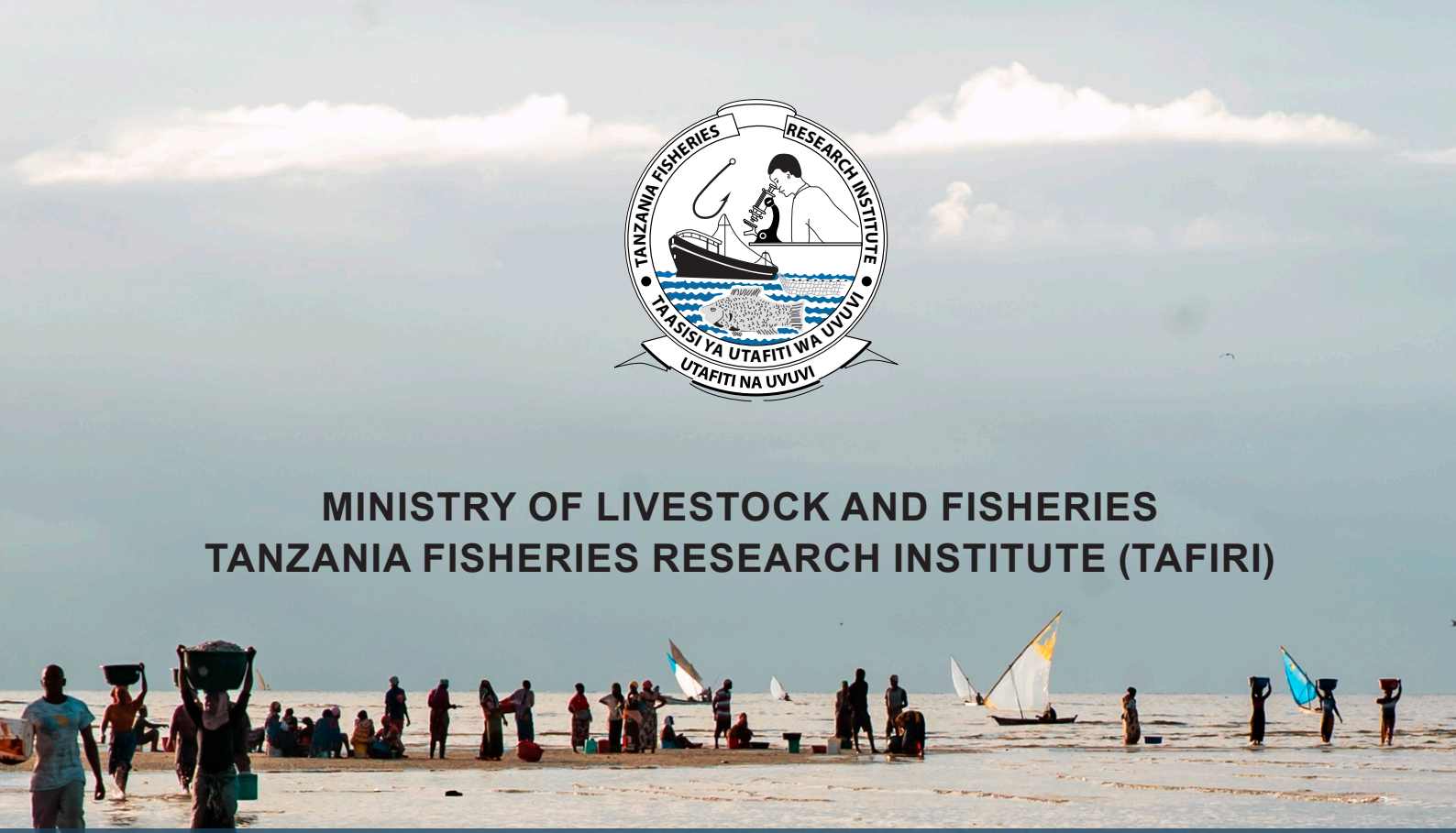

MINISTRY OF LIVESTOCK AND FISHERIES
TANZANIA FISHERIES RESEARCH INSTITUTE (TAFIRI)

FISHERIES AND AQUACULTURE RESEARCH FOR A VIBRANT BLUE ECONOMY (FAR4ViBE)

Second Annual Scientific Fisheries Research Conference
From 12th—14 thJuly ,2022 , Dar es Salaam ,Tanzania.

BOOK OF ABSTRACTS

FISHERIES AND AQUACULTURE RESEARCH FOR A VIBRANT BLUE ECONOMY (FAR4ViBE)

Second Annual Scientific Fisheries Research Conference
12th—14th July , 2022 ,
APC Hotel and Conference Centre,
Dar es Salaam , Tanzania.

BOOK OF ABSTRACTS

SPONSORS

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The Annual Fisheries and Aquaculture Research for a Vibrant Blue Economy Conference

Water is as old as the earth and is thought to be the origin of all life. This should also apply to all aquatic and marine ecosystems and resources. Because water is naturally blue, the resources contained within it are referred to as blue resources. The ecosystem goods and services provided by water—lakes, rivers, streams, and oceans—are vital to many coastal and riparian communities, as well as many people living in the hinterlands. These systems contribute significantly to the economies of our respective countries. Over 80 percent of global trade, for example, is transported through oceans, contributing significantly to global wealth and economies—a conservative estimate of oceanic wealth is 24 trillion US dollars. Oceans alone are estimated to contribute approximately $3 trillion in goods and services, including the absorption of over 90% of all anthropogenic heat.

While African lakes account for 27 percent of the world's surface freshwater, Lake Tanganyika alone accounts for about 17 percent of total global surface freshwater. When all of Africa's great lakes are considered together, it makes sense to pay attention to what happens in them and their environs, as well as to invest in their conservation and long-term management. Freshwater and marine blue resources help to ensure food and nutritional security for over 200 million people in Africa, as well as income for many more. Tanzania alone possesses about 32% of its landmass in terms of blue resources, while the fisheries sector employs over 4.5 million people and provides approximately 30% of animal protein. However, the sector is confronted with numerous challenges that necessitate immediate attention and solutions, necessitating research and innovation. This is true at both the regional and global levels, and as such, we must work together to address them.

The Fisheries and Aquaculture Research for a Vibrant Blue Economy (FAR4ViBE) conferences are intended to bring together research and development and innovations that will benefit policy and contribute to the development of a vibrant blue economy in the EAC and WIO regions. We believe that FAR4ViBE will help to achieve the development visions and agendas of our individual countries, regional (EAC Agenda 2050), continental (AU Agenda 2063), and global (Agenda 2030), particularly the various SDGs linked to SDG 14—life below water. The conference series will discuss and debate how to best integrate research and innovation into policy from both a basic and applied research standpoint. This is the second conference in a series aimed at learning about best practices and experiences from the East African and Western Indian Ocean regions. We invite you to participate in 11 keynote speeches and 70 presentations organized around 6 subthemes. We hope to gather policy-relevant ideas and pave the way for future research that will reverse the trajectories of investment in scientific research and aquatic ecosystem conservation in Tanzania, the EAC, and the WIO regions.

PROGRAM

Day 1: Tuesday 12 July 2022		
Time	Event	Responsible person/ Title
Facilitator: Dr. Mosha/Dr. Madala		
08:00 - 08:30	Registration	Secretariat
08:30 - 08:35	Prayer	Pastor
08:35 – 09:00	Choir	UDSM Choir
Opening session		
09:00 - 09:15	Introductions	Dr. Mathias Igulu
09:15 – 09:20	Remarks	Director General – ZAFIRI
09:20 – 09:25		Executive Secretary – WIOMSA
09:25 – 09:30		Dean – SoAF
09:30 – 09:40		Vice Chancellor
09:40 – 10:00		Director General – TAFIRI
10:00 – 10:10		TAFIRI Board of Directors
10:10 – 10:20		Permanent Secretary – Fisheries
10: 20 – 10:40		
10:40 – 11:10	Official opening by the	Guest of Honor
11:10-11:40	Group photo & Health/Tea Break	All
Key Note Speakers		Facilitator: Dr. Mosha/Dr. Madala
11:40 – 12:10	The potential of blue economy in developing island states: the case of Zanzibar	Dr. Hamad Bakar Hamad
12:10 – 12:40	Blue economy implementation plan: and the framework for blue governance coordination mechanism	Dr. Patrick Karani
12:40 – 13:10	The role of fisheries and aquaculture research in Uganda's economic agenda	Dr. Winnie Nkalubo
13:10 – 13:40	Contribution of aquaculture research to an inclusive blue economy	Prof. Yunus Mgaya
13:40 – 14:20	Lunch Break	All
Sub-Theme 1: Innovative and Sustainable Aquaculture Production (ISAP): ANTELOPE (Freshwater)		Chairperson: Dr. Shoko

14:20 – 14:35	Integration of Nile tilapia (*Oreochromis niloticus*) and vegetables (*Amaranthus hybridus* and *Brassica rapa pekinensis*) for improved production, water use efficiency and nutrient recycling	Dr. Deogratias P. Mulokozi
14:35 – 14:50	The implications of fisheries management measures on satellite lakes of Lake Victoria Basin, Tanzania	Fenant L. Mhagama
14:50 – 15:05	Production of on-farm floating fish feed using non-extrusion technology	Cesilia Mataba
15:05 – 15:20	Monitoring the environmental impacts of Fish cage culture in Shirati Bay, Lake Victoria, Tanzania	Tausi Khitentya
15:20 – 15:35	A comparative study of locally made complete feeds for Nile tilapia (*Oreochromis niloticus*) with reference to imported feeds in Lake Zone region, Tanzania.	Samwel M. Changarawe
15:35 – 15:50	Income and expenditure of fishers and fishmongers in Zanzibar	Ali A. S
15:50 – 16:05	Women and Gender roles in the Octopus Fishery Value chain in selected coastal fishing communities in Mainland Tanzania	Innocent Mwaka
16:05 – 16:20	N'GO Presentation	Gasby Africa
16:20 – 16:35	Discussion	All
Sub-Theme 1: Innovative and Sustainable Aquaculture Production (ISAP): NGUCHIRO (Marine)		Chairperson: Dr. Mahika
14:20 – 14:35	Importance of internal and external nutrient loading to the primary productivity of Lake Tanganyika	Prisca Mziray
14:35 – 14:50	Multi-Raft as Deep-Water Seaweed Farming Method	Yussuph Bakari
14:50 – 15:05	Partial replacement of fish meal with *Chaetomorpha sp*. improves feed utilization, survival, biochemical composition and fatty acids profile of *Penaeus monodon*	Siwema Luvanga
15:05 – 15:20	The endemic mariculture potential microalgae in the coastal waters of Tanzania	Dr. Angelina Michael
15:20 – 15:35	Multi-component biofilters with coconut husks, bivalves, moringa and azolla as a natural and sustainable approach for water quality management in aquaculture	Dr. Betina Lukwambe
15:35 – 15:50	A comparison of chicken (*Gallus domesticus*), African Sharptooth catfish (*Clarias gariepinus*) pituitary gland, and ovaprim hormone for inducing maturation in African sharptooth catfish (*Clarias gariepinus*)	Arnold A. Shoko
15:50 – 16:05	Fruits and vegetable scraps and kitchen wastes are suitable substrates for mass production of black soldier fly (*Hermetia illuncens*) larvae	Dr. Samwel M. Limbu
16:20 – 17:00	Discussion	All
Sub-Theme 1: Innovative and Sustainable Aquaculture Production (ISAP): TAI		Chairperson: Prof. Sheikh

14:20 – 14:35	Potential sites for seacucumber (*Holothuria scabra*) farming in Zanzibar coastal waters	Masoud Juma Ali
14:35 – 14:50	Effects of photoperiod on growth performance and melanogenesis pathway for skin pigmentation of Malaysian red tilapia	Atuganile Malambugi
14:50 – 15:05	Effect of Biosecurity Practices, Epiphytes and Diseases on Growth, Carrageenan properties and Proximate Composition of *Kappaphycus alvarezii* and *Eucheuma denticulatum* Cultivated in Zanzibar, Tanzania	Msafiri A. Ndawala
15:05 – 15:20	Fish cage culture and economic feasibility in Shirati Bay, Lake Victoria, Tanzania	Tausi Khitentya
15:20 – 15:35	Assessment of growth performance of Silver pompano (*Trachinotus blochii*) fingerlings fed with bio-activated blood meal protein	Changoma Fransis Marko
15:35 – 15:50	The effect of imported and local made fish feeds on growth, yield and economic benefit of Nile tilapia (*Oreochromis niloticus*)	Joice John Denis
15:50 – 16:05	Status of Shark and Ray Landings in Tanzania and Implications for Management	Abdallah S. Abdulla
16:35 – 17:00	Discussion	All
Day 2: Wednesday 13 July 2022		
	Key Note Speakers	Facilitator: Dr. Mosha/Dr. Madala
08:00 – 08:10	Registration	Secretariat
08:10 – 08:20	Recap	Joseph Luomba
08:20 – 08:50	Importance of fisheries and aquaculture research in supporting a vibrant blue economy	Dr. Christopher M. Aura
08:50 – 09:20	The evolution of endemic fish and diversity in the African Great Lakes and beyond: Adaptive Radiation and its relevance	Prof. Ole Seehausen
09:20 – 09:50	The use (and limits) of environmental DNA in aquatic ecological research	Prof. Martin J. Genner
09:50 – 10:20	Strategies for enhanced resource mobilization to support research for a vibrant Blue Economy	Dr. Antony Taabu-Munyaho
10:20 – 10:45	Health/Tea Break	All
Sub-Theme 2: Sustainable Inland and Marine Capture Fisheries (SIMCF): ANTELOPE (Marine)		Chairperson: Dr. Mathias Igulu
11:45 – 12:00	Prawn species composition, abundance and distribution, along Tanzanian coastal waters.	Dr. Catherine A. Mwakosya
12:00 – 12:15	Potential fishing zone in support of marine fisheries management in Tanzania	Dr. Baraka L. Kuguru
12:15 – 12:30	Characterization of the feeding patterns and reproductive dynamics of bigeye, kawakawa, and frigate tuna in the Pemba channel ecosystem	Dr. Alistidia P. Mwijage
12:30 – 12:45	Spatial and temporal variation in the catch rates and size of Octopus cyanea in Tanzania	Said S. Mgeleka

12:45 – 13:00	Population dynamics of the Devis' anchovy (*Encrasicholina devis*i, Whitley, 1940), Buccaneer anchovy (*Encrasicholina punctifer*,) and the Silver-stripe round herring (*Spratelloides gracilis*,) in the Tanzanian coastal waters	Dr. Salome D. Shayo
13:00 – 13:15	Reproductive Potential of the Mackerel Scad, *Decapterus macarellus* (Cuvier, 1833) in the Coastal Waters of Tanzania	Joseph S. Sululu
13:15 – 13:30	The Vulnerability of Fishery-Based Livelihoods to Climate Change in Coastal Small pelagic fishing Communities in Tanzania	Lyidia Kapapa
Sub-Theme 2: Sustainable Inland and Marine Capture Fisheries (SIMCF): NGUCHIRO (Freshwater)		Chairperson: Dr. Yohana Budeba
11:45 – 12:00	Fish species composition and Diversity in Nyegezi bay, Lake Victoria Tanzania	Mboni Elison
12:00 – 12:15	Conservation awareness and monitoring on a critically endangered Karomo tilapia in Malagarasi catchment, Tanzania	Charles A. Mashafi
12:15 – 12:30	Geographical Variation in *Clarias liocephalus* (Clariidae: Clarias) along Victoria and Kivu-Tanganyika basin Populations	Sophia S. Shaban
12:30 – 12:45	Assessment of factors affecting the long-term changes in pelagic fish catches in Lake Tanganyika, Tanzania	Huruma F. Mgana
12:45 – 13:00	Acceptance of new lights technology for Dagaa (*Rastrineobola argentea*) fishing in Lake Victoria-Tanzania	Philemon Nsinda
13:00 – 13:15	Bet-hedging strategies determine daily choices in effort allocation for Nile perch fishers of Lake Victoria.	Happy K. Peter
13:15 – 13:30	Species composition and spatial distribution of selected three artisanal tuna and tuna-like fish catch in Tanzania Mainland	Hakimu D. Matola
Sub-Theme 2: Sustainable Inland and Marine Capture Fisheries (SIMCF): TAI (Marine)		Chairperson: Dr. Emmanuel Sweke
11:45 – 12:00	Informing Artisanal Fishery Management through Fishery Patterns Mapping	Jean A. Mensa
12:00 – 12:15	SMART Objective Setting to Enhance Impact of Small-scale Fisheries Management	Dr. Grayson Mshana
12:15 – 12:30	Stock status assessment of five small pelagic species along the Tanzanian coast using length-based methods	Godfrey Fabiani
12:30 – 12:45	Catch composition and economics of fishing and fishery of small pelagic, Tanzania Mainland	Dr. Simon Kangwe
12:45 – 13:00	Identification of mesopelagic fish species using multi-frequency acoustic approaches – implications for biomass estimation	Benedicto Kashindye
13: 00 – 13:30	Discussion	All

13:30 – 14:30	Lunch Break	All
Sub-Theme 3: Aquatic Ecosystem and Environment (AEE): ANTELOPE (Marine)		Chairperson: Dr. Ngusaru
14:30 – 14:45	Effects of seagrass cover loss on seawater carbonate chemistry: Implications for seagrass mitigation potential of ocean acidification impacts	Rushingisha George
14:45 – 15:00	Seagrass structural complexity and environmental variables as a determinant of fish larvae assemblages in coastal waters of Tanga, Tanzania. Implications for seagrass management and conservation.	Fadhil M. Malesa
15:00 – 15:15	DNA barcoding and molecular identification of seagrass species from Tanzanian coastal waters	James Leonard Lusana
15:15 – 15:30	Citizen science reveals spatio-temporal dynamics in coastal nutrients conditions in Lake Tanganyika	Happiness Anold Moshi
15:30 – 15:45	Seagrass restoration in a high-energy environment in the Western Indian Ocean	January Wegoro
15:45 – 16:00	The cost of compliance: Subsidizing legal production inputs for natural resource use	Joseph Luomba
16:00 – 16:15	The influence of ocean conditions on spawning areas and seasons of frigate and kawakawa, in the coastal waters of Tanzania	Dr Baraka Sekadende
16:15 – 16:30	The seascape configuration influences big blue octopus catches, reef abundance, and biomass	Dr. Mathew O. Silas
16:30 – 16:45	Reduction of Post-harvest Loss of Tuna and Tuna-Like Species Through Value Addition to Improve Food Security in Tanzania	Dr. Rashid Suleiman
16:45 – 17:00	Discussion	All
Sub-Theme 3: Aquatic Ecosystem and Environment (AEE): NGUCHIRO (Freshwater)		Chairperson: Dr. Ngatunga
14:30 – 14:45	Postglacial fire regime changes and vegetation dynamics at Lake Victoria, Africa	Yunuén Temoltzin-Loranca
14:45 – 15:00	A fossil reconstruction of the Lake Victoria fish assemblage through 17 000 years reveals key insights into the process of adaptive radiation	Nare Ngoepe
15:00 – 15:15	The status of selected rift valley Lakes environment: Their impacts to the species diversity and fisheries	Charles N. Ezekiel
15:15 – 15:30	Multiproxy paleolimnological reconstruction of Lake Victoria's environmental history	Giulia Wienhues
15:30 – 15:45	Spatio-temporal variations and hotspots detection of land use/cover of four East African Great Lake catchments in recent 20 years	Prof. Qun Gao
15:45 – 16:00	Environmental drivers and genetic mechanisms underlying variation in a colour ornament	Tyler Linderoth

