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REGIONAL CATCH ASSESSMENT SURVEY SYNTHESIS REPORT FOR LAKE VICTORIA JUNE 2005 TO JUNE 2021

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EXECUTIVE SUMMARY

Sound fisheries resources management requires accurate and routine data on dynamics of the exploited stocks such as magnitude, distribution and trends of fishing effort and fish catches. Catch Assessment Surveys (CASs) are among the most popular tools used to assess and monitor exploited stocks to generate information required to guide their management. Since June 2005, the Partner States sharing Lake Victoria have been carrying out regular, regionally harmonized Catch Assessment Surveys (CASs) as one of the key ways of monitoring the fisheries resources of the lake. The June 2021 Catch Assessment Surveys (CASs) were conducted at 143 pre-selected fish landing sites comprising, 32 in Kenya, 64 in Tanzania and 56 in Uganda. These landing sites represent approximately 10% of all landing sites on sharing the lake. The CASs were conducted following regionally harmonised Standard Operating Procedures (SOPs) and adopted the electronic data collection system (eCAS). The information generated delivers a set of indicators to support decision-making in the context of policy and development planning and management plan evaluation. This report presents the current status and trends of the major fisheries of Lake Victoria for the period June 2005 to June 2021. It provides a baseline against which specific management measures could be undertaken or evaluated.

The monthly catches of dagaa, Nile perch, and Tilapia generally increased in 2021. Dagaa increased to 76405 tonnes in 2021 from 46567.4 tonnes in 2015. The increased was reported in both Kenya and Uganda at 62.2% and 82.7% respectively. Tilapia monthly catches increased by 51.6% to 3460.5 tonnes in 2021. The increment was recorded in all the riparian countries, but highly in Uganda at 53.8%. Also, the Nile perch catches increased by 26.5% in 2021 to 18470 tonnes. Although the catches of Nile perch increased in 2021 from 2015, the decreased catch rates in indicative of the immense ecological stress on its stocks. Emerging Synodontis spp and Caridina fisheries were observed in both Uganda and Tanzania respectively. The Synodontis spp fishery has been licenced in Uganda and thus requires close monitoring to avoid excessive exploitation of the species stocks. Similar to monthly catches, the annual catches in 2021 increased by 69.2% to 1,483,501.2t, dominated by dagaa catches.

Although dagaa had the highest monthly/annual catches around the lake, Nile perch contributed the highest lake-wide beach value. Nile perch contributed 52.98 % of the 1139300 million USD dollars estimated from the annual catches in 2021. Dagaa contributed

only 23.23% of the annual beach around the lake, which could be attributed to the post-harvest loss/poor handling process that reduces the beach value of the landed dagaa catches. These include adding sand into the catch, poor preservation, and drying infrastructures around the landing sites.

Due to the economic importance of the Nile perch fishery, the Partner States should take the necessary measures to counter the emerging trend of increasing exploitation of undersize Nile perch. These should include increased efforts in Monitoring Control and Surveillance MCS). Increase of fishing pressure is likely to be the driving force among factors affecting this fishery. Management measures aimed at streamlining fishing effort to increase production are required. Post handling infrastructure of dagaa fishery should be improved around the lake because it was prevalent in all riparian countries.

INTRODUCTION

1.1 Catch assessment surveys in Lake Victoria

Lake Victoria, with a surface area of 68,800 km^2, is the second largest freshwater body in the World. The lake is surrounded by three riparian countries, where Tanzania occupies the largest portion of 35,088 km^2 (51%), followed by Uganda 29,584 km^2 (43%), and Kenya 4,128 km^2 (6%). The lake has a shoreline length of 3,450 km: 1,150 km (33%) in Tanzania, 1,750 km (51%) in Uganda and 550 km (16%) in Kenya. The lakes' fisheries support an important fish export industry, which is one of the major foreign exchange earners of three Partner States. In addition to the fish exports, the lake is a very important source of high protein food, and employment for the peoples of the Partner States of the East African Community (EAC). The lake's fishery is dominated by three species: Nile perch, Nile Tilapia and silver cyprinid. An emergent haplochromine fishery has been reported especially on the Tanzanian portion.
The Partner States of the EAC through the Lake Victoria Fisheries Organisation (LVFO) monitors the exploitation of the fisheries resources of Lake Victoria. The LVFO has harmonized fisheries data collection around the lake, which includes biannual Frame Surveys (FS) since 2000 and Catch Assessment Surveys (CAS) since 2005. Through these surveys, the Partner States monitor the fisheries resources and the data generated by CASs provide Catch per Unit of Effort (CPUE), which, together with raising factors estimated from the data of regular FS are used to estimate total catches. This report brings together the regional CAS data collected from June 2005 to June 2021, providing trends and status of the commercial catches in the lake.

1.2 Purpose of Catch Assessment surveys

Fisheries Catch Assessment Surveys (CASs) aim at the harvest sector to generate information relating to both fish catches and fishing effort. The information generated delivers indicators to support decision-making in the context of policy and development planning and management plan evaluation. These indicators include the Gross value of production, Total catch by species, Total effort by gear, Mean catch per unit of effort by species and gear, and estimation of the optimum fishing effort of the main species. These indicators provide information needed to monitor removals and changes in the abundance of key species, assess the value of the fishery and changes in effort. In the long term, the CAS indicators also provide

estimates of fishing that maximize production, economic rent or employment in the harvest sector.

1.3 Specific objectives

The Catch Assessment Surveys in Lake Victoria aim at providing information on:

(i) The quantities of fish landed in the riparian local administrative units and countries;
(ii) The monetary value of the fish landed;
(iii) The contribution of different fish species to the total catches;
(iv) The contribution of different types of gears and boats to the total catches;
(v) The changes of catch rates of different fish species between areas, seasons, gear types and gear sizes; and boat types; and
(vi) The trends of fish catch rates and total catches in relation to total fishing effort.

2 METHODOLOGY

2.1 The Catch Assessment Survey Design

Lake-wide catch assessment surveys have been conducted around Lake Victoria since June 2005. The current survey was conducted in June 2021 in accordance with the approved harmonized Standard Operating Procedures for Catch Assessment Surveys for Lake Victoria (LVFO 2019). The current CAS piloted and adopted the electronic Catch assessment survey (eCAS) in data collection, processing, and analysis. The CAS was conducted in a two-stage stratified sampling design where within each of the riparian districts in Kenya, Tanzania and Uganda, a sample of at least 10% of fish Landing Sites (LS), i.e. the Primary Sampling Units (PSUs) were randomly selected using Probability Proportional to Size (PPS). At each PSU, stratified samples of Secondary Sampling Units (SSUs) i.e. the craft and gear type, were also randomly selected.

2.2 Selection of Sampling Units

A total of 32, 59, and 54 landing sites were selected for sampling around the Kenyan, Tanzanian and Ugandan parts of the lake respectively. The original sampling landing sites were maintained in the subsequent surveys, except in circumstances where a landing site was non-existent possibly due to flooding and closure. If additional landing sites have been

as evidenced in the FS conducted in 2020, re-evaluation or selection of LS was done before CAS data collection was conducted.

At each landing site, enumerators identified the numbers of all Craft-Gear (CG) types that landed or were expected to land during the sampling day and allocated sampling effort among the SSUs and CG types in proportion to the number of crafts to be sampled. The maximum sample per day was set at 20 crafts (Uganda and Tanzania) 15 crafts in Kenya. In each month during which a CAS was carried out, sampling was done on four days, staggered to two consecutive days in the first and third weeks or the second and fourth weeks of the month.

2.3 Data capture

Regionally harmonized data forms were used to record field data. The data forms contained 3 main parts, i.e. Part A: Document identification; Part B: Active crafts and Sampling targets; and Part C: Fishing operations (Appendix 5). At the beginning of the surveys in each country in 2005, enumerators were identified by the districts, and centrally trained together with supervisors at the district and lower local governments: The enumerators were provided with a *Field Guide* containing the data recording instructions. They were also provided with equipment and materials: Weighing scales (Spring balance); Fish weighing baskets/buckets; Clipboards; Sharpeners; Erasers; Pencils; Water proof bags for keeping the data sheets; Data sheets; Note books; a measuring tape for measuring boat lengths; Gumboots; Raincoats; and Umbrellas.

Before 2021, the earlier CAS data capture was based on paper forms which were filled manually in the field and into the different data handling tools including spreadsheets and access databases. of the eCAS data capture has helped to transform and ease data collection, processing, and analysis. The database has an intelligence which controls the quality of data entering the system in which the data is automatically processed and analysed.

Provision was made for close supervision of field enumerators by the Fisheries Officers at local government levels, District Fisheries Officers and Officers from Fisheries Research and Management Institutions in the partner states to ensure that data collection was conducted according to the planned procedures and schedules.

In successive surveys, replacement enumerators for those leaving the sampled landing sites were trained by the local supervisors. In cases where only one enumerator left, the partner

trained the incoming enumerator together with the local supervisor. Warn out equipment and materials were also regularly replaced in successive surveys.

2.4 Estimation of CAS-based Indicators

The data were stored and analyzed using Microsoft Excel. The fishing crafts were segregated into effort groups (Craft-gear combinations) and the CAS indicators estimated for each effort group.

(i) The mean fish catch rates (kg boat^{-1} day^{-1}) and price were estimated for each species effort group.

(ii) The total fish catches were estimated using the mean fish catch rates and the 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2020 FS data. For each effort group, the Boat-activity coefficient, i.e. the probability that a fishing craft of each craft-gear type would be active on any day during the month, was estimated as the mean number of days boats in each effort group fished in the week preceding the sampling day divided by the number of days in a week. The total catch of each effort group was then estimated.

(iii) The beach value of the catch was estimated by raising the estimated total catch in each effort group by the mean unit price of each species landed.

3 RESULTS

3.1. Fish catch rates by vessel-gear (V-G) combination

The catch rates for the exploited fish species in Lake Victoria in 2021 were recorded by vessel gear combination, revealing the persistence of illegal fishing gears (traps, monofilament gillnets, beach/boat seines, cast nets, and scoop nets) and vessels (parachutes and dugout cones) in the fisheries of the lake (**Figure 1, Appendix 1**). Both the legal and illegal V-G combinations landed catches of the target species in comparable proportions. Overall, the highest catch rates on Lake Victoria in June 2021 were recorded for both silver cyprinid (dagaa) and Caridina in the target V-Gs. Nile perch and tilapia were the most targeted species, landed in the majority of V-Gs recorded on the lake, while Dagaa and Caridina were majorly harvested by small seines (SS) in Ssese motorized (SMS), Ssese pointed (SP), parachutes (PA),

and catamaran (CA) boats. Synodontis spp in Uganda and Caridina in Kenya and Tanzania were harvested for the first time in large quantities.

