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An assessment of the marine protected area ecological monitoring framework in Kenya

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AN ASSESSMENT OF THE MARINE PROTECTED AREA ECOLOGICAL MONITORING FRAMEWORK IN KENYA

By

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Declaration

I certify that all the material in this dissertation that is not my work has been identified and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my personal views and are not necessarily endorsed by the University.

(Signature): 

(Date): 20th September 2021

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Abstract

Title of Dissertation: **An Assessment of the Marine Protected Area Ecological Monitoring Framework in Kenya**

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For certain marine protected areas (MPAs) in Kenya, the Kenya Wildlife Service (KWS) has instituted ecological management programmes tailored to fulfill a set of conservation objectives. Each of these programmes is accompanied by a monitoring plan to guide management action by measuring the impact of implemented activities using relevant indicators. The motive of this dissertation was to assess the ecological monitoring plans in place.

The study was initiated by a comprehensive review of the present ecological monitoring framework. This was followed by a look into the progressive development of ecological monitoring activities along the Kenyan coast based on the valuable contribution of research institutions, academia, and the local community.

A quantitative research methodology was then utilized to carry out this assessment by administering a semi-structured questionnaire to key MPA stakeholders' groupings. This availed a sample of stakeholders' thoughts and perceptions on the current ecological monitoring plans which serves as the primary source of data for this study.

Based on an evaluation of the findings retrieved, the study illustrates a mutual satisfaction with the current ecological monitoring framework. The study further shows the need to review factors surrounding funding allocations, stakeholder involvement, human capacity, policies, and data sharing and integration.

KEYWORDS: MPA, Ecological Monitoring Plan, Kenya Wildlife Service, Ecological Management Programmes, Framework.

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List of Abbreviations

BNR	Boni National Reserve
CBD	Convention on Biological Diversity
CCC	Convention on Climate Change
CMS	Convention on Migratory Species
CORDIO	Coastal Oceans Research and Development – Indian Ocean
DNR	Dodori National Reserve
EEZ	Exclusive Economic Zone
ERVs	Exceptional Resource Values
IUCN	International Union for Conservation of Nature
KBDCA	Kiunga-Boni-Dodori Conservation Area
KEA	Key Ecological Attribute
KMMPA	Kisite-Mpunguti Marine Protected Area
KWS	Kenya Wildlife Service
MPA	Marine Protected Area
MMPA	Malindi Marine Protected Area
NEMA	National Environment Management Authority
PA	Protected Area
UNEP	United Nations Environment Programme
WIOMSA	Western Indian Ocean Marine Science Association
WCS	Wildlife Conservation Society
WMPA	Watamu Marine Protected Area
WWF	World Wide Fund

1 Introduction

The Kenyan coast is inhabited by a substantial number of people who are highly dependent on the vast resources offered by its coastal and marine ecosystem (McClanahan et al., 2005). Based on the 2019 Kenya census the total population in the coast region added up to 4,329,474 hence making up 9% of the country's population (Kenya National Bureau of Statistics, 2019). This illustrates the significant value of the coast to a considerable size of the country's population.

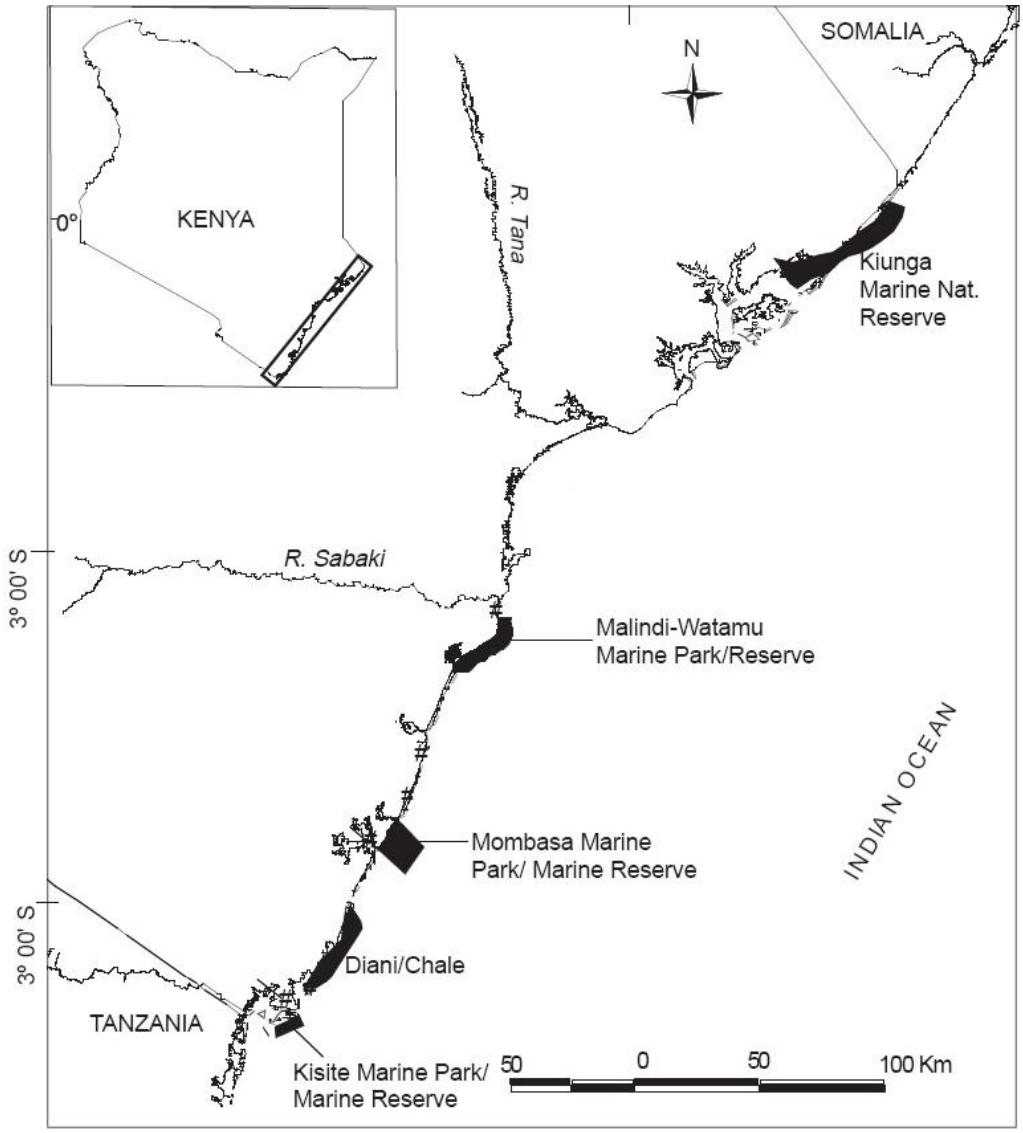
The integral value of the coastline to the financial and social wellbeing of locals and the nation at large dates back to colonialism when trade in poles made of mangroves was a vital commercial activity (Tuda & Omar, 2012). Today, ventures that rely on the availability of natural resources on Kenya's coasts include tourism, shipping, fishing, agriculture, and mining (McClanahan et al., 2005). These comprise the predominant economic activities in the coast region. However, unmonitored exploitation of natural resources has led to the deterioration of the coastal and marine ecosystem goods and services (Tuda & Omar, 2012).

Kenya's coastline is subjected to various pressures induced by climate change and human activities. These include destructive fishing practices such as dynamite fishing, marine pollution that is of land-based origins such as agricultural activities and waste from urban residences, overfishing, shoreline erosion and alterations, physical modification and damage of marine and coastal habitats and invasive species (National Environment Management Authority (NEMA), 2009).

In a bid to lessen the effects of the indicated detrimental pressures and to restore valuable aspects of the marine and coastal ecosystem up to 0.67 percent and 9.9 percent of Kenya's exclusive economic zone (EEZ) and territorial waters respectively make

up marine protected areas (MPAs) (UNEP-Nairobi Convention & WIOMSA, 2021). Currently, as shown in Figure 1, six government-initiated MPAs comprising of nine different designations are in place (Kaunda-Arara et al., 2004). The Malindi-Watamu Marine Park/Reserve illustrates the location of the Watamu Marine Protected Area(WMPA) and the Malindi Marine Protected Area(MMPA) which are in the same area (Figure 1).

Figure 1: Marine Protected Areas in Kenya



Note. The above image is a map of MPAs that are comprised of the indicated marine parks and reserves along Kenya's coastline. Adapted from "Long-term Trends in Coral Reef Fish Yields and Exploitation Rates of Commercial Species from Coastal Kenya", by B. Kaunda-Arara, G. A Rose, M. Muchiri and R. M. Kaka, 2003, Western Indian Ocean Journal of Marine Science, 2(2), p. 107 (10.4314/wiojms.v2i2.28437). Copyright 2003 by the Western Indian Ocean Journal of Marine Science (WIOJMS).

Table 1 further illustrates the nine designations that fall within the International Union for Conservation of Nature (IUCN) Protected Area category II and VI based on set management objectives (Tuda & Omar 2012; Nairobi Convention, 2021).

Table 1: Marine Protected Areas in Kenya

MPA	Designation	IUCN Category	Size (km^2)	Period of Establishment
Malindi- Watamu	Malindi-Watamu National Reserve	VI	213	1968
	Watamu Marine National Park	II	32	1968
Malindi	Malindi Marine Park	II	6.3	1968
Kisite-Mpunguti	Kisite Marine National Park	II	28	1978
	Mpunguti Marine Reserve	VI	11	1978
Kiunga	Kiunga Marine Reserve	VI	250	1979
Mombasa	Mombasa Marine Reserve	VI	10	1986
	Mombasa Marine Park	II	200	1986
Diani-Chale	Diani-Chale Marine National Park and Reserve	VI	75	1993

Note. Adapted from https://nairobiconvention.org/clearinghouse/node/411#overlay-context=user/35. Copyright 2021 by Nairobi Convention Secretariat.