16:00 -16:15	Empirical evidence of some life history variables of Nile perch (*Lates niloticus*, Linnaeus 1759) and its implication in fisheries management in Lake Victoria	Enock Mlaponi
16:15 -16:30	Water quality monitoring: Plankton as bio-indicator of environmental change, a case study at Wissmann Bay in Lake Nyasa	Athanasio S. Mbonde
16:30 – 17:00	Discussion	All
Sub-Theme 3: Aquatic Ecosystem and Environment (AEE): TAI (Freshwater)		Chairperson: Dr. Mzighan
14:30 – 14:45	Ancient DNA reveals past diversity of Lake Victoria's *haplochromine cichlids*	Dr. Moritz Muschick
14:45 – 15:00	Understanding the environmental pressures of Mwanza Gulf, Lake Victoria: From water to sediment	Dr. Qiushi Shen
15:00 – 15:15	Rising tides for prediction and solutions on antimicrobial resistance in aquatic ecosystems in Tanzania Using a one health approach	Prof. Robinson H. Mdegela
15:15 – 15:30	Infection status with Helminth parasite *Ligula intestinalis* in sardines *Rastrineobola argentea* from Mwanza Gulf in Lake Victoria	Magreth J. Musiba
15:30 – 15:45	The Status of Major Commercial Fish Stocks in Lake Victoria, East Africa: Their Contribution to the Blue Economy	Dr. Robert Kayanda,
15:45 – 16:00	Traditional cooking practices and preferences for stove from among coastal women in Tanzania: the case study of Jasini, Ndumbani and Moa Villages in Tanga, Tanzania	Ismail Said
16:00 -16:15	Ecological speciation promoted by divergent regulation of functional genes within African cichlid fishes	Dr. Madeleine Carruthers
16:15 – 16:30	Use of different fishing gears, gear sizes and methods in Lake Victoria: Implications to the sustainability of fisheries resources	Hillary D. Mrosso
16:30 – 16:45	Insights from genomics on the origins and fate of the biodiversity of East African *Oreochromis*	Prof. George F. Turner
16:45 – 17:00	The use (and limits) of environmental DNA in aquatic ecological research	Prof. Martin J Genner
17:00 – 17:15	Discussion	All
Day 3: Thursday 14 July 2022		
08:00 – 08:20	Registration	Secretariat
08:20 – 08:30	Recap	Dr. Samwel Limbu
	Key Note Speakers	Facilitator: Dr. Mosha/Dr. Madala
8:30 – 09:00	Organic pollutants in inland lakes: A case of Tanzania	Prof. Zhang Lu
09:00 – 09:30	Potential Collaborations and Research Experience in Tanzania	Prof. Sophia Shuang Chen
09: 30 – 10:00	Funding for Ocean Science	Dr. Arthur Tuda
10:00 – 10:50	Health/Tea Break	All

Sub-Theme 4: Fisheries and Aquaculture Value Chains and Marketing (FACM): ANTELOPE (Marine)		Chairperson: Dr. Bugwesa
10:50 – 11:20	Side event and Poster session	Aqua Farm Organisation (AFO)
11:20 – 11:35	The state of knowledge of fisheries & marine science in Zanzibar	Dr. Tum M Sheikh
11:35 – 11:50	Development of mobile phone application to access potential fishing zones in marine waters of Tanzania	Innocent Sailale
11:50 – 12:05	OceanWebApp: An interactive web application for Hydrographic Data analysis in the Pemba Channel	Masumbuko Semba
12:05 – 12:20	Remark from Collaboration partners	
12:20 – 12:35	Remarks from Directors General, TAFIRI	Prof. Bwathondi, Dr. Budeba, Dr. Ngatunga, Dr. Tamatamah
12:35 – 12:45	Appreciation Event	Chairperson – TAFIRI Board of Directors
12:45 – 13:00	Closing remarks	Minister of Blue Economy -Zanzibar
13:00 – 14:00	Lunch Break	All
14:30 – 16:00	UTT seminar and poster session—NGUCHIRO HALL	UTT Invitee
14:30 – 16:00	Seminar Core & Sediment Analysis—Tai hall	Interested
16:00 – 19:00	Cocktail, Gala Dinner and Networking	All

Aqua-Farms Organization

Aqua-Farms Organization will host a side event on application of the Seafood Traceability Principles & Pathway in an Octopus Fishery in Kilwa District, Tanzania. The event will take place at ANTELOPE HALL on Thursday 14th July, 2014 as highlighted in the table below;

Time	Event	Responsible
10:50 10:55	Introduction	Kate O'Rourke
10:56 11:05	Project's genesis	Melckedeck Koddy
11:06 -11:15	About the project	Fadhili Malesa
11:16 - 11:50	Panellist discussion	KateO'Rourke, Jovice Mkuchu, Bigeyo Kuboja, Jerry Mang'ena

KEYNOTE PRESENTATIONS

Blue economy implementation plan: and the framework for blue governance coordination mechanism

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ABSTRACT

The Blue Economy cuts-across several industries, sectors and thematic areas. This inherently creates complexity when attempting to understand the extent of its socio-economic context in aspiration of development achievement in Africa. The effect of human dependence on Blue Economy resources is not always monetary. Some of the people in particular, along the coastlines, lakes and riverbanks use the resources for artisanal purposes, for livelihoods, food security, exchange and trade, while others utilize it for the recreational and religious benefits associated with the blue natural resources. The well-being of people is a central pillar of the Blue Economy resulting in an immediate need to understand the socioeconomics of the Blue Economy as well as how to measure changes, or progress, associated with it for development achievement. The planning aspect of Blue Economy requires strategic interventions at local, national, regional, and continental levels that spur integration aspects of the Blue Economy into development achievement. Thae Africa Blue Economy Strategy (ABES) supported by AU-IBAR stipulates there are potential opportunities to be achieved from harnessing, effectively and efficiently utilizing Blue Economy resources. For example, value added of the Blue Economy Sectors and Value of Blue Economy components including and not limited to: Ecosystems Services, Education, Research from 2018 to 2063, contributed a value of USD 296 billion in 2018. It is projected that by 2030, figures will be USD 405 billion while in 2063 estimates would be USD 576 billion of value created. Considering employment opportunities from selected Blue Economy sectors: Fisheries, aquaculture, conservation and sustainable aquatic ecosystems; Shipping/transportation, trade, ports, maritime security, safety and enforcement; Coastal and maritime tourism, climate change, resilience, environment, infrastructure; Sustainable energy and mineral resources and innovative industries; and, Polices, institutional and governance, employment, job creation and poverty eradication, innovative financing, about 49 million jobs were created in 2019. It is projected that by 2030, figures will be 57 million while in 2063 estimates would be 78 million. However, the Blue Economy development achievements require engagement of the stakeholders and elaborate consultations of the African Union Member States and Regional Economic Communities. This is because Blue Economy entails the sustainable use and conservation of marine, inland, aquatic and coastal resources for food security, job creation, and economic growth. It is important therefore to ensure an overall consistency, coherency and synergy and develop bridges and leverage resources between the various implementation plans for strategies including Blue Economy strategies developed by some National and Regional Economic Communities (RECs) in Africa.

The role of fisheries and aquaculture research in Uganda's economic agenda

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ABSTRACT

Uganda is endowed with aquatic resources including lakes, rivers, streams, wetlands with potential for blue economy growth. These ecosystems provide opportunity for the fisheries and aquaculture sectors to flourish as they present openings to participate in sustainable blue economy for food and nutrition security, job creation, improving productivity, wealth creation and environmental sustainability. However, various stressors (e.g., overexploitation, pollution, loss of biodiversity, ecological function, climate change) threaten the functionality of these systems and realisation of accruing benefits. Hence, improving our understanding of these systems through research is critical to providing interventions needed to overcome the challenges that emanate from the various stressors, and to support a robust blue economy. In this paper, the role of fisheries and aquaculture research in shaping Uganda's economy is highlighted, and various study examples that have aided decision-making processes on several Uganda's water bodies presented.

Keywords: ecosystems; biodiversity; fisheries; aquaculture; economy

Contribution of Aquaculture Research to an Inclusive Blue Economy

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ABSTRACT

The blue economy supports a range of productive sectors including but not limited to fisheries, aquaculture, tourism, shipping and transport, marine energy and minerals, genetic resources and biotechnology, underwater mining and applications in pollution control fundamentals. Some of these activities have been conducted from time immemorial in Tanzania. The country has all the resources required for the blue economy including aquaculture. Aquaculture operations in Tanzania started in the 1950s, maintaining a slow growth until recently. Aquaculture activities have ramped up of late due to increased efforts by the Government to promote and develop aquaculture. Currently, Tanzania has 30,064 fish farmers scattered in different parts of the country, who have increased aquaculture production from 220 metric tons in 2000 to 28,856.87 metric tons (mainly composed of fish 25,286.46 tons) in 2021. The increased aquaculture production is partly attributed to research conducted on nutrition, seed production, production systems, processing methods and value chain analysis. Despite the research conducted, Tanzanian aquaculture has not contributed significantly to the blue economy due to several challenges including inadequacies in institutional capacity and legal framework, inadequate supply of key inputs – affordable quality seeds and feeds, and a high price of industrial feeds, limited adoption of better management practices, and low investment in commercial aquaculture. Other challenges include, limited cold chain facilities, value addition and markets, limited skills, knowledge generation and sharing, and limited financial capital. Therefore, concerted efforts are required to provide support to applied research, capacity building, information sharing, conducive aquaculture policy and legal frameworks, as well as establishment of marine spatial planning for sustainable aquaculture, an essential component of a prosperous blue economy.

Keywords: Tanzania; blue economy; aquaculture; seed production

Importance of Fisheries and Aquaculture Research in Supporting a Vibrant Blue Economy: The Kenyan Context

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ABSTRACT

The blue economic potential of Kenyan fisheries and aquaculture resources is critical for the socioeconomic development. The current study reports the importance of research in fisheries and aquaculture as a key pillar in blue growth. The report includes all aspects of research including oceanic, inland, aquaculture sciences, socioeconomics, governance and related outputs and outcomes. Kenya's inland capture fisheries contributes about 83%, aquaculture 12%, and marine artisanal fisheries 5%. Lake Victoria that contributes up to 70% of inland capture fish production and has shown decline in catches in the recent past and the trend indicates that the fishery may not be sustainable. The Kenya Exclusive Economic Zone (EEZ) has a coast line of about 647 km and an area of 142,000 km2 that constitutes about 42% of the country's surface area and has several commercially important species that are being assessed to provide decision support tools to boost production that currently stands at a paltry 26,000 mt annually with an estimated export value of about USD 50 million. Cage aquaculture is quickly expanding in Lake Victoria with the latest survey carried out in April 2022 that recorded a total of more than 5242 cages. The carrying capacity of cages in the lake; with best management practices is estimated to be more than 500% of the current cage culture production, which is estimated to be 21,000 mt. However, research showed no clear gradient on the concentration of the water quality parameters in various transects in the cage locations probably due to the dilution effect of the lake water which may deteriorate in the long run. The aforementioned estimates and scientific facts have played a critical role towards citizenry, community, and institutional support in providing data and information in notable examples such as in the development of unique publications, appropriate policies, plans, regulations and frameworks for resource management and conservation, as well as to guide business, and facilitate resource usage dispute resolution procedures.

Keywords: Kenya, Research, Marine, Inland, Aquaculture, blue economy, sustainability,

On the evolution of endemic fish diversity in the African Great Lakes and beyond

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ABSTRACT

The Great Lakes of Eastern Africa are among the most species rich freshwater ecosystems on Earth and contain nearly 10% of all known freshwater fish species. This extraordinary richness is due to a single family, cichlid fish, and mostly due to one lineage, the haplochromines. While these fish are one relatively unspectacular out of many faunal elements in most rivers, hundreds of endemic species have evolved in every larger lake. Contrary to most other young species radiations, many species are fully sympatric in the African lake cichlid radiation forming ecologically rich communities and food webs.

Amazingly, this species richness has often evolved in record time. 500 endemic species in Lake Victoria evolved in less than 16000 years. No parallel to this is known in any other biological system on Earth. Our research is directed at characterizing this diversity phenotypically, understanding the genetic basis and ecological correlates of phenotypes, the spatial and ecological distribution of species, and the mechanisms by which species arise and diversify. We use an integrative approach from ecology, distribution and phenotypes to genome sequence analyses and paleoecology. We have shown that the hundreds of species in Lake Victoria indeed diversified in less than 16000 years, and in Lakes Edward, Kivu and Albert in only a little more time. We discovered that this was only possible because the ancestors of all of these radiations were hybrids between distantly related species from Nile and Congo that formed more than 100000 years ago. Rapid speciation and adaptive radiation worked by sorting of hundreds of old genes that are much older than the species that now carry them. We found that in this and in many other systems, hybridization is a key mechanism of generating and regenerating genetic variation for adaptive radiation.

Our paleoecological reconstructions joined with population genomic inference suggest the rapid species diversification happened mostly before the end of the African Humid period at a time when the lake was oligotrophic and clear. Its persistence requires clear water. Pollution and eutrophication are major threats to the persistence of this global biodiversity hotspot. We need to understand and protect the evolutionary and ecological process in order to protect richness.

Keywords: Great Lakes; Eastern Africa; ecosystems; fish species; haplochromines

The use (and limits) of environmental DNA in aquatic ecological research

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ABSTRACT

Research in our group at the University of Bristol explores the origins of diversity (speciation and adaptive radiation), how diversity is structured over ecological gradients (niche use) and how it is influenced by changing environments (climate and invasive species). We work primarily on fishes of African freshwaters, European seas and the Southern Ocean. We use a range of research approaches including field surveys of biodiversity, to analyses of long-term ecological data, behaviour, morphology, stable isotope ratios, environmental DNA, and the composition of the genome, transcriptome and methylome. An important focus of our current research is on understanding the distributions of biodiversity using environmental DNA (eDNA). We have used eDNA-based methods to describe the composition of marine and freshwater fish assemblages, as well identifying the presence of harmful species, such as invasive crayfish and human pathogens.

Keywords: trace DNA, fish communities, invasive species, harmful pathogens

Potential Collaborations and Research Experience in Tanzania

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ABSTRACT

Water resources and the ecological environment are the common issues faced by the global sustainable development. Both China and Africa face challenges from development pressure, population growth, and environmental degradation. For Tanzania, where 6% of the land area is on the water surface, water resources utilization and ecological environment protection are of great significance for social and economic development. China in the past 40 years of rapid economic development has experienced the water environment pollution and difficult management process. China and Tanzania in the river basin water environment monitoring, water resources protection and ecological environment governance has a wide range of scientific and technological innovation cooperation prospects, research results can deepen the understanding of the water-social-ecosystem dynamic mechanism, contribute to strategies for sustainable urbanization in developing countries. Over the past decade or more, my colleagues and I have conducted effective cooperation with the Tanzania Fisheries Research Institute in water environment research, exploring cooperation models featuring mutual trust, mutual assistance and mutual benefit. We have achieved good results in personnel training and scientific research output. Follow-up cooperation projects are still in progress.

Keywords: Ecology, environment, development, innovation, technology

Strategies for enhanced resource mobilization to support research for a vibrant Blue Economy

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ABSTRACT

The concept of blue economy is a recent development in the sphere of marine and inland fisheries and aquaculture. The focus on harnessing blue economy comes at the time when aquatic systems are faced with enormous challenges manifested in resource over exploitation with associated environmental degradation. A vibrant blue economy can support not only SDG 14 but also the Global Goals on poverty, hunger, jobs, gender equality, partnerships, resilient communities, and climate change adaptation. Sustainable exploitation of the blue economy requires effective investment in Research for Development (R4D). We present the role of basic and applied research in harnessing the Blue Economy and highlight potential sustainable funding sources, key strategies employed in resource mobilization and modalities. We conclude that there are various sources that can support fisheries, aquaculture and water environment research and recommend resilience in the search for resources.

Keywords: Resource mobilization, Research for Development, sustainable funding

Organic pollutants in inland lakes: A case of Tanzania

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ABSTRACT

Inland lakes are pollution sink, and thus good indicator, for organic pollution emitted from catchments. Due to the inadequate control of the pollution sources of Persistent and Toxic Organic Substances (PTOS) in Tanzania, there are still continuous inputs of PTOS into the lake ecosystem. The burning of charcoal and straw, the irregular disposal of plastic waste, the use of pesticides, and the improper disposal of waste are all potential sources of PTOS pollution for lakes in Tanzania, threatening the lake ecosystem and human health. During February to March, 2020, a team from NIGLAS and TAFIRI investigated 18 lakes started from Dar es Salam, through Pangani, Moshi, Arusha, Babati, Singida to Dodoma. Based on this investigation, a systematic study was conducted on the pollution level, spatial distribution, source apportionment and risk assessment of four common PTOS, including phthalate esters (PAEs), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs). Although PTOS researches for individual lake in Tanzania was not scarce, we believe this is the first comprehensive investigation and comparison covering most of the inland lake types. Lakes in Pangani catchment were with more serious PTOS pollution. Among PTOS pollutants, the concentrations of PAEs were observed the highest which implies the necessary of control of plastic waste, which was already started from the banning of plastic bags. Although the overall PTOS pollution in the lakes of Tanzania was at a relatively low level, the OCPs in Tanzania lakes were predominant and higher than in lakes from Europe, Asia and America continent. .

Keywords: Tanzania; Inland lake; organic pollutants

Funding for Ocean Science

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ABSTRACT

The ocean provides a broad range of services and goods. Scientifically based management actions will be required to guarantee that these benefits will be available to future generations. Thus investments to enable knowledge-based decisions and to finance a sustainable marine research infrastructure have become essential to address local, regional and global issues, e.g. ocean-climate interactions, ecosystem variability and tsunami-generating earthquakes and undersea landslides. Technical infrastructure also contributes to the training of students and early-career researchers. This presentation highlights the role of the Western Indian Ocean Marine Science Association (WIOMSA) in supporting ocean science and infrastructure in the western Indian Ocean (WIO) region and Tanzania more specifically. It also provides an overview of other funding sources and mechanisms for ocean science in the WIO. It highlights government funding of ocean science using case studies and the region's current international funding structures. It also explores new opportunities for direct/indirect financial contributions to ocean science by the private sector and philanthropic support. It concludes with some forward-looking considerations.

