

UGANDA WILDLIFE RESEARCH AND TRAINING INSTITUTE



NATIONAL WILDLIFE RESEARCH AGENDA

2020/2029

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UGANDA WILDLIFE RESEARCH AND TRAINING INSTITUTE

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EXECUTIVE SUMMARY

Uganda is endowed with several wildlife resources, including National Parks, Forests and Wildlife Reserves. Despite the abundance of wildlife resources and their contribution to the economy of Uganda, there is limited understanding of the potential of wildlife biodiversity and how best to conserve them due to a lack of research on wildlife resources in Uganda.

A national wildlife research agenda is important in guiding research on wildlife resources and how best to conserve and utilize wildlife for the national economy through research based activities.

This wildlife research agenda is focused on four thematic issues that include: 1. Ecological monitoring, 2. Extractive industries, 3. Climate change and 4. Other cross cutting issues.

The implementation of the research agenda shall be in accordance with the legal framework and statutory requirements stipulated in the laws of Uganda and international laws on Wildlife.

Fourteen categories of stakeholders ranging from government, civil society organizations, private sector and academia have been identified and their roles stipulated in the implementation of the research agenda.

The time line for implementation of the focal areas of the research agenda shall be Immediate (I) (with in 1 year) or Short term (S) (1-2 years) or Medium term (M) (3-5 years) or Long term (L) (after 5 years) or Continuous (C) (staring immediately and continuous for 10 years).

The cost of implementing the research agenda is estimated at UGX.105, 200, 000, 000 over a period of 10 years (Table 1.3).

The evaluation of the research agenda shall be every after 3 years and a final evaluation after 10 years.



Dr. Arthur Mugisha.

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ACRONYMS

| | |
|-------|---|
| CFR | Central Forest Reserves |
| ITFC | Institute of Tropical Forest Conservation |
| IUCN | International Union for Conservation of Nature |
| LFR | Local Forest Reserves |
| MAAIF | Ministry of Agriculture, Animal, Industries and Fisheries |
| MOTWA | Ministry of Tourism, Wildlife and Antiquities |
| MUBFS | Makerere University Biological field station |
| NARO | National Agricultural Research Organization |
| NEMA | National Environmental management Authority |
| NFA | National Forestry Authority |
| NPs | National Parks |
| SWOT | Strength, Weaknesses, Opportunities and Threats |
| UBOS | Uganda Bureau of Statistics |
| UIRI, | Uganda Industrial Research Institute |
| UNCST | Uganda National Council of Science and Technology |
| UNDP | United nations Development programme |
| UNMA | Uganda National Meteorological Authority |
| UVRI | Uganda Virus Research Institute |
| UWA | Uganda Wildlife Authority |
| UWRTI | Uganda Wildlife Research Institute |
| WCS | Wildlife Conservation Society |
| WLR | Wild Life Reserve |

INTRODUCTION

CHAPTER ONE

1.1 The state of Wildlife resources in Uganda

Uganda is endowed with several wildlife resources, including over 20% National Parks(NPs), forests and wildlife reserves (Pomeroy et al., 2017). More specifically, wildlife resources are contained within the following main categories: Local Forest Reserves (LFR), Central Forest Reserves (CFR), Wild Life Reserve (WLR), and National Parks (NPs) (Figure 1-1); while the local forest reserves constitute second rank in the number of conservation areas (Figure 1-1 a), they are limited/negligible in the area coverage (Figure 1-1 b). This means that most of the wildlife resources are conserved in the remaining categories.

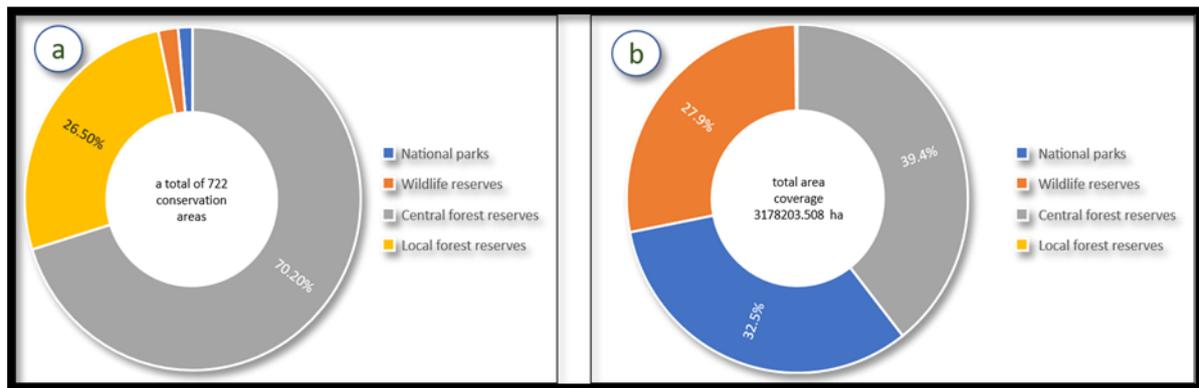


Figure 0.1 Categories of the wildlife protected areas

Other wildlife is also conserved in the vegetation cover outside the conservation reserves, especially where the vegetation cover is abundant besides in aquatic resources (Figure 1.2).

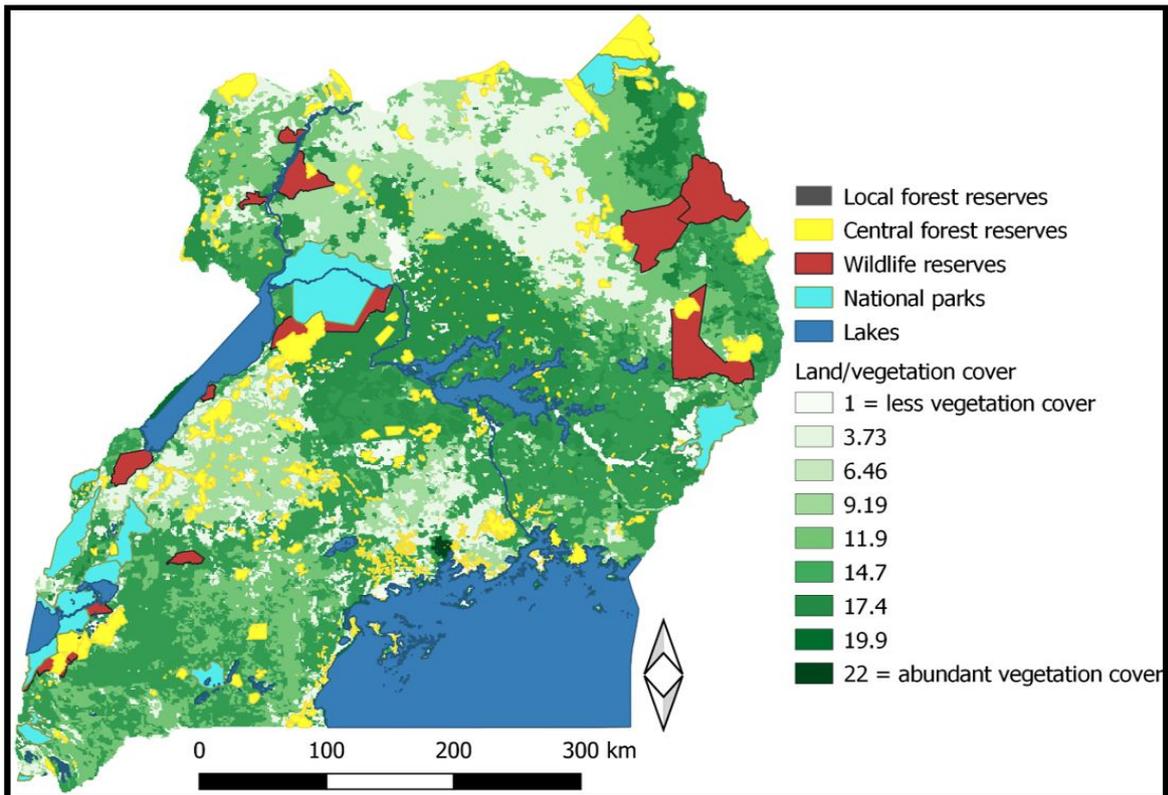


Figure 0.2 Uganda’s wildlife conservation areas and other wildlife areas

A clear inventory as well as data on the coverage of all wildlife resources is lacking (Pomeroy et al., 2017). However, based on the general categorization of biodiversity, wildlife resources (Figure 1-1) in Uganda could be considered at three levels; the genetic, species and ecosystem. At all levels, especially in the period 1970-1980, biodiversity was threatened, including some wildlife (e.g., the indigenous rhino) becoming extinct (Pomeroy et al., 2017; UNDP, 2009). One other species that has remained severely threatened, even until recently, is the cichlid fish from lake Victoria (Pomeroy et al., 2017).

From the 1980s, through the 1990s to the present, large mammals as well as wildlife resources outside the protected areas are reported to have increased. This could be attributed to the various conservation efforts, e.g., the tree-planting drives by various conservation institutions. However, most of the tree-planting drives support the paling of exotic species (Pomeroy et al., 2017), which has less conservation value for local biodiversity (

Bradshaw et al., 2007), and could support far fewer biodiversity in the long run (Pomeroy et al., 2017).