Category II designations are referred to as national parks. These are vast natural or near-natural premises that have been set apart to safeguard expansive ecological activities and the associated species and ecosystem traits (International Union for Conservation of Nature (IUCN), 2021). This avails opportunities for learning, recreation, scientific exploration, and spiritual activities that align with the given environmental and cultural setting (IUCN, 2021).

It is anticipated that category II areas ought to accommodate key natural domains and biological and environmental traits within an ample space that can sustain ecological activities (IUCN, 2021). Out of the nine designations in Kenya's MPAs, four fall within IUCN category II while the remaining five fall within IUCN category VI (Nairobi Convention, 2021).

Category VI refers to protected areas where natural resources are utilized sustainably. This is with the intent to create a balance between conservation and sustainable use through safeguarding a given natural ecosystem while utilizing its resources (IUCN, 2021). Protected areas also sustain the cultural significance of the area under conservation (IUCN, 2021). In addition, these designations comprise a region preserved in its natural state known as a no-take management zone (IUCN, 2021).

Based on the Convention on Biological Diversity (CBD) a marine protected area (MPA) is defined as follows: "a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives" (Wells et al., 2007). The 4,329,474 inhabitants of Kenya's coastal region are heavily dependent on marine and coastal ecosystem goods and services. Thus necessitating the need to inhibit irreversible impacts caused by human activities to the ocean through the establishment of MPAs (Rocliffe et al., 2014).

Globally, efforts are currently being channeled to protect and restore the ocean and its ecosystems. However, the lack of setting conservation objectives based on data on the

ocean's response to dynamic and accelerated human activities results in uninformed decision-making (Wisz et al., 2020). MPAs have been present in East Africa for several decades (Wells et al., 2007). Despite this majority of them lack baseline data on their condition before their establishment, ideal evaluation frameworks, and continuous monitoring (Wells et al., 2007). Monitoring of MPAs enables the evaluation of implemented procedures aimed towards conserving biodiversity (Bennett & Dearden, 2014).

In Kenya, following the *Wildlife Conservation and Management Act 2013* every MPA, national park, wildlife conservancy, and sanctuary is overseen based on an authorized management plan. This act also indicates that the development of the management plan is guided by the national wildlife conservation and management strategy. Every five years, the Cabinet Secretary in charge of wildlife matters is mandated to share a monitoring report on wildlife resources to the National Assembly and the general public (*The Wildlife Conservation and Management Act,* 2013) The report should illustrate the impact of the national wildlife conservation and management strategy.

Monitoring frameworks provide a feedback mechanism to measure the level of effectiveness of existing management plans which administer various aspects of the MPAs within ten years (Vreugdenhil et al., 2003). A participatory approach involving valuable stakeholders is utilized in the development of these plans (Muthiga et al., 2000). Management programmes from which monitoring plans are drawn tackle ecological aspects; tourism development; community partnership and conservation education; and operations and security. The mandate of implementing these management plans is designated to the KWS (*The Wildlife Conservation and Management Act,* 2013).

1.1 Aim of Study

This dissertation aims to assess the current ecological monitoring framework used for MPAs in Kenya.

It will be initiated by highlighting the historical and present-day state of ecological monitoring in MPAs through a literature review. Secondly, using a semi-structured questionnaire, the thoughts of stakeholders from key institutional categories on MPA ecological monitoring will also be captured. This information will be cumulatively utilized to fulfill the purpose of this study.

Ultimately the goal of conducting this study is:

- To allow stakeholders to provide their thoughts on the current state of ecological monitoring.
- To uncover barriers that hinder effective MPA ecological monitoring.
- To make recommendations to the KWS in respect to the ecological monitoring framework based on the findings retrieved.

1.2 Research Questions

Below are the research questions that will be explored in the course of this study.

- What is the current monitoring framework utilized by the KWS to measure the ecological wellbeing of MPAs in Kenya?
- What is the degree of effectiveness of the current monitoring framework used in Kenya's MPAs?

1.3 MPA Ecological Monitoring Framework: Kenya as a Case study

Currently, four out of the six MPAs in Kenya have management plans in place in which an ecological management programme is developed. These programmes provide guidelines for ecological monitoring. This aids in measuring anticipated positive impacts and likely negative impacts of implementing ecological management objectives using distinct indicators. A MPA monitoring indicator is defined as follows, "A unit of information measured over time that documents change in specific attribute(s) of the MPA"(Pomeroy et al., 2004) .

Ecological management objectives are developed through an analysis of significant ecological features, distinct biodiversity, and the dominant threats within a given protected area (PA) (Kenya Wildlife Service, 2015a). This is referred to as the conservation action planning (CAP) methodology (Kenya Wildlife Service, 2015a). The biodiversity and ecological features of a given PA define the conservation targets for which management action is developed.

In addition, stakeholders avail details on natural resources that provide them with valuable benefits and play a key role in preserving an area's distinctive traits and ecology in regards to biodiversity. These are referred to as exceptional resource values (ERVs) (Kenya Wildlife Service, 2015a) The ERVs aid in developing the purpose for establishing a given MPA. As seen in the following sections, conservation targets and ecological management objectives vary from one MPA to another.

1.3.1 Watamu and Malindi Marine Protected Areas

The purpose of establishing the WMPA and MMPA as indicated in the respective management plans is, “to preserve and maintain a representative area of the coral reef ecosystem together with the beaches which typify the Kenyan coast for the benefit of present and future generations” (Kenya Wildlife Service, 2015). Both MPAs are based on the territorial waters of Malindi sub-county, Kilifi county in Kenya (Kenya Wildlife Service, 2015).

The MMPA is made up of Malindi Marine National Park and Malindi National Reserve while the WMPA is made up of Watamu Marine National Reserve, Watamu Marine National Park, and a significant fraction of Malindi Marine National Reserve, (Kenya Wildlife Service, 2015). The MPA management plan is designed based on the certain ERVs as indicated in Table 2 and their respective management needs and

threats (Kenya Wildlife Service, 2015). This aids in the definition of conservation targets in the ecological management plan.

Table 2: Biodiversity ERVs and Conservation Targets for MMPA and WMPA

Biodiversity Exceptional Resource Values	**Conservation targets**
-Sea turtles -Marine mammals -Sharks and Rays -Billfish -Important bird areas -Seagrass -Intertidal habitats -Mangrove Forest at the delta of Sabaki River and Mida creek for Malindi MPA and Watamu MPA -Coral reef ecosystem -Sandy beaches -Shoreline habitats -Lagoons swamps & marsh habitats	-Coral reef ecosystem -Estuarine ecosystem -Sandy beaches and dunes -Seagrass bed -Waders -Sea turtles -Marine mammals

Note. Adapted from Malindi and Watamu Marine Protected Area Management Plan 2016-2026 by the Kenya Wildlife Service. Copyright 2015 by Kenya Wildlife Service.

The significant threats to WMPA and MMPA include climate change and sea-level rise, management conflict¸ harmful fishing practices such as seine net, overfishing, and coastal development (Kenya Wildlife Service, 2015). Hence the ecological management objectives aim to conserve threatened marine biodiversity and valuable habitats, reduce prevalent threats and provide a concrete understanding of ecological elements and processes (Kenya Wildlife Service, 2015). These objectives are monitored based on the prospective impacts and indicators seen in Table 3.

Table 3: Ecological Management Programme Monitoring Plan of MMPA and WMPA

Objective	**Potential Impacts**	**Verifiable Indicator**	**Indicator Sources**
Objective1: Conservation of threatened marine species enhanced	-Sufficient scientific information to support the management of threatened marine species is available	-Sea turtle nesting sites	-Turtle nesting monitoring data
	-Threats to threatened marine species are reduced	-Status of coral reef	-Coral reef degradation monitoring data
Objective 2: Important habitats sustainably conserved	-Increased support for marine conservation efforts	-Resource use conflicts	-Security database
	-Increased health of coral reefs and seagrass beds	-Status of coral reefs and seagrass beds	-Coral and seagrass monitoring data
	-Increase in the area under conservation land use	- A new gazetted protected area	-Gazette notice
Objective 3: Threats to critical components reduced	-Threats to the shoreline are understood and minimized	-Shoreline setbacks Established	-Management reports
		-Status of marine pollution	-Research and monitoring reports
Objective 4: Ecological components and processes are understood	-Ecological research and monitoring is being carried out	-Research studies and ecological monitoring carried out	-Research and monitoring reports

Note. The table includes positive and negative potential impacts. Adapted from Malindi and Watamu Marine Protected Area Management Plans 2016-2026 by the Kenya Wildlife Service. Copyright 2015 by Kenya Wildlife Service.

1.3.2 Kisite-Mpunguti Marine Protected Area

The Kisite Mpunguti Marine Protected Area (KMMPA) consists of Kisite Marine National Park and Mpunguti Marine National Reserve (Kenya Wildlife Service, 2014). Based on its management plan for the year 2015 to 2025 the purpose of establishing this MPA is as follows, "to preserve and maintain a typical representative area of the coral reef communities, migratory marine birds, and threatened and endemic marine wildlife for the benefit of present and future generations" (Kenya Wildlife Service, 2014). As seen in Table 4 the KMMPA has its unique traits in respect to biodiversity ERVs and conservation targets.

Table 4: Biodiversity ERVs and Conservation Targets for KMMPA

Biodiversity Exceptional Resource Values	**Conservation targets**
-Sea turtles -Marine mammals (whales, dolphins, dugongs) -Shimoni tropical forest -Coral reefs -Coconut crabs -Mangroves -Important Bird Area -Seagrass beds	-Mangrove ecosystems -Coral reef -Sea bed ecosystems -Intertidal habitat -Coastal forest habitat -Islands -Threatened marine mammals (whales, dolphins, dugongs) -Sea turtles

Note. Adapted from Kisite-Mpunguti Marine Protected Area Management Plan 2015-2025 by the Kenya Wildlife Service. Copyright 2014 by Kenya Wildlife Service.