Keywords: WIOMSA; finance; researchers governance; Tanzania;

ORAL PRESENTATIONS

Integration of Nile tilapia (*Oreochromis niloticus*) and vegetables (*Amaranthus hybridus* and *Brassica rapa pekinensis*) for improved production, water use efficiency and nutrient recycling

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ABSTRACT

Sustainable agriculture intensification is an urgent challenge for Tanzania. One potential solution is to adopt farming systems that increase farm production by optimizing resource use efficiency, and integrated aquaculture system, which involve farming of fish and crops is an example of such systems. This study investigated the impact of Integrated Agriculture and Aquaculture (IAA) farming on water use efficiency, fish and vegetable production, and overall system profitability, and how these parameters are affected by fish stocking densities. *Oreochromis niloticus* (2.5 g average initial weight) were stocked at: low density (5 fish m-3, LFD); medium density (8 fish m-3, MFD); and high density (12 fish m-3, HFD), and were cultured for 205 days. *Brassica rapa pekinensis* and *Amaranthus hybridus* cultivated adjacent to fish tanks, were irrigated with; (i) fish tank water, without any fertilizer inputs; (ii) fish tank water, partially fertilized; (iii) tap water, fully fertilized (farmers` practice); and (iv) tap water without any fertilizer inputs. Although the use of tank water from high fish stocking resulted in significantly higher vegetable yield, high fish stocking resulted in lower fish growth, profitability and water use efficiency compared to the other fish stocking densities, because of low survival rates (28%). The integration of fish at a medium stocking density with vegetables, resulted in significantly higher net income than when fish farming and vegetables production were grown separately.

Keywords: Integrated Agriculture and Aquaculture (IAA); Water use efficiency; tilapia stocking density; fish and vegetable yield; net income

The implications of fisheries management measures on satellite lakes of Lake Victoria Basin, Tanzania

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ABSTRACT

The satellites lakes around Lake Victoria are important reservoirs for endangered fish species rarely found in Lake Victoria. They harbor four important cichlid species of *Oreochromis esculentus*, *Oreochromis leucostictus*, *Oreochromis niloticus*, and *Oreochromis variabilis*. Of these, *O. esculentus* and *O. variabilis* are considered critically endangered species. Despite their importance and existing fisheries management measures, the sustainability of these lakes is threatened by illegal fishing, unregulated fisheries, unsustainable fishing methods and destructive fishing practices. Therefore, this study sought to determine the challenges of fisheries management measures in satellite lakes in the Lake Victoria basin, Tanzania. The study covers four satellites lakes in the Lake Victoria basin, all from the Tanzania side. The study employed a survey questionnaire with primary respondents, key informants and in-depth interviews with fisheries officers, village executive leaders and village community leaders. The analysis employed a Pearson correlation, content analysis and descriptive analysis using SPSS version 21. Findings revealed non-compliance by fishers operating in these satellite lakes, which could be attributed by inadequate knowledge of fisheries regulations. This has potential of contributing to persistent illegal fishing in these lakes. It is therefore recommended that there is a need of designing management measure that reflects the natural system of the lakes and sensitization with the local resource users through raising their awareness on the importance of protecting and conserving while strengthening or introducing community management system where there is no formal management system.

Keywords: Lake Victoria; cichlid; illegal fishing; management; satellite lakes

Production of on-farm floating fish feed using non-extrusion technology

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ABSTRACT

A steady decrease in fish diversity and abundance in Lake Victoria is mainly caused by the significant increase in fishing effort (both legal and illegal) as a result of the open-access regime; as well as lucrative regional trade in immature fish (primarily immature Nile Perch) has exacerbated the decline of fish stocks (Gitonga, 2013). Among the possible solution for the decline of fish stock, is for individuals and the community to practice fish farming, especially cage culture. The on-growing and production of farmed aquatic organisms in caged enclosures has been a relatively recent aquaculture innovation, however, it has several setbacks among many others is quality feed.

The production of on-farm floating fish feed using non-extrusion technology remains a challenge to fish farmers. This has made most fish farmers depend on commercial extruded feeds which are highly expensive. Hence, the study proposed the perceived current issues, challenges and mitigations to cage culture development, and in particular upon the need to maximize production by producing low-cost quality feed (non-extruded floating pellets) the potential impacts of the rapidly growing sector. The study aims to investigate the effect of nutrient inclusion levels (crude protein and different dietary lipids) on buoyancy. Oil and yeast will be used as buoyancy providers for the feed; hence twenty-six (26) diets will be formulated at two crude protein levels; 30% and 45%, one dietary lipid and yeast; vegetable oil incorporated at three inclusion levels; 5%, 10% and 15% and yeast incorporated at 5% in both levels.

Keywords: buoyancy; cage culture; fish feed; ingredients; non-extrusion

Fish cage culture and economic feasibility in Shirati Bay, Lake Victoria, Tanzania

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ABSTRACT

Cage fish farming was conducted at Shirati bay, Lake Victoria to investigate the performance and economic feasibility of the mixed-sex Nile tilapia fish fed on the Z-feeds and T-feeds. The fish from fry to harvest were fed on Z-feeds imported from Z-industry and T-feeds made from the locally collected feed ingredients processed at T-industry. Six fish ponds of 200m2 were used for raring fish fry with initial average weight of 0.1±0.02gram fed of Z-Mash and T-Mash. Cages of 100m3 were used to raise fish fingerlings with initial average weights of 41.7±0.54 and 37.5±0.23 grams fed on Z and T-pelleted diets respectively. Dietary treatments were allocated in triplicates to ponds and cages each with stocking densities of 57 fries/m2 and 100 fingerlings/m3 respectively. At fry and fingerling stages the fish fed up to 5% of their body weights four times a day. From grow-out to harvest the fish fed up to 3% of their body weights twice a day. Monitoring on the average weight gain of the fish, pH, temperature, and transparency of water was done weekly in the ponds and monthly at the cage sites. There was no difference in the water quality parameters in the ponds. The water quality parameters in cage sites was not significantly different. There was significant differences ($p < 0.05$) observed on weight gain, feed intake, protein efficiency ratio and survival rate among the fish fed Z and T diets. Significant differences ($p < 0.05$) on feed costs and profit observed to the fish fed on diets Z and T. The maximum performance was shown by the fish fed diets Z. Highest profit made through feeding fish on T diets. Understanding nutritional quality of feed ingredients is vital in formulation of the diets collected from locally environments. Developing fish seed and feed production technology is inevitable to improve aquaculture industry in Tanzania.

Keywords: Fish cage farming; fish seed and feed quality; economic feasibility

A comparative study of locally made complete feeds for Nile tilapia (*Oreochromis niloticus*) with reference to imported feeds in Lake Zone region, Tanzania.

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ABSTRACT

The study will be conducted to examine: (i) the physical quality of pellets (pellet length, diameter, hardness, expansion and Pellet durability (PDI)) of local extruded feeds with comparison to imported feeds, (ii) proximate analysis (Dry matter, CP, Crude lipid, Crude fiber, Ash, NFE, Gross Energy, and Amino acid profile) of feeds involved, (iii) the growth and feed utilization of Nile tilapia through feeding trial. Five isonitrogenous diets including imported feed as Control diet (DI), extruded feeds manufactured by local producers from Tarime (D2) and Luchelele (D3), and two diets from trials made by TAFIRI (D4 and D5).

An experiment will be set for 8 weeks followed by 3 weeks of digestibility experiment in indoor plastic tanks. Diets will be assigned randomly in triplicate groups of 20 fish, in a total of 15 tanks of 1000L. Initial average weight will be 5g. 10 fish will be selected as initial whole fish sample. During the experiment water quality parameters including temperature, DO, Ammonia, Nitrite, and pH will be monitored in daily basis. Fish will be fed to apparent satiation 3 times a day. Feed intake, Weight gain , Feed conversion ratio (FCR), Specific growth rate (SGR, %day–1), Nutrient and energy retentions, Condition factor (CF), Hepatosomatic index (HSI) , viscerosomatic index (VSI) and Apparent digestibility will be calculated. The statistical analyses will be done using the SPSS computer software. After dissemination of results and major findings, this study will help to know the status of our local feed industry on what we have really achieved and what we lack, and eventually what to improve to gain competitive advantage over imported feeds.

Keywords: Nile tilapia, feeds, pellet quality, growth performance, feed utilization, digestiblity

Income and expenditure of fishers and fishmongers in Zanzibar

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ABSTRACT

Fisheries sector is important to the economy of Zanzibar Island through provision of income, employment, food and nutritional security. The sector contributes about 4.9% to Zanzibar GDP as well as providing direct employment to about 63,000 people with 34,571 being fishers and 2,141 working as fishmongers. Nonetheless, information on the income and expenditure of individual fishers and fishmongers in Zanzibar remains unknown. Through interviews with 1272 respondents from 30 landing sites in Unguja and Pemba Islands, the study compares fishery income and expenditures with that of other income generating activities during Covid-19.

The results show that 38% of fishers earn between TZS 50,000 and 200,000 per month during high fishing season while 37% earn between TZS 200,000 and 500,000 during low fishing season. In addition, fish mongers earn between TZS 50,000 and 200,000 during high and low seasons. At the same time, 35% fishers and 39% fishmongers earned income between TSZ 50, 000 and 200,000 per month in high fishing season during covid-19. In addition, 43% of fishers earned income between TZS 50, 000 and 200,000 while 52% of fishmongers earned less than TZS 50,000 per month in low season during covid-19. Results on earnings from other activities indicate that 24.3% fishers and 22.1% fishmongers engage in farming, 5% fishers and 10.2% fishmongers in business 2.6% fishers and 6.1% fishmongers in seaweed farming, 3% fishers and 0.6% fishmongers in livestock keeping and 1.2% fishers involved in carpentry, 9.2% fishers and 59.3% fishmongers in other activities.

Based on these findings, it is evident that the earnings from fishery in both fishing season is inadequate to support socio-economic development of fishers and fishmongers as income is mostly used on buying food, health issues and educational needs. It is therefore suggested that efforts to improve livelihood of fisheries dependent communities should focus also target other activities that provide them with income.

Keywords: Income; fishers; fishmongers; expenditure; marine waters; Zanzibar

Importance of internal and external nutrient loading to the primary productivity of Lake Tanganyika

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ABSTRACT

A coupled hydrodynamic-ecosystem model (GOTM-FABM-ERGOM) was applied to test the hypothesis that primary production in the upper mixed layers of Lake Tanganyika are primarily controlled by internal nutrient inputs. The model was calibrated (data: May 2015–April 2016) and validated (data: May 2016-April 2017) against monthly field data of water temperature, dissolved oxygen, nutrients (nitrate, ammonium, phosphate) and chlorophyll a collected from Kigoma Bay in the northern part of the lake. Data of nutrients and discharge from the rivers (Ruzizi and Malagarasi) and atmospheric dry and wet deposition were derived from the literature. The model generally showed good agreement with the observed data for water temperature, dissolved oxygen and nutrients during the calibration and validation periods. The model satisfactorily reproduced the lake's seasonal dynamics (dry and wet seasons) induced by the lake's hydrodynamic processes. We found that both internal and external sources contribute importantly to total nutrient loading in the lake.

Keywords: GOTM-FABM-ERGOM, Internal nutrient inputs, External nutrient inputs

Multi-Raft as Deep Water Seaweed Farming Method

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ABSTRACT

Deep water seaweed farming has emerged as a new practice introduced in several tropical regions including Zanzibar which provides new ground for farming seaweeds while increasing its productivity. This farming practice came to address the long-term challenges observed to face the shallow water seaweed farming (off-bottom culture), however, information regarding the potential technique for farming seaweed in deep water is currently limited. In our study, we design a Multi-raft to study the growth rate of seaweed and observe the water quality parameters in the cultured area.

Multi-raft was constructed by placing the four wooden poles, each standing into every corner of individual rafts tied properly with coconut coir rope and nailed, the current raft had a height of 1.5m with three individual rafts. Each individual raft was made by connecting four wooden poles 3m each tied with coconut coir rope and nailed to produce an area of 9m2 for each raft. The multi-raft was installed 100m from the sea shore at a depth of 1.5m during low tide and 3m deep at high tide, supported with four anchors at the bottom and four buoys at the top. The seaweed seeds with weight of around 50-75 g were tied in the tie - tie ropes and tied in a nylon ropes of 3m. Each single raft held ten nylon ropes where the bottom and top raft had cottonii (*Kappaphycus alvarezii*) (cottonii 1 and cottonii 2 respectively) while spinosum *(Eucheuma denticulatum*) was placed at the centered raft.

The result showed that, the growth of both species cultivated in individual rafts was increasing per time where cottonii 1 showed 2,500g as the highest growth at week six, *cotonii* 2 had 2800g as the highest growth in a week six, and *spinosum* had 3,500g during week six where there was a slight difference in the water quality parameters; where the water temperature ranges from 28.5°C to 25.47°C, salinity ranges from 25.47 - 30 ppt, dissolved oxygen varies from 7.8 mg/l to 8.2mg/l and pH of the water varies from 6.5 to 7.8. Conclusively, the results from this study shows that multi-rafts can be used to cultivate seaweed in deep water to increase its production while addressing environmental challenges. However, more studies on the suitable materials for constructing multi rafts are needed because the current study used poles from the trees which may enhance environmental degradation

Keywords: Deep water farming, *Kappaphycus alvarezii, Eucheuma denticulatum*, off-bottom culture

Partial replacement of fish meal with *Chaetomorpha* sp. improves feed utilization, survival, biochemical composition and fatty acids profile of *Penaeus monodon*

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ABSTRACT

Prawn is an economic important shellfish species for aquaculture in Tanzania, however there are currently only a few small scale farms and one commercial farm on Mafia Island. Local communities have been unable to adopt commercial farming due to high cost of production, particularly the scarcity of high-quality prawns feed, which is reliant on commercial exported feeds. The current study looked into the efficacy of locally made feeds derived from green algae *Chaetomorpha* sp. On the survival, feed utilization and biochemical composition of the cultured P. *monodon* species in Tanzania.

The study was conducted in prawns earthen ponds located at Matakani Village along the Pangani River estuary, and lasted 45 days. Four experimental feeds named (F0, F1, F2 and F3) denoting replacement fish meal levels of 0, 10, 20 and 30 %, respectively. Post-larvae fingerlings weighing 0.49 ± 0.06 g on average were stocked in 2 cubic meter hapa nets in three replicates at a stocking density of 15 individuals per cubic meter set. Prawns fed with F2 treatment had a significantly higher ($p<0.05$,) survival rate (92.59±7.14) and compared to others the lowest survival rate exhibited by F3 diet (89.62±10.50) , higher weight gain was attained by prawns fed with F3 diet and F2 (W) (8.02 ± 0.26 g) and (7.80±0.49 g) respectively. The greatest effect of muscle somatic index (MSI) treatments was observed in prawns fed with F2. Prawns fed with F3 had the highest crude protein (CP) composition (79.11±1.05 %), which differed significantly ($P<0.05$) from the other treatments. Crude fat (CF) levels in prawn fed with low treatments levels (F0 and F2) were significantly higher ($p<0.05$) than in other treatments. Carbohydrate content was low in prawn fed with F0 (3.24±0.33 %) and F1 (3.42±0.44 %), which significantly ($p<0.05$) from prawns fed with F2 (4.64±0.11 %) and F3 (4.08 ± 0.05). Furthermore, when compared with other treatments, prawn fed with F0 and F1 treatments had a significantly higher ($p<0.05$) proportion of saturated fatty acids (SFA). In contrast, prawns fed with F2 and F3 treatments had relatively higher levels of polyunsaturated fatty acids (PUFA) than prawn fed with F0 and F1 treatments.

Since fish meal is more expensive than natural *Chaetomorpha* algae, 30% and 20% replacements are recommended. When low saturated fatty acid prawn muscle is desired, *Chaetomorpha* algae may be supplemented. Thus, at a 20% replacement level, *Chaetomorpha* algae are suitable for partial replacement of fishmeal in *P. monodon* feeds.

Keywords: *Peneus monodon*, fish meal, Chaetomopha spp, survival, biochemical composition, feed utilization

The endemic mariculture potential microalgae in the coastal waters of Tanzania

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ABSTRACT

The development of maricIture depends much on the availability of natural food, which are very essential during the larval developmental stages of shellfishes and most commercial value marine fishes. The live feed is an important component, and is considered as the heart of the hatchery. However, in Tanzania, the only, and recently established hatchery in Zanzibar for the production of some commercially important mariculture seeds still relies on the imported strains of live feeds.

Due to challenges facing the imported strains including frequent crashing of the large culture volume as a failure to acclimate to the environment, the current study aimed to identify and isolate the endemic mariculture potential phytoplankton from the coastal waters of Tanzania. Seventeen (17) species were recorded with the highest number in Pangani estuary, and during the northeast monsoon. Among, the identified species, three strains namely; Tetraselmis, Chorella, and Nannochlorum were successfully isolated by employing different techniques. Moreover, isolated strains were then subjected to varying laboratory conditions in order to determine their optimal growth conditions. For the effect of salinity, it was found that Chlorella is an euryhaline species which grows in a wide range of salinities but with maximum growth (cell density) production in salinity of 15 while Tetraselmis flourished well in full strength salinity levels. On the side of light, the two microalgae also differed in preferences as each performed better at its light intensity. This is the baseline information on some aquaculture potential microalgae available in the coastal waters of Tanzania which can be used in different aquaculture centres.

Keywords: Mariculture; Tetraselmis; Chorella; Nannochlorum; Zanzibar; Tanzania

Multi-component biofilters with coconut husks, bivalves, moringa and azolla as a natural and sustainable approach for water quality management in aquaculture

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ABSTRACT

The growth of the aquaculture industry in Tanzania has been affected by the frequent occurrence of disease, poor growth of cultured organisms, and management practices associated with nutrient loads. There is an immediate need to develop a competitive, environmentally friendly tactic to anticipate the major threats to aquaculture. One of the simplest, lowest-cost, and most effective approaches is to integrate coconut husks, bivalves (live organisms), moringa, and Azolla plants as natural biofilters into the aquaculture systems.

The use of multi-component biofilters solves water problems by allowing the reuse of water, controlling diseases, and improving fish production. Using locally available materials (herbal plants and live organisms) as biofilters and as supplements for fish feeds will increase fish production, income, and employment for fish farmers. Subsequently, there are great opportunities to increase aquaculture production through its adoption as the designed system could be affordable to many Tanzanian fish farmers. Therefore, future approaches that focus on designing affordable and portable biofilter systems should be prioritized to improve aquaculture production in Tanzania. The designed system aims to improve water quality, increase aquaculture production, as well as transform the lives of Tanzanian fish farmers. In general, the design of this system provides an ecological foundation for the development of an efficient and innovative approach to water quality management in Tanzania's aquaculture production.

Keywords: Biofilters, Bivalves, Moringa, Nile tilapia, Hatchery management, Recirculating system

A comparison of chicken (*Gallus domesticus)*, African Sharptooth catfish (*Clarias gariepinus*) pituitary gland, and ovaprim hormone for inducing maturation in African sharptooth catfish (*Clarias gariepinus*)

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ABSTRACT

Traditionally, artificial propagation of African sharptooth catfish has been achieved by using expensive synthetic hormones or a pituitary gland from another fish, which involves sacrifice leading to reduced production. This study compared the effectiveness of using ovaprim hormone, chicken heads, and African Sharptooth catfish pituitary glands for inducing African Sharptooth catfish reproduction. Twenty-five gravid females and matured males of African Sharptooth catfish were injected with a single dose of 4 ml, 1.5 ml, and 0.5 ml for chicken, African Sharptooth catfish pituitary extracts, and ovaprim hormone, respectively. After 24 hours, the latency period for each female was recorded, and eggs were stripped and counted. Incidence cost and profit index were used to assess the cost-effectiveness of using the three methods.