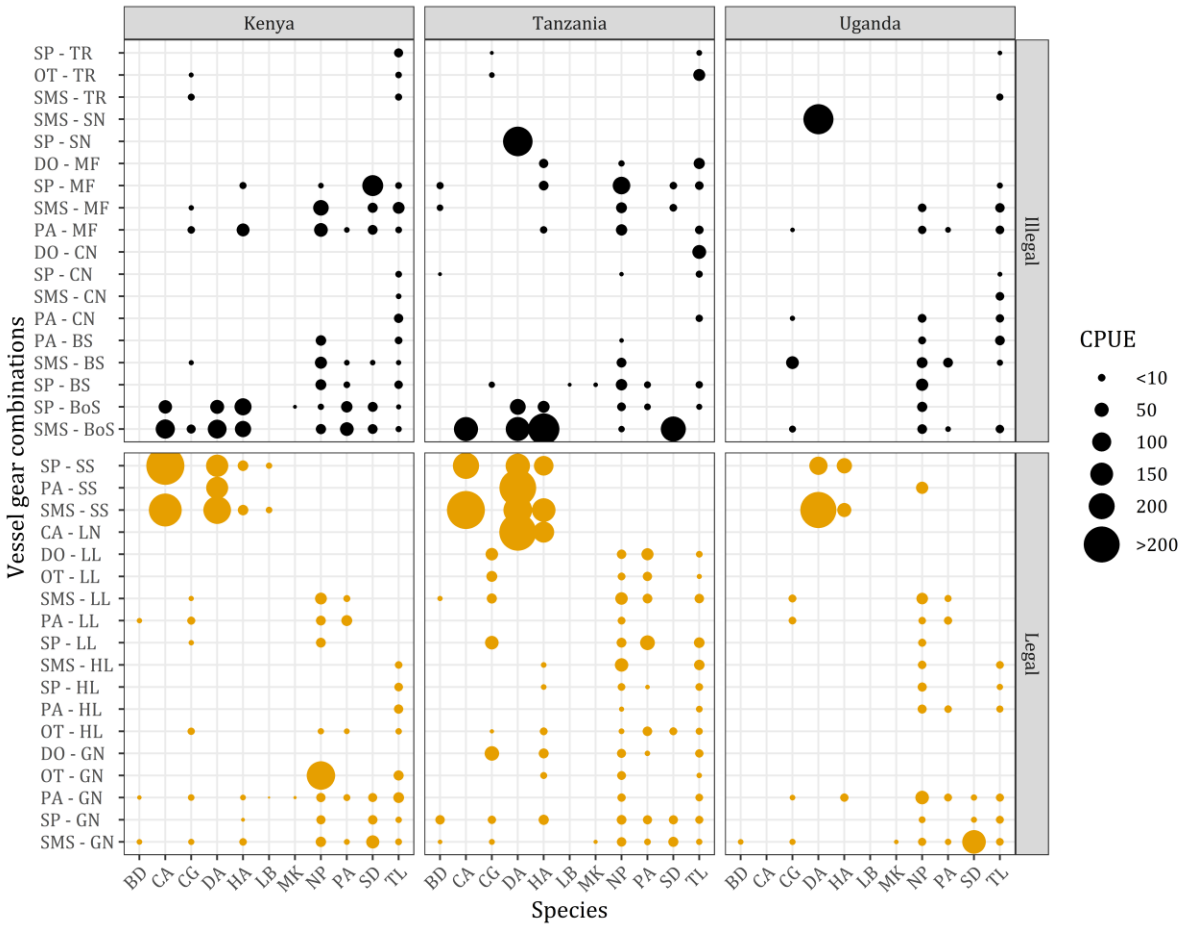

Figure 1: Catch rates of the harvestable fish species recorded on Lake Victoria in June 2021 presented by vessel-gear combination

3.2 Trends in fish catch rates

3.2.1 Nile perch catch rates

The main legal fishing gears for the Nile perch fishery were multifilament (MF) gill nets and long line (LL) hooks. The two gears are predominantly carried by two main boat categories, i.e. SP, which operate in the inshore waters, and the SMS for offshore waters. Four main V-G combinations target the species and their catch rates (Figure 2 and Appendix 2). The highest catch rates were recorded in Tanzania, followed by Uganda, and least in Kenya. The catch rates decreased in Uganda and Tanzania between 2015 and 2021 but increased in Kenya (Figure 2). One possible explanation for this scenario is that there is higher biomass which is

manifested in the hydro-acoustic surveys. The differences in fishing effort and environmental attributes are among other factors. In Kenya, there are many boats per area which leads to lower catch rates.

Generally, the LL fishery showed a decline in Nile perch catch rates in contrast to the increment between September 2011 and April 2014 (**Figure 2**). However, other factors at play which may temporarily maintain high catches against reduction of fish biomass in the lake, such as reduction of hook size and bait and mesh size of gillnets to target smaller Nile perch should be thoroughly investigated.

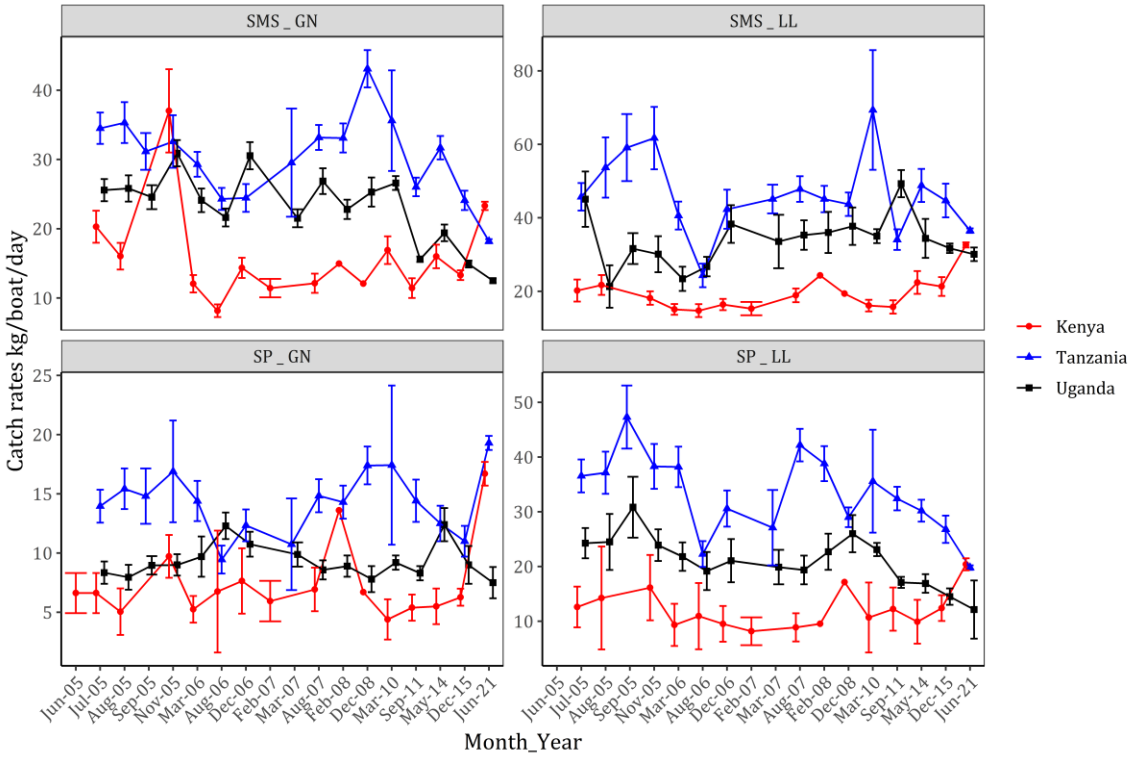

Figure 2: Trends of Nile perch catch rates in the SP and SMS using GN and LL in Lake Victoria

3.2.2 Tilapia catch rates

Tilapiines were among the lucrative fisheries and were abundantly caught in Lake Victoria before the introduction of the Nile perch and Nile tilapia between the 1950s and 1960s (Goudswaard et al. 2002). It is currently landed mainly in parachutes and paddled by Ssese crafts operating mostly gillnets and hand lines. Parachute fishing canoes are also largely encountered in the Ugandan and Kenyan waters, with few operating on the Tanzanian side of the lake waters. Tilapia are also caught in cast nets and monofilaments, which are common

across the three countries (i.e., Kenya, Uganda, and Tanzania). Tilapia catch rates for the main craft-gear types targeting the species are presented (Figure 3 and Appendix 3).

In the Kenyan part of the lake, the Tilapia catch rates in parachute boats using gill nets for the period between April 2014 and June 2021, increased substantially to 25.3±2.2 kg/boat/day from 2.4±0.7 noted in April 2014. In the Ugandan part of the lake, there was a slight increase to 7.1±0.4 kg/boat/day in June 2021 from 6.6±0.7 kg/boat/day recorded in April 2014. Catch rates in the Tanzania sector increased to 10.5±1.0 kg/boat/day in June 2021 from 4.1±4.4 kg/boat/day documented in November 2015. Over the period from April 2014 to June 2021, the tilapia catches rates for parachute craft operating hand lines increased to 17.7±1.2 kg/boat/day in June 2021 from 12.7±3.0 recorded in April 2014 in the Kenya part of the lake. An increase was also noted in the Ugandan waters to 6.9±0.8 kg/boat/day in June 2021 from 5.2±1.4 recorded in April 2014. In the Tanzania part of the lake, the catch rate for tilapia landed in parachute crafts using a hand line increased as well, to 7.0±1.3 kg/boat/day in June 2021 from 4.3±1.0 kg/boat/day observed in November 2015 surveys.

There was an increase in tilapia catch rates landed in Ssese crafts propelled by paddles with gillnets (SP-GN) in all the three partner states. In the Kenyan part, catch rates increased to 6.1±0.4 kg/boat/day in June 2021 from 1.41±0.21 kg/boat/day observed in November 2015. Within the same period, the Ugandan part recorded catch rates increasing to 11.42±1.2 kg/boat/day from the previous catch rate of 3.2±0.6 kg/boat/day in November 2015. The same increase in catch rates was noted in the Tanzanian part of the lake to 11.8 kg/boat/day in June 2021 from 2.8±0.7 kg/boat/day observed in November 2015.

The catch rates for Ssese paddle using hand lines (SP-HL) are still in an increasing trend to 14.3±4.5 kg/boat/day in June 2021 in the Kenyan part of the lake, from 0.5±0.7 and 2.17 ±1.1 kg/boat/day observed in April 2014 and November 2015 respectively. In Tanzania and Uganda, catch rates are still relatively low, but at least indicated a slight increase in Tanzania where 17.1±6.5 was reported in April 2014, which is higher than the 10.5±0.7 kg/boat/day observed in June 2021 from 7.4±4.9 kg/boat/day recorded in November 2015. A trivial decrease in catch rate was observed in the Ugandan part for the June survey (5.74±1.07 kg/boat/day) from 5.9±0.8 kg/boat/day in November 2015, which was slightly higher than the 4.7±0.9 kg/boat/day reported in April 2014.