1.2 The Lack of research and its implications for wildlife conservation

Despite the abundance of wildlife resources and their contribution to the economy of Uganda, there is limited understanding of the potential of wildlife biodiversity and how best to conserve them.

There is generally a lack of research on wildlife in Uganda. Current information on wildlife resources and conservation is hampered by the limited data. Monitoring is done on particular species level without a real national inventory of wildlife resources and conservation trends (Pomeroy et al., 2017).

Uganda Wildlife Authority (UWA) has since its establishment been conducting minimal monitoring of wildlife resources through its research and monitoring policy of 1999.

The overall goal of the 1999 Monitoring and Research policy under UWA is; “to provide relevant, accurate and timely information that will improve the capacity of UWA to conserve and sustainably manage wildlife resources and biodiversity inside and outside Protected Areas under its jurisdiction for the benefit of the present and future generations of Ugandans and the global community”. The policy seeks recognition of the importance of monitoring and research in providing information to the wildlife managers and policy makers. The monitoring and research policy highlights the need to support and undertake monitoring and research as identified and prioritized. The policy outlines the importance of data management, benefit and resource/information sharing and collaboration with partners in monitoring and research. However, the data that UWA is utilizing for monitoring is largely generated through researches conducted by external researchers driven by other agenda but not necessarily intended for wildlife conservation a condition that puts wildlife conservation at cross roads.

Considering the emerging issues in the efforts to sustainably manage wildlife such as global climate change and its impacts, invasive species, the oil exploration and exploitation within the protected areas, mining and tourism development activities on wildlife and ever increasing human wildlife conflicts, there is a need to have a dedicated effort to address these teething challenges through provision of long-term researched data. To achieve this, the research agenda should rationalize the current UWA Research Policy of 1999 mandate with the legal mandate of UWRTI to ensure rational use of wildlife resources, both financial, human resource and the research infrastructure.

Without applied research focused on conservation, it becomes difficult to plan for wildlife conservation in Uganda. The actual trend of wildlife resources and the underlying causes, the ecosystem services derived from the wildlife resources are not known without research. The economic value of the wildlife resources rather than the tourism related benefits are not known and the wildlife occurring outside protected areas are not documented. The nature and extent of wildlife resource use by local communities are not generally known. Little is known about the impact of tourism on ecosystems, sustainability of live animal trade and the impact of human activities on wildlife resources, encroachment to protected areas, increased human population, land-use changes, spread of invasive alien species, habitat loss and its impact on wildlife populations, emerging and re-emerging wildlife diseases and spatial and temporal use of resources by wildlife.

More over considering the increase in human population (UBOS, 2016) as well as the consequent impacts of climate change (e.g., Taylor et al., 2006), their impacts of wildlife resources cannot be assumed but need to be carefully studied.

1.3 The need for a national wildlife research agenda

A national wildlife research agenda is important in guiding research on wildlife. Such an agenda shall enable research based conservation of wildlife through a. tracking of trends of wildlife, determining economic and ecological values of wildlife resources and enhancing effective trans-boundary wildlife resource conservation.

The research agenda shall lead to the understanding of the potential of wildlife biodiversity, how best to conserve them as well as how best to utilize them for the national economy improvement through research based activities such as game viewing, sport hunting, wildlife farming, breeding and game ranching, eco-tourism, and ex-situ conservation, and game sanctuary.

1.4 The SWOT analysis for the wildlife research agenda

The Strength, Weaknesses, Opportunities and Threats (SWOT) for the research agenda are summarized in Table 1.1.

Table 1.1 SWOT Analysis for the research agenda

| Strength | Weaknesses |
|---|---|
| 1. There is a legal framework to support the research agenda | 1. Current staffing levels are inadequate to undertake research in all the specified areas. |
| 2. There is a commitment of government to establish infrastructure for research | 2. Limited research skills |
| 3. The wildlife resources to research on | 3. Limited research equipment |
| 4. The existing trainable staff at UWRTI to undertake the research. | 4. Un streamlined internal structure of management of research and training. |
| 5. The UWRTI has land | 5. Lack of existing research centres in each of the wildlife conservation area. |
| 6. Existing basic infrastructure and equipment for research | |

| Opportunities | Threats |
|---|--|
| <ol style="list-style-type: none"> 1. Available interested partners in wildlife research at national and international level. 2. Opportunities available for UWRTI to obtain higher qualifications 3. Emerging opportunities available for research. 4. National prioritization of research provides leverage for UWRTI 5. There are opportunities for wildlife enterprises which can be researched. | <ol style="list-style-type: none"> 1. Underfunding 2. Saline soils type that corrodes the established infrastructure. 3. Diminishing wildlife resources |

1.4 The role and mandate of Uganda Wildlife Research and Training Institute (UWRTI) in wildlife research

Uganda Wildlife Research Institute (UWRTI) was established by Act of the Parliament of the Republic of Uganda No. 17 of 2016, with the aim of conducting and overseeing wildlife research and training in the country. The overall purpose of UWRTI is to collect and disseminate timely and quality scientific information that will enhance the management and utilization of wildlife resources in the country. Therefore, UWRTI has the mandatory role of advising the Government, management authorities and the general public on best ways of conserving the wildlife resources both inside and outside protected areas.

Through conducting research, UWRTI has also the mandate to promote and facilitate the training of Ugandans in wildlife science. The national mandate of the Institute with regard to research and training of wildlife is reiterated

in the Wildlife Policy 2014. In accordance with its mandate, the main functions of UWRTI include coordination/management of all wildlife research in the country. This obligation is contained in Sections 4(1) and Section 5 (1) of the Act establishing the Institute. Thus, UWRTI has to provide guidance towards research that is relevant to conservation of wildlife and ultimately development of the wildlife industry. It is in this context that UWRTI has to draw up, a draft of the national wildlife research agenda which will bring all research players conducting wildlife research in the country under the coordination of Uganda Wildlife Research and Training Institute (UWRTI).

CHAPTER TWO

2.0 : THE FOCUS OF THIS WILDLIFE RESEARCH AGENDA

This wildlife research agenda is focused on four thematic issues that include: 1. Ecological monitoring, 2. Extractive industries, 3. Climate change and 4. Other cross cutting issues. These thematic issues were identified through a stakeholder consultative process involving Uganda Wildlife Authority (UWA) staff, Uganda Wildlife Research and Training Institute (UWRTI) staff, the Wildlife Conservation Society (WCS), Ministry of Tourism, Wildlife and Antiquities (MOTWA), Civil Society Organizations, local and international academia and research institutions.

In the preparation of this research agenda, it was also observed that there are some other thematic issues for conservation for wildlife found by recent scholars that need to be considered in the agenda. These include: the extent and factors influencing compliance to protected area regulations (Muhumuza and Balkwill, 2013) and the role of indigenous knowledge in conservation of Wildlife and how best it can be used together with community tourism to contribute to the boosting the economy (Muhumuza, 2015).

The detailed components of each of the themes that constitute this research agenda are elaborated in the next section.

2.1 Ecological monitoring

Ecological monitoring is an important thematic area of the research agenda. It shall consist of Biodiversity conservation and management, Utilization and Ecosystem Restoration, Key wildlife species extinction, Species composition and diversity overtime of key species-updated list, Buffer zone establishment and management, Wildlife Health.

The details of the research issues to be investigated under ecological monitoring are further described below.

2.1.1 Biodiversity conservation and management

The research shall focus on Monitoring population species, Fire ecology, Restoration needs in ecosystems, Invasive species, Vegetation mapping, Reintroduction as good opportunities for large scale experiments on biodiversity, Reintroduction in the context of Population Viability Analyses, Interaction of genetics, behavior, and new environment on the demographic parameters of released individuals and Biodiversity inventories including indicators for conservation.

2.1.2 Key wildlife species extinction

Research shall focus on continuously monitoring plant and animal populations, Species behavior and ecology, ecological indicator species, patterns of diversity with population dynamics and community structure and their trophic networks, population viability analyses, and ecological predictive modeling of wildlife populations in a changing landscape.

2.1.3 *Species composition and diversity overtime of key species-up dated list*

The research shall involve developing a general theory which links population increase and carrying capacity in specific habitats. Specifically the research shall focus on conducting an inventory of species in protected areas based on IUCN categories of species status, Drivers of species change in status/extinction (e.g predator-prey, habitat change), effectiveness of interventions to address species extinction (such as maintenance of viable populations through translocation, creation of corridors, restoration and mitigation studies, and use of fire as ecological tool). Such a research shall lead into the development of key datasets, methodologies and models for monitoring biodiversity at all levels.

2.1.4 Buffer zone establishment and management

The research shall focus on feasibility studies for buffer zone establishment, access and resource in buffer zones, management of buffer zones, and land use in buffer zones.

