LAKE KARIBA FISHERIES RESEARCH INSTITUTE

ANNUAL STATISTICS

2021

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Introduction

Lake Kariba (16.5°S, 28.8°E) is a large, man-made tropical reservoir with a length of 280 km, a volume of 185 km^3 and an area of 687,049 km^2 (Magadza, 2006). The lake forms five hydrological basins which are Mlibilzi, Binga, Ume, Sengwa and Sanyati (Begg, 1970). Lake Kariba Fisheries Research Institute (LKFRI) is a research centre under the Zimbabwe Parks and Wildlife Management Authority (ZPWMA). Research conducted at the institution include climate change, ecology, ecohydrology and ecotoxicology. Lake Kariba Fisheries Research Institute conducts several monitoring programs such as experimental gillnetting, length and weight frequencies and water quality assessments. The monitoring programs are done to collect important data which are used in the management of lake. The data is also compiled, analysed and published in research articles.

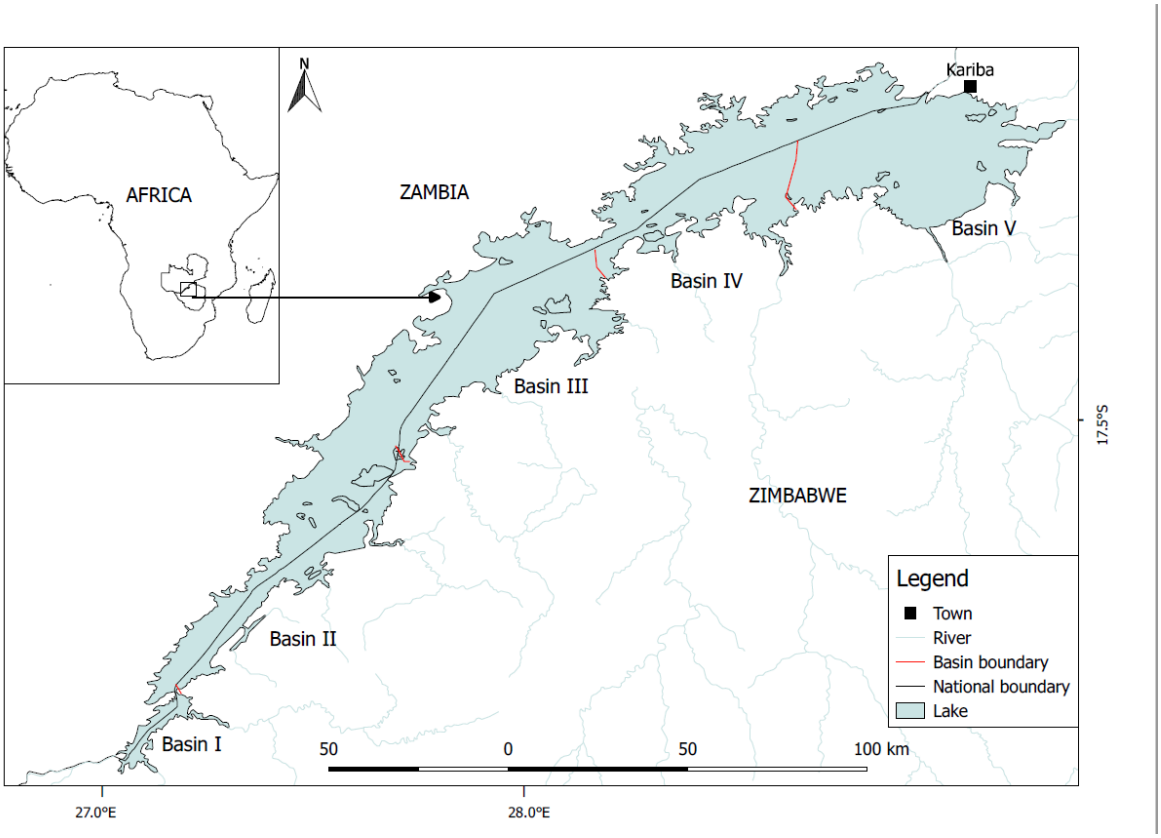

Figure 1. Lake Kariba hydrological basins

Kapenta fishery

Kapenta (*Limnothrissa miodon*) is one of the most commercially exploited fish species in Lake Kariba since their introduction in 1968/9. L. miodon occupies the pelagic niche of the lake and has colonised the entire lake (Magadza, 2006; Magadza, 2010). The kapenta fishery is shared between Zimbabwe and Zambia. In 2021, Zimbabwe had 244 companies operating with a total of 438 fishing vessels (Figure 2).

