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The African Great Lakes Regional Food System

The contribution of fisheries and the case of small pelagic fishes

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About FISH

The [CGIAR Research Program on Fish Agri-Food Systems \(FISH\)](#) is a multidisciplinary research program. Designed in collaboration with research partners, beneficiaries and stakeholders, FISH develops and implements research innovations that optimize the individual and joint contributions of aquaculture and small-scale fisheries to reducing poverty, improving food and nutrition security and sustaining the underlying natural resources and ecosystems services upon which both depend. The program is led by [WorldFish](#), a member of the CGIAR Consortium. [CGIAR](#) is a global research partnership for a food secure future.

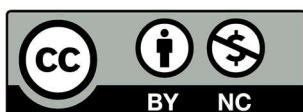
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Front cover: Local market at Mongu in Zambia (Clayton Smith/WorldFish); Page 6: Market and landing site in Kagoma on the shores of Lake Tanganyika, Tanzania (National Task Team, Tanzania); Page 15: Dried fish from inland waters (Clayton Smith/WorldFish); Page 16: Dried fish from Lake Victoria, sold by a women fish trader during the COVID-19 pandemic (Joshua Wesana/University of Greenwich); Page 21: Pounding fish into powder, Zambia (Chosa Mweemba/WorldFish); Page 25: Dried Fish (Mukene) at Kiyindi Landing Site (Lake Victoria) ready for packaging into sacks (Joshua Wesana/University of Greenwich); Page 28: Fishing boat landing at Kagoma port the shores of Lake Tanganyika, Tanzania (National Task Team, Tanzania); Page 31: Catch of the day (Georgina Smith/WorldFish).

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1. Executive Summary

Africa's Great Lakes Region comprises wetlands, rivers and lakes that account for approximately 25% of the earth's unfrozen freshwater surface area, with catchments spanning more than 850,000 km² (Cowx et al. 2019). The larger lakes are Lake Victoria, Lake Tanganyika and Lake Malawi, but the region also includes many smaller natural lakes and constructed reservoirs (Ogutu-Ohwayo et al. 1997). The African Great Lakes are amongst the most important freshwater ecosystems globally: rich in aquatic biodiversity (Darwell and Vie, 2005), and supporting the livelihoods and food and nutrition security of millions of people (Loiselle et al. 2014).

Over 287 million people live around the African Great Lakes (Table 3), and across these countries fisheries and aquaculture employ more than five million women and men (FAO et al., in prep). Across the 10 countries¹ surrounding the African Great Lakes around three million people are engaged directly in small-scale fisheries in inland water bodies for subsistence and income (FAO et al. in prep). These women and men are primarily engaged in harvesting of fish (64%), followed by trade (22%), processing (11%) and pre-harvest activities (2%). Around 44% of those engaged in small-scale fisheries are women, who disproportionately (88%) occupy roles as fish processors and traders (FAO et al. in prep). When the household members of fishers are accounted for, more than 15 million people are deriving income and food services from small-scale fisheries in these countries (Simmance et al., in prep). Whilst there is growth in aquaculture throughout the region, projections suggest that these countries will rely on capture fisheries, particularly small-scale fisheries, for decades to come (Chan et al. 2019). Nonetheless, the values of small-scale fisheries illustrate the need for careful introduction and management of aquaculture development, in ways that complement rather than compete with small-scale fisheries.

Amongst populations living close to water bodies, capture fisheries (which are predominantly small-scale, but industrial fisheries also operate on the lakes) are one of the largest sources of informal employment, and fish are the most accessible animal-source food in the region. In these settings, fish supplements otherwise starchy and low diversity diets. Small fish species dominate fish supplies to local areas, and are widely distributed (particularly in dried form) through predominantly informal, intra-regional trade.

The lakes are experiencing changes in species and biomass competition, with higher abundance of small species relative to larger species (as a result of fishing patterns). Over the past three decades, the quantity of small pelagic fishes caught has increased. Increasing catches and in-water biomass (observed in some areas) are a result of the relatively high turnover (growth and reproduction) rates of smaller species. Despite sustained, and even increasing, catches for some species, supplies of fish do not sufficiently reach all parts of society – particularly for people living further from water bodies, women of reproductive age, and in the first thousand days of life. Fish supplies are reduced where there is poor ecosystem governance, land- and water-use changes, increasing impacts of climate change, high rates of loss and waste along supply chains (Torell et al. 2020), and the export of small nutrient-rich fish out of the region, including for animal feeds rather than direct human consumption (Thiao and Bunting, 2021).

¹ Burundi, Democratic Republic of Congo, Kenya, Malawi, Mozambique, Rwanda, South Sudan, Republic of Tanzania, Uganda and Zambia

Improving investment in, and governance of, small pelagic fisheries presents a series of opportunities for the sustainable development of the Africa Great Lakes Region, and improving nutrition outcomes further afield. Yet, to date these opportunities have received relatively low levels of policy and investment attention. In the final decade of the Sustainable Development Goals (which are intended to be attained by 2030), there is a growing sense of urgency to secure, and to improve, the contribution that fish make within agri-food systems to support nutrition, health, incomes for the poor, and environmental sustainability. There is growing recognition that fisheries and fish supply chains, particularly those focused on small pelagic species, offer perhaps the strongest and most immediate opportunities for sustainable development in the region.

This Discussion Paper synthesizes current research and data on the status and values of fisheries and fish supply chains in the Africa Great Lakes Region, particularly those focused on small pelagic fish. We also use illustrative (rather exhaustive) examples of innovations and investments that have led to improvements in fisheries sustainability, nutrition outcomes, livelihood and wellbeing improvements, and greater inclusivity and efficacy of governance. Based also on existing commitments made in regional, global and national strategies we distil 10 action points for stakeholders, governance actors, funders and investors concerned with progressing sustainable development of the region. The Discussion Paper, and these 10 points, have been prepared for the renewed attention and commitment of actors attending the '5th SADC Industrialization Week' addressing the theme 'Bolstering Productive Capacities in the Face of COVID 19 Pandemic for Inclusive, Sustainable Economic and Industrial Transformation'. As part of SADC Industrialization Week, there will be a fisheries focussed side event on "Promoting Small Pelagic Fisheries in the African Great Lakes, A regional think tank and planning meeting".

Renewed commitment and increased investment in these 10 points for action, contribute to securing and improving the contributions fisheries and small pelagic fish make to food systems of the African Great Lakes region, i.e., spanning all elements of the food system – from environment, people, processes, infrastructures, institutions, and the activities from production, processing, distribution, preparation and consumption of fish as food (these 10 points are expanded on page 31);

1. Integrate fish into food, health and other cross-sector policies
2. Enable inclusion of fisheries, supply chain actors and their civil society groups into policy and investment decisions
3. Gender responsive and inclusive policy and action
4. Optimise management and secure supplies of small pelagic fishes
5. Increase recognition of the values small-scale fisheries and small pelagic fish provide for nutrition and health
6. Reduce loss and waste, ensure food quality
7. Enhance the economic benefits of small pelagic fishes
8. Design initiatives and policies that meet the needs of the most nutritionally and economically vulnerable
9. Develop supplementary and diverse livelihoods that build resilience and prosperity within economies of fishing communities
10. Invest in the research-policy nexus, and research that informs better policy

2. Introduction

2.1 An introduction to small pelagic fish in the African Great Lakes Region

Although small pelagic fishes dominated the wild-capture fisheries' catches in the ALGR, policy attention traditionally focuses on large-sized fish, hence minimal investments in scientific research and governance/management initiatives. Small pelagic fish species of the African Great Lakes Region (AGLR) are key sources of nutrients, and their harvesting and trade supports the livelihoods of many in the region and beyond. Since they can be eaten whole, small pelagic fishes can readily enrich starch-dominated diets of vulnerable population groups with key vitamins and minerals as well as healthy protein and polyunsaturated fatty acids. The small size of these fish species makes them more affordable and easy to prepare, hence are popular among rural and urban poor consumers.

Small pelagic fish species exhibit high turnover rates (Kolding et al., 2019) and are relatively resilient to fishing pressure, in some lakes biomass is increasing, whereas in others it has declined (LVFO, 2020). Adjusting management arrangements for the changing nature of the fisheries, and for the different life history and resilience traits of small pelagic fishes offers opportunities to optimise production of these species. Demand for small pelagic fishes as feed ingredients is increasing in recent years (REF). Growing demand for food is driving rapid conversion of land in the AGLs catchments into farms, providing avenues to extract water for irrigation. In some parts of the AGLR, abstraction of rivers to construct dams for hydro-electricity generation is reducing water flows necessary to sustain fish production.

As pressure is mounting for countries in the AGLR to increase agriculture, fisheries, aquaculture as well as energy productivity, policymakers need high level technical guidance in order to identify and manage tradeoff in the manage and use of natural resources, the interaction with other sources of fish supply, investments in supply chains improvement and integration of small pelagic fish in nutrition and health programming and targets.

2.1 Background on the African Great Lakes Region

The AGLR covers eleven countries in East and Southern Africa, including seven major lake basins and several smaller lakes, rivers and water bodies. This vast aquatic ecosystem is home to some of the most biodiverse freshwater species in the world, and supports abundant inland capture fisheries. However, it is one of the most socially and economically vulnerable regions, with one in three people experiencing food and nutrition insecurity. The region faces one of the greatest challenges in meeting the Sustainable Development Goals (SDG) and ending hunger by 2030 amidst increased population growth and climate change. Inland fisheries are the main domestic supply of fish, dominated by small-scale actors, with low aquaculture development in the region. The sector plays a critical role in rural economies and in supplying nutritious food for vulnerable populations. Fisheries provide employment to thousands of women and men across value-chains – those participating in fisheries supply chains have lower poverty and vulnerability to shocks (Simmanse et al., in prep). The sector also plays a critical role in nutrition: being the main accessible animal source food in diets in urban and rural environments (Simmanse et al., in prep). Children and households living near inland fisheries consume more fish and have higher dietary diversity than those further

away (O'Meara et al., 2021;). Fish are often purchased, and the trade of dried and smoked small fish is vital for increasing access to nutritious food in remote regions (Nankwenya et al., 2017;).

Economic development, urbanization and population growth have all contributed to changes in food systems i.e., away from traditional to mixed systems, to increasingly global food systems where access to food is increasingly connected to markets. Nonetheless, small-scale fisheries still continue to distribute fish through informal local to intra-regional fish trade (Chimatiro et al., 2018). Despite this, over two thirds of children in Zambia and Malawi lack ready access to fish due to failures in fisheries supply chains (O'Meara et al., 2021). When fish is reaching people further from water bodies (i.e., the original source of fish) it is in the form of dried fish products. Dried fish and smoked fish in the AGLR have been reported to have inelastic demand, meaning that low income consumers will still buy fish regardless of increasing price as the other alternatives of animal protein such as poultry and beef are not affordable (Nankwenya et al., 2017).

The significant growth in demand for fish is in some instances being met by imports of fish, but these are not accessible to local vulnerable populations (Kakwasha et al., 2020), and the supply chains of these fish are vulnerable to shocks (e.g., Covid-19). As demands on agriculture, including aquaculture, grow globally, so too has the demand for small fish as key ingredients for feeds, which may mean these small fish are being distributed away from local nutrition (Thiao and Bunting, in press; Wesana et al., in prep). Trade policies are needed that do not adversely affect nutritional needs of people within the ALGR, with development of local sustainable alternative feeds for aquaculture (Bunting et al., in prep), and harmonisation of food safety policies for provision of safe fish products. Reducing fish waste and loss across value chains, through improved processing, handling and storage technology and facilities, and fish-based products, can also enhance the supply and distribution of fish to those most vulnerable.



2.2 Purpose of this Discussion Paper

The aim of this discussion paper is synthesis of existing policy and strategic commitments that have been made already that implicate the fisheries for small pelagic fish. The Discussion Paper also presents some historical and also emergent data and evidence to help refine resultant actions to lead to improved nutrition, sustainability and economic potential of fisheries in the region. This discussion paper synthesizes current research and data on the status and values of fisheries and fish supply chains, particularly those focusses on small pelagic fish, operating in the Africa Great Lakes Region. We also use illustrative (rather exhaustive) examples of innovations and investments that have led to improvements in fisheries sustainability, nutrition outcomes, livelihood and wellbeing improvements, and greater inclusivity and efficacy of governance.

The Discussion Paper, and its 10 points require renewed attention and commitment from the participants of the '5th SADC Industrialization Week' that examines 'Bolstering Productive Capacities in the Face of COVID 19 Pandemic for Inclusive, Sustainable Economic and Industrial Transformation'. As part of this week, partners will host a side event on "Promoting Small Pelagic Fisheries in the African Great Lakes, A regional think tank and planning meeting".

3. Geography, population and fishery resources of the Africa Great Lakes Region

3.1 Geography of the African Great Lakes Region and its population

Africa's Great Lakes Region covers an area of more than 850,000 km² of vast lakes, rivers and wetlands that comprise approximately 25% of the earth's unfrozen freshwater surface area. There is no universally defined boundary for the African Great Lakes region, however the region comprises seven major lake basins: Albert, Edward, Kivu, Malawi, Tanganyika, Turkana and Victoria, and rivers: Congo, Zambezi and tributaries to the Nile, which flow to the Mediterranean Sea and Indian Ocean (Cowx & Ogutu-Owhayo, 2019). Hundreds of smaller lakes, wetlands and intermittent water bodies are also found across the region. The AGLR covers 10 countries (**Figure 1**): Burundi, Democratic Republic of Congo, Kenya, Malawi, Mozambique, Rwanda, South Sudan, Republic of Tanzania, Uganda and Zambia (Cowx & Ogutu-Owhayo, 2019). Over 287 million people live around the African Great Lakes (Lowe-McConnell 2003); and most of these people rely on fisheries, particularly for small-pelagic species, their food and nutrition security as well as livelihoods (**Tables 1 & 2**).