Various threats afflict the indicated biodiversity, habitats, and ecosystems in Table 4. Namely excessive resource utilization, invasive rodent species, pollution from marine litter, unsustainable fishing practices, tourism, production of charcoal, unlicensed logging, absentee landlords in coastal forests, and overfishing of sea urchin predators (Kenya Wildlife Service, 2014). The ecological management plan aims to achieve three objectives (Table 5).

Table 5: Ecological Management Programme Monitoring Plan of KMMPA

Objective	Potential Impacts	Verifiable Indicator	Indicator Sources
Objective 1: Rare endemic or threatened species are protected and restored	-The turtle population in the KMMPA is increasing and breeding sites are protected -Increased functional nests -Increased population size -The endangered dugong species population is increasing	- Population size -Turtle nests -Population size	- Population counts -Turtle nesting monitoring reports - Population counts
Objective 2: Marine ecosystems are maintained in a healthy functioning state	-Coral reef damage in KMMPA is reduced -Threats to the Mangrove ecosystem are reduced -Pollution is reduced and clean-ups conducted regularly	-Abundance of coral fishes -Population size of coral fishes -Coral cover -Coral mortality rate -Coral recruitment -Extent of degradation -Water quality	-Coral reef fisheries monitoring report -Mangrove forest monitoring reports -Water quality reports

Objective	Potential Impacts	Verifiable Indicator	Indicator Sources
Objective 3: Marine biodiversity is understood and appreciated	-Marine biodiversity is being conserved -Improvement in information availability -Knowledge and skills improved	-Species diversity and population size -Functional database -Training in relevant areas	-Population counts

Note. The table includes expected positive and negative impacts. Adapted Kisite-Mpunguti Marine Protected Area Management Plan 2015-2025 by Kenya Wildlife Service. Copyright 2014 by Kenya Wildlife Service.

Ecological objectives are based on the key ecological attributes (KEAs) of KMMPA, its conservation targets, and present threats. As seen in Table 5 these objectives dictate the indicators used to monitor the impact of ecological management objectives.

1.3.3 The Kiunga Marine National Reserve

The Kiunga Marine National Reserve is part and parcel of the Kiunga-Boni-Dodori Conservation Area (KBDCA) which was put in place for the following purpose, "to conserve and protect marine and coastal forest species, especially the threatened sea turtles, dugong, coastal Topi, wild dogs and elephants along with their associated habitats for the benefit of present and future generations" (Kenya Wildlife Service, 2012). The ecological management programme aims to rehabilitate, preserve and avail a better understanding of ecological elements and processes in addition to minimizing threats to vital ecological features (Kenya Wildlife Service, 2012). The objective is influenced by the unique ERVs and conservation targets in KBDCA (Table 6).

Table 6: Biodiversity ERVs and Conservation Targets for KBDCA

Biodiversity Exceptional Resource Values	Conservation targets
-Threatened and rare coastal forest species (Ader's duiker, Elephant shrew, coastal Topi, Hirola, wild dogs) -Threatened marine species (Dugong, Sea turtles) -Mangroves -Seagrass -Connectivity between the protected marine and terrestrial protected areas -Important Bird Area (IBA) status -Coral reefs	-Coral reefs -Mangrove forest -Coastal forest -Inland freshwater wetlands -Forest grasslands -Elephants -Sea turtles -Marine mammals -Migratory birds

Note. Adapted Kiunga-Boni-Dodori Conservation Area Management Plan, 2013-2023 by Kenya Wildlife Service. Copyright 2012 by Kenya Wildlife Service.

The identified threats to KBDCA conservation targets include dredging activities from Lamu port development, sedimentation, climate change, fishing in inland freshwater wetlands, conflicting policies in various sectors, beach development, and blockage of migratory routes (Kenya Wildlife Service, 2012). In light of this, the ecological management objectives include the conservation of vital habitats and key dispersal areas, conservation of threatened species, and dispersal of scientific information while ensuring awareness of ecological traits and dynamics (Kenya Wildlife Service, 2012). Table 7 highlights the ecological monitoring framework utilized.

Table 7: Ecological Management Programme Monitoring Plan of KBDCA

Objective	Potential Impacts	Verifiable Indicator	Indicator Sources
Objective 1: KBDCA's Key habitats (marine and terrestrial) and important dispersal areas are managed and maintained	- Habitat connectivity between the Dodori National Reserve (DNR) and Boni National Reserve (BNR) and the natural habitats adjacent to these two national reserves are maintained	- Extent of permanent agriculture/ settlements and wildlife habitat adjacent to the BNR and DNR	- KBDCA land cover change study, satellite imagery and ground observations
	- Elephants and other key species are able to continue moving between the BNR and DNR and surrounding dispersal areas	- Elephant movements	- GPS collaring of individuals
	- The coral reef integrity is maintained	- Coral diversity	- Coral monitoring Reports
	- Sea turtles continue to nest on KMNR Beaches	- Number of nests	- Turtle nest monitoring Reports
	- The area of grassland available for key grazing species in the KBDCA is maintained	- Area of grassland	- Land cover study, satellite imagery and ground observations
Objective 2: KBDCA species of conservation concern conserved	- The populations of all threatened species in the KBDCA are increasing at target rates	- Population size and recruitment rates	- Population counts

Objective	Potential Impacts	Verifiable Indicator	Indicator Sources
Objective 3: KBDCA's ecological components and dynamics understood and scientific information disseminated	- The ecological composition and dynamics of key habitats is studied	- Species composition	- Biodiversity inventory reports

Note. Adapted Kiunga-Boni-Dodori Conservation Area Management Plan (KBDCA), 2013-2023. Copyright 2012 by Kenya Wildlife Service.

1.3.4 Others

Mombasa Marine National Park and Reserve was established to inhibit uncontrolled fishing, shell, and coral collection, and safeguard the environment (Nairobi Convention Secretariat, 2021). On the other hand, Diani-Chale Marine National Park and Reserve was set up with the intent of protecting coral reefs, boosting local fisheries and tourism (Nairobi Convention Secretariat, 2021). Currently, no management plan is available for these MPAs.

2 Literature Review

As highlighted earlier, this study aims to assess the status of ecological monitoring in Kenya's MPAs. In this chapter, literature published between 2000 and 2018 related to the subject under study was reviewed. This provided insight into the importance of MPA monitoring, monitoring framework design, and the progressive development of ecological MPA monitoring in Kenya.

2.1 Background

Constructive ecosystem management is challenging due to ecosystem complexities and the impact of human pressure (Kelleher, 2000). The availability of a considerable amount of ecological data can facilitate monitoring when using an adaptive approach to ecosystem-based management and conservation initiatives (Freiwald et al., 2018). Monitoring mechanisms in MPAs enable assessment of the state under which a given MPA is established and allows measurement of the impact of its indicated objectives among key stakeholders (Ahmadia et al., 2015; IUCN, 2004). This aids in guiding MPA management activities and also provides a basis for national and international ecological assessments and reporting (Pelletier, 2020). Ecological monitoring activities are primarily initiated to evaluate the status of vital biodiversity.(UNEP-Nairobi Convention & WIOMSA, 2021).

Monitoring in respect to MPAs can be defined as follows, "A continuous systematic process of collecting and analyzing information, through the use of indicators" (IUCN, 2004). This exercise can be carried out for the indigenous residents of the area where the MPA is located, MPA management procedures, the well-being of biodiversity, and the ecosystem (IUCN, 2004). A variant of factors can be leveraged to design an ideal monitoring framework for MPAs.

Firstly, the monitoring scope should be established based on the available resources, personnel capabilities, and the priorities at hand (IUCN, 2004). This aids in the development of conservation objectives and the selection of relevant indicators for impact evaluation. One of the identified challenges of monitoring activities is the selection of inappropriate indicators that fail to measure the MPA outcomes or lack feasibility in terms of cost and capacity to implement (Ahmadia et al., 2015; IUCN, 2004).

A baseline evaluation of biodiversity, ecological traits, stressors, and socio-economic attributes of the MPA ought to be conducted to allow measurement of the impact of conservation efforts (IUCN, 2004; Kelleher, 2000; Vreugdenhil et al., 2003). The design and implementation of the MPA monitoring framework should be participatory to make it clear and provable among in-house and external stakeholders (IUCN, 2004; Vreugdenhil et al., 2003). Involvement of the local community aids in eliminating conflict in the course of implementing conservation objectives (IUCN, 2004; Kelleher, 2000). The expertise of independent scientists can also be leveraged in carrying out monitoring activities and in building local capacity in a bid to enable self-reliant future monitoring activities (IUCN, 2004; Kelleher, 2000).

2.2 Ecological Monitoring of MPAs in Kenya

The Malindi-Watamu Marine National Park and Reserve marked the inception of the establishment of five additional MPAs in Kenya between the period of 1968 to 1993. (Tuda & Omar, 2012). The process was informed by various global agreements namely the Convention on Migratory Species (CMS), Convention on Climate Change (CCC), Convention on Trade in Endangered Species (CITE), Convention on Biodiversity (CBD), and the Nairobi Convention (Muthiga et al., 2000). In addition to national policies such as the Wildlife Conservation and Management Act, 2013, these conventions provide guidelines for administering MPAs in Kenya.

In the years 1982, 2001, and 2009, various attempts were made to develop and execute management plans to aid in the running of MMPA and WMPA however implementation was poorly conducted (Kenya Wildlife Service, 2015a). Currently, management plans have been developed for the MMPA for the period 2016 to 2026, WMPA for the period 2016 to 2026, the KMMPA for the period 2015 to 2025, and the KBDCA for the period 2013 to 2023(Kenya Wildlife Service, 2012, 2014, 2015a, 2015c). Ecological management and subsequent monitoring are prime components of each management plan. The type of data collected for ecological monitoring includes details on benthic cover, coral and fish species richness, coral recruitment, and fish abundance (Obura, 2015).