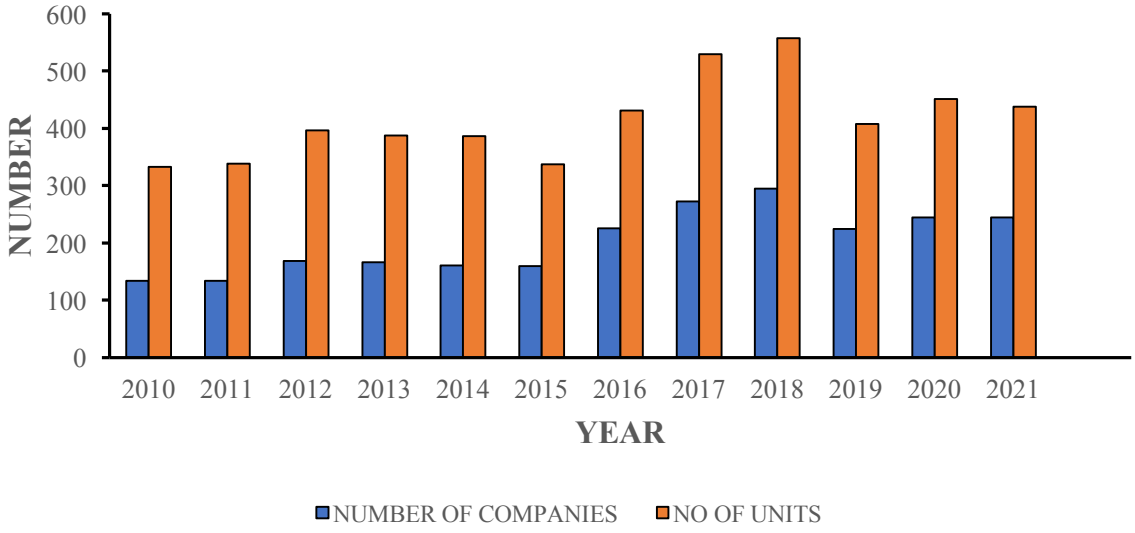

Figure 2. Trends of kapenta fishing companies and units in Lake Kariba

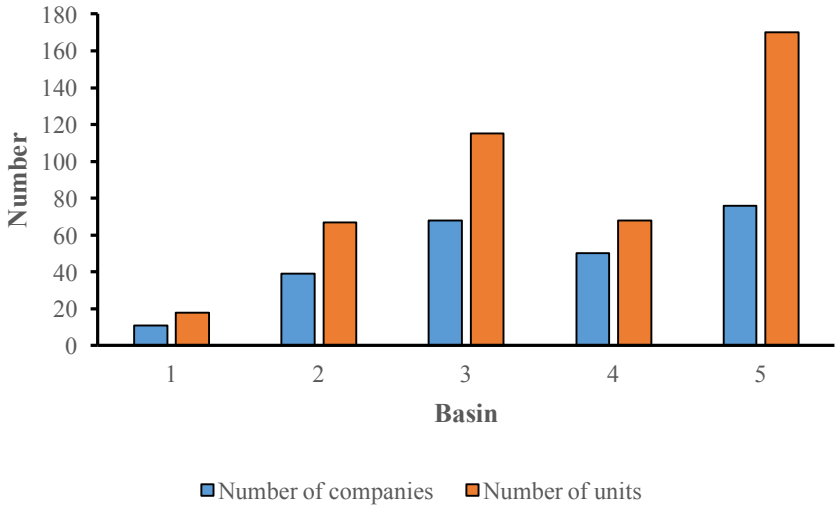

Figure 3. kapenta fishing companies and units in basin 1 to basin 5, Lake Kariba in 2021

Figure 3 shows the number of companies and units registered in each of the five hydrological basins. The most companies are operating in basin 5 (76 companies and 170 units).

Kapenta catch and effort statistics

The CPUE for 2021 (0.051 tonnes per boat/night) was higher than that of 2020 (0.047 tonnes per boat/night). Total estimated catch has been decreasing over the years, as shown in Table 1. Actual effort, measured as fishing nights, has increases to 78,888 fishing nights.

Table 1 Kapenta fishery annual catch statistics from 2019 to 2021

Year	CPUE (tons/boat-night)	Actual Catch (t)	Estimated Catch(t)	Actual Effort (boat nights)	Estimated Effort (boat nights)
2019	0.060	2514.696	6106.707	44355	107712
2020	0.047	2558.151	5586.732	54640	119328
2021	0.051	4059.079	5949.694	78888	115632

Kapenta are being harvested in all hydrological basins of Lake Kariba except basin 1. Climate change has resulted in the gradual receding of lake levels, and subsequently reducing fishing grounds. Basin 1 being the smallest and of riverine nature was heavily impacted with its water barely reaching the minimum permissible fishing depth of 20m hence since April 2019, basin 1 has been closed off from kapenta fishing.

Table 2 shows the total catch and CPUE of the 5 basins of Lake Kariba. More kapenta were harvested in basin 5 (2197.682 tonnes) followed by basin 3 (854.329 tonnes), basin 4 (695.326 tonnes) and basin 2 (310.683 tonnes).