Figure 1 Map of the AGLR and the seven major lake basins, as well as coastlines. Source: (Kolding et al., 2019).

Table 1 The AGLR and River & Lake Basin States

River/Lake Basin	Mean annual run-off (MCM ^a /year)	Basin population	Basin States
Zambezi	94,000	32 million	Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia, Zimbabwe
Congo	1,260,000	75 million	Angola, DRC, Tanzania, Zambia
White Nile	86,000		Sudan, South Sudan, Uganda
Albert		70,651,488	DRC, Uganda
Malawi/Nyasa	29,429	10,297,926	Malawi, Tanzania, Mozambique
Tanganyika	32,686	13,754,496	Tanzania, Burundi, Zambia
Kariba	5,259	6,240,000	Zambia, Zimbabwe
Kivu		2,203,403	DRC, Rwanda
Victoria		47,436,052	Kenya, Tanzania, Uganda
Mweru	5,022	4,269,364	DRC, Zambia
Turkana		10,922,974	Ethiopia, Kenya

Source: Adapted from Heyns (2003); ILEC & UNEP (2016); ^aMillion cubic metres. DRC = Democratic Republic of Congo.

3.1.1 The largest of the African Great Lakes

3.1.1.1 Lake Tanganyika

Lake Tanganyika has high levels of endemism, especially for cichlids. Around 300 of the 470 recorded species (64%) are cichlids, including species-rich lineages of substrate-brooding as well as mouth-brooding cichlids (Darwall et al., 2011). Lake Tanganyika is situated within the Albertine Rift Valley, the western branch of the East African Rift, and is confined by the mountainous walls of the valley. The lake has a surface area of approximately 32,600 km², shared by the Republic of Burundi (8%), the Democratic Republic of Congo (45%), the United Republic of Tanzania (41%) and the Republic of Zambia (6%). With a maximum depth of 1,470 m, Lake Tanganyika is the deepest lake in Africa and second deepest lake in the world, second only to Lake Baikal in Russia, which has a maximum depth of 1,637 m. The catchment of the lake is extensive, covering an area of 223,000 km² that includes the Lake Kivu basin. The small pelagic fishes of economic importance are the Lake Tanganyika Sardine (*Limnothrissa miodon*), which occupies a more inshore habitat throughout its life; and the Lake Tanganyika Sprat (*Stolothrissa tanganicae*), whose population inhabits relatively shallow shelf areas. *S. tanganicae* is also the principal food source for other larger pelagic fish species as well as for many bathypelagic and scavenging benthic fish and invertebrates. The sardine and sprat, as well as the Sleek Lates (*Lates stappersii*), constitute the major commercial fisheries. Both commercial and artisanal fisheries yield 165,000-200,000 tonnes of fish per year, employ about 100,000 people in fisheries related activities, and provide 25-40 percent of the protein needs to one million people living around the lake.

3.1.1.2 Lake Malawi/Nyasa/Niassa

Lake Malawi (also called Nyasa in Tanzania and Niassa in Mozambique) lies in the southern end of the western arm of the East African rift valley, at 474 m above sea level. The lake has a surface area of 29,500 km². In 2018, the Malawi part of the lake alone registered a total landing of 208,632 metric tonnes (artisanal production - 205,814 metric tonnes and commercial production 2,818 metric tonnes), accounting for 94 percent of the national total fish landings (Government of Malawi, 2019). Small pelagic fish species comprise the majority of the catch volume (**Figure 2**). Lake Malawi is considered to be the most diverse lake in the world, with exceptionally high diversity and endemism of freshwater species. Lake Malawi has over 800 species of cichlid fishes of which over 99% are endemic, around 909 species of freshwater decapods (crabs and shrimps), fishes, molluscs, odonates (dragonflies and damselflies) and plants native to the national park, of which 423 species (47%) are endemic to the catchment (Sayer et al., 2019); and many of which have not yet been formally described (Konings et al., 2016; Snoeks et al., 2000).

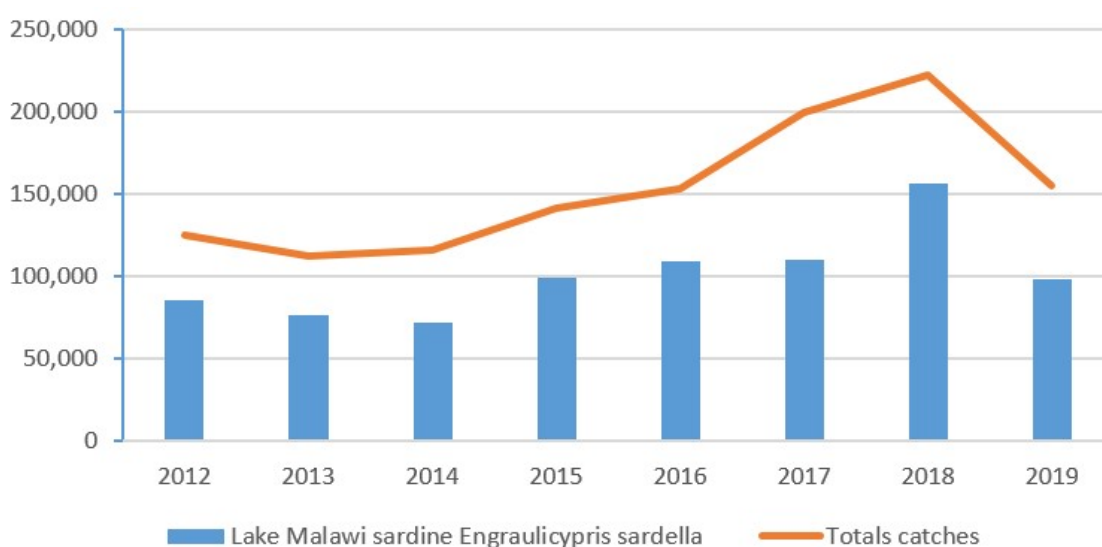


Figure 2 Total fish catches from Lake Malawi (tonnes) between 2012 and 2019 and proportion of catch consisted of the small pelagic fish species *Engraulicypris sardella*. Source: (Government of Malawi, 2019).

Lake Malawi and its influents, Lake Malombe and the Upper Shire River that connects the two lakes (Thieme et al., 2005). This region includes an estimated 800 species of fishes, most of which are endemic (see section 3.3.3). However, many species are not yet formally described, and have not been assessed for the IUCN Red List. In 2013, Tanzania reported that Lake Nyasa contributed about 3% to national fish catches (9,913 tonnes).

3.1.1.3 Lake Victoria

Lake Victoria may contain more than 600 endemic species (Thieme et al. 2005), which are largely made up of cichlids (Sayer et al. 2018), and several are critically endangered, with some now possibly extinct (Harrison and Stiassny, 1999). The most recent survey (by LVFO) indicates that the lake has around 3.47 million tons of fish, including *Caridina*, which was a 29% increase from the previous year of 2019 (2.68 million tons). Nile perch (30%) was the most dominant followed by *C. nilotica* (28%), dagaa (27%), and haplochromines and others (15%). The biomass of dagaa was estimated at mean standing stock of 950,714 tons which was concentrated in coastal and deep transects (and less in inshore areas). The biomass

of dagaa had increased by around 10% since the previous year, but this increase was only observed in Uganda and Kenya, whereas in Tanzania biomass had decreased.

3.1.1.4 Lake Kivu

This is one of the two smallest African Great Lakes, but is the third deepest and sits at the highest altitude. Lake Kivu is located in an area with one of the highest population densities and population growth rates in the AGL region. Lake Kivu is the largest local source of fish in Rwanda, providing more than 20,000 tons of fish per year and subsidizing fish imports for animal protein. The fishery supports 500,000 people in Rwanda and the Democratic Republic of Congo. The introduced Lake Tanganyika sardine (*Limnothrissa miodon*) forms the main fishery. The fishery supports 500,000 people in Rwanda and the Democratic Republic of Congo. The lake is home to around 28 fish species, half of which are cichlids found only in Lake Kivu. Extraction of the large volumes of methane in Lake Kivu is expected to generate up to 25 megawatts of electric energy but this extraction needs to be done in a safe manner as leaks could harm human health, biodiversity and the climate. There is a high potential for ecotourism on the islands and around the lake. Rapidly increasing fishing pressure, deforestation, agricultural intensification and urbanization and climate change are the major threats to the lake.

3.2 Small Pelagic Fisheries in the African Great Lakes Region

The African Great Lakes Region is among the major world sources of inland fisheries, others are the Lower Mekong Basin, the Peruvian and Brazilian Amazon, and the Brahmaputra and Ayeyarwady river basins (FAO, 2020). Species composition and biomass of many AGLs have shifted over the last three decades towards small, more productive and faster turnover fish (Kolding et al. 2019). Small pelagic species now make up most of the catches from nearly all African lakes; accounting for up to 75 percent of total yields, or almost 780,000 tonnes each year (Kolding et al., 2019: **Table 2**). The Lake Malawi sardine *Engraulicypris sardella* (locally referred to as usipa) has been reported to be among the most harvested small pelagic species in the world, with total landings of 156,717 tonnes in 2018 (FAO, 2020). Consequently, FAO and other agencies recognise the importance of small pelagic fishes as a highly important resource for sustaining the continued growth of Africa's human populations (Kolding et al., 2019). Yet, policy and investment attention remains occupied with larger species of fish, given their higher monetary value.

The ecological shift towards increased populations and catches of small pelagic fishes has had knock on economic impacts. For example, prices of small pelagic fishes have been reported to be rising higher than those of larger species, such as tilapia. The average retail prices of fresh catfish and fresh tilapia in Malawi tend to either remain stable or decrease by 4 and 10 percent while prices for fresh usipa increase by 3 to 4 percent, and dried usipa increase by 2 to 20 percent (IFPRI 2021). Likewise, kapenta prices in Lusaka have been consistently higher since 2019 (ZK45/kg) to date (2021) (ZK59/kg), than those of bream ZK30.3, ZK58/kg) (Zambia, 2020).

Table 2 Production and yield characteristics of the main small pelagic species in a range of major African lakes and reservoirs

Water body	Surface Area (km ²)	Main pelagic fish species	Total fish catches in the 1980s (tonnes)	Total fish catches in 2019 (tonnes)
Victoria (Lake)	68 800	<i>Rastrineobola argentea</i>	158 240	509 120
Tanganyika (Lake)	32 900	<i>Stolothrissa tanganyicae</i> & <i>Limnothrissa miodon</i>	72 380	11 860
Malawi (Lake)	30 800	<i>Engraulicypris sardella</i>	30.8	156,717
Turkana (Lake)	≈7 000	<i>Brycinus minutus</i> & <i>Brycinus ferox</i>	unknown	unknown
Mweru (Lake)	5 120	<i>Microthrissa moeruensis</i>	4 608	50 176
Kivu (Rwanda)	1 055	<i>Limnothrissa miodon</i>	1 (uncertain)	15 825
Kariba (River)	5 365	<i>Limnothrissa miodon</i>	11 803	30 044
Cahora Bassa (River)	2 665	<i>Limnothrissa miodon</i>	999	15 990

Source: FAO-FishStat (FAO, 2021) and (Kolding et al., 2019)

4. Fish in food systems of the African Great Lakes Region

4.1 Fish consumption, food security and nutrition in the AGLR

Fish are the most accessible animal-source food in the region, and fish complements otherwise starchy and low diversity diets. Small fish species dominate fish supplies to local areas, and are widely distributed in dried form through (largely informal) intra-regional trade. While fish has generally been reported as an important source of food, such importance has not been reflected in national food security, nutrition or food systems policies and strategies.

The average per capita supply of fish in Africa had peaked at 10.5 kg in 2014 and then declined to 9.9 kg in 2017 (FAO, 2020). Consumption rates experienced by people in Malawi, Zambia, Uganda (i.e., the landlocked countries in the AGLR) are above the continental average of supply (**Table 3**); most likely due to supply from the AGLs. The lack of recognition of the importance of small pelagic fish for nutrition, food security, livelihoods and public health has also prevented the necessary investments for improving the quality, shelf life and public awareness of this vitally important resource (Kolding et al. 2019).

Despite the potential for fish to contribute toward food security and nutrition, many countries in the AGLR are struggling to deal with malnutrition. For example, countries of the Southern African Development Community (SADC) in 2018 fell under the “serious” category of hunger and undernutrition, casting doubt as to whether the SADC region will achieve Sustainable Development Goal 2 (Kaunda and Chimatiro, 2019). Although the 2020 Global Hunger Index showed an improvement for most countries in the AGLR (**Table 3**), challenges still remain. Within Burundi, Democratic Republic of the Congo and South Sudan the degree and prevalence of hunger was reported to be “alarming” (von Grebmer et al., 2020). Therefore, policymakers in the AGLR need technical support in order to ensure that fish is incorporated into national food security, nutrition and food systems policies and strategies.

