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KMFRI

Editorial

Editorial: Kenya Aquatica Journal Vol 10(1) – *A Showcase of KMFRI's Pioneering Research in Freshwater Ecosystems*

The latest edition of Kenya Aquatica Journal, Vol 10(1) showcases pioneering research by KMFRI scientists on Kenya's freshwater ecosystems. This edition, supported by KMFRI and WIOMSA, covers ecological, socio-economic, and environmental challenges, providing valuable insights into sustainable management practices.

One notable study investigates disease surveillance and antimicrobial resistance in fish from lacustrine caged farms, emphasizing responsible antibiotic use to maintain fish health. Another study explores the impact of organochlorine pesticides on macroinvertebrates in Lake ecosystems, advocating for Rhagovelia spp. as a bioindicator for pesticide monitoring across food webs.

Research on Lake Baringo's small-scale fishery assesses the catch and effort composition, stressing the need for regulatory enforcement to avoid overfishing and advocating for capacity building among stakeholders for sustainable management. Additionally, a study on wild fish kills in Lake Victoria focuses on eutrophication and pollution, recommending integrated watershed management to protect the lake's fisheries and local livelihoods.

A comprehensive study on Lake Elementaita – one of Kanya's flamingos' sanctuaries, combines water quality, fisheries studies, and community surveys, calling for integrated watershed management, conservation, and sustainable agriculture. Research on fisheries co-management in Lake Baringo highlights the importance of local community involvement and sustained achievements in ecosystem management, despite challenges in law enforcement.

An article on the socio-economic dynamics of Lake Victoria proposes establishing a regulatory framework incorporating citizen science to manage the lake's resources for long-term sustainability. Addressing plastic pollution in Lake Turkana, a study recommends waste management solutions, public awareness, and better enforcement of regulations to tackle the issue.

The journal also features research on antimicrobial resistance (AMR), with a review exploring Kenya's aquatic biodiversity for potential novel antimicrobial agents. A genetic research study evaluates freshwater fish populations, identifying gaps and proposing future directions for conservation and management.

Lastly, the journal presents an evaluation of fish market dynamics in Lake Naivasha, recommending infrastructure development like fish markets and hatcheries to support the region's fishery sector.

This edition of Kenya Aquatica Journal provides crucial insights into Kenya's freshwater ecosystems, covering a wide range of research on sustainable management, environmental challenges, and the socio-economic factors influencing aquatic resources. The research highlights KMFRI's ongoing contributions to understanding and addressing these issues, fostering a deeper understanding of Kenya's aquatic biodiversity.

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About
Kenya Aquatica

Kenya Aquatica is the Scientific Journal of the Kenya Marine and Fisheries Research Institute (KMFRI). The aim of the Journal is to provide an avenue for KMFRI researchers and partners to disseminate knowledge generated from research conducted in the aquatic environment of Kenya and resources therein and adjacent to it. This is in line with KMFRI's mandate to undertake research in "marine and freshwater fisheries, aquaculture, environmental and ecological studies, and marine research including chemical and physical oceanography", in order to provide sci entific data and information for sustainable development of the Blue Economy.

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Featured front cover picture: Researcher sampling surface plankton in the Kerio River inlet to Lake Turkana. (Photo credit: Mr. John Malala)

Featured back cover picture: Chair of KMFRI Board of Management Amb. Dr. Wenwa Akinyi Odinga Oranga (seated middle), on her right, Ag. KMFRI CEO Dr. James Mwaluma, flanked by KMFRI Heads of Sections: Front (L-R) Dr. Victoria Tarus, Ms Caroline Mukiira, Dr. Jacob Ochiewo, Dr. Irene Githaiga, Mr. Abraham Kagwima. Back (L—R) Mr. Paul Waluba, Ms Jane Kiguta, Dr. Gladys Okemwa, Dr. Eric Okuku, Dr. Joseph Kamau, Mr. Isaac Kojo, Ms Joan Karanja, Mr. Milton Apollo. (Photo credit KMFRI)
Research Vessel MV Mtafiti in the background