Table 2. Kapenta Catch, CPUE and effort in basin 2 to basin 5 in 2021

Basin	CPUE (tons/boat-night)	Actual Catch(tons)	Estimated Catch(tons)	Actual Effort (boat nights)
2	0.036	310.683	4180.229	8594
3	0.044	854.329	5099.251	19373
4	0.052	695.326	5992.539	13417
5	0.059	2197.682	6781.48	37473

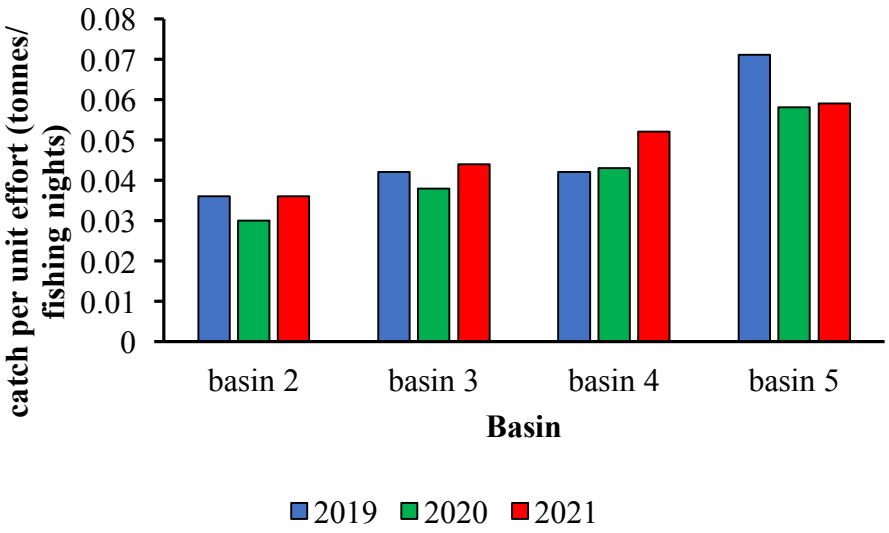

Figure 4. Kapenta catch per unit effort in basin 1 to basin 5 from 2019 to 2021

In basin 2, CPUE dropped from 0.036 in 2019 to 0.03 in 2020 and then recovered to 0.036 in 2021. There was an increase in CPUE in basin 3 from 0.042 (2019) to 0.044 (2021). A gradual increase in CPUE was observed in basin 4 (0.042 in 2019 to 0.052 in 2021). In basin 5, CPUE dropped from 0.071 in 2019 to 0.059 in 2021. In general, more fish are being caught in basin five compared to the other basins. There has been a general decrease in kapenta total catch and CPUE in lake Kariba from (Figure 5).

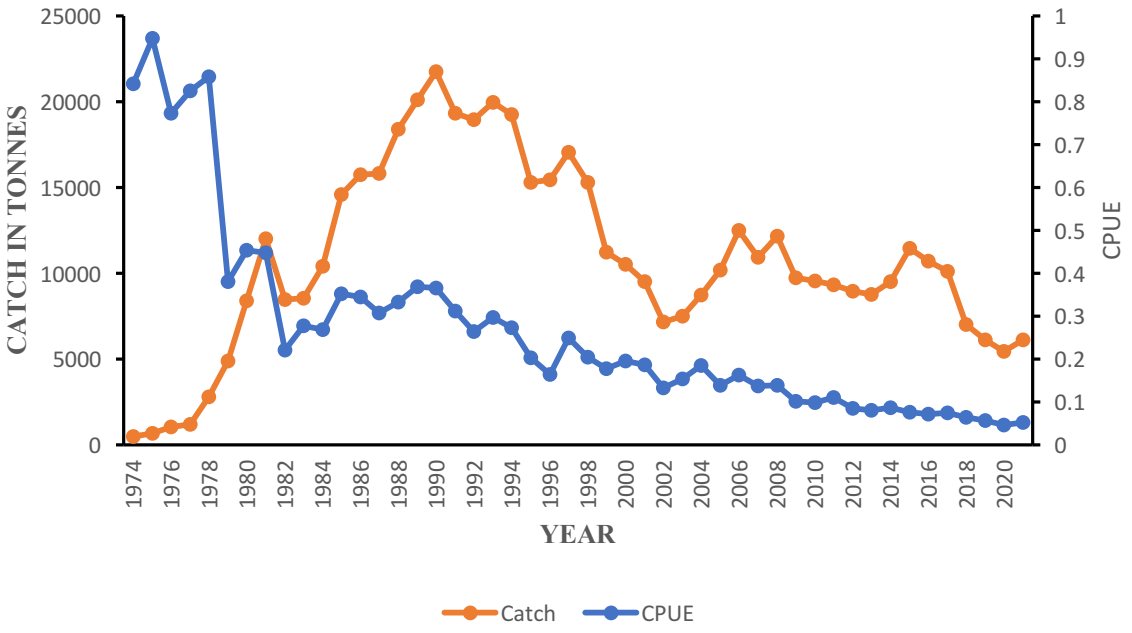

Figure 5 Kapenta catch and CPUE from 1974 to 2020

Kapenta length and weight

Kapenta length and weight statistics are an efficient way of monitoring kapenta growth patterns and general health. Fresh kapenta samples are collected from kapenta operators from basin 5 on a monthly basis. Length and weight measurements are measured recorded. Length and weight statistics are shown in Table 3. Mean kapenta length was highest in 2021 (37.80 mm) and lowest in 2019 (35.50 mm). Mean kapenta weight was lowest in 2019 (0.49 g) and highest in 2020 (1.94g). There was a decrease in kapenta mean weight in 2021 (0.64g).