The results showed that African Sharptooth catfish injected with ovaprim hormone and African Sharptooth catfish pituitary gland had significantly higher fecundity than those injected with the chicken pituitary gland ($p = 0.000$). Similarly, the African Sharptooth catfish injected with ovaprim hormone and African Sharptooth catfish pituitary gland had significantly higher percentage hatchability than those injected with the chicken pituitary gland ($p < 0.001$). A higher latency period was attained from African Sharptooth catfish injected with chicken gland followed by those injected with ovaprim hormone ($p < 0.001$) and finally African catfish pituitary gland ($p < 0.001$). The African Sharptooth catfish injected with chicken gland had significantly lower incidence cost and profit index than those injected with ovaprim hormone ($p < 0.001$) and African catfish pituitary gland ($p < 0.001$). Likewise, the African Sharptooth catfish injected with ovaprim hormone had significantly lower incidence cost but higher profit index than those injected with African catfish pituitary gland ($p = 0.002$). In conclusion, ovaprim is effective in inducing the maturation of African Sharptooth catfish at a lower cost. Farmers with access to ovaprim hormone can use it to induce the breeding of African Sharptooth catfish.

Keywords: Catfish; Sharptooth; hormone

Fruits and vegetable scraps and kitchen wastes are suitable substrates for mass production of black soldier fly (*Hermetia illuncens)* larvae

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ABSTRACT

The black soldier fly (*Hermetia illucens*) larvae (BSFL) are promising alternative high-quality protein ingredient for fish feed production replacing the expensive and limited available fishmeals. However, technology for mass production of BSFL is currently limited in most countries. This study assessed the appropriate organic substrates for attracting adult BSF for massive laying of eggs. Six replicates of attraction of fruits and vegetable scraps (FVS), kitchen waste (KW), fish offal (FO), and a mixture of the three substrates (FKF) were prepared for attracting BSF adults to lay eggs for five weeks. The eggs hatched were monitored for growth performance, survival rate, and yield by using the same substrates. The results showed that FVS and KW substrates attracted a significantly large mass of BSF adults to lay eggs compared to FKF and FO ($p < 0.05$). FKF and KW substrates supported significantly higher final weight and specific growth rate of larvae than FVS and FO ($p < 0.05$). Moreover, KW and FKF substrates had significantly higher BSFL survival rates than FVS and FO ($p < 0.05$). Furthermore, KW and FKF substrates had significantly higher BSFL yield than FVS and FO ($p < 0.05$). Taken together, FVS and KW are suitable substrates for attracting BSF adults for mass production of eggs while KW and FKF are suitable substrates for growth performance, survival rate and yield. We recommend using FVS and KW for attracting adults for massive BSFL eggs production, and KW and FKF for BSFL growing and production.

Keywords: Sustainable aquaculture; Black soldier fly larvae; Suitable substrates; fishmeal replacement; fish feed formulation

Assessment of growth performance of Silver pompano (*Trachinotus blochii*) fingerlings fed with bio-activated blood meal protein

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ABSTRACT

Silver pompano fish are among the commercial fish species capable of being cultured under captivity. Moreover, marine fish culture activities in Tanzania is limited, among the challenging causes are the feed ingredients and feed for marine fish. Limited studies have conducted in Tanzania to assess the feasibility of culturing Silver pompano fish under captivity. However, the feed for boosting immunity and improve their growth in Tanzania is also limited. This study assessed the growth performance and survival of pompano (salt water fish) fed with bio-activated blood meal protein cultured in experimental tanks. Three experimental feed containing blood meal bio-activated by using Bacillus subtilis were prepared in three different bio-activated blood meal protein concentration (35%, 45% and 55% respectively) and each feed treatment had three replicates experimental tanks. Control feed was made by preparing feed containing un-fermented blood meal. The pompano fingerlings were collected from the wild (Kunduchi campus sea shore) by beach seining and each tank was stocked with 10 fingerlings with mean weight of 41g. The reared fingerlings were monitored for Weight gain, Specific growth rate and Survival percentage with response to bio-activated blood meal inclusion in the experimental feed. The results showed that feed with 35% inclusion of bio-activated blood meal supported higher performance in Specific growth rate, Daily weight gain and Survival percentage compared with the control and the 45% and 55% experimental feeds. Moreover, 35% feed exhibited higher Daily Weight Gain (2.82 ±1.628) than the 45% (0), 55%(0) and the control feed (0). Similarly, the 35% feed supported higher specific growth rate (0.540 ±2.388) than the 45% (-3.599±0.002), 55% (-3.596±0.000) and the control (-3.633±2.074). Bio-activation process using useful microbes (Bacillus subtilis) showed to have positive effect on the growth performance, and survival percentage of reared pompano fish. This is a baseline study on the potential application of biotechnology to improve marine fish culture using locally available feed ingredients.

Keywords: Pompano, Bio-activation, Bacillus subtilis, fermented blood meal, marine fish culture

Potential sites for seacucumber (*Holothuria scabra*) farming in Zanzibar coastal waters

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ABSTRACT

Aquaculture in Zanzibar plays a significant contribution to the socio-economic perspectives due to improving income, food security and employment status. In this context, many inhabitants from coastal areas of Zanzibar engaged in sea cucumber farming as a new opportunity. However, there is limited information on the potential areas for seacucumber farming in Zanzibar.. The study identifies the potential sites for seacucumber (*Holothuria scabra*) farming in Zanzibar coastal water. This study was conducted in 24 villages, 16 villages from Unguja Island and 8 from Pemba. Data was collected using face to face interview with 10-12 respondents in each sampled village, and physical observation of the physical appearance of the seacucumber in the areas., Also, the water quality parameters including temperature, salinity and pH were measured using (YSI) equipment. The study found that, water quality parameters such as temperature ranges from 26-29 C0 , Salinity was 34.5- 35.0 ppt, and pH was 7.0-7. Based on the community interest of farming seacucumber, 99.5% of respondents from Pemba are very interested in sea cucumber farming, 78% from Unguja are interested while 12% are not interested at all. It is therefore concluded that, the selected sites have potential characteristics for sea cucumber farming. However, this study recommends more research on potential areas for seacucumber farming based on ecological aspects such as sea cucumber stock assessment, soil characteristics (nutrients profile/organic matters, color, porosity), chlorophyll, sea grasses cover, tidal range and seasonality, this will create better marine spatial plan (MSP) for improving the coastal and fishery resources management. Again, further studies are needed in the areas of effects of climate change on abundance and distribution of sea cucumber diversity in Zanzibar coastal water

Keywords: Holothuria scabra, Sea cucumber farming, Community.

Effects of photoperiod on growth performance and melanogenesis pathway for skin pigmentation of Malaysian red tilapia

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ABSTRACT

Farming of red tilapia is increasing rapidly. However, its commercial farming development is challenged by lack of clear information on genetic basis for skin color and pigmentation differences due to environmental changes. This study investigated the effects of photoperiod (light:dark, L:D) on the growth and skin color variation of Malaysian red tilapia. A total of 180 fish weighing 150.48 ± 0.44 g were reared under natural photoperiod (13L:11D, control), prolonged lightness (24L:0D) and prolonged darkness (0L:24D) in three replicates for 78 days. The weight gains of fish cultured under both prolonged light and darkness were significantly higher than fish under natural photoperiod. The tyrosinase level in ventral skin was significantly higher for fish cultured under prolonged darkness condition than in the other two photoperiod regimes. Contrary, the cysteine level in the dorsal skin was significantly higher in the fish cultured under natural photoperiod than in prolonged light and darkness. The relative mRNA expressions of SRY-related HMG-Box 10 (sox 10), tyrosine (tyr), tyrosine related protein 1 (tyrp-1) and solute carrier family 7 member 11 (slc7a11) genes were significantly higher in ventral skin of fish under prolonged darkness than the other two photoperiods. This study demonstrates that photoperiod has an impact on melanogenesis and growth of red tilapia. Understanding the effects of photoperiod on genetic basis of red tilapia will help in selective breeding programme of the important economic traits for the development of commercial red tilapia farming.

Keywords: cysteine, growth, melanogenesis, Photoperiod, red tilapia, tyrosine

Effect of Biosecurity Practices, Epiphytes and Diseases on Growth, Carrageenan properties and Proximate Composition of *Kappaphycus alvarezii* and *Eucheuma denticulatum* Cultivated in Zanzibar, Tanzania

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ABSTRACT

Tanzania is the third largest producer of the red seaweed *Eucheuma denticulatum* after Indonesia and Philippines, and it produces about 0.63% of world seaweed production. However, seaweed cultivation in Tanzania, like in many other countries worldwide has been affected by climate change which causes increased water temperatures resulting in high occurrence of diseases and epiphytes colonization. Application of on-farm biosecurity measure can help alleviate the situation. This study was conducted to assess the impact of epiphytes, diseases and application of on-farm biosecurity measures on growth, carrageenan properties, and proximate composition of *Kappaphycus* and *Eucheuma* in Muungoni, Zanzibar, Tanzania. The experiments covered two seasons (cold season; July-September 2020 and hot season; January-March 2021). The biosecurity measures included cleaning the seaweed and lines every third day. Results showed a significantly lower disease and epiphyte occurrence in K. alvarezii (50% and 38%) and *E. denticulatum* (45% and 31%) was observed for the bio-secured seaweed farm compared with the non-bio-secured farm during the cold and hot season, respectively. Disease incidence for K. alvarezii and *E. denticulatum* was correlated to temperature ($p<0.05$) and salinity ($p<0.05$). Kappaphycus alvarezii exhibited a significantly higher specific growth rate (SGR) (1.97-3.52%) at the bio-secured farm compared to non-bio-secured farm for both seasons and E. denticulatum had a greater SGR (3.05%) during the hot season. The carrageenan yield and gel strength were significantly higher for healthy seaweed species compared with infected seaweeds cultured during the cold and hot seasons respectively (Mann Whitney U Test, $p< 0.05$). These data clearly show that disease and epiphyte outbreaks can cause a significantly reduced SGR, carrageenan yield and gel strength in *K. alvarezi*i and *E. denticulatum*, and that these effects can be influenced by season. We conclude that, farm level biosecurity practices, however, can effectively reduce disease and epiphyte occurrence and enhance seaweed growth and lead to higher carrageenan content and strength of the seaweeds *Kappaphycus* and *Eucheuma*.

Keywords: Biosecurity practices, carrageenan properties, proximate composition, growth rate, Seaweed, diseases.

The effect of imported and local made fish feeds on growth, yield and economic benefit of Nile tilapia (*Oreochromis niloticus*)

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ABSTRACT

Recent studies show the presence of relative stability and decline in the major capture fisheries of the world, and aquaculture production reported increasing and further increased is expected in developing countries. Although Nile tilapia attributes to aquaculture, its production is undeveloped due to a lack of quality and affordable feeds. However, despite great demand and market flux, information on the quality of the produced or imported fish feeds is limited. Therefore, this study intends to evaluate the three major aquaculture feeds that are imported or locally made and available in the market to the growth performance and yield of the farmed Nile tilapia to understand the Feed Economic Potential to the growing aquaculture sector in Tanzania. Three diets, one imported (DOK) and two from local industries (GIS and AV), were randomly administered to 12 tanks, with a density of 4 monosex Nile tilapia fingerlings fish/ m2. Each treatment was then fed 5% of fish body weight per day for four weeks. Growth rates were tested for a normal distribution within the Shapiro-Wilk test for homogeneity of variances using Levene's test to assess if the data obeyed parametric assumptions. One-way ANOVAs was then used to assess differences of mean growth rate for different feed treatments, Tukey's HSD test to perform post-hoc mean comparison test for investigation of differences among growth patterns. Statistical analyses were carried out using EnvStats. The meangrowth rate (g-1fish-1week-1) of the different feed types (DOK, AV and GIS) was 30.35 Â± 13.9, 16.02 Â± 6.78, and 15.91 Â± 7.45 respectively. In addition, the differences were crucial ($F(3, 1) = 286.03$, $p < 0.05$). Turkeys multiple comparisons of means done for the mean growth rate on the three diets at 95% confidence showed DOK being significantly more important in supporting growth than AV and GIS, which showed no difference.

Keywords: fish feeds; Nile tilapia; capture fisheries; tilapia; Tanzania

Prawn species composition, abundance and distribution, along Tanzanian coastal waters.

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ABSTRACT

The composition, abundance, and distribution of prawn species in Tanzanian coastal waters were studied in order to determine the status of the stocks and the effectiveness of the industrial fishery closure. Moreover, the survey intended to investigate the effectiveness of the industrial prawn fishery closure which was imposed in 2007 to 2016 in the three major prawn fishing zones of Bagamoyo (zone 1), Rufiji (zone 2) and Kilwa (zone 3). It was hypothesized that the closure will improve the stocks recovery. To achieve this, two sampling approaches, ship surveys within three designated prawn fishing zones (zone I, zone II, and zone III) and land-based survey within two sites, (zone I Bagamoyo and zone II Nyamisati (Kibiti District)) were employed to collect data for the study.

Two ship surveys were carried out, one during the wet Southeast Monsoon (May to June 2018) and the other during the Northeast Monsoon (February to March 2020), while a land-based survey was conducted monthly from December 2017 to June 2020.On the two surveys (land and ship based), six prawn species were observed with two species, *Fenneropenaeus indicus* and *Metapenaeus Monoceros,* dominating the catch composition. For the land-based survey, the results indicated the highest catch rates in zone II - Kibiti (21.74kg/boat) and lowest in zone I - Bagamoyo (1.9kg/boat) while for the ship surveys, catch rates varied between zones and years. During the 2018 survey, zone II had the highest catch rate (109.6 kg/hr), followed by zone I (62.1kg/hr) and lastly zone III (38.6kg/hr) during the survey of 2018 whereas the 2020 survey, zone had the highest catch rates (71.95 kg/hr) followed by zone III (49.05kg/hr) and the lowest zone II (9.88kg/hr)/. The overall catch rates prior to these survey (in the year 2009) showed a slight increase in trend from 23.7 kg/hr to 55kg/hr in 2018 although the 2020 survey recorded decreased catch rates of 40.83kg/hr.

The species composition and dominant species were like the one observed prior the closure Parallel to this, the biomass estimates results showed that the stock has not shown a good sign of recovery since there is great variation between the biomass estimation of the 2018 survey (920.15) and that of 2020 (60.75) on the industrial fishery. Also, the values of exploitation rate for the two prawn dominant species exceed the optimization (Eopt) criterion of 0.5, an indicator of sustainable exploitation of the resource, suggesting that the prawn species are not exploited sustainably. Despite these findings to show positive response of stocks after a moratorium period, still the stock status is not yet stable, thus, the limitation of the exploitation of the resources is required. This can be done through controlling the number of license issued per year and continuation of imposing closed fishing season strategy that take into account the recruitment and spawning period of the prawn.

Keywords: Prawns, penaeid, catch rates

Potential fishing zone in support of marine fisheries management in Tanzania

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ABSTRACT

Management of the fish stock in the developing countries with large exclusive economic zone is a challenge. Spatial considerations are generally not included in fishery stock assessment and management because of the lack of spatially explicit data and a poor understanding of the spatial dynamics of fish populations, especially migratory ones. New powerful tools based on satellite-derived data, such as fishing activity at fine spatial scales and/or sea surface temperature (SST) fronts distribution also known as Potential Fishing Zone (PFZ) have been developed over the last decades. These tools have opened the door for a spatialized ecosystem approach to fisheries management. This study used satellite derived SST to determine hotspots (more PFZ) and cold spots (few PFZ) and compared yellowfin tuna catch information collected from purse seine vessels operated by Distant Waters Fishing Nations (DWFN) between Hotspots and cold spots in the EEZ of Tanzania. The results from this study revealed Monthly trend of PFZ in the EEZ were observed during North East Monsoon than during the South East monsoon season. High density of the PFZ is located in the northern part of Tanzania EEZ between longitude 39.5°E and 43°E and latitude between 7.5°S and 4.6°S where higher fishing events and cluster of significant-high catch rates of yellow fin tuna were observed. Low density of PFZ and low fishing effort as well as Non-significant clusters of yellowfin catch rate is in the central part towards the southern side of the EEZ. The information obtained from this study help to better understand the impacts of fishing on the ecosystem and integrate spatial ecology into ecosystem-based management.

Keywords: Potential Fishing zone (PFZ). Tanzania EEZ, industrial fishery, effort distribution, Yellowfin tuna (YET)

Characterization of the feeding patterns and reproductive dynamics of bigeye, kawakawa, and frigate tuna in the Pemba channel ecosystem

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ABSTRACT

Bigeye tuna (*Thunnus obesus*), kawakawa (*Euthynnus affinis*) and frigate (*Auxis thazard*) tuna-like are among the most fished and commercially important pelagic fish species in the Pemba channel. During the north east (NE) monsoon, the channel experiences wind-driven coastal upwelling, and the south east (SE) monsoon by the coastal "dynamic uplift" upwelling and westward nutrient advection, all of which trigger high primary productivity and small pelagic fish production. Considering that tuna species are income breeders, changes in the abundance of micro nekton they prey on as a result of upwelling have effects on their feeding pattern and reproductive cycle. The aim of this study was to determine the feeding patterns and reproductive dynamics of bigeye, kawakawa, and frigate in the Pemba channel. The feeding and reproductive traits of these species under different upwelling regimes were described using the feeding intensity and prey dominancy indices, spawning pattern and seasonality index, condition factor (K), and BF estimated from the biological and dietary related data. The results indicated that the feeding intensity indices, vacuity (VI) and repletion (RI) indices, were significantly different between the NE and SE monsoon seasons (Kruskal–Wallis ANOVA, ($\chi^2 \geq 32$, $p < 0.005$) and between months ($\chi^2 \geq 53$, $p < 0.005$). Despite the fact that September has a low VI that corresponds to the NE monsoon months, the SE monsoon months had the greatest VI and lowest RI when compared to the NE monsoon months. The preponderance index of food dominancy (PI) at species level, revealed that during the NE monsoon, the category of prey, sardines and anchovies ranked first for all tuna investigated (PI 99%), with the remaining <1% occupied by other prey items. During the SE monsoon, juveniles of large fish or mid-pelagic fish (PI = 85.5%) was the most common prey group for bigeye, followed by sardine and anchovy (PI = 10.2%), squid (PI = 2.3%), and unidentifiable materials (PI = 2.1%). For kawakawa and frigate, sardine and anchovy were rated top (PI 92.75%) and mid pelagic fish ranked second (PI 12.8%) during the SE monsoon. The gonadosomatic index (GSI), changed significantly with season ($\chi^2 \geq 9.4$, $p < 0.05$) and months ($\chi^2 \geq 28.3$, $p < 0.005$) for all species. Considering the results of condition factor (K) and GSI values of > 1, our results emphasize that all species spawn across all NE and SE monsoon months, with the highest intensity in October through January for bigeye, and September to November for kawakawa and frigate, respectively.