There was an increase in the catch rates in the parachute boats using hand lines for both Kenya (12.7±3.0 kg/boat/day in April 2014, 14.8± kg/boat/day, in November 2015, and 17.7±1.2 kg/boat/day in June 2021) and Uganda (5.2±1.4, 6.9±0.8 to 8.59±1.16 kg/boat/day). Tanzania, on the other hand, did not report any parachute boats in April 2014. The same boat type recorded an increase of 7.0±1.3 kg/boat/day in June 2021 from 4.1 kg/boat/day of tilapia in November 2015.

The tilapia caught in parachutes operating gill nets throughout all the surveys from July 2005 to June 2021 had the lowest catch rate of 0.25±0.28 kg/boat/day recorded in the Tanzanian part of the lake in March 2010 and the Kenyan part of the lake had the highest catch rate (25.3±2.2 kg/boat/day) observed in June 2021. The lowest catch rate (2.54±1.2 kg/boat/day) landed in Parachute boats using hand lines were observed in November 2005 in the Ugandan waters, with the highest (20.78±8.91 kg/boat/day) in this craft gear category landed in March 2005 in the Tanzanian part of the lake. Within the same period, SP crafts recorded the lowest catch rate of 1.27±0.27 kg/boat/day in March 2006 on the Tanzanian side of the lake, and both Tanzania and Uganda reported higher catch rates (11.8±0.9 kg/boat/day and 11.42±1.2 kg/boat/day) in June 2021 when compared to the figure reported in the Kenyan waters (6.15±2.9 kg/boat/day) in August 2006. Catch rates in Ssese paddle boats using hand lines were the lowest (0.5±0.7 kg/boat/day) in the Kenyan waters and the highest (28.96±6.3 kg/boat/day) within the same period (i.e., July 2005 to June 2021) was observed in July 2005 in the Tanzania part of the lake.

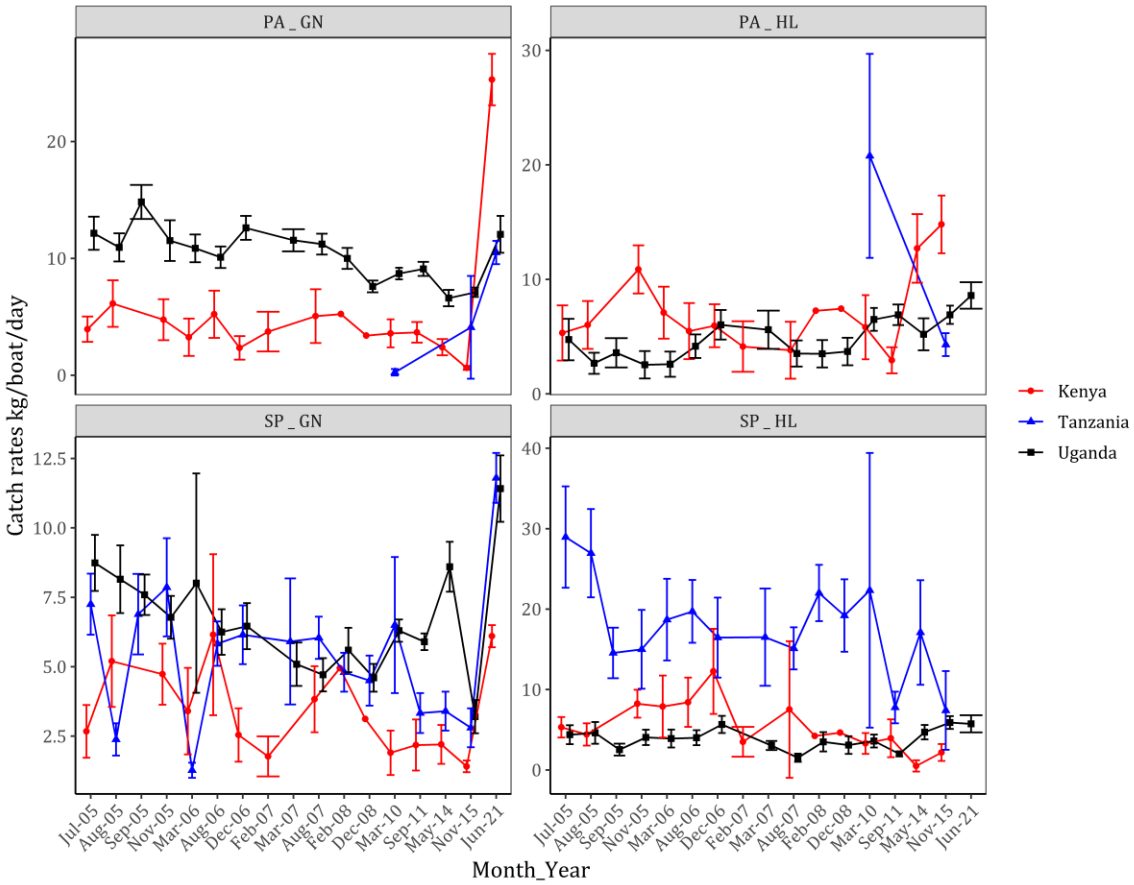

Figure 3: Trends of tilapia catch rates of PA and SP using GN and HL in Lake Victoria

3.2.3 The catch rates of Dagaa/Omena/ Mukene

Ssese motorized (SMS) and paddled boats using small seines were the main V-G combinations around the lake for the dagaa fishery. Except for Uganda in SP-SS and Tanzania in SMS-SS, the catch rates for dagaa generally increased in June 2021 (Figure 4). For instance, in Kenya, the catch rates in SMS-SS increased from 117.87 in 2015 to 226.80 kg/boat/day. Similarly, in Uganda, the catch rates increased from 237.6 in 2015 to 403.8 kg/boat/day in 2021 (**Figure 4**). The shift from the large fishes to small pelagic fishes has been observed in the major lakes including Victoria, Kyoga, and Albert (Mbabazi et al. 2012); (Kolding et al. 2019). The shift has been attributed to the reduced stocks of the large fishes due to overexploitation using illegal gears that have created an ecological vacuum for the small fishes to thrive. Also, the reduced competition for food and space has led to a proliferation in the stocks of the small pelagic fishes such as the Silver cyprinids. However, the increased catch rates coupled with the poor harvest handling of the small fishes have led to poor revenue generation compared to the large-bodied species. The increase in the catch rates was V-G combination specific. For

example, the highest catch rates were observed in SMS-SS because the fishers are able to access the offshore fishing grounds, which are associated with high stock biomass of the small fishes mostly Mukene/Dagaa/Omena.

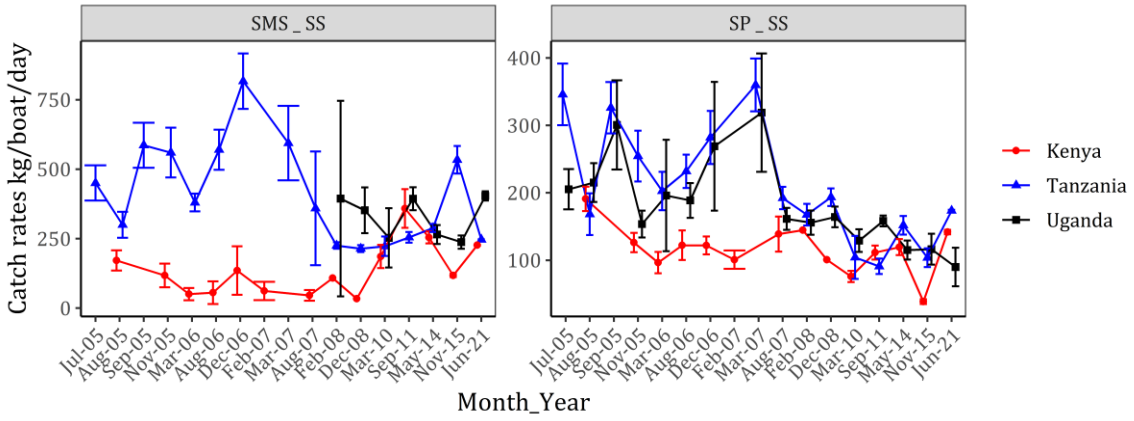

Figure 4: Dagaa/Omena/Mukene catch rates in the SMS and SP boats using small seines in Lake Victoria between June 2005 and **June 2021.**

3.3 Estimates of total fish catches of the major commercial species

3.3.1 Nile perch

The lake-wide estimated monthly total fish catches for Nile perch in June 2021 was 18,470 tonnes (t), up from the 13,568.5 tonnes recorded across the entire lake in November 2015 (Figure 5). This observation represents an overall increment of 26.5% between the two surveys. In both Kenya and Uganda, the Nile perch catches increased from 2,161.1 to 5,520.1 t (60.9%) and from 3,059.1 to 5,145.4 t (40.5%) respectively. However, in Tanzania, there was a 6% drop in monthly catches from 8,348.3 to 7,804.5 tonnes. Although the total catches were increasing steadily the catch rates of Nile perch were decreasing over time. As the fish stock biomass decrease, the fishers devise highly non-selective gear to maximize the catches. Therefore, the increased catches should be coupled with the size distribution information of the landed catches. Evidently, the Nile perch were landed in illegal gears including the monofilaments, and boat beach seines, which exerts intensive ecological pressure on its stocks.

3.3.2 Tilapia

The total monthly tilapia catch estimates for the entire lake in June 2021 was 3,460.5 tonnes, indicating a 51.6% increase from the 1674.3 t recorded in November 2015 (Figure 5). Tilapia

catches increased across all the countries; in Kenya 52.8% from 263.3 t to 558.1 t, in Tanzania 40.7% from 319.6 to 538.7 t, and in Uganda 53.8% from 1,091.4 to 2363.7 t over the survey periods. Prior to the 2021 surveys, there had been a general lake-wide decline in Tilapia monthly catches from 6,248.5 in September 2005 to 2,748 in September 2011 with some degree of recovery in April 2014 at 4,905.3 t before a drastic decline in November 2015. Similar to Nile perch catches, the increase in the catches of Nile tilapia/tilapiines was also attributed to increased fishing effort but not rather an improvement in the stock biomass.

3.3.3 Dagaa/Omena/Mukene

The total monthly catch for Dagaa on Lake Victoria estimated in June 2021 was 76,405 tonnes, representing a 39% increase from the 46,567.4 t in November 2015. In Uganda and Kenya, Dagaa catches increased by 82.7% and 62.2% respectively, however, in Tanzania, Dagaa caught decreased by a 16.3% margin from 35,658.5 to 30,648.3 t over the survey period. Despite the decrease, the lake-wide Dagaa catch estimates were heavily influenced by the Tanzanian part of the lake where total landings are exceptionally higher than in Kenya and Uganda (Figure 5).