Before the adoption of current MPA management plans, ecological monitoring of MPAs was primarily carried out by researchers in academic institutions and non-profit organizations. According to Cowburn and colleagues (Cowburn et al. 2018), the earliest records of the status of biodiversity and the ecological of Watamu Marine National Park dates back to 1969 courtesy of an expedition by Bangor University hence availing baseline data on the park's state before conservation efforts were put in place. Also in 1982, an assessment of sedimentation caused by Sabaki River on coral reefs was carried out in WMPA by a Netherlands institution, the University of Nijmegen (Katwijk et al., 1993).

Various non-profit organizations have also been instrumental in conducting and facilitating ecological monitoring activities in Kenya. From 1987 to date, the Wildlife Conservation Society (WCS) in Kenya instituted ecological monitoring in various MPAs (Cowburn et al., 2018). In Watamu alone, data collection initiatives by WCS especially in regards to the ecology and protection of coral reef span 30 years (Cowburn et al., 2018). For more than 15 years, WWF has also been engaged in management, research, and monitoring activities in Kiunga Marine National Reserve (Osuka et al., 2016). Coastal Oceans Research and Development – Indian Ocean (CORDIO) and the Coral Reef Conservation Project (CRCP) are also examples of

regional programs in Kenya that carry out coral reef monitoring (IUCN, 2004; Obura, 2015).

The involvement of the local community in ecological monitoring activities has also been evident. As early as 1999, a turtle monitoring initiative involving local youth was set up in Kiunga Marine National Reserve (IUCN, 2004). This allowed joint implementation of conservation practices rather than a top-down approach which often breeds conflict (Kawaka et al., 2017).

Over the years, the KWS has leveraged partnerships with non-profit organizations in monitoring in MPAs. In 1987, the CRCP in collaboration with the KWS conducted coral reef monitoring in five MPAs namely WMPA, MMPA, KMMPA, MMPA, and DMPA (IUCN, 2004). In 1999, a collaborative monitoring initiative was launched between the KWS, WWF, and CORDIO in Kiunga Marine National Reserve following the mass coral bleaching caused by the El Niño (Kanyange & Samoilys, 2008). Regarding marine biodiversity and ecology, collaborative monitoring has also been initiated between KWS and A Rocha Kenya (Cowburn et al., 2018). Partnerships have also served as a tool for attaining much-needed funding to support ecological and fisheries monitoring (McClanahan et al., 2005).

Presently, KWS has tailored ecological monitoring activities based on the conservation targets, the biodiversity ERVs and the threats of a given MPA. For the WMPA the ecological management programme focuses on carrying out monitoring activities for migratory species that are highly reliant on the area for various ecological services (Kenya Wildlife Service, 2015c). These monitoring initiatives include tagging sea turtles and air surveillance of dugongs (Kenya Wildlife Service, 2015c). While in the MMPA, monitoring of threatened species populations such as the Indo-pacific bottlenose dolphin is frequently undertaken (Kenya Wildlife Service, 2015b). The prevalence of invasive species such as the crown thorn starfish and the health of key

habitats, such as coral reefs, mangroves ecosystems, and seagrass, is regularly evaluated (Kenya Wildlife Service, 2015a).

In KBDCA, monitoring of endangered species such as the Olive Ridley and vulnerable species like the dugong is conducted collaboratively with the local community (Kenya Wildlife Service, 2012). Increased monitoring of key habitats is also undertaken due to the imminent threats caused by accelerating human pressure (Kenya Wildlife Service, 2012). Lastly, in KMMPA monitoring of the movement and habitats of species like whales, dolphins, and dugongs is conducted in collaboration with the local community. Sea urchin prevalence due to the destruction of coral reefs and over-exploitation of mangroves are examples of issues currently under surveillance.

3 Methodology

3.1 Self-administered Questionnaire

A semi-structured questionnaire was utilized to collect the primary source of data for this study. With this approach, soliciting of data was tailored to address the specific aim of the research (Hox & Boeije, 2004). In addition, with regards to the Covid-19 pandemic, this approach allowed the flexible collection of data anonymously at minimal costs and effort (Muijs, 2011).

The semi-structured questionnaire was disbursed via Google forms and is comprised of two sections. Section one sought to capture details on the respondent's current professional profile while section two aimed to sample respondents' thoughts and perceptions on the existing monitoring frameworks for MPAs' ecological management programmes in Kenya. As illustrated in Appendix 1, section two comprised of 2 multiple choice questions, a 10-point rating scale question, and 4 yes/no questions with follow-up open-ended questions to allow respondents to elaborate more on their answers.

The semi-structured questionnaire enabled respondents to

- Assess the present ecological monitoring framework utilized for Kenya's MPAs in respect to the level of effectiveness, policies, and adaptability.
- Provide views on the sufficiency of how funding, management infrastructure, and human capital are allocated in the MPAs.
- Point out observed barriers to effective ecological monitoring and solutions that can be explored to resolve indicated barriers.

3.2 Research Design

A research design can be described as a fundamental procedure that provides a link between the research questions and the research implementation enabling the generation of a report and publishing (Punch, 1998; Durrheim, 2006). It encapsulates the rationale behind the study, the conceptual framework, the description of data sources, and the means of collecting and analyzing the data (Punch, 1998). As mentioned earlier this study will employ the use of a semi-structured questionnaire hence implementing a quantitative research design.

In this research the questions used in the semi-structured questionnaire are designed to provide insight into;

- Funding allocations.
- Perceived obstacles to effective ecological monitoring, and viable solutions.
- MPA management infrastructure and capacity.
- Policy effectiveness.
- Stakeholder involvement.
- Management adaptability.

Quantitative research comprises an array of methods that aim to examine a given social phenomenon by use of statistical and numeric data (Watson, 2015). As highlighted by Vaus (2017), this approach allows one to capture accurate and elaborate information, in other words, hard evidence. Durrheim (2006) indicates its two principal strengths are that its findings are impartial and can be generalized. Through generalization of findings, researchers are can forecast, derive meaning and provide more clarity on the study at hand (Creswell, 1994).

3.3 Data Analysis

In consideration of the research approach, Microsoft Excel Version 2108 was utilized for data analysis purposes. The semi-structured questionnaire generated quantitative and qualitative data which was analyzed using descriptive statistics, and thematic analysis respectively. Thematic analysis enables one to find qualitative trends in data for evaluation and reporting while descriptive statistics provides summarized illustrations of quantitative data (Punch, 1998; Vaismoradi et al., 2013)

3.4 Ethical Considerations

Before engaging respondents, ethical clearance and approval was requested from the World Maritime University (WMU) Research and Ethics Committee (REC). Once approval was granted, participant engagement was initiated.

Firstly, prospective participants were informed about the purpose of the study, the type of data being solicited, the procedure to be used for data collection, data storage, and the nature of participation. It was clearly outlined that participation was voluntary, anonymous and one was at liberty to withdraw from engaging in the study whenever they wished.

A consent form illustrated in Appendix 2 was issued to those willing to participate in the study. This document further assured participants that the raw data collected will be safely stored and only used in regards to the researcher's dissertation.

4 Results

4.1 Research Participants

The development of MPA management plans in Kenya involves various institutional and conservation stakeholders. This participatory approach enables holistic management due to stakeholders' role in implementing, evaluating, and advocating for a given MPA management plan (Kenya Wildlife Service, 2012). In light of this, the study sought the participation of stakeholders with diverse roles (Table 8).

Table 8: Participants Roles

Role	Project Coordinator	Researcher	Manager	Land Use Planner	Warden
No.	2	6	3	1	1

Participating establishments include government agencies, non-profit organizations, research institutions, academia, and the private sector (Table 9). Throughout the years, the involvement of the above-named fraternities in the establishment and management of MPAs has been evident. Out of the 30 people contacted a total of 13 took part in the study.

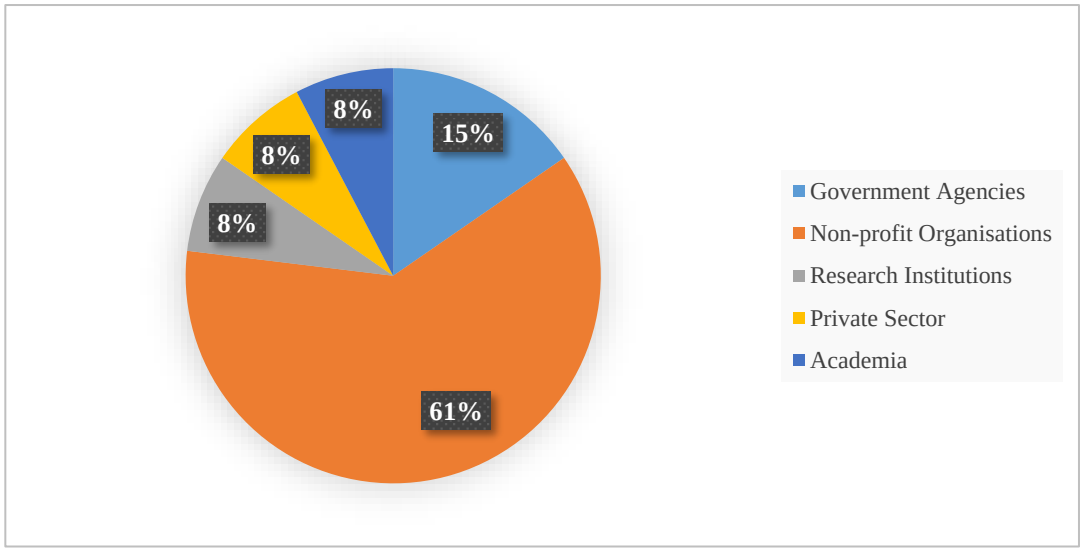
Table 9: Participants' Institutions

Sector	Institution
Government Agency	• Kenya Marine and Fisheries Research Institute (KMFRI) • Kenya Wildlife Service (KWS)
Non-profit Organization	• The Nature Conservancy • Coastal Oceans Research and Development in the Indian Ocean (CORDIO) • Ocean Sole • Wildlife Conservation Society (WCS)

Sector	Institution
	• African Group of Negotiators Experts Support (AGNES)
Research Institution	• Western Indian Ocean Marine Science Association (WIOMSA)
Academia	• Wildlife Research and Training Institute
Private Sector	• Consultant

Among those engaged in the study, 61%, work in non-profit organizations followed by 15% that work in government agencies (Figure 2).