Catch and effort composition and management implications of Lake Baringo's small scale fishery

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Abstract

Small scale fisheries in Africa especially within the tropics are an important source of livelihoods to millions of people who depend on the fish value chain for employment. The fishing sector plays an important role in food security by provision of essential minerals and proteins. However, with increased population growth rate, there has been a rapid demand for fish in most of the inland lakes in Kenya, including Lake Baringo. This has led to increased exploitation of the fishery resources as the fishers' target to maximize benefits. In order to come up with sound management of this resource, catch and effort data was collected through standard operating procedures for fish catch assessment survey (CAS). This was done in 6 landing beaches of Lake Baringo in 2024 by means of questionnaires and personal observations. Data collected included number of canoes that went fishing on the sampling day, gear types, fish species and catch landed among others. Results indicate that majority of the longline fishers used an average of 275 ± 6.0 hooks of sizes 8 and 9 to catch *Protopterus aethiopicus* and *Clarias gariepinus,* whose composition was 17.6% and 9.2%, respectively. Gill nets of stretched mesh sizes 25 mm to 125 mm were used, with 62.5 mm and 75 mm nets being most used at 35% and 25%, respectively. The mean sizes of *Oreochromis niloticus* was 19.5 ± 6.5 cm, 22.2 ± 12.6 cm for *Labeobarbus intermedius*, 39.7 ± 12cm for *C. gariepinus* and 79 ± 10.5 cm total length for *P. aethiopicus*. Total fish landings were estimated at 345 tonnes, with a beach value of KES 63 million. It is recommended that fishery regulations enforcement should be enhanced especially on fishing effort to avoid overfishing; and capacity building of BMUs and other stakeholders on sustainable management of the fishery should be done regularly.

Keywords words: management, catch assessment survey (CAS), catch per unit effort (CPUE), catch composition, fishing gear, beach value

Introduction

The fisheries industry occupies an important role in the global economy and human diets. It is a key foreign exchange earner, enhances food security and provides employment opportunity to many people. Around 100 million people are estimated to be involved in the small scale post-harvest sector which involves fish processing, transport and marketing. Fish production has increased immensely at the global level from 20 million tonnes in 1960 to about 214 million tonnes in 2020 (FAO, 2022). The global increment of fish consumption from 9.9 kg in the 1960s to 20.5 kg in 2020 has increased the world per capita fish consumption. This has been attributed to population increase, more incomes, urbanization and improved distribution of fish products (FAO, 2022). The vast majority of the world's fishers and fisher farmers live in the developing countries where they mostly use small crafts and boats with limited capacity of catch landings (FAO, 2022). Freshwater fisheries are an important source of livelihood and income to millions of the world's poorest people, and also contribute to the overall economic wellbeing of many developing countries (FAO, 2018).

Small scale- fishing in East Africa has been a source of food security to the people and employment opportunities supporting livelihoods of about 3 million people (LVFO, 2009). In the recent years the value of catch at some beaches is estimated at more than USD 550 million and export value of USD 260 million. The fishery produce in East Africa is estimated to be 1 million tonnes per annum, of which 14.8 % is from Kenya, 66.6 % from Tanzania and 18.6 % from Uganda (LVFO, 2013). This indicates that fish catch has been increasing over the years, influencing people's livelihoods and reducing vulnerability to poverty. Kenya's National Nutrition Action Plan (2018-2022), promotes fisheries as one of the sectors that can contribute to national nutrition goals under Kenya's Vision 2030: The national long-term development blueprint for transforming Kenya into an industrializing middle income country by 2030, recognizes the importance of the contributions of the fisheries sector (Kenya Vision, 2030).

