant threats must first be abated at the site. This is to ensure that the restored habitat can viably support the species for which it is being restored.

STAR Metric threat abatement and restoration scores for Kenya were calculated. Only threat abatement scores broken down by each level-two threat were presented in a graph. For the present application, the STAR Metric uses only IUCN-CMP level-two threats.

C. Expert Knowledge-based Survey Tools

Expert-based Threat Assessment Tool (EbTAT)

To assess the impact of direct threats on biological targets (Mammals, Birds, Amphibians, Fish, and Coral Reefs), a detailed Expert-based Threat Assessment Tool (EbTAT) was developed in Microsoft Excel Version 2004. This tool was designed specifically for use by experts who were well-known authorities in Kenya on one or more of the biological targets - henceforth, referred to as 'expert assessors'. The EbTAT allowed expert assessors to identify, rank, and prioritise current and future threats impacting biological targets in Kenya.

In the EbTAT, each of the 12 general threat classes were represented by individual labelled tabs, e.g. “Residential & Commercial Development”. Within each of these 12 general threat class tabs were each respective second and third-level threat types. Tabs representing relevant threats, as listed on the IUCN RLTS, were highlighted in red. Each expert assessor filled out the EbTAT for their respective taxonomic group or ecosystem of expertise.

The EbTAT, accompanied by guidance instructions, was shared by email with 60 expert assessors from academic and research backgrounds. Fifteen expert assessors completed the EbTAT. An additional five experts who were unable to complete the EbTAT provided relevant feedback on threats and resources through unstructured interviews.

Experts identified and assessed the impact of threats to biological targets using a ranking system. For target species, threats were assessed on their contribution to stressors such as reducing populations or degrading habitat, at the taxonomic Class level. For target ecosystems, threats were assessed on their contribution to destroying, degrading, and/or impairing (stressors) all or part of the ecosystem (Salafsky *et al*. 2008; TNC, 2007).

Threat Identification and Ranking

For each target taxon or ecosystem, assessors were asked to 1) assess the relevance of IUCN RLTS global threats to the local Kenyan context, 2) record existing local threats if missing from the RLTS global threat list, and 3) remove irrelevant global-level threats by assigning a ‘not applicable to Kenya’ label. Threats were assessed based on the most proximate factor affecting the target taxon or ecosystem. Less proximate threats were to be regarded as contributing factors and reported in the threat description. This three-step process allowed expert assessors to identify and describe at least 12 direct threats impacting target taxa and ecosystems in Kenya.

Relevant threats were ranked on a scale of Low, Medium, High, and Very High, using The Nature Conservancy’s (TNC) threat ranking system (TNC, 2007). This system was based on ‘contribution’ and ‘irreversibility’. Here, ‘contribution’ was the contribution from a particular threat to population declines and/or habitat degradation of a target taxon, while ‘irreversibility’ was the difficulty of reversing those declines or degredation. An overall threat rank was automatically calculated in the EbTAT based on expert assessor inputs. Each threat was ranked independently of other threats. As a final exercise, expert assessors were requested to identify three (out of their selected 12) threats which they considered to be a priorty for conservation action. Hereafter referred to as ‘priority threats’, while those with overall ranks of either ‘Very High’ or ‘High’ are referred to as ‘severe threats.’

The overall threat ranks generated through the EbTAT for level-two and level-three threats per target taxon and ecosystem were consolidated into a table. These were presented in twelve tables under the level-one threat classification headings. Here, threats which were attributed differing ranks by more than one expert assessor were starred, but only the highest rank was presented in the report tables. Using the descriptions of threats reported by expert assessors, the impact of each threat was determined to be current, emerging, or future.

Simplified Threat Assessment Tool (STAT)

As a complementary system to the EbTAT, a Simplified Threat Assessment Tool (STAT) was developed which did not require in-depth knowledge of taxonomic groups thus making it more accessible to government, private sector, and NGO assessors. This enabled a more inclusive threat assessment process allowing a wider range of stakeholders to be involved. The STAT was shared by email with 20 assessors from key government, private sector, and NGO stakeholders (which included some IUCN members), out of which nine completed the assessment.

In the STAT, assessors were requested to identify a maximum of 12 level-two threats impacting biodiveristy (species and ecosystems) in Kenya. The STAT did not include the third level of threats from the classification system. Assessors were also asked to indicate their top three (of their selection of 12) threats they perceived as having the greatest impact on biodiversity in Kenya. Each assessor completed one assessment using the STAT. The feedback from the assessments was consolidated and presented in a graph based on the percentage frequency each level-two threat was a) identified as a threat, and b) was considered a top threat by assessors. The frequency was calculated as the number of times assessors selected a specific threat.

2.2.3 Biodiversity Threat Assessment – County Level

Kenya has 47 counties, a large number of which are data deficient. Using STAR Metric threat abatement and restoration maps (Figure 2) areas with the highest potential for threat abatement and restoration were identified. Of these, two counties which included Taita Taveta and Nyandarua were selected as case studies. Published and unpublished literature was reviewed to determine the status and trend of threats affecting biodiversity in the two county case studies. Counties identified as priority richness and abatement hotspots and those that had supporting data were selected as case studies.

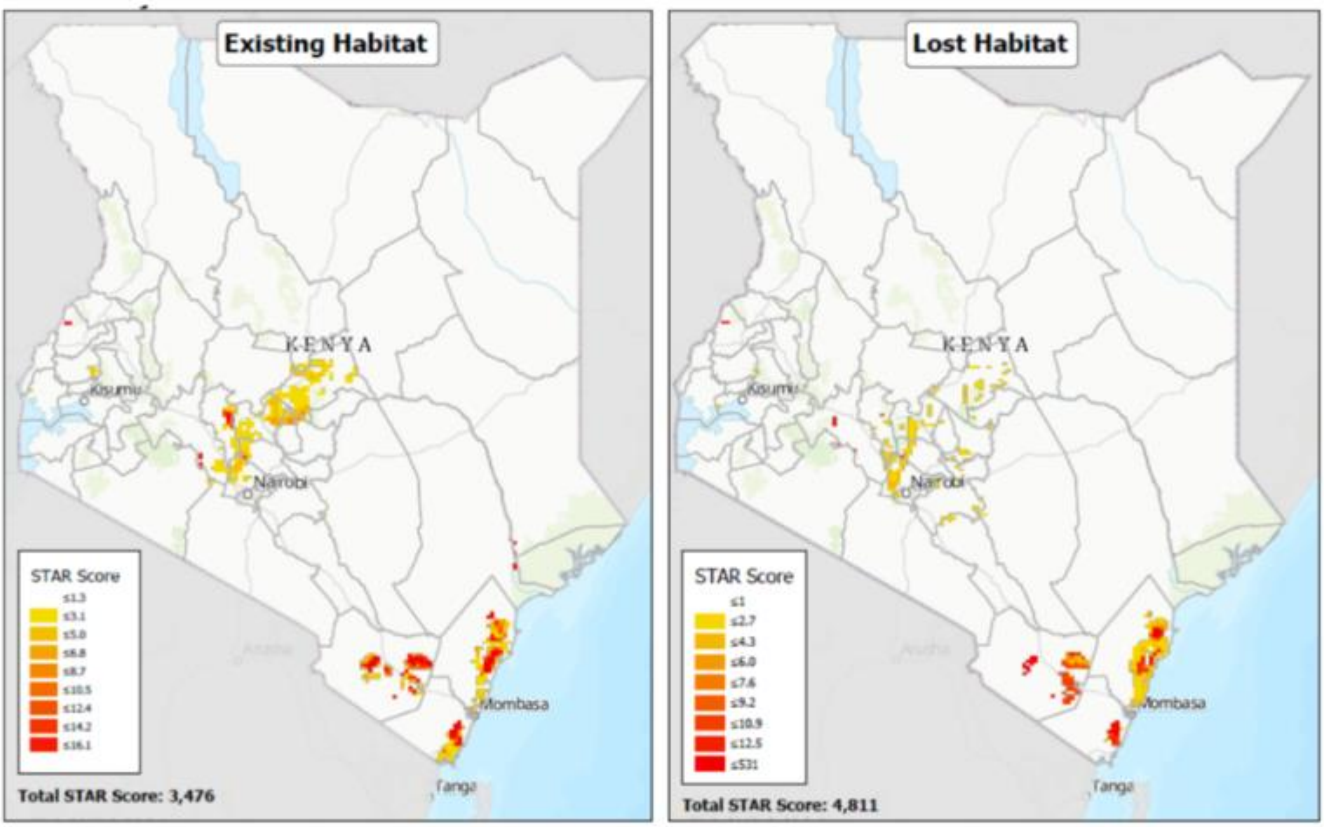

Figure 2: Mapped STAR Scores for Kenya showing threat scores per grid cell (left) and restoration scores per grid cell (right) at the 10km resolution.

3. Biodiversity Status & Trends

3.1 Scope of the Assessment

The study site, Kenya, is located within latitudes 4° 40' to the north and 4°20' to the south, sharing a common border with Tanzania, Uganda, South Sudan, Ethiopia, and Somalia (Kiringe and Okello, 2007). Kenya has a coastline that extends for 640 kms (Kimani et al., 2018) from the Kenya-Somalia border in the north (1.7°S; 41.5°E) to the Kenya-Tanzania border in the south (4.7°S; 39.2°E). It has an Exclusive Economic Zone (EEZ) covering 163,577.6 km² (Marineregions, 2020), extending 200NM outward from the shore. The administrative division and governance of Kenya has been devolved to county level since the new constitution was implemented in 2010, delineating 47 counties across the country (Figure 3).

Figure 3: Kenya boundary delineating 47 counties. *Source*: (Lewis 2016[16]).

[16] http://www.geocurrents.info/cartography/customizable-maps-kenya-ghana-ethiopia-belgium-south-korea/attachment/kenya-county-names-map

Kenya is a country with a rich and diverse array of natural resources (Figure 4). The mosaic of vegetation and soil types, topography, and climate have contributed to the rich floral and faunal diversity (Ogutu et al., 2016). Major landscape features like the Great Rift Valley, the Mau Escarpment, Aberdare Ranges, and Mounts Kenya and Elgon add to this diverse natural landscape (Western et al., 2009). Human activities over centuries have also shaped Kenya's natural environment (MEWNR, 2015). The interactions between people, plants, and animals have modified coral-reefs, grasslands, forests, and wetlands, perhaps more than any other ecosystem.

To effectively conserve this diverse natural capital, understanding the status and trends of biodiversity and ecosystem services is imperative. However, despite considerable resources being invested into monitoring since 1977 (Ogutu et al., 2016), quantitative data is either lacking or being poorly utilised to clearly demonstrate trends at the national level. A disparity in data also exists within and between taxonomic groups and ecosystems, with some being very well-studied while others remain poorly understood.

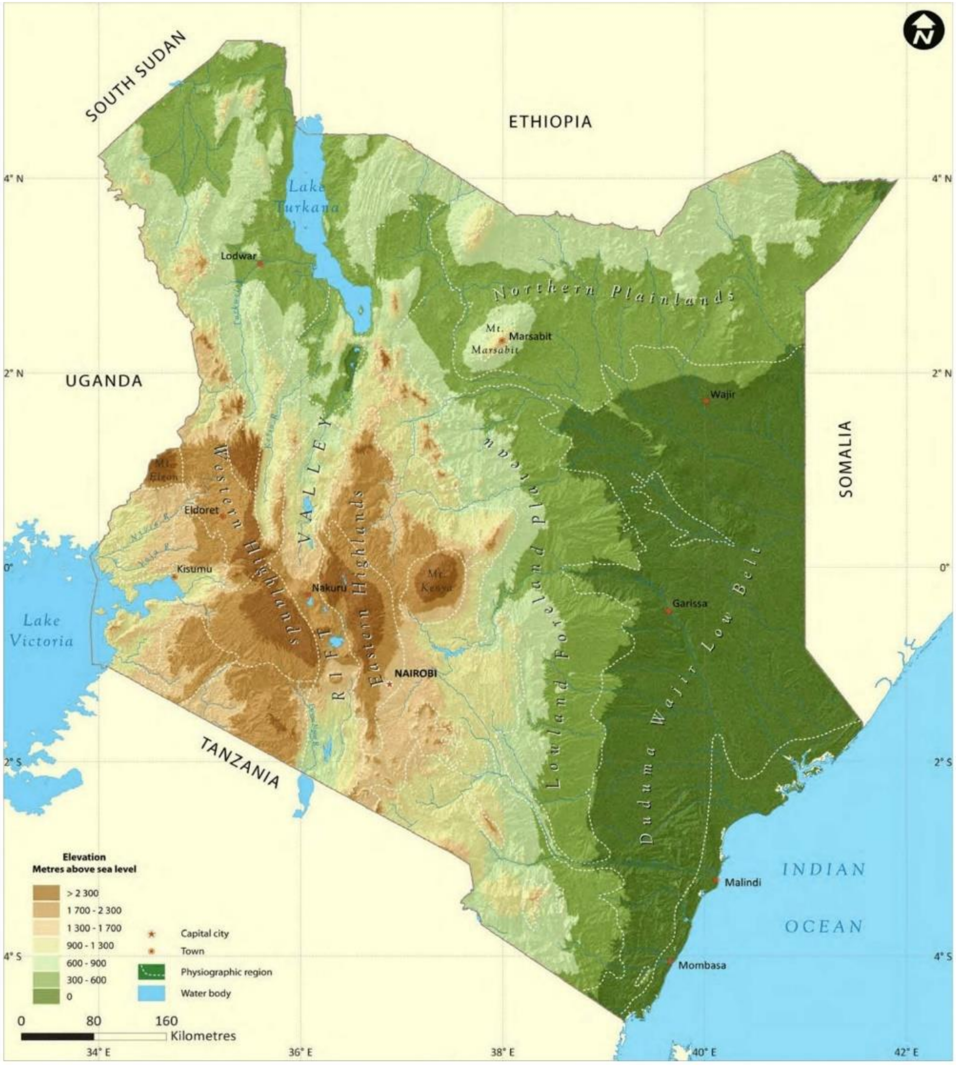

Figure 4: The physical landscape of Kenya. Source: DRSRS in (MEWNR, 2015).

3.2 Ecosystem Approach and Ecological Zones

3.2.1 Ecoregions

Ecoregions are commonly used ecological zones in biodiversity conservation planning and priority setting (Sayre et al., 2000 cited in Rao et al., 2007). Over 50% of the global coverage of four ecoregions are represented within Kenya. Dominated by Northern Acacia-Commiphora bushlands and thickets (Figure 5), Kenya hosts 81.4% (264,178 km²) of the total global coverage and over 95% (95,603 km²) of the entire global coverage of Masai xeric grassland and shrubland. Despite less than 3% of the Eastern Arc Forests being represented in Kenya, they harbour some of the richest biodiversity and endemism in the country.

3.2.2 Realms, Biomes, and Ecosystems

Kenya has a large diversity of ecosystems within the marine, terrestrial, and freshwater biosphere realms. However, a universally recognised system of ecosystem classification has not been adopted in Kenya, with differences found in multiple sources. In the same way that the classification of species through taxonomy is important, so too is a standardized, consistent, and spatially explicit typology and terminology for the "ecosystem" component of biodiversity (Keith et al., 2020).

The National Biodiversity Strategy and Action Plan (NBSAP) published in 2017, lists major 'natural' ecosystems of Kenya as forest, woodlands, shrublands, grasslands, deserts, and wetlands. The Fifth National Biodiversity Report published in 2015, lists an additional four ecosystems which include montane, afro-alpine, lakes and rivers, and marine. A finer scale and more accurate representation of marine and coastal ecosystems are presented in the State of Coast Report published in 2017 as sand dunes and sandy beaches, mangrove, estuary, seagrass, and coral reef (Government of Kenya, 2017). Human ecosystems were listed as cropland and urban areas (Government of Kenya, 2015).

The IUCN Global Ecosystem Typology V1.01 splits ecological zones into a hierarchy, from coarse (realms and biomes) to fine scale (ecosystem functional groups) (Keith et al., 2020), which can be applied to Kenya. Using geographic distribution maps and zone descriptions provided in the typology publication, Kenya can be classified into nine realms, 22 biomes, and 55 ecosystem functional groups (Appendix A).

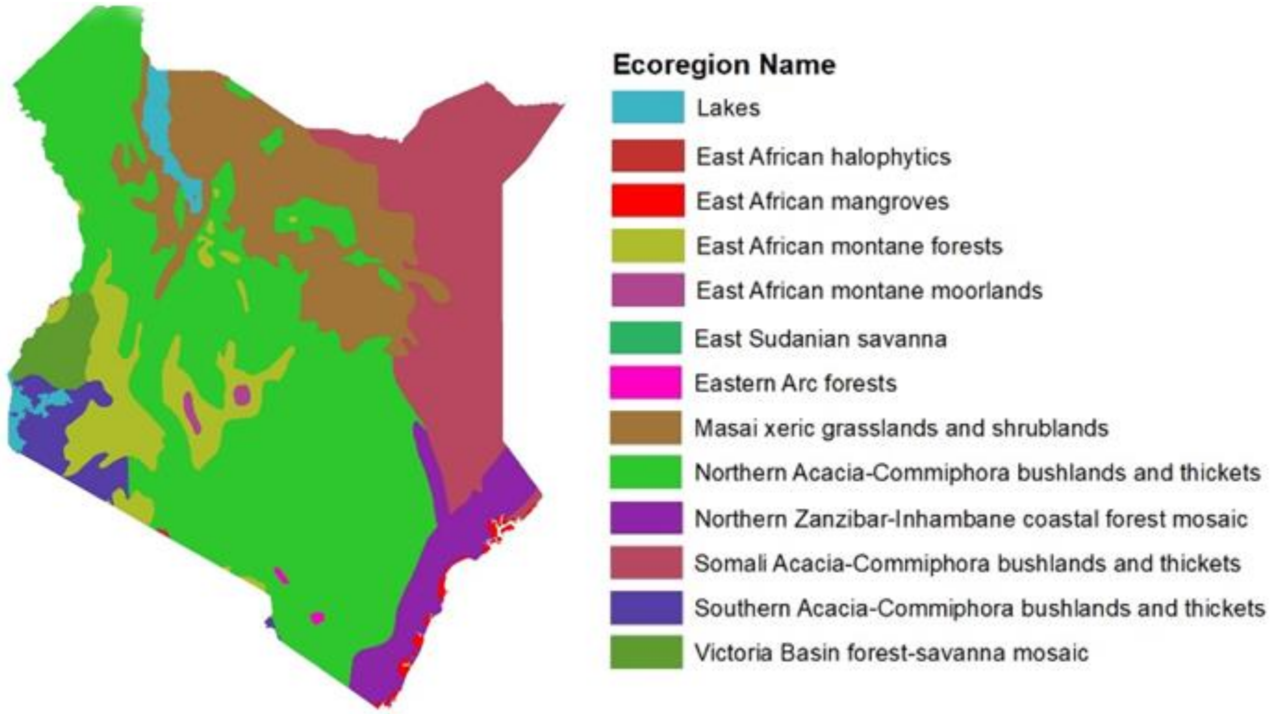

Figure 5: Global terrestrial ecoregions represented in Kenya. Source: (BIOPAMA, 2019; Dubois et al., 2018; Spalding et al., 2007; Olson et al., 2001) http://dopa-explorer.jrc.ec.europa.eu/

A. Terrestrial Realm

Around 85% of Kenya's terrestrial landscape is rangeland (Ogutu et al., 2016) or arid and semi-arid lands (ASALs), encompassing many biomes from grassland to semi-desert (Keith et al., 2020). Rangeland landscapes are dominated by grasslands covering over 47% of Kenya's land area (MEWNR, 2015) and support considerable densities of large mammals, birds, and invertebrates (Tyrell et al., 2019). Maasai Mara, the most well-known grassland in Kenya, is a trophic savanna functional ecosystem (Keith et al., 2020). Kenya's high-altitude grasslands extending from Mt. Kenya in the east to Mt. Elgon in the west, such as those of the Kinangop Plateau, have declined by 90% over 20 years. Only 16% remains suitable for habitat specialists such as the Sharpe's Longclaw (BirdLife International Africa, 2014). National-level coverage and trend data for grassland ecosystems was difficult to obtain despite how extensive grasslands are in Kenya. Around one percent of Kenya's land area is categorised as desert (Government of Kenya, 2015) which includes the Chalbi and Dida Galgalu Deserts, both of which are hyper-arid. (Keith et al., 2020).

Kenya's forests, particularly Kakamega, Mt Kenya, Tana, Taita Hills, and Arabuko-Sokoke, are highly biodiverse and host large numbers of endemic species (Peltorinne, 2004). The Kakamega Forest, a designated Key Biodiversity Area (KBA), is the easternmost remnant of a once continuous Guineo-Congolian rainforest belt (Schick et al., 2005) which harbours close to 100 endemic species (NEMA, 2012). The cloud forests of Taita Hills are among the 34 global biodiversity hotspots owing to their high species endemism, however less than 1,000 ha remain as isolated and fragmented forest patches (Rogo & Oguge, 2000; Pellikka et al., 2013). Kenya's coastal forests are an important 'vanishing refuge' for endemic species of plants, mammals, birds, reptiles, frogs, butterflies, snails, and millipedes, concentrated in the lower Tana River, Arabuko-Sokoke, Shimba Hills (Burgess et al., 1998). The forests of Mt Elgon, Mau, Cherangani Hills, Aberdare Range, and Mt. Kenya, Kenya's five main water towers, provide 75% of the country's water (Kenya Forest Service, 2016). Kenya's forests are also critically important natural resources for the agriculture and tourism sectors, though these activities have added significant pressures on forest ecosystems. Despite the heavy influence of farming and herding practices, they still primarily contain indigenous species (Peltorinne, 2004).

In 1995 it was estimated that only 1.24 million ha of closed canopy indigenous forest was left of the estimated original cover of 6.8 million ha (Wass, 1995). Between 1995 to 2015, it was estimated that 25% (824,115 ha) of total forest cover was lost in Kenya at a rate of 33,000 ha a year (WWF, 2020). However, focusing on humid primary forest, an estimated 42,000 ha was lost between 2002 to 2019, with an estimated 600,000 ha of primary forest remaining (Global Forest Watch, 2020). Total tree cover (not only primary forest) in Kenya is estimated to be 2.7% (3.5 million ha) of the total land area (Government of Kenya, 2017).

B. Freshwater Realm

Freshwater and saline ecosystems, which include lakes, rivers, wetlands, and estuaries (Keith et al., 2020), cover approximately 8% of Kenya's surface area. Kenya's five major river basins are: Lake Victoria, Rift Valley, Athi River, Tana River and Ewaso Ngiro basins (FAO, 1992). Kenya has nine large permanent lakes and over 30 small, ephemeral, or episodic ones. Naivasha, Baringo, and Victoria are large permanent freshwater lakes, while Turkana is semi-freshwater. The remaining large permanent lakes are sodic. Almost 90% of the total fish catch from Kenya is landed at Lake Victoria, providing food to a large portion of the population (Kiman et al., 2018). Kenya has six wetland types (MEMR, 2012) which cover between 3 – 4% of the country's land area (MEWNR 2015). Wetlands are important habitats for many wild species and contribute to key economic sectors such as agriculture, livestock, fisheries, and energy (MEMR, 2012), however they are disappearing rapidly (Harmsen, 2018).

C. Marine Realm

Marine ecosystems in Kenya provide an annual estimated value of US$ 2.5 billion to the national economy (Obura et al., 2017a, Gudka et al., 2018). Mangrove ecosystems cover an estimated 47,000 - 61,271 ha (Government of Kenya, 2017b) with an annual total economic value estimated at KES 269,450 per ha. They provide a myriad of important ecosystem services such as flood protection and nursery grounds for fish. Despite this, there has been a decline in mangrove coverage by 17.5% over

24 years particularly in Kilifi and Tana River Counties (Government of Kenya, 2017b). Seagrass meadows cover approximately 33,600 ha extending along the entire coastline and are comprised of 12 species of seagrass. They serve as primary food sources for several Endangered marine species. Although it is clear that the seagrass ecosystems are undergoing degradation, the extent of the damage has not been quantified. Coral reefs cover an area of 639 km², found along two-thirds of Kenya's coastline either as fringing reefs or reef patches, with breaks at the mouths of Tana and Sabaki Rivers. They are among the most productive ecosystems with a high diversity of coral and fish assemblages. Coral reefs have been severely impacted by coral bleaching events over the last two decades. Since the first severe bleaching event in 1998, hard coral cover has experienced slow recoveries to 25% cover (Obura et al., 2017b). Many marine and coastal ecosystems sustain tourism activities, while marine fisheries are an important food source and economic activity for coastal communities (Government of Kenya, 2015; Government of Kenya 2017a).

