UNITED REPUBLIC OF TANZANIA

DEEP SEA FISHING AUTHORITY

RESEARCH AGENDA FOR FISHERIES IN THE TANZANIA ECONOMIC EXCLUSIVE ZONE

2020 - 2025

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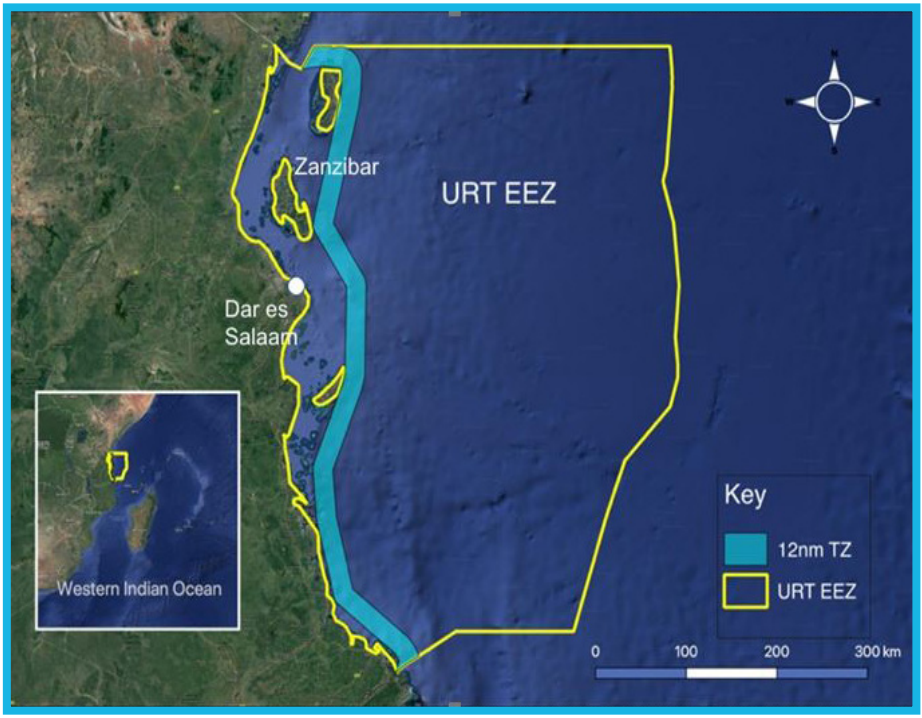


Figure 1: Map of the United Republic of Tanzania coastline showing the maritime zones

FOREWORD

The United Republic of Tanzania (URT) Exclusive Economic Zone (EEZ) has potential schools for tuna, tuna-like species, sharks and other living resources which can contribute to national food security, nutrition economic growth and industrialization. Currently, these resources are underutilised due to limited scientific information. The fisheries sector has the potential to compliment the Tanzania's Industrialisation Strategy shifting from an agrarian to a modern industrialized state. The strategy specifically calls for transformation of the fisheries sector to enable full exploitation of the offshore resources by increasing fish landings.

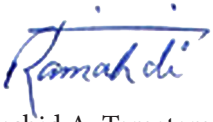
The United Nations Convention on Law of the Sea (UNCLOS III, 1982) calls for all states involved in fishing to exploit and manage the fishery resources sustainably based on the best scientific evidence available. It is towards this intention, the URT seeks to develop and manage marine fishery resources in the EEZ guided by a well-focused research agenda. Research and Development is of great importance in a range of business as the level of competition, production processes and methods are rapidly changing. Research and Development can also help to accelerate the pace of technological innovation of products, services, procedures and systems.

The priority research areas underlined in this Research Agenda are in line with the regional marine resource and conservation programmes that URT has ratified. This include the Indian Ocean Tuna Commission (IOTC), and Maputo declaration. Furthermore, the agenda considers the existence of Tanzania Research Priorities (2020-2025), the National Fisheries and Aquaculture Research Agenda (2020-2025) and the Zanzibar Research Agenda (2015-2020).

The Research Agenda also takes into account identification and determination of resource base in both spatial and temporal scales, biological characteristics of the fishery resources, environmental influences on the stock size, availability and accessibility by fishers, and economic feasibility of the resources. The research agenda: therefore, stands out as a useful blueprint to the scientists, managers, policy makers, potential investors, development partners, students

professionals who may be interested in the Tanzanian EEZ fisheries resources.

In collaboration with other sectors of the economy and the society at large, we must work tirelessly to address the greatest challenge of fisheries research and development. I exceedingly anticipate that, this blueprint will be used to improve the fisheries management and contribute at transforming Tanzania to be a middle-income country.



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PERMANENT SECRETARY – FISHERIES
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LIST OF ACRONYMS

ACP	African, Caribbean and Pacific
BMU	Beach Management Unit
CEAI	Coastal East Africa Initiative
CCRF	FAO Code of Conduct for Responsible Fisheries
CMM	Conservation and Management Measures
COSTECH	Tanzania Commission for Science and Technology
CPUE	Catch per unit effort
DASFT	Department of Aquatic Science and Fisheries Technology
DSFA	Deep Sea Fishing Authority
DWFN	Distant Water Fishing Nations
EAF	Ecosystem Approach to Fisheries
EEZ	Exclusive Economic Zone
EU	European Union
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GIs	Global Initiatives
GSI	Gonadosomatic index
IOC	Indian Ocean Commission
IOD	Indian Ocean Dipole
IOTC	Indian Ocean Tuna Commission
IUU	Illegal, unregulated and unreported
LME	Large Marine Ecosystem
MCS	Monitoring, control and surveillance
NPOA	National plans of action
NPP	Net primary productivity
RFMO	Regional Fisheries Management Organization
RFSP	Regional Fisheries Surveillance Plan

SAPPHIRE	Western Indian Ocean Large Marine Ecosystems Strategic Action Programme Policy Harmonization and Institutional Reforms
SOLSTICE	Sustainable Oceans, Livelihoods and Food Security through Increased Capacity in Ecosystem Research in the Western Indian Ocean
SST	Sea surface temperature
UNCLOS	United Nations Convention on Law of the Sea
URT	United Republic of Tanzania
VMS	Vessel Monitoring Systems
WP	Working Party
WWF	World Wildlife Fund for Nature
WIOMSA	Western Indian Ocean Marine Science Association

EXECUTIVE SUMMARY

The Deep Sea Fishing Authority (DSFA) is mandated to manage fishery resources in the Tanzania EEZ waters that lies beyond 12 nautical miles of the territorial waters. The DSFA recognizes and earmarks Tuna, tuna-like species, sharks and other living resources as being potentially economically important. Thus, the Research Agenda comes in view to enable sustainable exploitation of Tuna, tuna-like species, sharks and other living resources in Tanzanian National waters. The Agenda has been formulated to guide collection of scientific information necessary for decision-making process on management and development of the EEZ fisheries resources. The Agenda has also been developed and taken into accounts the research priority areas identified in the National Fisheries and Aquaculture Research Agenda (2020 – 2025) as well as Tuna Fisheries Management Strategy. This Research Agenda sets seven priority research areas as of utmost importance namely:

i) Biological
ii) Environmental
iii) Fishery related
iv) Stock assessment
v) Social and economic
vi) Monitoring, Control and Surveillance and
vii) Climate change and adaptation

Over each priority area, sub-priorities were also presented. The sub priorities reflect on the United Nations Conference on straddling fish stocks and highly migratory fish stocks (1995), FAO Code of Conduct for Responsible Fisheries (CCRF, 1995) and compliment IOTC research activities for 2017-2021.

This Agenda institutes a Research Committee and Tuna Working Group to be coordinated by DSFA that shall meet at least twice per annum to deliberate Research Agenda, review project progress, identify challenges and discourse potential solutions. The Working Groups will provide a useful forum for engagement and collaboration between managers, research research institutions, RFMOs, and the industrial and artisanal fishing sector.