Small-scale and industrial fishing sector in Kenya produces fresh and processed fish for domestic and export markets, accounting for about 0.5% of the country's Gross Domestic Product (GDP) (KCDP, 2013). Despite its limited contribution to the country's GDP, the fisheries sector generates employment for over two million Kenyans through fishing, boat building, equipment repair, fish processing, and other ancillary activities (FAO, 2018).

Catch and effort composition data have been utilized to come up with informed management decisions for sustainable utilization of the resources. When catch data is combined with information on fish prices, it can be used to estimate the gross value of production. This provides an indication of the economic importance of the fishery relative to other fisheries or sectors. This is important for helping shape policy and for development planning purposes (KCDP, 2013). Catch assessment surveys (CAS) aim at estimating stock abundance from catch landings and effort data through relative indices such as catch per unit effort (CPUE).

Fish landings in Lake Baringo have experienced oscillations in catches over the years which have reduced per capita earnings of the fishermen. The state of poverty in the region has also led to many young people who drop out of school to seek any available source of livelihood including illegal fishing using undersized nets. This study therefore aims to employ catch and effort data to recommend prudent management of the Lake Baringo fishery.

Materials and methods

Study area

The study was conducted in Lake Baringo, a shallow freshwater lake in the Eastern Rift Valley of Kenya (Fig. 1). The Lake lies between latitudes 0°30′ N and 0°45′ N and longitude 36° 00′ E and 36°10´ E., approximately 60 km North of the equator at an altitude of 975 m above mean sea level. It is also a source of freshwater used for domestic purposes especially drinking and livestock watering; and supports a substantial fishery in a semi-arid area. Its fishery comprises of four commercially important species (*Oreochromis niloticus, Clarias gariepinus, Protopterus aethiopicus* and *Labeobarbus intermedius*), while *Labeo victorianus* rarely appears in fishermen's catches (Mugo et al., 2022). The decreased fish diversity is thought to be due to overfishing and limnological changes (Hickley et al., 2004).

The Lake surface is reported to cover slightly over 130 km^2, with wide fluctuations in water levels due to climatic influences (Kallqvist, 1987; Hickley *et al.*, 2004). The catchment area is about 6820 km^2 and includes a large part of the Western escarpment of the Kenyan Rift Valley where most of the water is derived from.

The climate of the region is characterized by two rainy seasons with an annual average of about 600 mm (Omondi *et al*., 2014). Due to heavy rains experienced in 2011 in the Eastern African region, the lake water surface increased to 207 km^2. The dry season usually starts from September to February, while the rainy season occurs between March and August (Odada *et al.,* 2006; Omondi *et al*., 2014). The precipitation in the Lake area ranges from about 600 mm on the East and South of the Lake to 1500 mm on the Western escarpment of the Rift Valley. Lake Baringo faces a very high annual evaporation rate of 1650 – 2300 mm (Odada *et al*., 2006). The Lake has no known outflow and is supplied by inflows from seasonal rivers: (Endao, Lokesen, Makutani, Ol Arabel and Molo) and perennial River Perkerra (Omondi *et al*., 2014). The Lake is believed to have an underground seepage which maintains its freshness by losing approximately 108 m^3 yr^{-1} (Dunkley *et al*., 1993).

Data collection

Catch and effort data was collected through a modified design laid out in the approved Standard Operating Procedures for Catch Assessment Surveys for Lake Victoria (LVFO, 2005). The methodology involved two-stage stratified sampling design composed of sample of primary sampling units (PSUs) i.e., the fish landing sites at each selected beach management unit (BMU) followed by selection of Secondary Sampling Units (SSUs) i.e., the vessel-gear type, were randomly selected by a team of Kenya Marine and Fisheries Research Institute (KMFRI) staff who administered 60 questionnaires and key informant interviews. Sampling unit was fishing vessels and gears. Personal observations and recording of catch composition by species, size, weight, fishing gears, craft type and length, value of catch as well as fishing frequency was recorded.