The African Union has recognised the continued high level of malnutrition in Africa as a matter of serious concern and having enormous public health impacts, including significant consequences for physical, mental, cognitive and physiological development and, therefore, become a critical human rights issue (African Union, 2015). Furthermore, inadequate dietary/nutrient intake and diseases have been identified as the two main causes of malnutrition in Africa. The African Regional Nutrition Strategy (2015 – 2022) urges African countries to improve nutrition through agriculture programmes, by maintaining or improving the natural resource base and production of nutrient-dense foods, including fisheries (African Union, 2015).

Latest nutrient value research on fish in the region by catches (FAO et al. in prep.), confirm the health benefits associated with consumption (e.g., Byrd et al, 2021; O’Meara et al, 2021; Marinda et al, 2018). Small whole fish are among the most vital suppliers of micronutrients, such as vitamins, iodine, iron, zinc and calcium, which all play a critical role in cerebral development, immune system support and general health (Kolding et al., 2019; HLPE, 2014; Kawarazuka & Béné, 2011). The introduction of 10-20 g of dried kapenta in to a child’s diet can meet most of the child’s nutrient requirements, including minerals (zinc, calcium, iodine, iron), vitamin B12, long-chain omega-3 polyunsaturated fatty acids and choline), but not vitamins A, C and E (Haug et al., 2010). The nutritional status of children aged 6-23 months in Zambia, is associated with fish consumption, with children consuming fish are less likely to be stunted. The small fish (Kapenta) are particularly important in the diet of children in

urban poor households in Zambia and contributed to better nutritional outcomes (Marinda et al., 2018). A higher dietary diversity and food variety and dietary patterns characterized by maize, fish, beans and poultry intake was reported to be beneficial for growth of young children in this area, as these were associated with a 6 and 11% reduction in wasting (i.e., measures as ratio of weight to height), respectively.

High concentrations of nutrients are also found in other inland small pelagic species such as Mukene (*Rastrineobola argentea*), widely consumed in the countries around Lake Victoria. Serving of Mukene fulfils 27 percent of daily recommended Zinc intake for a pregnant woman and 24 percent for an infant (Byrd et al., 2021). Zinc is commonly lacking in many grain-based diets in countries in the AGLR, hence, in Malawi, it is included in the maize fertiliser for higher dietary uptake. For example, Usipa from Lake Malawi contain 444 mg/100 g wet weight of DHA, and serving of Usipa fulfils over 100 percent of the recommended DHA intake for both women and children within the first 1000 days of life, compared with the Atlantic Cod, which provides 30 percent or less (Byrd et al., 2021). However, wider challenges on health and nutrition status in fishing communities (FAO et al. in prep).



4.1 Fisheries contributions to economies of the AGLR

Contribution of fisheries to the economies of the countries of the AGL is smaller than that of agriculture, and as a result, allocations of the national budget to the sector tend to be lower. This has further limited the capacities of the ministries responsible for fisheries to put in place and implement management measures to safeguard the sector from total collapse. There is a need for countries to deepen their understanding about the relevance of their fisheries and aquaculture to economic development. An important step is to determine the economic value of the national fisheries; and use those values to guide policy and budget planning.

Two estimates of the economic contribution of Africa's fisheries are available. In the AGLR, the fisheries and aquaculture sectors account for millions of direct and indirect employment; an estimated 4% of the region's Gross Domestic Product (GDP) and 9% of the region's agriculture GDP (de Graf & Garibaldi, 2014). The more recent estimate using the Indicator of Relevance of Fisheries and Aquaculture showed that in many countries in the AGLR, fisheries and aquaculture sectors are considered key to development (Murekezi et al., 2020; **Table 3**). The exception was in Burundi, South Sudan and Sudan, where despite fisheries being important, national development policies don't prioritise the sector.

Where governments invest in smallholder farming, livestock, fishing and forests, evidence suggests poverty can be reduced. In the AGLR, SADC member states have prioritised two key pathways to food and nutrition security: first fish as a direct source of nutrients and second as a source income with which people access buy other types of food (Kaunda and Chimatiro, 2019).



Table 3 Performance matrix of the relevance of fisheries and aquaculture at the country level.

Country	IRFA*	Per capita supply (kg)	Total Employment	Employment (Women) ³	Poverty rate (%)	Global Hunger Index (2020) Ranking
Angola	11	20.2	33,298	11,721	51.8	26.5
Botswana	3	2.9	779	274	14.5	22.6
Burundi	6	2.9	10,267	3,522	72.8	35 – 49.9
DRC	7	5.0	956,815	712,031	77.2	35 – 49.9
Kenya	3	3.1	204,887	122,348	37.1	23.7
Malawi	7	12.3	195,586	30,719	70.8	22.6
Mozambique	9	12.5	106,998	992	63.7	33.1
Namibia	9	12.5	9,323	3,282	13.8	19.1
Rwanda	5	7.9	5,499	0	56.5	28.3
Sudan	3	1.1	219,765	77,359	12.2	27.3
South Sudan	1	3.0	220 000	-	44.7	35 – 49.9
Tanzania	7	7.0	904,750	46,279	49.4	25
Uganda	9	11.3	1,968,819	791,321	41.5	20–34.9
Zambia	7	12.0	312,210	125,485	58.7	20–34.9
Zimbabwe	3	3.5	34,963	12,307	33.9	20–34.9

Source: Compiled from various sources: (Murekezi et al., 2020; FAO, 2020; de Graf & Garabaldi, 2014; World Bank, 2020; von Grebmer et al., 2020)

Note: *IRFA is the Indicator of Relevance of Fisheries and Aquaculture where 1 is low relevance. DRC = Democratic Republic of Congo. The Global Hunger Index of between 20 and 34.9 is considered serious and those above 50 are extremely alarming.

These small pelagic fisheries form the basis of much employment in the AGLR. Employment comes from harvesting itself, with a single fishing unit operated by 10 – 15 crew. Trade and processing provide much employment, particularly of women (Nankwenya, 2018) (**Table 3**). Value chains that extend beyond national borders of the riparian countries are a major source of informal employment. International trade of dagaa (Silver cyprinid, *Rastrineobola argentea*) from Lake Victoria is an important source of livelihoods to women and youths as vulnerable groups; the fish is sold to all riparian countries (Odongkara et al., 2010). Cross-border trading of Silver cyprinid is enormous. Approximately 4.5MT of dagaa from Lake Victoria crosses the Tunduma/Akonde border daily from Tanzania to Zambia, worth an estimated TZS 0.9 billion (USD 4.4 million) (Uwamahoro et al., 2017).

4.1 Governance of fisheries in the AGLR

The Southern African Development Community has endorsed the Industrialisation Strategy & Roadmap (2015 – 2063), in which fisheries and aquaculture have been prioritised because (i) fish can form viable regional value chains capable of interacting with global value chains; and (ii) fish can be a tool for accelerating the economic empowerment of youth and women

(Kaunda & Chimatiro 2019). Small pelagic fishes already play a significant role in regional commodity value chains. For example, Kapenta from Lake Kariba, usipa from Lake Malawi and umena from Lake Victoria serve as regional products, as they are supplied to many countries, including Malawi, Mozambique, Democratic Republic of Congo, South Africa, Zambia and Namibia. These small pelagic fishes have the potential to enter into continental and global value chains, on condition that there is sustainable production, value-addition and functional cross-border marketing and trading systems.

Further to policy incoherence, protocols for national fisheries data collection and analysis are not comprehensive enough and as a result, a number of issues are not accounted for in fisheries statistics. One of the major issues overlooked in fisheries statistics are women and youth. Despite the significant participation of women in the sector, data collection systems in most AGLR countries fail to capture sex disaggregated data and overlook the youth who are employed in the sector. These data gaps reinforce the policy neglect of gender issues in fisheries, aquaculture and also other agricultural sectors.

Gendered barriers limit the capacity of women to generate incomes and build assets from fisheries; especially for poor women who face multiple barriers, including limited access to technology, extension services, infrastructure and credit. For example, women face gender-based discrimination, restrictions by husbands and social exclusions that prevent them from engaging in the lucrative small-scale fisheries value chains in Malawi (Manyungwa et al., 2019). The FishTrade Programme of WorldFish, NEPAD and African Union's Inter-African Bureau for Animal Resources (AU-IBAR), reported that failure to capture the participation of women in informal trade also reduced the development of gendered strategies. However, in most cases, income received from cross-border fish trade, especially by women, is used to improve livelihoods – just as in the case of formal fish trade (Chimatiro et al., 2018). Therefore, AGLR needs evidence-based, gender-focused interventions and innovation that address inequalities in the fisheries in order to positively influence production and equitable distribution of fish and achieve efficient food systems.

Poor fishing communities, especially women, face consequences of multidimensional aspects of poverty (FAO et al. in prep). As such, increased dependence on fisheries in the AGLR has increased poverty and inequalities among fish-dependent communities (Somoebwana et al., 2021). Therefore, ministries responsible for fisheries need to interact with other ministries and agencies in order to ensure that fishing communities are provided with other social services, such as health, water and sanitation, social protection as well as education.

4.3 Diversity of fish supplies

Over the past 30 years, fish has increased in the relative proportion of animal source food intake (e.g., Gilbert et al., 2019). Freshwater fish, dominated by small pelagic fishes, are the main animal source food consumed in both urban and rural households in the AGLR (Simmance et al., in prep). For example, in Lake Malawi, *Engraulicypris sardella*, locally known as usipa, accounted for 71 percent of all fish eaten in 2018, and is the major source of fish protein in the Malawian diet (Government of Malawi, 2019).

Whilst there is growth in aquaculture throughout the region, projections suggest that these countries will rely on capture fisheries, particularly small-scale fisheries, for decades to come (Chan et al. 2019). Nonetheless, the values of small-scale fisheries illustrate the need for careful introduction and management of aquaculture development, in ways that complement rather than compete with small-scale fisheries.

Consumption of fish in the AGLR are, on average, moderate to high relative to the Lancet universal reference diet 10.2kg of fish per year for people over two years of age (Willett et al., 2019). Households living close to water bodies consume fish twice as much and three times as frequently than households further from water bodies, and for these people fish increases their dietary diversity (O'Meara et al., 2021). A higher percentage of households reported consuming fish (33-73 percent compared to other animal-source foods (<40 percent eggs and beef, <20 percent poultry, goat and pork) in Malawi, Uganda and Tanzania (Simmance et al., in prep). This supports the needs of those most vulnerable – accessible food source for the urban and rural poor (e.g., FAO et al. in prep; and many others), reduces inequality in access to nutrient-dense food for rural populations (Simmance et al., in prep). This is particularly important where there are noticeable differences in consumption of fish between rural and urban areas, and across wealth strata. In urban Lusaka, greater household wealth has been associated with more frequent and more diverse fish consumption and the consumption of larger-sized fresh fish (Genschick et al., 2018). Tilapia tends to be consumed by wealthier households, whereas dried kapenta or a mix of small fish species (*Limnothrissa miodon* and *Stolothrissa miodon*) is more commonly consumed by households in the two lowest wealth quartiles. However, women and children do not always benefit in accessing fish – with 65 percent of children failing to consume fish in rural Zambia and Malawi (O'Meara et al., 2021).

4.4 Regional trade and distribution

Sustainable management of fisheries and aquaculture production has been singled out as one example of food systems practices which do not require land use change and do not create demand for more land conversion (FAO, IFAD, UNICEF, WFP and WHO, 2020). Informal cross-border trade is an important livelihood activity in Africa, contributing substantially to food and nutritional security and offering potential to contribute to poverty eradication. The current narrative often equates informal cross-border trading to smuggling; however, in many contexts this activity symbolises innovation and entrepreneurship, rather than an illegal activity intended to evade tax. Informal fish trade remains largely invisible to policy-makers and hence, receives limited investments from governments. In most cases, income received from cross-border fish trade, especially by women, is used to improve livelihoods – just as in the case of formal fish trade. Promoting intra-regional trade can provide a route to develop pro-poor trade policies with direct development impact at the household level. Field studies reveal that intra-regional informal fish trade is a well-organised entrepreneurial activity with the potential to support regional economic development and to enhance the lives of Africans. There is a need for further investments and attention from policy makers to unlock the potential of this important and often overlooked economic activity.

5. Drivers of change influencing fish agri-food systems

5.1 Livestock, aquaculture and non-food uses

While agricultural commodities are used as food, feed, fuel and raw materials for industrial applications; for fish, the main drivers of demand are population dynamics, disposable income, prices and consumer preference. O'Meara et al. (2021) reported that other socio-cultural drivers such as maternal education, nutritional knowledge and food preferences mediate the translation of wealth into diet quality. At the same time, growth in livestock and aquaculture industries will increase the demand for small fish as feed, and risks undermining the potential of small fish to contribute to positive local nutrition outcomes (Thiao and Bunting, in press; Wesana et al., 2021). The growth of the aquaculture and poultry industries have contributed to the rise in demand for dagaa (*Rastrineobola argentea*) which is used as a feed ingredient (LVFO 2016). Consequently, dagaa was utilised in the region as human food in only a small proportion of less than 30%, with the rest going into industrial feed mills as raw material for production of feeds for poultry, fish and livestock (LVFO, 2016).

