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Aquatic Ecology Monitoring: Water quality, fish, fish catch, sanitation and disease vectors

Monitoring No. 14

Date: 9th – 14th April 2014

Monitoring carried out by:

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On behalf of :
Bujagali Energy Limited (BEL)

Date of Report: June 2014

1.0 BACKGROUND

Ecological monitoring survey No. 14 (9th -14th April 2014) on the Upper Victoria Nile is the fifth one to be undertaken during the post-construction period of Bujagali hydropower dam. Construction was completed in February 2012, creating a reservoir behind the dam that extends beyond Kalange-Makwanzi, an upstream transect. A third transect was created in the mid reach (30 m deep) of the established reservoir during the 10th monitoring survey-April 2012. Since then, three transects have been maintained for the previous five ecological monitoring surveys. These transects are: mid-reservoir and the original two sampling ones, Kalange-Makwanzi and Buyala-Kikubamutwe. Two pre-construction baseline surveys in April 2000 and April 2006 were conducted and during construction phase, eight monitoring surveys (September 2007, April 2008, April 2009, October 2009, April 2010, September 2010, April 2011, September 2011) were conducted.

Since 2009, quarterly monitoring surveys were scaled down to biannual monitoring at an upstream and a downstream transect of the BHPP with emphasis on the following aspects: water quality determinants, biology and ecology of fishes and food webs, fish stock and fish catch including economic aspects of catch and sanitation/vector studies (bilharzias and river blindness). In the post-construction monitoring surveys, the assessments of algae, zooplankton and benthic macro-invertebrates which had been restrained since April 2008 were reverted. This report presents observations made on these aforementioned ecological aspects of the Upper Victoria Nile and draws comparisons of the present results with those made in the previous surveys a the three transects.

2.0 GENERAL METHODOLOGY AND DATA COLLECTION

2.1. Materials and Methods

For eleven surveys including one during April 2014, Kalange-Makwanzi and Buyala-Kikubamutwe, upstream and downstream transects respectively have been sampled for water quality, fish abundance, diversity and distribution, fish biology, fish catch, sanitation conditions, bilharzia and river blindness vectors. Due to reservoir conditions created from the dam up to beyond Kalange-Makwanzi, a third transect was created in between, from which assessment of parameters as at the upstream and downstream transects was also undertaken including assessment of algae, zooplankton and benthic macro-invertebrates.

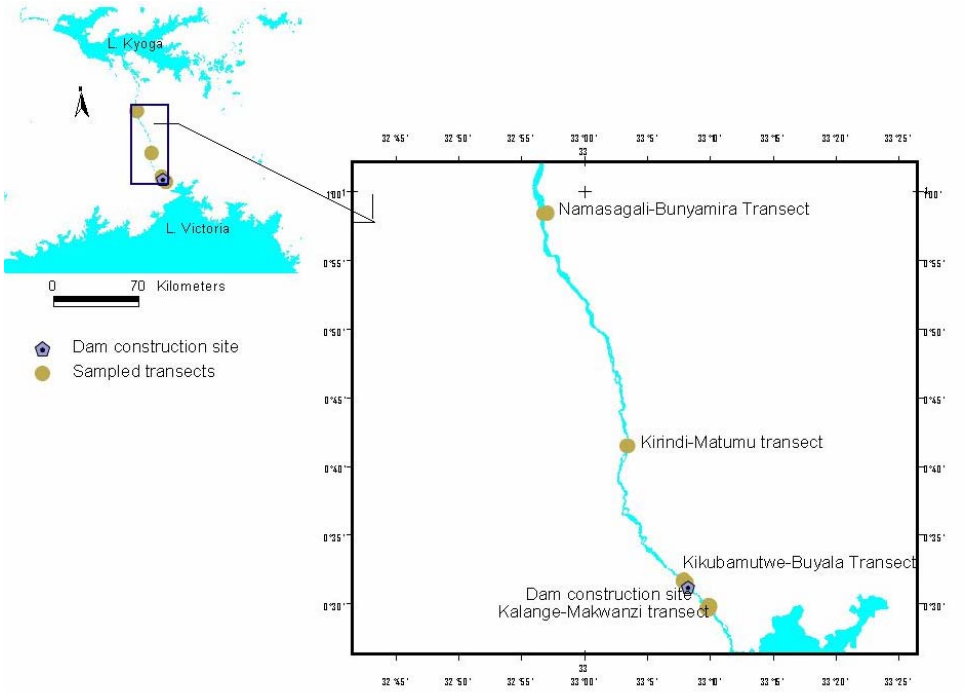

Figure 2.1a *A map showing the Upper Victoria Nile where the BHPP is located and river segments where baseline as well as monitoring samples were taken*