2.1.5 Wildlife Health

The research shall focus on disease surveillance programs, disease outbreak investigation (drivers and impacts), wildlife forensics, Wildlife ecosystems health, and ecological processes important in maintaining healthy wildlife and diversity.

2.1.6 Utilization and Ecosystem Restoration

The research shall focus on conservation economics and payment for ecosystem services, Natural Resources Management, Sustainable Wildlife utilization, Wildlife, community co-existence and conflict management and Biotechnology for sustainable utilization of wildlife resources.

2.2 Climate change

The past decade has witnessed a growing recognition of the inextricable link between climate change and biodiversity. According to the July 2016 World Meteorological Organisation (WMO), global temperatures for the first six months of 2016 were the highest in history (WMO, 2016). Global temperature increases of 0.4 °C to 2.6 °C by 2055 and 0.3 to 4.8°C by 2090 would be accompanied by rising sea levels, changes in precipitation patterns, substantial loss of summer Arctic sea ice, and increasing ocean acidification (SCBD,2014).

Uganda's climate is predicted to change such that the distributions of many of its species and ecosystems will shift in tandem with drier or wetter parts of the country. Climate change also causes changes in the temperature and alkalinity of aquatic systems affecting the survival of biodiversity (DEAT 2006).

Uganda has had its share of effects of climate change characterized by severe droughts and floods and evidence of change in glacial extent (area) on Mount Rwenzori (UWA, 2010). The main impact of climate change in Uganda has been observed to be climatic variability, the results of which are droughts and floods; while droughts lead to the drying of rivers and streams, floods result in submerged ecosystems. Although Uganda was assumed to be a net-sink for greenhouse gases, as part of this planet, the country also experienced adverse effects of global warming which contributed to the alteration of climates as was evidenced by the increasing frequency of droughts and floods which alter various ecological systems in Uganda.

Impacts of climate change on biodiversity have already been observed in some areas. As a result of global warming the ice caps on the Rwenzori ranges (the legendary mountains of the moon) have largely melted, leading to increased volumes of water in the Semliki River. This has led to erosion, siltation and shifting of the course of the river, which all lead to habitat disturbance, as reported in the Uganda National Adaptation Programmes of Action report (MWE, 2007). Species reported to be affected include the Mountain Gorilla, alpine and sub-alpine species on the Rwenzori's such as the Giant Lobelia, Tree Senecio, the Rwenzori Leopard and the Rwenzori Red Duiker. The Three-horned Chameleon and Senecio are reported to have already shifted their ranges upwards due to warmer temperatures.

Uganda's National Adaptation Programme of Action (NAPA) cites an average temperature increase of 0.28°C per decade in Uganda between 1960 and 2010, with the months of January and February especially exhibiting this warming trend, averaging a 0.37°C increase per decade (GoU, 2007, MWE, 2010). The frequency of hot days in the country has increased significantly, while that of cold days has decreased (MWE, 2010). The malaria parasite is spreading into new areas in the country (Namanya, 2009). Analysis of records on Uganda's glaciers has shown that the ice cap on Rwenzori has shrunk significantly in the last 100 years (IGAD, 2010). The rate of ice loss is highest on Mount Baker (96%) followed by Mount Speke (91%). Mount Stanley has the lowest rate of ice loss (68%). The changing temperature

patterns have been linked with drought and consequent increased cattle deaths in the cattle corridor (Oxfam, 2008).

Droughts undoubtedly have adverse effects on biodiversity. Droughts increase the changes of wild fires which destroy a lot of biodiversity. Droughts also result into migration of people into protected areas, migrations of animals, drops in water levels and disruption of the biological clock, especially in reproductive cycles. While there have always been droughts in Uganda, evidence suggests they are becoming more frequent and more severe (IGAD, 2010). The increased frequency and duration of droughts is the most significant climate-related change being experienced in Uganda (GoU, 2007; MWE, 2010). With respect to floods, the 1997/1998 El Nino flood, also attributed to climate change, caused a lot of habitat disturbance in addition to other economic and health effects. Floods in general destroy fauna and flora, a direct impact on biodiversity.

During the 1997/1998 floods, there was a 60 per cent drop in coffee exports and suspension of tea estates operations in eastern parts of the country, while 300 hectares of wheat were lost in the Kapchorwa District due to these floods (GoU, 2002). According to the Ugandan Agricultural Census (UBOS, 2011), at national level, 7 per cent of the 3.95 million agricultural households reported that they were prone to flooding, with most incidences reported in the Eastern Region.

Climate change mitigation and adaptation is needed based on research based information. In this research agenda, the following focal areas are planned for research. Nutritional quality of plants in relation to climate change, Human wildlife conflict challenges as a result of climate change, habitat suitability and variability management under different climate change patterns, comparison of application of new technology (use of smart phones and Drones) in monitoring elements of climate and their impact on wildlife, potential impacts of climate change on ecology of wildlife, animal and plant distribution patterns as a result of climate change, invasive species in light of climate change, migratory species and Migratory patterns of wildlife in light of climate change and change of landscapes.

2.3 Other cross cutting research issues

Taxonomy, access and benefit sharing, wildlife conservation, invasive alien species (IAS), human wildlife conflicts, community livelihoods and economics and business are a number of issues that are relevant to all aspects of biodiversity conservation. Other cross cutting issues include: gender and wildlife conservation, research Quality Assurance, impact of tourism on wildlife, local community and public relations with tourists, nature based tourism product identification and development and impacts of recreational disturbance on ecology of wildlife.

Reports from UWA and other conservation agencies worldwide show that challenges are immense, particularly in the areas of wildlife conservation, management of IAS, and climate change mitigation and adaptation, but there also opportunities for cooperation within the region and with partners in international community. Urgent action on identified issues should have positive impacts on biodiversity conservation, and increase prospects for achieving global biodiversity targets.

2.3.1 Taxonomy

You cannot conserve what you don't know. The number of species awaiting discovery far outweigh those that have been studied. Millions of plants and animals have yet to be studied and may hold tremendous potential as a source of food, medicine and other benefits.

According to CBD, in a world populated with more than 30 million species, taxonomists have identified only about 1.78 million species of animals, plants and microorganisms in 250 years of research. It is estimated that only 10 percent of vertebrates remain to be described, but greater than 50 percent of terrestrial arthropods and up to 95 percent of protozoa are un described.

Uganda is recognized for its rich biodiversity with surveys reporting occurrence of over 18,783 species of flora and fauna confined to the more known taxa such as birds, mammals, butterflies, higher plants, reptiles,

amphibians and fish (Nema, 2009). However, there is less species being discovered due to lack of taxonomical research conducted in the country. Unfortunately, almost hotspot as the high number of species including the endemic is threatened by more than 10 percent of their original habitats (MWLE, 2003).

The sheer number of species that have yet to be discovered requires an army of scientists, each with an area of their own expertise, to identify, name, classify, and study the millions of species on Earth. The issue is compounded by the unprecedented rate of global biodiversity loss due to habitat degradation, unsustainable use, pollution, climate change, and other pressures. These pressures increase the risk of extinction of vulnerable species and it is certain that some species are already lost even before they are named and described.

Uganda through this research agenda needs to build on current efforts to strengthen interest and support for Taxonomy. Improved scientific knowledge will help institutions prioritize taxonomic research, particularly on undiscovered species.

2.3.2 Access and Benefit Sharing (ABS)

Genetic resources have become increasingly valuable over time as the discovery of new medicinal plants and the development of drugs and health supplements from these resources have rapidly progressed. Biotechnology as an industry that maximizes the potential of these products, boasts of an annual growth of 3.7 percent from 2011 to 2016 with a reported revenue of amounting to USD 323 billion (BISWorld, 2016).

With Uganda identified as a biodiversity-rich country, it is inevitable to make significant progress in biotechnology research and development that the country has to offer. Uganda is realizing the need to seize the opportunity to benefit from the use of its own genetic resources.

The Draft Biotechnology and Bio-safety Bill is presently being debated in Parliament. Once passed into law, it will operationalize the National

Biotechnology and Bio-safety Policy of 2008 and will provide a more unified approach to the safe development and application of modern biotechnology in Uganda. The bill spells out a regulatory framework for biotech R&D in line with provisions of the Bio-safety Protocol; it designates a Competent Authority and a National Focal Point, establishes a National Bio-safety Committee, Institutional Bio-safety Committees and provides an overall framework for the regulation for the research, development and general release of genetically modified organisms (GMOs) in Uganda.

For Uganda providing genetic resources to industries and other sectors, it is imperative that a regulatory system be set in place to ensure that benefits are shared fairly and equitably from the use of the provided genetic resources. Benefits generated from such interactions can serve as important resources and opportunities for biodiversity conservation and even as a means to reduce poverty, targeting those who sustainably help sustain biodiversity.

The Convention on Biological Diversity (CBD) explicitly states as its third objective the “fair and equitable sharing of benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding”. “Article 15 of the CBD outlines framework for the implementation of Access and Benefit Sharing (ABS)”. To achieve this third objective, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their utilization to the CBD, or the Nagoya Protocol on ABS (NP-ABS), was adopted in Nagoya, Japan at the Tenth Meeting of the Conference of Parties (Cop 10) to the CBD in October 2010 and Uganda ratified to the Nagoya Protocol.