Finally, the Research Agenda sets up a funding mechanism and research partnerships. The Agenda proposes to inaugurate the Research Fund in partnership with private sectors. After all, this Agenda underlines clear synergy with national and regional bodies such as WIOMSA, COSTECH, WWF and other funding agencies to magnify funding opportunities.

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1. INTRODUCTION

1.1. BACKGROUND INFORMATION

The United Republic of Tanzania (URT) covers an area of about 945,200 km^2, consisted of the Tanzania mainland (942,800 km^2) and Zanzibar (2,400 km^2), with a total coastline length of 1,424 km. The territorial sea has an area of about 64,000 km^2 and the Exclusive Economic Zone (EEZ) of an area of 223,000 km^2. It is estimated that the Tanzanian marine fisheries provide up to 90% of the animal protein for coastal communities and 30% of the animal protein nationally. More than 90% of fishers in the marine sector are employed in the artisanal subsector, which contributes about 95% of the total marine catches (Jiddawi and Öhman, 2002). Recently frame surveys reported 54,511 marine fishers in mainland Tanzania and 49,312 fishers in Zanzibar. Fisheries sector plays an important role in nutrition and food security contributing about 1.7% and 5.7% to the Gross Domestic product (GDP) in Tanzania mainland and Zanzibar, respectively (Fisheries Frame Survey , 2018; and Zanzibar Fisheries Frame Survey , 2017). The commercial fishery is comprised of a small prawn fishing fleet. To develop the fisheries sector and maximize utilization of the potential of its economic benefits, several policies have been, or currently being developed.

Fisheries in the Tanzanian EEZ is managed by Deep Sea Fishing Authority (DSFA) through the Deep Sea Fishing Management and Development Act of 2020. Thus, the DSFA has an institutional mandate to manage tuna and tuna-like fisheries in the United Republic of Tanzania's EEZ beyond the 12 nautical mile limit, whilst the responsibility for management of artisanal fisheries in Inner Sea and Territorial Water lies with the Fisheries Divisions in the respective ministries responsible for fisheries in Tanzania Mainland and Zanzibar. Given that, the industrial and artisanal fisheries target shared stocks of tuna and tuna-like species, collaboration between these institutions and the integration of research efforts is essential.

Currently, there are limited national research programmes for tuna, tuna-like species, sharks and other living resources in Tanzania. These comprise

projects from individual researchers, research and higher learning institutions, which focus on identification and mapping of potential fishing grounds for tuna and tuna-like species in the EEZ, with a goal to reduce fishing pressure in in the territorial waters. The Tanzanian EEZ fisheries research agenda provides means of advancing research objectives and addressing information needs to improve the management for tuna, tuna-like species, sharks and other living resources in Tanzanian waters.

1.2. RATIONALE AND NEEDS FOR RESEARCH AGENDA

The DSFA' main mandates are to promote, regulate and control deep sea fishing in the Tanzania EEZ. Proper management of fisheries resources calls for the availability of scientific information upon which proper management measures can be taken. Yet, there is inadequate scientific information about tuna, tuna-like species, sharks and other living resources in Tanzanian waters. As a member of the Indian Ocean Tuna Commission (IOTC), the URT is obligated to collate, pack and disseminate relevant data related to tuna and tuna-like species catches. The strengthening of data collection to support regional stock assessment of relevant species is therefore of great importance.

In addition, there is a need for conducting priority research that will aid in assessing and developing sustainable management options and support the implementation of the Tanzania Tuna Fisheries Management Strategy. In addition, few of the tuna and tuna-like species such as yellowfin tuna, black marlin, Indo-Pacific sailfish, longtail tuna and narrow-barred Spanish mackerel have already been fully exploited, and they are currently subject to effort reduction measures. Also, the stocks of striped marlin, Indo-Pacific blue marlin, bullet tuna, Indo-Pacific king mackerel and frigate tuna have not been assessed. This presents great opportunity for exploitation subject to scientific assessments.

Potential also exists for exploitation of demersal resources at the edge of the continental shelf through drop lining, but more studies are required to assess their feasibility. Some tuna and tuna-like species including Yellowfin tuna, Black marlin, Indo-Pacific sailfish, Longtail tuna and Narrow-barred Spanish mackerel in the Indian Ocean are reported to be fully exploited, calling for effort reduction

measures. Furthermore, there is a need for scientific assessments of the resources in the Tanzanian EEZ to promote and guide investment opportunities and management of the resources. However, there is limited information on these resources in terms of types, quantity, and distribution and viability to attract business investments in the country.

Therefore, this research agenda comes in view to set priorities and direction for fisheries research in URT EEZ. Such information will guide the sustainable development and utilization of the resources that will ultimately contribute at improving household income, food security, employment, poverty reduction and industrial economic growth.

2. SITUATION ANALYSIS

2.1. SCIENTIFIC KNOWLEDGE BASE

This section provides a basic summary of the current state of scientific knowledge of the main tuna and tuna-like species dominating Tanzanian catches. Species under discussion are Yellowfin tuna (*Thunnus albacares)*, Bigeye tuna (*Thunnus obesus*), Skipjack tuna (*Katsuwonus pelamis*) and Swordfish (*Xiphias gladius*). A summary of published work undertaken in Tanzanian waters is also provided. A search for published scientific literature and IOTC reports was conducted, with results being limited to publications in English and confined to the Indian Ocean and West Indian Ocean region specifically. Studies included in the review have been presented by topic with information in the region (Table 1). In terms of research for the West Indian Ocean and Indian Ocean region, the four species appear relatively well-studied as highlihhted below.

Yellowfin tuna are known to preferentially occupy the surface mixed layer above the thermocline, but also have the physiological and behavioural ability to make deep dives, penetrating the deeper cold sections of the ocean (Dagorn et al., 2006). The vertical distribution of the adults in the Indian Ocean is influenced by temperature, and and dissolved oxygen concentrations and correlated to chlorophyll-*a* (Song et al., 2008).Variability in the distribution and catch rates of tuna species have been observed to associate with the Indian Ocean Dipole (IOD), a basin-scale pattern of sea surface and subsurface temperatures that affect climate in the Indian Ocean (Lan et al., 2013). Yellowfin tuna longline catch per unit effort (CPUE) was observed to be negatively correlated to the IOD with a periodicity of 4 years. During positive IOD events, sea surface temperatures (SSTs) were relatively higher, while net primary productivity (NPP) was lower, CPUE decreased and catch distributions were restricted to the northern and western margins of the western Indian Ocean. During negative IOD events, high CPUE were associated with lower SSTs and higher NPP, particularly in the Arabian Sea and seas surrounding Madagascar, and catches expanded into central regions of the western Indian Ocean. These findings provide insight into some of the key environmental features driving the distribution of Yellowfin tuna in the western Indian Ocean and associated variability in fisheries catches

(Lan et al., 2013).

Yellowfin tuna are considered day-feeders and adopt a wandering strategy (in small schools) when food resources are scarce; forming large schools when resources are abundant (Roger 1994a). The main prey items, as revealed by analysis of stomach contents, are epipelagic fish, crustaceans and cephalopods (Potier et al., 2004; Potier et al., 2007; Somvanshi, 2002). According to an analysis of sex-specific growth using sectioned otoliths, the growth curves of both sexes are similar up to 4 years of age, after which males start to grow larger than females, indicating sexual size dimorphism in growth curves after maturity (Shih et al., 2014). This species generally has one major reproductive season, during the north monsoon (Stéquert et al., 2001). This occurs in the months November–February when asynchrony in reproductive timing among sizes has been observed (Zudaire et al., 2013a). A second peak occurs in June (Zudaire et al., 2013a). In the West and Central Indian Ocean, the area between the equator and 10º south has been identified as the most active spawning ground, with January, February and June being the months when most developed ovaries were found, corresponding to the highest gonadosomatic index (GSI) values (Zhu et al., 2008). Yellowfin tuna exhibit indeterminate fecundity with asynchronous oocyte development (Zudaire et al., 2013b).