3.3 Biological Target: Ecosystem

3.3.1 Coral Reef Status and Trends

Coral reefs are some of the most biodiverse ecosystems in Kenya and the Western Indian Ocean, providing a multitude of ecosystem goods and services through fisheries, tourism, and cultural heritage (Obura, 2012, Obura et al., 2017b). They extend along almost the entire 640km coastline (FAO, 2015; Kimani et al., 2018) and consist of the southern fringing reefs and the northern patchy reefs (Obura et al., 2017b). The southern fringing reefs which extend from Malindi to the border of Tanzania are more biodiverse than the northern reefs which extend from Lamu to the border of Somalia. The highest coral diversity is found at Kisite-Mpunguti Protected Areas (PAs) in the south (Obura, 2012), partly due to lower anthropogenic disturbance (Muthiga 2009 cited in Government of Kenya, 2017b). Coral reefs are some of the most well-studied and consistently monitored ecosystems in Kenya (Gudka et al, 2018), however prior to 1998, there is limited information about their status.

Between 1995 – 1997, Kenya had around 28% coral cover, slightly lower than what was found in the rest of the Western Indian Ocean Region (McClanahan et al., 2007 and Atewerbehan et al., 2011 cited in Government of Kenya 2017b; Obura et al., 2017b). In 1998 a mass bleaching event occurred, with subsequent extensive coral cover losses, resulting in a reduction in coral cover from 28% to 8%. Some reefs lost between 50% – 90% of their living corals (Gudka et al, 2018). Recoveries of coral cover between 1999 - 2003 were slow and remained at low levels (8-10%). By 2016, coral cover had significantly improved to 18% (Obura et al., 2017b). In general, coral reefs within PAs had higher hard coral cover (40%) compared to open access areas outside of PAs (Government of Kenya, 2017b). Climate-related coral bleaching events have increased in their duration and frequency since 1998, occurring in 2002, 2005, 2010 and 2016. The strongest bleaching event to affect Kenya happened between January and May 2016. Despite this, less than 10% of reefs showed high or extreme bleaching (Gudka et al., 2020). The greatest impact on reefs was in Malindi and Shimoni, while the biggest losses of coral were in Lamu (51%) and Mombasa (10%) (Gudka et al., 2018).

3.4 Species Approach - Flora and Fauna

Kenya boasts a highly diverse and rich flora and fauna of global importance, represented within six kingdoms of life: Bacteria, Protozoa, Chromista, Fungi, Animalia, Plantae (Cavalier-Smith, 2004). Animalia (animals) and Plantae (plants) are perhaps the two most well-studied kingdoms in Kenya. The most comprehensive collection of information on Kenya's biodiversity to date is from the Biodiversity Atlas of Kenya (L. Njoroge 2020, personal communication 21 July). Individual checklists for select taxa from Kenya provide either more up-to-date or more accurate data.

Close to 60% of Africa's floral diversity is represented in Kenya by at least 7,004 species, comprising 1,720 genera, across 240 families (MEWNR, 2015). Kenya's faunal diversity is overwhelmingly dominated by invertebrate species, although they are very poorly known or studied (D. Martins 2020, Personal Communication, 22nd July). An estimated 25,000 species of invertebrate occur in Kenya (MEWNR, 2015). However, this is likely to be an underestimate (L. Njoroge 2020, personal communication 21 July) especially considering sub-Saharan Africa has approximately 100,000 insect species (Miller & Rogo, 2001), excluding all other invertebrates. Insects are the most diverse group of invertebrates (MEWNR, 2015). For the purpose of this study we focus on Animalia, otherwise known as fauna.

Kenya has between 2,528 (MEWNR, 2015) and 3,206 vertebrate species (Seeger et al., 2003; Anam & Mostarda, 2012; Spawls et al., 2014; FishBase, 2019; Musila et al., 2019; Spawls et al., 2020; IUCN Red List, 2020).

Birds, mammals, amphibians, and fish are some of the most well studied vertebrate groups in Kenya but even among these groups, new species previously unknown to science are still being discovered today (MEWNR, 2015). As well-known taxonomic groups make good surrogates for biodiversity (Lentini & Wintle, 2015; Margules & Sarkar, 2007; Sarkar et al., 2005; Wang, McShea, Li, & Wang, 2018 cited in Lindenmayer et al., 2015), in Kenya these four groups are suitable representatives of terrestrial, marine, and freshwater biodiversity. Understanding the survival probability of species within these taxonomic groups would provide an insight into the status and trends of biodiversity in Kenya. This understanding is important to fully conceptualise the impact of threats facing biodiversity in Kenya today and into the future.

Using the IUCN Red List Index (RLI)[17], it is possible to observe the survival probability for birds, mammals, amphibians, corals, and cycads. The RLI for Kenya demonstrates an overall downward trend or decrease in survival probability from 1993 (0.87) to 2020 (0.79) for these five species groups (Figure 6). The IUCN RLI includes classes such as cycads and corals that are not included as biological targets in this study, although corals are represented through coral reef ecosystems. To gain insights on how mammal, bird, amphibian, and fish biological targets are impaired by threats acting on them, the population trends and conservation status of species within each of these vertebrate classes are assessed further.

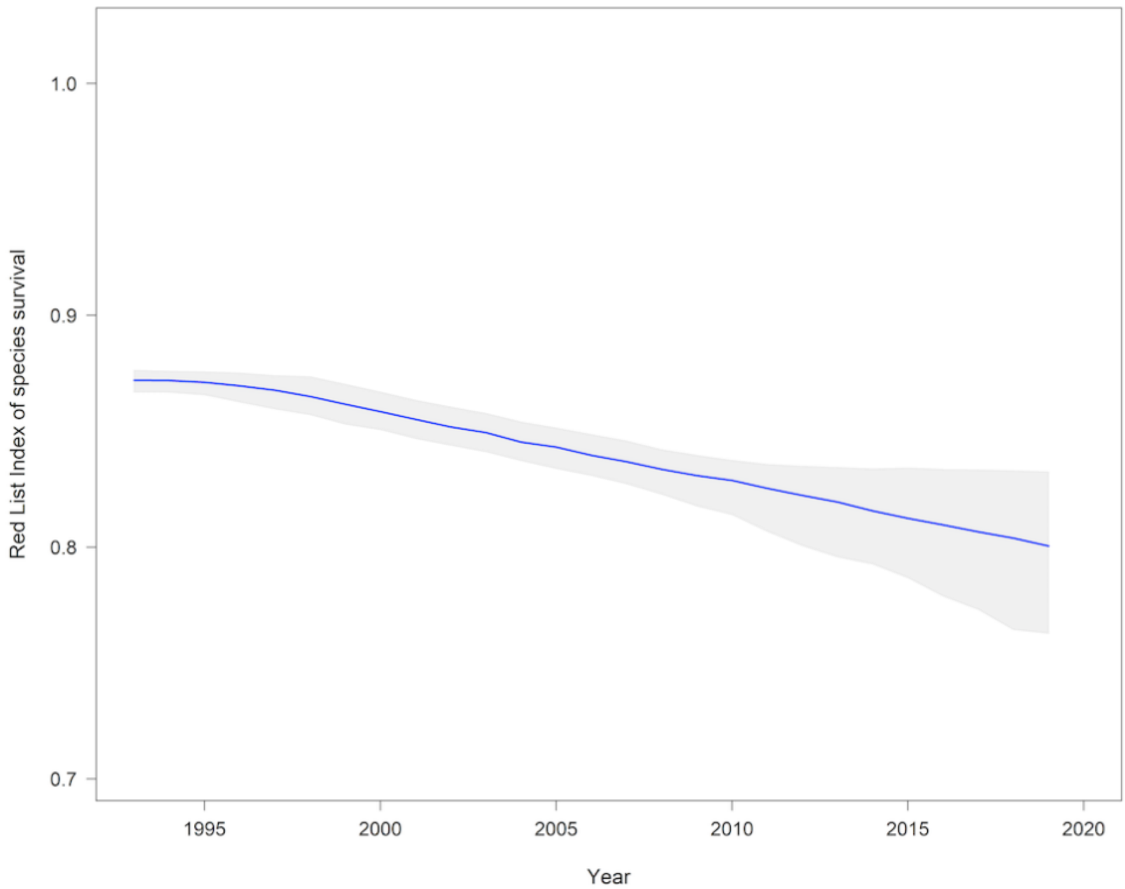

Figure 6: Red List Index of species survival for Kenya, weighted by the fraction of each species' distribution occurring within the country. Grey shading shows 95% confidence intervals, where relevant. The index varies from 1 to 0.

[17] For further information on RLI visit http://www.iucnredlist.org/about/publication/red-list-index.

3.4.1 Biological Targets: Taxonomic Groups

A. Mammals - Status & Trends

Mammal species richness in Kenya is comparatively high for Africa with 390 to 405 species described, depending on the source and nomenclature (MEWNR 2015; Musila et al., 2019; IUCN Red List, 2020; IBAT, 2020). An annotated checklist of Kenyan mammals published in 2019 provides the most comprehensive information, describing 390 (220 small and 170 large) species within 16 orders (Musila et al.,2019; Table 1). The highest mammalian species richness occurs along the coastal belt, the central and western highlands, and the southern border (Tyrell et al.,2019; Figure 7). Kenya has 21 endemic species, of which there are nine rats and two mice (Rodentia), six shrews (Soricomorpha), two monkeys (Primata), one sengi (Macroscellidea), and one bat (Chiroptera; Table 2). Narok county hosts approximately 30% of Kenya's large mammal populations (Ogutu et al., 2016). Only 41% of mammal species were adequately represented within the existing protected area network of Kenya (Tyrell et al., 2019). Very little is known about the conservation status and population of the species within the orders Rodentia and Chiroptera. Even some of the more well-known large mammal species lack data on status and trends at the national and county level (Ogutu et al., 2016). Of the mammal species found in Kenya, 41 are threatened (IBAT, 2020), while 91 species are experiencing declines in their global populations (IUCN Red List, 2020).

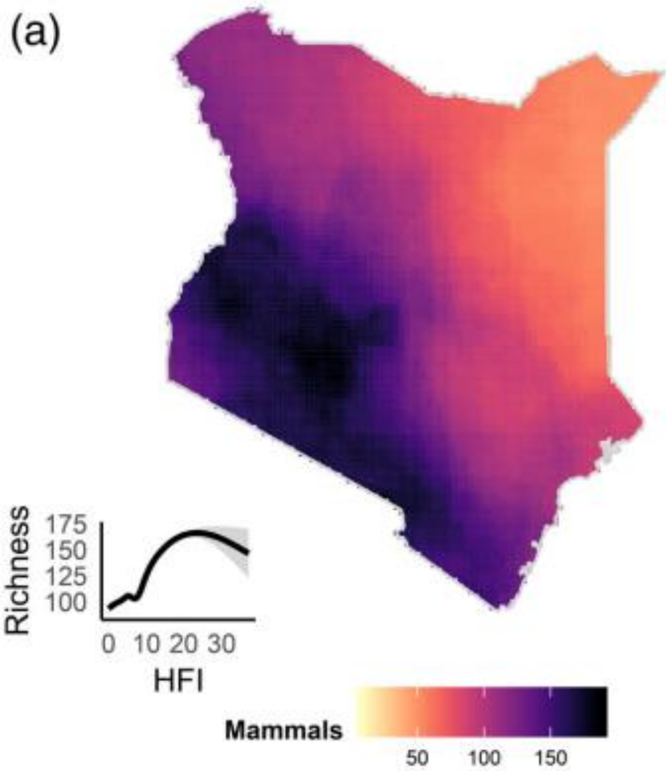

Figure 7: Mammal species richness in Kenya (Tyrell et al., 2019).

The orders with the highest species richness in Kenya are Rodentia and Chiroptera, each with over 100 species, however little is known of/about most of these small mammals. Kenya has 36 species of carnivore of which 15 are facing declines in their global populations and six are threatened (IUCN Red List, 2020). The most threatened carnivore in Kenya is the African Wild Dog with less than 900 individuals recorded (Appendix B). Of the 18 primate species found in Kenya, excluding *Homo sapiens,* 10 are experiencing declines in their global populations. The Tana River Red Colobus (*Piliocolobus rufomitratus)* and the Tana River Mongabey (*Cercocebus galeritus)* are the most threatened primates in Kenya (Musila et al., 2019; Appendix C). Both are endemic species and both have populations of approximately less than 1,000 individuals (IUCN Red List, 2020). Kenya has three species of pangolin belonging to the order Pholidota and family Manidae. The global populations of all three are in decline (IUCN Red List, 2020). Two (*Smutsia gigantea* and *Phataginus tricuspis*) are Endangered and occur in Western Kenya, while *Smutsia temminckii* listed as Vulnerable, has a much wider distribution (Musila et al., 2019).

There are 67 species of marine and terrestrial ungulates in Kenya from two orders (Perissodactyla and Cetartiodactlya) of which 31 are experiencing global population declines and 8 are threatened (Appendix D, E, and F).

The Hirola is a Critically Endangered antelope from the order Cetartiodactyla, endemic to south-east Kenya and south-west Somalia. It is the most threatened antelope in the world having declined by 95% over the last four decades (Butynski 2000, Probert et al., 2015; Ali et al., 2019). Less than 250 are estimated to survive in the wild, occupying less than 5% of their historic range on the Kenya-Somalia border (IUCN, 2017, Ali et al., 2019). Conservancies account for 90% of their population in Kenya (KWCA, 2016), with approximately 20 – 25% (191 – 131 individuals) found in Ishaqbini Hirola Sanctuary (NRT, 2019). Also, from the same order is the Roan Antelope (*Hippotragus equinus*), another highly threatened antelope with an estimated population of only 17 individuals left in the wild in Kenya. Other highly threatened Cetartiodactlya include Sable Antelope, Bongo, Sitatunga, and Greater Kudu, all with estimated populations lower than 700 individuals. Of the four Kenyan species belonging to the order Perissodactyla, the Grevy's Zebra and Black Rhino are threatened with extinction, however significant conservation efforts are leading to increases in the global populations of the latter.

Between 1977 and 1997, large terrestrial mammal populations in Kenyan national parks declined by 48% (Western et al., 2009). Over the same period, resident mammal populations declined by 58% in Maasai Mara National Reserve (Ottichilo et al., 2000) and this trend continued into 2009 (Ogutu et al., 2011). Similar declines are evident outside of government PAs, where almost 70% of Kenya's wildlife resides (Ottichilo et al., 2000; Ogutu et al.,2016). Between 1977 to 2016, large mammal populations declined by 68% across 17 rangeland counties (Ogutu et al., 2016). The steepest declines

(72 – 88%) were of Common Warthog, Lesser Kudu, Thomson's Gazelle, Eland, Oryx, Topi, Hartebeest, Impala, Grevy's Zebra, and Waterbuck. In contrast, Taita Taveta, Laikipia, Garissa and Wajir showed moderate to small increases in wildlife populations (Ogutu et al., 2016).

There is limited data on the status and trends of marine mammals off the coast of Kenya (Kiszka et al., 2009). However, the Kenya Marine Mammal Network, between May 2011 and September 2013, recorded a total of 681 sightings of 12 marine mammal species, including one Dugong (Government of Kenya, 2017b). The most sightings were from Watamu and Malindi (n=364), followed by Diani to Pemba (n=305). Indo-Pacific Bottlenose and Humpback Dolphins have been reported as resident along parts of the coast (Kiszka et al., 2009).

The only living species in the family Dugongidea is the Dugong (*Dugong dugon*) which is listed as Vulnerable on the IUCN Red List however, the last assessment was conducted in 2015 (Appendix G). A species abundant in the 1960s, Dugongs were sighted in a group of close to 500 individuals around Kenya's south coast in 1967 (Kiszka et al., 2009; Muir et al., 2012 &Husar, 1975 as cited in Government of Kenya, 2017b). Since the mid-1970s they have significantly declined with sightings down to only one or two individuals in 2016 (Government of Kenya, 2017b; MoTW, 2018). The Lamu archipelago, in particular around Kiunga, still supports some individuals (Kiszka et al., 2009).

Table 1: Orders and families of Mammal Species in Kenya

	Order	No. of Families	No. of Species
1	Primates (Non-human)	3	18
2	Chiroptera (Bats)	9	104
3	Afrosoricida (Tenerecs, Golden Moles)	2	3
4	Macroscellidea (Sengis)	1	5
5	Tubulidentata (Aardvark)	1	1
6	Hyracoidea (Hyraxes)	1	4
7	Proboscidea (Elephant)	1	1
8	Soricomorpha (Shrews)	1	36
9	Erinaceomorpha (Hedgehog)	1	1
10	Pholidota (Pangolins)	1	3
11	Sirenia (Dugong)	1	1
12	Perissodactyla (Odd-toed Ungulates)	2	4
13	Cetartiodactyla (Even-toed Ungulates)	4	63
14	Carnivora (Carnivores)	7	36
15	Lagomorpha (Hares)	2	3
16	Rodentia (Rodents)	11	106
	TOTAL	48	389

Source: Table adapted from (MEWNR, 2015) and populated with Data from (Musila et al., 2019).

Table 2: Endemic Mammal Species in Kenya and their Conservation Status.

	Species	IUCN Red List Status	Population Trend
1	Golden-Rumped Giant Sengi *(Rhynchocyon chrysopygus)**	EN	Decreasing
2	Tana River Red Colobus (*Piliocolobus rufomitratus)***	CR	Decreasing
3	Tana River Red Mangabey *(Cercocebus galeritus)*	EN	Decreasing
4	Mianzini Root-Rat *(Tachyoryctes annectens)*	NA	NA
5	Kenyan Root Rat *(Tachyoryctes ibeanus)*	NA	NA
6	King Root-Rat *(Tachyoryctes rex)*	NA	NA
7	Embi African Root Rat *(Tachyoryctes spalacinus)*	NA	NA
8	Short Snouted Thicket Rat *(Grammomys brevirostris)*	DD	Unknown
9	Giant Thicket Rat *(Grammomys gigas)*	EN	Unknown
10	Endorobo Wood Mouse *(Hylomyscus endorobae)*	LC	Unknown
11	Kerbis-Peterhans' Wood Mouse *(Hylomyscus kerbispeterhansi)*	LC	Unknown
12	Dollman's Vlei Rat *(Otomys dollmani)*	NA	NA
13	Afroalpine Vlei Rat *(Otomys orestes)*	NA	NA
14	Thomas' Vlei Rat *(Otomys thomasi)*	NA	NA
15	Smoky White Toothed Shrew *(Crocidura fumosa)*	LC	Decreasing
16	Nyiru Shrew *(Crocidura macowi)*	DD	Unknown
17	Rainey's Shrew *(Crocidura raineyi)*	DD	Unknown
18	Ultimate Shrew *(Crocidura ultima)*	DD	Unknown
19	Aberdare Mole Shrew *(Surdisorex norae)*	LC	Stable
20	Mt Kenya Mole Shrew *(Surdisorex polulus)*	DD	Stable
21	Kenya Butterfly Bat *(Glauconycteris kenyacola)*	DD	Unknown

Source: Musila et al., 2019; IUCN Red List, 2020; *Estimated population is at 13,000 adults, all others are unknown (IUCN Red List, 2020); **Treated as a valid species and separate genus by Kivai et al., 2018 cited in Schwitzer et al., 2019, Butynski et al., 2020, and the IUCN RLTS, while treated as a subspecies of *Procolobus rufomitratus* by Musila et al., 2019.

B. Birds (Avifauna) – Status & Trends

The avian diversity in Kenya is among the highest in Africa owing to the mosaic of habitats ranging from semi-arid scrub to montane forest (Fanshawe and Bennun, 1991, Muriuki et al., 1997) and Congo-Guinean rainforests (Bennun et al., 1996). The number of bird species (including migrants and vagrants) described in Kenya ranges from 1121 to 1187, belonging to 28 orders and 104 families (Lapage 2018, 2019 & 2020; IUCN Red List, 2020) depending on the source and nomenclature (Table 3). The highest avian species richness occurs in the central and western highlands and the semi-arid southern border (Tyrell et al., 2019) with Tanzania (Figure 8). In the absence of a national Red List for birds of Kenya, data on species population trends from the IUCN Red List of Threatened Species are the most robust and accessible. Although the data provides a list of species occurring in Kenya, the population trends described for each species is at the global rather than national level, thereby only reflecting local trends for endemics.

Overall, population trends (at the global level) for 698 species occurring in Kenya are either stable or increasing, however populations of 354 species, or approximately 32%, are on the decline. According to the records of the Nature Kenya Bird Committee, Kenya is home to nine endemic bird species (Table 4), and three introduced species (Lapage, 2018 & 2019). It should be noted that other sources list up to 13 total endemic species for Kenya. Nine species of bird are known to be locally extinct in Kenya, (Table 5). With more than 40 threatened (6 CR; 16 EN; 26 VU) bird species (IUCN Red List, 2020), Kenya is an important country for avian conservation at both national and global levels (Fanshawe and Bennun, 1991).

The East Asia/East Africa major flyway and the Mediterranean/Black Sea Flyway, used by migrating passerines, water birds, and birds of prey, (three of the most diverse groups of birds) fly through the Kenyan Highlands and the coastline (BirdLife International, n.d).

Passeriformes, or 'Passerines', are the most diverse taxonomic order of birds represented in Kenya. Of the 500 plus species, six have become locally extinct (Table 5), while global populations of 129 species which occur in Kenya are declining. All nine Kenyan endemics are passerines, of which Taita Apalis (*Apalis fuscigularis)* and Taita Thrush (*Turdus helleri*) are Critically Endangered and facing unprecedented population declines (Table 4). In total, there are 16 threatened[18] passerines in Kenya.

The second most diverse group of birds in Kenya, with 112 species, belong to the order Charadriiformes (shorebirds and waders), out of which 47 species are experiencing declines in their global population. In Kenya, the Madagascar Pratincole (*Glareola ocularis)* is the most threatened (VU) within this group.

[18] This study follows the IUCN Red List of Threatened Species definition of 'Threatened' which includes species listed as CR, EN and VU.

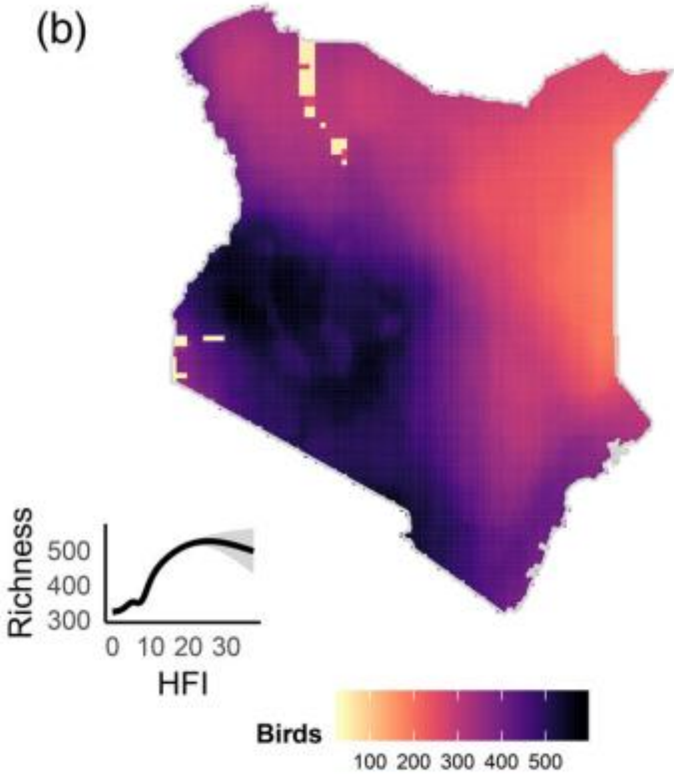

Figure 8: Bird (Avifauna) Species Richness in Kenya (Tyrell et al., 2019).

The most threatened group of birds in Kenya are birds of prey, or raptors, belonging to the orders Accipitriformes, Strigiformes, and Falconiformes. There are 18 species of owl (Strigiformes), in Kenya (Lapage, 2020) and 57 diurnal breeding birds of prey (Accipitriformes and Falconiformes) (Appendix H). Of the latter, vultures account for 7 of the 11 threatened species, four of which are Critically Endangered and two are Endangered (Appendix H). Global populations of all 11 threatened birds of prey are declining.

Over the last 19 years, the African Waterbird census has occurred annually in Kenya's Southern Rift Valley. Lakes Naivasha, Elementaita, and Nakuru were monitored consistently since 1991, and Lake Bogoria since 1992. This bird monitoring programme is one of the longest running in the country and provides reliable data on trends in waterbird numbers. Bennun and Nasirwa, 2000, reported declines for grebes, pelicans, cormorants, storks, gulls, rallids, kingfishers, terns, and raptors from all the sites when reviewing a long-term dataset. Between 2010 – 2018, 87% declines in Great White Pelicans and 23% declines in Red Knobbed Coot were recorded at Lake Naivasha (Gacheru et al., 2019). A 35-year (1976 – 2011) bird ringing dataset of palearctic migrant species in Tsavo West National Park revealed some long-term trend data in the species composition of catches of 16 species. Thus, the relative abundance of species could be inferred. Common Whitethroat, Willow Warbler, Rufus Scrub Robin, Upcher's Warbler, Basra Reed Warbler, Barred Warbler, and Isabelline Shrike all showed decreases (Pearson et al., 2014).