It is imperative that Uganda through this research agenda will formulate and develop ABS measures supported by regulations, guidelines and manuals for effective implementation and enforcement in the wildlife Areas. It will also allow for conducting research on how to encourage public participation, including indigenous people and local communities, by

involving, informing and consulting them in planning, management and other decision making activities.

2.3.3 Wildlife Conservation

With increasing global environmental pressures, it is quite evident that the world's species and ecosystems are under serious threat. All forms of wildlife face risks from the degradation of habitats through illegal logging, land conversion, pollution and others; overexploitation and use of illegal and destructive harvesting practices; and poaching and trafficking of wild plants and animals. These and many other threats undermine the population growth, diversity, and breeding and reproductive behavior of wildlife.

Thousands of Species are endangered and on the blink of extinction, leading to the possible loss of both endemic and economically important species. The massive loss of wildlife has led to rates of extinction that are considered at least 100 to 1,000 times higher than nature intended. The World Wide Fund for Nature's (WWWF) 2014 Living Planet Report found wildlife populations of vertebrate species-mammals, birds, reptiles, amphibians, and fish-have declined by 52 percent over the last 40 years.

These and various threats may already mean the loss of many unrecorded and little studied species that may have infinite benefits to human kind. Thus saving wildlife species and their habitats are a priority for this national wildlife research agenda through conducting wildlife research and come up with scientific approaches that will ensure that PAs are effectively managed with trained staff or partnerships in the areas of biodiversity identification, monitoring and assessment; data sharing and management; patrolling and monitoring; enforcement of laws and policies on wildlife conservation, arrest and apprehension and community development.

2.3.4 Invasive Alien Species

The proliferation of invasive alien species (IAS) disrupts the ecological balance of the areas being invaded. Indigenous species lose their natural habitat and food, which can lead to their extinction. Controlling and

reducing the number of these IAS require huge financial resources that may lead to major economic problems to the areas or countries being invaded.

There is a mix of indigenous and alien plant species in Uganda's national parks. Evidence shows that there are significant vegetation changes over the last 20 years. For instance, it has been found that in Queen Elizabeth National Park, between 1999 and 2019, there was a significant increase in forested area and a significant decrease in land area that had once been mostly savanna. Solberg (2019) attributes these changes to encroachment of both exotic invasive and native invasive woody plants in savannahs.

Invasive alien species have common characteristics: they can thrive under adverse conditions, reproduce and grow rapidly, have high dispersal ability and adaptability to new conditions, and survive on various food types and in a wide range of environmental conditions (CBD, 2017).

In Uganda, the water hyacinth (*Eichhornia crassipes*) had a profound impact on the socio-economic development of Uganda in terms of curtailment of water transport, reduction of hydropower output, interference with urban water supply and reduction in fish production from Lake Victoria in the 1990's. The cost of controlling and managing water hyacinth was estimated to be in millions of dollars. As these invasive species prevail in their new environments, indigenous species are unable to compete for space and food or are prey for the IAS, and eventually become extinct. Vital ecosystem functions, such as pollination, soil regeneration, and nutrient and water cycling functions, among others, eventually deteriorate.

Invasive species continue to demonstrate impacts both on land and water habitats, imposing heavy costs in control and management. Uganda through the research agenda, will conduct an in-depth research, survey, identification, and analysis of the priority IAS, including their pathways of introduction and early detection. Cost-effective eradication and restoration programs, including research on and testing of new control technologies, should be implemented. Comprehensive research on introduction pathways will contribute to management efforts, which should then be mainstreamed in government and private policies and action.

2.3.5 Human Wildlife Conflicts (HWC)

Conservation conflicts remain one of the complex and greatest challenges facing wildlife protection in Africa. Conflicts typically involve situations in which some species pose direct threat to people and their livelihoods, resulting in retaliation against the species they believe or suspect to be problematic. Human wildlife conflicts occurs when animals pose a direct and recurring threat to the livelihood or safety of the people and this leads to the persecution of that species. In 1997, wildlife experts identified HWCs as one of the major threats to conservation, and one of the most difficult problems that conservation manager's face in Africa (Hill, C., Osborn, F, & Plumped, A.J., 2002). These conflicts have intensified over recent decades as a result of human population growth and agricultural expansion, human settlement and industrial activities. The increasing human population has led to encroachment on wildlife conservation areas. HWC is often understood to mean crop raiding, livestock depredation, human attacks and disease transmission to humans and vice versa. In retaliation, local people kill some wildlife species as recently observed at Queen Elizabeth National Park where 11 lions were poisoned to death. A recent assessment by Traffic International reveals that, the Lion population is rapidly decreasing because of indiscriminate killing in defense of people and livestock, habitat loss, and prey depletion (Rossi, A, 2018).

HWCs are often associated with economic costs that come along with wildlife conservation. For instance, studies around the Budongo Forest Reserve, Uganda found the cost of crop raiding and guarding varying from US\$ 25-30 per month (Howard,P., 1995).

Article 8(j) of the convention on Biological Diversity obliges parties to respect, preserve and maintain the knowledge, innovations and practices of indigenous and local communities relevant for the conservation of biological diversity and to promote their wider application with the approval of knowledge holders and to encourage equitable sharing of benefits arising out of the use of biological diversity. Objective 2.4.1 and 2.4.2 of the Uganda wildlife policy 2014 highlight the need to promote sustainable management

of Uganda's wildlife populations in and outside protected areas respectively. Objective 2.4.4 of the policy emphasize the need effectively mitigate HWCs. HWCs undermine attainment of Sustainable Development Goals (SDGs) particularly poverty alleviation, sustainable economic development, sustainable consumption and production and conservation of terrestrial ecosystems among others. Hence, there is need to address HWCs to facilitate Uganda's contribution to the global development agenda. Uganda through the research agenda will strengthen research in human wildlife conflict issues to effectively manage wildlife resources.

2.3.6 Community conservation and livelihoods: The need for constructive engagement

In many developing countries of the southern hemisphere a large proportion of their often-considerable biodiversity is located outside protected areas (PAs) where it shares space and resources with rural people. It is estimated that over 50% of Uganda's wildlife resources still remain outside designated PAs, mostly on privately owned land; and is of most urgent concern for protection (Uganda Wild policy, 2014). In fact, about 1.4 billion of the world's extremely poor people live in such areas (<http://www.ifad.org/pub/ar.htm>), particularly in sub-Saharan Africa and South Asia where they often depend upon species of wild animals and plants for their survival (Roe et al. 2002). National Parks and other PAs, while retaining a key conservation role, are no longer sufficient to meet biodiversity conservation goals. They often fail to meet their mandate due to poor governance, lack of funds, human population increases along their perimeters, and lack of conserving wildlife populations outside of PAs, where governments have limited capacities to influence sustainable resource use, has thus become an increasingly high priority.

It is imperative to recognize the need to address the dual goals of biodiversity conservation and poverty alleviation and community conservation and identify the logical strategic response of benefitting the local people and improve their livelihoods through conducting sustainable research. By transferring ownership or use rights from the government to

e.g. the producer level, such as local communities, community conservation can provide affected communities with the necessary economic incentives to effectively conserve and sustainably utilize, rather than to “ mine”, terrestrial biological diversity outside the PA system, despite many shortcomings in community conservation implementation (Hulme and Murphree 2001, Baldus 2009; Roe, Nelson and Sandbrook 2009; Torquebiau and Taylor 2009; Nasco 2010). Neither does this ignore the fact that many governments are reluctant to relinquish control over natural resources by providing communities with adequate tenure (Hulme and Murphree, 2010), or the debate whether community conservation can adequately address rural poverty (Roe 2008, Adams et al. 2004)-but in biodiversity conservation terms, there really seems to be no alternative to community conservation outside PAs.

Clear alternative measures for effective community involvement, has to be identified through conducting research as a measure to provide alternative incomes to fight poverty. According to (Bagadion et. Al, 2014) indicates that ecotourism can provide a viable economic development alternative for local communities through craft production, guiding services, vehicle rentals, accommodations, and food for recreation services. He ascertains that, these types of businesses do not only benefit the local communities, but also plays a crucial role the success of ecotourism destination.

Conducting research on community conservation and livelihood improvement will ensure that decision makers have access to scientifically credible and independent information that accounts to the total value of ecosystem benefits, recognizing the complex relationships between biodiversity, ecosystem services and people. This will create dialogue between the scientific community, government, private sector and local resource users on the benefits from biodiversity and ecosystem services.

2.4 Extractive industries

Uganda has expanded the extractive sector with increase in the issuance of mining and development licenses, including Oil and Gas, Bio-fuels, sport

hunting amongst others. The National Development Plan II (NDP II) recognizes that tourism in Uganda is nature dependent and has demonstrated high potential for generating revenue and employment at a low cost, implying a high return on investment. Also minerals, oil and gas sector has a great potential of contributing to economic growth and poverty alleviation through mineral exports, use of oil and gas for local consumption/generation of electricity and employment generation.