Bigeye tuna are mainly distributed in tropical waters of the Indian Ocean between 10°N and 15°S (Lee et al., 2005). The optimal thermal range for this species, irrespective of sexual maturity and water mass is 10–16°C (Mohri and Nishida, 1999). The vertical distribution of tuna is predicted by the temperature profile; with Bigeye tuna only found in the deeper layers in the warmer tropical region and being distributed up to the shallower layers in the middle latitudes. Seasonal changes in temperature also influences distribution, with the size of fishing grounds in the tropical region decreasing during the period between June and September, and the size of the fishing grounds in the middle latitude increasing during this same period (Mohri and Nishida, 1999). Apart from temperature, chlorophyll-*a* and dissolved oxygen concentrations have also been found to significantly impact the spatial distribution of Bigeye tuna (Song and Zhou, 2010). This species feeds predominantly on cephalopods and mesopelagic fish (Potier et al., 2004). Bigeye tuna from the Indian and Pacific

Oceans are genetically distinct from those found in the Atlantic Ocean (Bremer et al., 1998). Genetic differentiation of Bigeye tuna within the Indian Ocean is minimal and overall non-significant (Appleyard, 2002), indicating that Bigeye tuna of the Indian Ocean constitute a single panmictic population (Chiang et al., 2008).

Due to the high energy demands of tropical tunas such as the Skipjack tuna, the biomass of available forage is a key factor in controlling the abundance and distribution (Roger, 1994b). Like the Yellowfin tuna, Skipjack tuna are considered day-feeders, and adopt a wandering strategy (in small schools) when food resources are scarce; forming large schools when resources are abundant (Roger 1994a). The movement of Skipjack tuna throughout its distribution in the Indian Ocean has been found to be highly variable in space and time (Adam and Sibert, 2002). Because of the fast and extensive movements of skipjack, it can be concluded that the population in the Indian Ocean is highly mobile (Fonteneau, 2014). The mixing rates of individual Skipjack that are fished in remote parts of the Indian Ocean are, however, probably low or very low (Fonteneau, 2014).

Genetic analysis has revealed that Skipjack tuna from the Indian Ocean are distinguishable from those collected both in the Atlantic Ocean and the western Pacific Ocean (Fujino et al., 1981). In addition, a number of local studies off Sri Lanka (Dammannagoda et al., 2011), India (Menezes et al., 2006; Menezes et al., 2012) and Japan (Menezes et al., 2006) suggests evidence of two distinct breeding stocks mixing on feeding grounds in Sri Lankan waters, four distinct groups occurring off the coast of India and sufficient differentiation to declare Japanese and Indian populations demographically independent.

The Skipjack tuna exhibits an indeterminate fecundity type fish with asynchronous ovarian development and asynchronous spawning (Grande et al., 2010). In the West Indian Ocean spawning occurs year-round, with increasing periods of spawning activity related to monsoon events: North monsoon (November to March) and South monsoon (June to August) (Grande et al., 2010; Grande et al., 2014). Model results suggest that observed trends in reported catches are connected to environmental conditions by means of recruitment

dynamics of this species (Dueri et al., 2012).

By combining the projections of up-to-date climate and ocean biogeochemical models with recent concepts of representation of fish habitat based on prey abundance and ambient temperature, Loukos et al., (2003) aimed to gain insight into the impact of climate change on Skipjack tuna. The authors concluded that for a world with doubled atmospheric CO_2 concentration, significant large-scale changes of Skipjack tuna habitat in the equatorial Pacific could occur. East of the international date line, conditions could be improved by an extension of the present favourable habitat zones of the western equatorial Pacific, a feature reminiscent of warming conditions associated with El Niño events.

The distribution (and catch rates) of Swordfish in the Indian Ocean are influenced by both climatic and environmental variation, with these environmental effects differing between the northwest and southwest Indian Ocean (Lan et al., 2015). According to Lan et al. (2015) changes in net primary production and shallow mixed layer depth during nominal IOD and negative Southern IOD events, results in notable increases in Swordfish abundance along the western coast of the northwest Indian Ocean.

The Southwest Indian Ocean likely functions as a unique panmictic population (Jean et al., 2006; Lu et al., 2006). Lu et al. (2006) observed some discrete genetic differences appearing that could possibly indicate influence from a second genetic pool in the northern part of the Indian Ocean. This structure appeared to be sex-dependent with genetic differences being higher among females than males, possibly indicating a higher level of spawning area fidelity for females with a subsequent sampling bias tending to homogenise male genotypic distributions.

Work conducted in the vicinity of Reunion Island indicated spawning occurred in these waters from October to April (Poisson and Fauvel, 2009a). Spawning activity is localized in discrete areas and the 7-month spawning period was observed, during which females lay successive batches of eggs, closely linked to SST (Poisson and Fauvel, 2009a). Batch fecundity was positively correlated with fish length, where older/larger females have earlier and longer spawning

seasons than younger/ smaller females; suggesting that older/larger females that are seasonally migrating in this spawning ground. The older lager females therefore play a major role in reproductive success of the species in producing significantly more offspring than younger females during an extended spawning season (Poisson and Fauvel, 2009b).

Information relating to the Tanzanian tuna fisheries includes studies examining fisheries, catches, economic contributions and bycatch. As previously mentioned, the Tanzanian fishing fleet is comprised of mainly artisanal vessels which use variety of gears to target a diverse of species. Since 1998, artisanal longliners have also targeted pelagic species such as tuna and billfishes (see Bultel et al., 2015), and in recent years this group has been estimated to make up as much as 7% of the total artisanal catches (Bultel et al., 2015). Artisanal fishers interviewed have indicated that tuna and tuna-like species form an important, and sometimes the sole source, of their income (Igulu et al., 2013). Changes in stock size and availability of these fish could have major impacts on the income of fishers and livelihood of coastal communities (Igulu et al., 2013).

There is a serious cause for concern, as the incidental capture of dolphins by artisanal gillnet and drift net fisheries to have a significant negative impact on the bycatch local populations (Berggren et al. 2002). A total of 96 dolphins were reported to have been incidentally caught between 1995 and 1999; 43 Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), 29 spinner dolphins (*Stenella longirostris*), 5 IndoPacific humpback dolphins (*Sousa chinensis*) and 19 unidentified dolphins. It is noted however that most of the research relating to the marine fisheries of Tanzania have been presented as grey literature (57%) with limited distribution (Jiddawi and Öhman, 2002). Therefore, this brief review likely may not encompass all the information available on tuna fisheries in Tanzania. An assessment of the artisanal tuna and billfish fisheries on Zanzibar was done by Mildenberger (2018) which considered migratory nature of fishers and management challenges.