Table 3: Orders and families of Avifauna in Kenya

	Orders	**No. of Families**	**No. of Species**
1	Struthioniformes	1	2
2	Passeriformes	43	583
3	Caprimulgiformes	2	29
4	Piciformes	3	49
5	Charadriiformes	13	112
6	Psittaciformes	1	9
7	Columbiformes	1	20
8	Galliformes	3	21
9	Accipitriformes	3	61
10	Strigiformes	2	19
11	Anseriformes	1	23
12	Gruiformes	3	21
13	Coraciiformes	3	29
14	Procellariiformes	3	10
15	Cuculiformes	1	20
16	Pelecaniformes	4	27
17	Falconiformes	1	18
18	Bucerotiformes	3	20
19	Suliformes	4	8
20	Trogoniformes	1	2
21	Otidiformes	1	8
22	Podicipediformes	1	3
23	Musophagiformes	1	11
24	Ciconiiformes	1	8
25	Pterocliformes	1	5
26	Phoenicopteriformes	1	2
27	Coliiformes	1	3
28	Phaethontiformes	1	2
	TOTAL	104	1125

Source: IUCN Red List 2020

Table 4: Endemic Birds, Kenya

	Species	County	IUCN Red List Status	Population Trend	Population Size
1	Sharpe's Longclaw (*Macronyx sharpei)*	Nyandarua	EN	Decreasing	6,000 - 15,000
2	Taita Thrush (*Turdus helleri)*	Taita-Taveta	CR	Decreasing	930
3	Taita Apalis (*Apalis fuscigularis)*	Taita-Taveta	CR	Decreasing	210 - 430
4	Taita White-Eye (*Zosterops silvanus)**	Taita-Taveta	EN	Unknown	250 - 999
5	Kikuyu White-Eye (*Zosterops kikuyuensis)**	Multiple - Central KE	LC	Unknown	Unknown
6	Clarke's Weaver (*Ploceus golandi)*	Kilifi	EN	Decreasing	2,000 - 4,000
7	William's Lark (*Mirafra williamsi)*	Isiolo & Marsabit	LC	Stable	200,000
8	Aberdare Cisticola (*Cisticola aberdare)*	Multiple - Central KE	VU	Decreasing	Unknown
9	Hinde's Pied Babbler (*Turdoides hindei)*	Multiple - Central KE	VU	Decreasing	1,250 - 4,500

*****Currently one species, taxonomic split is still being discussed by the Nature Kenya Bird Committee

Source: Don Turner and Nature Kenya Bird Committee; IUCN Red List, 2020.

Table 5: Bird Species Locally Extinct in the Wild, Kenya

	Species	Sighting
1	Forest Scimitarbill (*Rhinopomastus castaneiceps)*	*Known only from a specimen collected in Mumias District 1914. – Kakamega County*
2	Speckled Tinkerbird (*Pogoniulus scolopaceus)*	*Known only from historical specimen, Trans-Nzoia district 1930's. – Trans-Nzoia County*
3	Sabine's Spinetail (*Rhaphidura sabini)*	*Only three confirmed post-1966 records (Mt Elgon 1977, Kakamega 1978 and 1992). – Trans-Nzoia and Kakamega Counties*
4	Velvet-mantled Drongo (*Dicrurus modestus)*	*Known only from Kakamega Forest, no post-1990 records. - Kakamega*
5	Lowland Sooty Boubou (*Laniarius leucorhynchus)*	*Known only from single specimen Kaimosi Forest, April 1931. Kakamega*
6	Kretschmer's Longbill (*Macrosphenus kretschmeri)*	*South Kilimanjaro & Kitovu Forests, Taveta District (van Someren 1932). Taita-Taveta County*
7	White-winged Apalis (*Apalis chariessa)**	*Last recorded at Lower Tana, 1961. Nominate form globally extinct. – Tana River County*
8	Yellow-streaked Greenbul (*Phyllastrephus flavostriatus)*	*Only records at Fort Hall 1917 & Mt Kasigau 1938 (Zimmerman 1986). – Taita-Taveta County*
9	Yellow-mantled Weaver (*Ploceus tricolor)*	*Last recorded at Kakamega Forest 1972. – Kakamega County*

*All are Least Concern on IUCN Red List of Threatened Species, except White-winged Apalis, which is Near Threatened.
Source: Don Turner Pers. Comm. April 2020

C. Amphibians – Status & Trends

Kenya has between 111 to 115 species of amphibians that belong to two orders, Anura (frogs and toads) and Gymnophiona (caecilians) (IUCN Red List, 2020; AmphibiaWeb, 2020). Only seven caecilians occur in Kenya (Spawls, 2019). Little is known about tropical amphibians and their population status and trends compared to amphibians from other parts of the world (Lotters et al., 2006). While frogs and toads are well known by the public, caecilians remain largely unheard of, and to the lay person, are often mistaken for earth worms (Spawls, 2019). In Kenya, within the order Anura, toads are restricted to one family, Bufonidae, while the remaining frogs are found across 13 families (Table 6). The most diverse family within the order Anura is Hyperoliidae, consisting of 32 species across 5 genera (IUCN Red List, 2020). Kenya has 20 endemic amphibians of which 16 are from the order Anura and 4 from Gympnophiona (Table 7).

Globally, amphibians have been facing catastrophic populations declines and an estimated one fifth of afro-amphibian species are threatened with extinction (Lotters et al., 2006). In Kenya, 11 amphibian species are threatened, of which two, Du Toit's Torrent Frog and Taita Hills Warty Frog are critically endangered. As numerous attempts in the last 26 years failed to locate Du Toit's Torrent Frog across its known range on the slopes of Mt. Elgon, this species is listed as possibly extinct (IUCN Red List, 2020). Global population trends of 80 out of the 115 amphibian species found in Kenya are not known, and it is likely that trends at the national level are also poorly known. Global populations of at least eight frogs and one toad that occur in Kenya are declining, while 16 are stable or increasing (IUCN Red List, 2020). For many amphibian species, Red List assessments have not been updated since 2013. For a group of species that are highly sensitive to their environment and respond to changes rapidly, large intervals between assessments, even slightly outdated information could be severely inaccurate.

Kenya's amphibian species diversity is highest at lower altitudes, along the humid coastal belt, and in the Western highlands (Tyrell et al., 2019), where Central African forest forms can be found (Figure 9). While Central Kenya hosts many of the country's endemic species, total species richness is lower here, a result of the higher altitude (Spawls et al., 2012). Nine endemic species are from the highlands of central Kenya, with very little coverage by protected areas. Two more endemics occur only in the remaining, threatened indigenous forests of the Taita Hills, with a third occurring nearby on Sagalla Hill. Kakamega Forest in Western Kenya harbours 24 species of frog (Anurans) many of which are endemic to the forest (Schick et al., 2005). Kenya's PA network only effectively covers 16% of amphibians, leaving the remaining 84% exposed to the pressures of agriculture and urban development (Tyrell et al., 2019). 'Small-holder farms' and 'housing and urban areas' threaten the greatest number of species in Kenya – 40 and 35 respectively (IUCN Red List, 2020) – while the

Chytrid Fungus (*Batrachochytrium dendrobaditis*) threatens at least 35% of Kenya's anurans (Keilgast et al., 2009)

Very little research has been published on the amphibian fauna of Kenya, with only a handful of papers investigating specific regions or species. No exhaustive checklist of Kenya's amphibians exists, with the first field guide dedicated purely to Kenya's amphibians published in 2019 (S. Spawls 2020 personal communication, 4th May). Repeated, systematic zoogeographic surveys for Kenya are imperative to ascertain where each species occurs, the threats they face, and what their population trends are (Lotters et al., 2006). Further taxonomic reviews of various taxa will provide clarity on the true status of many of the forms (MEWNR, 2015).

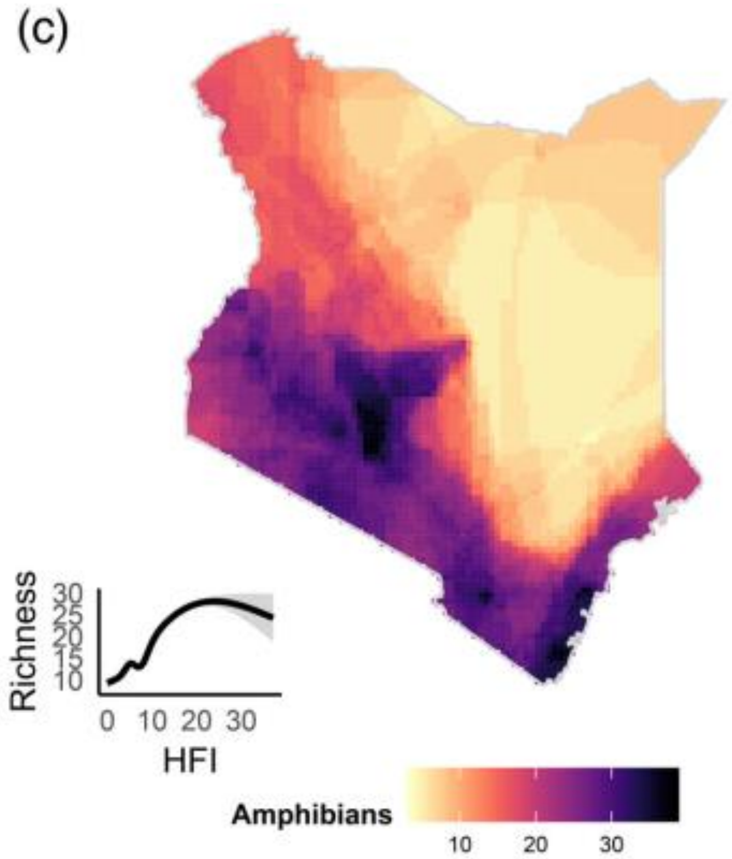

Figure 9: Amphibian Species Richness in Kenya (Tyrell et al., 2019).

Table 6: Orders, families, and genera of amphibians in Kenya.

Order	Family	No. of Genera	No. of Species			
			Amphibiaweb↓	*Spawls**	*IUCN†*	*AMNH≠*
Anura (Frogs & Toads)	Arthroleptidae	2	9	7	7	8
	Brevicipitidae	1	2	2	2	3
	Bufonidae	3	18	16	18	17
	Dicroglossidae	1	1	1	1	1
	Hemisotidae	1	2	1	2	2
	Hyperoliidae	4	31	28	27	30
	Microhylidae	1	1	1	2	2
	Petropedetidae	1	1	1	1	1
	Phrynobatrachidae	1	9	12	13	13
	Pipidae	1	5	3	4	4
	Ptychadenidae	2	11	10	10	11
	Pyxicephalidae	4	14	13	14	15
	Ranidae	1	2	2	2	2
	Rhacophoridae	1	3	3	3	3
Gymnophiona (Caecilians)	Dermophiidae	1	1	1	1	1
	Scolecomorphidae	1	0	1	0	1
	Herpelidae	1	5	5	4	5
TOTAL	16 Families	27	115	107	111	119

Source: ↓AmphibiaWeb. (2020); * Spawls et al., (2019); † IUCN Red List (2020); ≠ Frost (2020).

Table 7: Endemic Amphibians, Kenya.

	Common Name	County	IUCN Red List Status
1	Turkana Toad (*Sclerophrys turkanae)*	Turkana & Marsabit	DD
2	Lonnberg's Dwarf Toad (*Mertensophryne lonnbergi)**	Multiple - Central KE	VU
3	Mocquard's Dwarf Toad (*Mertensophryne mocquardi)*	Multiple - Central KE	DD
4	Nairobi Dwarf Toad (*Mertensophryne nairobiensis)*	Multiple Central & South KE	DD
5	Mackay's Forest Tree Frog (*Leptopelis mackayi)*	Kakamega	DD
6	Shimba Hills Reed Frog (*Hyperolius rubrovermiculatus)**	Kwale	EN
7	Sheldrick's Reed Frog (*Hyperolius sheldricki)*	Taita-Taveta & Tana River	LC
8	Mountain Reed Frog (*Hyperolius montanus)*	Multiple - Central KE	LC
9	Tigoni Reed Frog (*Hyperolius cystocandicans)**	Multiple - Central KE	NT
10	Taita Hills Warty Frog (*Callulina dawida)**	Taita-Taveta	CR
11	Kinangop Dainty Frog (*Cacosternum kinangopensis)*	Multiple - Central KE	LC
12	Gallman's Sand Frog (*Tomopterna gallmani)*	Multiple – Laikipia & Rift Valley	LC
13	Irangi Puddle Frog (*Phrynobatrachus irangi)**	Multiple – Central KE	EN
14	Kenya Puddle Frog (*Phrynobatrachus keniensis)*	Multiple - Central KE	LC
15	Kakamega Puddle Frog (*Phrynobatrachus kakamikro)*	Kakamega	DD
16	Kinangop Puddle Frog (*Phyrnobatrachus kinangopensis)*	Multiple - Central KE	LC
17	Denhardts' Caecilian (*Boulengerula denhardti)*	Meru & Tana River	DD
18	Sagalla Caecilian (*Boulengerula niedeni)*	Taita-Taveta	EN
19	Taita Hills Caecilian (*Boulengerula taitana)**	Taita-Taveta	EN
20	Spawls' Caecilian (*Boulengerula spawlsi)*	Meru	NA

*Decreasing population trend

Source: Species and red list status cited from IUCN Red List, 2020

D. Fish – Status & Trends

Marine and freshwater fish in Kenya belong in three classes Actinopterygii, Chondrichthyes, and Sarcopterygii (IUCN Red List, 2020) and include roughly 1058 species (FishBase, 2019). According to data extracted from the IUCN Red List (2020), for freshwater and marine fish assessed and occurring in Kenya, global populations of 8 species were increasing, 96 were decreasing, and 232 were stable. However, population trends of the majority were unknown. A total of 42 species (CR: 30 and EN: 12) were highly threatened with extinction.

i. Freshwater Fish

Kenya has between 180 (NEMA, 2011) to 206 freshwater fish species (excluding haplochromines from Lake Victoria) belonging to 38 families (Seegers et al., 2003). Cyprinidae are the largest fish family consisting of at least 50 species, followed by Cichlidae (n=28), Mochokidae (n=15), Mormyridae (n=15), and Characidae (n=12) (Seegers et al., 2003). A more recent or comprehensive checklist for freshwater fish in Kenya was not found.

Kenya has roughly 54 endemic freshwater fish species (excluding the Lake Victoria haplochromines) from several rivers and lakes (Seegers et al., 2003; Appendix I).

Lake Victoria had 500 endemic fish species and genera (haplochromine cichlid fishes), among the highest records of endemism in the East African great lakes. However, by the 1980s, 50% were presumed extinct, largely but not entirely due to the introduction of Nile Perch in the 1950s (Kauffman et al., 1997). The eradication of near 200 species was considered by scientists as one of the largest extinctions of vertebrate species in modern times (Goldschmidt et al., 1993 cited in Abila et al., 2004). Omena (*Rastrineobola argentea*) is the most successful cichlid from the lake currently dominating the fishery, producing 60,000 mt since 2010 and constitutes the second most important fishery in Kenya.

Lake Turkana also harbours endemic fish species with nine endemics restricted to the lake itself and two more found across the Turkana Basin (Seeger et al., 2003; Wakjira et al., 2017;).

ii. Marine Fish

The Kenyan coastal waters are rich in marine fish species, particularly in marine protected areas (Fondo et al., 2014). An estimated 692 (NEMA, 2011) to 736 marine fish species are found in Kenya (Fondo et al., 2014). Of these, 121 species are commercially exploited (Table 8), 193 are caught for ornamental aquaria (Okemwa et al., n.d), and 26 are threatened (Fondo et al., 2014). Over 190 finfish species have been identified in artisanal catches, representing 49 families (Kimani et al., 2018). Some of the main families that are captured include rabbitfish, emperor, parrotfish, snappers, surgeonfish, groupers, and sweetlips. Rabbitfish, emperor, and parrotfish are the main catches (Kimani et al., 2018). No comprehensive annotated checklist exists for marine fish species in Kenya, with information scattered in some published literature and online.

During the 1990s, a major decline in marine fish catch in nearshore fishing areas was associated with declines in fish abundance which later stabilised (Kimani et al., 2018). This was supported by an assessment of coral reef lagoon fish which reported reductions in the density and species richness of five families around the same time (McClanahan, 1994 cited in Fondo et al., 2015). Few studies on threatened marine fish species distribution and abundance have been undertaken in Kenya, with the exception of Whale Sharks and Coelacanths (Fondo et al., 2015; Table 9).

Table 8: The status of some key commercial fish species in coastal Kenya.

Fishery	Indicator species	Status
Small scale reef finfish fisheries	*Siganus sutor* *Leptoscarus vaigiensis* *Lethrinus lentjan*	Overfishing: declining yields, declining sizes, declining species richness, changes in species composition
Tuna and large pelagic species	*Katsuwonis pelamis* *Thunnus albacares* *Euthynnus affinis* *Thunnus obesus* *Xiphias gladius* *Tetrapturus audix*	Overfishing of *K. pelamis.* There are large variations in catches across years, stock status unknown for most species.
Small and medium pelagics	*Rastrelliger kanagurta* *Sphyraena flavicauda* *S. jello* *S. obtusata* *Hemiramphus far*	Overfishing: large temporal and spatial variations occur
Marine aquarium	*Amphiprion allardi* A. *akallopisos* *Pomacnthus imperator* *P. chrysurus* *P. maculosus*	Overfishing of some species: evidence of over exploitation of some species, high spatial variations influenced by recruitment patterns

Source: Kimani et al., 2018

Table 9: Bony fish and Elasmobranch species of conservation concern in Kenya.

Taxa	IUCN Red List Status	Species
Bonyfishes	Critically endangered	Lake Chala Tilapia (*Oreochromis hunteri*)
	Endangered	Humphead wrasse (*Cheilinus undulates*)
	Vulnerable	Green humphead parrotfish (*Bolbometopon muricatum*)
		Giant grouper (*Epinephelus lanceolatus*)
		Blue marlin (*Makaira nigricans*)
		Blacksaddled coral grouper (*Plectropomus laevis*)
		Bigeye tuna (*Thunnus obesus*)
		Spiny seahorse (*Hippocampus histrix*)
		Great seahorse (*Hippocampus kelloggi*)
		Spotted seahorse (*Hippocampus kuda*)
Sharks	Endangered	Scalloped hammerhead (*Sphyrna lewini*)
		Great hammerhead (*Sphyrna mokarran*)
	Vulnerable	Pelagic thresher (*Alopias pelagicus*)
		Bigeye thresher (*Alopias superciliosus*)
		Common thresher shark (*Alopias vulpinus*)
		Oceanic whitetip shark (*Carcharhinus longimanus*)
		Sandbar shark (*Carcharhinus plumbeus*),
		Great white shark (*Carcharodon carcharias*)
		Shortfin mako shark (*Isurus oxyrinchus*)
		Tawny nurse shark (*Nebrius ferrugineus*)
		Sicklefin lemon shark (*Negaprion acutidens*)
		Short-tail nurse (*Pseudoginglymostoma brevicaudatum*)
		Bowmouth guitarfish (*Rhina ancylostoma*)
		Whale shark (*Rhincodon typus*)
		Giant guitarfish (*Rhynchobatus djiddensis*)
		Zebra shark (*Stegostoma fasciatum*)
Rays	Critically endangered	Honeycomb stingray (*Himantura uarnak*)
		Giant manta (*Manta birostris*)
		Rhinoptera javanica (Flapnose ray)
Sawfish	Endangered	Narrow sawfish (*Anopristis cuspidata)*
	Critically endangered	Green sawfish (*Pristis zijsron*)

Source: (Government of Kenya, 2017b).

E. Plants – Status & Trends

Plants in Kenya belong in six classes Magnoliopsidia, Plypodiopsida, Liliopsida, Pinopsida, Cycadopsyda and Lycopodiopsida (IUCN Red List, 2020) and include roughly 7000 species (MEWNR, 2015). According to data extracted from the IBAT Country profile of Kenya (2020), for plants assessed and occurring in Kenya, a total of 122 species (CR: 25 and EN: 97) were highly threatened with extinction.

Table 10: Plant species conservation status in Kenya.

Taxonomic group (Class)	Total assessed species	Total known threatened species*	EX & EW	CR	EN	VU	NT	LR/CD	LC	DD
Magnoliopsida	861	237	0	18	72	147	31	0	556	9
Polypodiopsida	45	6	0	1	3	2	0	0	39	0
Liliopsida	386	51	0	4	20	27	7	0	319	9
Pinopsida	4	1	0	0	1	0	0	0	3	0
Cucadopsida	6	2	0	1	1	0	1	0	3	0
Lycopodiopsida	7	2	0	1	0	1	1	0	4	0

Source: IBAT Country profile of Kenya (2020).

*Threatened Species are those classified as CR, EN, and VU.

According to the IUCN Red List of Threatened Species (2020), for plants assessed and occurring in Kenya, 1.6% are critically endangered (CR), 7.1% endangered (EN), 9.8% vulnerable (VU), 4.1% are near concerned or lower risk, and 75.8% are least concerned.

The population trend of these species is declining for 14.0 %, increasing for 1.4 %, stable for 51.9 % and unknown for 32.7 % (IUCN Red List of Threatened Species 2020).

3.5 Areas of Conservation Importance

3.5.1 Key Biodiversity Areas

Key Biodiversity Areas (KBAs) are sites that significantly contribute to the global persistence of biodiversity in terrestrial, freshwater, and marine realms. Using a universal set of agreed scientific criteria, local stakeholders, including NGOs, academic institutions, and government, can identify KBAs. KBAs include both Important Bird Areas (IBAs) and Alliance for Zero Extinction Sites (AZEs). IBAs are referred to as KBAs in the rest of the document.

Kenya has 73 identified KBA sites (Figure 10) of which 67 are IBAs (Gacheru et al., 2019) and 6 are AZEs, with a further 47 potential KBA sites. Since 1980, there has been a 7.5% increase in the coverage of KBAs within PAs in Kenya (IBAT, 2020). The continuing establishment of conservancies may boost this percentage in the future. KBAs in Kenya have been assessed using the agreed KBA criteria to detect threats and evaluate the overall effectiveness of conservation actions using 'State', 'Pressure' and 'Response' measures (BirdLife International, 2006; BirdLife International, 2018). Between 2004 and 2018, the 'State' (which measures bird population trends, and extent and quality of habitat within KBAs), remained stable. Thus, there were no recorded species extinctions, de-gazettement of PAs that are KBAs, and new KBA sites were identified. However, KBAs were subjected to increasing pressure from illegal tree harvesting, poaching, human encroachment, increased infrastructure development, and land use conversion. KBAs lacking formal protection were the most impacted.

Through KBA assessments, it was also found that the overall conservation response to threats had reduced since 2014. This lowered response could have been attributed to reduced resource allocation by the government, lack of mainstreaming of biodiversity within key economic sectors, and, competing national agendas. However, more recently there have been concerted efforts to revive conservation actions within KBAs (Gacheru et al., 2019).

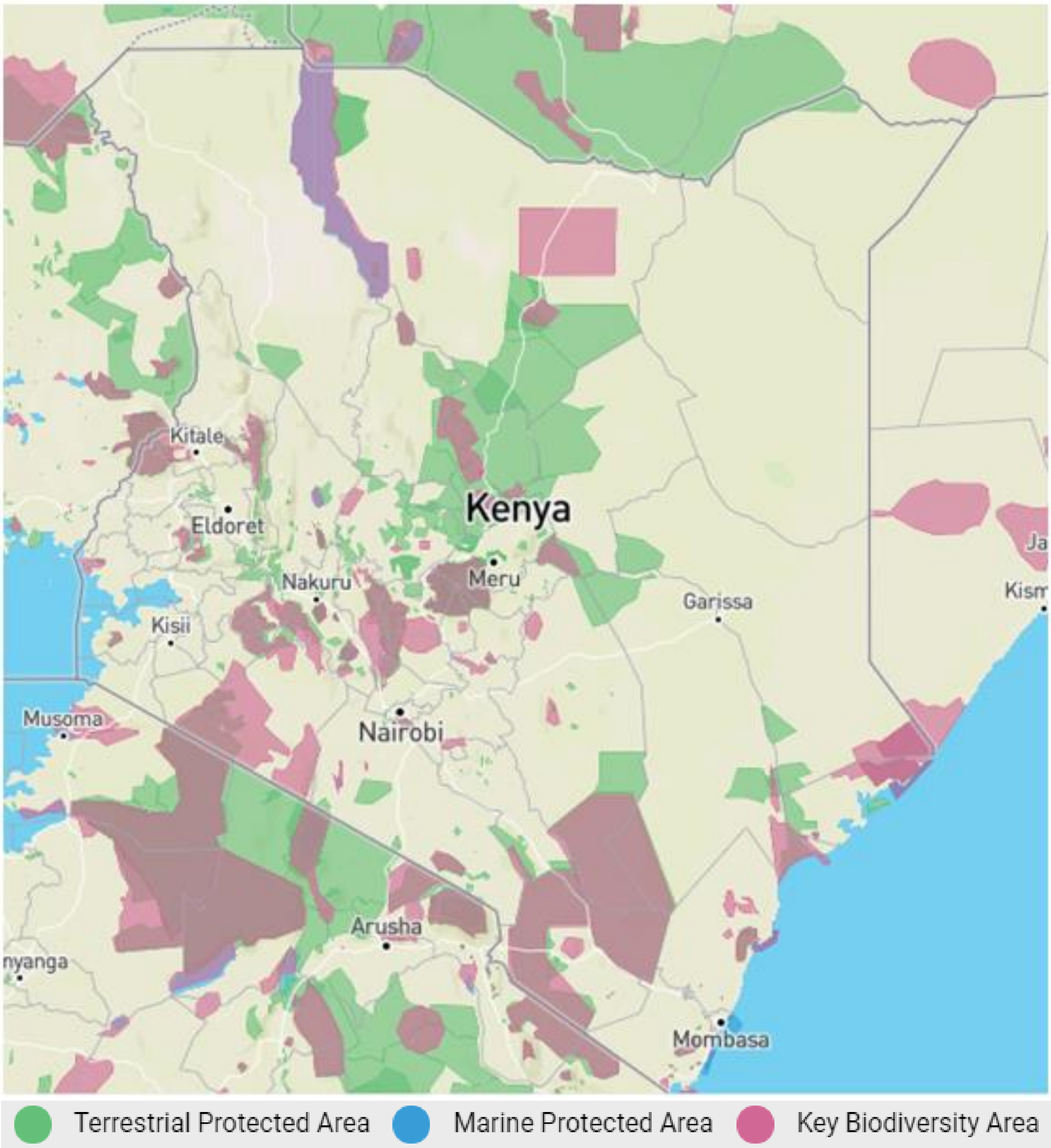

Figure 10: Protected Area and Key Biodiversity Area Boundaries in Kenya (IBAT, 2020).