Table 3. Kapenta mean length and weight from 2019 to 2021

Year	Average Length (mm) ± SD	Average Weight (g) ± SD	N
2019	35.50 ± 6.80	0.49 ± 0.29	2273
2020	37.08 ± 7.70	1.94 ± 0.85	27582
2021	37.80 ± 7.16	0.64 ± 0.37	33697

Inshore fishery

Several fishes such as cichlids, catfishes and mormyrids are harvested by artisanal fishers using gillnets. There are 41 fishing camps/ villages along the Zimbabwean shoreline of Lake Kariba. Zimbabwe Parks and Wildlife Management Authority (ZPWMA) administers fishing camps

that are adjacent to state-land and within the ZPWMA Estate. Fishing villages that are adjacent to communal areas are administered by Nyaminyami rural district council (RDC) and Binga RDC. The RDCs are issued annual fishing block permits by ZPWMA which they issue to fishers (co-operatives and individuals).

The inshore fishing area is divided into concessions, C1 to C7 (Figure 2), for administration purposes. Monthly catch returns are collected from fisher folk for monitoring purposes. Catch assessment surveys are also carried out to validate data collected from fishermen.

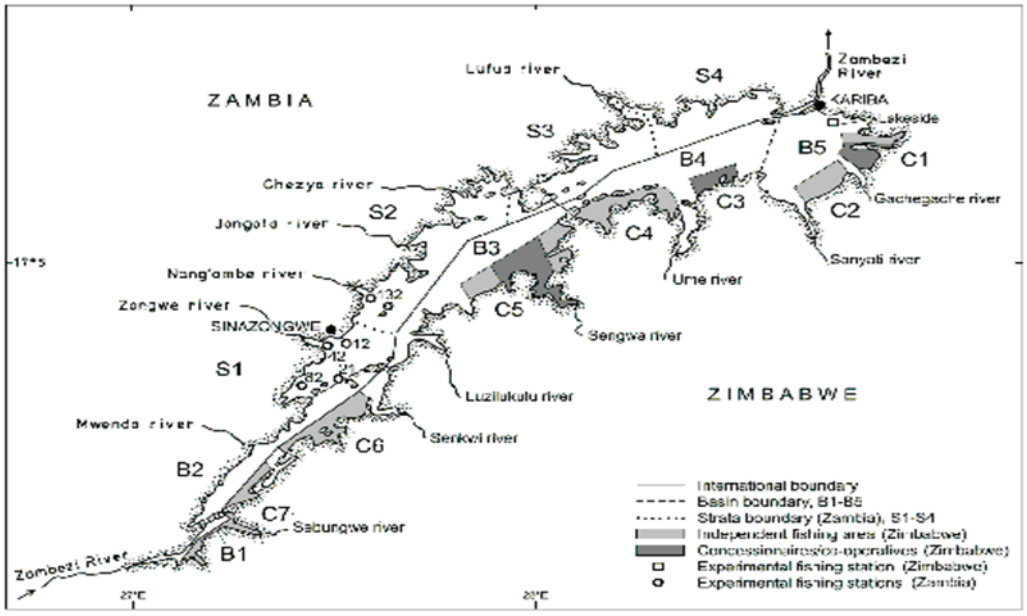

Figure 6. Inshore fishing area in lake Kariba

Inshore species composition

The inshore fishery exploits over 45 fish species in lake Kariba using gillnets. Common fish species that are caught by the fishers include *Distichodus schenga*, *Clarias gariepinus*, *Heterobranchus longifilis*, *Mormyrus longirostris*, *Mormyrops anguilloides*, *Hydrocynus vittatus*, *Synodontis zambezensis*, *Oreochromis mortimeri*, *Coptodon rendalli* and *Oreochromis niloticus*. In 2021 *O. niloticus* dominated the catch contributing a total of 68% of the fish caught (Figure 7). This was followed by *O. mortimeri* and *C. rendalli* with percentages of 17% and 8% respectively. *Distichodus schenga* and *H. longifilis* contributed the lowest percentages of the total number of fish caught in 2020, each with 0.02 %.