Table 1: A summary of tuna research in the West Indian Ocean

Topic and Sub-topic	*Tuna (general)*	*Thunnus albacares*	*Thunnus obesus*	*Katsuwonus pelamis*	*Xiphias gladius*
Biological Studies		IO, India	IO	India	India
Age and growth		IO, WIO, India	IO, WIO	India, Maldives	IO
Fecundity, Oogenesis, Sexual maturation	General	WIO		WIO	IO, SWIO (Reunion)
Sexual reproduction/ Spawning		WIO	IO	WIO, India	SWIO (Reunion)
Length frequency		IO			SWIO
Feeding ecology / Trophic relationships		IO, WIO	IO, WIO	WIO	WIO
Early life-history stages	WIO	CIO		India	India
Behaviour		General			
Catch Data Studies					
Bycatch	IO (European& Taiwanese fleets), WIO (purse-seine fisheries), Bycam WIOMSA-MASMA project **Zanzibar**				IO (Spanish fleet)

Catch, catch rates, catch/effort	IO, Tanzania	IO (Korean and Japanese fleet), WIO (Japanese fleet)	IO, IO (Korean fleet)		IO (Spaish, Taiwanese and Japanese fleet), SWIO
Catch Composition					
Fisheries	Minicoy (India), **Tanzania**	IO, **Zanzibar Channel**	IO	IO, India	IO (Spanish fleet), SWIO (Reunion)
Fishing Methods					
Fish Aggregating Devices (FADs)	General, WIO	Comoros		Comoros	
Population studies					
Genetics	**Tanzania** (***Euthynnus affinis***)	WIO, India	Global, IO	Global, NWIO, India	Global, IO, SWIO
Stock		India	IO	IO, NWIO, India	Global, SWIO
Population			Global, IO	Maldives, India	Global, IO, SWIO
Movement / Migration	WIO **(Tanzania)**	WIO	Global	IO, Maldives	WIO
Tagging				Maldives	
Distribution		WIO	IO (and vertical distribu-tion)		
Environment		IO	IO		IO, SWIO
Climate variability / change	IO	WIO		General	

IO Indian Ocean

CIO Central Indian Ocean

Considering the socio-economic importance and migratory nature of tuna, tuna-like species and sharks, it is obvious that understanding of the key scientific information of these species in the Tanzanian EEZ is an important milestone for sustainable management and implementation of national fisheries development strategies. For instance, Tanzania manages EEZ fish species as a single management unit due to the limited scientific information on the population structure, life history and the relevant oceanographic parameters influencing these species. In this situation, lack of relevant scientific information could lead to over-exploitation, subsequently discouraging potential investments in the sector.

Table 1 above shows inadequacy of research information on some of the tuna species in Tanzania and the wider WIO region. This also applies to other species of tuna, as well as tuna-like species, sharks and other living resources. Furthermore, there is paucity of data on aspects such as those on fisheries socioeconomics, governance, business planning, value chain analysis, marketing, and the impact of environmental variability and climate change. This problem is exacerbated by the complexity of undertaking research in deeper offshore waters with limited knowledge and infrastructural resources in Tanzania and the WIO region in general. This Agenda therefore attempts to address these issues by outlining prioritized research themes to be undertaken within the next ten years.

2.2. EXISTING CAPACITY

A review of existing capacity, undertaking gap analysis for conducting tuna-related research in the offshore environment.

Table 2a: Capacity for undertaking Biological Research

Research Priority	BIOLOGICAL RESEARCH					
Institution	Specialised research staff capacity	General Laboratory facilities	Specialised lab equipment	Training required	Vessel	Fieldwork budget and transport
Deep Sea Fishing Authority	Limited	None	Limited	Yes	N/A	Limited
IMS (University of Dar es Salaam)	Limited	Available	Limited	Yes	Yes	Limited
Ministry responsible for fisheries (Tanzania mainland)	Limited	None	None	Yes	N/A	Limited
Ministry responsible for fisheries (Zanzibar)	Limited	Limited but to be built (SWIOFish project)	None	N/A	N/A	Limited
Fisheries Research Institutes (Tanzania mainland and Zanzibar)	Limited	Limited	Limited	Yes	Yes	Limited
DASFT (University of Dar es Salaam)	Limited	Available	Limited	Yes	Yes	Limited
Sokoine University of Agriculture	Limited	Available	Limited	Yes	N/A	Limited
State University of Zanzibar	Limited	Limited	Limited	Yes	Yes	Limited

Table 2b: Capacity for undertaking Environmental Research

Research Priority	ENVIRONMENTAL RESEARCH					
Institution	Specialised research staff capacity	General Laboratory facilities	Specialised lab equipment	Training required	Vessel	Fieldwork budget and transport
Deep Sea Fishing Authority	Not available	None	None	Yes	N/A	Limited
IMS (University of Dar es Salaam)	Limited	Available	Limited	Yes	Yes	Limited
Ministry responsible for fisheries (Tanzania mainland)	Limited	None	None	N/A	N/A	Limited
Ministry responsible for fisheries (Zanzibar)	Limited	None	None	N/A	N/A	Limited
Fisheries Research Institutes (Tanzania mainland and Zanzibar)	Limited	Limited	Limited	Yes	Yes	Limited
DASFT (University of Dar es Salaam)	Limited	Limited	Limited	Yes	Yes	Limited
Sokoine University of Agriculture					N/A	Limited
State University of Zanzibar	Limited	Limited	Limited	Yes	Yes	Limited

Table 2c: Capacity for undertaking Fishery Related Research

Research Priority	BIOLOGICAL RESEARCH					
Institution	Specialised research staff capacity	General Laboratory facilities	Specialised lab equipment	Training required	Vessel	Fieldwork budget and transport
Deep Sea Fishing Authority	Limited for offshore requires offshore scientific observers	N/A	N/A	Yes	N/A	Limited
IMS	Limited	Limited	N/A Limited	Yes	Yes	Limited
Ministry responsible for fisheries (Tanzania mainland)	Limited requires offshore scientific observers	N/A	N/A	Yes	N/A	Limited
Ministry responsible for fisheries (Zanzibar)	Limited requires offshore scientific observers	N/A	N/A	Yes	N/A	Limited
Fisheries Research Institutes (Tanzania mainland and Zanzibar)	Limited	Limited	Limited	Yes	Yes	Limited
DASFT	Limited – not trained for offshore	Limited	Limited	Yes	Yes	Limited
SUA	Limited	Limited	Limited	Yes	N/A	Limited
SUZA	Limited	None	None	Yes	Yes	Limited

Table 2d: Capacity for undertaking Social and Economic Research, and Business Planning

Research Priority	SOCIAL AND ECONOMIC RESEARCH, BUSINESS PLANNING		
Institution	Specialised research staff capacity	Training required	Fieldwork budget and transport
Deep Sea Fishing Authority	Not available	N/A	Limited
IMS (University of Dar es Salaam)	Limited	Yes	Limited
Ministry responsible for fisheries (Tanzania mainland)	Requires consultation with other Departments at the Ministry	N/A	Limited
Ministry responsible for fisheries (Zanzibar)	Limited	Yes	Limited
Fisheries Research Institutes (Tanzania mainland and Zanzibar)	Limited	Yes	Limited
DASFT (University of Dar es Salaam)	Available but specialists required	Yes	Limited
Sokoine University of Agriculture (SUA)	Consultation with the University required	Yes	Limited
State University of Zanzibar (SUZA)	Limited	Yes	Limited

Table 2e: Capacity for undertaking Monitoring, Surveillance and Compliance

Research Priority	MONITORING, SURVEILANCE AND COMPLIANCE					
Institution	Specialised research staff capacity	General Laboratory facilities	Specialised lab equipment	Training required	Vessel	Fieldwork budget and transport
Deep Sea Fishing Authority	Limited	N/A	Limited	Yes	No offshore MCS vessel	Limited
Ministry responsible for fisheries (Tanzania mainland)	Limited	N/A	Limited	Yes	No offshore MCS vessel	Limited
Ministry responsible for fisheries (Zanzibar)	Limited	N/A	Limited	Yes	No offshore MCS vessel	Limited
Fisheries Research Institutes (Tanzania mainland and Zanzibar)	N/A	N/A	N/A	Yes	N/A	N/A
DASFT	N/A	N/A	N/A	Yes	N/A	N/A
SUA	N/A	N/A	N/A	N/A	N/A	N/A

3. LINKAGE WITH NATIONAL, REGIONAL AND GLOBAL RESEARCH FRAMEWORKS

Since the Research Agenda does not work alone, this section explores synergies and recognizes implications with other global, regional and other sectoral frameworks as follows:

3.1. NATIONAL FISHERIES AND AQUACULTURE RESEARCH AGENDA (2020 – 2025)

The National Fisheries and Aquaculture Research Agenda (2020 – 2025) was developed through in-depth consultations and participation of fisheries stakeholders. This agenda is an initiative of the Tanzania Mainland Ministry of Livestock and Fisheries Development aiming at providing guidance on priority research areas to fisheries and aquaculture research institutions and other stakeholders. The Research Agenda identified five main research priorities with short and long-term priorities:

i) **Aquatic ecosystems**: Aquatic invasive species and endangered species; fresh and marine water ecosystems inventories; aquatic productivity; water quality and pollution; effect of policies, legislation and regulation on fisheries resources and industrial development; sustainability of aquatic ecosystems and resources; anthropogenic activities on aquatic ecosystems; key and critical habitats; eco-tourism; and by-catch in relation to biodiversity.

ii) **Sustainable capture fishery**: Illegal, unreported and unregulated (IUU) fishing; fish stock assessment of priority fisheries; fish migration patterns such as tuna and tuna-like species in the EEZ; catch assessment and frame survey; fish ecology and critical habitats focusing on breeding and nursery areas in major water bodies; fishing gear technology, methods and crafts; Fish aggregating devices; limnology and oceanography; and fisheries modelling.

iii) **Aquaculture growth: Viable aquaculture species**; quality feeds and appropriate feeding strategies; optimized production systems for resh, brackish and marine waters; zonation and carrying capacity; seaweed production and value addition; aquaculture business development; breed improvement and mass production of seeds; ornamental aquaculture; and disease control and health management.

iv) **Marketing and trade of fish and aquatic products**: Commercialization, enterprise development and marketing of fisheries products, technology for improved food quality, quantity and storage and reducing post-harvest losses; innovations, applications and commercial value-addition advantages; marketing strategies and processes; consumers' behaviour, use of ICT in fish marketing; business transaction laws on trade in fish and fishery products investment in EEZ, Product development/ services; fish products and marketing; marketing modeling; globalization of fish trade; and business environment influences.

v) **Cross-cutting issues: Alternative livelihoods**; research extension linkages; collaborative management; conflicts resolution; value chains and post-harvest management; disaster risks and climate change; youth development and gender equity; governance and policies; and HIV/AIDS, communicable diseases, health and sanitation.

The priority research areas in Zanzibar are:

i) Small pelagic fish;
ii) Value addition, marketing and post-harvest management;
iii) Technological transfer in the fishery value chain;
iv) Marine endangered species and biodiversity conservation;
v) Climate change impact and conservation of biodiversity;
vi) Recreational fisheries and marine ecotourism;
vii) Fish stock assessment (territorial waters and deep sea); and
viii) Spawning aggregation of marine fish including tuna.

3.2. NATIONAL TUNA FISHERIES MANAGEMENT STRATEGY (2020-2025)

The National Tuna Management Strategy consists of the management measures selected to achieve the biological, ecological, economic and social aspects of the tuna and tuna-like species fisheries in Tanzania waters. It was designed to support the efforts of the Government in governing the tuna and tuna-like resource. The strategy emphasizes the importance of achieving the joint aspirations of the implementing institutions and other stakeholders at the national level. The overall goal of the strategy is to attain sustainable management and utilization of tuna and tuna-like species with optimum biological, environmental, social and economic benefits. To achieve the goal, five intervention areas were identified:

i) Sustainable fisheries management and development;
ii) Fisheries biodiversity and conservation;
iii) Research for development;
iv) Trade and marketing; and
v) Cross-cutting issues.

These strategies cannot be realised without being supported by viable scientific information. This Research Agenda acts as an important tool to guide collection of the required scientific information that will ensure sustainable management and development of fisheries resources in the Tanzanian EEZ.

3.3. IOTC TUNA, TUNA-LIKE SPECIES AND SHARK RESEARCH ACTION PLANS

The IOTC is a Regional Fisheries Management Organisation (RFMO) responsible for conserving and managing the tuna stocks in the Indian Ocean region. IOTCs main objective is to promote cooperation among the Contracting Parties (Members) and Cooperating Non-Contracting Parties (CPCs) of the IOTC with a view to ensuring the conservation and optimum utilisation of stocks. The four (4) key functions and responsibilities are:

i) to keep under review the conditions and trends of the stocks and to gather, analyse and disseminate scientific information, catch and effort statistics and other data relevant to the conservation and management of the stocks;
ii) to encourage, recommend, and coordinate research and development

activities in respect of the stocks and fisheries covered by the IOTC, and such other activities as the Commission may decide appropriate, such as transfer of technology, training and enhancement, having due regard to the needs to ensure the equitable participation of Members of the Commission in the fisheries and the special interests and needs of Members in the region that are developing countries;

iii) to adopt, based on scientific evidence – Conservation and Management Measures (CMM) to ensure the conservation of the stocks covered by IOTC and to promote the objective of their optimum utilisation throughout the region; and

iv) to keep under review the economic and social aspects of the fisheries based on the stocks covered by the Agreement bearing in mind the interests of developing coastal States.

IOTC data requirements include information on annual catches (nominal catches and discards), active crafts (number of vessels), catch and effort (surface fisheries, longline fisheries, coastal fisheries, supply vessels, FADs), size data (fish lengths), and socio-economic data (fish prices, country indicators).

The IOTC area of competence is the Indian Ocean, defined as statistical areas 51 and 57 by the Food and Agriculture Organization (FAO) statistical areas 51 and 57. Species under the management mandate of IOTC are shown in Table 3. In addition, data on non-target, associated and dependent species affected by tuna fishing operations (i.e. marine turtles, marine mammals, seabirds, sharks and fish bycatch) is also collated.

Table 3: Tuna and tuna-like species of the IOTC management

Scientific name	FAO English name
Thunnus albacares	Yellowfin tuna
Katsuwonus pelamis	Skipjack
Thunnus obesus	Bigeye tuna
Thunnus alalunga	Albacore tuna
Thunnus maccoyii	Southern Bluefin tuna
Thunnus tonggol	Longtail tuna
Euthynnus affinis	Kawakawa
Auxis thazard	Frigate tuna
Auxis rochei	Bullet tuna
Scomberomorus commerson	Narrow barred Spanish Mackerel
Scomberomorus guttatus	Indo-Pacific king mackerel
Makaira nigricans	Blue Marlin
Makaira indica	Black Marlin
Tetrapturus audax	Striped Marlin
Istiophorus platypterus	Indo-Pacific Sailfish
Xiphias gladius	Swordfish

There are currently seven (7) active IOTC Working Parties (WPs) operating in support of the IOTC Science Process. These are the WP on Billfish, WP on Data Collection and Statistics, WP on Ecosystems and Bycatch, WP on Methods, WP on Neritic Tunas, WP on Temperate Tunas and the WP on Tropical Tunas . Potentially complimentary IOTC work programmes (2017-2021) under these Working Parties, and potential areas of cooperation and collaboration are described in Table 4.