3.5.2 Protected Areas

The IUCN definition of a protected area (PA) is "a defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values", (IUCN, 2013). PAs are an essential tool for biodiversity conservation. In Kenya, PAs vary in size, management objectives, and governance types ranging from government national parks and reserves to private or indigenous and community conserved areas (Ogutu et al., 2016; IUCN, 2020; UNEP-WCMC, 2020).

Global platforms such as the IUCN World Database on Protected Areas (WDPA) and national sectoral reports provide data on the total number of PAs within Kenya. Using a combination of data from global and national datasets it is estimated that there are close to 500 PAs with varying governance types established in Kenya.

The IUCN WDPA lists 411 PAs in Kenya in total of which 235 were forest reserves managed by Kenya Forestry Services (KFS), which are not reported elsewhere. Government managed PAs were reported in 2018 as 28 (24 terrestrial; 4 marine) National Parks, 32 (26 terrestrial; 6 marine) National Reserves, and six Wildlife Sanctuaries. All terrestrial national parks and 6 terrestrial national reserves are managed by the Kenya Wildlife Service (KWS), while the remaining 20 terrestrial national reserves are managed by the respective county governments. All marine national parks and reserves are managed by KWS. In 2016, Kenya had a total of 160 private, community and indigenous conservancies (KWCA, 2016). However, more recent reports published by the Northern Rangelands Trust suggest small changes in the number of their conservancies, which would potentially increase the total number of conservancies in Kenya (NRT, 2019). Furthermore, there are 24 Locally Managed Marine Areas (LMMAs) identified in the literature (Kawaka et al., 2015), which is 20 more than what was reported in the State of Conservancies Report (KWCA, 2016). The total number of PAs may be even higher when including privately managed ranches and reserves, and International designations such as RAMSAR Convention on Wetlands and United Nations Educational, Scientific, and Cultural Organisation (UNESCO) World Heritage Sites.

i. Government Managed Protected Areas

Forest reserves are the most numerous government managed PAs in Kenya, but some have not yet been officially designated, while others have become mere ‘paper parks’, existing only on paper. Many forest reserves are less than 5 Km^2, creating a patchy and fragmented network, and only two (Mt Kenya and Aberdare) are larger than 1,000 Km^2 (UNEP-WCMC, 2020). It is therefore not surprising that forest reserves only cover a total area of approximately 19,000 Km^2 despite being numerous (UNEP-WCMC, 2020). Karura Forest was among the first PAs to be established, as early as 1932, along with 31 other forest reserves (UNEP-WCMC, 2020). Terrestrial national parks and reserves occur across 21 counties and cover a total area of 46,800 Km^2, or 7% of Kenya’s land area (MoTW 2018). Tsavo East and Tsavo West are the largest national parks representing over 70% of the total national park area. National reserves are generally larger in size, with seven covering an area greater than 1000km^2 each (MoTW 2018). Kenya has four marine national parks (70 Km^2) and six marine national reserves (871 km^2) covering a total area of 941 Km^2 (Government of Kenya, 2017b). This is one of the most extensive networks of marine protected areas in the Western Indian Ocean region (Griffiths, 2005). The total surface area (terrestrial and marine) of Kenya under government managed PA is roughly 8.2% (MoTW, 2018; KWCA, 2016).

ii. Private and Community Managed Protected Areas

The creation of private and communal conservancies substantially increased the total (marine and terrestrial) PA cover in Kenya by 11% (63,600 km²) across 28 counties (KWCA, 2016). The Kenya Wildlife Conservancies Association defines a conservancy model as “Land designated by a community or private landowner, groups of owners, or corporate body for purposes of wildlife conservation and other compatible land uses. A conservancy is therefore established on private or community land and is managed for a broad range of land uses.” Wildlife conservation is a key objective of a conservancy, although they are also established for livelihood development, peace and security, good governance, and pastoral movements and grazing (KWCA, 2016). The governance structure is varied, differing from one conservancy to another, but all are managed by non-government actors, some of which include communities, private land owners, and/or institutions (KWCA, 2016).

The counties of Kajiado and Taita-Taveta host the highest number of conservancies, while Samburu County, with only six conservancies, has the largest extent of land under conservancies, at 1,497 Km² (KWCA, 2017). The establishment of conservancies is dynamic, with new ones being formed relatively frequently. LMMAs, which also fall under the conservancy umbrella, are created and managed by local communities to improve their marine resources and livelihoods (Kawaka et al., 2015) and complement marine national parks and reserves. The first LMMA was set-up in 1995, while the most recent was set up in 2015. LMMAs vary in size, with the largest covering 17.3 Km² and the smallest covering 0.11 Km² (Kawaka et al., 2015). Despite the formation of LMMAs, less than 2% of Kenya’s EEZ is protected (Obura et al., 2017b).

iii. Protected Area Efficiency

Several studies have reviewed the effectiveness of Kenyan protected areas to conserve biodiversity using a range of parameters (Ottichilo et al.,2000; Ottichilo et al.,2001; Western et al., 2009, Ogutu et al., 2011; Ogutu et al., 2016; Tyrell et al., 2019). Since the 1970s wildlife populations have been precipitously declining in Kenya (Ottichilo et al., 2000). From 1977 to 1997, a similar rate of decline was observed for large mammal populations both inside and outside PAs, with the steepest declines from Tsavo East and West (63%) and Meru National Parks (78%), while declines in Masai Mara Reserve, at 25%, were much lower (Western et al., 2009). Between 1977 to 2009, over three-quarters of large mammal populations in the Masai Mara region had been lost and this was true inside and outside the reserve (Ogutu et al.,2011). In addition, the current formal protected area network of Kenya represents less than 50% of amphibian, mammal, and bird species richness (Tyrell et al., 2019) and less than 30% of wildlife densities (Ottichilo et al., 2000). This points to severe shortcomings with the current PA design and wildlife policies (Figure 11), emphasising the importance of biodiversity conservation on human-dominated landscapes. While PAs serve an important purpose in Kenya, its conservation policy must embrace a broader focus to human-dominated landscapes (Kareiva & Marvier, 2012 and Sayer et al., 2013 cited in Tyrell et al. 2019) to meet CBD post-2020 goals.

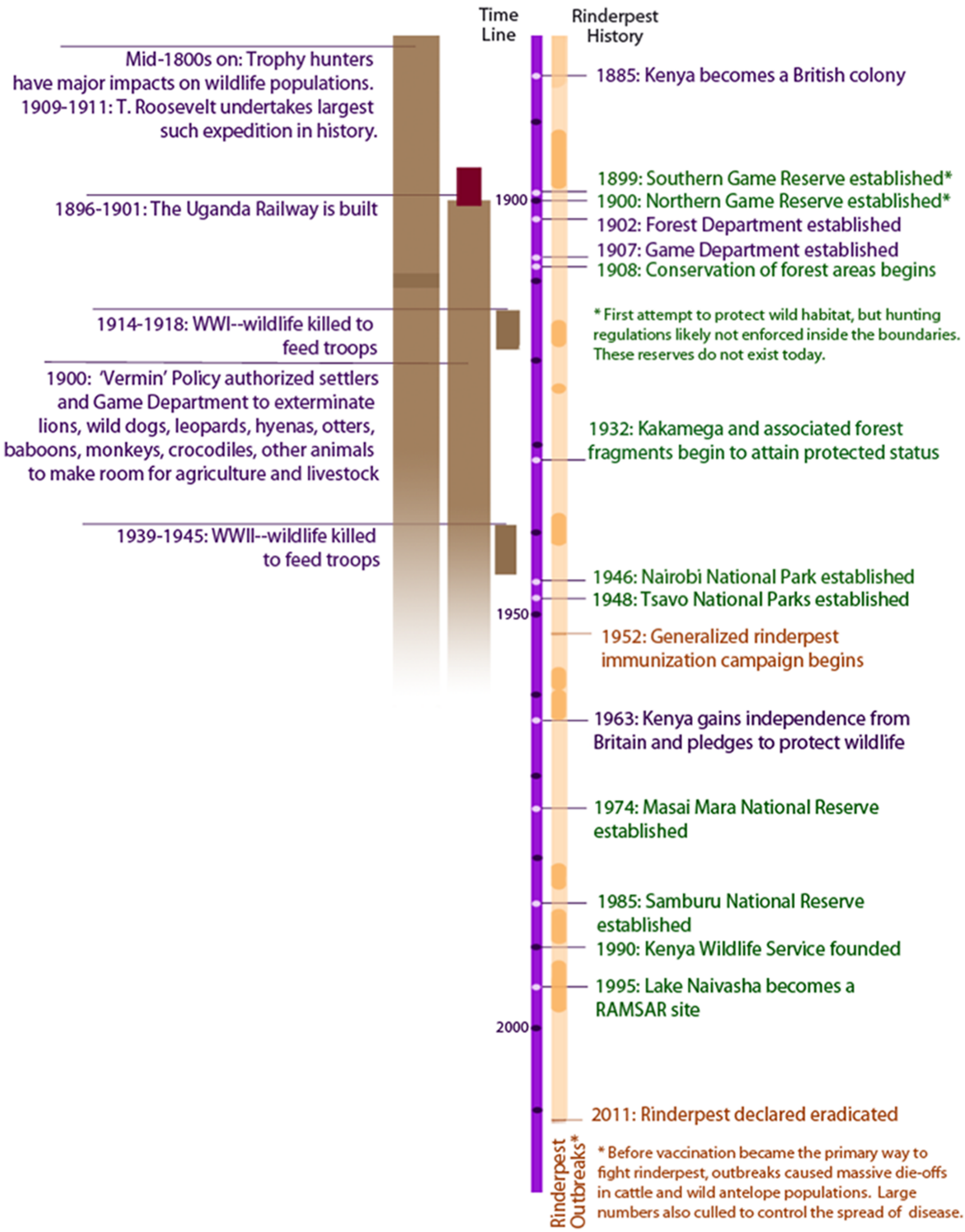

Figure 11: Kenya's Wildlife Policies. A timeline summarising Kenya's policy on natural resources and wildlife over the past 120 years (Toth et al., 2014).

4. Threat Assessment Results

4.1 National Level

4.1.1 STAR Metric - Kenya Scores

The STAR score for Kenya is 16,791, where the threat abatement score is 9,436 (56% of the national STAR score) and the restoration score is 7,354 (44% of the national STAR score) (Figure 12).

These scores show that for Kenya, the potential of threat abatement for reducing the species extinction risk is higher than the potential of habitat restoration. That confirm how relevant reducing pressures of economic activities is in Kenya.

Kenya contributes 0.29% of the global STAR score, ranked at number 35 out of 195 countries.

Annual & Perennial Non-timber Crops had the highest STAR threat abatement score of 2,722, closely followed by Logging & Wood Harvesting with a score of 1,897 (Figure 13). Livestock Farming & Ranching and Hunting & Trapping of Terrestrial Animals both had STAR threat abatement scores below 1000, while all other threats have abatement scores below 500.

That show that agriculture and forestry appear – according to the current STAR analysis – as the two main economic activities affecting species extinctions risk in Kenya. Reducing those threats offers the highest potential for enhancing species survival.

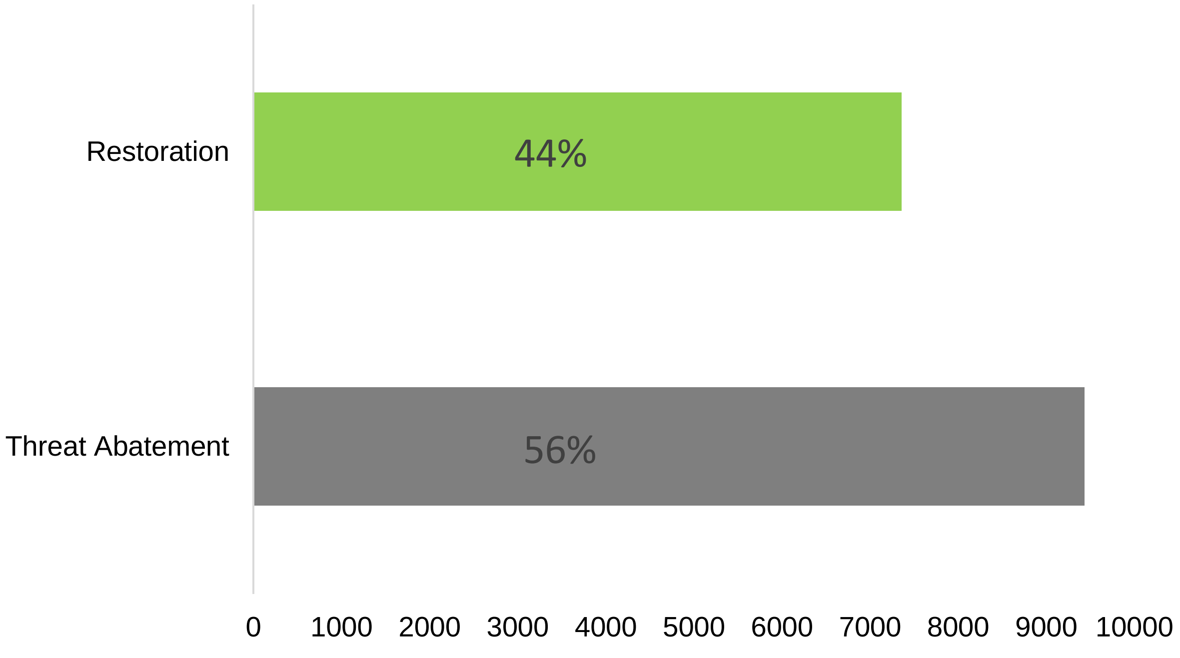

Figure 12: Summary STAR scores for Kenya

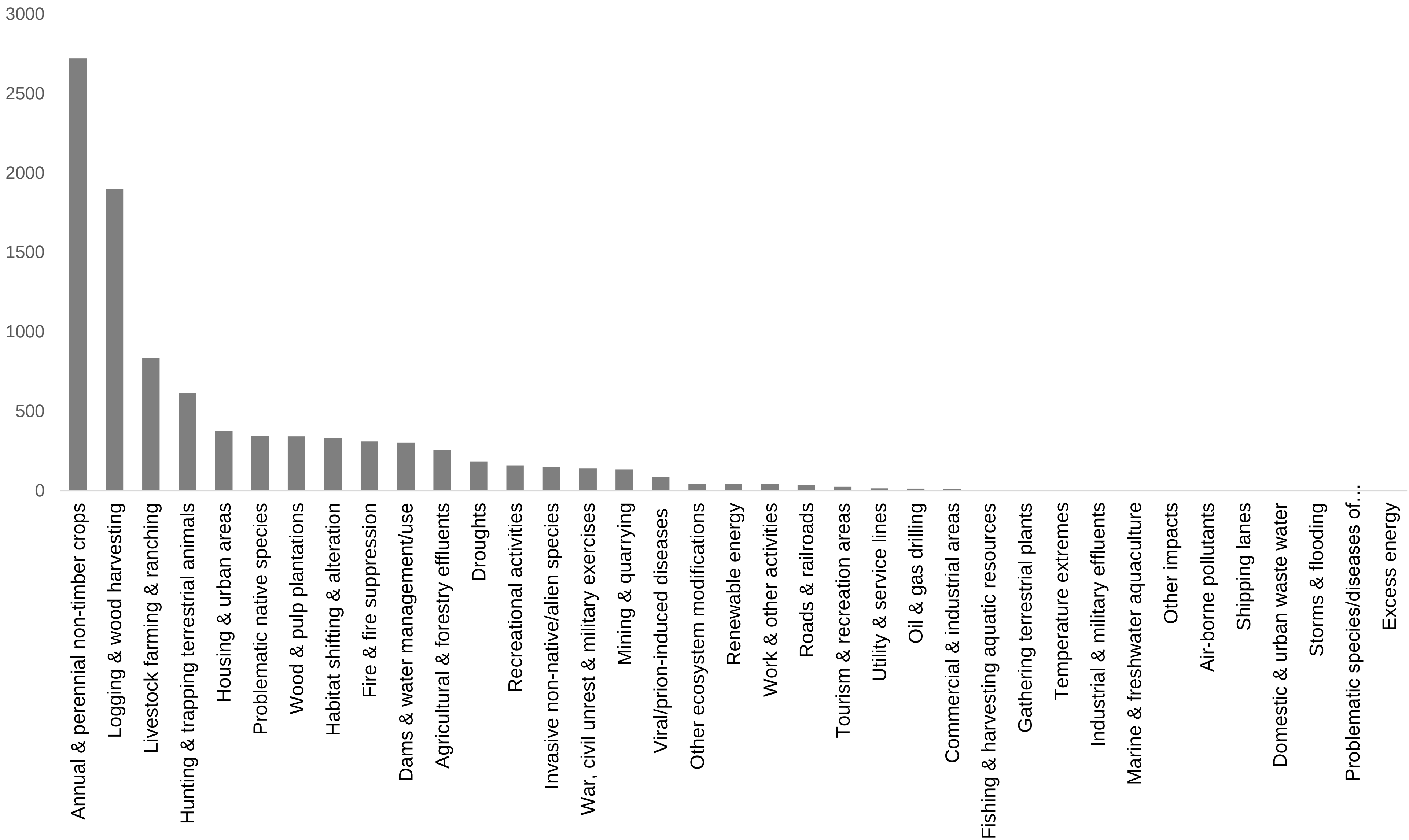

Figure 13: STAR Threat abatement scores for IUCN-CMP Classification System level-two threats for Kenya.

4.1.2 Expert-based Threat Assessment Tool (EbTAT)

Expert assessors (n = 15) each completed one threat assessment for their biological target using the EbTAT. Through this, a total of 64 level-two and level-three threats were identified as having an impact on at least one biological target. In terms of ranking, 27 threats were prioritised for conservation action, 18 were ranked as having a ‘Very High’ impact, and 22 were ranked as having a ‘High’ impact on at least one target.

A. Residential and Commercial Development

Amphibians were the only target to be greatly impacted by all three listed threats, where Housing & Urban Areas was considered a priority for conservation action (Table 10). Commercial & Industrial Areas were reported as having an impact on four targets, although to varying degrees, with the greatest impact on amphibians and mammals at ‘Very High’ levels. Of concern to assessors were impacts to amphibians from unplanned and unregulated developments near streams, rivers, or wetlands. Development of this nature have been known to destroy or degrade amphibian habitat in other parts of the world (Brown et al., 2012). However, assessors reported a need for further studies to fully understand the impacts in Kenya.

The development and expansion of ports in Mombasa, Lamu, and Shimoni, and their associated infrastructure, were reported to have ‘High’ impacts on coral reefs. Whereas, the expansion of industrial, commercial, and military developments within important wildlife dispersal areas were reported as having a ‘Very High’ impact on mammals. These developments particularly at Athi-Kapiti and Konza in Machakos County were reported to obstruct movement of large mammals and degrade their habitat.

Assessors reported that poorly planned development of urban and rural areas and their associated infrastructure resulted in habitat loss for many bird species in Kenya. Urban development has transformed green areas into highly fragmented and unsuitable habitat (Isaksson 2018, Rayner et al., 2015). Many species disappear as a result, thus reducing diversity (Isaksson 2018), while a few adaptable indigenous (e.g. Black Kite and Marabou Stork) and invasive alien species (e.g. Indian House Crow, House Sparrow, and Rock Dove) thrive (Rayner et al., 2015). As such, Housing & Urban Areas was reported to have a ‘High’ impact on birds. Of concern was also the lack of land-use planning regulations and weak enforcement of existing ones.

Table 10: Overall threat ratings of *Residential & Commercial Development* on target species and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Housing & Urban Areas	High* +	High	-	Low	-
Commercial & Industrial Areas	Very High +	-	Very High	Medium	High +
Tourism & Recreation Areas	High	-	-	-	High +

* Conservation priority threats

+ Difference in expert ranking (highest rank presented)

B. Agriculture and Aquaculture

Annual and Perennial Non-timber Crops were reported to have a large impact on amphibians, birds, and terrestrial mammals. Agro-industry Farming, reported as a priority threat for conservation action for amphibians and birds, was ranked as having a 'Very High' impact on both. Assessors reported that extensive conversion of natural habitat (e.g. old growth forest or grassland) into commercial monocultures (e.g. tea, coffee, wheat, maize, and sugarcane) was one of the biggest contributors to habitat loss (Mahiga et al., 2019) for amphibians, birds, and mammals. Agricultural expansion and intensification have been highlighted as top threats exerting pressure on KBA's in Kenya (Gacheru et al., 2018).

Assessors reported that, at the landscape scale, the collective impact from small farms (shambas) on bird, mammal, and amphibian habitat was considerable in some parts of Kenya, such as the Central Highlands. As such Small-holder Farming was ranked as having a 'High' impact on birds and amphibians.

Assessors reported impacts to amphibian habitat from widespread planting of exotic trees (e.g. *Eucalyptus spp*.) in small farms (shambas) which lower the water table and destroy suitable habitat. Therefore, impacts to amphibians from Wood & Pulp Plantations were reported as 'High'.

Agro-industry Grazing Ranching or Farming was reported as having a 'High' impact on terrestrial mammals. Poor livestock management practices were reported to contribute to land degradation and subsequent loss of suitable grazing potential for wild ungulate species, as well as leading to habitat loss.

Assessors reported a 'High' impact on marine fish from Subsistence and Artisanal Aquaculture. It was reported that since 2010, aquaculture has been promoted by the Kenyan government under the economic stimulus programme to boost food security. Assessors reported concern over potential threats to wild fish stocks (introducing invasive species, diseases, and new genetic material) if enforcement of existing regulations on aquaculture was weak. Assessors also reported mangrove habitat destruction from aquaculture, mainly at the industrial scale, currently ranked as having a 'Low' threat.

Table 11: Impact of *Agriculture & Aquaculture* on target species and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Annual & Perennial Non-Timber Crops	-	-	Very High*	-	-
Shifting Agriculture	-	-	-	-	-
Small-holder Farming	High	High*	-	-	-
Agro-industry Farming	Very High*+	Very High*+	-	-	-
Wood & Pulp Plantations	High +		-	-	-
Small-holder Plantations	-	-	-	-	-
Agro-industry Plantations	-	-	-	-	-
Livestock Farming & Ranching	Medium	-	-	-	-
Nomadic Grazing	-	-	-	-	-
Small-holder Grazing/Ranching/Farming	-	Medium	-	-	-
Agro-industry Grazing/Ranching/Farming	-	-	High	-	-
Marine & Freshwater Aquaculture	-	-	-	-	-
Subsistence/Artisanal Aquaculture	-	-	-	High*	Medium
Industrial Aquaculture	-	-	-	Low	-

* Conservation priority threats

\+ Difference in expert ranking (highest rank presented)

C. Energy Production & Mining

The impact of Energy Production and Mining was reported to have a greater impact on marine over terrestrial targets. Oil & Gas Drilling was reported as having 'Very High' impacts on marine fish and 'High' impacts to coral reefs. It was also reported as a priority for conservation action for marine mammals. Assessors reported increased government and private sector interest in oil and gas prospecting to further the Blue Economy. To date, oil prospecting has been limited to drilling offshore oil wells in the Lamu basin (National Oil, 2020) prospecting for hydrocarbon (Vasquez, 2013) and gas reserves (Nyaberi and Rop, 2014). Lamu basin refers to sedimentary rock of Mesozoic age, covering the entire Kenyan coastal zone (Nyaberi and Rop, 2014). Sand mining and harvesting for the expansion of Mombasa port, was also reported as a concern to all coral reefs and reef fish.