Keywords: Tuna, bigeye, kawakawa, frigate, diet, reproductive traits, NE monsoon, SE monsoon

Spatial and temporal variation in the catch rates and size of Octopus *cyanea* in Tanzania

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ABSTRACT

The Octopus cyanea fishery ranks third as mainland Tanzania's most economically important marine fishery in terms of metric tons exported. Its high exploitation has led to growing concerns over its sustainability, hence conservation efforts to encourage its management. This study has been conducted in three geographically isolated zones along the coast of Mainland Tanzania. Kwale and Mtambwe represent the northern zone in Tanga. The Middle zone includes Jojo, Bwejuu, and Jibondo, located on the island of Mafia, and the Southern Zone includes Songosongo (in Kilwa) and Mgao and Msangamkuu, both located in Mtwara. An 18-month catch and size data were analyzed to identify spatial and temporal variations in catch rates and octopus mean sizes. Results indicate seasonal variability in catch rates and temporal changes in individual mean octopus size. Catch rates are higher but decline from October to December and are fairly low and constant from November to April during the northeast monsoon. It is increasing and higher during the southeast monsoon from May to October. Individual mean sizes are generally smaller but increase in SE monsoon from June to October and higher but vary in NE monsoon from October to May. Higher catch rates between July and August correspond to small octopus individual mean sizes, while high catches during September to November correspond to big individual mean sizes. This catch pattern may indicate growth overfishing between July to August and recruitment overfishing from September to November. Therefore, these results may reflect that the artisanal fishery at Jibongo, Mgao, Msangamkuu, and Mtambwe may be currently exploiting smaller individual stock beyond the reach of the fishery.

Keywords: spatial and temporal variation, catch rates, mean size, monsoon season

Population dynamics of the Devis' anchovy (*Encrasicholina devisi*, Whitley, 1940), Buccaneer anchovy (*Encrasicholina punctifer*, Fowler, 1938) and the Silver-stripe round herring (*Spratelloides gracilis*, Temminck & Schlegel, 1846), in the Tanzanian coastal waters

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ABSTRACT

This study was conducted from October 2018 to May 2020 investigating the reproductive biology, population characteristics and catch of small pelagic fish caught by ringnet fishers along the Tanzanian coast. The major recruitment peak for *E. devisi* was recorded between April and May, May for *S. gracilis* and February for *E. punctifer*. The growth parameters for E. devisi was: asymptotic length = 12.71cm TL, instantaneous growth rate (K) = 0.77yr-1, growth performance index (ϕ)= 2.09, total mortality (Z) was estimated at 2.69yr-1, natural mortality (M) at 1.91yr-1, fishing mortality (F) at 0.77 yr-1, current exploitation rate (Ecurr) at 0.29, optimum fishing mortality (Fopt) at 0.76 year-1 and lifespan (Tmax) at 3.34 years.

The growth parameters for S. gracilis was: = 9.56 cm TL, K = 0.85 per year, t0 = –0.54 years, ϕ =1.89, Z= 3.79 yr-1, M = 2.21 yr-1, F= 1.58 yr-1, Ecurr = 0.42, Fopt=0.88 year-1 and Tmax=2.99 years. Moreover, the growth parameters for E. punctifer was: = 12.70 cm TL, K = 0.55 yr-1, ϕ =1.95, Z =1.57yr-1, M= 1.54 yr-1, F=0.03 yr-1, Ecurr = 0.02, Fopt= 0.62 year-1, Tmax = 4.58 years. The theoretical E0.5 that maximizes surplus production using relative biomass per recruit was 0.230, 0.228 and 0.225 for *E devisi*, *S. gracilis* and *E. punctifer* respectively. *E devisi* and *E. punctifer* had the E= 0.29, and 0.02 for respectively, were below the maximum acceptable limit (Emax= 0.355 for devisi and Emax =0.350 for punctifer) and biological optimum, indicating their stock is not overfished. While for S. gracilis the E = 0.42 was higher than the Emax = 0.353 and the biological optimum, indicating the stock is overfished. Management intervention such as closure during spawning period should be applied to protect the stock. Since the populations of short-lived species are generally unstable, effort applied to the fishery should be monitored and operated below E0.5 to avoid the risk of overfishing.

Keywords: Small pelagic, Population dynamics, Growth parameters, Ring-net fishery, Recruitment.

Assessment of factors affecting the long-term changes in pelagic fish catches in Lake Tanganyika, Tanzania

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ABSTRACT

Lake Tanganyika is a renowned nutritional and socio-economic resource. Nonetheless, changes in the fishery have been observed that jeopardize its socio-economic significance. We conducted a study to understand the factors driving the long-term changes in fish catches in the lake. We used historical catch and effort data from the Ministry of Livestock and Fisheries (MLF), biometric data collected by several previous projects, and new length-weight and gonad maturation data collected during 2015–2017 to understand the magnitude of departure from the available historical information. We found a 40% and 22% increase in the length overall (LOA) and the beam of the fishing boats, respectively; a 35% and 31% increase in the circumference and depth of the lift-net, respectively; and a 29% increase in the hauling poles (Polee). While the pelagic fish catches and catch per unit effort increased from the <1980s to higher catches during the 1980-2000s, we found a significant decline to lower values in the >2000s era, which relates to the change in fishing gear characteristics. The increase in fishing pressure might have contributed to the reduced size-at-first maturity (L_{50}) from 293 mm in 1994 to about 202 mm in 2017 for Lates stappersii, 80 mm in 2004 to 75 mm in 2017; and 123 mm in 2004 to 105 mm in 2016 for *Stolothrissa tanganicae* and *Limnothrissa miodon*, respectively. The results suggest a fishery is under high exploitation pressure, which requires that all relevant stakeholders collaborate to enforce closed seasons, limit fishing capacity, and provide alternative livelihoods to fishers to recuperate its fishery.

Keywords: Increased fishing effort; *Lates stappersi*i; S*tolothrissa tanganicae*; *Limnothrissa miodon*; artisanal fishing; historical changes; sizes-at-first maturity

Geographical Variation in Clarias liocephalus (Clariidae: Clarias) along Victoria and Kivu-Tanganyika basin Populations

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ABSTRACT

This study investigated geographical variation in *Clarias liocephalus* at n Nile/Victoria basin and Kivu/Tanganyika populations to decipher whether the specimens belong to same species. A total of 70 specimens from the Royal Museum for Central Africa were examined in detail. Three specimens were Holotype (HLTP), Paratype (PRTP) and Type (TP) where the rest of the specimens were to be examined and regrouped based on resemblances and differences on morphometric characters based on Teugels (1986). Principal component analysis (PCA) was used to explore and analyze multivariant pooled-group data sets. Based on the morphometric and observation characters, we found that selected speciemens belong in *Clarias liocephalus* group. Further analysis should be done based on genetic trait to confirm the species. On the other hand, difference among the specimen were not due to geographical localities.

Keywords: *Clarias liocephalus*, Morphometrics, Holotype, Paratype, Types, meristic.

Fish species composition and Diversity in Nyegezi bay, Lake Victoria Tanzania

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ABSTRACT

Nyegezi bay is among the numerous small bays in Lake Victoria. The bay is potential for aquatic laboratory as it is in vicinity of fisheries research and training institutions. The bay is subjected to increasingly residential, recreational and agriculture activities which may pose threats to the well-being of the bay. However little has been done to understand the nature and dynamics of the bay. This study investigate composition, abundance and diversity of fish species in Nyegezi bay. Samples were collected from five stations; of which 1 site was in the river entering the bay, while the other five (5) sites were in the bay. The sites in the Riverine ecosystem was FETA Bridge while the sites in the lake ecosystem were TAFIRI Pier, FETA Pier, Corner Point, Entrance Point and Centre Point. The study was conducted during October and November 2014 and February and June 2015. Fish data within the bay were collected using experimental gillnets from five stations in the bay and beach seine was used in one station from the River entering the bay. From each gillnet panel, fish samples were collected and identified to species level. Fish which could not be identified on the field were preserved in 10% formalin for identification at later stage. A total of eighteen fish species from 9 families were encountered and identified apart from *haplochromine* group. TAFIRI pier had more species richness and also demonstrated a more species evenness and diversity. The catch of Nile perch and Nile Tilapia was dominated with immature juvenile, this signifies the importance of Nyegezi bay as a breeding and nursery ground for the species. Proper management therefore should be enforced to regulate and control the fishing activities in the bay.

Keywords: Nyegezi bay, fish species, composition, abundance, richness, evenness, diversity

Conservation awareness and monitoring on a critically endangered Karomo tilapia in malagarasi catchment, Tanzania

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ABSTRACT

Fishery resources in Malagarasi river and its catchment are under threats. In the 2006 endemic Karomo tilapia "*Oreochromis karomo*" was reported as critically endangered fish of the world. Thereafter, no species-specific conservation initiatives have been taken towards fishery on the species in Malagarasi river and its catchments and hence the current population status of critical fish and its habitats is missing. The current study aimed at increasing awareness of the local community on Environmental conservation and resource uses towards the critically endangered O. karomo in Malagarasi and Lake Nyamagoma at Uvinza District. A fishery survey was conducted to observe the occurrence of critical fish along the river and the lake. It was observed that the community at Uvinza were not aware of the threats to the fishery resources, and thus, no conservation measures were previously taken directly to the endangered species in Malagarasi catchment. The targeted endangered species was only found in Lake Nyamagoma and none in the river Malagarasi, showing the importance of the lake to inhabit the fish and that the river ecosystem does not support existence of the fish. There was high variation in the number of occurrences between *O.karomo* and other fish species in the lake. Assessment on population trends and progressive fisheries monitoring in Malagarasi catchment is a vital to update status and produce baseline information of the resources including O*reochromis karomo*.

Keywords: Malagarasi catchment, Oreochromis karomo, Community conservation awareness

The cost of compliance: Subsidizing legal production inputs for natural resource use

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ABSTRACT

Like many common-pool resources, the Lake Victoria fisheries are characterize by poor compliance with production input regulations that are intended to reduce overexploitation. To explore the use of input subsidies to increase compliance, we determine the subsidy level required to induce demand for legal fishing nets, thereby compensating fishermen for loss of productivity net of enforcement risk. Our study additionally tests the subsidy-enhancing effect of a norm-nudge. A new multiple price list procedure for eliciting revealed willingness to pay for multiple units of a production input is developed, adapted to the demands of a challenging field setting, and implemented with 462 fishermen at 20 landings sites on the Tanzanian lakeshore. Consistent with the high prevalence of illegal fishing gear at our sites, we find a zero median demand for legal net panels at local market prices. The subsidy required to shift median demand to at least one legal net panel is a 21% discount. Norm-nudging generates no policy-relevant enhancement of the subsidy.

Keywords: compliance; natural resource management; subsidies

Acceptance of new lights technology for Dagaa (*Rastrineobola argentea*) fishing in Lake Victoria-Tanzania

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ABSTRACT

Lanterns were the sole source of Dagaa (*Rastrineobola argentea*) fishing lights before the introduction of solar lights in Lake Victoria. Dagaa fishery contributes both micro-and macro-economies of the riparian States of East Africa making it valuable for their livelihoods. To maximize profit, fishers inverted solar lamps and battery-powered lights for fishing. To understand the extent of adoption, questionnaires were administered to examine their acceptance over the lanterns used in the past. Out of 240 respondents sampled, 93% were males of which, 83% attained primary education. Level of education, however, had no influence on preference in the usage of solar lights. The new light technologies constituted the largest share of capital cost, but dropped consequently in the ongoing operations such that 95% adopted solar lights basing on low risks, reduced operational costs, extended technical support from solar light suppliers, easy implementation, and being environmentally friendly..

Keywords: Lanterns; Dagaa; *Rastrineobola argentea,* Lake Victoria

Bet-hedging strategies determine daily choices in effort allocation for Nile perch fishers of Lake Victoria.

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ABSTRACT

Small-scale fishers experience high variability in daily catches within a resource space limited in extent by operational constraints, and biophysical factors affect daily choices in spatial effort allocation. We focus on the management consequences of the extent of the individual fisher's resource space and his options to handle risk arising from daily catch variability through a portfolio of sizes and species from within that resource space. Gillnet and longline Nile perch fishers in south-eastern Lake Victoria, Tanzania were provided with a GPS and recorded their position together with their daily catch and operations.

Three different gillnet and longline fishing strategies could be discerned. All had bet-hedging characteristics, differing in the size of their resource space of on average 120–141 km2, distance from the shore fished and emphasis on the mix of sizes of Nile perch and other species caught. The daily choice of fishing locations did not relate to previous days' catch success. Still, fishers used the general inshore to offshore distributional patterns of small and large Nile perch in their daily choices of mesh and hook sizes. The mix of sizes and species reduced day-to-day catch variability due to a portfolio effect.

Current mesh and landing size regulations based on classical arguments around growth-overfishing interfere with these strategies and force individual fishers to specialize in size, species, and area. They must accept higher uncertainties by either choosing their fishing locations further offshore or accepting a more variable lower catch, leading to higher personal and occupational risk or ongoing management conflicts when disregarding regulations. Portfolio management of fished resources by compromising on mesh size regulations would make sense by allowing fishers to utilize a certain proportion of smaller mesh or hook sizes that are now illegal as part of their fishing strategies.

Keywords: Effort allocation; resource space; catch portfolio; bet-hedging; uncertainty and risk; Lake Victoria.

Species composition and spatial distribution of selected three artisanal tuna and tuna-like fish catch in Tanzania Mainland

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ABSTRACT

The demand for tuna and tuna-like species is particularly increasing in Tanzania and in the WIO region, resulting in an increase in its fishing activities. The aim of this study is to determine the species composition and spatial distribution of selected three artisanal tuna and tuna-like fish species namely; frigate, kawakawa and skipjack in Tanzania Mainland. The two enumerators collected monthly catch and effort data for 10 days in order to cover all seasons. The catch was sorted to species and total weight taken by the enumerators in order to obtain the species composition of tuna and tuna-like species. The Kawakawa was observed to have the highest catch by number about 95% in Mafia. The Skipjack was observed to dominate the catch at Mtwara by 68% by number while the lowest was at Tanga by 0.003%. The comparison of Length-Weight Regressions of the kawakawa in between the districts using analysis of variance (ANOVA) resulted length value between 3.1 and 3.3 which is not significant. This research also recommends further work is needed to improve the reliability of the catch series. Reported catches should be verified or estimated, based on expert knowledge of the history of the various fisheries or through statistical extrapolation methods.

Keywords: tuna; Tanzania; Species; composition; skipjack; kawakawa; frigate

Status of Shark and Ray Landings in Tanzania and Implications for Management

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ABSTRACT

The United Republic of Tanzania (URT) has a considerable fisheries impact on sharks and batoids in the country's waters and in the WIO yet has limited data on shark and batoid species and their catches for their effective management. To bridge this knowledge gap, the Wildlife Conservation Society's (WCS) has been monitoring the sharks and batoids landed in Zanzibar and mainland Tanzania. We present the results from the past three years. Artisanal catch surveys from 2019–2021 across mainland Tanzania and Pemba and Unguja islands revealed at least 61 chondrichthyan species being caught, representing 62% of chondrichthyan species confirmed in the URT.

In Zanzibar, 58 species were caught, with more than double and nearly four times more species than previously reported, in 1997 and 2004, respectively. At mainland Tanzania landing sites, 44% of the individuals caught were classified as threatened (including several Critically Endangered species), compared to 47% at Unguja and 53% at Pemba sites. There were also numerous shark and ray species recorded that are listed on the appendices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the Convention in the International Trade in Endangered Species of Wild Fauna and Flora (CITES), as well as species with retention bans as implemented by the Indian Ocean Tuna Commission (IOTC). Results show a considerably larger presence of sharks in Pemba and a lower presence of batoids, in comparison to Unguja and Mainland. Lastly, the data show a notable effect of fishing gear type on the catch demography, with sharks caught primarily with hook-and-line (36%) and longlines (28%) followed by gill nets (several types for a total of 27%) and ring nets (6% of the total catches).

This was considerably different from the catches of batoids where the main gear was gill nets (35%) followed by ring nets (32%), spears (13%) and hook-and-line (12%). These findings demonstrate the importance of species-level, long-term catch monitoring as well as the opportunity and need for improved fishery management and conservation to limit or avoid catches of threatened species. We hope with this work to present a model for ecological monitoring of shark and ray landings and to contribute to advancing knowledge in the URT and the WIO, thus supporting the future development of improved management measures and more sustainable fisheries for sharks and rays.

Keywords: Sharks; WCS; CITES; Mainland Tanzania; Zanzibar

Informing Artisanal Fishery Management through Fishery Patters Mapping

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ABSTRACT

We present results from a study on Pemba Island to guide community zoning designation through fishery patterns mapping, ecological surveys, and analysis of catch landings. We pioneered data collection methods to effectively collect benthic data over an area of more than 200sqkm, characterize fishing grounds of 11 communities through a participatory process, and centralize catch data collection at landing sites with the use of smartphones and open-source tools. We will present our methodology and results from the analysis showing how the different datasets complement each other to produce applicable management solutions for communities and fishery managers by identifying areas of high ecological value and productivity and potential threats to ecosystems linked to improper fishing activities. Ultimately, we present a methodology that can be applied at a large scale by MPA and fishery managers to support small-scale fishery management, spatial planning, and conservation activities.

Keywords: ecological monitoring, fishery mapping, small scale fishery management

SMART Objective Setting to Enhance Impact of Small-scale Fisheries Management

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ABSTRACT

Small scale fisheries (SSF) management is a joint responsibility between Kenya and Tanzania communities and governments. Nearshore fisheries are overexploited, making improved management a priority. However, many communities lack management plans or plans have too many objectives to be practical, objectives are not numeric, and there are no clear priorities. There is a need for methods to help communities prioritize key threats and create targeted objectives (SMART: specific, measurable, ambitious, realistic, time-bound). We worked with six SSF communities across the Kenya-Tanzania border, an ecological important area with emerging trans-boundary governmental management (Trans-Boundary Conservation Area; TBCA). TBCA communities share culture and ecological resources, but have different governmental systems. We implemented a learning and objective setting process and evaluated differences in the objectives emerging across the border, and how communities used objectives influenced action planning. The TBCA context allowed generating a shared and tested approach to SSF management that can be replicated, and that enhanced community capacity to track progress of SSF management on to ecosystem and social resilience. The objective setting framework resulted in a replicable, focused approach to solving challenges in SSF that enabled focused action plans that assess impact and provide accountability. Experiential learning was key to understand the need to improve management. Action planning was linked to capacity, and communities could support most work without external funding, while identifying funding needs for partners.

Keywords: Small scale fisheries (SSF), Kenya-Tanzania Trans-Boundary Conservation Area-TBCA, SMART Objective Setting and social-ecological survey

Stock status assessment of five small pelagic species along the Tanzanian coast using length-based methods

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ABSTRACT

Small pelagic fish (SPF) account for more than 30% of the total landings of marine capture fisheries worldwide and play an essential role in ensuring global food security. A significant increase in the fishing effort of SPF has been observed in recent years in Tanzania. To understand the status of the stock of SPF populations, we assessed population parameters of SPF in marine waters in Tanzania, using length-frequency data collected between October 2018 and June 2020.

The TropFishR software package and Froese's length-based indicators for fishing sustainability were used for assessment of five important commercial species. Our findings indicate that all species, had the highest growth rates (K) > 0.53. Except for *S. commersonii,* the fishing mortality for all species was higher than natural mortality. Our findings also suggest that the exploitation rate (E) was > 0.5, which is higher than the optimum value (E = 0.5). All fish species were fished at higher rates with more than F 80% of the Fmax values indicating over-exploitation, except for *S. commersonii*, which was exploited at a rate less than 35% of their respective Fmax, indicating under exploitation of the population. The spawning potential ratios (SPR) were below the suitable precautionary SPR target which is ≥ 40% a proxy for Maximum Sustainable Yield (MSY). Therefore, for the fishery's sustainability, management measures have to be instituted, such as increasing mesh sizes and reducing the fishing effort for *A. sirm*, *E. heteroloba, E. punctifer* and *S. gracilis*, for sustainable exploitation of these important resources.