2.4.1 Oil and gas

The Albertine Graben, which is the main oil and gas exploration region, is an ecologically sensitive region, harboring most of the nation's unique species of high conservation value, distinct ecosystems and several tourist destinations. It harbors more species of vertebrates than any other region on the African continent. This region shelters more than half of continental Africa's bird species and nearly 40% of its mammal species. There are more endemic mammals, birds and amphibians found in the Rift than any other site in continental Africa. Conservation International recently listed the Albertine Rift as one of the world's most endangered spaces, based on levels of species endemism and rates of habitat destruction.

Oil and gas exploration in this area is expected to have various negative effects on surrounding ecosystems, including adjacent and downstream communities; coping with pollution problems such as soil contamination by drill wastes and oil spills which affect the nearby water and aquatic life like fish around lake Albert, wildlife animals and coping with air emissions due to combustion as the primary source of gaseous pollution (CO₂, CO, HCO₃, SO₂) which are key challenges at both local and national level (e.g., to mitigate climate change and its effects). Oil exploration requires vegetation clearance, causing loss of plant species and leaving the soil bare to erosion which greatly affects functioning of the ecosystem including wildlife habitats.

Therefore oil and gas exploration in this region requires research to understand its effects on wildlife and how the negative effects of the production and use of oil and gas, bio-fuels and other extractive industries on wildlife can be mitigated.

2.4.2 Mining

The research is needed to understand the ecological and environmental impacts of mining in conservation areas. The research would focus on waste management from mining, Biodiversity / Habitat loss as result of mining, general adaptation syndrome / wildlife stress to mining activities, Impact of infrastructure (roads, power lines, pipe lines, camps – on wildlife affecting migratory routes or biological corridors and effect of Mining on wildlife health.

2.4.3 Sport hunting

The research issues under sport hunting shall include: Population dynamics, (age, Sex, threatened or endangered), Impact of sport hunting on wildlife conservation, Public attitude, perceptions and ethical issues of sport hunting, carrying capacity and sustainable yield off take, Effectiveness of sport hunting as a conservation tool and cost benefit analysis of sport hunting

CHAPTER THREE

3.0 IMPLEMENTATION PLAN FOR THE WILDLIFE RESEARCH AGENDA

The implementation of the research agenda shall be in accordance with the legal framework and statutory requirements stipulated in the laws of Uganda and international laws on Wildlife. The implementation shall be multi stake holder driven but with the oversight responsibility with the Uganda Wildlife Research and Training Institute.

3.1 Institutional framework for the implementation of the research agenda

The implementation of the research agenda shall be governed by:

- i. The 1995 constitution of the Republic of Uganda.
- ii. Uganda Wildlife policy, 2014.
- iii. The Uganda Wildlife Act, 2019.
- iv. The national climate change policy, 2018.
- v. The national oil and gas policy for Uganda, 2008
- vi. The mining Act, 2003.
- vii. Uganda Wildlife Education Center Act, 2015.
- viii. The National Forestry and Planting Act, 2003.
- ix. The Uganda wildlife research and training Institute Act, 2016.
- x. The National Environment Act, Cap 153 of 2000.
- xi. The universities and other tertiary institutions Act of 2001.
- xii. The guidelines of the Uganda National Council of Science and Technology (UNCST).

In performing their respective roles, institutions under the wildlife sector, relevant civil society organisations and Universities shall maintain good working relationships and will be consulted to avoid conflicts and duplications of the activities in the research agenda.

a). Uganda Wildlife Research and Training Institute

As the lead agency for wildlife research and training, UWRTI shall be the main implementing agency for the wildlife research. The UWRTI shall

execute its functions through identification of the pertinent research priorities to follow a consultative process involving various stakeholders (see Table 1.2). Work with the stakeholders to draw an implementation plan of each selected research area.

The institute shall in consultation with the Uganda National Council of Science and Technology establish research ethics committee for human and nonhuman research projects.

The institute shall create a platform for sharing developed concepts and research findings.

The implementation of the research recommendations shall be done by the Uganda Wildlife Authority working closely with the technical team under the UWRTI that conducted the wildlife research and made recommendations.

b). The Ministry responsible for wildlife:

The Ministry responsible for wildlife will provide the overall supervision and guidance for conducting wildlife research in the implementation of the research agenda.

c). Uganda Wildlife Authority (UWA)

As the lead agency for wildlife management in Uganda, UWA shall be in charge of identifying researchable areas within their protected area management plans for effective implementation of the research agenda.

d). Uganda Wildlife Education Centre

As the lead agency for conservation education in Uganda, UWEC shall be consulted on handling rescued animals and their rehabilitation and drafting effective conservation messages that contribute to the implementation of the research agenda

d) National Forestry Authority

As the institution in charge of forestry management in Uganda, NFA shall in accordance with this research agenda allow UWRTI to conduct wildlife research within its jurisdiction under technical guidance of Uganda Wildlife Authority.

e). Ministry responsible for wetlands

As the Government Ministry responsible for wetland management, the Ministry shall in accordance with this research agenda allow UWRTI to conduct wildlife research within its jurisdiction under technical guidance of Uganda Wildlife Authority.

f). As the lead department for Natural resources management in local Government, the department of natural resources management shall in accordance with this research agenda allow UWRTI to conduct wildlife research within its jurisdiction under technical guidance of Uganda Wildlife Authority.

g). As the lead agency for oil and gas development in Uganda, the Ministry responsible for exploration and development of oil and gas will allow UWRTI to conduct wildlife research within its jurisdiction under technical guidance of Uganda Wildlife Authority.

h). National Environment Management Authority (NEMA).

As the regulator for environment management and compliance in Uganda, UWRTI shall implement the research agenda in consultation with NEMA on key developments taking place in the wildlife Areas.

i). Private sector, Civil Society and Academia

UWRTI recognizes the important role played by the Academia, Media, NGOs and the private sector in the management of Wildlife. In order to encourage their participation in the implementation of the research agenda; UWRTI through the line ministry, Government shall provide necessary support,

guidelines and collaborative initiatives to private sector, civil society and academia to play a meaningful role in the implementation of the research agenda.

j). Regional and International cooperation

International and regional cooperation is an important conservation tool. Uganda is a signatory to and has ratified a number of international and regional wildlife conservation treaties. The provisions provided for in the various treaties encourage and often help individual countries to meet their respective obligations. Wildlife research on cross border ecosystems and migratory wildlife population issues, by their nature, necessitate regional and international cooperation. UWRTI in implementation of the research will consult on regional and international Institutions through the Ministry of Tourism Wildlife and Antiquities.

3.2 Stakeholders mapped for the implementation of the research agenda

Fourteen categories of stakeholders ranging from government, civil society organizations, private sector and academia have been identified and their roles stipulated in the implementation of the research agenda (Table 1.2).

Table 1.2 Stakeholder mapping for implementation of the research agenda

| Stakeholder | Role of the stakeholder |
|--|--|
| 1. Ministry of Tourism Wildlife and Antiquities (MOTWA) | Oversee the research activities of UWRTI End users of the research findings. Provide research funds Provide technical guidance on the research conducted by UWRTI |
| 2. Uganda Wildlife Research and Training | Conduct research and training services for the conservation and management of Uganda’s wildlife resources, in fulfillment of the needs for continued |

| | |
|---|--|
| Institute | capacity building in natural resources management. |
| 3. Uganda Wildlife Authority (UWA) | End users of the research findings Identification of research needs. Provide contact bases for research activities in selected protected areas |
| 4. National Environmental management Authority (NEMA) | End users of the research findings Identification of research needs. Provide technical expertise in specific research areas |
| 5. National Forestry Authority (NFA) | End users of the research findings Identification of research needs. Provide technical expertise in specific research areas Provide contact bases for research activities in selected protected areas |
| 6. Ministry of Agriculture, Animal, Industries and Fisheries (MAAIF) | End users of the research findings Identification of research needs. Provide technical expertise in specific research areas. |
| 7. Local leaders | End users of the research findings Identification of research needs. Mobilisation of the community geared towards intended research activities and implementation of research findings |
| 8. Ministry of Health | End users of the research findings Identification of research needs. Provide technical expertise in specific research areas. |
| 9. Religious and cultural institutions | End users of the research findings Identification of research needs. Mobilisation of the community geared towards |

| | |
|---|--|
| | intended research activities and implementation of research findings |
| 10. Partner research institutions (NARO, MUBFS, ITFC, UIRI, UVRI, etc) | End users of the research findings Identification of research needs. Provide technical expertise in specific research areas |
| 11. Partner universities | End users of the research findings Identification of research needs. Provide technical expertise in specific research areas Provide student research Provide training to UWRTI staff |
| 12. International agency partners | End users of the research findings Identification of research needs. Provide technical expertise in specific research areas Provide funding for research |
| 13. The local community | End users of the research findings Identification of research needs. |
| 14. The Private Sector | Mining companies, wildlife ranchers and companies whose business directly depends on nature. |
| 15. Uganda National Meteorological Authority (UNMA) | Provide data on climate and climatologically studies Provide expertise |

3.3 Timeline of implementation of the focal research areas of the research agenda

The time line for implementation of the focal areas of the research agenda shall be Immediate (I) (with in 1 year) or Short term (S) (3 years) or Medium term (M) (3-5 years) or Long term (L) (after 5 years) or Continuous (C) (staring immediately and continuous for 10 years). The time plan for each of the focal areas is shown in Appendices 1 to 12.