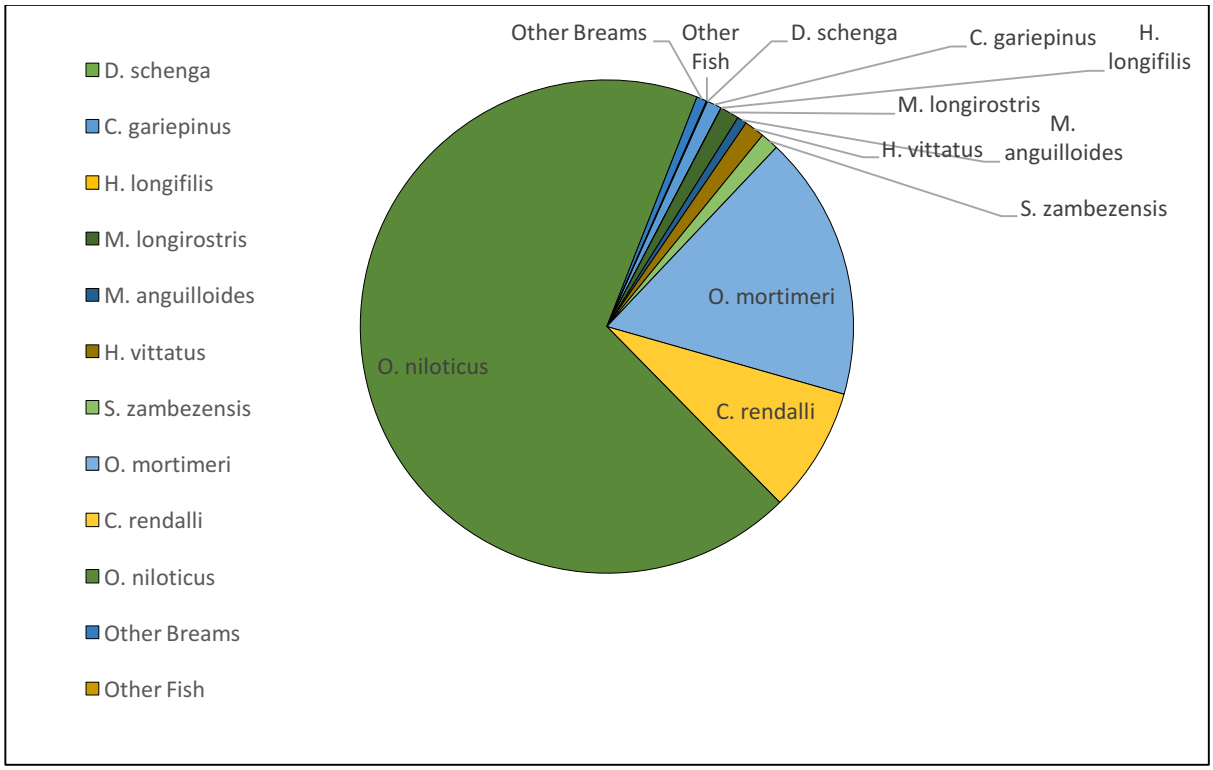

Figure 7. Inshore species composition for the year 2021

In terms of weight, *O. niloticus* contributed the highest percentage (69.64%), followed by *O. mortimeri* (13.21%), *C. rendalli* (6.24%) and *M. longirostris* (4.30%). The lowest percentage by weight was recorded in *D. schenga* - 0.03% - and some unidentified fish -0.03% (Table 4).

Table 4. Species composition and abundance of fish caught by gillnets by inshore fishers for 2021

Species	Number of Fish	Weight (kg)	Percentage (weight)
D. schenga	15	14.5	0.03
C. gariepinus	736	846	1.56
H. longifilis	12	76.6	0.14
M. longirostris	945	2336	4.30
M. anguilloides	476	1170	2.15
H. vittatus	1008	950	1.75
S. zambezensis	901	194	0.36
O. mortimeri	13176	7176	13.21
C. rendalli	6234	3389	6.24
O. niloticus	51838	37828	69.64

Other Breams	504	328.5	0.60
Other Fish	37	14.5	0.03
Total	75882	54323.1	100.00

Species rich has not changed much over the years as 12 fish species have been caught since 2018 except for 2021 where 11 species were caught. The diversity indices- Dominance (D), Simpson`s index of diversity (1-D), and Shannon diversity index (H`) indicate highest diversity in 2018 and lowest diversity in 2020 (Table 5).

Table 5: Diversity of fish species in Lake Kariba (Inshore data)

Test	**2018**	**2019**	**2020**	**2021**
Species richness	12	12	12	11
Dominance (D)	0.1781	0.2904	0.5974	0.3162
Simpson_1-D	0.8219	0.7096	0.4026	0.6838
Shannon_(H)	2.015	1.642	0.9947	1.478
Evenness_e^H/S	0.6249	0.4303	0.2253	0.3986

Inshore catch statistics

More fish (weight) were caught in 2021 followed by 2020 and lastly 2019. The CPUE in 2020 was highest (1.35 kg/ 100m), and lowest in 2021 (0.606 kg/ 100m). Total effort was highest in 2020 and lowest in 2021 (Table 6).