Table 4: Complimentary IOTC work programmes for 2017-2021

i) Stock structure (connectivity)	**Genetic research to determine the connectivity of neritic, tropical and albacore tuna, billfish and sharks throughout their distributions in the Indian Ocean.** Determine the degree of shared stocks for all neritic tunas under the IOTC mandate in the Indian Ocean. Genetic research to determine the connectivity of neritic tunas throughout their distributions.
ii) Biological information (parameters for stock assessment)	**Age and growth research; Age-at-maturity (neritic, tropical and albacore tunas, billfish, blue shark, shortfin mako shark and oceanic whitetip shark and silky shark)** Quantitative biological studies are necessary for all groups and species mentioned above, throughout their distribution range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.
iii) Ecological information	**Spawning time and locations (tropical and albacore tuna, billfish, blue shark, shortfin mako shark, oceanic whitetip shark, silky shark)** Collect gonad samples from groups and species mentioned above to confirm the spawning time and location of the spawning area that are presently hypothesized for albacore.

iv) Sports/recreational fisheries	**Fishery trends (marlins and sailfish)** The catch and effort data for sports/recreational fisheries targeting marlins and sailfish in the Indian Ocean should be submitted to the IOTC Secretariat to assist in future assessments for these species. CPCs with active sports/ recreational fisheries targeting marlins and sailfish should undertake a comprehensive analysis for provision to the Billfish Program.
v) Fisheries data collection	**Implementation of Regional Observer Schemes (key IOTC shark species)** **Artisanal fishery data collection** Artisanal fisheries • For countries that are known for already having well established sampling systems in place, assess the outcomes / review the projects and proceed with immediate actions and support (if needed). • Assessment of the status of all countries whose sampling systems are not fully known or established. • Develop minima data requirements for the routine collection of data at the landing sites, through sampling by enumerators. • Develop General Guidelines for data collection from artisanal fisheries; including development of a set of indicators to be used to assess the quality of data collection and management systems for artisanal fisheries. • Develop/Amend Fisheries specific data collection protocols, by country, where necessary.

	• Assist implementation of pilot sampling activities in countries/fisheries not/insufficiently sampled in the past; priority to be given coastal fisheries inTanzania and other countries in the Indian Ocean including Indonesia, Pakistan, Sri Lanka, Yemen, Madagascar, Comoros, Thailand and Malaysia.
vi) Fishery independent monitoring	All of the tropical tuna stock assessments are highly dependent on relative abundance estimates derived from commercial fishery catch rates, and these could be substantially biased despite efforts to standardise for operational variability (e.g. spatial-temporal variability in operations, improved efficiency from new technology, changes in species targeting). Accordingly, the IOTC should continue to explore fisheries independent monitoring options which may be viable through new technologies. There are various options, among which some are already under test. Not all of these options are rated with the same priority, and those being currently under development need to be promoted, as proposed below: i) Acoustic FAD monitoring, with the objective of deriving abundance indices based on the biomass estimates provided by echo-sounder buoys attached to FADs. ii) Longline-based surveys (expanding on the Indian model) or "sentinel surveys" in which a small number of commercial sets follow a standardised scientific protocol.

	iii) Aerial surveys, potentially using remotely operated or autonomous drones. iv) Genetics-based tagging techniques using recaptured individuals or identification of closely related pairs.

3.4. WWF COASTAL EAST AFRICA INITIATIVE

The Coastal East Africa Initiative (CEAI) is one of the 13 Global Initiatives (GIs) that the Worldwide Fund for Nature (WWF) has embarked on since 2007 (WWF, 2012). These GIs are intended to be transformational interventions implemented through concerted network action to meaningfully impact critical threats, opportunities in support of biodiversity conservation and development targets within priority places or on priority themes (van der Linde, 2016). The CEAI focuses on three countries along the East African coast, namely Kenya, Tanzania and Mozambique, with the long-term goal being "By 2025, the governments and peoples of the coastal East Africa region are effectively controlling decisions over their natural resources and exercise their responsibility for ensuring that key ecosystems and habitats are sustainably managed". The CEAI core team focuses on the higher-level governance and trade issues, particularly at a regional, international and/or transboundary level (van der Linde, 2016). Within the Southwest Indian Ocean tuna fisheries, significant achievements have been made resulting from in-country work and collaborations amongst, *inter alia,* Southwest Indian Ocean countries, WWF, IOTC and the World Bank.

3.5. ECOSYSTEM APPROACH TO FISHERIES PROJECT

The long-term objective of the Ecosystem Approach to Fisheries (EAF) project is to strengthen regional and country specific efforts to reduce poverty and create conditions to assist in the achievement of food security through development of sustainable fisheries management regimes and specifically through the application of the ecosystem approach to fisheries in a number of developing countries at global level, with an early emphasis on Sub-Saharan

Africa. This objective would be achieved through the provision of support for the development and country driven application of the conceptual framework of the EAF through capacity-building, promoting standardized data collection and monitoring, supporting policy development and management practices consistent with EAF principles and contributing to an expanded knowledge base.

The immediate objectives of the project are to provide the fisheries research institutions and management administrations in the participating countries with additional knowledge on their ecosystems for their use in planning and monitoring, and to further the acceptance and application of the key principles of the EAF. The key principles are that:

i) Fisheries should be managed to limit their impact on the ecosystem to an acceptable level;
ii) Ecological relationships between species should be maintained;
iii) Management measures should be compatible across the entire distribution of the resource;
iv) Precaution in decision-making and action is needed because the knowledge on ecosystems is incomplete; and
v) Governance should ensure both human and ecosystem well-being and equity.

The DSFA may arrange to meet with the FAO team with a view to incorporate some of the research objectives into the EAF Nansen Research program. This constitutes a good way in which to solicit the use of an offshore research vessel.

3.6. COMMISSION FOR SCIENCE AND TECHNOLOGY IN TANZANIA

The Tanzania Commission for Science and Technology (COSTECH) is a parastatal organization with the responsibility of co-ordinating and promoting research and technology development activities in the country. COSTECH is the chief advisor to the Government on all matters pertaining to science and technology and application to the socio-economic development of the country. By bringing together the top leadership of the scientific and technological institutions in the country under one forum, the Commission maintains a system

of collaboration, consultation and cooperation with parties within Tanzania whose functions relate to the development and application of science and technology, with the main roles of the Commission being:

i) To advise the Government on all matters relating to science and technology including but not limited to the formulation of science and technology policy, priority setting for research and development, allocation and utilization of resources;
ii) To promote, coordinate, monitor and evaluate scientific research and technology development and technology transfer activities in the country;
iii) To facilitate national, regional and international cooperation in scientific research and technology development and transfer; and
iv) To acquire, store, and disseminate scientific and technological information and popularize science and technology.

3.7. SUSTAINABLE OCEANS, LIVELIHOODS AND FOOD SECURITY

Sustainable Oceans, Livelihoods and Food Security through Increased Capacity in Ecosystem Research in the Western Indian Ocean (SOLSTICE) aims at strengthening capacity in the WIO to address challenges of food security and the sustainability of livelihoods of the 60 million people dependent on the region's marine ecosystems. This is reflected in the main objectives of the project:

i) To grow marine environmental research capability to address challenges facing the WIO region in a cost-effective way via state-of-the-art technology transfer, collaborative environmental and socio-economic research and hands-on training;
ii) To strengthen the capacity of UK marine scientists to apply leading-edge technologies in developing countries, and work with regional and local experts to ensure that their research addresses local and regional needs;
iii) To strengthen the ability of WIO scientists to effectively deliver evidence-based environmental and socio-economic information to support policy development and implementation at national and regional levels;
iv) To ensure future sustainability of marine research capability in the

region by training and mentoring early career scientists and post-graduate students from the WIO and by developing on-line resources for use in distance learning and hands-on training of marine scientists outside the partner organisations and beyond the duration of the project; and

v) To ensure on-going support for an Ecosystem Approach to Fisheries in the WIO by building lasting strategic research partnerships between UK marine science and regional centres of excellence, between these centres and other WIO research organisations, and between marine scientists and government agencies and NGOs mandated to deliver sustainable development and exploitation of marine living resources in the WIO.

This project provides a significant opportunity for funding, but a meeting point with the project leaders may be required to facilitate incorporation of tuna research activities.

3.8. WESTERN INDIAN OCEAN MARINE SCIENCE ASSOCIATION

The Western Indian Ocean Marine Science Association (WIOMSA) provides several opportunities to apply for research funding. Meetings should be set up between the DSFA and WIOMSA to discuss aspects of the research plan which may be suitable to attract funds through WIOMSA.