Keywords: Growth; Mortality; Exploitation; Small pelagic; Spawning potential ratio; Tanzania

Catch composition and economics of fishing and fishery of small pelagic, Tanzania Mainland

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ABSTRACT

This study investigated catch composition and economics of small pelagic fishery along the Tanzanian coast. Sampling was conducted on a monthly basis from October 2018 to May 2020. Engraulidae are the dominant family in the total catch, with three species accounting for more than 51% of the estimated total landings on the mainland, with Clupeidae comprising 26% of the landings, Scombridae 7% and Carangidae 6%. The dominant species are; *Encrasicholina devisi, Encrasicholina punctifer, Spratelloides gracilis, Stolephorus commersonnii, Decapterus kurroides, Dussumieria acuta*, and *Rastrelliger kanagurta*. Socio-economic study revealed that 90% of capital is used for vessel and ringnet construction. Financial analysis across different processing methods show that capital cost for boiling and sun drying is higher than other processing methods. Processors involved in smoking have a higher profitability rate than others. Moreover, the processing sector is constrained by lack of fish handling and processing facilities, which in turn lead to high post-harvest losses as well as reduced income. Also, fishers do not keep records of their catch and income which make it difficult to generate the contribution of fisheries to households as well as national economies.

Keywords: Catch composition; small pelagic; ringnet; Tanzania

Identification of mesopelagic fish species using multi-frequency acoustic approaches – implications for biomass estimation

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ABSTRACT

Mesopelagic fishes are found in the ocean's twilight zone at depths between 200 and 1000m. They remain one of the least investigated components of the open-ocean ecosystem, with major uncertainties about their biomass. Hydro-acoustic surveys are typically used to estimate their abundance. However, the separation of mesopelagic fish species echoes from those of other abundant co-existing fish, plankton, and other sound-scattering organisms is a challenge. This study uses multi-frequency acoustic techniques to discriminate between major mesopelagic aggregations (lanternfish and lightfish), and co-occurring hake, horse mackerel, small pelagics, krill, plankton, and jellyfish). Verification of identified targets was done in LSSS aided by data recorded with an in-trawl camera system (Deep Vision), that continuously records images as they pass into the cod-end of the trawl. The frequency response of the major scattering organisms has been extracted to enable discrimination between mesopelagic fish species and other sound scatterers. Classification success rates and the implications of this work for mesopelagic biomass estimation are presented.

Keywords: Benguela, species identification, mesopelagic fishes, lanternfish, lightfish, multi-frequency acoustics, frequency response

Effects of seagrass cover loss on seawater carbonate chemistry: Implications for seagrass mitigation potential of ocean acidification impacts

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ABSTRACT

The world's oceans have absorbed approximately 48 percent of anthropogenic CO_2 emitted into the atmosphere and continue to absorb 30 percent of CO2 emitted annually, resulting in increased acidity (decreased pH) and changes in the carbonate chemistry of seawater, a phenomenon known as ocean acidification (OA). Changes in seawater carbonate chemistry and pH reduction are known to have an impact on marine species and ecosystems, particularly calcifying organisms like coral reefs that require calcium carbonate ($CaCO_3$) minerals for survival and development.

Seagrass meadows can mitigate OA effects at the local level by increasing both pH and aragonite saturation state (Ar) in seawater during the day by absorbing CO_2 during photosynthesis. However, little is known about how a decrease in seagrass cover affects local seawater carbonate chemistry. In order to determine the impact of decreasing seagrass cover on pH and seawater carbonate chemistry, we evaluated pH, dissolved inorganic carbon (DIC) and partial pressure of CO_2 (pCO2) as well as the saturation state of aragonite (ΩAr) and calcite (ΩCa) in areas with varied seagrass cover.

The findings show that a decrease in seagrass cover has a significant impact on the buffering potential of seagrass meadows to OA impacts, resulting in a decrease in pH, ΩAr, and ΩCa, but an increase in $_pCO_2$ and DIC of the seawater, indicating a limited ability of seagrass meadows to mitigate the effects of OA on coastal habitats. The study recommends the protection, conservation, and restoration of seagrass meadows to enhance their ability to offset the impacts of OA on critical coastal ecosystems and marine species, including coral reefs that support fisheries and tourism.

Keywords: ocean acidification, seagrass meadows, dissolved inorganic carbon, pH.

Seagrass structural complexity and environmental variables as a determinant of fish larvae assemblages in coastal waters of Tanga, Tanzania. Implications for seagrass management and conservation.

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ABSTRACT

Seagrass meadows are among the most productive ecosystems in the world and are used by fish as spawning and nursery areas. The study examined the influence of tropical seagrass meadows' structural complexity and environmental variables on fish larvae assemblages in Tanga coastal waters. Fish larvae and environmental variables were sampled in four seagrass meadows dominated by Thalassia hemprichii from June 2019 to January 2021. There were significant differences in fish larvae abundance among seagrass meadows ($p = 0.0036$). The fish larvae that were identified to family level would be either herbivores, carnivorous or omnivorous once matured and were mostly coral-seagrass-associated fish. Multiple regression analysis indicated that seagrass cover and canopy height were the foremost predictors for fish larvae assemblages. Moreover, fish family richness was significantly predicted by environmental variables ($R^2 = 0.25$, $p = 0.015$). Based on these findings, seagrass structural complexity and location of seagrass habitats are important determinants of fish larvae assemblages. These findings suggest that the reduction of anthropogenic stressors in seagrass meadows will allow the development of seagrass structural complexity and ultimately support increased fish recruitment in the adjacent coastal habitats

Keywords: Seagrass, fish larvae, assemblages, coastal waters, anthropogenic stress

DNA barcoding and molecular identification of seagrass species from Tanzanian coastal waters

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ABSTRACT

Seagrasses of the world, and in the Western Indian Ocean (WIO) region, in particular, have received the least attention and research compared to their counterparts i.e., mangroves and coral reefs. There is some uncertainty about the identity and diversity of seagrass found in Tanzanian coastal waters. As a result, it is critical that the seagrass diversity of Tanzania be thoroughly investigated in order to develop effective and appropriate management and conservation plans. In this study Internal Transcribed Spacer (ITS1 and ITS2) and ribulose-bisphosphate carboxylase (rbcL) DNA barcoding were coupled with morphology to identify seagrass from Tanzanian coastal waters. Seagrass samples were collected from the coastal waters of Tanga, Dar es Salaam, Mtwara, Mafia and Zanzibar in Tanzania during low spring tides, from August 2020 to February 2022. Morphological diagnosis, phylogenetic analyses and evolutionary divergences inferred from the ITS and rbcL genes supported the identification of twelve (12) seagrass species. It is the first time that Halodule pinifolia and *Zostera capensis* are reported in coastal waters of Mainland Tanzania. This is the first study reporting the assessment of seagrass species using DNA barcoding coupled with morphology in the East African coastal waters.

Keywords: DNA barcoding, Seagrass, Morphology, ITS, rbcL, WIO

Citizen science reveals spatio-temporal dynamics in coastal nutrient conditions in Lake Tanganyika

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ABSTRACT

Several studies in Lake Tanganyika have effectively employed traditional methods to explore changes in water quality in open waters; however, coastal monitoring has been restricted and sporadic, relying on costly sample and analytical methods that require skilled technical staff. This study aims in validating citizen science water quality collected data (nitrate, phosphate and turbidity) with those collected and measured by professional scientists in the laboratory and to identify the patterns of seasonal and spatial variations in nutrient conditions and forecast potential changes based on expected changes in population and climate (to 2050).

The results showed that the concentrations of nitrate and phosphate measured by citizen scientists nearly matched those established by professional scientists, with overall accuracy of 91% and 74%, respectively. For total suspended solids measured by professional and turbidity measured by citizen scientists, results show that, using 14 NTU as a cut-off, citizen scientist measurements of secchi tube depth to identify lake TSS below 7.0 mg/L, showed an accuracy of 88%. In both laboratory and citizen scientist-based studies, all measured water quality variables were significantly higher during the wet season compared to the dry season.

Climate factors were discovered to have a major impact on the likelihood of exceeding water quality restrictions in the next decades (2050), which could deteriorate lake conditions. Upscaling citizen science to more communities on the lake and other African Great Lakes, would raise environmental awareness, inform management and mitigation activities, and aid long-term decision-making.

Keywords: Lake Tanganyika; water quality; nitrate; phosphate

Seagrass restoration in a high-energy environment in the Western Indian Ocean

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ABSTRACT

The coast of Tanzania has only a few island shelters, creating an open exposed coast with a long wind fetch generating strong wave exposure on the coastline. Still, seagrass meadows are present but has similar to global trends declined due to e.g. warmer ocean temperatures, coastal developments and destructive fishing methods. In view of the above challenges, there is a strong need for restoring seagrass meadows along the coast of Tanzania and the western Indian Ocean at large. This study addressed three specific objectives.

Firstly, we evaluated the suitability of the commonly used plugs and sprigs planting methods by comparing percentage survival of the seagrass *Syringodium isoetifolium*. Second, we examined the direct effects of small (7 cm diameter) and large (10 cm diameter) plug used to harvest initial shoot density and water depth by monitoring the shoot, rhizome and internode success of *Syringodium isoetifolium* transplants along a depth gradient. Thirdly, we examined the influence of environmental variables on internode and shoot plastochrone interval, and rhizome and shoot growth rates. The study was conducted in the intertidal seagrass meadows at Puna located between 07o 04' 29.82''S, 039o 32' 31.73'E and 07o 04' 30.27''S, 039o 32' 33.08''E along the coast of Dar es Salaam, Tanzania. Three experimental plots were established at the study site within the tidal pools (depth ranging 0.5-1 m during low spring tide). The pools were located at the upper, middle and lower intertidal zones. The plug and sprig method were tested in this study. The study further tested the effect of plug size diameter on seagrass restoration success whereby 7 and 10 cm (internal diameter) PVC corers were used. 6 bio-degradable hessian sacks, three for each plug size, were filled with sediments collected from adjacent bare habitat.

The hessian sacks were installed in bare pools to provide substrate for seagrass growth and facilitating sediment accretion and reducing water depth in the pools. The results suggest clearly that the plug method in contrast to the sprig method, particularly when employing the large-sized plug is considerably very suitable for seagrass transplantation in high-energy wave environments in Tanzania. It is early predicting if the plug method will show the same results for other regions across the Western Indian Ocean, but similar results have been attained along the coast of Mozambique. For development of guidelines and best practice for seagrass restorations, it is apparent that the depth gradient cannot be ignored.

Keywords: seagrass; Tanzania; rhizome,

Development of mobile phone application to access potential fishing zones in marine waters of Tanzania

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ABSTRACT

Tanzania Fisheries Research Institute and Deep-Sea Fishing Authority have been conducting a study to help fishers access profitable fishing grounds from 2018 to 2020. The research integrated high-resolution satellite data obtained from the ground satellite e-Station at TAFIRI. The research used in-situ observation data from fishers to identify, delineate and map profitable fishing areas in the territorial and exclusive economic zone (EEZ) waters. The key finding from the study revealed that Potential fishing zone (PFZ) are distributed both in the territorial water and EEZ (space) and throughout the year (time). We hypothesized that establishing the mobile application would assist fishers in increasing their confidence to fish in the offshore waters that are not on their usual fishing ground. Local private companies investing in tuna fishery and local fishers will also be the beneficiaries. The study concluded that artisanal fishers and local industrial fishers can now use PFZ information to access new profitable fishing grounds. The study recommended the establishment of an android application that will allow fishers to access directly PFZ information through mobile technology.

Keywords: Potential fishing zone, Android mobile Application, Fishers, Fishing ground

The influence of ocean conditions on spawning areas and seasons of frigate and kawakawa, in the coastal waters of Tanzania

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ABSTRACT

Tuna and tuna-like species are very important economically, and make up a substantial contribution of catch, and consequently providing one of the most accessible sources of protein and income generation to the coastal community in the WIO region. However, due to their unknown life history such as spawning areas and seasons as well as nursery grounds, they face a challenge of being overexploited at juvenile and spawning phases especially in artisanal ring net fishery. This study sought to find out the spawning areas and seasons of the two species of tuna namely, Kawakawa and Frigate, and to associate the findings with the environmental variables that influence their spawning.

This study was conducted in Tanga, Mtwara and Unguja, from August 2020 to July 2021. Information which was collected involved length of the fish, weight, gonadal maturity and fecundity. Remote sensing data covering a period between 2003 -2021 were downloaded from TAFIRI e-Station. Monthly SST and Chl-a composites data had a spatial resolution of one kilometer and monthly composites had four kilometers resolution. The study found that Spawning season of Kawakawa and Frigate is mainly during the NE monsoon both in Pemba channel and Mtwara waters that coincides with high phytoplankton abundance and high fishing season and maturation and spawning especially in the Pemba channel is controlled more by upwelling. Although tunas do not feed on chlorophyll-a, high concentration support lower trophic levels, which provide food for tunas. In Pemba channel waters (parts of Tanga and northern Zanzibar), Chundo and Wamba are mainly used as the nursery grounds for both Kawakawa and skip jack species. In Mtwara waters, Majomvi is the most productive fishing ground both in NE and SE; and it is potentially used by Kawakawa as nursery and spawning ground. In Tanga, Kitungamwe is utilized by kawakawa and Boma is utilized by Frigate as the potentially spawning grounds. The study recommends that, management of the neritic tuna should be season and ecosystem-based as the study observed seasonal and spatial differences/variations in spawning periods and areas.

Keywords: kawakawa, Frigate, spawning grounds, nursery grounds, monsoon seasons

The seascape configuration influences big blue octopus catches, reef abundance, and biomass

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ABSTRACT

Seascape configuration influences the fish distribution and abundance in tropical regions. However, little is known about how the highly diversified seascape layout in tropical regions influences the availability and features of landed fish, such as octopuses—one of the most commonly encountered cephalopods in the Western Indian Ocean (WIO). This study aimed to compare octopus weight and abundance in classified reef types based on water depth and hydrodynamic exposure (i.e. submerged and outer reefs), and proximity to fishing villages and assessed the influence of reef habitat size on octopus abundance landings.

For this, octopus landing data from eight landing sites covering the entire Tanzanian coast were collected between 2018 and 2020. We also mapped the reefs that octopus fishers target and assessed abundance, biomass, and landed weight for different fished reefs to determine how the seascape layout influences the properties of landed octopuses. The findings showed no difference in octopus captures between large and small reefs. In addition, we discovered that reefs near fishing settlements and those exposed (outer reefs) have lower octopus catches than distant reefs and submerged reefs.

The low catch in reefs near fishing settlements and outer reefs is attributed to high fishing pressure, and in submerged and remote reefs, octopuses have enough time to grow before being caught. In summary, any management policy encouraging the exploitation of distance reefs and submerged reefs would result in more octopus landings. It would also lessen fishing pressure on nearshore reefs, where it is higher, allowing octopuses from these reefs to grow.

Keywords: Octopus, seascape, fishing, reef size, Western Indian Ocean

Postglacial fire regime changes and vegetation dynamics at Lake Victoria, Africa

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ABSTRACT

Lake Victoria lies across two major climatic zones with a temperature and moisture gradient and associated tropical biomes, the rain forest, and the savanna. Primarily triggered by climate shifts, these three biomes and fire regimes have been dynamically interspersing over the last 17,000 years. Here, we present a robust ^{14}C chronology mainly based on macroscopic charcoal using the MICADAS system of LARA at the University of Bern, new palynological data used as biostratigraphic control, and the first continuous charcoal record in Lake Victoria to establish the fire history.

Our pollen and macro–charcoal records, support the assumption that throughout time regional fire dynamics are controlled by biome's changes, and that climate was the main driver of these vegetation shifts at least until the Iron Age. Our results indicate that during the Last Glacial Maxima and Heinrich Stadial 1, under dry and colder climates the savanna was dominating, with low fire regimes before 15,000 cal yr BP and increased fire occurrence between 15,000 and 14,000 cal yr BP.

After this period, the Afromontane forest started to expand, and warmer and humid climates promoted the growth of rain forests and reduced fire events, which is particularly observed in the African Humid Period (between ca. 11,500 and 5000 cal yr BP). Subsequently, our records indicate a global maximum of fire occurrence at 5000 cal yr BP, followed by unexpectedly low fire regimes during the Iron Age and the subsequent periods.

Keywords: Fire, vegetation changes, pollen, charcoal, chronology

A fossil reconstruction of the Lake Victoria fish assemblage through 17 000 years reveals key insights into the process of adaptive radiation

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ABSTRACT

Ecological opportunity and versatility, priority effects and dominance are key concepts for understanding the process of adaptive radiation. We investigate these ecological dynamics in Lake Victoria (LV), home to the largest known recent adaptive radiation of fish. The lake underwent total desiccation in the Late Pleistocene and refilled ~17ka ago. Several fish families colonized the refilling lake including catfishes, cyprinids, and cichlids, but in the course of time, the community became dominated by over 500 endemic haplochromine cichlid species that occupy various roles in the food web. We used subfossil teeth to uncover patterns in lake colonization, habitat occupation and abundance through time. We took sediment cores from four sites along a transect from the shallow inshore habitat to the deep offshore parts of the lake.

The cores were screened for fish remains using a stereomicroscope. The subfossils were identified to taxa using a reference collection from the modern fish assemblage. Five fish families were identified and cichlids were further resolved into the radiating haplochromini and the non-radiated oreochromini. We observe a high family diversity right upon refilling, with cyprinids and cichlids at similar numbers, suggesting a priority effect is unlikely to have allowed the haplochromine adaptive radiation. Initially, the radiating haplochromines showed no ecological dominance, but when the lake became deeply inundated and vast offshore pelagic habitat formed, all taxa but cichlids became exceedingly rare. This attests to the ecological versatility of cichlids, allowing them to persist in the new open water habitat and dominate it. However, only one of these cichlid groups radiated into many endemic species.

Our study is the first to reconstruct the temporal development of an adaptive radiation community through time and provides a direct window into the evolution of the lake's fish diversity. Our work reveals key aspects of the diversification process where ecological opportunity and versatility are required but are insufficient for adaptive radiation.

Keywords: Adaptive radiation; Haplochromine cichlids; Fish fossils

The status of selected rift valley Lakes environment: Their impacts to the species diversity and fisheries

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ABSTRACT

Tanzania is well endowed with aquatic habitats including the rift valley lakes. Five rift valley lakes of Eyasi, Manyara, Burungi, Kindai, and Singidani were surveyed for water sampling in 2010 during wet season. Lake Babati was also visited. All of these lakes are shallow, alkaline to varying extents and fall within the eastern arm of the East African Rift Valley. The lakes are however threatened by human activities where management regime is not in place. Long term climatic desiccation in the area has resulted in a number of these lakes to shrink and unless the water supply exceeds evaporation they will continue to shrink until they become pans and eventually saline grasslands. Water samples were taken at 20 geo-referenced sampling sites from the six lakes visited.