Assessors reported that the extraction of oil and gas nearshore, could destroy coral reefs and impact reef fish, while exacerbating climate change due to increased greenhouse gas emissions. Of concern was the poor involvement of conservation organisations in planning processes such as selection of oil blocks and during Environmental and Social Impact Assessments (ESIA). Assessors reported that without expert consultation, drilling activities would be conducted without consideration for critical marine ecosystems, habitat, and important migratory corridors.

The impact of Renewable Energy on birds was considered by assessors as a priority for conservation action due to the increasing number of wind farm developments. In future, these developments were reported as likely to have a greater impact on birds than at current 'Medium' levels mainly around important flyways and nesting sites of resident threatened species.

Table 12: Impact of *Energy Production & Mining* on target species and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Oil & Gas Drilling	-	-	Medium*	Very High*+	High
Mining & Quarrying	-	-	Medium	Medium	Medium
Renewable Energy	-	Medium*	-	-	-

* Conservation priority threats

+ Difference in expert ranking (highest rank presented)

D. Transportation & Service Corridors

Utility & Service Lines was reported by assessors as a priority for conservation action with a 'High' impact on birds (Table 13). Of greatest concern were collisions and electrocutions of birds with power lines and other electrical infrastructure, resulting in mass mortalities in Kenya. Large birds such as cranes, storks, bustards, vultures, and other birds of prey were at higher risk due to their size and difficulty manoeuvring to avoid power lines (Smallie and Virani, 2010). The expansion of electrical infrastructure, particularly traversing important migratory corridors and movement pathways was reported as likely to increase this impact.

The impact on marine fish from Shipping Lanes was ranked as 'High' while for marine mammals they were reported as a priority for conservation action with a 'Medium' impact. Of concern for marine areas, was the rapidly developing maritime industry in Kenya, and the increased risks of ship strikes and noise pollution to large marine mammals. Assessors also reported that dredging channels for ships while developing ports, such as in Lamu County for the LAPSSET (Lamu Port, South Sudan, Ethiopia Transport Corridor) Corridor Program, was responsible for destruction of marine habitats (e.g. mangroves).

Roads & Railroads were reported as having a 'Very High' impact on terrestrial mammals. Assessors reported that roads and railways have been planned or built through several protected areas, thereby degrading or fragmenting critical habitat, and obstructing migratory pathways. Assessors reported major concerns over poor stakeholder engagement by government and the private sector during the planning and ESIA phases of large infrastructure developments. Thus, effective mitigation of impacts to target taxa and ecosystems fails.

Table 13: Impact of *Transportation & Service Corridors* on target taxa and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Roads & Railroads	-	-	Very High	-	-
Utility & Service Lines	-	High*	Medium	-	-
Shipping Lanes	-	-	Medium*	High*+	-
Flight Paths	-	Medium	-	-	-

* Conservation priority threats

+ Difference in expert ranking (highest rank presented)

E. Biological Resource Use

Activities associated with Biological Resource Use appear to have the greatest reported impact on mammals, fish, and coral reefs, and the smallest impact on amphibians.

Assessors reported 'Very High' impacts to terrestrial mammals from Hunting & Collecting, primarily for bushmeat, but also to 'control' conflict. Assessors highlighted drought, food insecurity, and poverty as some of the main drivers of bushmeat hunting. In Kenya, these illegal activities have shifted to more commercial uses from previous subsistence-based consumption (Wato et al., 2006), leading to population declines of targeted mammal species. Even within protected areas such as Tsavo West National Park, the intensity of snaring was high, concentrated adjacent to highways, trans-national boundaries, ranches, and urban areas (Wato et al., 2006).

Assessors also reported considerable losses of target and non-target mammal species from retaliatory killings associated with Human-Wildlife Conflict (HWC). HWC was considered to be a result of human population growth and subsequent encroachment near protected areas (Kiringe and Okello, 2007). Birds of prey (mainly vultures) were also reported to be unintentionally poisoned in this way. Assessors reported that waterfowl, viewed as both pests and food, were routinely poisoned around rice paddies, and sold for human consumption. Bunyala and Mwea rice schemes in Western and Central Kenya were known hotspots (Odino, 2010). Owls were frequently persecuted, and their eggs collected for superstitious beliefs. As such, Persecution & Control of birds in Kenya was reported as a priority for conservation action and as having a ‘High’ impact.

Bushmeat, HWC, and poaching for trophies were found to be some of the main threats impacting protected areas in Kenya (Kiringe and Okello, 2007).

Subsistence and small-scale production of charcoal and fuel wood collection was reported to destroy important forest and woodland habitat, thus, making it more open and accessible for farming and settlements. Assessors also reported that large-scale commercial and illegal extraction of timber and other forest resources have led to the degradation, loss, and fragmentation of indigenous forest habitat, endangering forest-dependent species. The unintentional effects from Logging & Wood Harvesting at both small and large scales was therefore reported as having a ‘Very High’ impact on terrestrial mammals. Most Kenyan forests and montane national parks were threatened by illegal logging, charcoal production, and forest cultivation (Kiringe and Okello, 2007).

Fishing & Harvesting Aquatic Resources was ranked as having a ‘Very High’ impact (Table 14). Assessors reported overfishing in nearshore waters leading to a loss of coral reef ecological function, phase-shifts to algal dominated systems, and reduced recovery of coral reefs. Heavy fishing also results in increased sea urchin abundance, reduced hard coral and coralline algal cover (McClanahan & Arthur, 2001 cited in Kimani et al., 2018). Healthy fish populations are essential to maintain ecologically functional coral reef systems (MacNeil et al., 2015).

Artisanal fisheries are the most widespread and common fishery in Kenya (Degen et al., 2010). In this type of fishery, beach seines, spears, and gill nets cause the most direct physical damage to corals (Mangi and Roberts 2006), the most destructive of which are beach seines (Samoilys et al., 2011). Of particular concern to one assessor was the small-scale commercial purse-seine (ring net) fishing adjacent to coral reefs, reported to receive political intervention. Purse-seine fishing, an adaptation to beach seines, was introduced to Kenya by migrant fishers in the 90s and is currently an open access seasonal fishery without regulations or controls (Okemwa et al., 2017).

Also reported was the extraction of coral reef species such as corals, fish, and invertebrates for the aquarium industry and tourist market. Having begun in the 1960s, the marine aquarium trade is increasing from a total of 150,000 live fish exported in the 1990s to 270,000 in 2015 (Kimani et al., 2018). However, assessors noted that the impact of these extractions to the reef ecosystem has not yet been fully quantified and requires more research.

The intentional and unintentional impacts of fishing at both small and large scales were reported as having ‘High’ impacts on fish populations in Kenya. However, one or more assessors ranked the impact lower. Assessors reported that uncontrolled fishing efforts and illegal modification of fishing gear was enhancing fishing efficiency and leading to overfishing in marine and freshwater systems. Fishing pressure, especially targeting spawning aggregations and slow growing threatened species (e.g. groupers and sharks), has led to over-exploitation of coastal fish species.

A large number of Artisanal/Small-scale fishers was reported to be putting a strain on inshore waters. Further, the open access nature of the fishery, poor membership within Beach Management Units, the absence of species-level management plans, and lack of catch data hamper effective management of artisanal fisheries. Assessors reported that accidental catch of non-target species (bycatch) was not common in artisanal/Small-scale fisheries, however, sharks, whales, turtles, and the occasional dugong have been caught this way.

Assessors reported that in Kenya, illegal and unregulated large-scale fishing activities lead to overfishing and exploitation of target species such as Tuna. Of concern to assessors was the licensing by the Kenyan Government of several longliners and trawlers to operate at semi-industrial scales in shallow and deep waters within the EEZ. This places further pressure on already exploited species, exacerbated by weak enforcement of regulations, hindering effective management and monitoring of these commercial fisheries. Assessors reported that trawl, longline, and purse seine fisheries accounted for the most bycatch particularly of threatened and endangered billfish, sharks, rays, and skates.

Table 14: Impact of *Biological Resource Use* on target species and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Hunting & Collecting Terrestrial Animals	-	-	Very High*	-	-
Intentional Use	-	Medium	-	-	-
Unintentional effects	-	Medium	-	-	-
Persecution/Control	-	High*	-	-	-
Logging & Wood Harvesting	Medium*	-	-	-	-
Intentional Use: subsistence/small scale	-	-	-	-	-
Unintentional effects: subsistence/small scale	-	Medium	Very High	-	Medium
Unintentional effects: large scale	-	-	Very High*	-	-
Fishing & Harvesting Aquatic Resources	-	-	Medium	-	Very High +
Intentional Use: subsistence/small scale	-	-	-	High* +	-
Intentional Use: large scale	-	-	-	High* +	-
Unintentional effects: subsistence/small scale	-	-	-	High* +	-
Unintentional effects: large scale	-	-	-	High* +	-

* Conservation priority threats

\+ Difference in expert ranking (highest rank presented)

F. Human Intrusions & Disturbance

Mitigating the impacts of Recreational Activities on marine mammals was considered to be a priority for conservation action, however it was not reported as a threat for terrestrial mammals. Assessors reported concerns with uncontrolled and unregulated wildlife-viewing activities and their impacts on large charismatic species (e.g. Dolphins, Whales).

Table 15: Impact of *Human Intrusions & Disturbance* on target species and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Recreational Activities	-	Low	Medium*	-	Low
War, Civil Unrest and Military	-	-	-	-	-
Work & Other Activities	-	-	-	-	-

* Conservation priority threats

G. Natural System Modification

Assessors reported impacts from Dams & Water Management/Use as having a 'Very High' impact on habitat for mammals and 'High' impact on bird habitat (Table 16). Of concern were the impacts to freshwater and terrestrial ecosystems from large dams (e.g. Gibe III and Owen Falls Dam) and over-harvesting of water to supply urban centres, industries, and farms. Assessors reported a decrease in critical bird habitat quality due to excessive abstraction of water from key water systems (e.g. Lake Naivasha and Tana River Delta) for irrigation, dams, and urbanization.

Table 16: Impact of *Natural System Modification* on target species and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Fire & Fire Suppression	-	-	-	-	-
Dams & Water Management/Use	-	High*	Very High	Medium	-
Other Ecosystem Modifications	-	-	-	Low	-

* Conservation priority threats

H. Invasive & Other Problematic Species, Genes & Diseases

The impact of Invasive Species and/or Diseases appears to be greatest for terrestrial targets. Invasive Alien Species were reported as a priority for conservation action and as having a 'Very High' impact on mammals and a 'High' impact on birds. Invasive alien plant species such as Parthenium Weed (*Parthenium hysterophorus)*, Prosopis/Mathenge (*Prosopis juliflora),* and Prickly Pear Cactus (*Opuntia spp.),* were reported as invading large areas across Kenya. In rangelands invasive flora have degraded ecosystems and habitat (Obiri 2011, Wabuyele et al., 2015), thus reducing foraging and nesting potential for both domestic stock and many wild bird and mammal species.

Transmission of diseases from domestic animals to wildlife (e.g. Canine Distemper, Rabies, and Rinderpest) were also reported to cause significant declines in mammal populations. African Wild Dog are especially vulnerable to Canine Distemper (Alexander and Appel, 1994), while Wildebeest were affected several times in the past by Rinderpest, now eradicated (FAO, 2019). Water Hyacinth (*Eichhornia crassipes)* was reported to threaten freshwater birds' habitat and food sources. Assessors also reported concerns regarding pervasive invasions of the House Crow (*Corvus splendens)* along coastal belt, competing with, and preying upon, native avifauna and leading to localized declines of avian diversity (Ryall 1992).

Table 17: Impact of *Invasive & Other Problematic Species, Genes & Diseases* on target species

and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Invasive Non-Native/Alien Species/Diseases	High +	High	Very High*	Medium	Low

* Conservation priority threats

+ Difference in expert ranking (highest rank presented)

I. Pollution

Agricultural & Forestry Effluents appears to have the greatest impact on all target taxa and ecosystems, with the exception of birds, when compared to other forms of pollution. It was reported as having a 'Very High' impact on amphibians. Water pollution from urban and agricultural run-off can lead to an overabundance of nutrients (e.g. nitrogen and phosphorus) in wetlands, lakes, and streams, resulting in eutrophication (Minnesota Pollution Control Agency, 2008, USGS, 2020). Elevated levels of nitrogen in watersheds can lead to amphibian mortalities (Rouse et al., 1999), while eutrophication reduces the amount of dissolved oxygen in the water, degrading habitat and making it difficult for fish to survive (Minnesota Pollution Control Agency, 2008).

Nutrient Loads was ranked as having a 'Very High' impact on freshwater fish and considered to be a priority for conservation action. Assessors reported that fertilizer run-off from agricultural activities have increased the levels of nitrogen and phosphorus in Lake Naivasha and Lake Victoria. Assessors further reported that the Tana and Sabaki Rivers drain into the ocean carrying nutrients which, in high concentrations, could pose a risk to reef fish. However, the impact is not as pronounced as in freshwater systems.

Assessors reported amphibians to be at high risk of chemical exposure due to their semi-permeable skin, particularly at developmental stages. During rainy seasons, when most amphibians are breeding, impacts from increased chemical run-off could be exacerbated. In North America, agricultural pesticides have been linked to population declines of Anura species (Sparling et al., 2001). Assessors reported Pesticides & Herbicides as having a 'Very High' impact on mammals (Table 18). The discharge of agro-chemicals into water systems was reported as leading to bioaccumulation in food chains and potential direct-poisoning of some species. Assessors also reported poisoning of small mammals from the direct application of agro-chemicals in the environment and around farms. Wild rodents are often targeted in these chemical applications on agricultural production systems.

Sewage was reported as having a 'Very High' impact on mammals. For example, general pollution from Nakuru Town was adversely affecting Lake Nakuru (Kiringe and Okello, 2007). Run-off from urban and domestic waste water was reported as a priority for conservation action for coral reefs (Table 18). Several sectors are known to contribute to this type of pollution in Kenya, including coastal development, agriculture, processing industries, mining, transportation, and energy (Government of Kenya, 2009 cited in Fondo et al., 2015). Assessors reported concerns of run-off carrying nutrients, chemicals, and sediments from urban centres, such as Mombasa, being discharged into creeks and then open ocean, leading to increased turbidity and pollution at adjacent reefs. During heavy rains, the impacts from increased run-off are amplified. Coral reefs around Likoni, Mombasa Marine Park, Tudor, and Mtwapa were reported to have declined as a result. Studies conducted around Port Reitz Creek, Mombasa, found elevated heavy metal concentrations in water, sediment, and selected fish species (Muohi et al., 2001 and Mwashote, 2002 cited in Fondo et al., 2015).

Assessors reported different threat ranks of 'Very High' and 'Medium' for perceived impacts to coral reef ecosystems from Soil Erosion & Sedimentation (Table 18). Changes in land-use around river basins (McClanahan and Obura, 1997) and increased deforestation of coastal and mangrove forests were reported by assessors to increase sediment supply to nearshore coral reefs (Maina et al., 2013). Subsequent increases in turbidity, mainly around river mouths such as the Sabaki River, can lead to coral reef compositional changes (McClanahan and Obura, 1997). A combination of poor water quality and increased sedimentation can hamper coral recovery from bleaching events, increasing the potential deterioration of coral reefs (Maina et al., 2013).

Table 18: Impact of *Pollution* on target species and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Domestic & Urban Waste Water	High	-	-	-	-
Sewage	-	-	Very High	Medium*	Medium
Run-off	-	-	-	Medium +	Medium*
Type Unrecorded	-	-	-	-	-
Industrial & Military Effluents	-	-	-	-	-
Oil Spills	-	-	Medium	-	-
Seepage from Mining	-	-	-	-	-
Type Unknown/Unrecorded	-	Medium	-	Medium +	-
Agricultural & Forestry Effluents	Very High*+	-	-	-	-
Nutrient Loads	-	-	High	Very High* +	-
Soil Erosion, Sedimentation	-	Medium	Medium	Medium +	Very High* +
Herbicides & Pesticides	-	Medium	High*	-	-
Unintentional effects: large scale	-	-	Medium	-	-
Type Unknown/Unrecorded	-	-	-	-	-
Garbage & Solid Waste	-	Medium	Medium	Low	Low

* Conservation priority threats

\+ Difference in expert ranking (highest rank presented)

J. Climate Change & Severe Weather

Climate Change & Severe Weather appear to have the greatest impact on marine species and ecosystems. Habitat Shifting & Alteration has the most wide-spread impact, affecting all five targets assessed but to varying degrees. The greatest impact of Habitat Shifting & Alteration was reported on marine fish and coral reef ecosystems as 'Very High', followed by marine mammals as 'High' (Table 19). Habitat Shifting & Alteration was attributed to climate-related coral bleaching, degrading critical habitat, and leads to changes in the abundance of highly specialized reef fish. However, for marine mammals, these impacts were more concerned with potential future impacts, reported by assessors as requiring more study. Temperature Extremes was reported to be the most pervasive long-term threat to coral reefs in Kenya.

The interconnectedness of the Habitat Shifting & Alteration and Temperature Extremes was highlighted by assessors such that climate change driven temperature increases induced coral bleaching, which led to shifts/alterations in coral reef ecosystems. Global consensus was reached that the impact of climate-related coral bleaching and mortality are more significant threats to coral reef ecosystems than the impacts from anthropogenic sedimentation, pollution, and exploitation (Wilkinson, 1999). Increased rainfall and extreme storms, which caused coastal beach erosion and destruction of coral reefs and other marine habitat, were reported to have a 'High' impact on fish.

Other impacts such as ocean acidification was reported to have similarly high impacts due to the profound effects on fish skeletons, and coral and plankton calcification. Mobile or migratory marine mammals may be better adapted to responding to climate-related habitat changes than resident species (Simmonds and Isaacs, 2007). Assessors reported potential changes in behaviour (breeding and feeding patterns), movement, and overall health of resident and migratory marine mammals as a result of climate change.

Table 19: Impact of *Climate Change & Severe Weather* on target species and ecosystems in Kenya.

Threats	Target Species and Ecosystems				
	Amphibian	*Bird*	*Mammal*	*Fish*	*Coral Reef*
Habitat Shifting & Alteration	Medium	High +	High	Very High* +	Very High*
Droughts	Medium	-	-	-	-
Temperature Extremes	Low	-	High	Medium	Very High*
Storms & Flooding	Low	-	-	High	Medium
Other Impacts	-	-	-	Very High	Medium

* Conservation priority threats

\+ Difference in expert ranking (highest rank presented)

4.1.3 Simplified Threat Assessment Tool (STAT)

Assessors representing government institutions, private sector, and NGOs identified a total of 32 (level-two) threats using the IUCN-CMP Threat Classification System through the Simplified Threat Assessment Tool (STAT). Out of the 32 threats, four were considered to be top threats, such that assessors perceived these threats to have the greatest impact on biodiversity in Kenya (Figure 14). Hunting & Collecting Terrestrial Animals was reported by 100% of assessors and also most frequently reported threat perceived as having the greatest impact on biodiversity in Kenya.

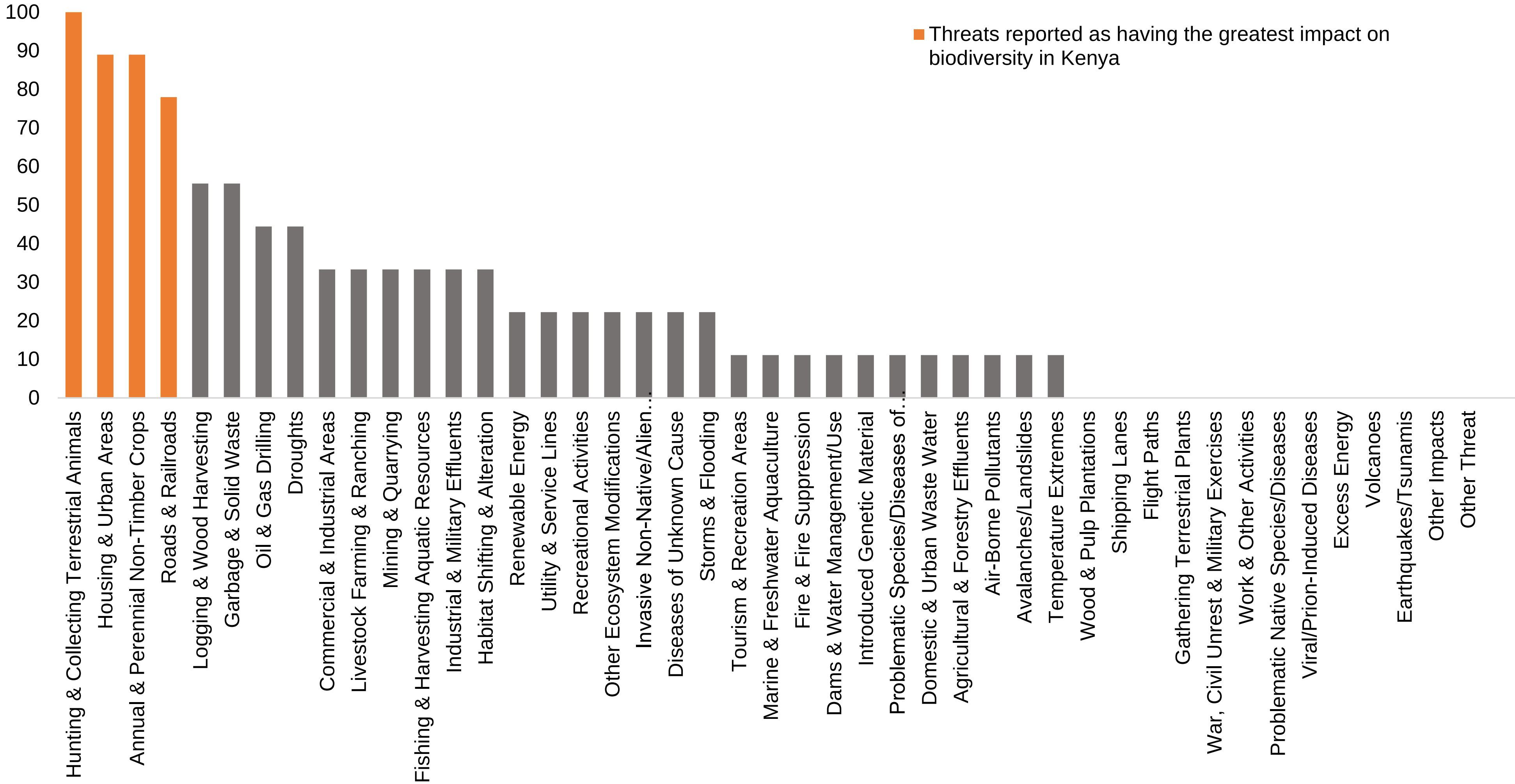

Figure 14: Frequency (%) of IUCN-CMP Threat Classification System level-two threats reported by assessors using the Simplified Threat Assessment Tool (STAT).

4.2 County Level

Using a combination of the Tyrell species (mammal, amphibian, and bird) richness maps and STAR threat abatement score maps, we were able to narrow down to the priority biodiversity hotspot areas (dark blue) and areas which have the most potential for threat abatement (red zones). The counties of Nyandarua, Kilifi, Kwale, and Taita Taveta, all demonstrate a clear overlap and can be considered as priorities.

4.2.1 Case Study 1: Nyandarua County

Nyandarua County (3, 245 km²) is located within the fertile Central Kenyan Highlands, bordering Nyeri, Nakuru, Laikipia, and Kiambu Counties (MoALF, 2016a). The county is divided into five administrative sub counties, whose largest town and county headquarters are in Ol Kalou (County Government, 2020). Agriculture is the main economic activity in the county with over 80% of farmers engaged in small-scale crop (potato, carrots, cabbage, garden peas, and other vegetables) or dairy farming. Cow milk and beef contributed the most to livestock income, while Irish potato and cabbage contributed the most to crop income (MoALF, 2016a).

A. Biodiversity

Areas of Biodiversity importance include the Aberdare Range forests (Aberdare and Kipipiri Forests), Lake Ol Bolossat, and the Kinangop Plateau grasslands. The Aberdare Range is designated as a KBA, and the highest peak is over 4,000 m a.s.l. One of Kenya's five main water towers, the range and its forest ecosystem, feed six rivers: the Athi, Malewa, Ewaso Ngiro, Tana, Chania, and Thika. Over 50% of the country's hydropower is generated through dams from three of these rivers (NEMA, 2011). Located on the eastern edge of the Rift Valley, The Aberdare Forest ecosystem, covers an area of 226,522 (Wambugu et al., 2018) to 256,515 ha (NEMA, 2011). The forest is located between longitude 36°30‟E and 36°55‟E and latitude 0°05‟S and 0°45‟S (Wambugu et al., 2018). The entire Aberdare ecosystem does not occur neatly within the county borders as the border of Nyeri county cuts through the Aberdare National Park and Forest Reserve from North to South. An area of 760 km² of the forest falls within the Aberdare National Park (NEMA, 2011).