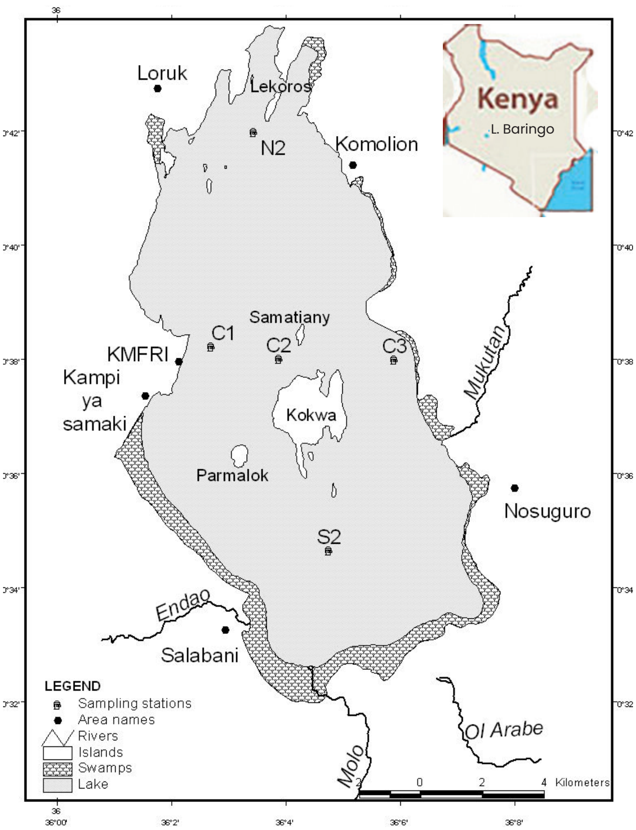

Figure 1. Map of Lake Baringo depicting some of fish lnding sites (Kampi samaki,Loruk, Komolion, Salabani) (Source: Authors)**.**

Data analysis

The raw information and data collected was pooled, entered, cleaned and stored electronically using statistical packages Microsoft Excel 10 and SPSS. The fishing crafts were segregated into effort groups (vessel-gear combinations) and the CAS indicators estimated for each effort group.

The mean fish catch rates (kg^{-1} boat^{-1} day^{-1}) were estimated for each effort group by species using the formulae:

$$CPUE = C / E = q N$$

Where C = catch landed

E = effort deployed

Q = catchability coefficient

N = abundance of the target stock

The total fish catches were estimated using the mean fish catch rates based on the number of vessels enumerated. The beach value of the catch, i.e., the gross income to the fishers, was estimated by raising the estimated total catch in each effort group by the mean unit price of each fish species landed.

Results

Fishing vessels composition

Traditional non-motorized fishing vessels referred in the local language as *Kandich* were the most dominant vessels in Lake Baringo at 60.6% followed by *Sesse* at 21.2% and fiber glass boats at 18.2%. The mean sizes of *Kandich* were 2.5 ± 0.2 m, fiber glass 8.5 ± 0.3 m and Sesse 6.3 ± 0.2 m. The number of crew per *Kandich* was 1 while fiber glass and Sesse had 3 to 4 crew.

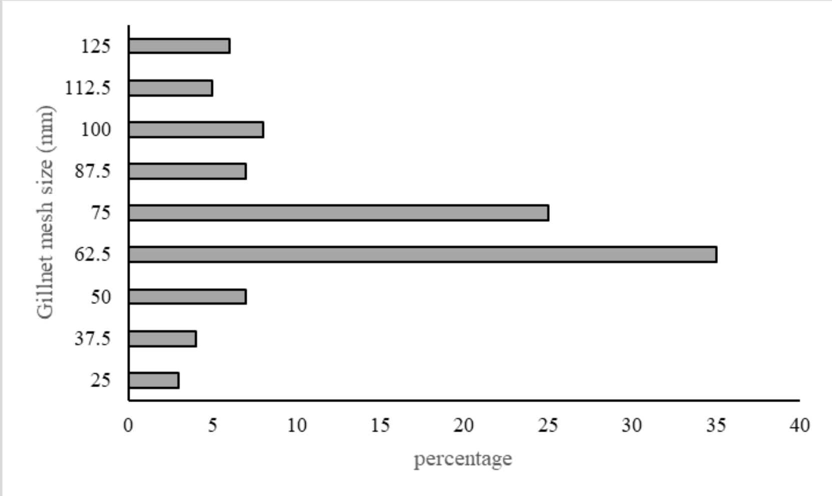

Figure 2. Composition of gill net used in Lake Baringo.