5.2 Poor fisheries governance

According to NEPAD, the benefits from fisheries resources in Africa are severely threatened by ineffective fisheries governance, resulting in fisheries being over-exploited economically and often well beyond biologically sustainable limits (NEPAD, 2009). Poor performance of fisheries management in Africa, including the AGLs, has been characterised by decline in fish catches, decline in fish exports, increase in use of illegal fishing gears and methods, overfishing and increase in catching of immature fish. Many governments in the AGLR are trying to address poor governance aimed at addressing the difficult challenge of managing the fisheries resources. One measure has been the redistribution of responsibility between the central government (usually the Department of Fisheries) and the end users ("the fishing community") as the two principal players in co-management reform (Hara, 1996; Njaya, 2007). While such co-management structures have gone a long way to address governance challenges, analysis, based on decentralization and power frameworks in Lake Malawi has shown that co-management arrangements are characterized by unequal power distribution among these different actors, often resulting in the marginalization of the fishers themselves (Njaya et al., 2011). While the Department of Fisheries and Beach Village Committees draw their formal powers from the Act of Parliament, policy, and legislation, the traditional leaders have remained influential through their customary powers (Njaya et al., 2011). Therefore, policymakers should recognise that co-management reforms will not achieve their true empowerment objective and benefits to the most marginalized households unless the political dimension (the question of power distribution) of those reforms is recognized and addressed (Njaya et al., 2011).

5.3 Climate change and disaster risks

According to NFDS (2013), fishers and fish farmers are affected by disasters such as storms, cyclones or hurricanes with associated flooding and tidal surges, droughts, floods and landslides. The frequency and intensity of these extreme weather events is expected to increase due to climate change, thus increasing the development challenges that fishing communities are already facing. The fisheries and aquaculture sectors are also vulnerable to general disasters of human origin such as oil and chemical spills. It is for this reason that

the Joint Ministerial Conference on Agriculture, Fisheries and Aquaculture, which was held in Addis Ababa in 2014, urged “Member States to include fisheries/aquaculture in existing climate change adaptation and mitigation, and Disaster Risk Management Policy and Strategy” (African Union, 2014). While some positive impacts of climate change have been identified (e.g., increased precipitation leading to the expansion and improved connectivity between some fish habitats), deliberate efforts to take advantage of them, new investments as well as flexibility in policies, laws and regulations, and post-harvest processes are needed. It is recommended that adaptive management measures be within the framework of an ecosystem approach to fisheries to maximize success (Barange et al., 2018).



As a result of climate change, the African Great Lakes Region has experienced both the rise of air (Wardlow et al., 2012), elevated has decreased water temperatures (Tierney et al., 2010, Vollmer et al., 2005) and decreased precipitation (Niang et al., 2014). At the same time, some parts of the AGLR have experienced extreme precipitation events (e.g., droughts, heavy rainfall) over the past 30 to 60 years (Niang et al., 2014).

The impact of climate change on fish production has been apparent. In this regard, an approximately 30 percent reduction in fisheries production in Lake Tanganyika has been attributed to climate change (O'Reilly et al., 2003), as increased temperatures and reduced wind velocity had weakened lake mixing, with a subsequent reduction in nutrient availability. Cohen et al., (2016), reported that paleoclimate and instrumental records demonstrated sustained warming in Lake Tanganyika during the last ~150 y, which affected biota by strengthening and shallowing stratification of the water column. Reductions in lake mixing have depressed algal production and shrunk the oxygenated benthic habitat by 38% in our study areas, yielding fish and mollusc declines. In Lake Kariba, the influence of climatic variables on the stocks of the sardine fish species *Limnothrissa miodon* (Boulenger), was immense. As rainfall is decreasing at a rate of 0.63 mm per year around Lake Kariba, temperatures is rising since 1964, and Kapenta fish production has decreased at an average rate of 24 metric tons per year (Ndebele-Murisa, 2011), leading to a drastic decline in small-scale fisheries catches since 1974.

Climate change is expected to impact fishery- and aquaculture-based livelihoods in a number of ways, for example through changes in the availability and quality of fish for food and less stable livelihoods, including increasing economic instability (e.g., extreme variations in catch, changing distributions and abundance of target species, fluctuations in catch potential (Poulain et al., 2018). Impact on livelihoods of fish-dependent communities will be more severe in the AGLR as countries are most dependent on fisheries resources for food and nutrition security; and the countries lack financial resources to invest in climate adaptation (Allison et al., 2009). The capacity to put in place adaptation measures is also constrained by the lack of national and regional coordination and inability of the countries to access information with which to forecast impacts of climate change on fisheries.

5.4 Other water uses

BOX 1 The Added Value of a Nexus Approach

The Zambezi Basin countries can achieve long-term benefits through integrated and coordinated operation of existing and planned hydropower facilities, cooperative flood management, and irrigation development. Cooperation of riparian states in Dam Synchronization & Flood Releases in the Zambezi River Basin to time release of water, can achieve optimum production of electricity, agriculture, fisheries, aquaculture, environmental flow, dam safety, and flood protection. Retrofitting existing dams for multipurpose can improve internal rates of return. Itezhi-Tezhi dam on Kafue River in Zambia was designed for both hydropower production and irrigation, but now has a thriving kapenta fishery. Kariba Dam was primarily commissioned for hydropower generation, now other major uses include aquaculture, kapenta fishery, urban water supply, tourism, support to national parks and wildlife, lake transportation and mining activities. Basin-wide Nexus Approach will provide opportunities for sustainable, cooperative investment in water, energy, food & nutrition security.

Source: Adapted from ZAMCOM Factsheet

The impact of climate change is being exacerbated by increased demand for water for use in irrigation and/or hydro-electricity generation. As pressures to improve food supply increases, there will likely be large-scale land-use changes. This would result in use of river floodplain habitats for agriculture. Intensive cultivation of lakeshores and river floodplain banks will in turn have impacts on basin hydrology (run-off, evapotranspiration) and water quality (sedimentation, agricultural chemicals, eutrophication), climatic, physico-chemical and biological characteristics of the AGLR's inland waters and their capacity to support the food systems. These impacts

have prompted SADC to come up with the Water-Energy-Food Nexus Approach (SADC, 2013), which has some benefits to small pelagic fish (**Box 1**). In this regard, the SADC Industrialisation Strategy & Roadmap urges states to improve provision of climate service and identify opportunities for improvement in terms of future demand and supply of services to climate sensitive sectors such as Water-Energy-Food Nexus.

5.5 Biological diversity and conservation in the AGLR

The African Great Lakes have rich and diverse fish fauna with at least 1,419 freshwater fish species across the five (Mapendembe & Sassen 2014). This accounts for half of the total number of freshwater fish species in all of Africa and about 10% of all freshwater species globally. The majority of the fish species in the AGL are endemic, often to a single site, and 223 are currently recognized as globally threatened which is 40% of all Africa's fish species on the Red List (Holland & Darwall, 2011) (**Table 4**).

While countries in the region have instituted measures to safeguard small-scale fisheries, such as protected areas (e.g., Lake Malawi National Park), such protected are also threatened by (i) tourism development, (ii) encroachment by both artisanal and commercial

fishers, as well as (iii) rapid development of agriculture on the shoreline. Therefore, governments should address the recommendations from IUCN's Red List and intensify implementation of existing commitments towards sustainable fisheries and environmental management.

Table 4 Threatened species (CR, EN, VU) by country and taxonomic group, according to the IUCN Red List version 2014.3 (IUCN 2014)

Country	Mam mals	Bird s	Repti les*	Amp hibia ns	Fish es*	Moll uscs *	Othe r Inver ts*	Plant s*	Total *
Burundi	11	13	0	5	17	4	3	7	60
DRC	34	36	5	13	84	43	10	107	332
Kenya	31	38	9	10	69	17	67	187	428
Malawi	9	17	3	5	98	7	9	23	171
Mozambique	13	29	12	4	59	3	64	77	261
Rwanda	23	15	0	6	9	0	2	6	61
Uganda	28	23	3	6	61	9	10	49	189
Zambia	39	45	29	58	175	15	114	504	979
South Sudan	10	16	1	0	0	0	0	15	42

Note: * It should be noted that these groups of species that were assessed by 2014, therefore, there are still many more that await assessment by IUCN for Red List.

Wetlands are important as contiguous systems to the lakes and form breeding and nursing sites for fisheries. It is for this reason that most countries in the AGLR have declared some wetlands as Ramsar sites in order to provide for national action and international cooperation regarding the conservation of wetlands, and wise sustainable use of their resources. Ramsar identifies wetlands of international importance, especially those providing waterfowl habitat. In Mozambique, this includes Lake Niassa and its shoreline; in Zambia, they include Lake Mweru Wantipa, Lake Tanganyika and Zambezi Floodplains. Malawi has Lake Chilwa, and recently in 2017, Elephant Marsh was also designated as a Ramsar site. In Uganda, the Murchison Falls-Albert delta wetland system is a Ramsar site. The wetland system stretches from Murchison Falls to Lake Albert, and forms a shallow area that is important for water birds; spawning and breeding grounds for indigenous fish species that are critical for fisheries of Lake Albert. Lake Victoria has four sites, namely Sango Bay – Kagera Wetland, Nabajjuzi Bay wetland, Lutembe Bay Wetland and Mabamba Bay Wetland systems. While Ramsar sites are clearly important for the conservation and wise use of some important small pelagic fish species, it is important to ensure that benefits accrue to the riparian communities. There are doubts as to whether the recent declaration of Elephant marshes in Malawi involved participation of the local population in the decision-making processes or indeed whether the Ramsar designation will lead to improved livelihoods (Kosamu et al., 2020).

5.6 Distribution and food environments

Although there has been an increase in production of small pelagic fishes across countries in the AGLR, contribution of small pelagic fishes to nutrition has been uneven among the populations, particularly the most vulnerable ones. While it has been assumed that those close sources of fish (lake, river and floodplain shores) might have better access, proximity to such sources may not be sufficient to guarantee nutritious diets. Insufficient investment in research to understand factors that influence fish intake, especially among low income and vulnerable populations, has led to ineffective policy and strategic actions necessary for small pelagic fishes to contribute to food and nutrition security.

Direct access to fish via direct engagement in fishing activities or the physical and economic ability to purchase the fish from markets are the key determinants of fish consumption (Bruyn et al. 2021). Other important factors operating in food environments that have bearing on use of small pelagic fishes as a source of food are (i) availability (type and diversity of fish products); (ii) affordability (prices, relative to, say poultry, or to an income); (iii) product properties (quality and appeal, safety, and convenience); (iv) vendor properties (type and characteristics of retail outlets) and (v) food messaging (promotion, advertising and information about food) (WorldFish, 2020). While demand for dried fish, smoked fish, fresh fish and tinned fish was inelastic (i.e., the various fish products were substitutes), households would increase their expenditure on fish products if their income increased; but they would not necessarily decrease purchase if price rose (Nankwenya et al., 2018). Simmance et al. (in prep) found that across the AGLR fish was the most commonly consumed and most affordable animal-source food accessible to urban and rural populations (**Figure 3**).



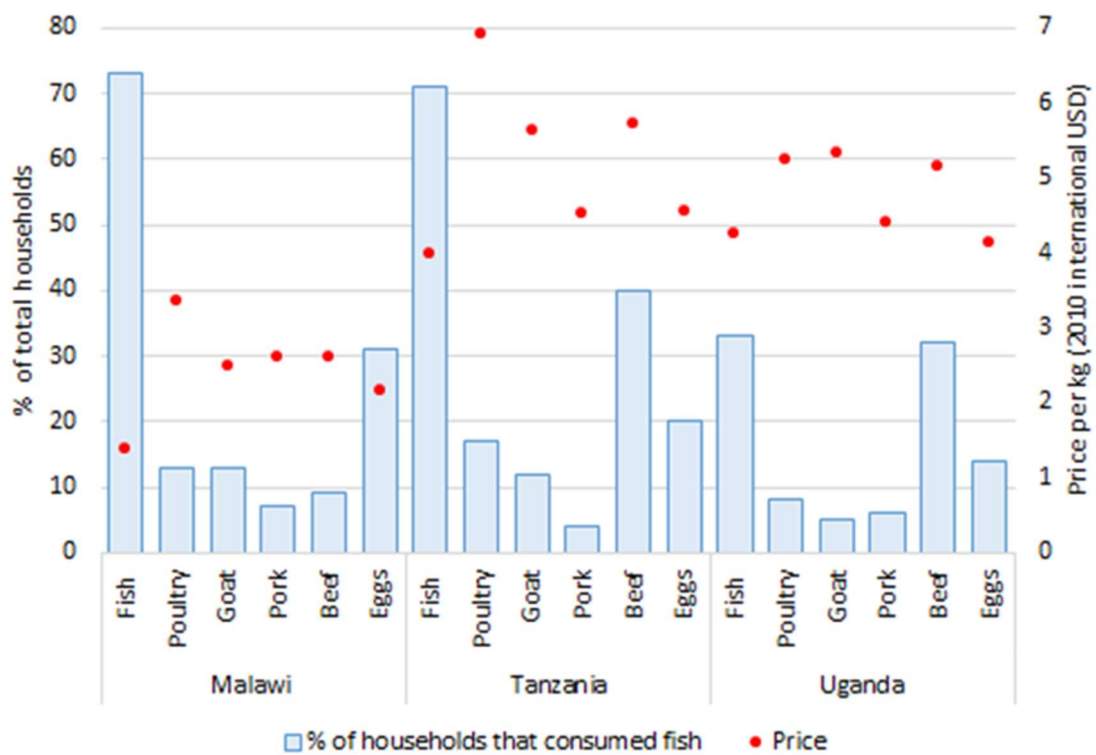


Figure 3 Household consumption of animal-source foods and prices of foods purchased in Malawi, Tanzania and Uganda. Data source: (Simmance et al., in prep). Note: Percentage of total households (n=18,715) who consume some portion of animal-source foods in the past 7-day recall period. Prices of foods are based on surveyed household purchases (average price per kilogram in international USD).