Table 6. Inshore catch, effort and CPUE statistics from 2019 to 2021

Year	**Total Catch (tons)**	**Number of fish caught**	**Effort (Length of nets in m)**	**CPUE (no of fish per 100m)**	**CPUE (kg per 100m)**
2019	38.022	59825	3686150	2	1.030
2020	97.37	100640	7227802	1	1.35
2021	19746.300	26106	3257300	1	0.606

Catch and effort data was collected for only two fishing concessions, C1 and C5 (Table 7). The total catch in C1 was higher (18442.8 kg) than in C5 (1303.5 kg). Catch per unit effort was higher in C5 than C1. Catch and effort data was collected for all fishing areas except for C6 in 2020. We have added catch and effort statistics for 2020 (Table 8) in order to highlight the productivity of the inshore fishing areas. Fishing area C3 recorded the highest total catch and the highest CPUE compared to other areas. The lowest total catch and CPUE was recorded in

fishing area C5. In 2020, the CPUE was generally low as most areas recorded less than 1 kg/ 100m, and 1 fish per 100m of gillnet.

Table 7. Catch and effort statistics recorded for fishing areas CI and C5 in 2021

Fishing Area	Total Catch (kg)	Number of fish caught	Effort (Length of nets in m)	CPUE (no of fish per 100m)	CPUE (kg per 100m)
C1	18442.8	23674	3064200	1	0.602
C5	1303.5	2432	193100	1	0.675

Table 8. Catch and effort statistics recorded for fishing areas CI, C2, C3, C4, C5 and C7 in 2020

Fishing Area	Total Catch (kg)	Number of fish caught	Effort (Length of nets in m)	CPUE (no of fish per 100m)	CPUE (kg per 100m)
C1	11870.74	15562	1485800	1	0.80
C2	295.5	607	84000	1	0.35
C3	64922.6	62237	2681722	2	2.42
C4	7491.8	6703	998250	1	0.75
C5	1891.8	2013	615400	0	0.31
C7	1415.2	1026	139050	1	1.02

Lakeside Experimental Gillnetting

Lakeside experimental gillnetting produces fisheries independent data which can be used together with fisheries dependent data (from inshore fishers) to monitor the fish species in lake Kariba. Data collection began in 1960 and it is done in areas which are closed to commercial fishing. Multi-mesh and monofilaments gillnets are set overnight at Lakeside, Sanyati basin, every month. The nets are of varying mesh sizes which allows sampling across all fish sizes. Nets are set at 1600 hrs and collected at 0700 hrs the next day. Fish removed from the nets are sorted according to species and the following parameters are recorded: date, mesh size, fish weight, standard length, sex and gonad development stage. Gonad development stage represents the reproductive state of the fish at the time of sampling.

Fish species caught during experimental gillnetting are similar to those caught by inshore fishers with the most common species being *Clarias gariepinus*, *Hydrocynus vittatus*, *Synodontis zambezensis*, *Oreochromis mortimeri*, *Coptodon rendalli* and *Oreochromis niloticus*. The most dominant fish species was *S. zambezensis* (52.8%) followed by *H. vittatus*

(15.4%), *S. condringtonii* (7.4%) and *B. imberi* (5.9%). The least number of fish caught belonged to *L. cylindricus* (0.1%), *O. mortimeri* (0.29%), and *S. nebulosus* (0.29%) (Figure 8).