Gear composition

The commercial fishery of Lake Baringo involved use of gillnets (GN) and longlines (LL) as the main gears, while seine nets (SN) were used illegally to catch live fish baits for longlines. *P. aethiopicus* and *C. gariepinus* were caught mainly by LL, while *O. niloticus, C. gariepinus* and *L. intermedius* were targeted by GN. The commonly used hooks were size 8 and 9 with fishers using an average of 275 ± 6.0 hooks. Gillnets used varied from 1" (25 mm) stretched mesh to 5" (125 mm). Mesh size 2.5" (62.5 mm) was the most commonly deployed at (35%) followed by 3" (75 mm) and 4" (100 mm) nets (Fig. 2). The species caught in the various gillnets were *O. niloticus, C. gariepinus* and *L. intermedius.*

Longline gear usage was highest at Salabani (62%) followed by Komolion (60%) and Loruk (54%) beaches. While gillnet usage was highest at Kampi samaki (53%) followed by Kokwa (52%) and Ngenyin (50%). Seine nets were mostly used at Kampi samaki (10%) followed by Ngenyin (8%) and Salabani (7%) (Fig. 3).

O. niloticus (O.n) was the most abundant fish landed in Lake Baringo constituting 69.2% followed by *Protopterus aethiopicus* (Pa) 17.6%, *C. gariepinus* (Cg) at 9.2% and *L. intermedius* (Li) 4% as depicted in figure 4.

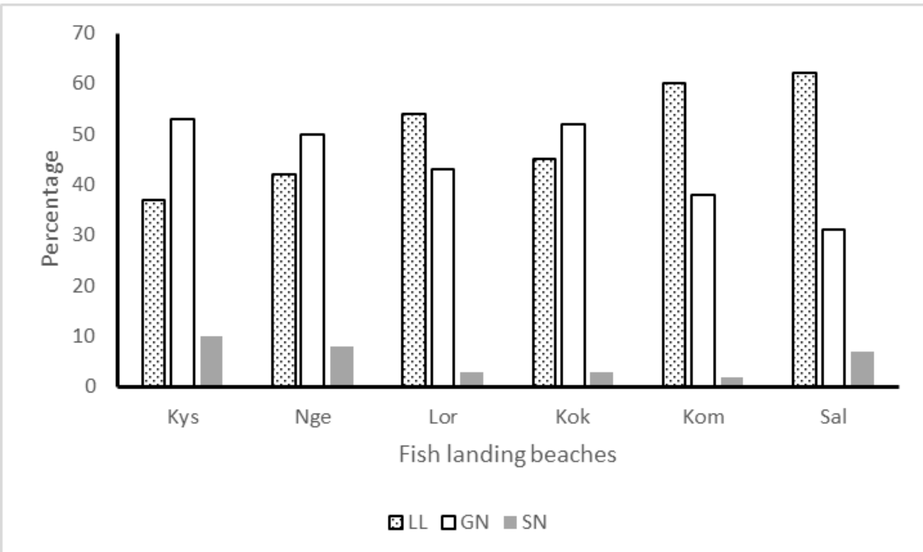

Figure 3. Gear composition in different fish landing beaches (Kys: Kampi Samaki, Nge: Ngenyin, Lor: Loruk, Kok: Kokwa, Kom: Komolion, Sal: Salabani).