6. Policy frameworks and governance

There are numerous opportunities to strengthen the fisheries and food systems in the AGLR, by learning from 'bright' spots across the AGLR and wider geographies. Additional lessons will be drawn from the Think Tank Event that will be held in late November 2021, and will include a number of themes on pressing areas of understanding and enhancing the potential of fisheries and fish in the region's food system. These 'bright spots' include where the sector has acted as a model for sustainable and inclusive food systems, or overcome challenges from drivers of change – that can be built upon or used to develop further actions and investment for food futures. The focus will be on learning from innovations and solutions across consumption to production. Outlined below are some of the themes which the Think Tank can build upon and report on key messages.

6.1 Sustainable development and characteristics of food systems in the region

In 2012, all countries in the AGLR made a commitment at the Declaration of the Rio de Janeiro United Nations Conference on Sustainable Development, known as Rio+20 – the future we want. Particularly, for fisheries, SDG14 - on Life below Water, all the countries have endorsed the achievement of a series of targets by 2030. Most of the targets relate to a better exploitation of the inland fisheries and wetlands, preservation of the environment and prevention of pollution and other harmful changes resulting from human activities. In order to assess the status of achievement of the SDG, all members of the United Nations have committed to undertake Voluntary National Reviews. However, in 2020 in the AGLR, only Burundi, Democratic Republic of Congo, Kenya, Malawi, Mozambique, Uganda and Zambia were able to complete their Voluntary National Reviews (UN, 2021).

6.1.1 Uganda

In Uganda, the Voluntary National Review reported that despite notable progress on climate and environment as well as decent work and economic growth-related SDGs, the Voluntary National Review has anticipated several SDGs will not achieve their 2030 targets under the current momentum: no poverty (SDG1), zero hunger (SDG2), quality education (SDG4), clean water and sanitation (SDG6), affordable and clean energy (SDG7), sustainable cities and communities (SDG11), life on land (SDG15) and peace, justice and strong institutions (SDG16). Uganda's performance on these goals has stagnated, meaning the scores on relevant indicators are unmoving or trending below a 50 percent growth rate. For other SDGs, there have been improvements but with limited acceleration interventions, risking the chance of meeting these goals by 2030. However, there was an improvement of SDG scores on health (SDG3), gender equality (SDG5), decent work and economic growth (SDG8), partnerships (SDG17), and industrial innovation and infrastructure (SDG9). Nonetheless, the growth rate remains below the needed pace to achieve the SDGs by 2030.

With regard to SDG 14, Uganda reported on target 14.4.1 – "Proportion of fish stocks within biologically sustainable levels" and 14.b.1 "Degree of application of a legal /regulatory/policy/institutional framework which recognizes and protects access rights for small-scale fisheries". Key achievements reported in 2019 included: restoration of 293.28 ha of degraded wetlands in nine districts; demarcation of 185.4 km of wetland boundaries demarcated in eight districts; restoration of 150 ha of degraded riverbanks in Mabira CFR and between Isimba and Owen Falls; surveying and demarcation of 42.7 km of the Extended Kalagala Falls Shoreline; ongoing construction of 5 irrigation schemes in Doho-II (58.9%), Ngenge (64.8%), Mubuku-II (36.5%), Tochi (72.3%) and Wadelai (29%); and the distribution of 4,293,404 tree seedlings in the five irrigation catchments under construction, to facilitate

restoration of approximately 4,293 ha and 120 kms of river banks (Government of Uganda, 2020) .

6.1.2 Malawi

In Malawi, the Voluntary National Review revealed that commendable progress was achieved on 29 of the 169 targets and moderate progress on 59 of the targets and the country shows insufficient to no policy change or otherwise poor performance on 81 of the targets. The 29 targets on which Malawi is making significant progress included SDG 3 (Good Health and Well-Being), Target 3.2, under-five mortality rates are significantly declining and likely to be met; SDG 4 (Education for All), Target 4.5, gender parity in primary schools is already equal to parity, Net Enrolment in Primary Schools is close to target. Targets on which the country was making moderate progress included SDG 2 (Zero Hunger), despite significant progress that has been achieved through reduction and turning the curve on child malnutrition indicators (Stunting, Underweight, and Wasting). Despite the progress, the country continues to suffer the challenges of poverty, unemployment, rapid population growth and environmental degradation, and vulnerability to external shocks, among others. Achieving the SDGs is therefore in Malawi's best interest as the country endeavours to address its socio-economic challenges pursuing the vision of inclusive wealth creation and self-reliance.

With regard to SDG 14, Malawi made commitments towards Indicator 14.4.1: "Capture Fisheries (metric tonnes)" and Indicator 14.7.1: "Sustainable fisheries as a percentage of GDP". Key achievements were: fishing in Malawi is composed of capture fisheries, aquaculture, and aquarium trade sub-sectors. The national fish catch statistics from all water bodies show that total fish production increased from 157,268 metric tonnes in 2016 to 199,454 metric tonnes in 2017, representing a 26.8 percent increase. In 2017, Lake Malawi alone registered a total fish landing of 188,345 metric tonnes, when artisanal and commercial production figures are combined. Aquaculture production increased by 3.7 percent in 2014/15; 4.5 percent in 2015/16; and 9.7 percent in 2016/17. While the consistent increase in national aquaculture production is encouraging, the growth rate is far below the required rate if the National Agriculture Investment Plan production target of 20,000 metric tonnes is to be achieved by 2021. The sustainable fisheries as a percentage of GDP in 2018 were estimated at 1.6 percent (Government of Malawi, 2018). The fisheries sector indirectly employs over half a million people who are engaged in ancillary activities, such as fish processing, fish marketing, boat building and engine repairs. The industry supports over 1.6 million people and makes a substantial contribution to their livelihoods. Malawi also exports fish to other parts of the world like Japan, USA, the UK and other countries. The other category, though not very prominent, is sport fishery where people do angling for fun and competitions as part of tourism (Government of Malawi, 2020).

Further information can be found in the brief [Sustaining and improving the contribution small-scale fisheries make to healthy and sustainable food systems in Malawi](#) (Simmance et al. 2021).

6.1.3 Zambia

In Zambia, the Voluntary National Reviews revealed that headcount multi-dimensional poverty reduced from 50 percent in 2016 to 44 percent in 2020. In rural areas, multidimensional poverty declined from 69 percent in 2016 to 59 percent in 2020 while in urban areas, poverty declined from 25 percent to 18 percent respectively. The reduction in poverty levels was mirrored by a decrease in stunting levels, which were estimated at 53

percent in 2001-2002 and 35 percent in 2018. The prevalence of stunting was higher among children in rural areas (36 percent) than among children in urban areas (32 percent). Similarly, the level of underweight declined from 23 percent in 2001-2002 to 12 percent in 2018. The prevalence of underweight was higher among children in rural areas (12.4 percent) than among children in urban areas (10.8 percent). On gender equity and empowerment, the number of women reported to have experienced physical violence had declined from 43.3 percent in 2014 to 36 percent in 2018. On combating climate change, Zambia had so far reduced cumulative emissions by 39 percent (14,846.9 Gg CO₂ equivalent) between 2015 to 2019. With regard to SDG 14, it was not covered because it was reported to have not been applicable to Zambia (Zambia, 2020).

6.1.4 Mozambique

In Mozambique, the Voluntary National Review revealed that Poverty still affects almost half the population, around 46% of children aged 0-17 are multidimensional poor while 49% are monetary poor. The prevalence of HIV, estimated at 12.6% (ages 15-49), is the second-highest rate in the SADC region, after South Africa. Inequalities are significant and have a strong gender, disability and territorial component - women are poorer and poverty is concentrated in the centre and north of the country. This situation is exacerbated by Mozambique's high exposure to climate change due to its geographical location and increase in extreme cyclical events (such as droughts, floods and cyclones) that have become increasingly regular in recent years. Its effects are devastating on the country's social and economic sphere. The country's socio-economic performance has been positive on several fronts and the scenario is encouraging, but there is much more to be done to ensure that "no one is left behind".

The 2019 SDG Index ranked Mozambique 136 (of the 162 countries considered in this ranking), with a score of 53 points in terms of its performance in the SDGs. Estimates indicated that Mozambique performed well in "responsible consumption and production" (SDG 12). On the other hand, some progress was being made regarding "climate action" (SDG13), "good health and well-being" (SDG3), and "sustainable cities and communities" (SDG11). With regard to "life below water" (SDG14), Mozambique committed to promote small-scale fisheries. Artisanal fishers were a strategic partner to ensure a better future for marine life and people. To ensure their participation in decision making and implementation of measures for the management, exploitation, marketing and exploitation of natural/fishery resources, mechanisms such as the co-management committee at local, district and provincial levels and the Fisheries Administration Commission for participatory management have been established. In addition to these, the country has 310 'community fisheries councils', which are non-profit community organisations that contribute to the participatory management of fisheries, as well as to compliance with existing management measures and the management of conflicts resulting from this activity. For all other SDGs, the assessment concludes that Mozambique continues to face challenges, with progress towards meeting the 2030 targets (Government of Mozambique, 2020).

6.2 Regional fisheries and nutrition policy thrust

The African Union endorsed the Policy Framework & Reform Strategy for Fisheries & Aquaculture, in May 2014, as a common African Fisheries Policy; and one of the key one of the seven policy priorities is "Small-Scale Fisheries Development". It was on the basis of the Policy Framework & Reform Strategy for Fisheries & Aquaculture that African countries overwhelmingly endorsed the SSF Guidelines during the Thirty-first Session of the Committee on Fisheries in June 2014. Further to this, the "Strategy for Rational

Management of African Inland Fisheries” (AU-IBAR, 2018), has been prepared with the aim to “improve and strengthen the contribution of inland fisheries to poverty alleviation, food and nutrition security, wealth creation and socio-economic benefits to fishing communities”. Some of the key thematic areas of the Strategy include (i) Strengthen inland fisheries to contribute to food and nutrition security; (ii) Enhance capacity at various levels for development of inland fisheries and promote a regulated investment in post-harvest sector and value addition; (iii) Protect rights of fishers, especially vulnerable groups such as women, children and physically impaired, and formulate policies to achieve equality; (iv) Take cognizance of cross cutting issues that affects inland fisheries, especially health issues, HIV and related problems; and (v) Strengthen cost-effective and pragmatic research (i.e., information generation system, analysis and knowledge) to support decision-makers.

At the SADC level, the overarching regional framework on fisheries and aquaculture is provided for under the SADC Protocol on Fisheries (2001); whose objective is to promote responsible and sustainable use of the living aquatic resources and aquatic ecosystems of interest to State Parties. The SADC Food and Nutrition Security Strategy (2015-2025) clearly outlines strategies aimed at “Significantly reduce food and nutrition insecurity in the region by 2025”, with a sub-strategy on “Improved productivity of diverse, safe and nutritious foods”, which includes fisheries. The Common Market for Eastern and Southern Africa Strategy for the Sustainable Development of Fisheries Strategy (2011), aims to increase and sustain the contributions of fisheries and aquaculture to socio-economic development and food security in the region served by the Common Market for Eastern and Southern Africa. Among others, the Strategy focuses on (i) establishment of regional fora for discussion of fisheries policy and management; (ii) enhance quality, relevance and sustainability of research support to inland fisheries; and (iii) support collaboration on shared fisheries resources among riparian states. The East African Fisheries and Aquaculture Policy (LVFO 2017), aims to (i) increase fish production from capture fisheries and aquaculture to optimal levels and reduce fish post-harvest losses; ii) increase fish per capita consumption in the EAC and increase annual fish exports from capture fisheries and aquaculture; (iii) increase public financing and Private Sector investments in the fisheries and aquaculture sector; enhance the capacity of centers of excellence on management, development, research and sharing of fisheries and Aquaculture data and information; (iv) increase intra and inter regional trade in fish and fishery products; and (v) strengthen data and information collection and dissemination in fisheries and aquaculture for effective management and development at all levels.

6.3 Support to Non-State Actors in SSF

The African Union Inter-African Bureau for Animal Resources (AU-IBAR) and the African Union Development Agency (AUDA-NEPAD) have been supporting the establishment of sub-regional platforms for non-state actors in fisheries and aquaculture. While the platforms have a broader membership than small-scale fisheries organizations, there is a focus on small-scale fisheries because of the sub-sector’s importance in Africa. In April 2018, the Southern African Regional Non-State Actors Platform in Fisheries and Aquaculture was established and in March 2018 the West Africa Non-State Actors for Artisanal Fisheries and Aquaculture held its constitutive General Assembly. In July 2019, a workshop was co-organized by WorldFish, FAO, AU-IBAR and the SADC in Botswana to explore the possibility to create a pan-African non-stake actor platform and how such a platform could link to global processes taking place within the SSF Global Strategic Framework. On 17-19 November 2021, the AU-IBAR organised a workshop in Accra, Ghana, for establishing the continental non-stake actor platform. The AGLR needs to further empower its NSAs so that they can support and advocate for the need for stronger policy focus and public sector investments in sustainable management of the small pelagic fishes.