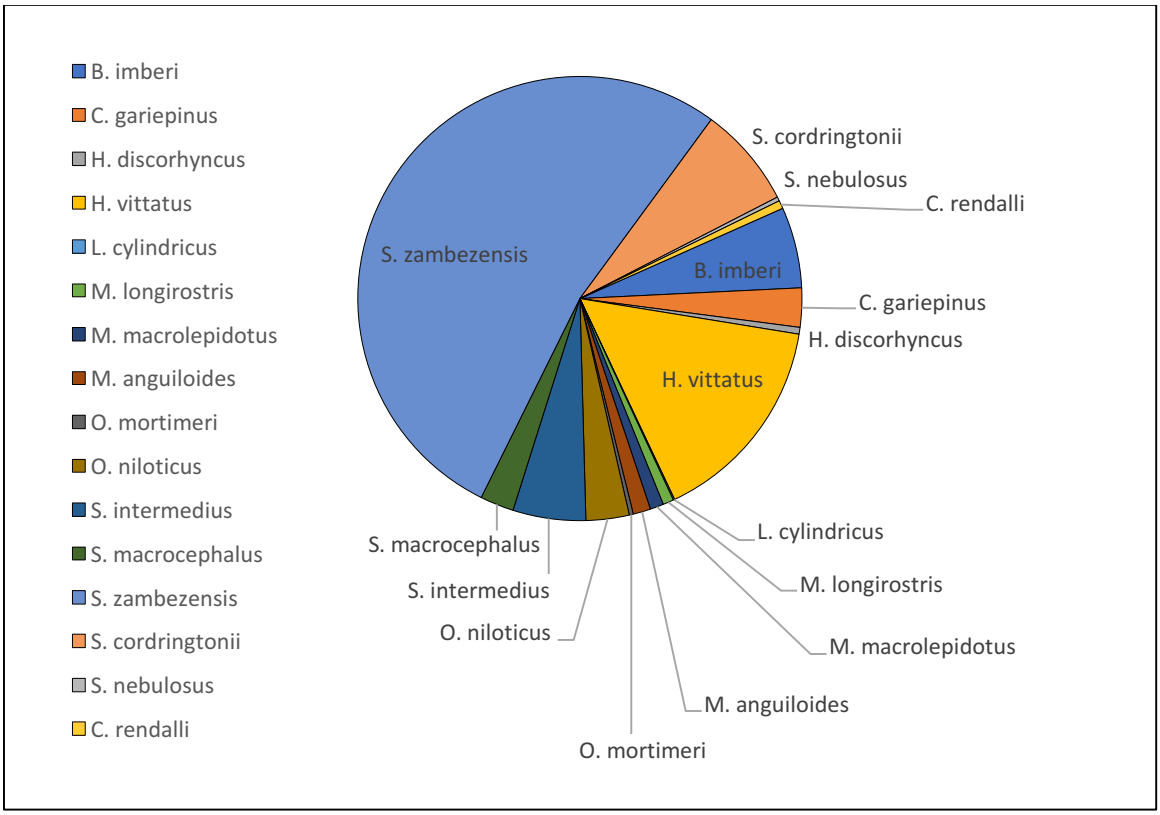

Figure 8. Species composition (numbers) of fish caught at Lakeside, Sanyati basin in 2021

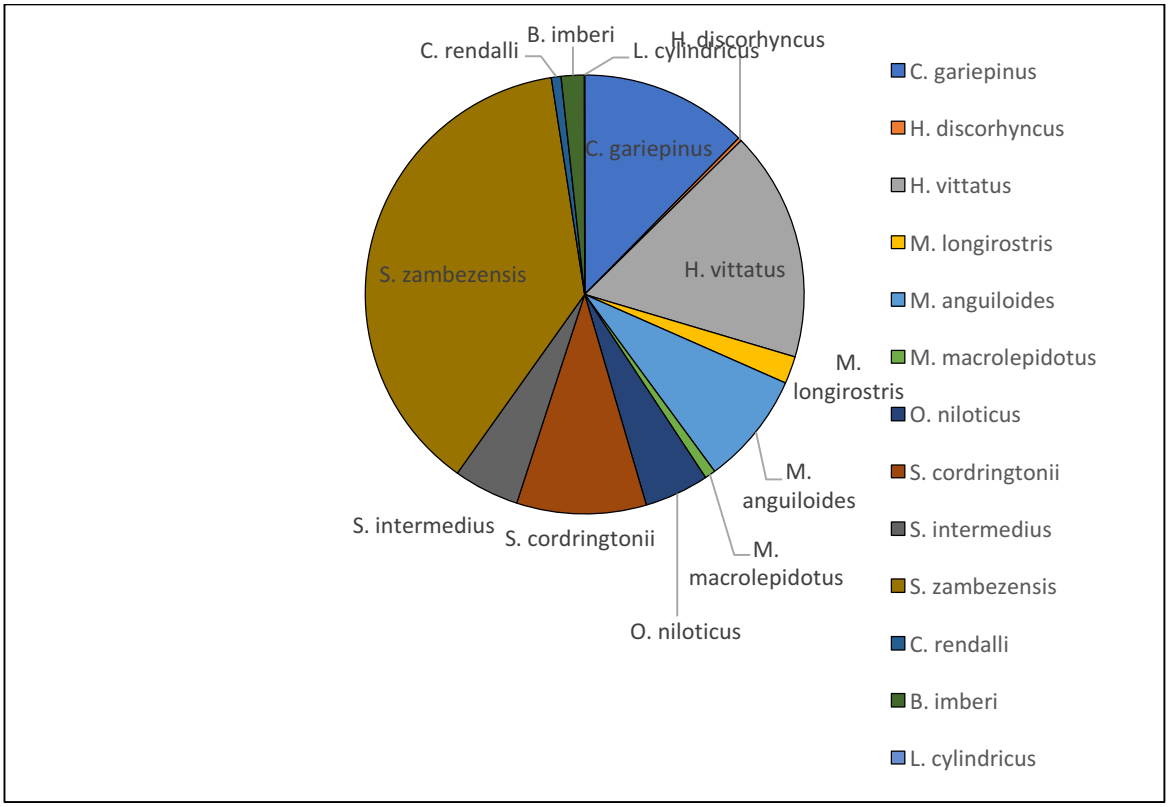

Figure 9. Species composition (weight) of fish caught at Lakeside, Sanyati basin in 2021

The diversity indices- Dominance (D), Simpson`s index of diversity (1-D), and Shannon diversity index (H`) indicate highest diversity in 2019 and lowest diversity in 2020 (Table 9).