Geographical locations (coordinates) and altitude (elevations) were recorded using the Global Positioning System (GPS): The sites were randomly chosen with interests on the physiographic features, such as water depth, vegetation, bays, or open waters. Key physico-chemical and nutrient parameters were determined using their respective field and laboratory protocol methods and equipment. The objective was to collect baseline information on the status of the environment of Lakes Eyasi, Manyara, Burungi, Singidani, Kindai, and Babati. The values for physico-chemical parameters among the sampling sites in all lakes showed spatial variations, which could be attributed to altitude, human activities such as effluents from domestic, factories, agriculture, livestock, wild animals, geology, and drainage.

Fishing in these lakes is a seasonal activity but still provide an important source of livelihood to the nearby communities around these lakes as reported fisheries to be the most important source of income (47%), followed by farming (42%), while the remaining 11% depended on casual labouring. It is possible that the population pressure and its associated anthropogenic activities in the catchments is influencing the water quality characteristics that could alter the quality of the water draining into the lakes, with subsequent impacts on the species in these lakes. It is generally expected that less-disturbed areas have higher species diversity, implying that human activities related to land use are shaping the lakes' floral and faunal communities.

Keywords: alkaline, climatic desiccation, geo-referenced, physiographic features, spatial variations, rift valley lakes

Multiproxy paleolimnological reconstruction of Lake Victoria's environmental history

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ABSTRACT

Lake Victoria (LV), Africa's largest lake is situated in the African Great Rift Valley. Due to its shallowness (max.68 m; mean 40 m) and limited river inflow, LV is very sensitive to variations in climate and lake level fluctuations. As a result, LV has undergone repeated low stand periods, or even complete desiccation during the Late Pleistocene with profound effects on the aquatic ecosystem. One example is the emergence of a unique biodiversity of endemic cichlid species following the lake's last desiccation event during the last glacial and subsequent refilling commencing ~15,000 years ago.

In an interdisciplinary project we aim at reconstructing linkages between paleoenvironmental variability, disturbances, and adaptive species radiation by combining approaches from paleogenomics, paleoecology and paleolimnology. For this purpose, four sediment cores along a depth-transect (near-shore to offshore), covering ca. the past 16,000 years, are analysed. We present first paleolimnological results of long-term changes of using (isotope-) geochemical indicators including: Sedimentary pigments and biogenic silica to infer aquatic productivity supported by micro X-ray Fluorescence (XRF) derived element geochemistry, 13C and 15N, and sedimentary phosphorus fraction analyses providing information on changes in sediment composition. The results suggest that the infilling of the LV basin was a long-term step-wise process. This is shown by elevated and variable indicators for lithogenic input (e.g Ti, Zr and K) and interpreted as mobilization of substrate from the shorelines by a dynamic lake level prior to its stabilization in the Early and Mid-Holocene.

This process is mainly reflected in the core taken at the greatest water depth (65 m). Simultaneously, the aquatic productivity (BSi and chloropigments) increased rapidly after the refilling of the lake basin in the Late-Glacial. A gradual drying of the climate and a following shift to a more oxygenated water column is observed in the Mid-to Late Holocene indicated by a decline in chemically weathered material (e.g Rb/K & K/Al ratios) and abundance of Mn.

Keywords: Lake Victoria, Sediments, Reconstruction, Geochemistry, Phytoplankton

Spatio-temporal variations and hotspots detection of land use/cover of four East African Great Lake catchments in recent 20 years

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ABSTRACT

The interaction between global change and local socioeconomic developments, such as anthropogenic deforestation, non-sustainable farming, and industrial mining activities, has led to land degradation in East African Great Lake catchments. Land use/cover change (LUCC) trend is one of the key indexes used to identify whether there is land degradation or not, which will impact on the changes in lake water quality and Aquatic Ecosystem. To respond land degradation neutrality of SDG15.3, preservation and sustainable use of land resources are imperative for this region. For better understanding the dynamic of LUCC, the spatio-temporal variations and hotspots detection were investigated in last 20 years around four East African Great Lake catchments, i.e., Lake Victoria, Lake Tanganyika, Lake Rukwa and Lake Nyasa (Lake Malawi).

The temporal changes and features of land use/cover data from three eras, the 2000s, 2010s, and 2020s, were studied using land use dynamic degree and land use transfer matrix. It was demonstrated that land use/cover had altered dramatically. The fraction of forest land was clearly declining, while the proportion of cultivated land increased somewhat and grassland varied. Under the strain of population development, the artificial area increased due to the expansion of urban and rural informal settlements. It was discovered that forestland and grassland were being transformed to farmland. And the conversion of grassland and cultivated land contributed to the increase in artificial areas. Kernel density estimation was used to identify spatial change hotspots associated with various land use patterns.

Furthermore, the shrinking and dispersion of hotspot zones indicated the spatial distribution characteristics of forestland, grassland, and cultivated land tending to fragmentation, while the hotspot zones of artificial area expanded and linked , revealing its growth. The concentration degree continued to increase, which formed a spatial clustering pattern from "single center" to "multiple center". In the lakeshore zones, the dynamic degrees of each land use type were higher, and the transformations of forest and grassland to cultivated land and artificial area were more significant.

Keywords: land use/cover dynamics; land degradation; change hotspots; lakeshore zone; East African Great Lakes

Environmental drivers and genetic mechanisms underlying variation in a colour ornament

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ABSTRACT

Uncovering the ecological drivers and the genetic developmental mechanisms driving adaptation is key to understanding organismal diversification. Here, we address the mechanisms underlying egg-spot variation in the cichlid fish *Astatotilapia calliptera* from Lake Masoko/Kisiba, a small crater lake in Tanzania. Egg-spots are circular pigmentation markings present in cichlid males' anal fins and vary in number and colour. They are sexually selected via female choice or male-male competition and play an important role in their breeding behaviour. Lake Masoko/Kisiba has a steep depth gradient where two diverging A. calliptera ecomorphs exist – littoral and benthic. We found that littorals have yellow egg-spots on a grey anal fin, in comparison benthics have less egg-spots, but these are orange on a black anal fin. Visual modelling, accounting for the lake's light profile and ecomorph visual system, confirmed that orange spots on a darker background maximises their visibility at deeper depths, thus maintaining trait signalling in a low light environment. Using a GWAS approach, we found that the gene oca2 is associated with number variation, whereas tmem24 and cdc42 are associated with colour variation. Functional validation of these loci is ongoing. Preliminary comparisons between oca2-/- and wild-type shows that, despite egg-spot presence, anal fin pigmentation develops differently in mutants, providing insights into how variation might appear during development. Taken together, we identified environmental drivers and loci associated with the rapid evolution of variation in a male colour ornament, in a model system that allows for an integrative approach towards understanding why and how organisms diversify.

Keywords: Ecology; pigmentation; GWAS

Empirical evidence of some life history variables of Nile perch (L*ates niloticus*, Linnaeus 1759) and its implication in fisheries management in Lake Victoria

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ABSTRACT

The intensive fishing to which Nile perch is currently subjected, revealed in uncertainty about the supplies. Body size of Nile perch plays a key role for the productivity and resilience of aquatic populations. This work analyses the variation in body size indicators expressed as Length-weight relationship, length at first maturity, sex ratio and fecundity estimate for *Lates niloticus* (L.) stock in Lake Victoria studied from 2104 individuals fish samples collected between March and April 2021.

The relationship between total length (TL) and total weight (TW) for both sexes were curvilinear and statistically significant, with the regression equation for the males TW=0.0082TL3.0995 (r^2=0.9608, p<0.001) and that for the females was TW=0.0077TL3.1101 (r^2=0.9709, p<0.001). 50% maturity size of males and females was found to be 51.3cm TL and 85.7 cm TL, respectively. Generally, males were more numerous at smaller size classes up to 66-70cm TL, however, skewed in favour of females at larger sizes. Sixty-four fish samples that ranged in length from 63.2 cm to 114.8 cm TL and in weight from 3,070 g to 19,930g were used in fecundity estimates. The weight of ripe ovaries ranged from 41g to 792g with a mean weight of 173.86±16.77g.

Fecundity ranged from 1.5 x 106 eggs fish-1 to 21.4 x 106 eggs fish-1, for the female of 63.2 and 114.8 cm TL, respectively. The relationships between fecundity and TL is given by Log(F) = 29896TL-0.9072; r2 = 0.4484, n=87, p<0.01) and fecundity and Total Weight is given by Log(F)=0.916(W)+3.3602; r2 = 0.4161, n=87, p<0.01) were curvilinear while the relationship between fecundity and ovary weight (OW) (F= 37.812OW0.7811, R2=0.4177), n=87, p<0.01) was linear. Results imply that Length at first maturity has not decreased as it might have been expected to have done. This suggests that the proportions of spawning stock of Nile perch in Lake Victoria need to be protected. Nile perch fishery is not only driven by socioeconomics but also its life-history trait influences the fishery. However, our study highlights the need to review our fisheries regulations with biological reference points in order to prevent long-term

Keywords: Length-weight relationship, Sex maturity, Sex ratio, Gonads, Fecundity

Water quality monitoring: Plankton as bio-indicator of environmental change, a case study at Wissmann Bay in Lake Nyasa

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ABSTRACT

Plankton are bio-indicator of environmental change in aquatic environment. The water quality of Wissmann Bay in Northern Lake Nyasa is threatened by anthropogenic activities that are likely to impact the bay directly or indirectly via its inflows. In order to understand the status of water quality at the bay, the present study investigated the plankton composition and status of some physico-chemical parameters at the bay for two years. In situ measurement and water samples were collected at 2 sampling sites - inshore and offshore, between August 2020 and May 2022 on a weekly basis. The most dominant phytoplankton groups through out the sampling period were Bacillariophyceae (37%), Chlorophyceae (35%) and Cyanophyceae (26%); and for zooplankton were Copepoda (51%), Monogononta (40%) and Branchiopoda (9%).

A total of 47 and 8 species of phytoplankton and zooplankton were identified, respectively. Diatoms especially Aulacoseira species (60% of diatoms) were most abundant during the period of southern trade winds June to September indicating high silica concentrations at that period. A chlorophyte Mougeotia sp (70% of chlorophyceae) and cyanobacteria, Microcystis species (80% of cyanobacteria) bloomed during stable water column conditions between October to May. Zooplankton abundances were inversely related to phytoplankton abundances. Inshore phytoplankton abundances were significantly higher (P=0.004, T=3.03) than offshore abundances, indicating increased nutrients in near-shore waters. However, the general plankton species composition observed during this study indicate oligotrophic environment within the bay. This study has revealed that the spatial and temporal variations of plankton at Wissman Bay is affected by trade winds and anthropogenic activities near the shore, and that, plankton composition and abundance can therefore be used to indicate the distribution patterns of nutrients and planktivorous fish in the water column.

Keywords: Wissmann Bay, Lake Nyasa, Water quality, Phytoplankton, Zooplankton, Monitoring

Ancient DNA reveals past diversity of Lake Victoria's *haplochromine* cichlids

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ABSTRACT

Many evolutionary processes unfold over time periods longer than we can observe directly, with environmental conditions and ecological settings constantly changing. Hence, inferring the causes and consequences of past diversification, extinction and migration from data of extant populations alone is often difficult. Cichlid fishes of the East African Great Lakes are renowned for their exuberant species-richness and ecological specialisations and are a famous study system in evolutionary biology.

Their extant diversity and phylogenetic relationships within and between lake radiations are largely known, but the conditions at the beginning and during these radiations are much less studied. Here we present findings from paleogenetic analyses of fish remains from the sediment record of Lake Victoria, the largest tropical lake in the world, where haplochromine cichlid fishes radiated into hundreds of species since the basin refilled just 15-17 ka ago. A very sensitive cichlid-specific qPCR assay allows us to screen hundreds of individual fish remains for endogenous DNA and generate mitochondrial and low-coverage nuclear genome sequences from the most promising samples through single-stranded library preparation and sequence capture. We gauge mitochondrial haplotype diversity through time, leveraging a reference database with hundreds of re-sequenced modern species for comparison. We discuss our findings in the context of environmental and anthropogenic change, and highlight the scientific opportunities - but also methodological challenges - of this approach for the study of cichlid fish biodiversity and evolution.

Keywords: haplochromine cichlids; phylogenetic; paleogenetic; Lake Victoria

Understanding the environmental pressures of Mwanza Gulf, Lake Victoria: From water to sediment

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ABSTRACT

Lake Victoria is the largest tropical lake in the world and the most important freshwater resource in East African District. Mwanza Gulf is one of the largest bays in the southern part of Lake Victoria with the area around 500 km2. Serving as drinking water sources, source water for agricultural irrigation and industrial activities, aquaculture farms, and habitat for floras and faunas, Mwanza Gulf plays an irreplaceable role in the development of human society and the maintenance of ecosystem in the sub-catchment. However, the deterioration of the water environment the gulf is facing is looming large. In our study, water quality changes, eutrophication status as well as sediment pollution and the potential ecological effects from both nutrients and heavy metals were researched in Mwanza Gulf of Lake Victoria.

Results showed that N and P nutrient pollution was relatively severe in central and southern parts of Mwanza Gulf owing to external agricultural emissions and internal release associated with physically disturbed sediment resuspension. We also found that the water body in the central and south part of the gulf are eutrophic and dominated with Microcystis flos aquae, contributed by N and P pollution of the sediments. Results showed that there were moderate accumulations of heavy metals (HMs) in sediments from the southern part of the gulf.

The mean contamination factor of HMs ranged from 1.19 (Ni) to 2.85 (Hg) suggesting moderate contamination of HMs in the sediments. The average potential ecological risk of HMs in sediments of the Mwanza Gulf is at moderate level (RI 205.49). Hg and Cd posed considerable or moderated risks with mean ecological risk of 114.18 and 44.16, which accounted for 51.08% and 21.54% of the total RI, respectively. High bioavailability and mobility of HMs were found in sediments near Mwanza city, particularly Zn and Cd, of which the bioavailability risks were at medium to high levels. Given the biological and environmental importance of the Mwanza Gulf and. To respond to challenges associated with climate change and local socioeconomic development, long-term monitoring of the lacustrine environment and systematic limnological studies will be required.

Keywords: Leutrophication; nutrients; nitrogen; phosphorus; phytoplankton; heavy metal; water quality; pollution

Rising tides for prediction and solutions on antimicrobial resistance in aquatic ecosystems in Tanzania Using a one health approach

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ABSTRACT

Tanzania is not immune to the global challenges related to substantial exploitation of fisheries resources and to climate change. These challenges have been due to overfishing and anthropogenic activities. To reduce the alarming depletion rate of fisheries resources and enhance resilience to climate change impacts, aquaculture has been identified as a reliable solution due to its potential to provide sustainable, safe, and alternative food. Despite its value, hyper-intensive cage culture is prone to environmental stressors with potential to harm fish health by inducing physiological stress, and by affecting immune systems and gut microbiomes. Thus, use of vaccines produced from local strains and reliance on strict biosecurity measures, together with minimal application of FAO-authorized antimicrobials, have been proven to be successful regimens for the prevention and control of infectious diseases in aquaculture. In Tanzania, however, no validated vaccines and tested antimicrobials are currently available and permitted by the Government for use. Given the complexity of such systems, One Health approach will be required to predict, detect and respond to the challenges.

Keywords: fisheries resources; climate change; aquaculture; environmental stressors; microbiomes

Infection status with Helminth parasite Ligula intestinalis in sardines *Rastrineobola argentea* from Mwanza Gulf in Lake Victoria

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ABSTRACT

This study reports an infection status of Sardines *Rastrineobola argentea* locally known as Dagaaa with the flatworm Ligula intestinalis. Dagaa were collected from fishers at three landing sites (Bwiru, Mswahili and Kijiweni) in Mwanza region and 1012 fish were examined for L. intestinalis plerocercoid infestation. The results showed that the infected fish carried one to three parasites with a prevalence and mean intensity of 6.5% and 2.08 respectively. Adult fish were more infected than the juveniles implying that infestation increased with age of fish due to ontogenetic dietary shift. Likewise, the female fish were also more infected than males. The presence of the parasites had reduced the condition coefficient of the infected fishes.

Keywords: prevalence, mean intensity, Ligula intestinalis, Mwanza Gulf

Women and Gender roles in the Octopus Fishery Value chain in selected coastal fishing communities in Mainland Tanzania

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ABSTRACT

This paper highlights the contribution of women in Octopus fishery value chain in the selected coastal communities of Tanzania Mainland within the framework of co-management. Data was collected from 150 participants in a total of nine villages selected from Tanga, Mtwara and Mafia regions. A questionnaire survey was employed to generate information on participants' perceptions and experience in the fishery, Knowledge about fishing techniques, socialization, social cultural factors such as belief systems and taboos, income and capital investment, and ownership and access rights. Results indicate that women play a very vital role in financing both the Octopus fishing operations and the household-based livelihoods as well as ensuring access to basic needs. There exist significant differences and similarities in the factors affecting fishing participation between men and women. Despite the lack of information on child participation into fishing, the survey observed a significant number of children [with school going age] involved in the Octopus fishery value chain related activities. It was found that most children are engaged in fish preparation activities prior to actual processing and value addition stages, carrying buckets of fish as paid casual labours, and assist in weighing fish during trade. This paper will contribute to the body of knowledge by broadening an understanding of gender issues in the Octopus fishery and help policy and decision makers device appropriate interventions.

Keywords: fishing access, gender roles, participation, socialization

Traditional cooking practices and preferences for stove from among coastal women in Tanzania: the case study of Jasini, Ndumbani and Moa Villages in Tanga, Tanzania

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ABSTRACT

Wood fuels and other form of energy derived from forests products are important form of energy used primarily by most households for cooking, heating, and lighting in rural Tanzania. For the coastal communities, mangroves and remnants of coastal forests are used as to serve the purpose. The demand and frequency of woods collection from mangrove and coastal forests increases when the type of cooking stoves used are inefficient. To achieve a sustainable utilization of mangroves forests, the practice of fuel wood use call for design and distribution of improved cookstoves that reduces fuels consumption, increase combustion efficiency, and lessen indoor air pollution (Bryden et al. 2001, TaTEDO, 2013) which causes detrimental health impacts.

The objective of this study is to assess stove options, fuel type and usage and preferences for different available stove technologies. We conducted a literature review on the types of stoves in use and their corresponding efficiencies by household's in the northern coastline of Tanzania in Mkinga District. We then presented these results to communities showing the different characteristics in terms of efficiency and emissions of the various types of stoves. We then proceeded to survey communities to assess what stoves were currently in use and which of the fuel-efficient stove options was the preferred one. The study identified six stove options namely open fire, ceramic, metal, kuni mbili, gas and kerosine stoves being used by households in Moa, Ndumbani and Jasini communities in Mkinga District. Results showed that in average, 64.3% of households in the three villages/BMUs was found to use open fire stove as their primary stove option. In addition, the study revealed that 25.5% of households was found to use ceramic stove as their second options and 33.7% of the household not having second stove option. In addition, the study revealed that the average proportion of 62.7% preferred Jiko bora as alternative stove solution followed by gas stove for an average of 18.5% while 7.6% showing no preference for improved stove options. Regarding, stove of preference, 62.7% of women preferred Jiko bora stove as their primary stove while 18.5% showed preference in gas stove, 1.5% preferred electrical and 1.5% for kuni mbili stove.