3.4 Dissemination of the findings from the research

The findings of the research shall be disseminated through various ways, formally and informally. Some of the dissemination channels include:

1. The policy briefs
2. The flyers
3. The journal papers
4. Technical reports
5. Books

The mandate of UWRTI ends at generating the research and putting it across to the appropriate ministries and agencies and presenting the research findings at various local, national and international forums.

3.5 Estimated cost for the implementation of the research agenda

The cost of implementing the research agenda is estimated at UGX.105, 200, 000, 000 (One hundred and five billion, two hundred million shillings only) over a period of 10 years (Table 1.3). The average wildlife research budget annually is estimated at UGX.10, 520,000,000 (Ten billion, five hundred twenty million shillings only).

Table 1.3 Estimated costs of implementing the research agenda over a 10 Year period.

| Extractive industries: Oil and gas | Estimated cost in Uganda shillings |
|--|---|
| Ecological and environmental impacts of oil and gas exploration and production in conservation areas | 800 Million |
| Waste management from oil and gas exploration and production | 800 Million |
| Biodiversity / Habitat loss as result of exploration and production | 2 Billion |
| General adaptation syndrome / wildlife stress to oil and gas exploration and production | 1 Billion |
| Impact of infrastructure (roads, power lines, pipe lines, | 500 Million |

| | |
|---|---------------------|
| camps – on wildlife affecting migratory routes or biological corridors | |
| Oil and gas and Wildlife health | 800 Million |
| Sub total 1 | 5.9 Billion |
| Extractive industries: Mining | |
| Ecological and environmental impacts of mining in conservation areas | 4 Billion |
| Waste management from mining | 400 Million |
| Biodiversity / Habitat loss as result of mining | 500 Million |
| General adaptation syndrome / wildlife stress to mining activities | 500 Million |
| Impact of infrastructure (roads, power lines, pipe lines, camps – on wildlife affecting migratory routes or biological corridors | 200 Million |
| Mining and wildlife health | 800 Million |
| Sub total 2 | 6.4 Billion |
| Extractive industries: Sport hunting | |
| Population dynamics, (age, Sex, threatened or endangered), carrying capacity and the impact of sport hunting on wildlife conservation | 10 Billion |
| Public attitude and perceptions on sport hunting | 1 Billion |
| Effectiveness of sport hunting as a conservation tool | 200 Million |
| Cost benefit analysis of sport hunting including ethics | 500 Million |
| Sub total 3 | 11.7 Billion |
| Ecological monitoring: Biodiversity inventories including indicators for conservation | |
| Monitoring population species | 20 Billion |
| Fire ecology | 600 Million |
| Restoration needs in ecosystems | 600 Million |
| Invasive species | 800 Million |
| Reintroduction as good opportunities for large scale experiments on biodiversity | 2 Billion |

| | |
|--|--------------------|
| Interaction of genetics, behaviour, and new environment on the demographic parameters of released individuals. | 2 Billion |
| Sub total 4 | 26 Billion |
| Ecological monitoring: Key wildlife species extinction | |
| Continuously monitoring plant and animal populations | 20 Billion |
| Research into species behaviour and ecology (Open grass land for hunting by a cheetah) | 10 Billion |
| Research into ecological indicator species (raptors) | 1 Billion |
| Patterns of diversity with population dynamics and community structure and their trophic networks. | 800 Million |
| Population viability analyses and ecological predictive modeling of wildlife populations in a changing landscape | 200 Million |
| Sub total 5 | 32 Billion |
| Ecological monitoring: Species composition and diversity overtime of key species-updated list | |
| Develop a general theory which links research into population increase beyond sustainable numbers. | 800 Million |
| Research into effectiveness of interventions to address species extinction (e.g. Maintenance viable populations through translocation, creation of corridors, restoration and mitigation studies, use of fire as ecological tool) | 1 Billion |
| Sub total 6 | 1.8 Billion |
| Ecological monitoring: Buffer zone establishment and management | 1 Billion |
| Sub total 7 | 1 Billion |
| Ecological monitoring: Wildlife Health | |
| Research into wildlife Diseases | 1 Billion |
| Wildlife snaring | 800 Million |
| Diversity of indigenous knowledge in animal health systems | 800 Million |

| | |
|--|--------------------|
| Sub total 8 | 2.6 Billion |
| Ecological monitoring: Utilization and Ecosystem Restoration Thematic area | |
| Conservation economic valuation and payment for ecosystem services | 400 Million |
| Identification, monitoring and management of indicator species | 500 Million |
| Wildlife, community co-existence and conflict management | 5 Billion |
| Terrestrial and aquatic resources Pollution | 1 Billion |
| Sub total 9 | 6.9 Billion |
| Ecological monitoring: Impact of tourism on wildlife | |
| Impact on tourism and quality of tourists | 1 Billion |
| Public relations regarding tourists and how it affects wildlife conservation | 1 Billion |
| Sub total 10 | 2 Billion |
| Climate change | |
| Nutritional quality of plants in relation to climate change | 800 Million |
| Human wildlife conflicts challenges as a result of climate change | 1.2 Billion |
| Research into the habitat suitability and variability management under different climate change patterns | 1 Billion |
| Comparison of application of new technology (use of smart phones and Drones) in monitoring elements of climate and their impact on wildlife. | 2 Billion |
| Potential impacts of climate change on ecology of wildlife | 1 Billion |
| Studies based on animal and plant distribution patterns as a result of climate change. | 600 Million |
| Invasive species in light of climate change. | 600 Million |
| Migratory species and Migratory patterns of wildlife in light of climate change | 500 Million |
| Climate change and change of landscapes | 500 Million |

| | |
|--|---------------------------|
| <i>Sub total 11</i> | <i>8.2 Billion</i> |
| Other cross cutting research issues | |
| Gender and wildlife conservation | 100 Million |
| Research Quality Assurance and indicators | 200 Million |
| Indigenous Knowledge | 1 Billion |
| <i>Sub total 12</i> | <i>1.3 Billion</i> |
| Grand Total | 105.8 Billion |

4. MONITORING AND EVALUATION PLAN

The research agenda is proposed for a period of 10 years. There shall be midterm evaluation every after 3 years and a final evaluation after 10 years. The specific indicators that shall be monitored under each of the research focal areas are shown in Appendices 1 to 10.

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6. APPENDICES

Key: I= Immediate, S=Short term, M= Medium term, L= Long term, C= Continuous

Appendix 1: Oil and gas

| Thematic areas | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I, S,M, L, C |
|--|---|---|-----------------------------|---|----------------------------------|---|--------------|
| Ecological and environmental impacts of oil and gas exploration and production in conservation areas | <ul style="list-style-type: none"> Identify sites where there is oil and gas in PA Assess the impact of oil and gas on Fauna and Flora in the sites | Map of spatial distribution of oil and gas exploration and production in PA and area of coverage A report on the nature of impact, and | Map An assessment report | A mitigation plan on how to deal with the impact as deemed necessary from the research. | A plan on the mitigation measure | The impact of oil and gas to wildlife are mitigated / prevented | I |

| | | | | | | | |
|--|--|---|-------------------|---|---|--|---|
| | | extent of impact. | | | | | |
| Waste management from oil and gas exploration and production | Find out the waste generated The methods of disposal The impact of the waste on wildlife resources | A report containing the types of waste generated, methods of disposal and impacts to wildlife | A report | The waste management plan on how to deal with wastes | A plan on waste management | Waste properly managed and have minimum or no effect to wildlife resources | I |
| Biodiversity / Habitat loss as result of exploration and production | Habitat mapping and identification of the affected fauna | A spatial and temporal map of habitat loss map | Map | A Plan to recover/restore/rehabilitate loss of habitats | A restoration/rehabilitation, recovery plan | Habitat loss minimized | C |
| General adaptation syndrome / wildlife stress to oil and gas exploration and | Study animal behavior in relation to mining | A relationship between animal | A research report | A proposal with measures that | A proposal | The effect of oil and gas exploration | C |

| | | | | | | | |
|--|--|---|----------|---|-----------------------------|--|---|
| production | activities Study the animals stress levels through psychological /physiological | behavior and mining activities A relationship between animal stress level and mining | | minimally affect the behavior and stress of animals such as relocation of animals or oil and gas activities | | n and production on animal behavior or stress is reduced and minimized | |
| Impact of infrastructure (roads, power lines, pipe lines, camps - on wildlife affecting migratory routes or biological corridors | Study the routes of animals Study the infrastructure development Study the relationship between the infrastructure | A report that matches the areas of infrastructure development and the movement of animals | A report | A plan on relocating the infrastructure Modify the nature of the infrastructure to | A redesigned infrastructure | Minimum /no effect of infrastructure on movement of the animals | I |

| | | | | | | | |
|-----------------------------|---|---|----------|---|-----------------------|-------------------------------------|---|
| | and the routes of animals | | | accommodate the movement of animals | | | |
| Oil and gas Wildlife health | Study the health of selected wildlife in areas of oil and gas and in areas away from oils and gas | A report on the state of health and the extent the state is attributed to oil and gas | A report | A plan to treat the health of the affected animals and organize away of minimizing exposure that affects the health of the animal | A treatment of plant. | The health of the wildlife improved | I |