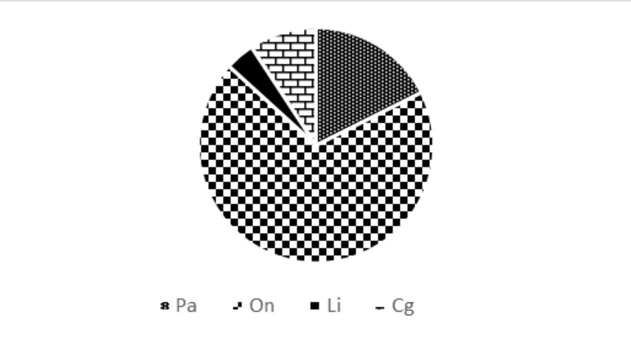

Figure 4. Catch composition of commercial fish species *O. niloticus* (O.n), *Protopterus aethiopicus* (Pa), *L. intermedius* (Li), *C. gariepinus* (Cg).

Catch rates for various fish species

The average catch per boat was highest for *O. niloticus* 82.5 kg^{-1} boat^{-1} day^{-1} followed by *P. aethiopicus* at 21.0 kg^{-1} boat^{-1} day^{-1}, *C. gariepinus,* 11 kg^{-1} boat^{-1} day^{-1} while *L. intermedius* had the lowest catch of 4.8 kg^{-1} boat^{-1} day^{-1} (Fig. 5). The fishers spent an average of 6 days of fishing every week. The total fish landings were estimated at 345 tonnes with a beach value of KES 63 million.

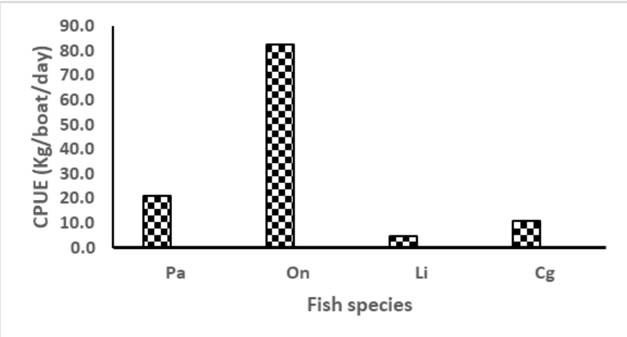

Figure 5. Catch per unit effort of commercial fish species in Lake Baringo Pa *(P. aethiopicus)*, Cg (*C. gariepinus*), Li (*L. intermedius*), On (*O. niloricus*).

The mean sizes of commercial fish species is shown in table 1.

Table 1. Mean (± SD) of sizes (Total Length, TL) of commercial fish species.

Fish species	Sample size (n)	Mean size in cm
P. aethiopicus	165	79 ± 10.5
C. gariepinus	193	39.7 ± 12
L. intermedius	265	22.2 ± 12.6
O. niloticus	242	19.5 ± 6.5

Catch prices by species

The average prices of the four commercial species are as depicted in Table 1. *O. niloticus* was the most expensive at KES 230.20 ± 2.70 kg^{-1} followed by *P. aethiopicus* at KES 220.40 ± 2.60 kg^{-1}, while *L. intermedius* was the cheapest at 120.30 ± 1.30 per kg (table 2)

Table 2. Average prices (± SD) of commercial fish species of Lake Baringo

Fish species	Sample size (n)	Mean price (KES kg^{-1})
P. aethiopicus	190	220.40 ± 2.60
C. gariepinus	160	160.60 ± 4.30
L. intermedius	182	120.30 ± 1.30
O. niloticus	200	230.20 ± 2.70

Discussion

Majority of the fishers in Lake Baringo used the traditional fishing vessels known as *Kandich* (60.6%) in their fishing expeditions. This was informed by relatively low construction costs compared to *Sesse* and fibre glass vessels since plant materials for construction of *Kandich* are found within the Lake region. The main gear used by these fishers was longline. Majority of the fishers were located in the beaches towards the Northern area of the Lake: Komolion (60 %) and Loruk (54 %) and Southern part of the Lake, Salabani (62 %), away from the main shopping centre, Kampi Samaki. Their main target was *P. aethiopicus* and *C. gariepinus,* whose CPUE was relatively lower compared to that of *O. niloticus*. The highest contributor to total fish landings was *O. niloticus* at 69.2 %, which was a major shift from the previous years where *P. aethiopicus* and *C. gariepinus* had contributed >85% of total landings, while *O. niloticus* contributed < 5% (Mugo *et al.,* 2018).