Lake Ol Bolossat is a freshwater lake and one of the major wetlands within the Ewaso Ng'iro North basin (MEMR, 2012). The Lake spans 43 Km², located at latitude of 0º 09'S and longitude 36º 26'E at an average altitude of about 2340 m (Zacharia et al., 2013). The entire catchment area is approximately 4800 km² (Zacharia et al., 2013). A KBA, the lake and its catchment consist of a variety of important habitats for threatened biodiversity including swamps, marshes, forests, and springs

(MEMR, 2012). The wetland is surrounded by small-scale dairy and horticultural farmers who rely on it for irrigation (Njeri and Kinyamario, 2012; Zacharia et al., 2013), and grazing livestock (Njeri and Kinyamario, 2012).

The Kinangop Plateau (0°32′–46′S; 36°29′– 38′E), a designated KBA, is dominated by high altitude (2,400–3,000 m) montane grassland, supporting several endemic species (Muchai et al., 2002). Small-scale crop farming and livestock rearing dominate the landscape with an increasing number of exotic tree plantations (Muchai et al., 2002).

B. Threats

Threats impacting the forests include charcoal production, logging, settlements, agriculture (crop farming), and livestock grazing (NEMA, 2011). Fencing was recommended as an important factor in halting deforestation. However, blocking migratory pathways of large mammals such as elephants, could lead to forest destruction in the long-term due to elephant activities. At the time of writing a new plan by Nyandarua County to hive off 163 acres from Aberdare National Park for expansion of Ndaragwa township, along with the new Mau highway through the forest, have emerged as additional threats to this ecosystem[19].

Since 1993, subdivision of land parcels within the Lake Ol Bolossat catchment area has caused significant habitat fragmentation (Zacharia et al., 2013), while land-use changes have led to siltation, overgrazing, degradation of riparian land, agrochemical pollution, and excessive water abstraction (MEMR, 2012). The lake significantly shrunk in size by 68% between 1989 and 2010 due to significant land-use changes occurring around the region. Commercial and subsistence agricultural farms adjacent to the lake increased by 31%, while deforestation upstream was considered to be responsible for the decrease in forest cover by 30%. A reduction by 26% in floodplains were also recorded as a result of farmland encroachment. Settlement and urban development increased by 33% in response to increasing human population (Zacharia et al., 2013). Improved land and water management are needed to tackle concerns over the dwindling lake levels and extensive land use changes around the lake.

Dairy farming has been the predominant land use in the Kinangop plateau since 1964, however in recent decades natural grassland is being converted into crop farms (e.g. wheat, barley, maize, beans etc.) and exotic tree plantations (e.g. Eucalyptus). Overgrazing, burning, and removal of perennial tussock grass has also further degraded any remaining grasslands.

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[19] https://www.businessdailyafrica.com/news/counties/Nyandarua-eyes-Aberdare-Forest-to-expand-town/4003142-5579026-11g1lfp/index.html
https://www.nation.co.ke/kenya/news/controversy-dogs-road-to-be-built-through-aberdare-forest-240952

4.2.2 Case Study 2: Taita Taveta County

Taita Taveta is one of six coastal counties of Kenya located covering 17,084.1 km² (Government of Kenya, 2017b) and lies between latitudes 2046' South and 4010' South and longitude 37036' East and 30014' East (GoK, 2018). Administratively, the county is divided into four sub-County units namely: Wundanyi, Mwatate, Voi, and Taveta. The county headquarters is in Mwatate. The county is divided into three major topographic zones which include Taita, Mwambira, and Sagalla Hills. Within the Taveta region, water bodies consist of Lake Jipe and Lake Chala, three rivers (Tsavo, Lumi, and Voi), and ten springs (GoK, 2018).

A. Biodiversity

Areas of Biodiversity importance include Mt Kasigau, Mt Sagala, and Taita Hills which are all part of the Eastern Arc Mountains, and Tsavo (East and West) National Park. Tsavo National Park accounts for 62% of the entire county land area (MoALF, 2016b; Government of Kenya, 2017b). Forest reserves cover approximately 1,108 ha while Trust Land covers 5,275 ha, with an additional six community forests (Government of Kenya, 2017b).

In both Tsavo National Parks, the largest parks in Kenya, significant declines by 63% to 89% of wildlife were recorded between 1977 – 2014 (Ogutu et al., 2016). However, Tsavo West is only included within the boundary of Taita Taveta County, while Tsavo East is divided between Taita Taveta, Kitui, and Tana River counties. During a survey of wildlife between 1977 to 1997, Tsavo National Park exhibited the some of the steepest declines out of seven of Kenya's protected areas surveyed (Western et al., 2009).

The Taita Hills, the northernmost part of the Eastern Arc Mountains are a global biodiversity hotspot and critically important area for conservation (Bytebier, 2001; Maeda et al., 2010). Taita Hills are located between 3°15' - 3°30' S and 38°15 – 38°30' E, in Taita Taveta County (National Museums of Kenya, 2001). They consist of indigenous cloud forest with high levels of species richness and endemism with a mere one percent of the original range still persisting (Maeda et al., 2010). Three bird endemics (Brooks et al., 1998) are known - the Taita Thrush (*Turdus helleri)*, Taita Apalis (*Apalis fuscigularis)*, and Taita White-Eye (*Zosterops silvanus)* - all of which are on the brink of extinction (Table 4). Three amphibian endemics (Measey, Malonza, and Muchai, 2009), are recorded, one of which is the Critically Endangered Taita Warty Frog (*Callulina dawida*) (Tyrell et al., 2019; Table 6). A survey conducted by the National Museums of Kenya (2001), found 26 species of small mammals in forest fragments which included the first record of climbing shrews (*Sylvisorex spp.*) in south-eastern Kenya.

B. Threats

Wildlife declines in Tsavo were attributed to agricultural expansion and subsequent range loss, as well as the bisection of the park by a highway into East and West, obstructing wildlife movements (Western et al., 2009). Human-Wildlife Conflict was also cited as a frequent occurrence, potentially threatening wildlife in Tsavo (Mukeka et al., 2018) due to retaliatory killings by farmers.

A long list of threats in Taita Hills has been identified in the literature including, expansion of settlement, agriculture, livestock grazing, extraction of firewood and building materials, fires, and exotic tree species (EAWLS, 2005 in Pellikka, 2013). Since only around 22% of the county total land area is available for settlement and economic activities (Government of Kenya, 2017b), there is a lot of pressure from population growth on remaining forests and natural areas.

Climate change is also likely to have a significantly large impact on the remaining tracts of cloud forest that are already restricted to the highest altitudinal band.

Agroforestry is widely practiced throughout the county (MoAFL, 2016b) of which Eucalyptus plantations have a large impact on ground water and streams leading to severe water scarcity during the dry seasons in Sagalla (Measey, Malonza, and Muchai, 2009).

Agricultural expansion was considered the greatest threat to the Taita Hills, leading to near disappearance and continued degradation of indigenous cloud forests (Maeda et al. 2010; Maeda 2012). The forests are 12 fragmented islands (400 – 600 ha) restricted only to the highest peaks and steepest slopes, surrounded by settlements and farms (Pellikka et al., 2009; Nature Kenya et al., 2015). Although ranching is the most extensive land use covering 77,350 ha, it is practiced primarily in the lowlands. Small-scale farming occurs in the highlands and midlands (MoAFL, 2016), and is likely to be the main activity expanding into forests. It was projected that by 2030, almost 60% of the Taita Hills will be occupied by agriculture (Maeda, 2012).

C. Environmental Management and Policy

Precipitous declines in the indigenous forests has slowed due to participatory forest management and conservation (Himberg et al., 2009). A five-year Action Plan from 2015 – 2020 for the conservation of critically endangered birds of Taita Hills was developed for implementation by various stakeholders (Nature Kenya et al., 2015). A Taita Taveta County Environment and Forest Act, 2018[20] was passed to manage, protect, and conserve the environment and forests within the county. Implementation and updating of existing management plans, such as the Lake Jipe Basin Integrated Management Plan (2009-2014) and the Taita Taveta District Development Plan (1997-2004) by the county government to mitigate the impacts of pollution, are recommended (Government of Kenya, 2017b).

[20] http://kenyalaw.org/kl/fileadmin/pdfdownloads/bills/2018/TheTaitaTavetaCountyEnvironmentandForestBill_2018.pdf

5. Discussion

This study set out to assess direct threats to biological targets in Kenya and rank their severity to determine which threats are having the greatest impact on biodiversity in Kenya. The purpose of the assessment was to identify two economic sectors driving the highest impacting threats to prioritise them for engagement through the BIODEV2030 Project.

Table 20: Summary of threats with severe (“Very High’ & ‘High’) impacts from the EbTAT and STAT with their corresponding STAR threat abatement scores.

	IUCN-CMP Level-two Threats with Severe (Very High & High) Impacts	STAR Threat Abatement Score	Priority for Conservation Action Threats	Most Frequently Reported as a Threat - STAT	Most Frequently Reported as Most Severe Threat - STAT
1	Annual & Perennial Non-Timber Crops	2722	✓	✓	✓
2	Logging & Wood Harvesting	1897	✓	✓	
3	Hunting & Collecting Terrestrial Animals	611	✓	✓	✓
4	Housing & Urban Areas	375	✓	✓	✓
5	Habitat Shifting & Alteration	330	✓	✓	✓
6	Dams & Water Management/Use	303	✓		
7	Agricultural & Forestry Effluents	256	✓		
8	Invasive Non-Native/Alien Species/Diseases	146	✓		
9	Roads & Railroads	37		✓	
10	Tourism & Recreation Areas	23			
11	Oil & Gas Drilling	12	✓	✓	
12	Commercial & Industrial Areas	8			
13	Fishing & Harvesting Aquatic Resources	2	✓		
14	Temperature Extremes	1	✓		
15	Domestic & Urban Waste Water	0.04	✓		

In Chapter One, it was demonstrated that the general trend for biological targets in Kenya were declines in populations of mammal, bird, amphibian, and fish and coral reef ecosystem degradation. In Chapter Two, the threats driving the species declines and ecosystem degradation of biological targets were assessed. Data or information on impact severity of direct threats to biodiversity in Kenya is currently lacking in published and grey literature. STAR Metric threat abatement scores for Kenya were therefore used as a primary means to assess threat severity. To gather rich threat data for Kenya and due to the limitations of the STAR Metric to adequately represent marine and freshwater biodiversity, expert knowledge was incorporated into the study.

Since STAR threat abatement scores were 12% higher than restoration scores, the potential to reduce species declines and extinction risk in Kenya is higher from threat abatement than restoration. In addition, for restoration to be effective, threats must first be abated. This is to ensure that the restored habitat can viably support the species for which it is being restored. It was for these reasons that threat abatement scores was the focus over restoration scores for Kenya.

The threat score indicates the potential contribution the site-based abatement of this particular threat could make to halting declines in species survival probability in this area. The higher the score per threat, the greater the potential conservation benefit for species.

5.1 Crop Farming, Logging and Wood Harvesting

STAR threat abatement scores were highest for Annual & Perennial Non-timber Crops (Non-timber Crops), followed closely by Logging & Wood Harvesting suggesting that these two threats have the highest impact on biodiversity but also offer the greatest potential to improve species survival probabilities if abated. Further emphasising the threat from Non-timber Crops, it was one of the most frequently reported threats by assessors using the STAT. Non-timber Crops was also perceived by assessors to be one of four top threats impacting biodiversity in Kenya. Farming leads to the loss of habitats displaced by crops and a reduction in the abundance of species supported by the converted land (Perrings and Halkos, 2015).

Using the EbTAT, expert assessors reported that economic activities such as Agro-industry and Small-holder Farming associated with Non-timber Crops posed severe threats to terrestrial biological targets. The severity of the impact on biodiversity (especially birds and amphibians) from Non-timber Crops is scale dependent, with agro-industry farming ranked as having a higher impact than small-scale farming. This is also likely the case for mammals, however level-three threats for mammals were not assessed.

Although small-scale farming is the predominant form of agriculture in Kenya, the use of inputs such as fertilizer, pesticides, and machinery is lower than in large-scale intensive farming (Government of Kenya, 2010), which could account for its lower impact on biodiversity. If we were to review and compare the extent of land-area under both types of farming, we may find an altogether different scenario, however these data were only accessible for 2000 (Figure 15). Intensive farmland 20 years ago represented a small proportion of agroecosystems in Kenya, mainly concentrated in the central highlands producing wheat, tea, sugarcane, rice, and maize (WRI et al., 2007). Most of the landscape consisted of 50 – 60% active cropland mixed with forests or woodlots (WRI et al., 2007). The current extent of land under agriculture (crop and pasture) is vast, covering over 45%[21] of Kenya's land area, of which 10-12% is arable. This is land capable of supporting production of tea, coffee, horticulture, floriculture, maize, wheat, potatoes etc.

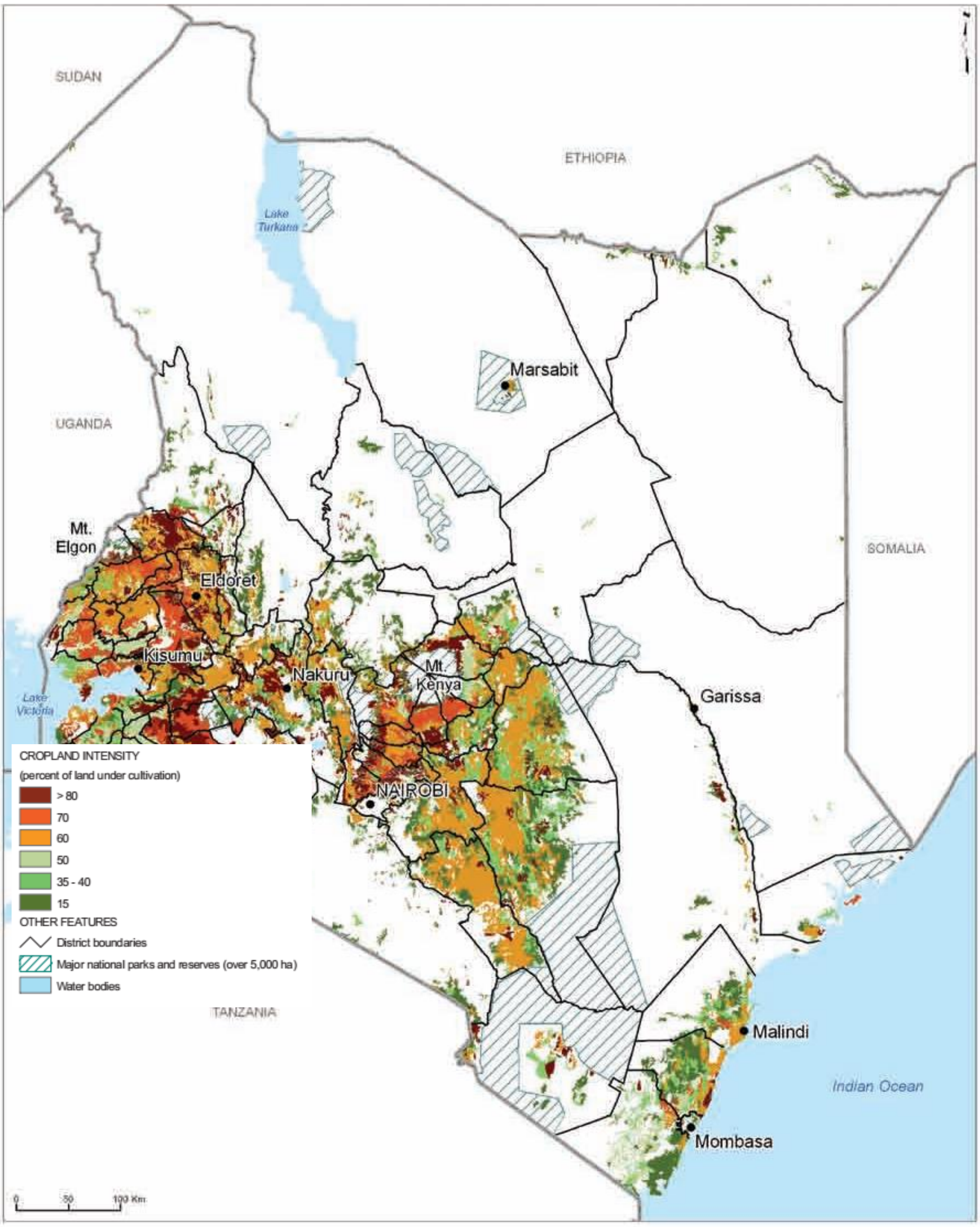

Figure 15: Intensity of Crop Cultivation in Kenya in 2000 (WRI et al., 2007).

[21] https://tradingeconomics.com/kenya/agricultural-land-percent-of-land-area-wb-data.html

Although Logging & Wood Harvesting had the second highest STAR threat abatement score, it was only reported by expert assessors using EbTAT as a severe threat for mammals. This impact was primarily related to unintentional effects of Logging & Wood Harvesting at both large and small scale. Logging and wood harvesting especially in indigenous forest is often a product of agricultural expansion. Charcoal, firewood, and timber extraction are activities which facilitate this process and lead to deforestation (Figure 16). They are also often linked to poaching and bushmeat hunting of forest species. In this context, there is a stronger association with small-holder crop farming. These threats are intricately linked to one another both driven by economic activities associated with the agricultural and forestry sectors.

When considering other threats associated with agricultural and forestry activities such as effluents, it is clear that the consequences are far reaching and severe, impacting terrestrial, freshwater, and marine biodiversity. Compared to other forms of pollution, the impact of effluents from agricultural and forestry activities was the greatest on biodiversity, with the exception of birds, but hugely impacting amphibians and freshwater fish (Minnesota Pollution Control Agency, 2008). Once in water systems, rivers eventually carry the effluents downstream into the ocean introducing harmful nutrients and chemicals to marine biota (Wafar et al., 2011).

5.2 Hunting, Crop Farming, and Livestock Farming

Hunting & Collecting Terrestrial Animals was reported by 100% of assessors as a threat using the STAT and considered to be a top threat. It was also ranked as a severe threat by expert assessors using the EbTAT. As the threat with the fourth highest STAR threat abatement score, it has a high potential to increase species survival probabilities if abated. Other studies found that Hunting & Collecting (e.g. poaching and HWC) was also the most frequently reported and severe threat affecting biodiversity in Kenya (Kiringe et al., 2007; Okello and Kiringe, 2010), and globally (Schulze et al., 2017), however these studies focused only on PAs.

To better understand the impact of land-uses such as agriculture, the focus must be on private and communal lands outside of PAs. This is especially true for Kenya when considering that most of its biodiversity occurs outside PAs (Ogutu et al., 2016; Tyrell et al., 2019). Biodiversity in these human-dominated landscapes face some of the greatest pressures from economic-activities (Di Marco, Venter, Possingham, & Watson, 2018 cited in Tyrell et al., 2019).

HWC, poaching, and agriculture were among seven major threats to wildlife across 21 rangeland counties in Kenya (Ogutu et al., 2016). Agricultural activities can also lead to HWC, persecution, and control (threats categorised under Hunting & Collecting). This is particularly true adjacent to PAs or areas with high wildlife densities where agriculture has led to land use changes and subsequent habitat loss (Mukeka et al., 2018), and increased the number of encounters between people and wildlife. Conflict hotspots in Kenya are around Mau, Laikipia, Transmara, Tsavo, Athi Plains, and Lamu (Houdet et al., 2015; Figure 17).

HWC is most commonly associated with crop and livestock farming, where crop raiding is the most common type of conflict, followed by livestock depredation (Mukeka et al., 2018). Livestock Farming & Ranching had the third highest STAR threat abatement score and reported as having a 'High' impact to mammals due to HWC. In cases involving HWC, the 'relevant' threat to biodiversity is the act of retaliation by farmers towards wild herbivores which raid crops and carnivores which attack livestock. In these situations, the use of poison and poison baits is common. Mammals and birds were the most adversely impacted targets, of which birds appear to disproportionately suffer the greatest losses in numbers, e.g. birds of prey (Ogada et al., 2016). It is therefore surprising that the impact on birds from Persecution & Control was ranked 'High' rather than 'Very High'. Assessors may have felt that the threat was moderately reversible with only a small percentage of species affected. Also noteworthy was some ambiguity between level-three threats under Hunting & Collecting resulting in ranking difficulties for assessors.

Electric fencing of wildlife areas adjacent to farms was promoted in Kenya's Agricultural Strategy to mitigate HWC (Government of Kenya, 2010). In Tsavo PAs, KWS intensified fencing efforts to restrict elephant movement where they accounted for 64% of reported HWC-related cases (Mukeka et al., 2018). While fences may help to prevent HWC for larger mammals, they are not effective for smaller ones e.g. baboons (Kassily et al., 2008). Fencing can also cause long-term challenges associated with halting dispersal and movements, such as inbreeding and isolation, overabundance, loss of genetic diversity and evolutionary potential, (Hayward and Kerley, 2008) and habitat degradation.

5.4 Development, Infrastructure, and Transport

Housing & Urban Areas reported by over 85% of assessors in the STAT, had the fifth highest STAR threat abatement score and was considered a priority for conservation action in the EbTAT. Housing & Urban Areas were considered to be primarily associated with uncontrolled expansion leading to habitat loss and fragmentation especially where land-use planning regulations were not adhered to. However, expert assessors using EbTAT reported Commercial & Industrial Areas to have a more severe impact on four out of five biological targets assessed compared to Housing & Urban Areas. Expert assessors were concerned about the impact on biodiversity from large developments such as ports driven by the LAPSSET Corridor Program (Vasquez, 2013). Other developments linked to LAPSSET such as The Standard Gauge Railway Lines were criticized by conservationists for their ecological footprint. Constructed railway lines led to blockages of important migratory pathways for large mammals, especially around PAs (e.g. Tsavo) and encroached on over 87 hectares of the Nairobi National Park (Ambani, 2017). In addition, proposed road networks through PAs in Nyandarua

County are perceived to be unconstitutional and likely to have a severe impact on biodiversity. Therefore, over 80% of assessors reported Roads & Railways as a severe threat to biodiversity using the STAT and expert assessors using EbTAT reported the impact to be greatest to mammals.