3.3.4 Haplochromines

Haplochromine catches have been prominent in the Tanzanian and Uganda portions of the lake where this fishery seems to be more developed than in Kenya (Figure 5). In 2021, the monthly total catch of the Haplochromines estimated for the entire Lake Victoria was 4905.2 t, revealing a 48.8% overall decrease in its catches. The highest Haplochromine catches were recorded in Uganda (2740.3 t while Kenya recorded the lowest (618.4 t). The haplochromine catches have fluctuated from 5,852.3t in March 2010 to a maximum of 11,490.2 t in September 2011 and decreased to 5,449.4 t in April 2014 with a slight increase (1.5%) to 5,531.2 in November 2015. Lake-wide total catches decreased almost two-fold from 11,644 t in September 2011 to 6,045.7 t in April 2014 followed by a 20.7% increase to 7,292 t in November 2015. Between 2015 and 2021, the Haplochromine catches registered almost a four-fold reduction on the Tanzanian part, while increasing by 54.8% and 14.1% margins in Uganda and Kenya respectively. A peak of the total Haplochromine catches in the Tanzanian waters of 17,898.8 t was recorded in November 2005, but reduced to a minimum of 1550.1 t in June 2021.

3.3.5 Other fish species

The monthly total catches of all other fish species other than those listed above were estimated at 20,384.5t, representing an overall increase of 85.6% from that recorded in November 2015. In both Uganda and Tanzania, the monthly catches for the other species increased by > 90% between 2015 and 2021 and by 43% in Kenya over the same period. It should be noted that June 2021 recorded the highest catches for the other species since the onset of CASs in June 2005. There was a slight decrease in catches for this type of species from 1021.2 t in March 2010 to 977.8t in September 2011 and increased to 2,088.6 t in April 2014 and 5,309.8 in November 2015. The drastic increase in the contribution of other species was mainly attributed to the two emerging species i.e. Synodontis in Uganda and Kenya and Caridina in Kenya and Tanzania.

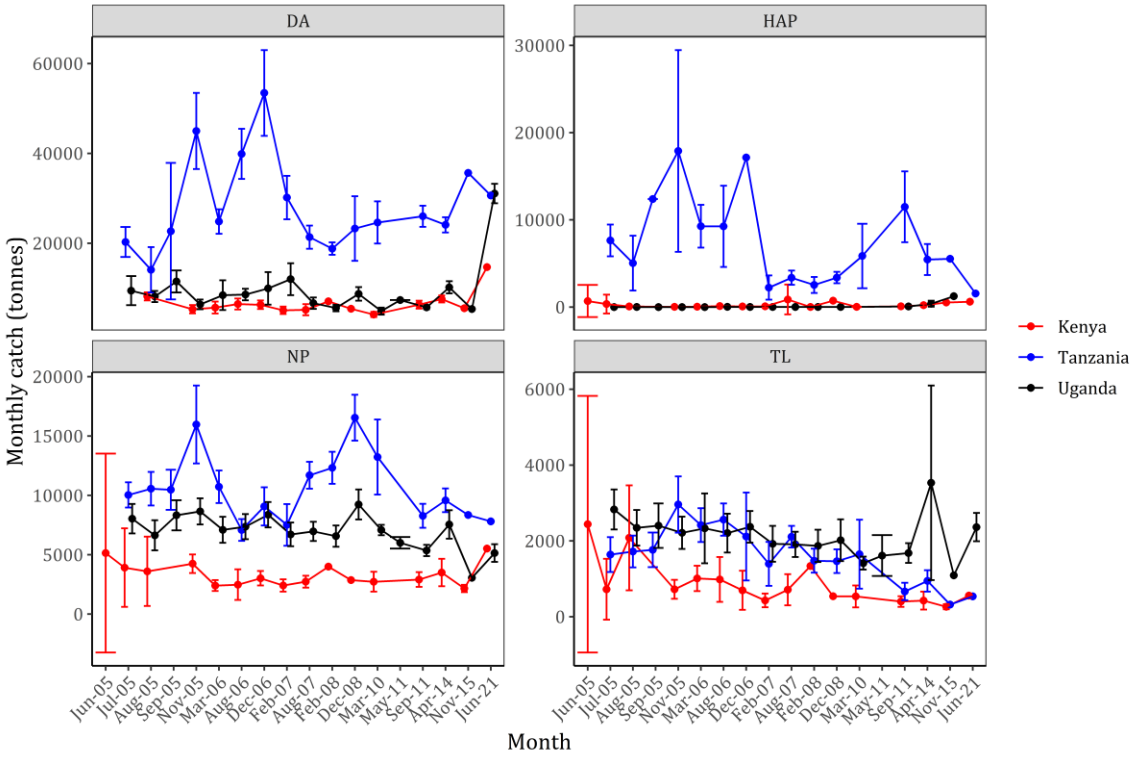

Figure 5: Estimated monthly total catches of the major commercial fish species (Nile perch, Tilapias, Dagaa, and Haplochromines) in Lake Victoria between June 2005 and June 2021.

3.4 Total annual catches

The trend of lake-wide total catches for the sampled years is presented in Table 1. The total lake wide annual catch estimate for 2021 was 1,483,501.2 tonnes, representing a 41% increment compared to the 876,547.5t estimated in 2015 (Table 1). In this survey, Dagaa had

the highest contribution at 916,858.8t (61.8%), followed by species other groups (244,614.0 t, 16.5%), Nile perch (221,640.0 t, 14.9%), and Haplochromines (58,862.4 t, 4%), and least for tilapia (41,526.0 t, 2.8%). Overall, since the commencement of CASs in 2005, the lowest total lake wide catches were realized in November 2015 with the highest recorded in June 2021 (Table 1).

The contribution of Nile perch to the overall total catches has improved to 221,640.0 t in June 2021 when compared to 165,083.4 t in November 2015. The highest was reported in the year 2008 when it was estimated to be 309,099.5 t, reduced to 198,624 t in September 2011 and increased thereafter to 251,063.3 t in April 2014.

Similarly, the contribution of tilapia to the annual catch in June 2021 was 41,526.0 t. This is an increase after a drastic decrease from the previous survey from 20,371 t reported in November 2015. The highest estimate of 52,242 t was recorded in 2008 and reduced to a minimum of 32,976 t in September 2011 and then increased to 59,598.1 t in April 2014. On the other hand, the contribution of Dagaa was the highest in 2006 at 602,295.6 t, decreased to a minimum of 403,912.2 t in March 2010, and increased to 456,721.2 t, 509,598.1 t, and 566,570 t in September 2011, April 2014 and November 2015 respectively. The Nile perch and Tilapia total catch estimates decreased by 34.2%, from 251,063.3 to 165,084.3 t and by about 65.9% from 59,681.3 to 20,371 t in April 2014 and to 165,083.4 t November 2015 respectively. Dagaa catch estimates increased by 11.2% from 509,598.1 t in April 2014 to 566,570 in November 2015. Haplochromine catch estimates increased by 20.7% from 73,556 t to 88,794 t in April 2014 and November 2015 respectively. The total lake-wide catch declined by 4.7% from 919,310.1 t to 876,547.5 t between the last two surveys.

Table 1: Estimated Lake wide annual total catches (MT) June 2005 to June 2021

Year	Nile perch	Tilapia	Dagaa	Haplochromines	Others	Total
2005	286,716.6	71,531.7	453,006.6	138,451.5	5,304.0	955,010.7
2006	264,070.0	69,635.6	602,295.6	146,533.2	7,063.6	1,089,598.4
2007	233,941.3	54,650.2	600,659.7	95,211.5	14,436.6	998,899.7
2008	309,099.5	52,242.0	413,352.3	40,091.9	10,595.5	825,381.7
2010	276,428.7	43,196.0	403,912.2	70,449.1	12,254.4	806,240.4
2011	198,624.0	32,976.0	456,721.2	139,728.0	11,733.6	839,782.8
2014	251,063.2	59,681.3	509,598.1	73,556.0	25,411.4	919,310.1
2015	165,083.4	20,370.1	566,570.0	88,793.6	35,729.9	876,547.5
2021	221,640.0	41,526.0	916,858.8	58,862.4	244,614.0	1,483,501.2

3.5 Estimated Annual Beach Value

The total landings from Lake Victoria were valued at (USD) at 1,139,300 in June 2021 compared to (USD) 588,680,971 in November 2015 and USD 840,887,252 in April 2014 (Table 2). Although Nile perch is second in contribution to the catches in terms of quantities landed, it still contributes the highest value to the Lake Victoria fishery, (52.2%) followed by dagaa (31.7%) compared to 64.9 % and 16.1 % April 2014.

Table 2: Estimated Annual Beach Value (*1000 USD) of Catch based on the June 2021 CAS

Species	Uganda	Tanzania	Kenya	Total	%
NP	164.34	280.404	158.84	603.59	52.98
DA	63.732	144.324	56.616	264.67	23.23
TL	54.18	16.104	12.24	82.524	7.24
HA	9.756	6.72	3.384	19.86	1.74
Others	144.64	9.384	14.628	168.65	14.80
Total	**436.64**	**456.936**	**245.71**	**1139.3**	**100**

4 DISCUSSION OF RESULTS

The 2021 CAS results reveal an overall increase in total lake wide annual catch from 876,547.5 t in 2005 to 1,483,501.2 t in 2021. The 2021 annual lake wide catch represent an increase of 46% in comparison to the 2015 estimates. The improvement in monthly and projected annual catches could be attributed to the improvement in management in the three countries. In Tanzania, there was strict enforcement of 7-inch size limit for the Nile perch fishery and removal of illegal fishing gears. In Uganda, the Fisheries Protection Unit (FPU), an arm of the Uganda Peoples Defence Force (UPDF) started effective enforcement of the fisheries regulation on Lake Victoria in 2018, however, no catch data had ever been collected on the Lake since December 2015 (LVFO, 2016). The entry of FPU in fisheries management on the Uganda sector of Lake Victoria resulted in a reduction in illegal fishing effort on the lake. The details of improved fisheries management on Lake Victoria are reflected and contained the 2020 Regional Frame Survey report for Lake Victoria (LVFO, 2020a). Improved fish stocks on Lake Victoria are also reflected in the 2020 Hydroacoustic survey report (LVFO, 2020b), which revealed a 25% increase in the stock biomass of Nile perch in Lake Victoria between 2018 and 2020. Prior to the 2021 CASs, the catches on Lake Victoria had drastically reduced to the lowest level in December 2015. For instance, between 2014 and 2015, the lake

wide catches of Nile perch and Tilapia decreased by 34.2% and 65.9% respectively (Table 1). The only species that registered slight increases during the same period were Dagaa and Haplochromines in proportions of 11.2% and 20.7% respectively. Factors such as reduction of hook and bait size and mesh size of gillnets to target smaller Nile perch were then associated to the observed declines.