Table 9: Species diversity of fish in Lake Kariba (Lakeside data- Bain 5)

Test	**2018**	**2019**	**2020**	**2021**
Species richness	16	15	15	15
Dominance_D	0.3076	0.1682	0.4577	0.3482
Simpson_1-D	0.6924	0.8318	0.5423	0.6518
Shannon_H	1.736	2.162	1.161	1.617
Evenness_e^H/S	0.3547	0.5792	0.2128	0.3359

A large number of fish was caught in 2020 with a total catch of 634.626kg, followed by 2021 (226.060kg) and lastly 2019 (55.375kg). Catch per unit effort was highest in 2019 -0.520kg/ 100m, and lowest in 2020- 0.4kg/ 100m (Table 10). The CPUE with respect to the number of fish was constant for all the three years.

Table 10. Catch, effort, and CPUE for fish caught at Lakeside in the Sanyati basin

Year	Total Catch (kg)	Number of fish caught	Effort (Length of nets)	CPUE (no of fish per 100m)	CPUE (kg per 100m)
2019	55.375	236	10620	2	0.520
2020	634.626	3557	160065	2	0.400
2021	226.060	996	44820	2	0.504

Tiger fish tournament statistics

The tiger fish tournament is held every year in Lake Kariba by the National Anglers Association. LKFRI collects data on the number, length, weight and gonad stage of fish caught during the tournament. Figure 10 shows the trends of tiger fish caught from 2012 to 2021. There is a decrease in catch from 2012 (2341 fish) to 2021 (184 fish). This is influence by the number of teams participating at the tournament each year.

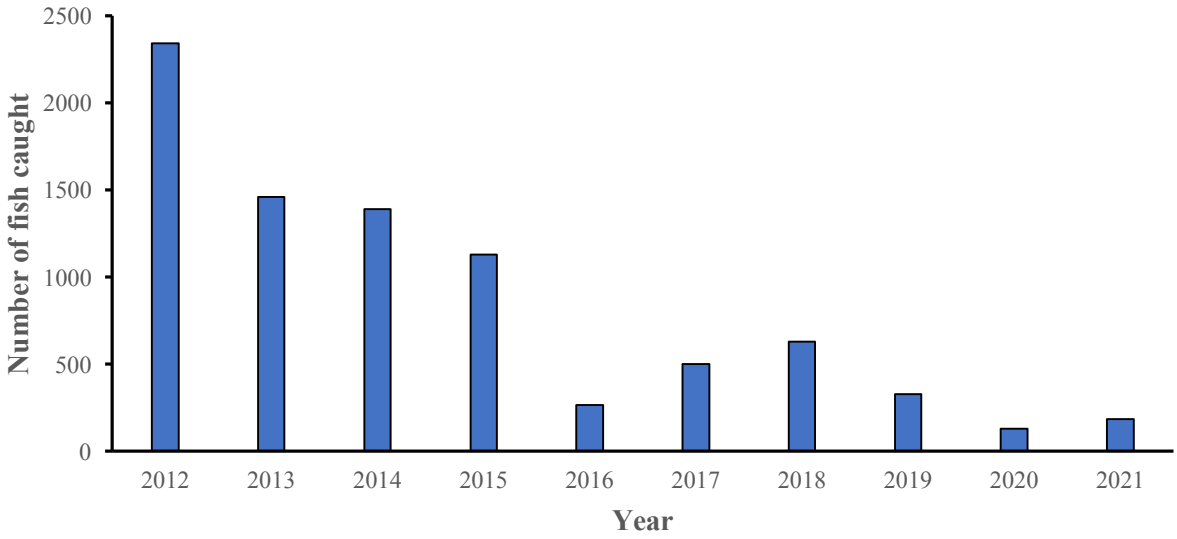

Figure 10. Number of tiger fish caught in lake Kariba from 2012 to 2021

Tiger fish gonad maturation

Gonad maturation is assessed using a simplified scale as follows:

- Inactive (IA) –immature fish and adults in resting stage. Gonads are very small, eggs indistinguishable to the naked eye.
- Active ripe (AR) – the eggs become distinguishable to the naked eye. Testes become pale white in colour.
- Ripe - running (RR) – eggs are big and clearly visible, and testes are white coloured. Light pressure on the fish belly will discharge the sexual products from the gonads.

- Spent (S) – sexual products have been discharged

Table 11. Number of tiger fish in different gonadal stages in 2021

	Inactive	Inactive Active	Active	Ripe	Spent
Male	92	0	8	0	0
Female	74.1	1.2	21	2.5	1.2

Most tiger fish caught during the 2021 tiger fish tournament were inactive, both males (92%) and females (74.1%). Eight percent of the males and 21% of the females were active. A few females (1.2) had already spent their eggs, while 2.5% of the ovaries had ripe ovaries.

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