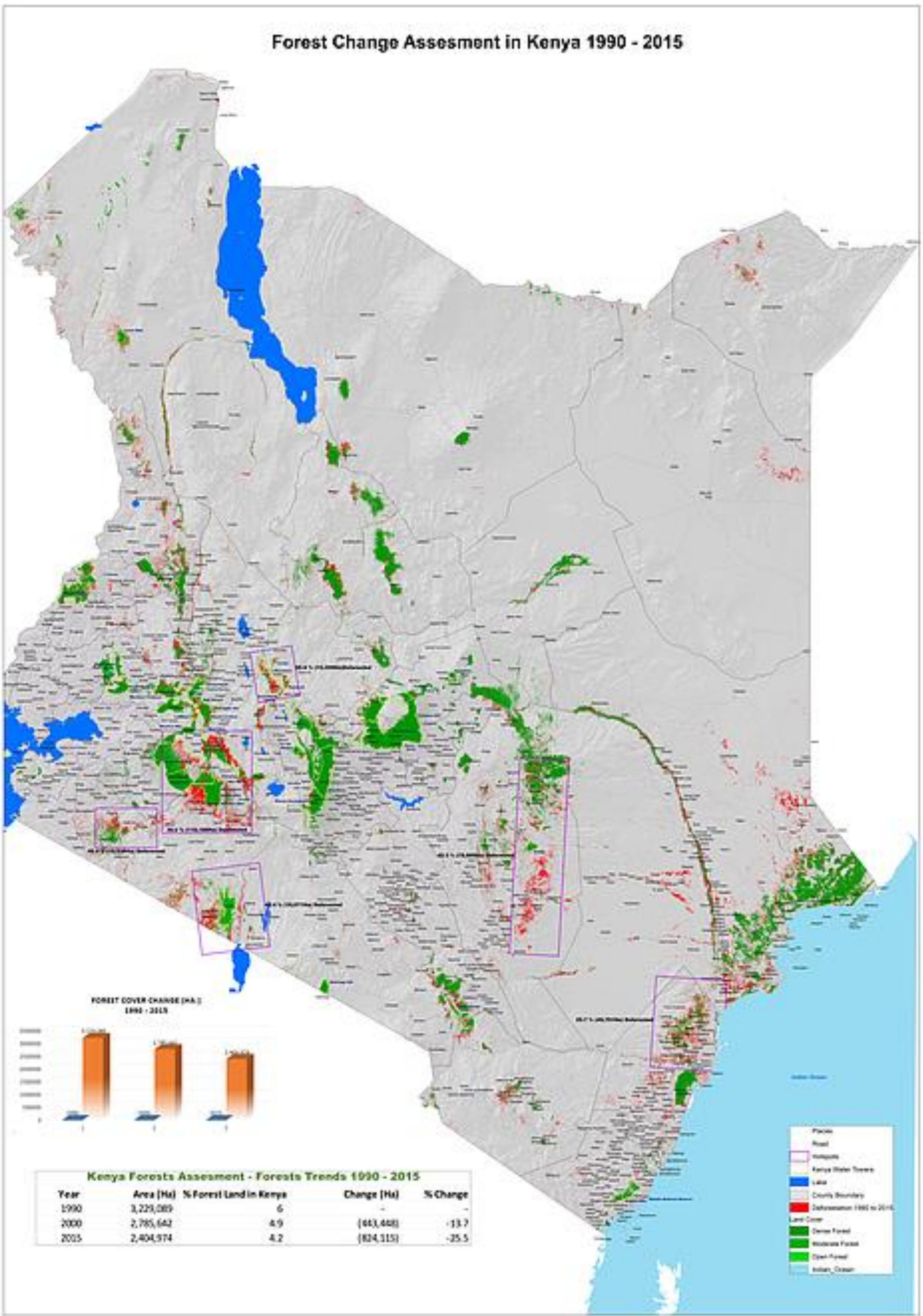

Figure 16: Deforestation Map of Kenya Source:
https://www.wwfkenya.org/keep_kenya_breathing_/state_of_forest_in_kenya/

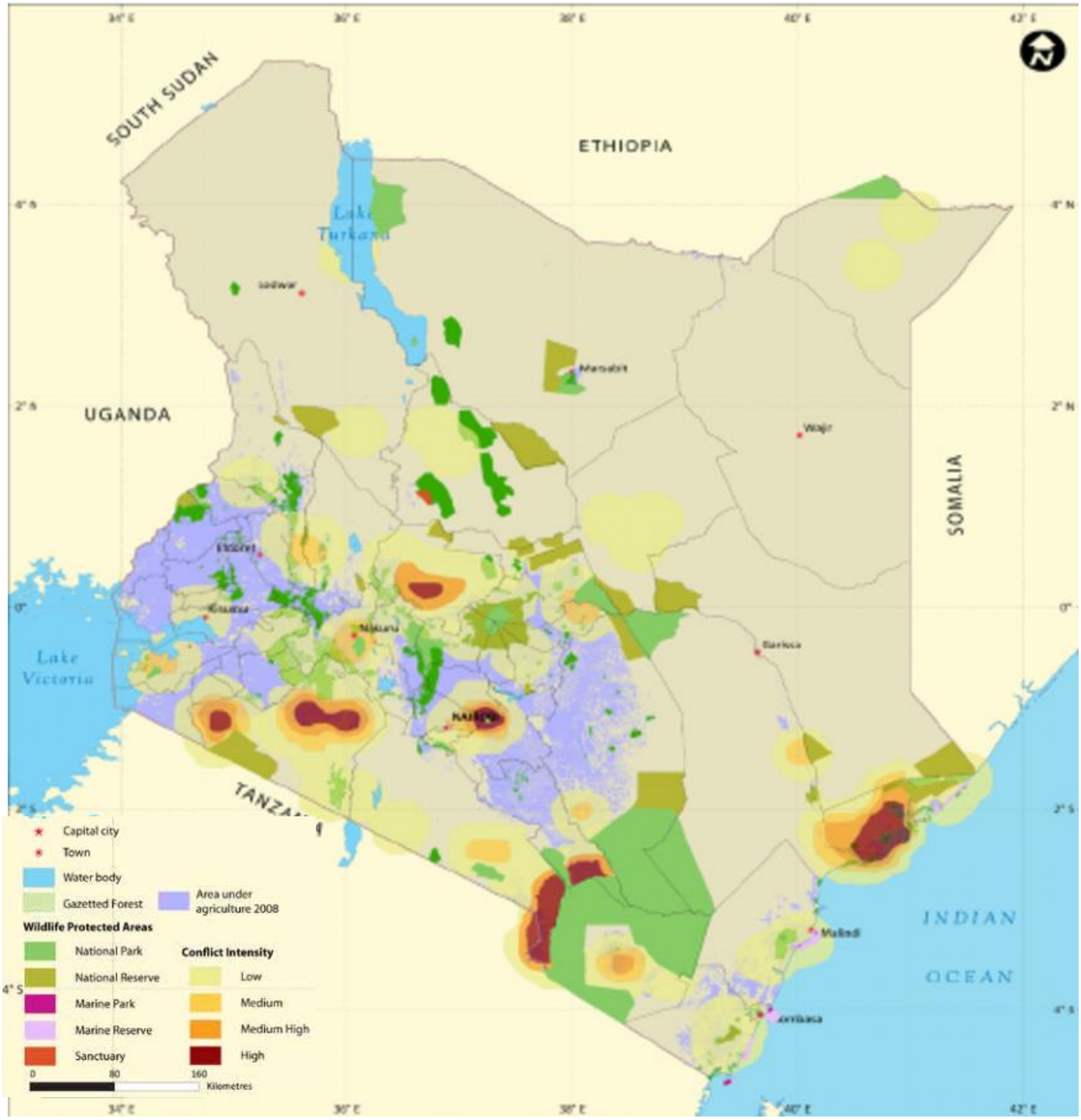

Figure 17: Human-Wildlife Conflict hotspots across Kenya in relation to national parks. The heaviest conflicts are in Laikpia, Mau, Transmara, Tsavo, Athi plains and Lamu. Source: KWS. (Houdet et al., 2015)

5.5 Climate Change, Fishing, and Oil Prospecting

Climate related Habitat Shifting & Alteration had the greatest impact on marine targets using the EbTAT. However, it had low STAR threat abatement scores and was not very frequently reported by assessors using STAT. It is likely that the limitations of STAR, the small number of assessors who used STAT and inherent biases among assessors favouring terrestrial over marine biodiversity led to these results. The threat data from the EbTAT are likely the most reliable for marine biodiversity in this study and should be given emphasis over STAT and the STAR Metric results. This also applies to Fishing & Harvesting Aquatic Resources and offshore Oil & Gas Drilling.

After climate related threats, Oil & Gas Drilling and Fishing & Harvesting Aquatic Resources were the most severe threats to marine targets, according to study findings.

Oil & Gas is still an emerging sector where activities offshore are mainly for prospecting (Nyaberi and Rop, 2014; Figure 18) and therefore low impact based on expert assessors using the EbTAT. However, expert assessors reported the potential for severe impacts to the entire marine and coastal zone of Kenya, should considerable deposits be found.

In contrast, Fishing & Harvesting Aquatic Resources is a threat that currently has a severe impact on both marine and freshwater targets. Overfishing and destructive fishing gear not only have an impact on the target species but also on non-targets species and habitats. At both small and large-scales, fishing was a threat to freshwater and marine fish. In Marine areas, national parks were shown to help increase densities of some fish species (including commercially important ones) or reduce declines while national reserves showed no positive effect (Fondo et al., 2014; Samoilys et al., 2017). Overfishing leaves fewer and smaller fish which leads to changes in the ecology of coral reef ecosystems (Fondo et al., 2014).

Marine fisheries include small-scale, semi-industrial, industrial, aquarium, and recreational types. The sector contributed around 10% (160,000 mt) of the total national fishery production, while freshwater fisheries contribute 90% of fish catch (Kimani et al., 2018). Fish and fisheries are important for food security, employment, and poverty alleviation in Kenya (Fondo et al., 2015), with over 60,000 fishers and a further 1.2 million people involved in the production and supply chain (Kimani et al., 2018). The main freshwater fishing grounds in Kenya are four lakes (Lakes Victoria, Turkana, Naivasha, Baringo) and five rivers (Tana, Athi, Sabaki, Nzoia, and Yala Rivers) (Kimani et al., 2018). The main marine fishing areas are inshore lagoons, reefs, and deep waters of coastal and open ocean ecosystems (Fondo et al., 2015).

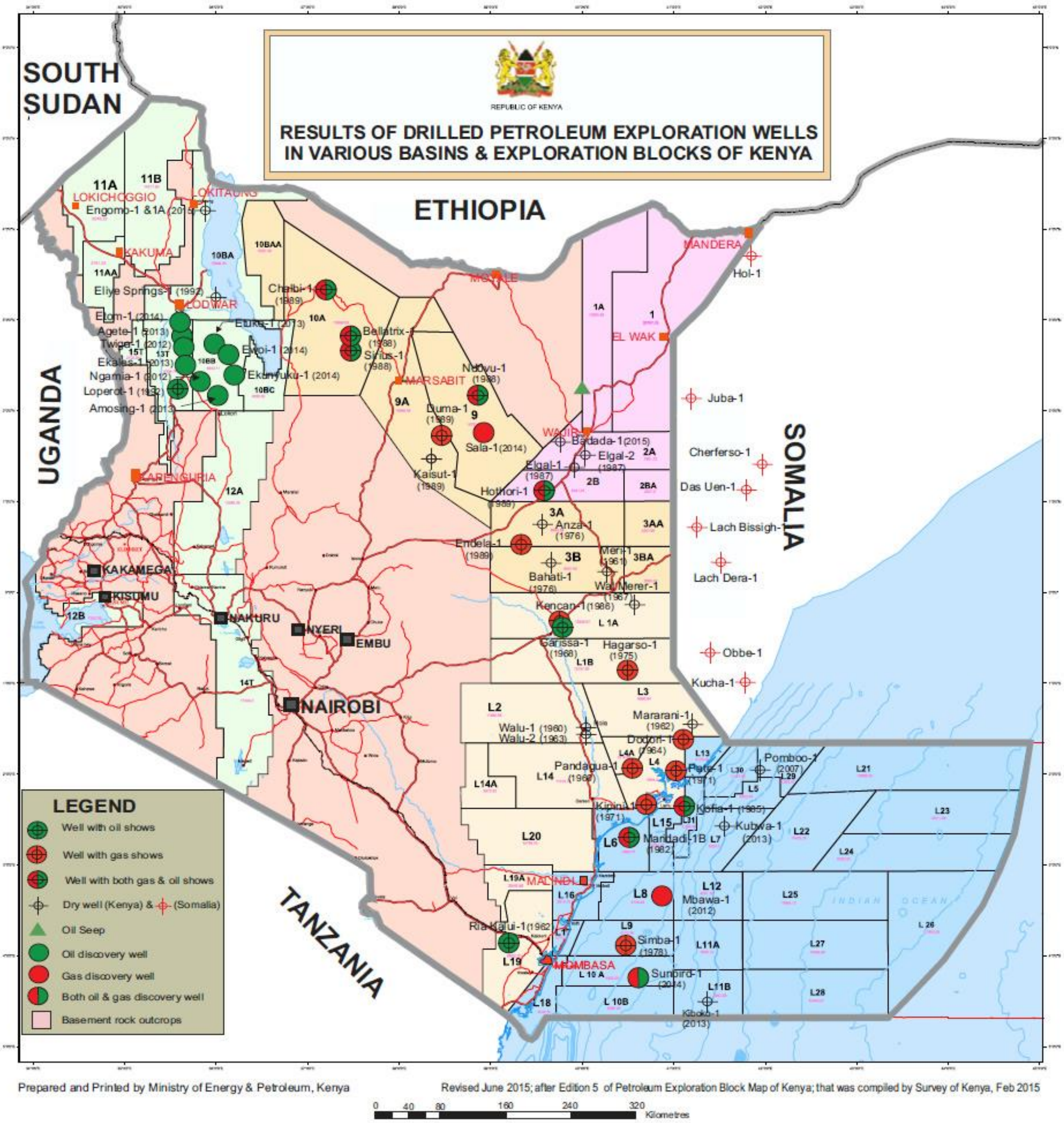

Figure 18: Results of Drilled Petrolium Exploration Wells in Various Basins and Exploration Blocks in Kenya. (GoK 2015) *Source*: https://nationaloil.co.ke/opportunities-for-oil-exploration/

5.6 Study Limitations

- A small number of assessors (n=9) undertook the STAT, therefore it is difficult to make any concrete conclusions based on the output.
- The STAR metric, only covering mammals, birds, and amphibians, does not represent aquatic and marine species well. The only representation of marine systems are marine mammals, and amphibians and water birds for freshwater systems. Plants are not covered either.
- There may be inherent biases even among biodiversity experts when presented with 'biodiversity' assessments favouring terrestrial species and ecosystems over aquatic ones. Therefore, it was important to break down the assessment into key species and ecosystems that are representative of all three realms.
- Not all experts were able to pinpoint threats at the scale of level three, so there were some differences in scale between assessment tools that made it difficult for seamless cross comparison.
- Experts on plants did not participate in the assessment, therefore plants were subsequently excluded from the report.
- Experts on freshwater fish did not participate in the assessment so the data is biased towards marine fish.

6. Conclusion

This study set out to identify threats with the greatest impact on biodiversity in Kenya and the economic sectors driving them. Differences in threats and their impacts were found between terrestrial and aquatic (marine and freshwater) biodiversity. Based on the study findings, Annual & Perennial Non-timber Crops and Hunting & Collecting Terrestrial Animals had the greatest impact on terrestrial biodiversity, while climate related Habitat Shifting & Alteration had the greatest impact on aquatic, particularly marine biodiversity, followed by Oil & Gas Drilling and Fishing & Harvesting Aquatic Resources. The economic sectors driving these threats were identified as agriculture, forestry, energy, and fisheries.

It was evident that several high impact threats with equally high threat abatement scores were linked either directly (Non-timber Crops) or indirectly (Logging & Wood Harvesting and Hunting & Collecting) to agricultural activities, of which crop farming was most prominent. During the CBD drafting workshop, participants from MoEF, KFS, and NEMA also concluded that the agricultural sector had the greatest impact on biodiversity.

Non-timber Crop Farming and Logging & Wood Harvesting had the two highest STAR threat abatement scores. When also considering the intricate links between agricultural (crop) expansion, effluents, logging, and wood harvesting, the potential to reduce species declines is multiplied significantly by focusing on synergies between the agriculture and forestry sectors. Effluents from agricultural and forestry activities, compared to other forms of pollution, had a large impact on freshwater biodiversity, especially on amphibians and freshwater fish.

Focusing on the agriculture and forestry sectors alone will not adequately represent Kenya’s freshwater biodiversity and less so its marine biodiversity. Climate related Habitat Shifting & Alteration was the greatest ranked threat to marine targets, however abating these threats may be challenging. Numerous economic sectors contribute to green-house gas emissions and would require concerted efforts across sectors at the national and even global levels to be effective. Climate change action requires considerable coordination and effort and may be beyond the scope of the BIODEV2030 project. After climate related threats, Oil & Gas Drilling and Fishing & Harvesting Aquatic Resources had the greatest impact on marine targets. Considering the effort required to address climate change, focusing on abating these two threats through the energy and fisheries sectors may be more appropriate. While prospecting for oil and gas is an emerging sector in Kenya with potentially high impacts on biodiversity in the future, the threats from fishing and harvesting are current and the impacts high. Therefore, the potential to abate threats to marine biodiversity through an economic sector is best demonstrated by engaging with the fisheries sector. In addition, engaging with the fisheries sector is also important for threat abatement to freshwater biodiversity.

7. Recommendations

Marine, freshwater, and terrestrial biodiversity should be given equal consideration when setting voluntary commitments, thus avoiding any inherent biases favouring one over the others. To effectively conserve terrestrial, marine, and freshwater biodiversity in Kenya, it is recommended that the agriculture, forestry, and fisheries sectors are prioritised for engagement when setting voluntary commitments through BIODEV2030.

The following recommendations have been made to help guide the process of establishing voluntary commitments:

1. *Spatial Prioritisation and Key Biodiversity Areas avoidance:* In Kenya, areas where intensive crop farming is concentrated coincide with areas harbouring the highest species richness and remaining indigenous forests in the central highlands and parts of western and coastal Kenya. Establishing voluntary commitments focusing on intensive crop farming in these areas may have a high potential to conserve biodiversity. Avoiding Key Biodiversity Areas (KBA), when implementing development project will contribute to conserve biodiversity.

2. *Stakeholder Engagement:* When establishing voluntary commitments, engaging stakeholders involved in large-scale or agro-industry farming which is widespread throughout Kenya will be most effective at the national level. Engaging small-scale farmers will be most effective at the county level, especially in the areas identified as having the highest biodiversity e.g. central highlands. NGOs, IUCN members could be involved depending on their core activities to support initiatives on the ground. Multi-stakeholder engagement will be critical for establishing voluntary commitments on freshwater and marine fisheries sectors and should focus on improving overall regulation (e.g. fishing effort, gear, catch quotas, species etc.) by state actors as well as compliance by private sector actors. Controlling access, improving catch data collection, and improving governance of fishers could be important aspects of fisheries management to consider during voluntary commitment negotiations.

3. *Sectoral Linkages:* Identifying synergies between economic sectors while defining voluntary commitments will strengthen their threat abatement potential as seen with agriculture and forestry. For example, the links between logging, charcoal production, and forest clearing as catalysts for agricultural expansion, or agricultural and forestry activities leading to effluent discharges into water systems. Voluntary commitments could foster enhanced coordination between sectors to facilitate biodiversity mainstreaming and development of integrated biodiversity management plans. This will also contribute to the simultaneous achievement of climate change targets as well as land degradation neutrality.

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9. Appendices

Appendix A: Global Ecological Zone Typology for Kenya (Keith et al., 2020).

	Realm	Biome	Ecosystem Functional Group (EFG)
1	Terrestrial	T1 Tropical-subtropical forests	T1.1Tropical-subtropical lowland rainforests
2	Terrestrial	T1 Tropical-subtropical forests	T1.2 Tropical-subtropical dry forests and scrubs
3	Terrestrial	T1 Tropical-subtropical forests	T1.3 Tropical-subtropical montane rainforests
4	Terrestrial	T3 Shrublands & shrubby woodlands	T3.4 Rocky pavements, screes, and lava flows
5	Terrestrial	T4 Savannas and grasslands	T4.1 Trophic savannas
6	Terrestrial	T4 Savannas and grasslands	T4.2 Pyric tussock savannas
7	Terrestrial	T5 Deserts and semi-deserts	T5.1 Semi-desert steppes
8	Terrestrial	T6 Polar-alpine	T6.2 Polar-alpine rocky outcrops
9	Terrestrial	T6 Polar-alpine	T6.5 Tropical alpine meadows and shrublands
10	Terrestrial	T7 Intensive land-use systems	T7.1 Croplands
11	Terrestrial	T7 Intensive land-use systems	T7.2 Sown pastures and old fields
12	Terrestrial	T7 Intensive land-use systems	T7.3 Plantations
13	Terrestrial	T7 Intensive land-use systems	T7.4 Urban and infrastructure lands
14	Subterranean	S1 Subterranean lithic systems	S1.1 Aerobic caves
15	Subterranean	S2 Anthropogenic subterranean voids	S2.1 Anthropogenic subterranean voids
16	Subterranean-Freshwater	SF1 Subterranean freshwaters	SF1.1 Underground streams and pools
17	Subterranean-Freshwater	SF1 Subterranean freshwaters	SF1.2 Groundwater ecosystems
18	Freshwater-Terrestrial	TF1 Palustrine wetlands	TF1.3 Permanent marshes
19	Freshwater-Terrestrial	TF1 Palustrine wetlands	TF1.4 Seasonal floodplain marshes
20	Freshwater-Terrestrial	TF1 Palustrine wetlands	TF1.5 Episodic arid floodplains
21	Freshwater	F1 Rivers and streams	F 1.1 Permanent upland streams
22	Freshwater	F1 Rivers and streams	F 1.2 Permanent lowland rivers
23	Freshwater	F1 Rivers and streams	F 1.4 Seasonal upland streams
24	Freshwater	F1 Rivers and streams	F 1.5 Seasonal lowland rivers
25	Freshwater	F1 Rivers and streams	F 1.6 Episodic arid rivers

26	Freshwater	F2 Lakes	F2.1 Large permanent freshwater lakes
27	Freshwater	F2 Lakes	F2.2 Small permanent freshwater lakes
28	Freshwater	F2 Lakes	F2.3 Seasonal freshwater lakes
29	Freshwater	F2 Lakes	F2.5 Ephemeral freshwater lakes
30	Freshwater	F2 Lakes	F2.6 Permanent inland salt lakes
31	Freshwater	F2 Lakes	F2.7 Ephemeral salt lakes
32	Freshwater	F2 Lakes	F2.8 Artesian springs and oases
33	Freshwater	F2 Lakes	F2.9 Geothermal wetlands
34	Freshwater	F3 Artificial fresh waters	F3.1 Large reservoirs
35	Freshwater	F3 Artificial fresh waters	F3.2 Constructed lacustrine wetlands
36	Freshwater	F3 Artificial fresh waters	F3.3 Rice paddies
37	Freshwater-Marine	FM1 Transitional waters	FM 1.2 Permanently open riverine estuaries and bays
38	Marine	M1 Marine shelves	M1.1 Seagrass meadows
39	Marine	M1 Marine shelves	M1.3 Photic coral reefs
40	Marine	M1 Marine shelves	M1.5 Marine animal forests
41	Marine	M1 Marine shelves	M1.6 Subtidal rocky reefs
42	Marine	M1 Marine shelves	M1.7 Subtidal sandy bottoms
43	Marine	M1 Marine shelves	M1.8 Subtidal muddy bottoms
44	Marine	M2 Pelagic ocean waters	M2.1 Epipelagic ocean waters
45	Marine	M2 Pelagic ocean waters	M2.2 Mesopelagic ocean waters
46	Marine	M3 Deep sea floors	M3.1 Continental and island slopes
47	Marine	M3 Deep sea floors	M3.2 Marine canyons
48	Marine	M4 Anthropogenic marine systems	M4.1 Submerged artificial structures
49	Marine-Terrestrial	MT1 Shoreline systems	MT1.1 Rocky shores
50	Marine-Terrestrial	MT1 Shoreline systems	MT1.2 Muddy shores
51	Marine-Terrestrial	MT1 Shoreline systems	MT1.3 Sandy shores
52	Marine-Terrestrial	MT2 Supralittoral coastal systems	MT2.1 Coastal shrublands and grasslands
53	Marine-Terrestrial	MT3 Anthropogenic shorelines	MT3.1 Artificial shores
54	Marine-Freshwater-Terrestrial	MFT1 Brackish tidal systems	MFT 1.1 Coastal river deltas
55	Marine-Freshwater-Terrestrial	MFT1 Brackish tidal systems	MFT1.2 Intertidal forests and shrublands

Appendix B: Full List of Carnivore Species, Conservation Status and Population Trends, Kenya.