6.4 Implementation of SSF Guidelines

FAO is reinforcing the capacity of African countries to implement the SSF Guidelines through dedicated projects and by developing and making available guidance and tools. In Malawi, FAO in collaboration with the Department of Fisheries has been implementing a project for empowering women in small-scale fisheries for sustainable food systems since 2020, in order to support SSF women actors in the post-harvest value sector of the value chain in three districts along Lake Malawi, namely Mangochi, Salima and Karonga. In addition to supporting the women to improve post-harvest management, Malawi has requested support for developing a National Plan of Action that will guide the implementation of the recommendations of the SSF Guidelines (NPOA-SSF). The empowering women project also has activities in Uganda and raises awareness about how important it is to eat fish for a nutritious and balanced diet, especially for children's physical and cognitive development. In some of the target countries, this may translate into strengthening people's capacity to process safe fish products that can then be marketed or served in their communities, for instance in schools.

In September 2020, the Ministry of Fisheries and Marine Resources in Namibia committed itself to implement the SSF Guidelines by developing NPOA-SSF, with the support of FAO. Despite generating a lot of income for actors and foreign exchange earnings, the Marine Resources Act of 2000 and the Inland Fisheries Resources Act of 2003, are silent on small-scale fisheries. Consequently, there is no data on small-scale fisheries, rendering their roles invisible and poorly focused on by policy and interventions. The project ("Implementation of the Small-Scale Fisheries Guidelines" towards a National Plan of Action for Small-Scale Fisheries in Namibia), is being implemented in all 14 regions of Namibia, using a cluster approach with the primary target of the NPOA-SSF being coastal and inland fishing communities (including fisherwomen, fishermen and youths), riverine communities and communities that depend on fisheries as a source of food, income and livelihood.

The United Republic of Tanzania launched its NPOA-SSF in March 2021 based on an extensive consultative process coordinated by a ministry-led multi-stakeholder National Task Team. Moreover, the Tanzania Women Fish Workers Association was established in 2019. Immediately at the launch, the network was accepted as a member of the African Women Fish Processors and Traders Network (AWFishNet), and soon after the launch, the members of Tanzania Women Fish Workers Association did a thorough review of the Tanzanian fisheries law and submitted their views to the Ministry of Livestock and Fisheries Development. Implementation of the SSF Guidelines will enable Tanzania to deliver the implementation of SDG target 14.b.



7. Key areas for policy, research and investment

Based on a synthesis of current research and data on the status and values of fisheries and fish supply chains, and tested innovations that promote improved nutrition, income and sustainability outcomes related to the governance and use of small pelagic fish in the Africa Great Lakes Region. These 10 points of action are for the attention of stakeholders, governance actors, funders and investors concerned with progressing sustainable development of the region. The Discussion Paper, and these 10 points have been prepared as a starting point for deliberation; specifically for participants of the '5th SADC Industrialization Week' addressing the theme 'Bolstering Productive Capacities in the Face of COVID-19 Pandemic for Inclusive, Sustainable Economic and Industrial Transformation'. As part of SADC Industrialization Week, there will be a fisheries focusses side event on "Promoting Small Pelagic Fisheries in the African Great Lakes, A regional think tank and planning meeting".

These 10 points, in many instances, represent a need for restating, reaffirming and increasing commitment to existing policies, declarations and strategies. This includes continued efforts to promote and enhance the implementation of existing policy frameworks, such as the SSF Guidelines. The SSF Guidelines provide a comprehensive framework for strengthening governance of the small-scale fisheries subsector and enable its important contribution to sustainable development.

New, renewed or increased focus on any of these areas, will likely contribute to more secure and improved contributions of fisheries and small pelagic fish to food systems of the African Great Lakes region span all elements of the food system – from environment, people, processes, infrastructures, institutions, and the activities from production, processing, distribution, preparation and consumption of fish as food.

7.1 Integrate fish into food, health and other cross-sector policies

Africa's Great Lakes are not only important as a source of fish, but also their vast quantities of water drive hydroelectric generation, irrigation and an important source of water for municipal, agricultural and industrial uses. As such, the lakes represent an interaction between sectors, their agencies and policies. The governance and use of the Africa Great Lakes is also influenced by existing commitments to climate change adaptation and mitigation, and disaster risk management (African Union, 2014).

Whilst there is growth in aquaculture throughout the region, projections suggest that these countries will rely on capture fisheries, predominantly for decades to come (Chan et al. 2019). Nonetheless, there are opportunities for aquaculture to increase supplies of fish and income in certain contexts, and for certain people. Integration of aquaculture into the Lakes systems will require careful planning of complementary and sustainable developments, in contextually appropriate aquaculture, to maintain environmental sustainability, improve incomes and not undermine the benefits from existing economic activities like small-scale capture fisheries.

Effective governance requires an integrated approach to making and enacting policies. Whilst integrated policies and cross-sector strategies have political attention (e.g., the SADC Water-Energy-Food Nexus), the pragmatics of such policy making processes and implementation require ongoing, and even renewed attention. The research community can serve cross-sector governance by bringing new analysis and insights to the opportunities

and costs different policy configurations may have for fisheries values and supplies of small pelagic fish.

7.2 Enable inclusion of fisheries, supply chain actors and their civil society groups into policy and investment decisions

At global and regional levels, there are increased calls for fisheries, water and food governance to be more inclusive of and responsive to civil society groups and non-state actor representatives and platforms. There is now an even greater opportunity for inclusive governance that emerges from concurrent and complementary investments that have been made in establishing and building capacity of non-state actor groups and platforms. This includes building upon and maintaining a focus on the SADC National Committees mandate for non-state actors to be members of the sub-committee on Food Agriculture & Natural Resources, in which fisheries issues are discussed and solutions determined.

Those with influence over the governance of the AGLR have the opportunity to consolidate regional and national non-state actors in order to streamline their actions so that they align with the priorities to safeguard the small pelagic fishes. Non-state actor groups such as AWFISHNET, SANSAFA and EARFISH, should be provided with opportunities and empowerment to engage with government agencies in planning, implementation and advocacy, including in making the case for increased funding allocations from national budget to the management and development of small-scale fisheries for pelagic fish, and associated supply chains.

7.3 Gender responsive and inclusive policy and action

New estimates suggest that around 1.4 million women are engaged in inland small-scale fisheries and supply chains in the countries surrounding the African Great Lakes (FAO et al. in prep). Yet, the labour of women, particularly the informal labour associated with many fisheries supply chains, is undervalued and rarely captured by economic, employment or fisheries statistics. This gap in data perpetuates and even permits the exclusion of women from economic opportunities and governance. To challenge sexist data that perpetuate the cycle of invisibility and inequality, it is suggested to (i) broaden the definition of fisheries systems to include pre- and post-harvest activities, (ii) implement sex- and age-disaggregated data standards, (iii) delivering women-focused research to rebalance policy perceptions of labor and (iv) facilitating inclusive governance (Kleiber et al. in press). Methodologies and case studies are available for, and from, the AGLR to implement and progress prior commitments made in the region, and these recommendations, but meaningful progress toward SDG on Gender Equality will require increased and sustained investment and commitment in practice.

Gendered barriers limit the capacity of women and youth to generate incomes and build assets from small pelagic fisheries. These barriers and underlying inequities intensified the impact of COVID-19 containment measures women and their business experienced (Atkins et al. 2021). A series of 10 recommendations have been provided to build forward better towards greater resilience in fish supply chains, greater equity and inclusivity in the economic and food sectors (McDougall et al. 2021).

Overall, consideration should be given to (ii) strengthen capacity for evidence-based development interventions, especially access to fish, processing and trading; (iii) gender-inclusive agrifood systems, with women-targeted financing and enterprise models for fish supply chains, including but not limited to those focussed on small pelagic fish; and (vi)

promote and increase opportunities for youth employment, entrepreneurship, technical and organisational capacity for fisheries management, fishing, processing and trading.

7.4 Optimise management and secure supplies of small pelagic fishes

Small pelagic fish are often caught with small-meshed fishing gears, most of which are deemed illegal. However, recent scientific evidence shows that small pelagic fish are underexploited and that catches are on the rise due to their high productivity (Kolding et al. 2019). There is a need to revise the regulatory instruments that govern the fishing of small pelagic fishes in order to catalyse on the opportunities of increased supply and securing relatively cheap, locally produced and highly nutritious commodities (Kolding et al. 2019).

The African Regional Nutrition Strategy (2015 – 2022) urges African countries to improve nutrition through agriculture programmes, by maintaining or improving the natural resource base and production of nutrient-dense foods, including fisheries (African Union, 2015). However, only Malawi, Mozambique and Uganda have endorsed the achievement of a series of SDG 14 targets related to a better exploitation and preservation of inland fisheries (UN, 2021). Opportunities exist to strengthen fisheries governance via a nutrition-sensitive approach, and to preserve the habitats of fisheries via an ecosystem based approach (Barange et al., 2018).

7.5 Increase recognition of the values small-scale fisheries and small pelagic fish provide for nutrition and health

Although many countries in the AGLR have included fisheries and aquaculture food and nutrition policy priorities, the specific potential of small pelagic fish is still frequently undervalued and overlooked.

Small pelagic fish offer immense benefits for improving the nutrition status of vulnerable populations, such as those living further from water bodies, and particularly women and children in the region. Small pelagic fish are one of the most nutrient dense animal-source foods that is accessible to the rural poor. A 100g portion of small fish harvested from the African Great Lakes Region meets over 40 percent of daily calcium, selenium, zinc and omega-3 fatty acid requirements for women of reproductive age (FAO et al. in prep). The trialling of fish-based products in neighbouring Zambia has demonstrated that small fish can be leveraged and scaled in nutrition interventions to address malnutrition (Ahern et al. 2021; Byrd et al. 2021).

There are some pertinent economic and human nutrition trade-offs that require improved governance and increased attention to progress toward SDG2. For example, these trade-offs are evident in estimates that 70% of dagaa are being used for non-food purposes, being used instead as ingredients for feeds for poultry, fish and livestock (LVFO, 2016). It is important to create awareness among policymakers of the trade-offs between the use of “low-value” but highly nutritious fish as animal feed or human food and prioritize direct human consumption over animal feed production (Kolding et al., 2019).

There is a need to improve data systems, reporting and accessibility for food assessments, so that currently under reported or invisible food values provided by small scale fisheries are accounted for in food system and health policies (Bunting et al., in prep; Kakwasha et al., 2020; Chan et al., 2019; FAO et al. in prep).

7.6 Reduce loss and waste, ensure food quality

The UNFSS has renewed commitment to reducing waste and loss in food supply chains, because losses of quality and quantity significantly reduce the nutrition outcomes from food production. The quantity and quality of nutrient fish reaching consumers is estimated to decline, on average, by 30% along the value chain. For example, in Malawi, supplies of small pelagic fish experience high physical and quality losses; up to 19.3% of the economic value and 69 percent of the nutritional value of small fish is lost along the supply chain (Torrell et al. 2020). For example, dagaa from the landing sites and markets around Lake Victoria, Uganda, contain high levels of aflatoxins and degraded fats, leading to reduced quality and nutritive value (Kigozi et al., 2020). Participatory piloting of social and technical innovations in fisheries value chains has demonstrated both gender equality can be increased, and waste and loss decreased (Cole et al., 2020). Critically, alongside these technical developments, social and gendered barriers must also be understood and addressed, otherwise root causes of waste and loss (e.g., time paucity, labour burdens, physical exclusion) will remain.

Improving the infrastructure for storage, transportation and distribution of these small fishes, especially to vulnerable regions through improved policies that do not adversely affect nutritional needs of local people, as well as improving food safety standards, can reduce loss and waste and enhance the supply of nutritious fish (Mussa et al., 2017; Torell et al., 2020). Fish handling (e.g. crates, clean water) and post-harvest processing (e.g. solar drying technologies, cold chains) technologies are important areas for investment. Whilst improved fish handling at landing sites (e.g., provision of low-cost crates), post-harvest processing techniques (e.g., solar drying technologies and icing), implementation of food safety standards and improved capacity development, as well as development of value-added fish-based products would contribute to improved economic and nutritional benefits across value-chains.

7.7 Enhance the economic opportunities and benefits from fisheries for small pelagic fishes

Small pelagics are predominantly accessed by small-scale fisheries and informal supply chain actors, the economic value is often undervalued. This impedes the appreciation of the wealth generating potential of these small fishes by policymakers. Because informal domestic and cross-border fish trade remains largely invisible to policy-makers and hence, receives limited policy attention and investments from governments (Chimatiro et al., 2018). Yet, improved management and utilisation of the resource, reduction of waste and loss along supply chains, and development of new fish-based products, all represent opportunities to increase economic benefits from existing fisheries. To date, these have been overlooked relative to investments made in increasing production through other, more intense and unsustainable, means. But these three areas of investment to increase and maintain supplies will all form the foundations of sustainable and equitable economic opportunities in the fisheries sector.