Figure 2: Institutional Representation



To assess participants' suitability in taking part in the study, details on their years of experience in maritime-related activities was captured. Approximately half, 54%, have worked in the maritime sector for 0-10 years while 23 % for 10-20 years and more than 20 years each (Figure 3). In addition, participants reported having been indulged in various MPAs in the course of conducting their work-related duties. The study sought to establish which specific MPA each participant has worked in (Figure 4).
The results show that WMPA has actively engaged 10 out of 13 of the participants involved in this study. Details on the number of participants engaged in the other 5 MPAs are also captured in Figure 4.

Figure 3: Maritime Work Experience

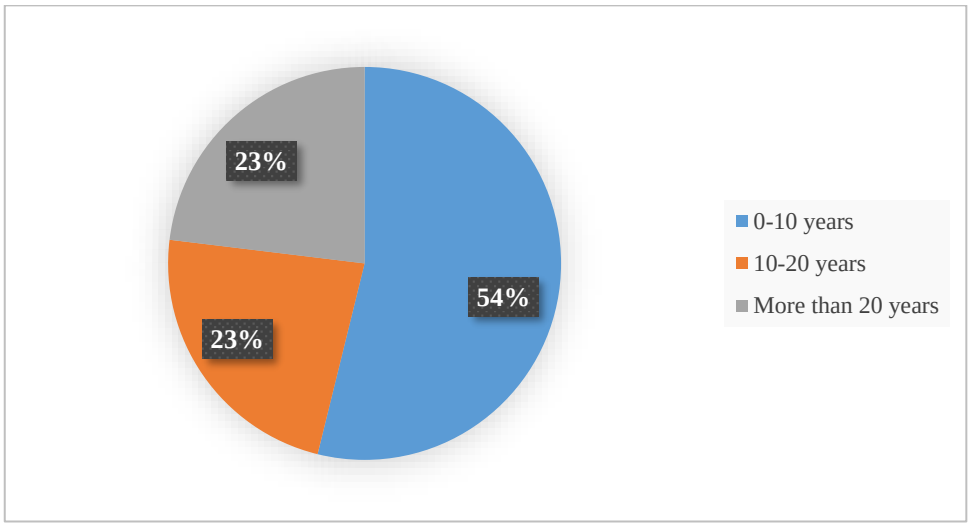
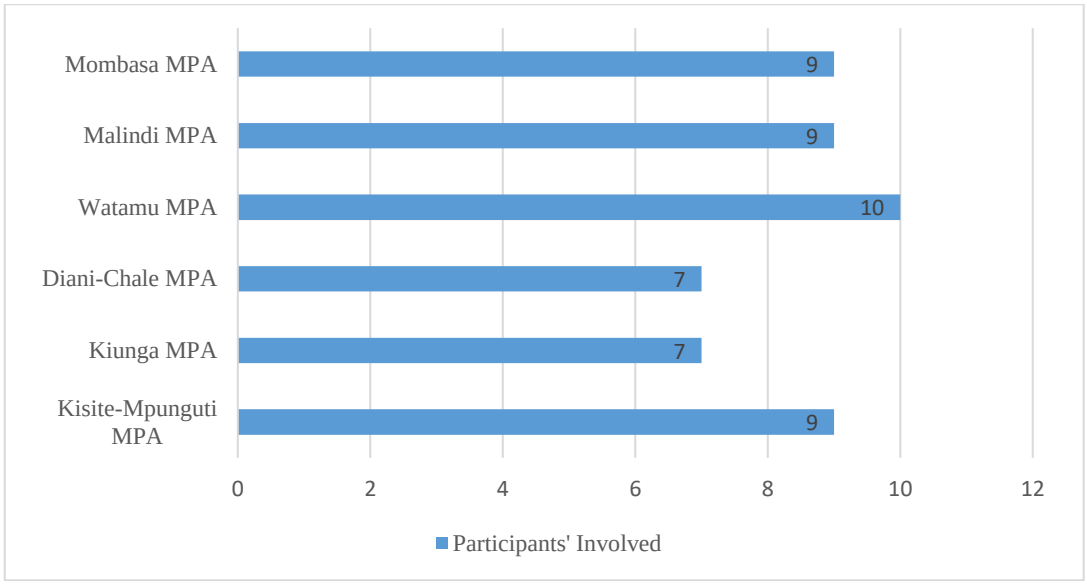


Figure 4: Participants' Involved in MPA



For data analysis, participants shall be anonymously referenced as shown in Table 10.

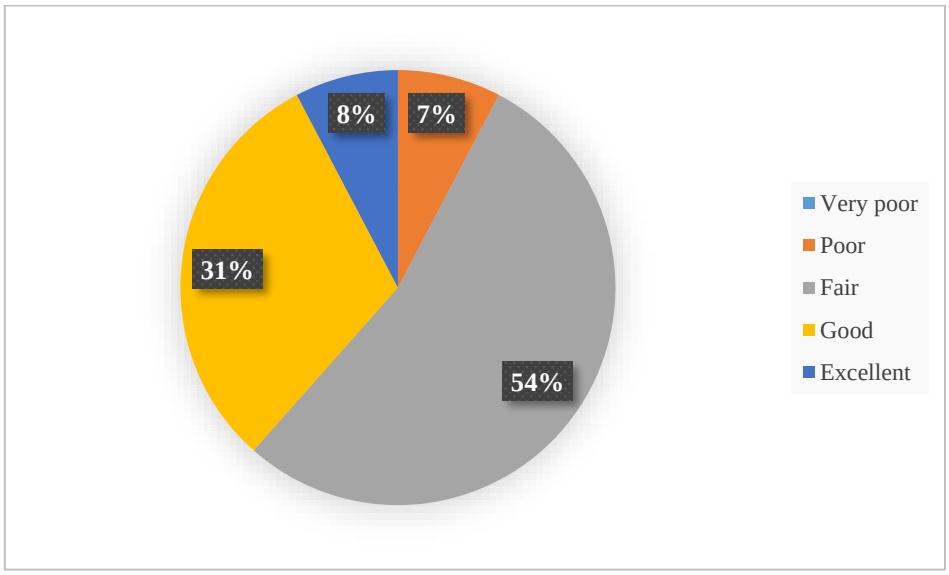
Table 10: Participant Identification

No.	Participant Identity	Sector
1.	Participant 01	Non-Profit Organization
2.	Participant 02	Non-Profit Organization
3.	Participant 03	Non-Profit Organization
4.	Participant 04	Research Institution
5.	Participant 05	Government Agency
6.	Participant 06	Academia
7.	Participant 07	Non-Profit Organization
8.	Participant 08	Non-Profit Organization
9.	Participant 09	Private Sector
10.	Participant 10	Non-Profit Organization
11.	Participant 11	Non-Profit Organization
12.	Participant 12	Government Agency
13.	Participant 13	Non-Profit Organization

4.2 Assessment of MPA Ecological Monitoring Framework

This section will provide elaborate details on the findings retrieved from the questionnaire. The approach utilized in this study was initiated by capturing participants' overall perceptions of the present-day state of ecological monitoring. In general, participant's ratings of the current monitoring mechanism mainly fall within the fair and good category at 54% and 31% respectively (Figure 5). This was followed by input on other aspects surrounding MPA ecological monitoring.

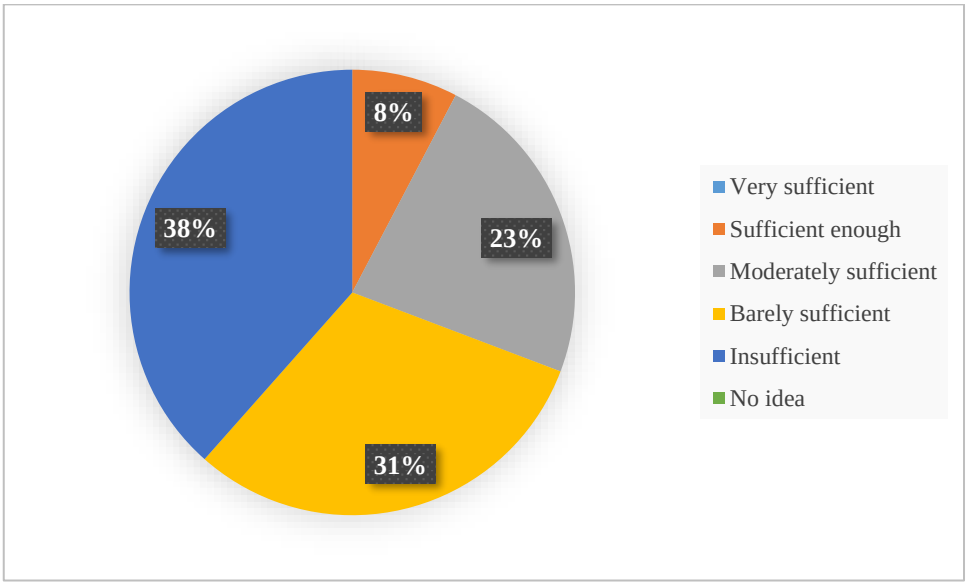
Figure 5: Framework Assessment



4.2.1 MPA Funding Allocation

In respect to resource allocation for MPA management, 38% of participants are of the view that funding allocation is insufficient then followed by 31% who believe it is barely sufficient (Figure 6). These findings established a general dissatisfaction with the current MPA funding mechanisms.