3.9. EMERGING OPPORTUNITIES AND CHALLENGES

The following opportunities and challenges have been explored from the situation analysis and linkage sections:

Opportunities

i) Availability of local non-state actors and international entities capable of conducting relevant researches;
ii) Existence of research programmes;
iii) Availability of potential financial sources for fisheries research;
iv) On-going infrastructural improvement such as laboratories; and
v) Emergence of new private sector partners offering opportunities for broader based financing and investments.

Challenges

i) Limited research papers/journal produced locally;
ii) Fragmentary data collection and storage;
iii) Limited manpower development and training;
iv) Degradation of marine natural resources; and
v) High post-harvest losses; and low public expenditure and disbursement on research.

4. RESEARCH PRIORITY AREAS

This section provides the vision, mission, overall objective and detailed research priorities.

4.1. VISION

DSFA to be a hub institution for scientific information on tuna, tuna-like resources in the Western Indian Ocean.

4.2. MISSION

Strengthening data collection and supporting regional scientific assessment for tuna, tuna-like resources in the Western Indian Ocean.

4.3. GOAL

Research capability being built and long-term ecosystem management achieved in the Western Indian Ocean through cost-effective, technology transfer, collaborative studies and training.

4.4. RESEARCH PRIORITY AREAS

The situation analysis and linkage sections above draw seven research priority areas, namely:

i) Biological;
ii) Environmental;
iii) Fishery-related;
iv) Stock assessment;
v) Social and economic;
vi) Monitoring, control and surveillance; and
vii) Climate change and adaptation.

4.5. BIOLOGICAL RESEARCH

The potential yield from a stock is dependent on the biological characteristics of the stock, particularly age structure, species and sex composition of the stock,

and the timing of fishing in relation to attainment ofmaturity and spawning (FAO, 1997). Certain biological parameters are important for stock assessment, such as age, growth, age or size -at-maturity and mortality data. This section draws four priorities as follows:

i) Age and growth studies including using fish otolith or other hard parts;
ii) Quantitative biological studies determining key biological parameters such as age/size-at-maturity, fecundity-at-age/size, length relationships, age-length keys;
iii) Sexual reproduction: spawning time and location, fecundity, oogenesis, sexual maturation; and
iv) Feeding ecology/Trophic relationships.

4.6. ENVIRONMENTAL RESEARCH

The marine environment and habitats are critical to the various life history stages of the tuna and tuna-like stocks. The environmental habitat preferences and environmental conditions that influencing spatial distribution are essential to the conservation of marine species. In addition, the relation between tunas and the environment has strong impacts on their catchability and catch rates. As such information on environmental conditions influencing catch and CPUE is important. This section draws three (3) priorities as follows:

i) Environmental factors influencing catch and CPUE;
ii) Environmental factors influencing distribution; and
iii) Spawning time and location of the spawning area that are presently hypothesized for albacore.

4.7. FISHERY RELATED RESEARCH

Effective management of tuna and tuna-like species in the Tanzanian national waters needs to consider both the artisanal and industrial fleets as well as fishing gears. The impact of each of these fleets on tuna resources needs to be considered. As such fishery specific data and information such as the number of vessels; gear characteristics and selectivity; catch and effort; catch composition; fishing seasonality; and fishing locality (in relation to the distribution of the stock and other fleets) is required. This section draws eight priorities as follows:

ii) Characteristics of artisanal fishery;
iii) Characteristics of industrial fishery;
iv) Characteristics of recreational fishery;
v) Catch and effort data;
vi) Catch composition data;
vii) Fishing effort, distribution, seasonality (links to climate change / variability); and
viii) Benthic and seabed structure (essential to the development of new fishing techniques.

4.8. STOCK ASSESSMENT RESEARCH

Tanzanian tuna fishery is complex; both the artisanal and industrial (national and DWFN) fleets target tuna and tuna-like species. It is thought that these fisheries are targeting a single, shared stock. This needs to be verified, as fishing activity beyond 12 nm could well impact inshore stocks, or vice versa, and hence the economic contribution or viability of these fisheries. Outcomes of this work will directly influence how stocks of tuna and tuna-like species are managed in the Tanzanian EEZ. The status of Yellowfin and Bigeye tuna stocks in the Tanzanian EEZ was reviewed by the Tanzania Fisheries Research Institute in 2011. Discrepancy in IOTC data and data from the Tanzanian Department of Fisheries was noted, with the IOTC data showing a sharp decline of both species to lowest values in 2007 and Department data showing that both species' catches declined sharply from a peak in 2004, to lower levels a year later in 2005 (Mgaya, 2011). It was concluded that the IOTC data clearly underestimated the Tanzanian EEZ tuna catches, highlighting the need for regular assessment of local tuna stocks and improved quality and resolution of data submitted to IOTC. This section draws six priorities as follows:

i) Genetic research to determine the existence of a single shared, or multiple stocks;
ii) Tagging studies to determine the connectivity and movement rates between stocks within and beyond 12 nm;
iii) Catch and effort data;
iv) Catch composition data;
v) Assessment of local (Tanzanian EEZ) stocks; and

vi) Genetic research to determine the connectivity of neritic tunas throughout their distributions.

4.9. SOCIAL AND ECONOMIC RESEARCH

Business opportunities (catching, processing, and marketing) at a local level need assessing, including creation of viable small scale industrial and industrial fisheries. Social and cultural features and the economic characteristics of the people and communities within the system are currently poorly understood. Any fisheries management decision is likely to have an impact on peoples' livelihoods, hence the purpose of collecting and analysing social and economic information is to be able to anticipate the nature and extent of these impacts and to make appropriate in decisions. Collection and analysis of data on relevant social, economic and institutional factors is essential for responsible fisheries management (FAO, 1997). One aim of the National Policy for Deep Sea Fishing is to address the dependence on a single source of income by diversifying income sources. Feasibility studies on alternative sources of employment and income are therefore necessary in achieving this goal. In addition, comparative assessments of fishing technologies cost and benefits analysis will provide a baseline to inform and guide the long-term vision of the government regarding the development of a national fleet (phasing out foreign vessels in the Tanzanian EEZ). This section draws fourteen (14) priorities as follows:

i) Business planning (fisheries opportunities at a local level; creation of fisheries industrial sector, possible link with offshore fishing opportunities);
ii) Economic factors related to the fishery, particularly the economic and social dependence of the different stakeholder groups on the fishery;
iii) Comparative assessment of fishing technologies and costs and benefits analysis of the fishery in the region;
iv) Role of the fishery in providing employment to different stakeholder groups;
v) Alternative sources of employment and income;
vi) Current status of access to or ownership of the resources;
vii) Information on the history of the fishery and the historical roles of the different stakeholder groups within that fishery;

viii) Value chain analysis;
ix) Legal, sectoral conflicts and social conflicts;
x) Population, Health and Environment dynamics in industrial fishing
xi) Extent of fisheries related infrastructure development and accessibility (fishing ports, fish handling, storage, processing and distribution facilities; fish processing technologies, quality assurance and standards);
xii) Chemical composition; Nutrition values and Fish farming;
xiii) Business environment influences (product development/services; distribution channels; price variability and impact; product promotion strategies); and
xiv) Marketing processes (consumers behaviour; globalization of fish trade; marketing modelling).