The economic and social development potential of fisheries is even more compelling when you focus on small and medium enterprise (SME) in Africa; however, currently SMEs suffer under-funding due to lack of information about the business potential, this inturn makes it impossible for finance institutions to appraise fisheries and aquaculture enterprises (AUC-NEPAD 2014). Securing finance can be particularly difficult for women, and financial security

was one of the factors that intensified women's experiences of hardship in the face of COVID-19 (Atkins et al. 2021). This contributed to further dysfunction in fish supply chains. Therefore, policy and strategy needs to focus on ensuring that SMEs have access and control over the fisheries resources and financial assets and services. In addition, government reforms are urgently required in order to establish national and sub-national governance and institutional arrangements that enable the societal contribution generated by small-scale fisheries have the greatest impacts at the most appropriate level, especially the SMEs.

7.8 Design initiatives and policies that meet the need for the most nutritionally and economically vulnerable

Nutrition-sensitive approaches to governing fisheries and their supply chains will examine, and respond to, where nutrition needs are the greatest - particularly for the nutrients that are known to be contained by fish. However, many people, especially pregnant and lactating mothers as well as infants, are still malnourished in AGLR, and other populations nourished by fish are vulnerable to the loss of fish from diets. A range of interventions around education, policy reform and improve program design can help improve access to and consumption of safe and nutritious small fish amongst nutritionally vulnerable groups, women of reproductive age, and infants during the first 1000 days of life and particularly those that live further from water bodies (O'Meara et al., 2021; Byrd et al., 2021; de Bruyn et al., 2021).

There is substantial opportunity for research to pilot and test novel fish-based nutritious products, whose nutritive values are clearly labelled in order to inform consumers. There are substantial opportunities to introduce fish-based products (e.g., dried and powdered fish) into school feeding programmes and relief aid programmes to target and improve the nutritional status of women and children (Ahern et al. 2021; Byrd et al. 2021).

7.9 Develop supplementary and diverse livelihoods that build resilience and prosperity within economies of fishing communities

There are places and contexts where fishing as a livelihood is not a choice, but rather a necessity. In many contexts fish-dependent households lack alternative livelihood options or opportunities to improve their current livelihood (Somoebwana et al., 2021). Therefore, urgent efforts must be directed at supporting fish dependent communities, especially fishers, fish processors and traders, to manage their activities as business; be encouraged to save what they earn and invest in non-fish businesses.

In some contexts, a diversity of livelihood strategies can build resilience - as individuals and households experience greater opportunities to choose and adjust as conditions change. For example, Evidence from Kenya has shown that fish dependent households that pursued diversification livelihood strategies had a lower deprivation score compared to those that engaged solely in fishing, implying that marine fishery has the potential to reduce poverty and inequality if supplemented with other livelihood options (Somoebwana et al., 2021).

7.10 Invest in the research-policy nexus, and research that informs better policy

There is a need for government, research and civil society stakeholders of the AGLR to determine priority research areas. This will require increased responsiveness of research institutions to the needs and priorities of government, civil society groups region and fishes and fish workers themselves. There are strong examples of research in the region that illustrate commitment to principles of relevance, effectiveness and legitimacy. These examples provide the foundation on which to build some principles of research engagement - to ensure that research serves the region and its priorities even more effectively.

To complement these efforts, the capacity and interest of policy makers in the development value of research can be built, to overcome a long-standing science-policy deadlock that is experienced in some sectors and contexts. The emerging research-policy relationship, open dialogues, and networks that span policy and governance domains, will stimulate more public investments in small pelagic fishes research and sustainable management in order to achieve the wealth-generating potential of the small pelagic fishes of the AGLR.

References

- African Union. (2014). AU Joint Conference of Ministers of Agriculture, Rural Development, Fisheries and Aquaculture. Theme: "Transforming Africa's Agriculture for shared prosperity and improved livelihoods: Harnessing Opportunities for Inclusive Growth and Sustainable Development". Addis Ababa, African Union.
- African Union. (2015). Africa Regional Nutrition Strategy (ARNS) to cover the period 2015 – 2025. African Union Commission, Ethiopia.
- Ahern, M. B., Thilsted, S. H., Kjelleovold, M., Overå, R., Toppe, J., Doura, M., ... Franz, N. (2021). Locally-Procured Fish Is Essential in School Feeding Programmes in Sub-Saharan Africa. *Foods* . <https://doi.org/10.3390/foods10092080>
- Allison, E. H., Perry, A. L., Badjeck, M. C., N. Adger, W., Brown, K., Conway, D., ... Dulvy, N. K. (2009). Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries*, 10(2). doi.org/10.1111/j.1467-2979.2008.00310.x
- Atkins M, McDougall C and Cohen PJ. 2021. COVID-19 impacts on women fish processors and traders in sub-Saharan Africa: Insights and recommendations for building forward better. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Report: FISH-2021-12.
- AU-IBAR. (2018). Strategy for rational management of African inland fisheries. AU-IBAR, Nairobi.
- AUC-NEPAD. (2014). The Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa. Compiled and prepared by, in alphabetical order: Dr. Sloans Chimatiro (Head of Fisheries, NEPAD Agency); Dr. Simplicie Nouala (Chief Animal Resources Officer, AU-IBAR); and Dr. Mohamed Seisay (Senior Fisheries Officer, AU-IBAR).
- Belton, B., & Thilsted, S. H. (2014). Fisheries in transition: Food and nutrition security implications for the global South. *Global Food Security*, 3(1). doi.org/10.1016/J.GFS.2013.10.001
- Bunting, S., & Thiao, D. (in prep). Evaluating options for the rational and healthy use of pelagic small fish species in Sub-Saharan Africa.
- Byrd, K.A., Pincus, L., Pasqualino, M.M., Muzofa, F., & Cole, S.M. (2021). Dried small fish provide nutrient densities important for the first 1000 days. *Maternal & Child Nutrition*. doi.org/https://doi.org/10.1111/mcn.13192
- Chimatiro, S., Linton, J., Omitoyin, B., & J. de Bruyn. (2018). Informal cross-border fish trade: Invisible, fragile and important. Policy Brief No. 2. FishTrade Program. WorldFish
- Cohen, A.S., Gergurich, E.L., Kraemer, B.M., McGlue, M.M., McIntyre, P.B., . Russell, J.M., Simmons, J.D. & P.W. Swarzenski. (2016). Climate warming reduces fish production and benthic habitat in Lake Tanganyika, one of the most biodiverse freshwater ecosystems. *PNAS* 113(34). doi/10.1073/pnas.1603237113
- Cole, S. M., Kaminski, A. M., McDougall, C., Kefi, A. S., Marinda, P. A., Maliko, M., & Mtonga, J. (2020). Gender accommodative versus transformative approaches: a comparative assessment within a post-harvest fish loss reduction intervention. *Gender, Technology and Development*, 24(1), 48–65. <https://doi.org/10.1080/09718524.2020.1729480>
- COMESA. (2011). COMESA Strategy for the Sustainable Development of Fisheries and Aquaculture. Report of the Fourth Meeting of the Joint Ministers of Agriculture, Environment & Natural Resources. Common Market for Eastern & Southern Africa. Ezulwini, COMESA.
- Cowx, I. G., & Ogutu-Owhayo, R. (2019). Towards sustainable fisheries and aquaculture management in the African Great Lakes. *Fisheries Management and Ecology*, 26(5). doi.org/10.1111/fme.12391
- Darwall, W., Smith, K., Allen, D., Holland, R., Wright, E., & Harrison, I. (2011). The Diversity of Life in African Freshwaters: Under Water, Under Threat. An Analysis of the Status and Distribution of Freshwater Species Throughout Mainland Africa.
- Darwall, W.R.T.; Vié, J.-C. Identifying Important Sites for Conservation of freshwater Biodiversity: Extending the Species-Based Approach. *Fish. Manag. Ecol.* 2005, 12, 287–293.
- de Bruyn, J., Wesana, J., Bunting, S. W., Thilsted, S. H., & Cohen, P. J. (2021). Fish Acquisition and Consumption in the African Great Lakes Region through a Food Environment Lens: A Scoping Review. *Nutrients* 13(7). doi.org/10.3390/nu13072408
- de Graaf, G., & Garibaldi, L. (2014). The value of African fisheries. *FAO Fisheries Technical Paper*. doi.org/10.1578/AM.40.3.2014.297

- FAO, Duke University, & WorldFish. (in prep). Illuminating Hidden Harvests: The contribution of small-scale fisheries to sustainable development.
- FAO, IFAD, UNICEF, WFP, & WHO. (2020). The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. Rome, FAO. doi.org/10.4060/ca9692en.
- FAO. (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action. Nature and Resources 3. doi.org/10.4060/ca9229en
- FAO. (2021). Database for fish and animal protein supply quantity. FAOSTAT New Food Balances. Retrieved from <http://www.fao.org/faostat/en/#data/FBS>
- Genschick, S., Marinda, P., Tembo, G., Kaminski, A. M., & Thilsted, S. H. (2018). Fish consumption in urban Lusaka: The need for aquaculture to improve targeting of the poor. *Aquaculture* 492. doi.org/10.1016/j.aquaculture.2018.03.052
- Gilbert, R., Benson, T., & Ecker, O. (2019). Are Malawian diets changing? An assessment of nutrient consumption and dietary patterns using household-level evidence from 2010/11 and 2016/17. Washington, IFPRI. doi.org/10.2499/p15738coll2.133522
- Government of Malawi. (2018). Annual Economic Report 2018 Annual Economic Report 2018: 2.
- Government of Malawi. (2019). Annual Economic Report 2019. Ministry of Finance, Economic Planning and Development. Department of Economic Planning and Development, Lilongwe.
- Government of Malawi. (2020). The Second Voluntary National Review Report on the Implementation of the 2030 Agenda for Sustainable Development. June 2020. Ministry of Finance & Economic Planning and Development. Lilongwe, Malawi.
- Government of Mozambique. (2020). Report Voluntary National Review of Agenda 2030 for Sustainable Development Mozambique. Ministry of Economy & Finance. Maputo, Government of Mozambique.
- Government of the Republic of Zambia. (2020). The Second Voluntary National Review Report on the Implementation of the 2030 Agenda for Sustainable Development. Lusaka, Ministry of National Development Planning, Government of the Republic of Zambia.
- Government of Uganda. (2020). The Second Voluntary National Review Report on the Implementation of the 2030 Agenda for Sustainable Development. June 2020. Kampala, The SDG Secretariat Office of the Prime Minister,.
- Hara, M. (1996). Problems of introducing community participation in fisheries management: Lessons from Lake Malombe and upper Shire River (Malawi) participatory fisheries management programme. *S. Afr. Perspect.* 59..
- Harrison I.J., Stiassny M.L.J. (1999) The Quiet Crisis. In: MacPhee R.D.E. (eds) Extinctions in Near Time. *Advances in Vertebrate Paleobiology* 2. Springer, Boston, MA. doi.org/10.1007/978-1-4757-5202-1_12
- Haug, A., Christophersen O, C., Kinabo J., Kaunda, W & LO Eik. (2010). Use of dried kapenta (*Limnothrissa miodon* and *Stolothrissa tanganicae*) and other products based on whole fish for complementing main-based diets. *African Journal of food agriculture nutrition and development* 10(5).
- Heyns, P. (2003). Water-resources management in Southern Africa. In: International waters in Southern Africa. Mikiyasu Nakayama (eds). Tokyo: United Nations University Press
- HLPE. (2014). Sustainable fisheries and aquaculture for food security and nutrition. A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.
- ILEC and UNEP (2016). Transboundary Lakes and Reservoirs: Status and Trends. Nairobi, United Nations Environment Programme.
- International Food Policy Research Institute (IFPRI). (2021). Livestock, livestock products and fish, June 2021. MaSSP Price Bulletin 9b. Washington, DC: International Food Policy Research Institute. <https://ebrary.ifpri.org/digital/collection/p15738coll2/id/134513>
- Kakwasha, K., Simmance, F. A., Cohen, P., Muzungaire, L., Phiri, H., Mbewe, M., ... Siamudaala, V. (2020). Strengthening small-scale fisheries for food and nutrition security , human well-being and environmental health in Zambia. Penang. WorldFish.
- Kaunda, E. & S. Chimatiro. (2019). Contribution of Fisheries to Food and Nutrition Security in the SADC region. SADC House, Gaborone.
- Kawarazuka, N., & Béné, C. (2011). The potential role of small fish species in improving micronutrient deficiencies in developing countries: building evidence. *Public Health Nutrition*, 14(11), 1927–1938. doi.org/10.1017/S1368980011000814