Similar to the previous surveys, the 2021 survey revealed dominance of Dagaa in the annual catch, followed by the Nile perch, Haplochromines, and Tilapia. However, when combined together, the rest of species groups accounted for 16.5% of the lake catch, slightly more than the Nile perch. This group was dominated by Synodontis spp in Uganda and Kenya and Caridina in Kenya and Tanzania. In Uganda, ……. fishing boats were licenced to harvest *Synodontis spp*, mainly by fishers in the Island districts of Namayingo and Buvuma. The species is harvested for at least six months from April to September, when they are known to be abundant, a period that coincided with the 2021 CASs. Despite its large contribution to the annual catch in Uganda, further research is needed specifically on the biology and ecology of this species as well as gear selectivity to guide on the fishing periods and optimal gillnet mesh sizes.

Despite the overall increase in monthly and annual lakeside catches in 2021, the CPUE in the major vessel gear combinations for the main commercial fish species (Nile perch, Tilapia, and Dagaa) showed declines. Generally, fishers always strive to maintain or increase their catch, therefore, they respond to low catches by adopting more efficient fishing gears and methods, which in most cases are illegal and destructive to the target and non-target stocks. In June 2021, many illegal vessel-gear combinations (Figure 1) landed substantial quantities of catch which could explain the increase in the annual landings. The observed increase in monthly and annual catches should therefore be treated with caution as it may not be sustainable, given that it was largely contributed by illegal fishing gears. It appears the earlier efforts on the Lake to eliminate illegal fishing gears by FPU in Uganda and ……. In Tanzania have relaxed, hence the hight prevalence of these gears as observed in the June 2021 CASs. Management efforts should be directed towards eliminated such gears from the Lake to allow fish stock recovery and sustainability. Given the economic importance of the Nile perch fishery, the partner states should take the necessary measures to maintain the recent observed recovery in the Nile perch catches. The impact of capture of undersize Nile perch, should be adequately

assessed and quantified to guide targeted management interventions to stop the practice. The impacts of the rapidly expanding Nile perch long line fishery according to Frame survey data 2000 to 2020 (LVFO 2020b), with apparently good catch with respect to bait and fishing ground need to be examined.

The catches of Tilapia remained relatively stable between 2005 and 2014, before registering a drastic decline to the lowest catch of 20,370.1 t in 2015. However, the recent June 2021 CAS reveal an improvement in catch landings of Tilapia by a two-fold increase (Table 1). While the increase portray an improvement in the tilapia fishery, it should be noted that the largest portion was landed in the illegal vessel-gear combinations (Figure 1). In fact, was highly targeted by almost all the vessel-gear combinations in June 2021. Being a near shore fishery, Tilapia is the most easily accessible with simple fishing crafts such as *Parachutes* boats, rafts, foot fishers and simple fishing gears like hand lines and cast nets. Increase of fishing pressure on Tilapia is likely to be among the factors affecting this fishery. To ensure sustainability of the tilapia fishery, all fishing vessels and gears that compromise its sustainability such as cast nets, beach seines, traps, parachute and dugout boats, and undersize gillnets should be removed from the lake through improved Monitoring Control and Surveillance (MCS). Appropriate stock assessment methods for tilapia should be sought to better understand the status of its biomass in the lake and guide on optimal harvest levels.

Dagaa dominated the catch landings estimated on Lake Victoria in June 2021 by ~60% (Table 1, Figure 5). Further, the estimated total catches of Dagaa showed a 39% improvement in June 2021 in comparison to the 566,570.6-t recorded in November 2015. The dominance and increase in Dagaa catches are also reflected in the finding of lake wide acoustic surveys of 2020 (LVFO, 2020a), where the species dominated the lake biomass by 10% between 2019 and 2020. Despite the substantial contribution to the catch and livelihoods of the many dependent communities along the Lake Victoria shores, its harvest in small seines using solar light attraction techniques has generated conflict with the Nile perch fishers. The major concerns are excessive fishing effort, competition for fishing ground, increasing panelling of small seines, and use of solar as a light attraction source. Urgent studies are urgently needed to regulate the Dagaa fishery in terms of optimal net panels, light attraction source (kerosene versus solar), and fishing periods to ensure harmonious co-existence with the Nile perch fishers.

Despite dominating the lake wide catch, the economic contribution of Dagaa remained low. Factors affecting its quality at production and processing levels need to be addressed in order to promote its human consumption and improve the economic value. The Nile perch still remains the major economic power of the Lake Victoria fishery. However, with the increasing development of the Nile perch maw, its sustainability and economic power is at threat. It is becoming clearer to fisher that the Nile perch maw is more lucrative compared to its flesh. The fishers have since resorted to extracting the maw in ungazzeted areas using unhygienic methods. The maw is sold independently of the flesh, which is consumed in the local markets. This deprives fish factories of this important raw material, since factories do not accept fish tampered with due to the phytosanitary standards and requirements. It is now common to find very big Nile perch on fish stalls in local fish markets and such is sold in kilograms at relatively cheap prices. Since it is no longer a secret that the Nile perch maw is more profitable, fish factory owners (processors) should adjust and offer good prices for the Nile perch, taking into account the potential value of the maw, if they are to attract Nile perch to their factories. There is also need to regulate the Nile perch maw business and establish gazetted areas for the maw extraction to maintain hygienic standards and attract revenue from this previously black-market commodity. Further, there is need to protect the large Nile perch (above 85 cm) due to their high reproductive potential to replenish the Nile perch stocks. The larger the Nile perch, the higher its fecundity (Ogutu-Ohwayo 1988); (Dadebo et al. 2006). Because of this, fishers are now hunting for the Largest Nile perch in the lake which may in the long term affect stock recruitment. We therefore recommend that the harvest of Nile perch above the upper 85 cm limit of total length is regulated through the gillnet mesh size restrictions.

5 CONCLUSIONS AND RECOMMENDATIONS

The catches and economic value of catch on Lake Victoria substantially increased in June 2021. However, the increase should be treated with caution given that significant portion was landed in the illegal fishing gear-vessel combinations. The electronic catch assessment data collection was piloted for the first time on Lake Victoria but proved cost-effective in sustainable data acquisition. The following measures are recommended to promote stock recovery and ensure sustainability of the lake commercial fisheries.

1. The national governments should adopt the eCAS and recruit permanent enumerators at landing sites to collect catch data daily or regularly. This will make

data available to the national and regional CAS working groups for analysis and regular update of the status to inform management decisions.

2. The responsible departments of the national governments should strengthen the MCS efforts in the territorial waters to remove all the illegal fishing vessels (parachutes, rafts, dugout, and foot fishers) and gears (cast nets, beach seines, traps, and undersize gillnets and hooks), that compromise sustainability of the Nile perch and Tilapia fisheries.
3. There is need for comprehensive stock assessment of Tilapia using appropriate stock assessment methods to quantify the status of its biomass in the lake and guide on optimal harvest levels.
4. Joint lake wide studies on Dagaa are urgently needed to regulate the Dagaa fishery in terms of optimal net panels, light attraction source (kerosene versus solar), and fishing periods to ensure harmonious co-existence with the Nile perch fishers.
5. There is also need to regulate the Nile perch maw business to ensure that extraction, processing, and marketing are performed at established gazetted areas to maintain hygienic standards. In addition, the harvest of Nile perch above the upper 85 cm limit of total length should be regulated through the gillnet mesh size restrictions.
6. The emerging fisheries of Synodontis in Kenya and Uganda and Caridina in Tanzania and Kenya need to be thoroughly studied in terms of their biology and ecology as well as the optimal harvesting gears and methods to guide their harvest and development on the Lake.
7. There is need for regular MCS to ensure recovery of the Nile perch Fishery as the survey results indicated substantial catches of the species landed in illegal fishing gears.
8. Future Catch Assessment Surveys should take into account the major seasonal variations in the moon phase. We propose the sampling days in a month to be doubled to eight days, staggered into two days per week, each sampling days coinciding to each of the four major moon phases.
9. A comprehensive social economic study should be conducted to evaluate the value chain of the fisheries sector in the fisheries sector around the riparian countries. Perhaps the study should be conducted for the major species fisheries including tilapia, Nile perch and dagaa.

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APPENDICES

Appendix 1: Catch rates (kg/boat/day) for the different vessel-gear combinations recorded on Lake Victoria in June 2021 presented per county.

Country	VG	BD	CA	CG	DA	HA	LB	MK	NP	OT	PA	SD	TL
Kenya	SMS - BoS		100.4 ± 2.2	16 ± 4.8	96.8 ± 1.4	69.2 ± 2.1			22.3 ± 1.5	0 ± 0	46 ± 5.9	20.4 ± 2.6	5.6 ± 1
Kenya	SP - BoS		44 ± 4.1		47.9 ± 1.5	76.5 ± 1.4		1 ± 0	5.8 ± 1.1		30 ± 0	20.7 ± 4.4	2.9 ± 0.8
Kenya	SP - BS								26.6 ± 1.2		7 ± 0		13.4 ± 2
Kenya	SMS - BS			3 ± 1.3					33.8 ± 1.9		4 ± 1.4	3.8 ± 2.5	3.1 ± 0.8
Kenya	PA - BS								24.2 ± 2.7				10.3 ± 1.8
Kenya	PA - CN												17.3 ± 2.2
Kenya	SMS - CN												4 ± 0
Kenya	SP - CN												7 ± 0
Kenya	SMS - GN	4 ± 0		5.6 ± 0.7		10 ± 0			23.3 ± 0.6		4.7 ± 0.7	41.7 ± 2.3	7.4 ± 1.1
Kenya	SP - GN					1 ± 0			16.7 ± 1			17.8 ± 3.3	6.1 ± 0.4
Kenya	PA - GN	1.7 ± 1.4		6.8 ± 0.7		4.3 ± 1.4	0.1 ± 0	0.4 ± 0.7	17.5 ± 1		8.1 ± 0.7	15.9 ± 1.6	25.3 ± 2.2
Kenya	OT - GN								242 ± 0				21.8 ± 3.2
Kenya	OT - HL			9.5 ± 2.1					5.8 ± 2		4.3 ± 0.6		6.4 ± 0.5
Kenya	PA - HL												17.7 ± 1.2
Kenya	SP - HL												14.3 ± 4.5
Kenya	SMS - HL								0 ± 0				9.8 ± 1
Kenya	SP - LL			3.4 ± 1.4					20.4 ± 1.1				
Kenya	PA - LL	3.5 ± 2.2		12.2 ± 2.6					20.2 ± 1		26.5 ± 4.2		