	Species	IUCN Red List Status	Global Population Trend	Global Population Size	Local Population Size
1	African Wolf (*Canis lupaster)*	LC	Decreasing	Unknown	Unknown
2	Side-striped Jackal (*Lupulella adusta)**	LC	Stable	Unknown	Unknown
3	Black-backed Jackal (*Lupulella mesomelas)**	LC	Stable	Unknown	Unknown
4	African Wild Dog (*Lycaon pictus)*	EN	Decreasing	1409	845
5	Bat-eared Fox (*Otocyon megalotis)*	LC	Stable	Unknown	Unknown
6	Zorilla (*Ictonyx striatus)*	LC	Stable	Unknown	Unknown
7	Africa Striped Weasel (*Poecilogale albinucha)*	LC	Unknown	Unknown	Unknown
8	African Clawless Otter (*Aonyx capensis)*	NT	Decreasing	Unknown	Unknown
9	Spot-necked Otter (*Hydrictis maculicollis)*	NT	Decreasing	Unknown	Unknown
10	Honey Badger/Rattel (*Mellivora capensis)*	LC	Decreasing	Unknown	Unknown
11	Two-spotted Palm Civet (*Nandinia binotata)*	LC	Unknown	Unknown	Unknown
12	African Lion (*Panthera leo)*	VU	Decreasing	23,000 – 39,000	1970
13	Leopard (*Panthera pardus)*	VU	Decreasing	Unknown	Unknown
14	African Golden Cat (*Profelis aurata)*	VU	Decreasing	Unknown	Unknown
15	Caracal (*Caracal caracal)*	LC	Unknown	Unknown	Unknown
16	Serval (*Leptailurus serval)*	LC	Stable	Unknown	Unknown
17	Cheetah (*Acinonyx jubatus)*	VU	Decreasing	6674	1160
18	Wild Cat (*Felis silvestris)*	LC	Decreasing	Unknown	
19	Genet (*Genetta genetta)*	LC	Stable	Unknown	
20	Large-spotted Genet (*Genetta maculate)*	LC	Unknown	Unknown	

21	Servaline Genet (*Genetta servalina)*	LC	Unknown	Unknown	
22	African Civet (*Civettictis civetta)*	LC	Unknown	Unknown	
23	Striped Hyena (*Hyaena hyaena)*	NT	Decreasing	5,000 – 9,999	1000
24	Spotted Hyena (*Crocuta Crocuta)*	LC	Decreasing	Unknown	2000 – 4000
25	Aardwolf (*Proteles cristata)*	LC	Stable	Unknown	
26	Marsh Mongoose (*Atilax paludinosus)*	LC	Decreasing	Unknown	
27	Egyptian Mongoose (*Herpestes ichneumon)*	LC	Stable	Unknown	
28	Somali Slender Mongoose (*Herpestes ochraceus)*	LC	Unknown	Unknown	
29	Slender Mongoose (*Herpestes sanguineus)*	LC	Stable	Unknown	
30	Bushy-tailed Mongoose (*Bdeogale crassicauda)*	LC	Unknown	Unknown	
31	Jackson's Mongoose (*Bdeogale jacksoni)*	NT	Decreasing	Unknown	
32	Sokoke Dog Mongoose (*Bdeogale omnivora)*	VU	Decreasing	7,000 – 9,400	
33	White-tailed Mongoose (*Ichneumia albicauda)*	LC	Stable	Unknown	
34	Banded Mongoose (*Mungos mungo)*	LC	Stable	Unknown	
35	Somali Dwarf Mongoose (*Helogale hirtula)*	LC	Unknown	Unknown	
36	Common Dwarf Mongoose (*Helogale parvula)*	LC	Stable	Unknown	

*Musila et al uses the genus *Lupullela,* while other sources, including the IUCN RLTS, use the genus *Canis*

Appendix C: Full List of Primate Species, Conservation Status and Population Trends, Kenya

	Species	IUCN Red List Status	Global Population Trend	Local Population Size
1	Angola Colobus (*Colobus angolensis)*	LC	Unknown	Unknown
2	Guereza Colobus (*Colobus guereza)*	LC	Decreasing	Unknown
3	Mt. Kilimanjaro Guereza Colobus (*Colobus caudatus)*	EN	Decreasing	200-300
4	Tana River Red Colobus (*Piliocolobus rufomitratus)*	EN	Decreasing	1100-1300
5	Tana River Mangabey (*Cercocebus galeritus)**	CR	Decreasing	1000-1200
6	Yellow Baboon (*Papio cynocephalus)*	LC	Stable	Unknown
7	Olive Baboon (*Papio anubis)*	LC	Increasing	Unknown
8	Patas Monkey (*Erythrocebus patas)*	LC	Decreasing	Unknown
9	Tantalus Monkey (*Chlorocebus tantalus)*	LC	Stable	Unknown
10	Vervet Monkey (*Chlorocebus pygerythrus)*	LC	Decreasing	Unknown
11	De Barazza's Monkey (*Cercopithecus neglectus)*	LC	Unknown	Unknown
12	Gentle/Sykes Monkey (*Cercopithecus mitis)*	LC	Decreasing	Unknown
13	Red-tailed Monkey (*Cercopithecus ascanius)*	LC	Decreasing	Unknown
14	Potto (*Perodicticus potto)*	LC	Stable	Unknown
15	Large-eared Greater Galago (*Otolemur crassicaudatus)*	LC	Stable	Unknown
16	Small-eared Greater Galago (*Otolemur garnettii)*	LC	Decreasing	Unknown
17	Northern Lesser Galago (*Galago senegalensis)*	LC	Decreasing	Unknown
18	Somali Lesser Galago (*Galago gallarum)*	LC	Stable	Unknown
19	Kenya Coast Dwarf Galago (*Paragalago cocos)*	LC	Decreasing	Unknown

Table D: Full List of Perissodactyla Species, Conservation Status, and Population Trends, Kenya.

	Species	IUCN Red List Status	Global Population Trend	Global Population Size	Local Population Size
1	Grevy's Zebra (*Equus grevyi*)	EN	Stable	1956*	2812
2	Plains Zebra (*Equus quagga*)	NT	Decreasing	150,000 - 250,000	98820
3	Black Rhino (*Diceros bicornis)*	CR	Increasing	3142	745
4	White Rhino (*Ceratotherium simum*)	NT	Decreasing	10,080	512

Table E: Full List of Marine Cetartiodactyla Species, Conservation Status, and Population Trends, Kenya.

	Species	IUCN Red List Status	Global Population Trend	Global Population Size
1	Sei Whale (*Balaenoptera borealis)*	EN	Increasing	50,000
2	Bryde's Whale (*Balaenoptera edeni)*	LC	Unknown	Unknown
3	Blue Whale (*Balaenoptera musculus)*	EN	Increasing	5000 -15000
4	Fin Whale (*Balaenoptera physalus)*	VU	Increasing	100,000
5	Humpback Whale (*Megaptera novaeangliae)*	LC	Increasing	84,000
6	Pygmy Killer Whale (*Feresa attenuate)*	LC	Unknown	Unknown
7	Short-Finned Pilot Whale (*Globicephala macrorhynchus)*	LC	Unknown	Unknown
8	Fraser's Dolphin (*Lagenodelphis hosei)*	LC	Unknown	Unknown
9	Killer Whale/Orca (*Orcinus orca)*	DD	Unknown	Unknown
10	False Killer Whale (*Pseudorca crassidens)*	NT	Unknown	Unknown
11	Indo-Pacific Humpback Dolphin (*Sousa chinensis)*	VU	Decreasing	Unknown
12	Indian Ocean Humpback Dolphin (*Sousa plumbea)*	EN	Decreasing	Unknown
13	Pan-Tropical Spotted Dolphin (*Stenella attenuate)*	LC	Unknown	Unknown
14	Stenella Longirostris (*Stenella longirostris)*	LC	Unknown	Unknown
15	Rough-Toothed Dolphin (*Steno bredanensis)*	LC	Unknown	Unknown
16	Indo-Pacific Bottlenosed Dolphin (*Tursiops aduncus)*	NT	Unknown	Unknown
17	Common Blottlenose Dolphin (*Tursiops truncatus)*	LC	Unknown	Unknown
18	Pygmy Sperm Whale (*Kogia breviceps)*	DD	Unknown	Unknown
19	Dwarf Sperm Whale (*Kogia sima)*	DD	Unknown	Unknown
20	Sperm Whale (*Physeter macrocephalus)*	VU	Unknown	Unknown
21	Longman's Beaked Whale (*Indopacetus pacificus)*	DD	Unknown	Unknown
22	Blainville's Beaked Whale (*Mesoplodon densirostris)*	DD	Unknown	Unknown
23	Ginkgo-Toothed Beaked Whale (*Mesoplodon ginkgodens)*	DD	Unknown	Unknown

Table F: Full List of Terrestrial Cetartiodactyla Species, Conservation Status, and Population Trends, Kenya.

	Species	IUCN Red List Status	Global Population Trend	Global Population Size	Local Population Size
1	Bushpig (*Potamochoerus larvatus)*	LC	Stable	Unknown	Unknown
2	Forest Hog (*Hylochoerus meinertzhageni)*	LC	Decreasing	Unknown	Unknown
3	Desert Warthog (*Phacochoerus aethiopicus)*	LC	Decreasing	Unknown	Unknown
4	Common Warthog (*Phacochoerus africanus)*	LC	Decreasing	Unknown	Unknown
5	Common Hippopotamus (*Hippopotamus amphibious)*	VU	Decreasing	115,000 - 130,000	6500
6	Giraffe (*Giraffa camelopardalis)*	VU	Decreasing	68293	28730
7	African Buffalo (*Syncerus caffer)*	NT	Decreasing	400000	Unknown
8	Lesser Kudu (*Tragelaphus imberbis)*	NT	Decreasing	90000	Unknown
9	Greater Kudu (*Tragelaphus strepsiceros)*	LC	Stable	300,000 - 350,000	762
10	Bushbuck (*Tragelaphus scriptus)*	LC	Stable	1,000,000 - 1,500,000	Unknown
11	Sitatunga (*Tragelaphus spekii)*	LC	Decreasing	90,000 - 120,000	256
12	Bongo (*Tragelaphus euryceros)*	NT	Decreasing	15,000 - 25,000	96
13	Eland (*Tragelaphus oryx)*	LC	Stable	100,000 - 110,000	Unknown
14	Suni (*Nesotragus moschatus)*	LC	Stable	Unknown	Unknown
15	Blue Duiker (*Philantomba monticola)*	LC	Decreasing	Unknown	Unknown
16	Common Bush Duiker (*Sylvicapra grimmia)*	LC	Decreasing	Unknown	Unknown
17	Ader's Duiker (*Cephalophus adersi)*	VU	Decreasing	14,000	Unknown
18	Harvey's Duiker (*Cephalophus harveyi)*	LC	Decreasing	Unknown	Unknown
19	Black-Fronted Duiker (*Cephalophus nigrifrons)*	LC	Decreasing	Unknown	Unknown
20	Weyn's Duiker (*Cephalophus weynsi)*	LC	Decreasing	Unknown	Unknown
21	Yellow-Backed Duiker (*Cephalophus silvicultor)*	NT	Decreasing	Unknown	Unknown

22	Steenbok (*Raphicerus campestris)*	LC	Stable	Unknown	Unknown
23	Salt's Dikdik (*Madoqua saltiana)*	LC	Stable	Unknown	Unknown
24	Kirk's Dikdik (*Madoqua kirkii)*	LC	Stable	Unknown	Unknown
25	Guenther's Dikdik (*Madoqua guentheri)*	LC	Stable	Unknown	Unknown
26	Thomson's Gazelle (*Eudorcas thomsonii)*	LC	Stable	145,000	44000
27	Grant's Gazelle (*Nanger grantii)*	LC	Decreasing	Unknown	Unknown
28	Gerenuk (*Litocranius walleri)*	NT	Decreasing	Unknown	Unknown
29	Oribi (*Ourebia ourebi)*	LC	Decreasing	Unknown	Unknown
30	Mountain Reedbuck (*Redunca fulvorufula)*	EN	Decreasing	Unknown	Unknown
31	Bohor Reedbuck (*Redunca redunca)*	LC	Decreasing	Unknown	Unknown
32	Waterbuck (*Kobus ellipsiprymnus)*	LC	Decreasing	Unknown	Unknown
33	Klipspringer (*Oreotragus oreotragus)*	LC	Stable	Unknown	Unknown
34	Impala (*Aepyceros melampus)*	LC	Stable	2,000,000	Unknown
45	Hirola (*Beatragus hunteri)*	CR	Decreasing	200-250	450
36	Topi (*Damaliscus lunatus)*	LC	Decreasing	Unknown	Unknown
37	Hartebeest (*Alcelaphus buselaphus)*	LC	Decreasing	Unknown	Unknown
38	Blue/Common Wildebeest (*Connochaetes taurinus)*	LC	Stable	Unknown	Unknown
39	Roan Antelope (*Hippotragus equinus)*	LC	Decreasing	50,000 - 60,000	17
40	Sable Antelope (*Hippotragus niger)*	LC	Stable	50,000 - 60,000	Unknown
41	Beisa Oryx (*Oryx beisa)*	EN	Decreasing	11,000 - 13,000	13725

Table G: List of Proboscidea & Sirenia Species, Conservation Status, and Population Trends, Kenya.

Species	IUCN Red List Status	Global Population Trend	Global Population Size	Local Population Size
Bush Elephant (*Loxodonta africana*)	VU	Increasing	Unknown	33,548
Dugong (*Dugong dugori*)	VU	Decreasing	Unknown	2

Appendix H: Resident Breeding Birds of Prey (Raptors) and their Population Trends over 40 years in Kenya.

	Order	Family	Common Name	IUCN Red List Status	Global Population Trend	Local Population Trend
1	Accipitriformes	Sagittariidae	Secretarybird (*Sagittarius serpentarius*)	VU	Decreasing	Decreasing (94%)
2		Pandionidae	Osprey (*Pandion haliaetus*)	LC	Increasing	
3		Accipitridae	Black-winged kite (*Elanus caeruleus*)	LC	Stable	Decreasing (70%)
4			African swallow-tailed kite (*Chelictinia riocourii*)	LC	Decreasing	
5			African cuckoo-hawk (*Aviceda cuculoides*)	LC	Stable	
6			African harrier-hawk (*Polyboroides typus*)	LC	Stable	
7			Bearded vulture (*Gypaetus barbatus*)	NT	Decreasing	
8			Palm-nut vulture (*Gypohierax angolensis*)	LC	Stable	
9			Egyptian vulture (*Neophron percnopterus*)	EN	Decreasing	
10			Bateleur (*Terathopius ecaudatus*)	NT	Decreasing	Decreasing (48%)
11			Beaudouin's snake eagle (*Circaetus beaudouini*)	VU	Decreasing	
12			Black-chested snake eagle (*Circaetus pectoralis*)	LC	Unknown	Decreasing (39%)
13			Brown snake eagle (*Circaetus cinereus*)	LC	Decreasing	Decreasing (23%)

14	Southern banded snake eagle (*Circaetus fasciolatus*)	NT	Decreasing	
15	Western banded snake eagle (*Circaetus cinerascens*)	LC	Decreasing	
16	White-headed vulture (*Trigonoceps occipitalis*)	CR	Decreasing	
17	Hooded vulture (*Necrosyrtes monachus*)	CR	Decreasing	Decreasing (88%)
18	African white-backed vulture (*Gyps africanus*)	CR	Decreasing	Decreasing (74%)
19	Ruppell's griffon/vulture (*Gyps rueppellii*)	CR	Decreasing	Decreasing (31%)
20	Lappet-faced vulture (*Torgos tracheliotus*)	EN	Decreasing	Decreasing (65%)
21	Bat hawk (*Macheiramphus alcinus*)++	LC	Stable	
22	African crowned eagle (*Stephanoaetus coronatus*)	NT	Decreasing	
23	Martial eagle (*Polemaetus bellicosus*)	VU	Decreasing	Decreasing (21%)
24	Long-crested eagle (*Lophaetus occipitalis*)	LC	Decreasing	Decreasing (93%)
25	African hawk-eagle (*Aquila spilogaster*)	LC	Decreasing	
26	Cassin's hawk-eagle (*Aquila africana*)	LC	Decreasing	
27	Tawny eagle (*Aquila rapax*)	VU	Decreasing	Decreasing (11%)
28	Verreaux's eagle (*Aquila verreauxii*)	LC	Stable	
29	Ayres's hawk-eagle (*Hieraaetus ayresii*)	LC	Stable	Decreasing (96%)*
30	Wahlberg's eagle (*Hieraaetus wahlbergi*)	LC	Stable	Decreasing (49%)
31	Lizard buzzard (*Kaupifalco monogrammicus*)	LC	Stable	
32	Dark chanting goshawk (*Melierax metabates*)	LC	Stable	
33	Eastern chanting goshawk (*Melierax poliopterus*)	LC	Stable	Increasing (284%)
34	Gabar goshawk (*Micronisus gabar*)	LC	Stable	
35	African marsh harrier (*Circus ranivorus*)	LC	Decreasing	
36	African goshawk (*Accipiter tachiro*)	LC	Decreasing	
37	Chestnut-flanked sparrowhawk (*Accipiter castanilius*)	LC	Decreasing	

38			Great sparrowhawk (*Accipiter melanoleucus*)	LC	Decreasing	
39			Little sparrowhawk (*Accipiter minullus*)	LC	Stable	
40			Ovambo sparrowhawk (*Accipiter ovampensis*)	LC	Increasing	
41			Rufous-breasted sparrowhawk (*Accipiter rufiventris*)	LC	Increasing	
42			Shikra (*Accipiter badius*)	LC	Stable	
43			African fish eagle (*Haliaeetus vocifer*)	LC	Stable	
44			Black kite (*Milvus migrans*)	LC	Unknown	Decreasing (55%)
45			Grasshopper buzzard (*Butastur rufipennis*)	LC	Decreasing	Decreasing (53%)*
46			Augur buzzard (*Buteo augur*)	LC	Stable	Decreasing (91%)
47			Mountain buzzard (*Buteo oreophilus*)	NT	Decreasing	
48	Falconiformes	Falconidae	African hobby (*Falco cuvierii*)	LC	Decreasing	
49			Common kestrel (*Falco tinnunculus*)	LC	Decreasing	
50			Dickinson's kestrel (*Falco dickinsoni*)	LC	Stable	
51			Greater kestrel (*Falco rupicoloides*)	LC	Stable	
52			Grey kestrel (*Falco ardosiaceus*)	LC	Stable	
53			Lanner falcon (*Falco biarmicus*)	LC	Increasing	Decreasing (6%) *
54			Peregrine falcon (*Falco peregrinus*)	LC	Stable	
55			Pygmy falcon (*Polihierax semitorquatus*)	LC	Stable	Increasing (203%)
56			Red-necked falcon (*Falco chicquera*)	NT	Decreasing	
57			Taita falcon (*Falco fasciinucha*)	VU	Decreasing	
58	Strigiformes	Tytonidae	African Grass Owl (*Tyto capensis*)**	LC	Decreasing	
59			Barn Owl (*Tyto alba*)**	LC	Stable	
60		Strigidae	Pearl-spotted Owlet (*Glaucidium perlatum)****	LC	Stable	
61			Red-chested Owlet (*Glaucidium tephronotum*)**	LC	Stable	

62	African Barred Owlet (*Glaucidium capense*)**	LC	Decreasing	
63	Sokoke Scops Owl (*Ottus ireneae*)**	LC	Decreasing	
64	African Scops Owl (*Ottus senegalensis*)**	LC	Stable	
65	Northern White-faced Scops Owl (*Ptilopsis leucotis*)**	LC	Stable	
66	Southern White-faced Scops Owl (*Ptilopsis granti*)**	LC	Stable	
67	African Long-eared Owl (*Asio abyssinicus*)**	LC	Stable	Rare
68	Marsh Owl (*Asio capensis*)**	LC	Stable	
69	African Wood Owl (*Strix woodfordii*)**	LC	Stable	
70	Cape Eagle Owl (*Bubo capensis*)**	LC	Stable	
71	Spotted Eagle-Owl (*Bubo africanus*)**	LC	Stable	
72	Greyish Eagle-Owl (*Bubo cinarescens*)**	LC	Stable	
73	Verreaux's Eagle-Owl (*Bubo lacteus*)**	LC	Stable	
74	Pel's Fishing Owl (*Scotopelia peli*)**	LC	Decreasing	

Source: Species list is from birds of Kenya checklist, global population trend and status data is from IUCN Red List, 2020 and Local population trend data is from Ogada, D., Shaw, P., Virani, M.Z., Thiollay, J.M., Kendall, C.J., Odino, M., Patel, T., Wairasho, P., Dunn, L., Thomsett, S., in prep. Raptor declines in Kenya over the past 40 years.

**Nocturnal species

*** Nocturnal and diurnal species

++ Crepuscular species

*population trend from Protected Areas only.

Table I: Full list of Endemic Freshwater Fish, Conservation Status, and Population Trends, Kenya (Seegers et al., 2003; IUCN Red List, 2020).

	Species	**Endemic to**	**IUCN Red List Status**	**Global Population Trend**
1	Lake Magadi Tilapia/Graham's Cichlid (Alcolapia grahami)	Originally Lake Magadi, later introduced elsewhere	VU	Unknown
2	Graham's Stonebasher (*Hippopotamyrus graham)*	Lake Victoria basin	LC	Unknown
3	Bernhard's Elephant-snout Fish (*Mormyrus bernhardi)*	Athi River System	DD	Unknown
4	Hildebrandt's Elephant-snout Fish (*Mormyrus hildebrandti)*	Athi River System	DD	Unknown
5	Athi Elephant-snout Fish *(Mormyrus tenuirostris)*	Athi River System	LC	Unknown
6	Tana-Churchill (*Petrocephalus tanensis)*	Tana River	DD	Unknown
7	Amboseli Barb (*Enteromius amboseli)*	Amboseli swamps, streams & Mzima Springs	EN	Unknown
8	Bunjako Barb (*Enteromius magdalenae)*	Lake Victoria Basin	LC	Unknown
9	Ewaso Nyiro Barb *(Enteromius mimus)*	Northern Ewaso Nyiro Drainage	LC	Unknown
10	Nyanza Barb (*Enteromius nyanzae)*	Lake Victoria Basin*	LC	Unknown
11	Kavirondo Barb *(Enteromius sexradiatus)*	Kisumu Bay	DD	Unknown
12	Lake Turkana Barb (*Enteromius turkanae)*	Lake Turkana	LC	Stable
13	Red Pangani Barb (*Enteromius venustus)*	Pangani Drainage (Lake Jipe) *	DD	Unknown
14	Victoria Barb *(Enteromius victorianus)*	Lake Victoria Shores	DD	Unknown
15	Nzoia Barb (*Enteromius yongei)*	Lake Victoria Drainage*	LC	Unknown
16	Loveridge's Barb (*Enteromius loveridgei)*	Lake Victoria Drainage	DD	Unknown
17	Undescribed (*Barbus/Enteromius sp. "Nzoia 1")*	Nzoia River System		No data
18	Undescribed (*Barbus/Enteromius sp. "Nzoia 2")*	Nzoia River System		No data
19	Taveta Barb (*Barbus sp. "Pangani")*	Upper Pangani Drainage	VU	Unknown

20	Rhinofish *(Labeobarbus rhinoceros)*	Athi & Tana River Drainages	DD	Unknown
21	Ewaso Nyiro Labeo (*Labeo percivalli)*	Northern Ewaso Nyiro Drainage	Vu	Unknown
22	Nairobi Labeo (*Labeo trigliceps)*	Athi River System	VU	Unknown
23	Victoria Labeo (*Labeo victorianus)*	Lake Victoria Drainage*	CR	Decreasing
24	Tana Labeo (*Labeo aff. Mesops)*	Tana River Drainage	DD	Unknown
25	Mzima Springs Labeo (*Labeo sp."mzima")*	Mzima Springs	VU	Unknown
26	Red Tail Labeo (*Labeo spec. "Baomo")*	Lower Tana	VU	Unknown
27	Athi Sardine *(Neobola fluiviatilis)*	Athi-Sabaki & Tana River Drainage	LC	Unknown
28	Lake Turkana Minnow (*Neobola stellae)*	Lake Turkana	LC	Stable
29	Lake Victoria Sardine (*Rastrineobola argentea)*	Lake Victoria Drainage	LC	Increasing
30	Large-toothed Lake Turkana Robber (*Brycinus ferox)*	Lake Turkana	LC	Stable
31	Dwarf Lake Turkana Robber (*Brycinus minutus)*	Lake Turkana	LC	Unknown
32	Lake Victoria Deepwater Catfish (*Xenoclarias eupogon)*	Lake Victoria	CR	Unknown ‡
33	Lower Tana Squeaker *(Synodontis sp. "Lower Tana")*	Lower Tana	DD	Unknown
34	Feather-barbelled Squeaker (*Synodontis manni)*	Lower Tana possibly	DD	Unknown
35	Omo Lampeye (*Aplocheilichthys jeanneli)*	Turkana Basin*	LC	Unknown
36	Turkana Lampeye (*Aplocheilichthys rudolfianus)*	Turkana Basin	LC	Stable
37	Baringo Lampeye (*Aplocheilichthys sp. "Baringo")*	Lake Baringo Drainage	CR	Decreasing ‡
38	Naivasha Lampeye *(Aplocheilichthys sp. "Naivasha")*	Lake Naivasha	EX	Extinct ‡
39	Boji Plains Nothobranch (*Nothobranchius bojiensis)*	Northern Ewaso Nyiro Drainage	VU	Decreasing
40	South Coast Nothobranch *(Nothobranchius elongatus)*	Marshes & Pools in Kwale & Kilifi Counties	VU	Unknown
41	Kilifi Nothobranch *(Nothobranchius interruptus)*	Marshes near Kikambala, Kilifi County	EN	Decreasing
42	Mnanzini Nothobranch *(Nothobranchius willerti)*	Lower Tana seasonal pools	VU	Unknown
43	Turkana Perch (*Lates longispinis)*	Lake Turkana	DD	Increasing

44	McConnel's Haplo (*Haplochromis macconneli)*	Lake Turkana	LC	Increasing
45	Blue Victoria Mouthbrooder (*Haplochromis nubilus)*	Lake Victoria	VU	Unknown
46	Lake Rudolf Haplo (*Haplochromis rudolfianus)*	Lake Turkana	LC	Stable
47	Migori Haplo (*Haplochromis spec. "Migori")*	Lake Victoria Drainage		No data
48	Amboseli Haplo (*Haplochromis sp. "Amboseli")*	Amboseli Swamps	CR	Unknown
49	Turkana Haplo *(Haplochromis turkanae)*	Lake Tukana	LC	Stable
50	Lake Chala Tilapia (*Oreochromis hunteri)*	Lake Chala	CR	Decreasing
51	Baringo Tilapia (*Oreochromis niloticus baringoensis)*	Lake Baringo Drainage & hot Springs near Bogoria	EN	Unknown
52	Suguta Tilapia (*Oreochromis niloticus sugutae)*	Suguta River System	VU	Unknown
53	Turkana Tilapia (*Oreochromis niloticus vulcani*	Lake Turkana Drainage	LC	Increasing
54	Victoria Tilapia (*Oreochromis variabilis)*	Lake Victoria Drainage*	CR	Decreasing ‡

*IUCN Red List shows these species as occurring in 1 or more neighbouring countries, while Seeger et. al (2003) lists them as endemic

‡Extinct or possibly extinct