Keywords: Mangroves, fuel wood, efficient stoves, emission, women and children, health issues

Ecological speciation promoted by divergent regulation of functional genes within African cichlid fishes

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ABSTRACT

Rapid ecological speciation along depth gradients has taken place repeatedly in freshwater fishes, yet molecular mechanisms facilitating such diversification are typically unclear. In Lake Masoko, an African crater lake, the cichlid Astatotilapia calliptera has diverged into shallow littoral and deep benthic ecomorphs with strikingly different jaw structures within the last 1,000 years. Using genome-wide transcriptome data, we explore two major regulatory transcriptional mechanisms, expression and splicing QTL variants, and examine their contributions to differential gene expression underpinning functional phenotypes. We identified 7,550 genes with significant differential expression between ecomorphs, of which 4.2% were regulated by cis-regulatory expression QTLs, and 6.4% were regulated by cis-regulatory splicing QTLs. We also found strong signals of divergent selection on differentially expressed genes associated with craniofacial development. These results suggest that large-scale transcriptome modification plays an important role during early-stage speciation. We conclude that regulatory-variants are important targets of selection driving ecologically-relevant divergence in gene expression during adaptive diversification.

Keywords: ecological speciation, transcriptome, gene expression, cis-regulation, quantitative trait loci

Use of different fishing gears, gear sizes and methods in Lake Victoria: Implications to the sustainability of fisheries resources

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ABSTRACT

In the past the fisheries of Lake Victoria used to be multi-species, mostly indigenous species. This has shrunk down to only three commercially important species including the exotic Nile perch and Nile tilapia, on one hand, and indigenous Dagaa on the other. Fishing dynamics, ecological and environmental factors have been extensively explored to explain these changes. This paper focuses on the means and methods currently engaged in exploiting the remaining fisheries resources in Lake Victoria. An assessment of the different fishing gears, gear sizes and methods is hereby done on the basis of Catch Assessment Survey (CAS),

Frame Survey (FS) and other study data sets collected in the period of 2005 to the present. Trends in such data show that while Nile perch has remained the most economically important species, its size structure has changed remarkably shifting from the large sizes to over 90% below 50 cm Total length (TL). A similar change has been observed in Dagaa fishery. The most noticeable change in Nile tilapia fishery is the drastic fall in catch rates despite adaptive changes in fishing methods and increased fishing effort.

Apart from effects of size selectivity, the available data shows that choice of fishing gear, gear size and methods influence quantities of by-catch species. Use of Dagaa nets of fewer vertical panels operated in shallow waters without fishing lights catches immature individuals of a wide range of fish species including several threatened species. Likewise, over 85% of Nile perch caught in single panel gillnets operated mostly in shallow waters (=< 20 m) is immature. It is hereby recommended that fishing grounds be mapped to facilitate management and guidance of fishing activities in addition the currently emphasized gear type and gear size based management measures.

Keywords: fishing gears, resource sustainability,

Insights from genomics on the origins and fate of the biodiversity of East African *Oreochromis*

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ABSTRACT

With rising appreciation of the threat of emerging infectious disease and climate change, maintenance of native genetic diversity of crop and livestock species is increasingly recognised as vital for long-term global food security. East Africa, particularly Tanzania is host to the majority of native species of the genus Oreochromis, globally important in tropical freshwater aquaculture, many of them narrow endemics. However, aquaculture is largely targeted on non-native strains of Nile Tilapia, which often escape or are deliberately stocked into natural water bodies. Here we summarise recent research using a range of molecular methods including full genome sequencing based on extensive recent sampling. We demonstrate the existence of previously unknown diversity and estimate the evolutionary relationships among the majority of taxa, revealing cases of ancient hybridisation between nearby populations. We also report that farmed *O. niloticus* strains are frequently contaminated by other taxa lacking the fast growth and large maturity of this species, including *Coptodon rendalli* and *Oreochromis leucostictus*. Furthermore, poor biosecurity and hatchery management practice means that the farmed species have sometimes already hybridised with local species in the hatcheries. In addition, in many locations where farmed species have been stocked, there is clear evidence of introgressive hybridisation and in some cases, of replacement of native species. It seems likely that current practices will lead to a major loss of native genetic diversity of this key food fish. We are unaware of any current efforts to preserve these threatened species ex-situ or in-situ.

Keywords: Tilapia, aquaculture, native strains, genetics, conservation

OceanWebApp: An interactive web application for Hydrographic Data analysis in the Pemba Channel

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ABSTRACT

The importance of using oceanographic data in the management of coastal and marine resources cannot be overstated. Despite several expeditions and local surveys that collected oceanographic data in Tanzania's coastal and marine waters, such data have always been difficult to obtain. This issue is exacerbated in part by the mode of data sharing and storage. With the increased generation of data, the oceanographic field requires rapid, dependable sharing of findings to enable collaborative, reproducible research between individuals and teams.

Static methods of sharing information are becoming increasingly inadequate for conveying the complexities of information. To address this challenge, we created OceanWebApp, an interactive web application for analyzing and visualizing previously collected oceanographic data from expeditions and field surveys in Tanzania. In comparison to traditional tools, OceanWebApp tools are simple to use while still providing appealing, dynamic visualizations that can be shared with users.

While the actual code and complexities underlying the analysis are hidden, users can now interact with the data directly through features such as dropdown menus, slide bars, and text boxes. OceanWebApp also allows users to analyze data and display results in interactive tables, plots, and maps. Interactivity is especially useful for sharing results, and the apps convey far more information than static graphs. OceanWebApp is available as a Shiny web-application for greater accessibility and usability, which can be accessed via any web browser at https://semba.shinyapps.io/OceanWebApp/

Keywords: OceanWebApp, Oceanographic, Pemba Channel, Tanzania, R, Shiny,

The state of knowledge of fisheries & marine sciences in Zanzibar – Tanzania

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ABSTRACT

This study aimed to synthetically present the state of knowledge of fisheries and marine science for the marine waters of Zanzibar. It Also to present research conducted in the marine waters of Zanzibar between 1999 and 2020. The objective of this study is to identify gaps for fisheries and marine science research areas. Also, identify areas within the seascape of Zanzibar where researches were less conducted, which require special attention for future researches. Further, the study compiles the available abstracts to gather information necessary for the preparation of country research agenda on fisheries and marine science. The Information was gathered from peer-reviewed publications, reports, chapters in books and grey literature from 1999 to 2020. These literatures were accessed through multiple journals and research databases, also from direct communication with research and academic institutions. In addition, a number of grey literatures were identified through Internet. Finding discovered that large number of researches (85.5%) have been conducted in Unguja Island only as compared to 5.03% of Pemba Island. It demonstrate that, the annual amount of researches on fisheries and marine science in Zanzibar for the period of 21 years is relatively uniform, with little decline in some years. However, the researches categories under the following topics, marine conservation, fisheries, aquaculture, coral reef ecosystem, mangrove ecosystem, seagrass ecosystem, human pressures on marine resources, marine pollution, endangered marine species, climate change, and sea weed. During this period of 1999 and 2020, more researches were directed on studying marine conservation and fisheries management Followed by fisheries (21 percent) coral reef, sea grass and mangrove ecosystems, which are 8 percent, and 6 percent respectively. Therefore, it is recommended that more researches need to be conducted in thematic areas that have been overlooked by researchers, for example physical oceanography, human pressures on marine and coastal resources and ecosystems, and oil and fish stock assessment. However Pemba Island needs special attention.

Keywords: fisheries, Marine science, Unguja, Pemba, research

Reproductive Potential of the Mackerel Scad, *Decapterus macarellus* (Cuvier, 1833) in the Coastal Waters of Tanzania

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ABSTRACT

This study intended to investigate the reproductive biology of *Decapterus macarellus* locally known as ''Msumari, one of the most economically important scad fish along the coastline of Tanzania. Fish samples were collected from ring net artisanal fishers operating in Tanga and Bagamoyo coastal waters, monthly between April 2019 and September 2020.

Findings indicated that *D. macarellus* spawns throughout the year with peaks in August at Tanga and September at Bagamoyo. Overall sex ratio (M: F) was 1:1.03 (Tanga) and 1:1.2 (Bagamoyo) in favour of females. The males and females of *D. macarellus* at Tanga attained the first maturity at 145.5 mm and 153.2 mm, respectively, whereas at Bagamoyo males attained first maturity at 149.9 mm and females at 156.9 mm. Batch fecundity was not statistically significant (U = 500.5; P = 0.73), with Tanga having mean values of 46,105.9 Â± 4243.4 ova and Bagamoyo 43,082 Â± 2272.9 ova. Although this species appears to spawn all year round, management interventions such as seasonal closure and reduced fishing effort should be used during their spawning peaks to protect the spawners, recruits and ensure the species' long-term survival in the Tanzanian coastal waters.

Keywords: Scad, *Decapterus macarellus*, reproductive potential, ring net fishery, Tanzania

The Vulnerability of Fishery-Based Livelihoods to Climate Change in Coastal Small pelagic fishing Communities in Tanzania

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ABSTRACT

Fishery-based livelihood activities are an essential means of income and well-being for millions living in the coastal areas worldwide. These livelihoods are most affected by any slight changes in climate. There is minimal information on how fishery-based livelihood systems at the local level are vulnerable to climate change, especially in developing countries. Using Climate Vulnerability and Capacity Analysis (CVCA) tool, this paper examines the link between the sensitivity of a fishery system to climate change impacts. The impact of exposure is associated with socioeconomic characteristics such as demographics (age, socioeconomic status, social capital) and environmental factors. The paper also examines the adaptive capacity of fisheries-dependent communities. Based on fishers' perceptions, it argues that if the potential impacts of climate change are more significant than community adaptive capacity, then an individual cost of living will be high. The results showed that climate change has negatively affected fishery in which fishers depend for income, employment, and food security hence affecting fishers' economy. Strong winds reduce fishing activities which reduces catches and increases operation costs. Prolonged rainfall causes high post-harvesting losses and affects the fishers' price of small pelagic fishes and lower-income. The paper explores how the lack of adaptive capacity contributes to the vulnerability of small pelagic fishers, such as low-income levels and wages from fishing-related activities and lack of alternative livelihood activities.

Keywords: Vulnerability; Adaptive capacity; Exposure; Fishers; Income

The Status of Major Commercial Fish Stocks in Lake Victoria, East Africa: Their Contribution to the Blue Economy Growth

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ABSTRACT

Inland waters and especially Lake Victoria have great potential to contribute to inclusive Blue Economy growth in East Africa and support livelihood of people who depend directly or indirectly on fisheries. The Lake Victoria being the world's most productive inland fisheries, current production in 2021 stands at about 1.5m tonnes. The native dagaa, (*Rastrineobola argentea*) contributes about 62%, Nile perch (*Lates niloticus*) 15% and the rest were contributed by *Haplochromines* and Other fish species. Currently, there has been a concern about the state of these fish stocks and their current status is reviewed by examining trends in biomass, catch per unit efforts and general fishing effort targeting these fish species. The present paper is providing this state with a view of their contribution to Blue Economy growth of the Riparian States in terms of employment creation, food and nutritional security, income among others by ensuring that the fisheries is sustainable and able to produce benefits to the current and future generations.

Keywords: Blue Economy; Dagaa; Inland fisheries; Lake Victoria; Nile perch

Reduction of Post-harvest Loss of Tuna and Tuna-Like Species Through Value Addition to Improve Food Security in Tanzania

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ABSTRACT

Tuna and tuna-like species (TTS) is an excellent source of high-quality protein and other micronutrients. However, they are highly perishable as they are composed of 70-84% water. This contributes to high-postharvest losses if not proper preserved. The objective of this study was to promote value addition as ways of reducing post-harvest loss of TTS. The study was conducted in Dar-es-Salaam and Mtwara regions. Different methodology was used to accomplish the study. The study found the main ways to reduce post–harvest losses of TTS is through value-addition and use of modern processing techniques. Eight different TTS valued added products were developed then tested for its sensory parameters and analyzed for nutrient contents. Three drying techniques (KinoSol, box drier and electric box drier) were tested. From the proximate analysis, it was observed that the protein content of value-added products ranged from 14.15±0.15% to 73.14±0.38%. Tuna fillets dried using KinoSol had the highest protein content (73.14±0.38%). Blood samples from Kunduchi had higher nutrient contents than those from Mtwara. Furthermore, minced fish had the highest TPC and FC 1.180 x 107 CFU/g and 9.5 x 104 CFU/g, respectively. In conclusion, the value addition of TTS will reduce postharvest losses, increase product diversities, increase the nutritional contents of tuna, and improve coastal communities' economies.

Keywords: tuna and tuna like species, post-harvest losses, value addition, Tanzania

POSTER PRESENTATIONS

POSTER

Tanzanian octopus fishery trade flow: Market traceability and product leakages

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ABSTRACT

Octopus fishery is important to Tanzania economy as it provides employment and contributes significantly to food security and export earnings. However, the ongoing changes in the international seafood market concerning food safety, ecology, and environment call for a better understanding on the socio-economic structure octopus value chain. This study using primary data collected from all major districts fishing octopus along Tanzania mainland, and review of literature map the trade flow and examine the market traceability system and product leakages.

The results indicate that legislation to address fisheries management and traceability does exist, but they are not implemented. For instance, 100% of fishers and traders indicated that they do not keep records of their catch, where they fish and fishing vessels' information used to access fishing grounds. In addition, fishers think that record keeping is unimportant while traders keep record only for economic purpose, but not traceability. A well-functioning traceability was only noted at fish processing plants throughout the production channels. Inadequate traceability negatively impacts octopus fishery by reducing integrity of product among consumers and profits to fishers. In addition, it contributes unreported and unregulated fishing. It is suggested that traceability can be enhanced through provision of training on importance of record keeping to market traceability. Furthermore, improving market efficiency of current market networks by maximizing the incomes of actors located at the tail of value chain present a good opportunity to enhance existing resource management strategies. This will lead to designing market opportunities that improves efficiency in market system.

Keywords: Octopus traceability; market; supply chain; traceability improvement

POSTER

Using fish traps to estimate fish abundance in marine protected area and community fished reef

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ABSTRACT

WCS tested, in collaboration with MPRU, a new methodology to estimate fish abundance in MPAs and community reefs, using fish traps. The method tries to standardize the use of artisanal fish traps to record the catch of reef fish. To prove the concept, traps were deployed in and around Kirui Marine Reserved Area in the Tanga Marine Reserves System. 20 traps were deployed per site at an average distance of 30m from each other. Traps remained in the water to 24 hours after which information on the fish caught was recorded and fishes released. All fish were released alive making this methodology non-invasive.

Length measurements were transformed to weight estimates through the length-weight relationship with a and b coefficients taken from the fish base. Preliminary results showed that the catches varied across sites. In total, seven species were identified; *Naso brevirostris, Plectorhinchus gibbosus, Ctenochaetus striatus, Diodon Liturosus, Triggerfish spp, Naso Tuberosus and Siganus Sutor.* The fish caught ranged in length between 16-36cm total length (TL) and in weight between 93.2 and 583 grams. Aggregating data per site showed that MPA had a higher number of fish species (i.e. 5 species) with a total biomass of 4523 gr and the size ranged from 17-36 cm TL. On the community fished reefs, the study identified 3 fish species at the size range of 16-28 cm TL and 583-93.2 gr for a total weight of fish of 3095.52 gr. While more data would be needed to draw statistically reliable conclusions, the preliminary study indicates that the fishes caught in the surveyed MPA have in average large body size, higher fish species diversity, and fish biomass compared to the ones in the community fished reef.

Other two marine species with the length ranging from 24-26 cm TL was also found in the trap set in the MPA while in the community reefs no other marine species were observed. The survey did not observe sea urchins in the traps deployed in the MPA while a total of 18 sea urchins were observed in the community fished reef. Results from this preliminary study are encouraging and show how simple technology can be used to monitor reefs in the MPAs and community reefs. During this presentation, we will discuss the advantages and disadvantages of this methodology showing potential for future applications..

Keywords: ecological monitoring, MPA, effective management, fishery management, fish trapping

POSTER

Stock depletion status of dominant by-catch species in Octopus fishery in Tanzania

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ABSTRACT

All commercial fisheries across the world produce by-catch. In tropical areas where multi-species and multi-gear fisheries are popular, one fishery's principal commercial target species may be a by-catch in another. In such circumstances, the management of tropical fish resources remains a challenge. This study aimed to examine the stock status of the vulnerable non-targeted species caught in the Tanzanian octopus fishery as a condition for achieving a Marine Stewardship Certificate. The most common non-targeted by-catch species in octopus fishery were Holothuria scabra (sea cucumber), Panulirus sp (Lobster) and Epinephelus sp (Grouper). These species' stock vulnerability and Octopus cyanea were examined using the Productivity and Susceptibility Analysis (PSA) model as a simplified qualitative risk analysis tool. PSA mode was used because it can be used in studies with limited data. The results revealed that the levels of stock depletion varied among species in the octopus fishery. Octopus, the Sea cucumber and Lobster were at a medium level of depletion. However, Grouper was found to be at a higher risk of depletion. In this regard, a policy-driven action is recommended for grouper fishery in Tanzania. For sustainability of other stocks in Octopus fisheries, this study suggests further research using other fisheries reference tools.

Keywords: By-catch, Octopus cyanea, Productivity Accessibility Analysis (PSA), vulnerable species

POSTER

Reproductive biology and population dynamics of Decapterus kurroides caught off the Coast of Bagamoyo, Tanzania

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ABSTRACT

This study was conducted from June 2020 to May 2021 to investigate the reproductive biology and population dynamics of Decapterus kurroides from ringnet operated artisanal fishers in Bagamoyo. The major peak spawning season for *D. kurroides* was recorded between September and October, and a minor peak between January and February. While the major peak in recruitment was recorded between October and November, and a minor one between February and March. The size at first maturity of the species was 15.4 cm and 15.7 cm TL for males and females, respectively.

Both males and females of *D. kurroides* exhibited negative allometric growth (b< 3; t test, P< 0.001) with b values of 2.64 and 2.78, respectively. The sex ratio (M: F) of D. kurroides was 1:1.24 being significantly in favour of females ($\chi 2 = 18.67$; df = 1; $p < 0.001$). Moreover, the relative fecundity of this species ranged from 585.3 to 1955.7 ova per gram of fish with an average (±SE) of 1019.6 ± 25.7 ova per fish gram. The growth parameters for D. kurroides were: asymptotic length ( ) = 24.26 cm TL, instantaneous growth rate (K) = 0.94 yr-1, theoretical age at birth (t0) = –0.18 years, growth performance index ($\phi = 2.74$, total mortality (Z) at 2.33 yr-1, natural mortality (M) at 1.82 yr-1, fishing mortality (F) at 0.51 yr-1, the current exploitation rate (Ecurr) at 0.22, the optimum fishing mortality (Fopt) at 0.73 year-1 and the lifespan (Tmax) at 3.01 years. The theoretical E0.5 that maximizes surplus production using relative biomass per recruit was 0.240.

The calculated exploitation rate was 0.22, which is below the maximum acceptable limit (Emax = 0.369) and biological optimum (E0.1= 0.303). Although the present study reveals that this species is under-exploited, managers should set strong measures to limit ringnet fishery during peak spawning and recruitment seasons (September, October and November) to protect the stock.

Keywords: Spawning, *Decapterus kurroides*, growth parameters, small pelagic

Presenters' Index

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