Figure 6: Funding Allocation

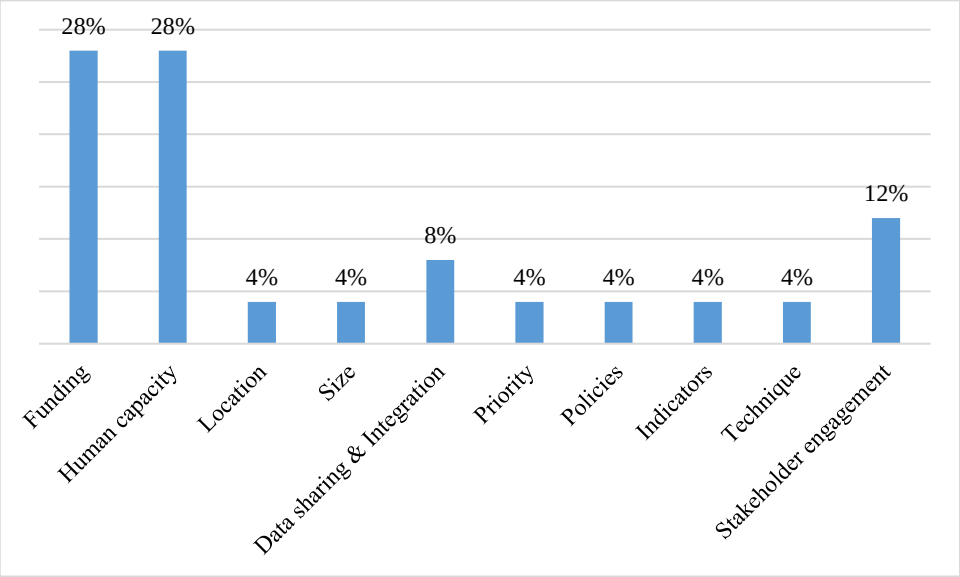


4.2.2 MPA Ecological Monitoring Barriers

Regarding barriers to effective MPA ecological monitoring, participants' inputs showed challenges in respect to funding and human capacity were dominant (Figure 7). While reiterating prior sentiments, participants indicated that funding is inconsistent hence inhibiting regular ecological monitoring activities.

Concerning human capacity, participants highlighted limitations in needed manpower and technical expertise to carry out ecological monitoring. Lack of engagement with relevant institutional and conservation stakeholders and poor data sharing and integration practices were also cited as current barriers to effective MPA ecological monitoring (Figure 7).

Figure 7: MPA Ecological Monitoring Barriers



Below are instances of participants' input in this regard.

Participant 08 (Non-Profit Organization), "1. Limited technical capacity for both government and external stakeholders (can barely afford to employ marine biologists hence employ in one person who is overwhelmed) 2. Insufficient funds to facilitate the process"

Participant 03 (Non-Profit Organization), "The government agency in charge has limited capacity in terms of personnel. Normally members of staff have to move to multiple MPAs from the headquarters to conduct ecological monitoring. This is very costly."

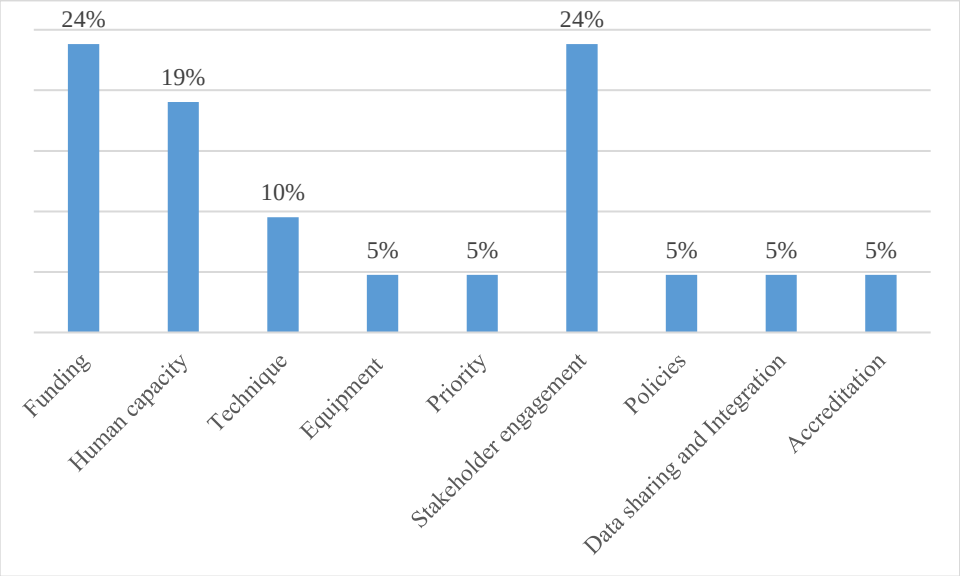
Participant 05 (Government Agency), "Poor government policies"

Participant 12 (Government Agency), "Rigid and fix monitoring program"

With reference to the indicated barriers, participants were further prompted to provide feasible solutions that can be explored to tackle the challenges at hand. Solutions towards resolving challenges concerning funding, stakeholder engagement, and human capacity were dominant in tandem with the indicated barriers (Figure 8).

Regular and sufficient funding allocations for MPA ecological monitoring activities were advocated for. Channeling more efforts towards eliminating personnel skillset gaps and engagement of the local community in ecological monitoring activities was also encouraged. As for stakeholder engagement, participants championed partnership schemes that enable alignment of MPA ecological objectives to conservation stakeholders' activities. Other categories of solutions proposed by participants were on the level of prioritization given to ecological monitoring activities in MPAs, monitoring equipment, the technique utilized to develop ecological management programs, policy implementation, accreditation, and data sharing and integration.

Figure 8: Solutions to MPA Ecological Monitoring Barriers



Samples of responses from participants are presented below.

Participant 08 (Non-Profit Organization), "1. KWS has to have a comprehensive way to ensure all people who are involved in marine-related work or ecological data collection are able to submit that data to them so that we all have that data rather than siloed data that people are not willing to share. They need to create a transparent mechanism."

Participant 03 (Non-Profit Organization), "Monitoring should be conducted by in-house trained personnel permanently stationed at every MPA for this very purpose."

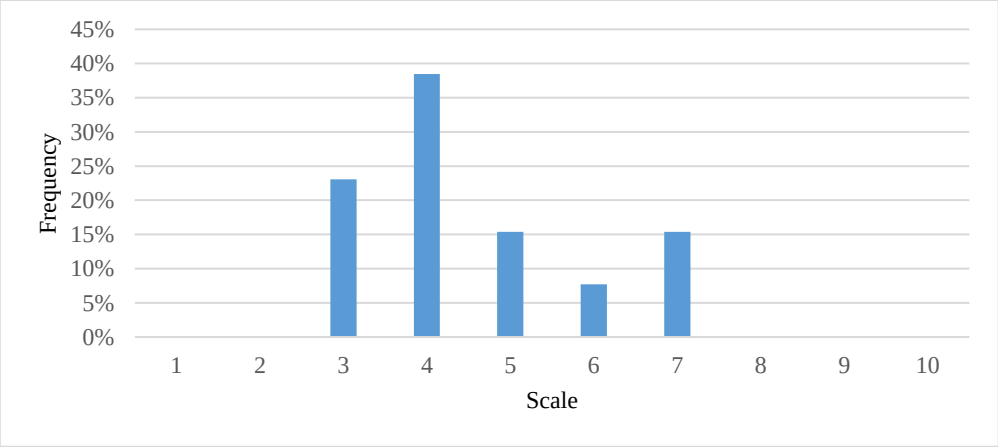
Participant 05 (Government Agency), "Reform and enforcement of the policies"

Participant 12 (Government Agency), "targeted monitoring of species and habitat depending on seasonality, where they are and resources in place"

4.2.3 Stakeholder Involvement

The study sought participants' views on the rate of stakeholder involvement in the design and implementation of the ecological monitoring framework. On a scale of 1-10, 1 being low and 10 being high, the results show that 61% of participants indicated that the rate of stakeholder involvement is below the scale of 5 (Figure 9).

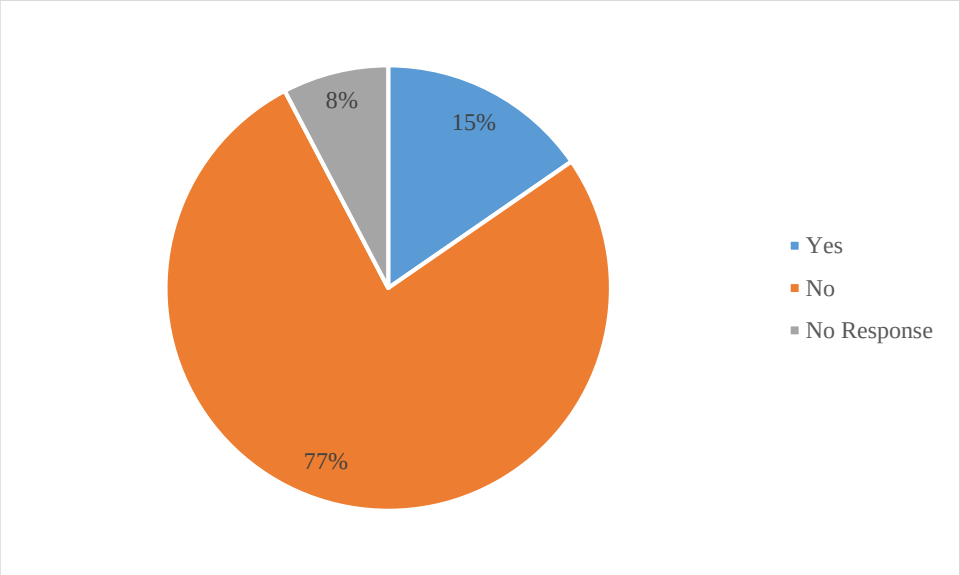
Figure 9: Stakeholder Involvement



The study also established that the current monitoring mechanism is not transparent and verifiable to external stakeholders. 77% of participants believe that current monitoring activities are not available for public and peer review (Figure 10). This left 15% with a contrary opinion objecting that the process and reports are available to

stakeholders who have shown minimal interest in ecological monitoring. Only 8% of participants had no response in this regard.