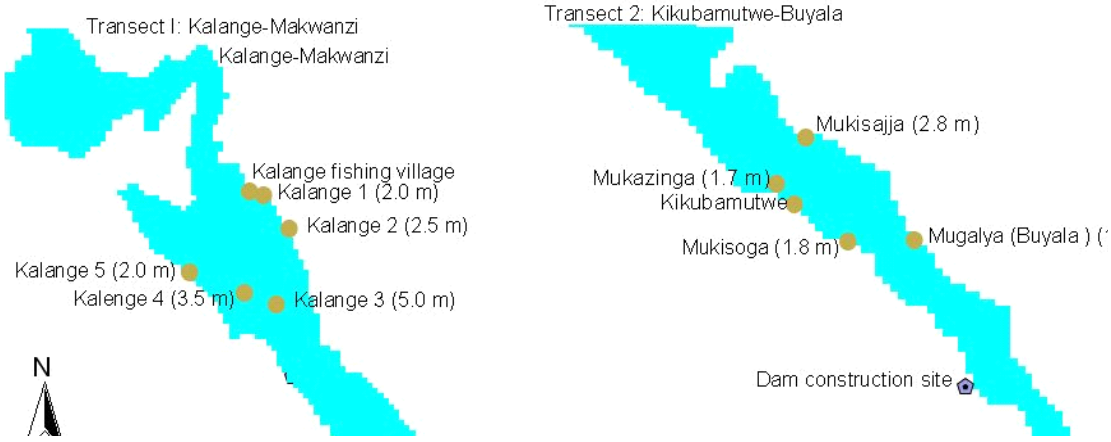

Figure 2.1b *Detailed maps of the two sampled transects: Transect 1 = Kalange-Makwanzi and Transect 2 = Buyala-Kikubamutwe and associated locations on the Upper Victoria Nile.*

Sampling, analytical procedures and techniques used in the previous surveys were followed. Sampling of zooplankton was done at designated field stations using conical plankton net of 0.25 metre mouth diameter and 60 µm mesh, towed vertically through the water column from just above the bottom sediments to the surface. Three tows taken at each sampling point were combined to make a composite sample, preserved in 4% sugar-formalin in a clean, labelled, plastic sample bottle. Species identification was done with the help of available published taxonomic keys (Boxshall & Braide, 1991; Korinek, 1999; Korovchinsky, 1992; Koste, 1978; Rutner-Kolisko, 1974) each species separately counted and recorded. Species numbers were noted and areal density estimates calculated for each station in conjunction with the diameter of the sample net and depth of sampling. Benthic macro-invertebrates were identified and classified using keys from Merrit & Cummins 1997, Pennak 1989 and Mandahl-Barth 1954, and enumerated as mean numbers per square meter.

3.0 RESULTS

3.1 Status of Water Quality

3.1.1. Physico-chemical parameters

Table 3.1.1 *Trends in mean values of water physico-chemical parameters upstream at Kalange-Makwanzi, mid-section of the reservoir and downstream at Buyala-Kikubamutwe*

Parameter	Site	Monitoring Dates													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Apr-06	Sept. 07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14
Dissolved Oxygen (mg/L)	Kalange-Makwanzi	4.2	7.2	5.6	4.5	5.9	6.7	5.4	4.8	6.3	5.9	6.3	7.7	5.5	6.13
	Mid section of the Reservoir										5.2	6.4	7.02	5.3	6.27
	Buyala-Kikubamutwe	6.3	7.7	7	7.2	7.2	9.3	7.8	7.1	7.5	7.5	5.9	7.5	6.1	6.96
	NEMA Std	3	3	3	3	3	3	3	3	3	3	3	3	3	3
pH	Kalange-Makwanzi	7	7.3	8.2	6.7	7.6	6.8	7.1	7.4	7	8.5	7.1	7	7	7.05
	Mid section of the Reservoir										8.2	7.5	7.4	7.4	6.65
	Buyala-Kikubamutwe	7.4	7.4	7.7	6.8	7.4	7	7	7.3	7	8.2	7.4	7.17	6.9	8.59
	Upper NEMA Std	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	Lower NEMA Std	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Temperature (ºC)	Kalange-Makwanzi	26.7	26.1	26.2	26.4	25.7	25.6	24.8	26.4	24.9	25.3	25.9	26.9	25.2	26.56
	Mid section of the Reservoir										26.1	25.4	26.9	25.3	26.69
	Buyala-Kikubamutwe	26.4	25.7	26.9	26.8	25	25.8	25.4	26.9	26.5	26.1	25.3	27.1	25.6	27.22
	Upper NEMA Std	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	Lower NEMA Std	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Conductivity (µS/cm)	Kalange-Makwanzi	103	112	81.1	95.5	96.9	87.3	100	129	105	92.3	90.0	101.4	110.0	100.7
	Mid section of the Reservoir										97.4	95.0	101.6	110.0	101.6
	Buyala-Kikubamutwe	88.5	114	82.8	97.6	97.7	86.1	102	N/D	114	94.8	100.0	101.5	112.0	111.9
Secchi Visibility (m)	Kalange-Makwanzi	1.9	1.6	1.9	2.2	2.2	2.3	2.2	2.2	N/D	1.5	2.1	1.72	2.03	1.71
	Mid section of the Reservoir										1.7	2.1	1.62	2.16	1.56
	Buyala-Kikubamutwe	1.7	1.8	1.8	2.3	1.9	1.9	2.1	2.5	1.3	1.4	1.5	1.63	1.77	1.59
Total Suspended Solids (mg/L)	Kalange-Makwanzi	2	2.7	4.2	7.9	3.7	3.5	2.9	3	2.4	3.1	3.3	1.92	1.78	1.2
	Mid section of the Reservoir										3.6	3.3	1.5	3.6	4.67
	Buyala-Kikubamutwe	2	4.2	3.6	5.4	3.6	3.2	2.5	4.9	4.3	3.2	2.8	1.67	3.07	2.53
	NEMA Std	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Oil & Grease (mg/L)	Kalange-Makwanzi	0.6	0.1	0	0.02	0.08	0.04	0.06	0.07	0.1	0.17	0.18	0.12	0.13	0.19
	Mid section of the Reservoir										0.21	0.17	0.14	0.19	0.23
	Buyala-Kikubamutwe	0.9	0.8	0	0.06	0.52	0.08	0.08	0.08	0.13	0.22	0.18	0.1	0.16	0.21
	NEMA Std	10	10	10	10	10	10	10	10	10	10	10	10	10	10