Kenya	SMS - LL			3.2 ± 0.9					32.6 ± 0.7		7.8 ± 2		
Kenya	PA - MF			10 ± 2.8		40 ± 0			45.7 ± 1.8	0 ± 0	4 ± 0	20 ± 0	7 ± 0.6
Kenya	SMS - MF			3.5 ± 1					62.6 ± 4.1			21.5 ± 4.5	32 ± 5.8
Kenya	SP - MF					8.5 ± 2.1			4 ± 0			123 ± 9.8	7.6 ± 0.9
Kenya	SMS - SS		332 ± 4.6		226.8 ± 1.6	23.6 ± 1.1	6.5 ± 1.7						
Kenya	PA - SS				138.2 ± 6.9								
Kenya	SP - SS		451.9 ± 5.5		141.8 ± 3.3	24.7 ± 2.1	6 ± 0						
Kenya	SMS - TR			8 ± 0									8.5 ± 1.1
Kenya	OT - TR			2.8 ± 0.6									6.6 ± 1.1
Kenya	SP - TR												16 ± 0
Tanzania	SMS - BoS		170 ± 11.6		168 ± 3.2	300.1 ± 3.1			6.3 ± 1.2			184.4 ± 4.3	
Tanzania	SP - BoS				64.8 ± 2.9	32.8 ± 1.3			14.8 ± 1.1		7 ± 0		5.3 ± 1.2
Tanzania	SP - BS			6 ± 1.4			1 ± 0	2 ± 0	29.2 ± 1	0 ± 0	8 ± 0		9.5 ± 1.9
Tanzania	SMS - BS								20 ± 0				
Tanzania	PA - BS								2 ± 0				
Tanzania	PA - CN												9.5 ± 1.7
Tanzania	SP - CN	1 ± 0							1.8 ± 1				8.2 ± 0.9
Tanzania	DO - CN												47.5 ± 7.3
Tanzania	SMS - GN	1.9 ± 0.3		4.7 ± 0.4				1.3 ± 0.7	18.2 ± 0.3		7.1 ± 0.5	21.6 ± 1.3	5.8 ± 0.3
Tanzania	SP - GN	18 ± 0		13 ± 1		22.5 ± 1.9			19.3 ± 0.6		16.6 ± 1.1	16.8 ± 2.2	11.8 ± 0.9
Tanzania	PA - GN								13 ± 0	0 ± 0			10.5 ± 1
Tanzania	OT - GN					7.8 ± 0.9			15.3 ± 2.9				3.8 ± 0.9
Tanzania	DO - GN			52.6 ± 4.6		21 ± 0			16.2 ± 0.7	0 ± 0	3.7 ± 0.6		13 ± 2.8

Tanzania	OT - HL			1.5 ± 1		11 ± 3.2			4.5 ± 1.2		19 ± 1.4	11.3 ± 1.9	8.5 ± 0.6
Tanzania	PA - HL								3 ± 0				7 ± 1.3
Tanzania	SP - HL					4 ± 2			10.5 ± 0.9		2 ± 0.7		10.5 ± 0.7
Tanzania	SMS - HL					4 ± 0			44.3 ± 3.2				24 ± 0
Tanzania	SP - LL			45.3 ± 1.5					19.8 ± 0.4		55.3 ± 2.1		24.3 ± 2.4
Tanzania	PA - LL								10.6 ± 2.1				
Tanzania	SMS - LL	3.1 ± 0.7		21.3 ± 1					36.5 ± 0.6		19.1 ± 2.1		17.9 ± 3.3
Tanzania	OT - LL			26.2 ± 2.7					10.6 ± 1.4		17.5 ± 4.9		3 ± 0
Tanzania	DO - LL			36.7 ± 4.5					18.3 ± 0.8		33.9 ± 3.2		7.2 ± 1
Tanzania	CA - LN				425.3 ± 11.8	125 ± 12							
Tanzania	PA - MF					9.5 ± 2.9			28.4 ± 3.6				14.3 ± 1.3
Tanzania	SMS - MF	6.8 ± 1.2		0 ± 0					26.5 ± 4			10.5 ± 2.2	
Tanzania	SP - MF	9 ± 0				19.3 ± 1.3			82.8 ± 4.5			10 ± 2	14.5 ± 0.7
Tanzania	DO - MF					17.4 ± 2.4			6 ± 0				27.7 ± 2.9
Tanzania	SP - SN				262.5 ± 1.7								
Tanzania	SMS - SS		448.6 ± 4.8		246.6 ± 0.9	161.8 ± 3.7							
Tanzania	PA - SS				418.8 ± 11.1								
Tanzania	SP - SS		204.7 ± 15.3		173.6 ± 1.3	105.8 ± 3.6				0 ± 0			
Tanzania	OT - TR			4 ± 0									32.9 ± 1.5
Tanzania	SP - TR			1 ± 0									4.5 ± 0.9
Uganda	SMS - BoS			8 ± 2					19.46 ± 2.48		4 ±		13.67 ± 5.6
Uganda	SP - BoS								22.62 ± 10.56				
Uganda	SP - BS								35 ± 16				

Uganda	SMS - BS			39 ±					26.54 ± 5.96		20 ± 0		5.38 ± 0.71
Uganda	PA - BS								11.62 ± 1.4				19.07 ± 15.51
Uganda	PA - CN			3.25 ± 0.25					14.67 ± 7.84				13.14 ± 1.24
Uganda	SMS - CN												14.4 ± 3.07
Uganda	SP - CN												2.5 ± 0.5
Uganda	SMS - GN	4 ±		5.33 ± 0.74				2 ± 0.58	12.5 ± 0.32		6.45 ± 1.04	161.7 ± 10.17	10.49 ± 0.66
Uganda	SP - GN								7.5 ± 1.32			5.15 ± 0.67	11.42 ± 1.2
Uganda	PA - GN			4 ± 1		13 ±			45.17 ± 37.42		11.5 ± 4.55	5.83 ± 0.83	12.06 ± 1.58
Uganda	PA - HL								16 ± 4.36		10 ± 3.02		8.59 ± 1.16
Uganda	SP - HL								17 ± 8				5.74 ± 1.07
Uganda	SMS - HL								13.34 ± 2.09				10.73 ± 1.19
Uganda	SP - LL								12.12 ± 5.32				
Uganda	PA - LL			10.25 ± 2.06					9.83 ± 2.15		12.5 ± 2.85		
Uganda	SMS - LL			11.5 ± 2.43					30.07 ± 1.85		8.33 ± 1.32		
Uganda	PA - MF			2 ± 0					13.3 ± 2.47		4.5 ±		14.49 ± 1.2
Uganda	SMS - MF								14 ± 4.33				17.79 ± 2.83
Uganda	SP - MF												5.12 ± 2.07
Uganda	SMS - SN				273.33 ± 6.67								
Uganda	SMS - SS				403.77 ± 16.83	49.4 ± 19.11							
Uganda	PA - SS								35 ± 0				
Uganda	SP - SS				90 ± 28.64	60 ± 0							
Uganda	SMS - TR												8.62 ± 2.81
Uganda	SP - TR												2 ± 0

Appendix 2. Nile perch catch rates from the main effort groups in Lake Victoria July 2005 to June 2021

Ssese paddle boats using gillnets (SP-GN)						
	Kenya		**Tanzania**		**Uganda**	
	Wt(kg)	**95%CI**	**wt (kg)**	**95%CI**	**wt (kg)**	**95%CI**
Jun-05	6.62	1.69				
Jul-05	6.62	1.69	13.96	1.39	8.35	0.94
Aug-05	5.05	1.96	15.43	1.72	7.96	1.05
Sep-05			14.81	2.34	8.96	0.78
Nov-05	9.72	1.81	16.9	4.3	9.0	0.9
Mar-06	5.25	1.13	14.4	1.7	9.7	1.7
Aug-06	6.75	5.15	9.45	1.18	12.30	1.12
Dec-06	7.64	2.76	12.34	1.34	10.75	1.05
Feb-07	5.94	1.71				
Mar-07			10.74	3.87	9.88	1.02
Aug-07	6.93	1.84	14.84	1.40	8.58	0.81
Feb-08	13.61		14.30	1.40	8.90	0.90
Dec-08	6.70		17.40	1.60	7.80	1.10
Mar-10	4.40	1.7	17.43	6.72	9.2	0.60
Sept-11	5.39	1.10	14.42	1.79	8.3	0.6
May-14	5.5	1.5	12.5	1.5	12.4	1.4
Nov-15	6.27	0.72	11.0	1.3	9.0	1.6
Jun-21	16.7	1	19.3	0.6	7.5	1.32
Ssese paddle boats using long lines (SP-LL)						
Jun-05	12.34	3.67				
Jul-05	12.6	3.72	36.55	3.01	24.27	2.76
Aug-05	14.25	9.41	37.14	3.85	24.49	5.12
Sep-05			47.31	5.76	30.83	5.56
Nov-05	16.14	5.97	38.3	4.1	23.9	2.9
Mar-06	9.33	3.86	38.2	3.7	21.8	2.6
Aug-06	10.93	6.06	22.28	2.35	19.16	3.48
Dec-06	9.52	3.27	30.58	3.30	21.06	3.95
Feb-07	8.17	2.54				
Mar-07			27.10	6.88	19.89	3.15
Aug-07	8.88	2.57	42.18	2.97	19.37	2.63
Feb-08	9.54		38.80	3.20	22.70	3.30
Dec-08	17.14		29.00	1.80	26.00	3.40
Mar-10	10.68	6.4	35.58	9.40	23.1	1.20
Sept-11	12.22	3.95	32.41	2.16	17.10	1.0
May-14	9.9	4.0	30.2	2.0	16.9	1.7
Nov-15	12.4	2.36	26.8	2.5	14.5	1.5
Jun-21	20.4	1.1	19.8	0.4	12.12	5.32
Ssese boats with motor/sail using gillnets (SMS-GN)						
Jun-05	20.29	2.32				
Jul-05	20.29	2.32	34.51	2.27	25.58	1.6
Aug-05	16.04	1.92	35.32	2.95	25.82	1.9
Sep-05			31.16	2.66	24.56	1.73

Nov-05	37.02	6.02	32.6	3.8	30.9	1.9
Mar-06	12.06	1.26	29.3	1.8	24.1	1.7
Aug-06	8.16	0.91	24.31	1.59	21.62	1.30
Dec-06	14.35	1.46	24.45	2.01	30.55	1.96
Feb-07	11.43	1.33				
Mar-07			29.54	7.81	21.51	1.3
Aug-07	12.13	1.39	33.18	1.80	26.87	1.86
Feb-08	14.97		33.10	2.10	22.80	1.40
Dec-08	12.07		43.10	2.70	25.30	2.10
Mar-10	16.9	2.0	35.61	7.26	26.60	1.00
Sept-11	11.43	1.43	26.03	1.34	15.6	0.4
May-14	16.0	1.7	31.7	1.7	19.4	1.2
Nov-15	13.3	0.7	24.1	1.4	14.9	0.5
Jun-21	23.3	0.6	18.2	0.3	12.5	0.32
Ssese boats with motor/sail using long lines (SMS-LL)						
Jun-05	19.97	2.86				
Jul-05	20.19	3	45.71	3.75	45.07	7.54
Aug-05	21.71	2.71	53.69	8.19	21.29	5.76
Sep-05			59.11	9.11	31.62	4.19
Nov-05	18.15	1.82	61.7	8.5	30.1	4.9
Mar-06	15.07	1.47	40.6	3.8	23.4	3.3
Aug-06	14.73	1.75	24.32	3.21	26.73	2.65
Dec-06	16.39	1.53	42.32	5.32	38.30	5.13
Feb-07	15.27	1.82				
Mar-07			45.1	3.9	33.55	7.27
Aug-07	18.89	1.86	47.83	3.50	35.31	4.01
Feb-08	24.31		45.10	3.60	36.00	5.60
Dec-08	19.34		43.70	3.20	37.70	5.10
Mar-10	16.1	1.6	69.36	16.30	35.0	1.90
Sept-11	15.73	1.80	34.06	2.82	49.3	3.7
May-14	22.4	3.1	48.8	4.5	34.4	5.3
Nov-15	21.3	2.56	44.7	4.6	31.7	1.3
Jun-21	32.6	0.7	36.5	0.6	30.07	1.85