Figure 10: Monitoring Transparency and Verifiability to Stakeholders



Below are samples of participants' justification in regards to the input reflected in Figure 10.

Participant 01 (Non-Profit Organization) selected 'No', "Reports from these ecological monitoring are not readily available"

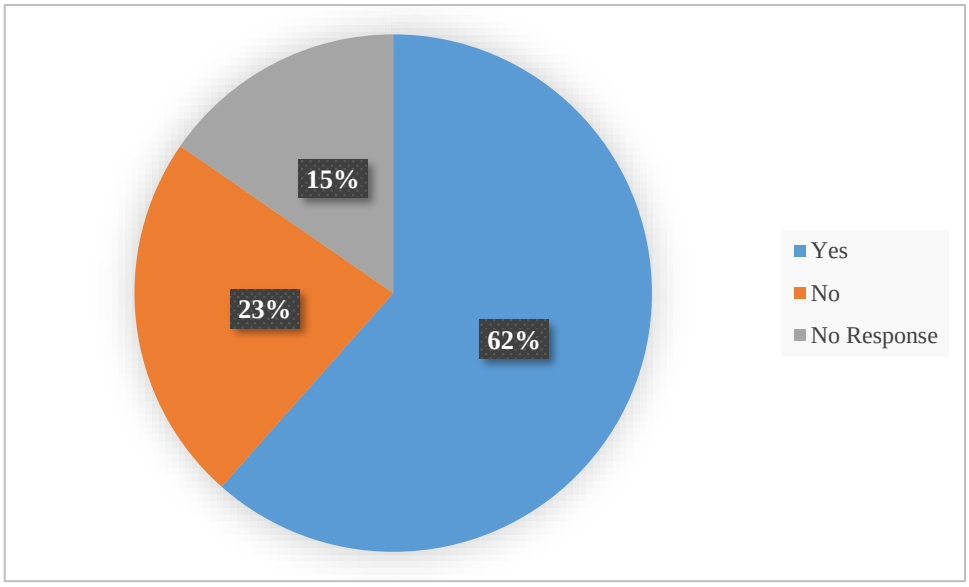
Participant 06 (Academia) selected 'Yes', "We share the data with other stakeholders as we prepare the national status of coral reefs under the Global Coral Reef Monitoring. Status of MPA report also shared."

Participant 07 (Private Sector) selected 'No', "Stakeholder involvement is not robust enough with partners and local community"

4.2.4 Policies

Concerning policies, the study established that 75% of participants believe that the available legal provisions required to facilitate ecological monitoring activities are in place (Figure 11). Only 15% are of a contrary opinion indicating that policies lack implementation mechanisms.

Figure 11: Policy Sufficiency



Below are sample quotations from participants.

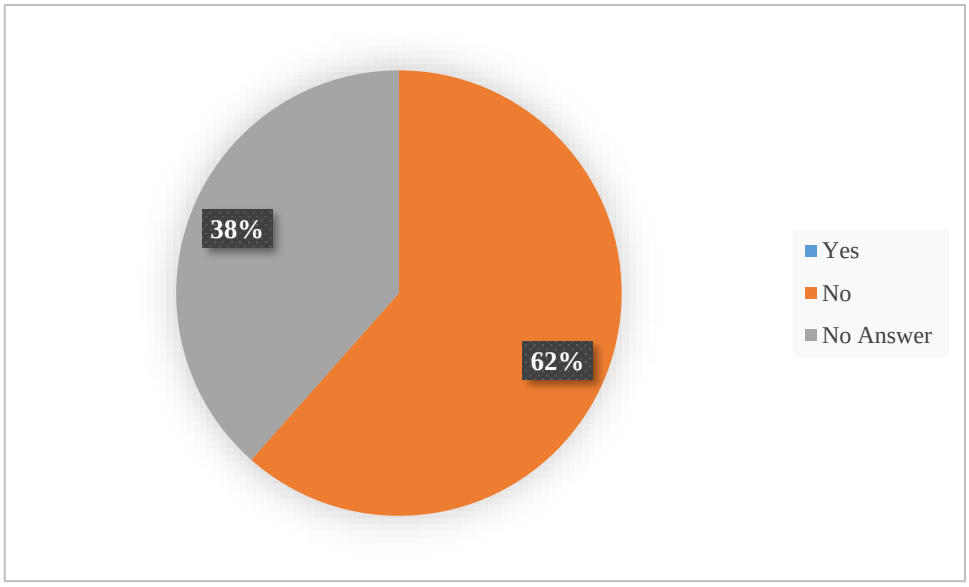
Participant 02 (Non-profit Organization) selected 'Yes', "The law has provisions for ecological monitoring of the marine environment."

Participant 04 (Research Institute) selected 'No', "Policies lack mechanisms for action."

4.2.5 Management Infrastructure and Capacity

In regards to MPA management, the study showed that 62% of participants believe that management infrastructure and capacity are not well appropriated (Figure 12). This further reiterates prior sentiments on the lack of adequate human capacity to support ecological monitoring activities.

Figure 12: Allocation of Management Infrastructure and Capacity



Below are samples of input given by participants to justify the response reflected in Figure 12.

Participant 10 (Non-profit Organisation) selected 'No', "It is largely done on an ad hoc basis as NGOs can afford it."

Participant 12 (Government Agency) selected 'No', "Some MPAs have more resources allocated to them than others, this is largely pegged on the amount of revenue the MPA generates"

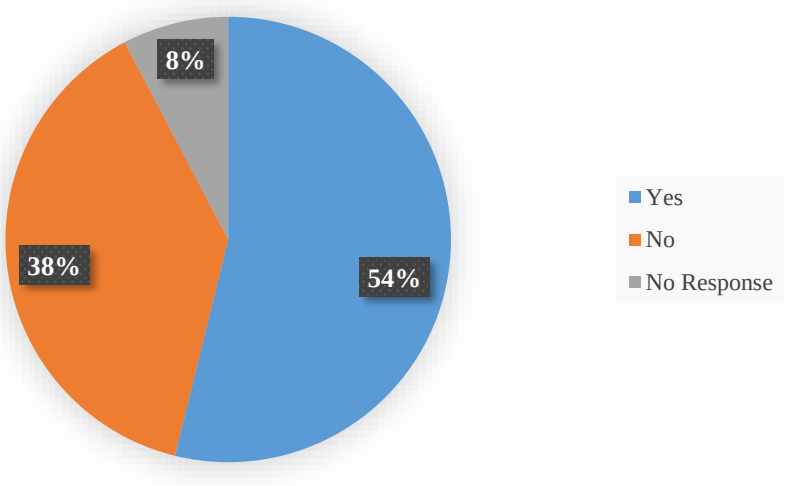
Participant 04 (Research Institution) selected 'No', "Little understanding of the needs and value of MPAs. There is much focus on terrestrial systems."

4.2.6 Adaptive Management

Lastly, the study sought to establish participants' views on how adaptable management and administrative activities are based on the present ecological monitoring mechanism in place (Figure 13).

Findings reveal 54% of participants are of the view that the current ecological monitoring program enable quick response to any changes that arise. 38% of participants were of a contrary opinion while 8% showed no response.

Figure 13: Adaptive Management



Below are samples of input given by participants to justify their response above.

Participant 03 (Non-profit Organisation) selected 'No', "More reactive approach is in place."

Participant 09 (Private Sector) selected, 'No, "Government lacks funds to employ enough to hire needed staff and maintain equipment".

Participant 03 (Non-profit Organisation) selected 'Yes', "The monitoring of benthic communities is reasonable like coral bleaching from sea surface temperature rise (KMFRI)".

5 Discussion

As mentioned earlier the main objective of this study was to assess the current ecological monitoring framework utilized for MPAs in Kenya. This assessment was based on stakeholders' perceptions of the ecological framework's effectiveness, adaptability, policies, institutional financial resources, human capacity, observed barriers, and prospective solutions. This section provides a discussion of the findings retrieved.

5.1 Discussion of Research Findings

The study was initiated by capturing the collective view of stakeholders on the current ecological and monitoring framework utilized for MPAs in Kenya. In line with the analysis conducted, the overall thoughts of those who took part in the study rate the present framework within the fair to good category. This illustrates a satisfactory inclination towards the current ecological monitoring mechanism with the need for improvements in various areas. As shown in the following sections, certain aspects in respect to the ecological monitoring framework's design and implementation illustrate the context behind this conclusion.

Presently, the funding for the management of MPAs in Kenya is primarily sourced from the marine park or reserve visitor fees through budgetary allocations from KWS (Francis et al., 2002; McClanahan et al., 2005) Allocated funds are mainly utilized to facilitate management activities in addition to community social responsibility (CSR) initiatives (Kenya Wildlife Service, 2012). Funding is also outsourced through local and international partnerships such as the Kenya Coastal Development Programme (KCDP) and international organizations namely the WCS and A Rocha Kenya (Kenya Wildlife Service, 2015b).

The study shows that the funding allocated for the management of MPAs in Kenya is not sufficient enough. McClanahan et al. (2005) also highlighted the absence of continuous funding programs as a major challenge in Kenya's MPAs. This has been reflected as a barrier to ecological monitoring activities. Previous studies also show that the absence or insufficiency of funding is not a unique challenge. For instance, in the year 2013, up to 65 unsynchronized monitoring initiatives in the Great Barrier Reef lacked the necessary funding to enable implementation (Dunham et al., 2020). In the Western Indian Ocean (WIO), government funding in MPA is said to be limited leading to financial strain (UNEP-Nairobi Convention & WIOMSA, 2021; Wells et al., 2007). Considering the Covid-19 pandemic, the need for innovating alternative funding mechanisms for MPAs is evident since gains from the marine park or reserve visitor fees declined due to international and domestic travel restrictions(Tahanout & Berkane, 2021).