The high percentage composition of *O. niloticus* can be attributed to the impact of the overall rise in the Lake level (as from 2020), providing suitable breeding ground and refugia for the juveniles. Studies done in many African lakes, found a positive correlation between increase in lake levels and fish production, whereby increase in lake levels provide suitable breeding grounds and abundant food. (Junk *et al.*, 1989; Kolding and van Zwieten, 2012; Gownaris et al., 2015; Anton, 2016; Kolding et al., 2016). Gillnets were more prominently used at Kampi Samaki and Kokwa beaches, contributing to the landings of *O. niloticus* (with highest CPUE of 82.5 kg^{-1} $boat^{-1}$ day^{-1}), which was >70% that of *P. aethiopicus*, the second-highest landed fish species. Gillnets of 2.5" (62.5 mm) and 3" (75 mm) mesh size were the most commonly used though they are below recommended mesh size of 4 inches (100 mm) and above. This has the potential of reducing the recruitment of many fish species that encounter with this gear.

The catch per unit effort from this study was a bit high, especially for *O. niloticus,* suggesting that fishers might have targeted this species probably due to market demand, as alluded by the high average market price of this species. Catch oer unit effort (CPUE) is commonly used to estimate relative abundance of a population (Harley *et al.*, 2001, Maunder *et al.*, 2004, and Lynch *et al.,* 2012). These indices of relative abundance are utilized in stock assessment to make decisions of how to manage fish stocks by fisheries managers and policymakers. *O. niloticus* had the highest average market prices of KES 220.40 ± 2.60 followed by *P. aethiopicus* at 160.60 ± 4.30 while *L. intermedius* had the lowest price of 120.30 ± 1.30.

The demand of Lake Baringo fish is evident as fish are distributed to far off markets in Karbarnet, Nakuru, Eldoret and Kisumu. These prices are still relatively low compared to those of similar fish from Lake Victoria (Onyango *et al.*, 2021) Total fish landings for 2024 were estimated at 345 tonnes, with a beach value of KES 63 million. Though the fish landings would seem to be within sustainable levels, the fishing effort may still be high due to illegal, unreported and unregulated (IUU) fishing activities. Climate change and lack of other livelihood alternatives by fishers can also impact negatively on the sustainability of Lake Baringo fisheries.

Conclusion and recommendations

Majority of longline fishers were using an average of 275 ± 6.0 hooks, sizes 8 and 9 to catch *P. aethiopicus* and *C. gariepinus,* whose composition was 17.7% and 9.2%, respectively. Gill nets of sizes 25mm to 125mm stretched mesh were used with 62.5 mm and 75mm nets being most used at 35% and 25%, respectively. The average catch per boat was highest for *O. niloticus* 82.5 kg^{-1} $boat^{-1}$ day^{-1} followed by *P. aethiopicus* at 21.0 kg^{-1} $boat^{-1}$ day^{-1}, *C. gariepinus* at 11 kg^{-1} $boat^{-1}$ day^{-1}, while *L. intermedius* had the lowest catch at 4.8 kg^{-1} $boat^{-1}$ day^{-1}. The total fish landings were estimated at 345 tonnes with a beach value of KES 63 million. It is recommended that fishery regulations enforcement should be enhanced especially on fishing effort to avoid overfishing: and capacity building of BMUs and other stakeholders on sustainable management of the fishery should be done regularly.

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