Appendix 2: Mining

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I, S,M, L, C |
|--|---|--|--|--|------------------------|---|--------------|
| Ecological and environmental impacts of mining in conservation areas | <ul style="list-style-type: none"> Identify sites where there is Mining in PA Assess the impact of Mining on Fauna and Flora in the sites | <p>Map of spatial distribution of Mining in PA and area of coverage</p> <p>A report on the nature of impact, and extent of impact.</p> | <p>Map</p> <p>An assessment report</p> | <p>A mitigation plan on how to deal with the impact as deemed necessary from the research.</p> | <p>A plan</p> | <p>The impact of Mining to wildlife are mitigated / prevented</p> | I |
| Waste management from mining | Find out the waste generated | A report containing the types of | A report | The waste management plan on | A plan | Waste properly managed | I |

| | | | | | | | |
|--|---|--|-------------------|---|---|---|---|
| | The methods of disposal The impact of the waste on wildlife resources | waste generated, methods of disposal and impacts to wildlife | | how to deal with wastes | | and have minimum or no effect to wildlife resources | |
| Biodiversity / Habitat loss as result of mining | Habitat mapping and identification of the affected fauna | A spatial and temporal map of habitat loss map | Map | Plan to recover/re-store/rehabilitate loss habitats | A restoration/rehabilitation, recovery plan | Habitat loss minimized | C |
| General adaptation syndrome / wildlife stress to mining activities | Study animal behavior in relation to mining activities Study the animals stress levels through | A relationship between animal behavior and mining activities A relationship between animal stress | A research report | A proposal with measures that minimally affect the behavior and stress of animals | A proposal | The effect of oil and gas on animal behavior or stress is reduced and minimized | C |

| | | | | | | | |
|--|--|--|----------|---|-----------------------------|---|---|
| | psychological /physiological | level and mining | | such as relocation of animals or oil and gas activities | | | |
| Impact of infrastructure (roads, power lines, pipe lines, camps – on wildlife affecting migratory routes or biological corridors | Study the routes of animals Study the infrastructure development Study the relationship between the infrastructure and the routes of animals | A report that matches the areas of infrastructure development and the movement routes of animals | A report | A plan on relocating the infrastructure Modify the nature of the infrastructure to accommodate the movement of animals | A redesigned infrastructure | Minimum /no effect of infrastructure on movement of the animals | I |
| Mining and wildlife | Study the | A report on | A report | A plan to | A | The | C |

| | | | | | | | |
|--------|---|---|--|---|------------------|---------------------------------|--|
| health | health of selected wildlife in areas of oil and gas and in areas away from oils and gas | the state of health and the extent the state is attributed to oil and gas | | treat the health of the affected animals and organize away of minimizing exposure that affects the health of the animal | treatment plant. | health of the wildlife improved | |
|--------|---|---|--|---|------------------|---------------------------------|--|

Appendix 3: Sport hunting

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I, S,M, L, C |
|---|---|---|------------------------------|---|-------------------------------|---|---------------------|
| Population dynamics, (age, Sex, threatened or endangered), carrying capacity and the impact of sport hunting on wildlife conservation | Find out the species of animals sport hunted, and the carrying capacity of the habitats, How they are hunted and the effect of sport hunting on the populations Study the population | The list of spot hunted animals A report with pros and cons on species preferred for sport hunting | A list A report | A list of species that could be spot hunted and those that should not be spot hunted based on their population dynamics | A list of species | Sport hunting is stopped for animal species that are not viable for sport hunting | C |

| | | | | | | | |
|--|--|---|----------|---|----------|--|---|
| | dynamics of species of animals prefer for sport hunting | | | | | | |
| Public attitude and perceptions on sport hunting | Ask local communities about their views on sport hunting vs poaching | A report with views of the local communities on sport hunting and how they perceive it and their attitude towards participation in it | A report | A plan developed on whether or not they could be included in sport hunting and how they could do it sustainably | A plan | An effectively negotiated resources use agreement based on sport hunting | C |
| Effectiveness of sport hunting as a | Set up an experiment to | A report comparing the | A report | A design for sport | A design | Sport hunting | I |

| | | | | | | | |
|---|--|---|----------|--|----------|--|---|
| conservation tool | determine whether sport hunting is a conservation tool | viability of a population of a species in a spot hunted area and outside as spot hunted area. | | hunting that enhances conservation | | exclusively done for purposes of enhancing conservation. | |
| Cost benefit analysis of sport hunting including ethics | Find out alternative uses of animals sport hunted Calculate the economic benefits of sport hunting vs other benefits that could be derived from sport hunting | A cost benefit analysis report | A report | Information about the benefits of sport hunting over the other economic ways of using the sport hunted species | A report | Sport hunted animals are put to better economic use | M |

Appendix 4: Biodiversity inventories including indicators for conservation

| Thematic area | Activities | Outputs | Indicators | Outcomes | Indicators | Impact | I, S,M, L, |
|----------------------|-------------------|----------------|-------------------|-----------------|-------------------|---------------|-------------------|
|----------------------|-------------------|----------------|-------------------|-----------------|-------------------|---------------|-------------------|

| | | | of outputs | | of outcomes | and indicators of impact | C |
|---------------------------------|---|--|-------------------|---|--|--|----------|
| Monitoring population species | Carry out population census of selected species | Population Census Report containing spatial and temporal data on key species | Report | List of species and their conservation status | List and species and number of individuals per species | Designed conservation tool for selected species affected | C |
| Fire ecology | Set up an experiment to determine the effect of fire on vegetation in protected areas | A report on the effect of fire on vegetation dynamics | Research report | Fire management strategies developed | Documentation of vegetation change | Integration of fire in the vegetation management plan | C |
| Restoration needs in ecosystems | Carry out vegetation | A report on vegetation | Report | Vegetation species | Designed restoration | Affected vegetation | C |

| | | | | | | | |
|--|---|---|--------|---|---|---|---|
| | inventory | inventory | | richness and abundance | plan | species restored | |
| Invasive species | Carry out vegetation mapping to determine spatial and temporal distribution of invasive, determine the effect of invasive species on ecosystems | Report of vegetation mapping, effect of I.S on ecosystems | Report | Invasive species identified, vulnerable native species identified | Design control/ management plan for I.S | Designed I.S management plan, & I.S managed | C |
| Reintroduction as good opportunities for large scale experiments on biodiversity | Carry out ecosystem assessment in relation to species to be | Ecosystem assessment report indicating status of | Report | Decision criteria for reintroduction | Introduction guiding principle/ | Successful reintroduction done | S |

| | | | | | | | |
|--|---|--|--------|-------------------------------|---|------------------------------|---|
| | reintroduced | suitability of target ecosystem | | | | | |
| Interaction of genetics, behaviour, and new environment on the demographic parameters of released individuals. | Carry out population assessment after reintroduction and genetic diversity studies. | List and abundance of species A report on the diversity status before and after introductions | Report | Developed Reintroduction plan | Reintroduction done successfully without undesirable consequences | Affected population restored | I |

Appendix 5: Key wildlife species extinction

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I, S,M, L, C |
|--|---|--|--|--|---|---|---------------------|
| Continuously monitoring plant and animal populations | assess biodiversity by regularly carrying population census and vegetation mapping/sampling | a report on species richness and abundance | A report, list of species & their numbers | Conservation status of key species known | List of species or population of concern | Restoration or population regulation plan | C |
| Research into species behaviour and ecology (Open grass land for hunting by a cheetah) | Study behaviour changes of selected animal in | A report on animal behaviour change in relation to | A report on selected animal behaviour change | Specific behaviour changes known | List of species with their respective behaviour | Management/rehabilitation plan developed | C |

| | | | | | | | |
|--|--|---|--|--|-------------------------------|---|---|
| | different ecosystems | changes or activities in the ecosystem e.g. hunting | | | changes | to address behaviour change of concern | |
| Research into ecological indicator species (raptors) | Carry a population census/inventory of selected indicator species | Population census data of important indicator species | Population census report | Conservation/restoration plan for indicator species of concern | Conservation/restoration plan | Species of concern conserved / restored | I |
| Patterns of diversity with population dynamics and community structure and their trophic networks. | Study the species richness and abundance and distribution in space and time Study the | Information on the species ecology in space and time | An ecological report about the species | A plan on habitat modification and management to redistribute species according to their | A plan | The species are evenly distributed and rationing appropriately the available food | M |

| | | | | | | | |
|--|---|--|---|--|--------|--|---|
| | feeding relationships among species | | | feeding relationships | | | |
| Population viability analyses and ecological predictive modeling of wildlife populations in a changing landscape | Study how the species shall change with time under different scenarios as a futuristic research | A forecast on the population viability for 100 years | A projection of population viability in 100 years | The plan to change the course of population change | A plan | A population that emerges based on a planned model in light of changes | I |