Appendix 3. Tilapia catch rates of the main effort groups in Lake Victoria between June 2005 and June 2021

Parachute boats using gillnets (PA-GN)						
	Kenya		**Tanzania**		**Uganda**	
	wt (kg)	95%CI	wt (kg)	95%CI	wt (kg)	95%CI
Jun-05	3.94	1.34				
Jul-05	3.94	1.08			12.15	1.42
Aug-05	6.13	1.99			10.94	1.21
Sep-05					14.83	1.46
Nov-05	4.75	1.75			11.52	1.74
Mar-06	3.25	1.60			10.86	1.19
Aug-06	5.22	2.02			10.10	0.92
Dec-06	2.34	1.01			12.61	1.02

Feb-07	3.73	1.70				
Mar-07					11.55	0.95
Aug-07	5.06	2.30			11.22	0.89
Feb-08	5.23				10.00	0.90
Dec-08	3.39				7.60	0.50
Mar-10	3.58	1.2	0.25	0.28	8.7	0.5
Sept-11	3.67	0.88			9.1	0.6
May-14	2.4	0.7			6.6	0.7
Nov-15	0.63	0.17	4.1	4.4	7.1	0.4
Jun-21	25.3	2.2	10.5	1	12.06	1.58
Parachute boats using handlines (PA-HL)						
Jun-05	5.32	2.41				
Jul-05	5.32	2.41			4.74	1.81
Aug-05	6.02	2.09			2.67	0.92
Sep-05					3.59	1.28
Nov-05	10.87	2.10			2.54	1.20
Mar-06	7.09	2.27			2.59	1.10
Aug-06	5.48	2.45			4.16	1.03
Dec-06	5.95	1.88			6.03	1.29
Feb-07	4.13	2.21				
Mar-07					5.60	1.67
Aug-07	3.81	2.49			3.52	1.14
Feb-08	7.26				3.50	1.20
Dec-08	7.44				3.70	1.20
Mar-10	5.82	2.8	20.78	8.91	6.50	1.00
Sept-11	2.93	1.14			6.9	0.9
May-14	12.7	3.0			5.2	1.4
Nov-15	14.8	2.52	4.3	1.0	6.9	0.8
Jun-21	17.7	1.2	7	1.3	8.59	1.16
Ssese Paddle boats Using Gillnets (SP-GN)						
Jun-05	2.67	0.95				
Jul-05	2.67	0.95	7.25	1.10	8.74	1.01
Aug-05	5.20	1.65	2.38	0.58	8.15	1.22
Sep-05			6.89	1.45	7.59	0.73
Nov-05	4.73	1.10	7.86	1.77	6.78	0.77
Mar-06	3.40	1.56	1.27	0.27	8.01	3.95
Aug-06	6.15	2.90	5.83	0.80	6.25	0.82
Dec-06	2.54	0.96	6.15	1.06	6.46	0.83
Feb-07	1.77	0.72				
Mar-07			5.91	2.27	5.09	0.78
Aug-07	3.83	1.19	6.04	0.76	4.71	0.60
Feb-08	4.95		4.80	0.70	5.60	0.80
Dec-08	3.12		4.50	0.90	4.60	0.50
Mar-10	1.90	0.8	6.50	2.45	6.30	0.40
Sept-11	2.18	0.92	3.33	0.72	5.9	0.3
May-14	2.2	0.7	3.4	0.7	8.6	0.9
Nov-15	1.41	0.21	2.8	0.7	3.2	0.6
Jun-21	6.1	0.4	11.8	0.9	11.42	1.2

Ssese paddle boats using hand lines (SP-HL)						
Jun-05	5.31	1.27				
Jul-05	5.31	1.27	28.96	6.30	4.39	1.18
Aug-05	4.42	1.38	26.95	5.49	4.61	1.35
Sep-05			14.55	3.14	2.53	0.74
Nov-05	8.24	1.73	15.00	4.90	4.05	0.96
Mar-06	7.89	3.85	18.69	5.08	3.91	1.11
Aug-06	8.42	3.07	19.72	3.91	4.01	0.93
Dec-06	12.26	5.29	16.46	4.97	5.66	1.06
Feb-07	3.50	1.85				
Mar-07			16.51	6.05	3.04	0.56
Aug-07	7.52	8.49	15.12	2.62	1.52	0.51
Feb-08	4.23		22.00	3.5	3.50	1.20
Dec-08	4.64		19.20	4.50	3.10	1.10
Mar-10	3.30	1.3	22.34	17.08	3.60	0.8
Sept-11	3.94	2.36	7.77	1.97	2.0	0.3
April-14	0.5	0.7	17.1	6.5	4.7	0.9
Nov-15	2.17	1.05	7.4	4.9	5.9	0.8
Jun-21	14.3	4.5	10.5	0.7	5.74	1.07

Appendix 4. Dagaa/Omena/Mukene catch rates of the main effort groups in Lake Victoria between June 2005 to June 2021

Ssese Paddle Boats Using Small Seines (SP-SS)						
	Kenya		Tanzania		Uganda	
	wt (kg)	95%CI	wt (kg)	95%CI	wt (kg)	95%CI
Jun-05						
Jul-05			345.84	45.66	205.29	29.80
Aug-05	191	18	168.30	30.91	215.18	28.78
Sep-05			326.13	38.13	300.70	66.14
Nov-05	126.28	14.37	254.43	37.61	153.69	19.84
Mar-06	96.61	15.83	202.64	28.44	196.03	82.60
Aug-06	122.30	21.95	231.89	24.67	188.67	25.82
Dec-06	121.9	13.27	282.05	39.47	268.97	95.5
Feb-07	100.83	13.59				
Mar-07			359.84	39.17	318.85	87.70
Aug-07	138.80	25.99	192.19	16.58	161.30	16.29
Feb-08	144.62		167.60	16.00	155.80	17.90
Dec-08	100.73		193.50	13.10	164.20	15.30
Mar-10	76.0	8.3	104.23	31.93	129.10	16.80
Sept-11	111.40	10.33	91.06	11.55	158.3	8.0
May-14	119.5	11.8	151.9	13.8	115.2	14.1
Nov-15	38.67	3.49	103.8	14.0	116.4	22.9
Jun-21	141.8	3.3	173.6	1.3	90	28.64
Ssese Boats with Motor or Sail Using Small Seines (SMS-SS)						
Jun-05						
Jul-05			450.36	63.34		
Aug-05	171.53	36.3	300.06	46.71		

Sep-05			586.33	81.0		
Nov-05	117.74	42.68	559.90	89.40		
Mar-06	50.42	22.16	380.06	32.05		
Aug-06	55.69	40.72	570.00	72.21		
Dec-06	135.25	87.11	816.66	99.74		
Feb-07	61.79	33.06				
Mar-07			593.94	133.90		
Aug-07	45.97	19.13	359.00	204.57		
Feb-08	108.33		225.40	11.70	394.20	352.10
Dec-08	34.26		214.30	12.50	352.10	82.40
Mar-10	185.9	41.8	222.74	35.25	253.0	106.7
Sept-11	358.59	69.70	254.66	19.07	393.7	41.3
April-14	254.4	21.6	288.6	14.7	265.1	34.0
Nov-15	117.87	6.07	533.9	49.7	237.6	23.9
Jun-21	226.8	1.6	246.6	0.9	403.77	16.83

Appendix 5. Estimated monthly total fish catches in Lake Victoria between June 2005 and June 2021

1. Kenya

	Nile perch		Tilapia		Dagaa		Haplochromines		Others		TOTAL	
	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI
Jun-05	5,141.0	8,379.0	2,440.0	3,384.0			692.0	1,840.0	192.0	345.0	8,465.0	13,948
Jul-05	3,914.7	3,309.0	723.8	802.7			341.1	1,083.8	94.3	76.5	5,073.9	5,272.0
Aug-05	3,601.5	2,921.6	2,080.8	1,382.9	8,179.7	894.6	73.1	97.6	78.4	129.9	14,013.5	5,426.6
Sep-05												
Nov-05	4,241.1	782.8	722.9	251.0	5,312.3	924.2	25.1	27.8	181.5	180.9	10,483.0	2,166.8
Mar-06	2,403.5	462.0	1,010.5	334.0	5,678.0	1,323.4	44.4	61.7	194.1	91.6	9,330.5	2,272.7
Aug-06	2,479.9	1,287.2	983.4	592.0	6,482.3	1,225.7	106.7	108.9	66.2	66.4	10,118.6	3,280.3
Dec-06	3,020.4	614.1	696.6	515.6	6,312.7	958.1	73.4	54.0	148.6	161.3	10,251.8	2,303.1
Feb-07	2,412.2	520.9	430.7	181.7	5,077.1	828.7	81.0	129.7	1,656.8	489.2	9,657.8	2,150.3
Aug-07	2,729.6	500.1	711.8	409.9	5,197.4	1,237.6	867.2	1,715.2	380.0	238.3	9,886.0	4,101.2
Feb-08	3,993.9		1,338.1		7,083.4		15.6		457.9		12,888.9	
Dec-08	2,859.1		539.9		5,424.2		730.5		331.4		9,885.2	
Mar-10	2,728.10	840.5	535.9	287.6	4,146.90	577.9	18.5	27.4	545.7	134.1	7975.1	2,684.5
Sep-11	2,912.0	623.4	400.9	139.1	6,323.30	883.6	89.4	81.2	613	334	10,338.7	2,061.3
April-14	3,502.9	1,152.8	426.2	236.0	7,596.3	789.1	212.0	166.4	841.6	504.0	12,579.5	2,848.4

Nov-15	2161.1	306.4 306.4	263.3	69	5,544.4	358.4	528.1	132.5	1,213.6	414.8	9,710.6	1,280.7
Jun- 21	5520.1		14695.6		558.1		614.8		2129.2		23517.8	