- Kigozi, J., Namwanje, M., Mukisa, I.M., Omagor, I. & S.K. Chimatiro. (2020). Microbial quality, aflatoxin content and nutrient degradation of silver cyprinid stored at landing sites and in markets in Uganda. *Cogent Food & Agriculture* 6: 1844512
- Kleiber D, Harper S, Appiah S, Atkins M, Bradford K, Choudhury A, Cohen PJ, de la Puente S, De la Torre Castro M, Duffy-Tumasz A et al. Gender and small-scale fisheries: Moving beyond sexist data structures. In FAO, Duke University and WorldFish. In press. *Illuminating hidden harvests: The contribution of small scale fisheries to sustainable development*. Rome: FAO
- Kolding, J., van Zwieten, P., Marttin, F., Funge-Smith, S., & Poulain, F. (2019). Freshwater small pelagic fish and their fisheries in the major African lakes and reservoirs in relation to food security and nutrition. *FAO Fisheries and Aquaculture Technical Paper* 642 (124). doi.org/10.4060/ca0843en
- Konings, A. (1990). *Konings's book of cichlids and all the other fishes of Lake Malawi*. Neptune, T.F.H. Publications.
- Koppmair, S., Kassie, M., & M. Qaim. (2016). Farm production, market access and dietary diversity in Malawi. *Public Health Nutrition*: 20(2). doi:10.1017/
- Kosamu, I.B.M., Schaafsma, M., Spake, R., Ogutu, B. (2020). Elephant Marsh Fishery, Malawi. In: Isaacs, M., Onyango, P., Akintola, S.L. (Eds.) *Small-Scale Fisheries in Africa: A Regional Portrait*. TBTI Global Publication Series, <https://tbtiglobal.net/>. St. John's, NL, Canada, 132pp.
- Lake, A.; Townshend, T. *Obesogenic Environments: Exploring the Built and Food Environments*. *J. R. Soc. Promot. Health* 2006 (126).
- Loiselle, S.; Cozar, A.; Adgo, E.; Ballatore, T.; Chavula, G.; Descy, J.P.; Harper, D.M.; Kansime, F.; Kimirei, I.; Langenberg, V.; et al. Decadal Trends and Common Dynamics of the Bio-Optical and Thermal Characteristics of the African Great Lakes. *PLoS ONE* 9.
- Lowe-McConnell, R. (2003). Recent research in the African Great Lakes: fisheries, biodiversity and cichlid evolution.
- LVFO. (2016). *State of Lake Victoria Dagaa (Rastrineobola argentea): Quantity, quality, value addition, utilisation and trade in the East African region for improved nutrition, food security and income*. Region Synthesis Report. Jinja, LVFO Regional Socio-economics Working Group..
- LVFO. (2017). *The EAC Fisheries and Aquaculture Policy*. Jinja, Lake Victoria Fisheries Organization Secretariat.
- Manyungwa, C.L., Hara, M.M. & S.K. Chimatiro. (2019). Women's engagement in and outcomes from small-scale fisheries value chains in Malawi: Effects of social relations. *Maritime Studies*. doi.org/10.1007/s40152-019-00156-z
- Mapendembe, A., & Sassen, M. (2014). *Commodities and Biodiversity in the Great Lakes Region of East and Central Africa (Glr)*.
- Marinda, P. A., Genschick, S., Khayeka-Wandabwa, C., Kiwanuka-Lubinda, R., & Thilsted, S. H. (2018). Dietary diversity determinants and contribution of fish to maternal and under five nutritional status in Zambia. *PLoS ONE*, 13(9), 1–18. doi.org/10.1371/journal.pone.0204009
- McDougall C, Marwaha N, Atkins M, Cohen PJ, Patel A, Beyene BA, et al.... 2021. COVID-19 impacts on women fish processors and traders in sub-Saharan Africa: 10 recommendations for building forward better. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Policy Brief: FISH-2021-17.
- Miriti, E.A. African Great Lakes Information Platform. <https://www.africangreatlakesinform.org/article/lake-kivu>
- Murekezi, P., Martone, E., & Menezes, A. (2020). *Assessment of the integration of fisheries and aquaculture in policy development Framework and application in Africa*. Rome. Food and Agriculture Organization of the United Nations doi.org/10.4060/ca9322en
- Mussa, H., Kaunda, E., Chimatiro, S., Kakwasha, K., Banda, L., Nankwenya, B., & Nyengere, J. (2017). Assessment of Informal Cross-Border Fish Trade in the Southern Africa Region: A Case of Malawi and Zambia. *Journal of Agricultural Science and Technology B*, 7(5). doi.org/10.17265/2161-6264/2017.05.009
- Nankwenya, B., Chimatiro, S., & Kaunda, E. (2017). The Demand for Fish Products in Malawi: An Almost Ideal Demand System Estimation. *J Econ Sustain Dev*. 2017;8(16).
- Ndebele-Murisa, R., Mashonjowa, E. & T. Hill. (2011). The implications of a changing climate on the Kapenta fish stocks of Lake Kariba, Zimbabwe. *Transactions of the Royal Society of South Africa* Vol. 66(2).
- NEPAD. (2009). *International Partnership for African Fisheries Governance and Trade*. Programme Memorandum (2009 – 2014). 18th December 2009. NEPAD, Midrand, South Africa.

- NFDS. (2013). Gap analysis of national and regional fisheries and aquaculture priorities and initiatives in Western and Central Africa in respect to climate change and disasters. NEPAD-FAO Fish Partnership Programme.
- Niang, I., Ruppel, O.C., Abdrabo, M.A., Essel, A., Lennard, C., Padgham, J. & Urquhart, P. 2014. Africa. In V.R. Barros, C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee et al., eds. (2014). *Climate change: Impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*
- Njaya, F. J. (2007). Governance challenges for the implementation of fisheries co-management: Experiences from Malawi. *International Journal of the Commons* 1(1):123–139.
- Njaya, F., Donda, S. & C. Béné. (2011). Analysis of Power in Fisheries Co-Management: Experiences from Malawi. *Society & Natural Resources* 25(7), 652-666.
- O'Meara, L., Cohen, P. J., Simmance, F., Marinda, P., Nagoli, J., Teoh, S. J., ... Byrd, K. A. (2021). Inland fisheries critical for the diet quality of young children in sub-Saharan Africa. *Global Food Security* 28: 100483. doi.org/10.1016/j.gfs.2020.100483
- O'Reilly, C. M., Alin, S. R., Plisnier, P.-D., Cohen, A. S., & McKee, B. A. (2003). Climate change decreases aquatic ecosystem productivity of Lake Tanganyika, Africa. *Nature* 424(6950). doi.org/10.1038/nature01833
- Odongkara, K., Abila, R., & Luomba, J. (2010). The Contribution of Lake Victoria Fisheries to National Economies. *African Journal of Tropical Hydrobiology and Fisheries* 12(1). doi.org/10.4314/ajthf.v12i1.57369
- OECD/FAO. (2019), *OECD-FAO Agricultural Outlook 2019-2028*, OECD Publishing, Paris/Food and Agriculture Organization of the United Nations, Rome. doi.org/10.1787/agr_outlook-2019-en
- Ogutu-Ohwayo, R.; Hecky, R.E.; Cohen, A.S.; Kaufman, L. (1997) Human Impacts on the African Great Lakes. *Environ. Biol. Fishes* 50: 117–131.
- Poulain, F., Amber Himes-Cornell, A & C. Shelton. (2018). Chapter 25: Methods and tools for climate change adaptation in fisheries and aquaculture, 535 – 567p. In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F., eds. *FAO Fisheries and Aquaculture Technical Paper No. 627*. Rome, FAO. 628 pp.
- SADC. (2001). *Protocol on Fisheries*. Southern African Development Community.
- SADC. (2013). *6th SADC Multi-Stakeholder Water Dialogue: Watering Development in SADC: Exploring the Water, Energy and Food Nexus*. Lusaka, SADC.
- SADC. (2014). *Food and Nutrition Security Strategy (2015-2025)*. SADC Secretariat, Gaborone.
- Sayer, C.A., Máiz-Tomé, L. and Darwall, W.R.T. (2018). *Freshwater biodiversity in the Lake Victoria Basin: Guidance for species conservation, site protection, climate resilience and sustainable livelihoods*. Cambridge, UK and Gland, Switzerland, IUCN.
- Sayer, C.A., Palmer-Newton, A.F. and Darwall, W.R.T. (2019). *Conservation priorities for freshwater biodiversity in the Lake Malawi/Nyasa/Niassa Catchment*. Cambridge, UK and Gland, IUCN.
- Simmance, F, Cohen, P. J., Huchery, C., Sutcliffe, S., Suri, S. K., Tezzo, X., ... Phillips, M. J. (2021). Nudging fisheries and aquaculture research towards food systems. *Fish and Fisheries* 00:1–20. doi.org/10.1111/faf.12597
- Simmance, F, Nico, G., Funge-Smith, S., Basurto, X., Franz, N., Teoh, S., ... Mills, D. (in prep). Proximity to small-scale inland and coastal fisheries is associated with improved income and food security.
- Simmance FA, Kanyumba L, Cohen PJ, Njaya F, Nankwenya B, Gondwe E, Manyungwa C, Chimatiro S, Byrd K, O'Meara L et al. 2021. *Sustaining and improving the contribution small-scale fisheries make to healthy and sustainable food systems in Malawi*. Penang, Malaysia: WorldFish. Program Brief: 2021-27.
- Snoeks, J. B. T.-A. in E. R. (2000). How well known is the ichthyodiversity of the large East African lakes? In *Ancient Lakes: Biodiversity, Ecology and Evolution* (Vol. 31, pp. 17–38). Academic Press. [https://doi.org/https://doi.org/10.1016/S0065-2504\(00\)31005-4](https://doi.org/https://doi.org/10.1016/S0065-2504(00)31005-4)
- Somoebwana, M.I, Ayuya, O.I., & J.M. Mironga. (2021). Marine fishery dependence, poverty and inequality nexus along the coastal lowlands of Kenya, *National Accounting Review*.
- Thiao, D., & Bunting, S. (2021). Socio-economic and biological impacts of the fish-based feed industry for sub-Saharan Africa. *Fisheries and Aquaculture Circular*, FAO, Rome.
- Thieme, M. L., World Wildlife Fund DC (USA), W., Abell, R., Stiassny, M. L. J., Skelton, P., Lehner, B., ... Olson, D. (2005). *Freshwater ecoregions of Africa and Madagascar: a conservation assessment*. Washington, Island Press.

- Tierney, J. E., Russell, J. M., Eggermont, H., Hopmans, E. C., Verschuren, D., & Sinninghe Damsté, J. S. (2010). Environmental controls on branched tetraether lipid distributions in tropical East African lake sediments. *Geochimica et Cosmochimica Acta*, 74(17), 4902–4918. doi.org/10.1016/j.gca.2010.06.002
- Torell, E. C., Jamu, D. M., Kanyerere, G. Z., Chiwaula, L., Nagoli, J., Kambewa, P., ... Freeman, P. (2020). Assessing the economic impacts of post-harvest fisheries losses in Malawi. *World Development Perspectives*, 100224. doi.org/https://doi.org/10.1016/j.wdp.2020.100224
- United Nations. (2021). UN Human Rights – Office of Human Rights Commissioner. <https://www.ohchr.org/EN/Issues/SDGS/Pages/2020VoluntaryNationalReviews.aspx>
- Uwamahoro, F., Kakwasha, K., Onyango, P., Mpangala, H. & A. Mkazala. (2017). Informal cross-border fish trade at Tunduma border post, Tanzania, East Africa. A Field Report, FishTrade Progra, University of Dar es Salaam, Tanzania.
- Vollmer, M. K., Bootsma, H. A., Hecky, R. E., Patterson, G., Halfman, J. D., Edmond, J. M., ... Weiss, R. F. (2005). Deep-water warming trend in Lake Malawi, East Africa. *Limnology and Oceanography*, 50(2), 727–732. doi.org/https://doi.org/10.4319/lo.2005.50.2.0727
- von Grebmer, K., J. Bernstein, R. Alders, O. Dar, R. Kock, F. Rampa, M. Wiemers, K. Acheampong, A. Hanano, B. Higgins, R. Ni Cheilleachair, C. Foley, S. Gitter, K. Ekstrom, and H. Fritschel. (2020). 2020 Global Hunger Index: One Decade to Zero Hunger: Linking Health and Sustainable Food Systems. Bonn: Welthungerhilfe; and Dublin: Concern Worldwide.
- Wardlow, B. D., Anderson, M. C., & Verdin, J. P. (2012). Remote sensing of drought: Innovative monitoring approaches. *Remote Sensing of Drought: Innovative Monitoring Approaches*. Taylor & Francis. doi.org/10.1201/b11863
- Water-Energy-Food Nexus in the Zambezi River Basin. http://www.zambezicommission.org/sites/default/files/publication_downloads/factsheet-2-wef-english-1.pdf
- Wesana, J., Yossa, R., Bunting, S., & Phillipa, C. (in prep). Analysing the feed-food nexus of small pelagic fish species in sub-Saharan Africa: a scoping review.
- Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., ... Murray, C. J. L. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet* 393(10170), 447–492. doi.org/10.1016/S0140-6736(18)31788-4
- World Bank. (2020). *Poverty and Shared Prosperity 2020: Reversals of Fortune*. Washington, DC: World Bank. doi: 10.1596/978-1-4648-1602-4
- WorldFish. (2020). *2030 Research and Innovation Strategy: Aquatic Foods for Healthy People and Planet*. Penang, Malaysia: WorldFish.
- Government of Zambia (2020). *National Fisheries Report*.



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The CGIAR Research Program on Fish Agri-Food Systems (FISH) is a multidisciplinary research program. Designed in collaboration with research partners, beneficiaries and stakeholders, FISH develops and implements research innovations that optimize the individual and joint contributions of aquaculture and small-scale fisheries to reducing poverty, improving food and nutrition security and sustaining the underlying natural resources and ecosystems services upon which both depend. The program is led by WorldFish, a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

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