4.10. MONITORING, CONTROL AND SURVEILLANCE

The successful implementation of policy is dependent, inter alia, on the effectiveness of monitoring, control and surveillance, which in turn is dependent on the collection, collation and analysis of accurate and relevant data and information (FAO, 1997). Monitoring involves the collection, measurement and analysis of data and information on fishing activities essential to the implementation of a management plan (FAO, 1997). Control refers to the terms and conditions under which resources could be harvested and surveillance involves checking and supervising fishing activities to ensure all applicable laws and regulations are being observed by the participants in the fishery (FAO, 1997). This section draws six (6) priorities as follows:

i) Expansion of pilot sampling activities for Tanzanian coastal fisheries (improved data collection);
ii) Observer programme: Continue with the training of (Cap. Marine) and deployment of observers on tuna fishing vessels (improved data collection and validation);
iii) Acoustic FAD monitoring, with the objective of deriving abundance indices based on the biomass estimates provided by echo-sounder buoys attached to FADs;
iv) Longline-based surveys (expanding on the Indian model) or "sentinel surveys" in which a small number of commercial sets follow a

standardised scientific protocol;

v) Aerial surveys, potentially using remotely operated or autonomous drones; and

vi) Genetics-based tagging techniques using recaptured individuals or identification of closely related pairs.

4.11. CLIMATE CHANGE AND ADAPTATION

Developing an understanding of the potential impacts of climate change on tuna and tuna-like species and catches in the Tanzanian EEZ is essential to the future sustainability and economic contribution of these fisheries. The Paris Declaration on Climate Change in 2015 that, *inter alia*, aims at strengthening the ability of countries to deal with the impacts of climate change affords Tanzania an opportunity to leverage funding to develop and implement appropriate mitigation measures once potential impacts are identified. This section draws six priorities as follows:

i) Identification of potential impacts of climate change on tuna and tuna-like species (species vulnerability assessments) and fisheries climate change economics;

ii) Climate variability; impact, vulnerability and adaptation;

iii) Indicators and bio-indicators;

iv) Resistance and resilience of aquatic organisms;

v) Greenhouse gases; ocean acidification; Sea level change; coral bleaching and diseases; and

vi) Aquatic productivity and aquatic modelling.

5. ENABLING ENVIRONMENT FOR IMPLEMENTATION

5.1. NATIONAL PARTNERSHIP AND COLLABORATION

This research agenda proposes formulation of a DSFA Research Committee (DSFA-RC) and a National Tuna Working Group. The DSFA-RC will constitute of members from respective government and non-government research institutions, i.e. RFMOs and NGOs (e.g. artisanal fisher community and industrial fishery representatives) that will promote integration of tuna and tuna-like fisheries in research and other business opportunities. The National Tuna Working Group will provide a useful forum for engagement and collaboration between managers, research institutions, RFMOs, and the industrial and artisanal fisheries sector. Stakeholder participation in the Working Groups would also bring fishers information, experience, and expertise into the scientific framework. Identified outcomes of stakeholder participation and cooperation in such working groups would improve quality of data required for scientific assessments of fish stocks, and improved policy buy-in and management implementation.

The Research Committee (RC) will be coordinated by DSFA, and meet at least twice per annum to plan and facilitate tuna and tuna-like research agenda, review research progress, identify challenges and obstacles and discuss possible solutions, and decide on the goals and way forward for the following year. The DSFA in collaboration with RC are expected to solicit research funds and partnership with private industry.

5.2. REGIONAL AND INTERNATIONAL PARTNERSHIP AND COLLABORATION

Tanzania being a member of the RFMO bodies such as IOTC, SWIOFC, SADC, IOC/UNESCO has an obligation to cooperate and/or seek assistance from these regional organizations on issues pertaining to research in the EEZ waters. Tanzania also benefits from regional and international cruises and expeditions such as the International Indian Expedition (IIOE-2) and the EAF Nansen Project.

5.3. GENERAL ROLES AND RESPONSIBILITIES

The implementing institutions of this Research Agenda will be responsible to solicite funds, coordinate and carrying researches identified. The research agenda assumes five roles and responsibilities as follows:

i) Development of tuna fisheries policy, legislations and by-laws: DSFA, Ministries responsible for fisheries (Tanzania mainland and Zanzibar) and Local Government Authorities;
ii) Management of tuna fisheries: DSFA, Ministries responsible for fisheries (Tanzania mainland and Zanzibar), Local Government Authorities (District councils) and Inter-sectoral coordination committees;
iii) Formulation of guidelines on tuna fisheries: DSFA, Ministries responsible for fisheries (Tanzania mainland and Zanzibar), Local Government Authorities (District councils) and Inter-sectoral coordination committees;
iv) Procurement and financing: DSFA responsible for project and budget approval; Ministries responsible for fisheries (Tanzania mainland and Zanzibar) for planning and budgeting; Ministry responsible for finance and planning (Tanzania mainland and Zanzibar) will provide rules on procurement of public goods/services, allocating funds, financial report and auditing; and
v) Coordination, information sharing and communication: Ministries responsible for fisheries (Tanzania mainland and Zanzibar), Stakeholder coordination (national); Prime Minister's Office – Regional Administration and Local Government.

Table 5: Summary of coordination, information exchange and communication

Biological Research	
Research priority	Institutions responsible
1. Age and growth; Quantitative biological; Sexual reproduction; and Feeding ecology/ trophic relationships	Academic and Research Institutions, Deep Sea Fishing Authority, and Ministries responsible for fisheries (Tanzania mainland and Zanzibar)
Environmental Research	
1. Environmental factors influencing distribution of the stock, catch and CPUE	Academic and Research Institutions, Deep Sea Fishing Authority, Ministries responsible for fisheries (Tanzania mainland and Zanzibar) and Local Government Authorities
Fishery Related Research	
1. Characteristics of artisanal fishery	Ministries responsible for fisheries (Tanzania mainland and Zanzibar) and Local Government Authorities
2. Characteristics of industrial fishery	Deep Sea Fishing Authority
3. Characteristics of recreational fishery	Ministries responsible for fisheries (Tanzania mainland and Zanzibar) and Local Government Authorities
4. Catch and effort data	Deep Sea Fishing Authority, Ministries responsible for fisheries (Tanzania mainland and Zanzibar) and Local Government Authorities
Stock Structure Research	
1. Genetic research to determine the existence of single shared or multiple stocks and tagging studies to determine the connectivity and movement rates between stocks within and beyond 12 nm.	Academic and Research Institutions, Deep Sea Fishing Authority and Ministries responsible for fisheries (Tanzania mainland and Zanzibar)

2. Assessment of local (Tanzanian EEZ) stocks	Deep Sea Fishing Authority, Ministries responsible for fisheries (Tanzania mainland and Zanzibar)
Social and Economic Research	
1. Economic factors related to the fishery, particularly the economic and social dependence of the different stakeholder groups on the fishery	Deep Sea Fishing Authority (Industrial fishery), Ministries responsible for fisheries (Tanzania mainland and Zanzibar) and Ministry of Finance and Planning (Tanzania mainland and Zanzibar)
2. Employment and income genaration, and comparative assessment of fishing technologies and a costs and benefits analysis of the fishery to the region	Deep Sea Fishing Authority (Industrial fishery); Ministries responsible for fisheries (Tanzania mainland and Zanzibar on artisanal fishery), Natural Resources and Ministry of Finance (Tanzania mainland and Zanzibar)
3. Current status of access to or ownership of the resources and other information related to fisheries	Deep Sea Fishing Authority (Industrial fishery) and Ministries responsible for fisheries (Tanzania mainland and Zanzibar on artisanal fishery)
Monitoring, Control and Surveillance	
1. Expansion of pilot sampling activities for Tanzanian Coastal fisheries (improved data collection)	Ministries responsible for fisheries (Tanzania mainland and Zanzibar), Local Government Authorities and Local communities
2. Observer programme: Continue with the training of (Cap Marine) and deployment of observers on tuna fishing vessels (improved data collection and validation).	Deep Sea Fishing Authority

Climate Change and Adaptation	
Potential impacts of climate change on tuna and tuna-like species (species vulnerability assessments) and fisheries.	Academic and Research Institutions in collaboration with the Deep Sea Fishing Authority, Ministries responsible for fisheries (Tanzania mainland and Zanzibar)

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