2. Tanzania

	Nile perch		Tilapia		Dagaa		Haplochromines		Others		TOTAL	
	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI
Jul-05	10,036.5	1,062.7	1,640.7	459.5	20,287.9	3,333.1	7,635.0	1,822.3	144.9	118.6	39,745.0	6,796.2
Aug-05	10,562.0	1,410.0	1,719.0	419.0	14,081.0	5,050.0	5,038.0	3,140.0	233.0	241.0	31,633.0	10,260.0
Sep-05	10,471.0	1,688.3	1,765.8	456.4	22,689.6	15,188.4	12,391.6	38,356	144.9	136.5	47,462.9	55,825.8
Nov-05	15,970.2	3,281.7	2,959.7	743.0	44,985.2	8,483.3	17,898.8	11,569	149.7	161.4	81,963.6	24,238.8
Mar-06	10,721.9	1,367.1	2,417.6	446.2	24,832.5	2,725.4	9,270.1	2,452.5	426.9	151.0	47,669.0	7,142.2
Aug-06	7,087.8	915.9	2,563.0	425.7	39,881.1	5,576.3	9,253.9	4,651.7	279.3	209.2	59,065.0	11,778.7
Dec-06	9,072.0	1,612.8	2,114.8	1,159.1	53,447.5	9,553.7	17,139.1	23,909	267.9	164.9	82,041.3	36,399.5
Mar-07	7,513.4	1,753.8	1,395.5	579.7	30,170.5	4,828.0	2,234.3	1,384.6	171.2	196.9	41,485.0	8,743.0
Aug-07	11,690.7	1,133.6	2,110.4	285.7	21,356.7	2,577.1	3,365.5	814.4	373.5	181.0	38,896.7	4,991.7
Feb-08	12,320.8	1,346.4	1,477.9	316.2	18,800.0	1,383.7	2,532.4	920.7	302.8	168.8	35,433.7	4,135.8
Dec-08	16,539.9	1934.94	1,464.4	312.0	23,280.4	7,194.8	3,382.5	652.8	279.0	132.1	44,946.2	10,226.6
Mar-10	13,226.8	3162	1,649.5	910.3	24,619.3	4,694.9	5,852.3	3,697.9	277.3	316.0	45,625.2	12,781.5
Sep-11	8,278.0	1,014.2	667.1	230.2	26,001.3	2,348.1	11,490.2	4,065.3	172.4	170.2	46,609.0	7,828.0
April-14	9,582.5	996.0	945.7	282.2	24,095.3	1,705.5	5,449.4	1,777.2	437.5	171.9	40,570.4	4,932.8
Nov-15	8,348.3		319.6		35,658.5		5,531.2		199		50,056	
Jun- 21	30648.3		7804.5		538.7		1550.14		2085.7		42627.34	

3. Uganda

	Nile perch		Tilapia		Dagaa		Haplochromines		Others		GRAND TOTAL	
	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI
Jul-05	8,031.2	1,242.4	2,828.9	526.7	9,445.0	3,239.0	2.3	3.7	251.3	224.2	20,558.7	5,236.0
Aug-05	6,633.9	1,268.9	2,346.0	469.0	8,142.6	1,252.5	3.0	4.7	99.1	130.2	17,224.6	3,125.3
Sep-05	8,322.8	1,268.0	2,401.9	586.9	11,494.2	2,450.2	1.2	1.5	99.8	95.4	22,319.9	4,402.0
Nov-05	8,646.3	1,100.8	2,214.4	425.1	6,384.7	1,087.4	2.5	4.6	99.1	93.5	17,347.0	2,711.4
Mar-06	7,099.1	1,098.3	2,331.2	921.4	8,430.8	3,311.3	2.6	4.1	221.9	200.2	18,085.6	5,535.3
Aug-06	7,367.7	1,058.7	2,206.2	512.9	8,587.0	1,275.2	29.2	36.7	147.2	126.2	18,337.3	3,009.7
Dec-06	8,371.0	1,066.5	2,371.3	416.9	9,948.3	3,629.1	15.0	13.0	155.2	141.1	20,860.8	5,266.6
Mar-07	6,710.6	998.1	1,923.4	472.5	11,994.6	3,541.0	17.0	16.8	230.0	168.4	20,875.6	5,196.8
Aug-07	6,965.4	807.3	1,908.0	332.4	6,660.1	1,270.6	10.4	16.3	225.9	154.0	15,769.9	2,580.6
Feb-08	6,569.0	894.6	1,869.2	424.6	5,582.4	721.6	17.1	22.7	277.8	156.1	14,315.5	2,219.5
Dec-08	9,233.9	1,264.5	2,017.5	550.2	8,721.7	1,508.8	3.8	9.7	117.1	101.1	20,094.0	3,434.3
Mar-10	7,080.8	433.7	1,414.3	169.4	4,893.1	790.9			198.2	55.3	13,586.4	1,449.3
May-11	6,005.1	481.1	1,612.5	539.1	7,356.7	0.1			300.4	98.2	15,274.7	1,118.5
Sep-11	5,362.0	474.9	1,680.0	261.3	5,735.5	432.2	64.4	36.2	192.4	65.0	13,034.3	1,269.6
April-14	7,550	1,201.3	3,532.8	2,564.9	10,193.2	1,361.5	384.3	350.5	809.5	392.4	22,469.8	5,870.7
Dec-15	3,059.1		1,091.4		5,364.5		1,238.8		1,524.1		12,277.9	
Jun-21	5145.4	745.1	2364.1	374.6	31060.6	2163.2	18910.3	2795.6			57480.4	6078.5

4. Lake wide

Month	Nile perch		Tilapia		Dagaa		Haplochromines		Others		TOTAL	
	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI	wt (t)	95%CI
Jul-05	23,208.7	10,684.1	6,909.6	4,370.2	29,732.90	6,572.10	7,978.4	4,190.4	588.2	687.8	68,417.8	26,504.6
Aug-05	21,110.6	5,987.9	4,788.8	1,690.7	22,223.60	6,302.50	5,382.1	4,228.5	426.4	447.7	53,931.5	18,657.3
Sep-05	22,395.3	5,877.9	6,248.5	2,426.2	42,363.5	18,533.2	12,465.9	38,455.3	323.1	361.8	83,796.3	65,654.4
Nov-05	28,857.6	5,165.3	5,897.0	1,419.1	56,682.2	10,494.9	17,926.4	11,601.9	430.3	435.8	109,793.6	29,117.0
Mar-06	20,224.5	2,927.4	5,759.3	1,701.6	38,941.3	7,360.1	9,317.1	2,518.3	842.9	442.8	75,085.1	14,950.2
Aug-06	16,935.4	3,261.8	5,752.6	1,530.6	54,950.4	8,077.2	9,389.8	4,797.3	492.7	401.8	87,520.9	18,068.7
Dec-06	20,463.4	3,293.4	5,182.7	2,091.6	69,708.5	14,140.9	17,227.5	23,976.0	571.7	467.3	113,153.9	43,969.2
Mar-07	16,636.2	3,272.8	3,749.6	1,233.9	47,242.2	9,197.7	2,332.3	1,531.1	2,058.0	854.5	72,018.4	16,090.1
Aug-07	21,385.7	2,441.0	4,730.2	1,028.0	33,214.2	5,085.3	4,243.1	2,545.9	979.4	573.3	64,552.6	11,673.5
Feb-08	22,883.7		4,685.1		31,465.8		2,565.1		1,038.4		62,638.1	
Dec-08	28,632.9		4,021.9		37,426.3		4,116.9		727.5		74,925.5	
Mar-10	23,035.7	4,436.6	3,599.7	1,367.3	33,659.3	6,063.7	5,870.8	3,725.3	1,021.2	505.4	67,186.7	16,915.3
Sep-11	16,552.0	2,112.5	2,748.0	630.6	38,060.1	3,663.9	11,644.0	4,182.7	977.8	569.2	69,982.0	11,158.9
April-14	20,635.3	3,350.2	4,905.3	3,083.1	41,884.8	3,856.2	6,045.7	2,294.1	2,088.6	1068.3	75,559,7	13,651.9
Nov 15	13,568.5		1,674.3		46,567.4		7,298.1		2,936.7		72,045.0	
June 2021	18470		3460.9		76404.5				23125.2		121460.6	

Serial No.

Appendix 5. Catch Assessment Survey Form

Part A Document identification

Date	
Country	
District	
Sub-county/Division	
Parish/Location	
Landing site Name/Code	
Enumerator's name	

Part B – Vessels landing and Sampling targets

Number of vessels (all types) that landed at the site during the sampling day (00:00 to 24:00 hrs)	=	
Maximum number of vessels that can be sampled	=	
Sampling proportion	=	

Number of Vessels landing during the sampling day (00:00 – 24:00hrs)						**Number of Vessels to be sampled**				
	Main gear type						Main gear type			
Vessel type	**SS/SN**	**GN**	**LL**	**Other**		**Vessel type**	**SS/SN**	**GN**	**LL**	**Other**
Parachute (Bawo tatu)						Parachute				
Sesse (Motorised/Sail)						Sesse (Motorised/Sail)				
Sesse (Paddled)						Sesse (Paddled)				
Other						Other				

Form Codes for Part C

Vessel type Code	**Description**
1	Sesse flat at one end
2	Sesse pointed at both ends
3	Parachute
4	Dugout
5	Rafts
6	Foot fishers (fishing without a boat)
7	Catamarans (twin boats for mukene)
Propulsion code	
O	Outboard motor

Gillnet panel code	**Description**
S	Single
D	Double
T	Triple
Mode of operation code	
A	Active
D	Drift
S	Stationary
Construction code	
MO	Monofilament

P	Paddles
S	Sail
Gear type code	
GN	Gillnet
LL	Long line
SS	Small seine net (Mukene fishery)
SN	Scoop net (Mukene fishery)
HL	Hand line
LN	Lift net (Mukene fishery)
CN	Cast net
TR	Trap
BS	Beach/Boat seine
OT	Other

MU	Multifilament
Fish species code	
NP	Nile perch
TL	Tilapia
DA	Dagaa/Mukene
HA	Haplochromines (Furu/Nkejje)
BD	Bagrus docmac
PA	Protopterus aethiopicus
CG	Clarias gariepinus
OT	Other

Part C – Fishing Operations

Form Number		District	
Date		Landing site Name or Code	
Country		Enumerator's Name	

Use separate rows for each gear size and species. Ensure that hours fished with each gear type is recorded

VESSEL DETAILS							GEAR AND EFFORT DETAILS								FISH CATCH DETAILS			
Serial Number	Reg. No.	Vessel type code	Length (m)	Propulsion code	Crew	Days fished in the last one week	Gear type code	Construction code	GN panel code	Number of units	Size GN mesh (inches) SS mesh (mm) or Hook size N	Mode of operation Code	Hours fished	Number of lamps (Dagaa)	Species name or Code	1. No. of fish (large spp) 2. No.	1. Catch wt (kg) large spp 2. Wt (kg) 1	1. Price (shs/kg) large spp 2. Price of 1