Appendix 6: Species composition and diversity overtime of key species-updated list

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I, S,M, L, C |
|--|--|---|--|---|---|--|---------------------|
| There is a need to develop a general theory which links research into population increase beyond sustainable numbers. | A research into options for viable conditions to survive under certain ecological conditions | A report | Alternative ways of sustaining viable populations in non conventional conditions | A profile of alternative conditions to sustain the population | A profile | Populations can thrive in alternative ecological conditions | M |
| Research into effectiveness of interventions to address species extinction (e.g. Maintenance viable populations through translocation, creation of corridors, restoration and mitigation studies, use of fire as ecological tool) | Test out different conservation interventions and assess their effectiveness | A profile of interventions and their strength over the others | A report | A tested intervention that is most effective for the survival of wildlife | A description of the intervention and how it is applied | The wildlife is managed based on the most effective intervention | M |

Appendix 7: Buffer zone establishment and management

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I, S,M, L, C |
|--|---|---|---------------------------------------|---|---|---|---------------------|
| Buffer zone establishment and management | Feasibility studies for buffer zone establishment | A report on the buffer zone establishment and management | List of buffer zones and their state. | A proposal on how to effectively establish and manage buffer zone | A buffer zone establishment plan in place | Buffer zone established and effectively managed | S |
| | Research on resource access to buffer zones | A report on the resource use of flora and Fauna in buffer zones | Resources extracted from buffer zones | Information on effect of resource use from buffer zones | The positive or negative effects of resource access in buffer zones | The negative effects of resource use from buffer zone mitigates | S |
| | Research into management of buffer zones | A report on performance of buffer zones | Ranking performance of buffer zone | Evidence on state of management of buffer | A profile of buffer zones well managed and those | Effective buffer zone management | S |

| | | | | | | | |
|--|--------------------------|--|--------------------------------|--|-----------------------------------|---|---|
| | | | | zones | poorly managed | implemented | |
| | Land use in buffer zones | A report on the different land uses in buffer zone | Map of land use in buffer zone | A profile of good and bad land use practices in buffer zones | State of land use in buffer zones | Proper land use of buffer zones enhanced. | S |

Appendix 8: Wildlife Health

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I, S,M, L, C |
|---------------------------------|---|--|------------------------------|--|-------------------------------|---|---------------------|
| Research into wildlife Diseases | Disease surveillance Disease outbreak investigation (Drivers and impacts) | A surveillance report on diseases, frequency, and populations affected in space and time | A research report | Propose implementation interventions to address the underlying cases of certain diseases | An implementation plan | Disease outbreaks prevented and managed | C |
| Wildlife snaring | Research Drivers and Impacts of snares on | A survey report on the drivers of snares | A research report | Proposing measures to mitigate or prevent | A list of measures | Animal snares prevented | I |

| | | | | | | | |
|--|--|---|----------------------------------|---|-------------------------------------|--|---|
| | animal snares | | | animal snares and implementation plan | | | |
| Diversity of indigenous knowledge in animal health systems | Research traditional knowledge of animal health management | Documented indigenous knowledge and practices that are useful in animal health management | A report on indigenous knowledge | An interpretation of the role of indigenous knowledge in the Animal health. | Application of indigenous knowledge | Indigenous knowledge is integrated in Animal health management | I |

Appendix 9: Utilization and Ecosystem Restoration

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I, S,M, L, C |
|--|--|--|------------------------------|---|-----------------------------------|--|---------------------|
| Conservation economics and payment for ecosystem services | Research into the viable economic instruments for conservation | The list of economic instruments for conservation | Economic instruments | The agreement on conservation through particular economic instruments | Agreement | Wildlife conserved / restored through implementation of economic instruments | S |
| Identification, monitoring and management of indicator species | Identify indicator species in particular ecosystems | A list of indicator species and what they indicate | Indicator species | Popularize the indicator species | The popularized indicator species | Make a decision on restoration /intervention based | I |

| | | | | | | | |
|--|--|--|----------|---|--|--|---|
| | | | | | | on indicator species. | |
| Wildlife, community co-existence and conflict management | Find out why interventions are not working Propose better wildlife conflict management intervention | A report on hindrances to effectiveness of community wildlife conflict interventions | A report | A recommendation on better alternatives for Wildlife management | More effective proposal of wildlife management | Wildlife conflicts with community addressed. | C |
| Terrestrial and aquatic resources Pollution | Research the anthropogenic factors that lead to pollution | Research report on the types and nature of the anthropogenic pollution | A report | How to deal with the pollution | A pollution management plan | Pollution prevented/ Mitigates | I |

Appendix 10: Impact of tourism on wildlife

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicator s of outcomes | Impact and indicators of impact | I,S,M, L, C |
|--|--|--|--|--|---|--|--------------------|
| Impact on tourism and quality of tourists | List of Tourism activities. Impact of each of the activities on wildlife | The impact assessment of Tourism on Wildlife | Impact assessment report | A mitigation plan for addressing the impact of tourism on wildlife | A Plan of mitigation . | The impact of Tourism on wildlife minimized/ prevented | C |
| Public relations regarding tourists and how it affects wildlife conservation | Research on public perception towards tourists and wildlife conservation | A public perception report | A relationship between public perception of tourists and wildlife conservation | The plan of addressing negative perceptions | To enhance an attitude towards tourists that promotes wildlife conservation | The conservation of wildlife enhanced. | C |

Appendix 11: Climate change

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | I,S,M, L, C |
|---|--|--|------------------------------|--|-------------------------------|--|--------------------|
| Nutritional quality of plants in relation to climate change | Find the uptake of water and minerals and nutrients by selected plants | A physiological report | A report | A mitigation plan ameliorate effects of climate change | A plan | Negative effect mitigated | C |
| Human wildlife conflicts challenges as a result of climate change | The nature and extent of wildlife conflicts | A research report on human wildlife conflict as a result of climate change | A research report | A plan to mitigate the effects | A Plan | Effects mitigated | C |

| | | | | | | | |
|--|---|--|------------------------------------|---|--------------------------------------|--|---|
| Research into the habitat suitability and variability management under different climate change patterns | Nature and types of habitats and preferences | A Research on the relationship between climate change and habitat change | A research report | A proposal to mitigate habitat change as a result of climate change | A mitigation plan | The effects of climate change on habitats mitigated | C |
| Comparison of application of new technology (use of smart phones and Drones) in monitoring elements of climate and their impact on wildlife. | The use of various technologies in research. | A tested technology in monitoring wildlife research | A report on the tested technology. | Most effective technology selected | A profile of the selected technology | The most effective modern technology used in Monitoring wildlife | C |
| Potential impacts of climate change on ecology of wildlife | Changes in elements of weather (temperature and rainfall) | A research on effects of climate change on wildlife | A research report | Mitigation measures proposed | A mitigation plan | Effect of climate change on Wildlife mitigated | C |

| | | | | | | | |
|---|--|---|-------------------|--|---|---|---|
| | How changes in elements are affecting wildlife | ecology | | | | | |
| Invasive species in light of climate change. | Find the relationship between CC and invasive species | Correlation between CC and invasive species | A report | A plan to address invasive species identified | A plan on climate change based management | The Invasive species managed | C |
| Migratory species and Migratory patterns of wildlife in light of climate change | Research the relationship between CC and migration of Wildlife | Correlation between CC and migratory Wildlife | A research report | A plan to manage the migration of wildlife based on the climate parameters | A mitigation plan | Migration of wildlife ecologically managed. | |

Appendix 12: Other cross cutting research issues

| Thematic area | Activities | Outputs | Indicators of outputs | Outcomes | Indicators of outcomes | Impact and indicators of impact | Timeline |
|---|---|---|--|--|--|---|-----------------|
| Gender and wildlife conservation | A research on gender relations in wildlife conservation | A gender main streaming plan | A plan | A gender based research | A gender mainstreaming plan | Gender aspects integrated in Wildlife conservation | Cross cutting |
| Research Quality Assurance and indicators | Checking the data collection and management process | Research quality assurance tools | Monitoring tools. | Research that is of good quality | A research quality assurance plan | Quality research conducted | Cross cutting |
| Indigenous Knowledge | Research on the understanding of the role of indigenous knowledge in conservation of Wildlife | A profile of beneficial indigenous knowledge in wildlife conservation and how it can be applied | Indigenous knowledge within each research report | Process of integration of IK in wildlife conservation stipulated | A research proposal that integrated Indigenous knowledge | Indigenous knowledge is integrated in Wildlife conservation | Cross cutting |