Failure in ecological monitoring eventually results from the absence of sufficient immediate and long-term funding (Field et al., 2007). It also leads to limited access to required expertise and equipment which negatively affects the frequency of monitoring (Fox et al., 2014). Data collection is also executed inadequately resulting in the accumulation of more information rather than relevant data on the monitoring indicators used to measure the impact of MPA ecological objectives (Dunham et al., 2020).

Other identified barriers to effective ecological monitoring pertain to human capacity, stakeholder engagement, and data sharing. The KWS is tasked with conducting all monitoring activities in Kenya's MPAs(*The Wildlife Conservation and Management Act*, 2013). The study shows that only a few personnel have the required technical capacity and equipment to implement monitoring initiatives. Assignment of trained MPA ecological monitoring personnel to terrestrial areas has also been cited as a concern. This results in work overload for those available and overdependence on

other government and non-government agencies when conducting ecological monitoring.

These sentiments agree with previous studies that reflect regressive growth of MPA capacity and expertise in Kenya since the 1990s due to limitations in donor support (Wells et al., 2007). Areas such as the Kiunga Marine Reserve are said to be under-resourced resulting in reliance on external donors such as WWF for ecological monitoring equipment. The study has further established that allocation of management infrastructure and capacity is not well appropriated due to limited understanding of the needs and value of MPAs. A higher priority is placed on terrestrial areas. Prior studies show that lack of capacity inhibits many agencies and scientific institutions from supporting ecological monitoring functions (Freiwald et al., 2018).

The need for a mechanism to integrate multiple data sources on oceans and coasts has become predominately evident due to the vast amounts of information continually emerging (Wisz et al., 2020). This study has also indicated a similar demand. For several decades, numerous non-profit organizations and independent scientists have conducted ecological research in Kenya's MPAs. This has generated numerous studies and vast amounts of ecological data which government agencies often rely on for ecological monitoring reporting. Despite this, concerns for poor data sharing and lack of peer review practices have been raised. No structures are available to enable integration and open access to the vast amount of ecological data available.

Regarding stakeholder involvement, Francis et al. (2002) state that consultation during monitoring activities is fundamental in MPA operations. This study shows that there is still a need for more collaborative initiatives between the KWS and relevant stakeholders such as indigenous communities and the private sector. The presence of non-government stakeholders that have been involved in long-term ecological monitoring activities presents opportunities to develop partnerships geared towards joint ecological monitoring. Instead, based on this study, expert opinion is mostly

sought for on a need basis.Often, several research initiatives are conducted concurrently in the same MPA with minimal coordination among researchers and MPA managers (Pelletier, 2020). The research efforts of external stakeholders can be aligned to meet government information needs through incentivized initiatives (Wisz et al., 2020). In addition, capacity and skill set gaps can also be addressed through alliances between external scientists and MPA management personnel (Wells et al., 2007).

The study also shows low involvement of local communities in respect to the design and implementation of ecological monitoring. This agrees with the findings of Wells et al. (2007) that showed limited consultation of local fishing communities during the establishment of MPAs in Kenya. This eventually raises conflicts as observed while instituting Diani-Chale and Mombasa MPAs (McClanahan et al., 2005; Wells et al., 2007). In the course of MPA management, minimal compliance and commitment of local communities in conservation initiatives is often observed due to the use of a top-down approach in the implementation of MPAs (Vasiliki et al., 2013; Wells et al., 2007).

Another factor that the study sought to tackle is the sufficiency of national policies in facilitating ecological monitoring activities. Presently, Kenya has formulated and adopted various national policies to facilitate the monitoring of MPAs. These include the Wildlife Conservation and Management Act, Environmental Management and Coordination Act, Forest Act, and the Fisheries Management and Development Act (Osuka et al., 2016). Kenya is hailed as a pioneer in enacting and adopting conservation-centric legislation in Africa (Weru, 1975). Similarly, the findings from this study show a mutual satisfaction with the current policies in place. However, concern has been raised on the lack of mechanisms to facilitate and evaluate policy implementation. A prior study attributed ineffective policy implementation to local bias due to cultural perspectives and lack of enforcement capacity by relevant bodies (Osuka et al., 2016).

Lastly, this research has established that the current framework utilized for ecological monitoring is adaptable to observed changes that require speedy management action. The use of Strategic Adaptive Management which allows progressive enhancement of management efforts while managing unforeseeable changes within a given ecosystem was highlighted in the study (Kingsford & Biggs, 2012).

5.2 Conclusion

Globally MPAs have been evidenced as effective tools in mitigating anthropogenic impacts to the coastal and marine ecosystem (Kawaka et al., 2017). From as early as 1968, Kenya has been at the forefront of implementing various conservation initiatives particularly MPAs to preserve marine and coastal resources (McClanahan et al., 2005). Steps have also been made towards effective ecological monitoring through instituting adequate policies, frameworks, and management mechanisms. However, this study has highlighted various factors that need to be addressed.

Firstly, the availability of consistently available sufficient funding to facilitate ecological monitoring activities should not be undermined. Budget allocations ought to accommodate ecological objectives and the required monitoring activities and equipment for a given MPA. Also, in addition to visitor fees and donor support, more innovative funding schemes are required.

The availability of permanently assigned ecological monitoring staff for each specific MPA is paramount. This will allow regular monitoring activities based on a given MPA's ecological characteristics. Avenues for professional improvement of MPA staff should also be availed. Training programs should be initiated to improve on required ecological monitoring skills and competencies.

Stakeholder engagement is a needful requirement for effective ecological monitoring and management. More partnerships programs with scientists, research institutions, indigenous communities, and non-profit organizations involved in ecological research within MPAs should be explored. Analysis of prior studies illustrates existing partnerships however the research at hand shows more can be leveraged in this area. The involvement of members of the local community in ecological monitoring can enable inclusivity of indigenous knowledge, reduce monitoring costs and advocate for compliance with management activities.

Presently there are vast amounts of siloed data on the ecological state of various MPAs in Kenya. Initiatives to consolidate this data can aid in streamlining the harmonization of conservation efforts. Research gaps can also be uncovered and resources can be prioritized to facilitating research activities where information is lacking. Finally, since adequate policies in support of MPA ecological monitoring have been put in place, the mechanisms that facilitate policy implementation should be instituted.

This assessment has provided an elaborate overview of the current ecological monitoring framework in Kenya. The valuable infrastructure to facilitate monitoring is in place. However, the need to review and adjust factors surrounding funding allocations, stakeholder involvement, human capacity, policies, and data sharing and integration is necessary for effective MPA ecological monitoring.

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Appendices

Appendix 1 Semi-structured Questionnaire

Assessing the Effectiveness of MPA Ecological Monitoring Framework.

This questionnaire aims to gather your thoughts on the level of effectiveness of existing ecological monitoring frameworks for the marine protected area (MPA) ecological management programmes in Kenya.

Disclaimer: The responses to the questionnaire will only be used as a direct reference in the dissertation of the interviewer. All interviewees will remain anonymous in the dissertation.

Section 1

1. Name:
2. Name of organization:
3. What is your current role in this organization?
4. How long have you been involved in marine-related activities? (multiple choice)
    - 0-10 year
    - 10-20 years
    - More than 20 years
5. Which of these marine protected areas are you most familiar with? (check box)
    - Watamu Marine Protected Area
    - Malindi Marine Protected Area
    - Kisite Mpunguti Marine Protected Area
    - Kiunga Marine National Reserve
    - Mombasa Marine National Park and Reserve
    - Diani-Chale Marine National Park and Reserve

Section 2

6. How would you rate the current ecologically monitoring framework utilized for marine protected areas in Kenya? (multiple choice)
    - Very poor
    - Poor
    - Fair
    - Good
    - Excellent
7. In your view, the amount of funding allocated to the management of marine protected areas is (multiple choice)
    - Very sufficient
    - Sufficient enough
    - Moderately sufficient
    - Barely sufficient
    - Insufficient
    - No idea
8. What do you identify as barriers to effective ecological monitoring of marine protected areas in Kenya?
9. What would you propose to be adopted to tackle the barriers indicated above?
10. Rate the level of stakeholder involvement in the design and implementation of ecological monitoring frameworks. (Scale of 1-10 where 1 is low and 10 is high)
11. Do national and local policies support effective ecological monitoring of marine protected areas in Kenya? Yes /No

    11.1 Kindly indicate the reason for your answer above.
12. Is the allocation of management infrastructure and capacity well appropriated for all marine protected areas? Yes /No

    12.1 Kindly indicate the reason for your answer above.

13. Do you consider the current ecological monitoring framework for marine protected areas transparent and verifiable to external stakeholders? Yes /No
    13.1 Kindly indicate the reason for your answer above.
14. Does the current ecological monitoring framework facilitate rapid management and administrative response to changes in the field or new threats? Yes /No
    14.1 Kindly indicate the reason for your answer above.

Appendix 2 Consent Form

Dear Participant,

Thank you for agreeing to participate in this research survey, which is carried out in connection with a Dissertation that will be written by the interviewer, in partial fulfillment of the requirements for the degree of Master of Science in Maritime Affairs at the World Maritime University in Malmo, Sweden.

The Topic of the Dissertation is **"An Assessment of the Marine Protected Area Ecological Monitoring Framework in Kenya"**

The information provided by you in this interview will be used for research purposes and the results will form part of a dissertation, which will be published online and made available to the public. Your personal information will not be published. You may withdraw from the research at any time, and your data will be immediately deleted.

Anonymized research data will be stored in my laptop and hard disc secured with a strong password. All the data will be deleted once the degree is awarded on 31 October 2021

Your participation in the interview is highly appreciated.

Student's name Tracy Masicha Wafula
Specialization Ocean Sustainability, Governance, and Management
Email address w1904721@wmu.se

* * *

I consent to my data, as outlined above, is used for this study. I understand that all personal data relating to participants is held and processed in the strictest confidence, and will be deleted at the end of the researcher's enrolment.

Name: ……

Signature: ……

Date: ……