The mean concentrations of dissolved oxygen at Kalange-Makwanzi (Upstream Transect) and Buyala-Kikubamutwe (Downstream Transect) remained comparable over the monitoring period and well above the permissible National Environment Management

Authority (NEMA) lower limit of 3 mgL^{-1} (Table 3.1.1). The minimum permissible concentration of 3 mgL^{-1} is good for survival of most aquatic organisms including fish.

The mean pH was also comparable with that recorded in past surveys and was within the NEMA permissible range of 6 to 8 at all sites (Table 3.1.1). It was circum-neutral (7.1) at the upstream transect, weakly acidic in the reservoir (6.7), and relatively alkaline at the downstream transect (8.6).

Water temperatures varied very slightly among sites, probably due to the different times of the day when data was recorded at the respective sites. Despite the marginal differential in temperature, the recorded values were within the permissible NEMA range of 20ºC to 35ºC at the sampled sites.

Water electrical conductance ranged between 100 and 112 µS/cm, registering 100.7 µS/cm at the upstream transect, 110 µS/cm in the reservoir and 11.9 µS/cm at the downstream transect (Table 3.1.1). The recorded values of the electrical conductance were within acceptable ranges similar those recorded for unpolluted sites of Lake Victoria waters, ≤ 120µS/cm.

Water clarity in the mid reservoir and at either the upstream or downstream transect was comparable during this survey April 2014, unlike in the previous survey of September 2013 (Table 3.1.1). Water clarity reduced in a downstream direction, probably attributed to inflows of eroded particles from the surrounding landscape.

The mean concentration of Total Suspended Solids (TSS) of 4.7 mg/L was highest in the mid reservoir transect and lowest 1.2 at the upstream transect (Table 3.1.1). The mean concentration of TSS at the downstream transect was 2.53 mg/L). Despite the observed variation, the recorded concentrations of TSS were far below the permissible NEMA standard of 100 mg/L.

The concentration of oil and grease at all sites was slightly more than what was observed in September 2013 (range 0.13 to 0.19 mg/L) at the three sampling zones, but remained far below the NEMA permissible upper limit of 10 mg/L (Table 3.1.1).

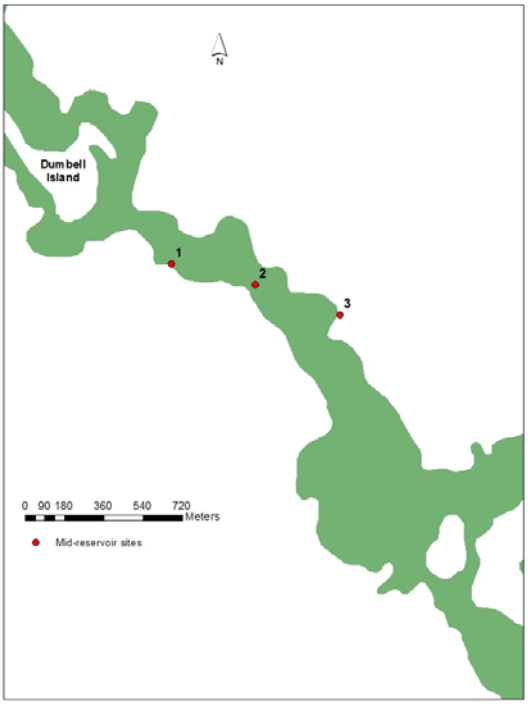

Figure 3.1.1 *Sampled points (1, 2, 3) on the section of the river where depth profiles of temperature, dissolved oxygen and conductivity were taken.* (*NB: Base map used was before dam construction*)

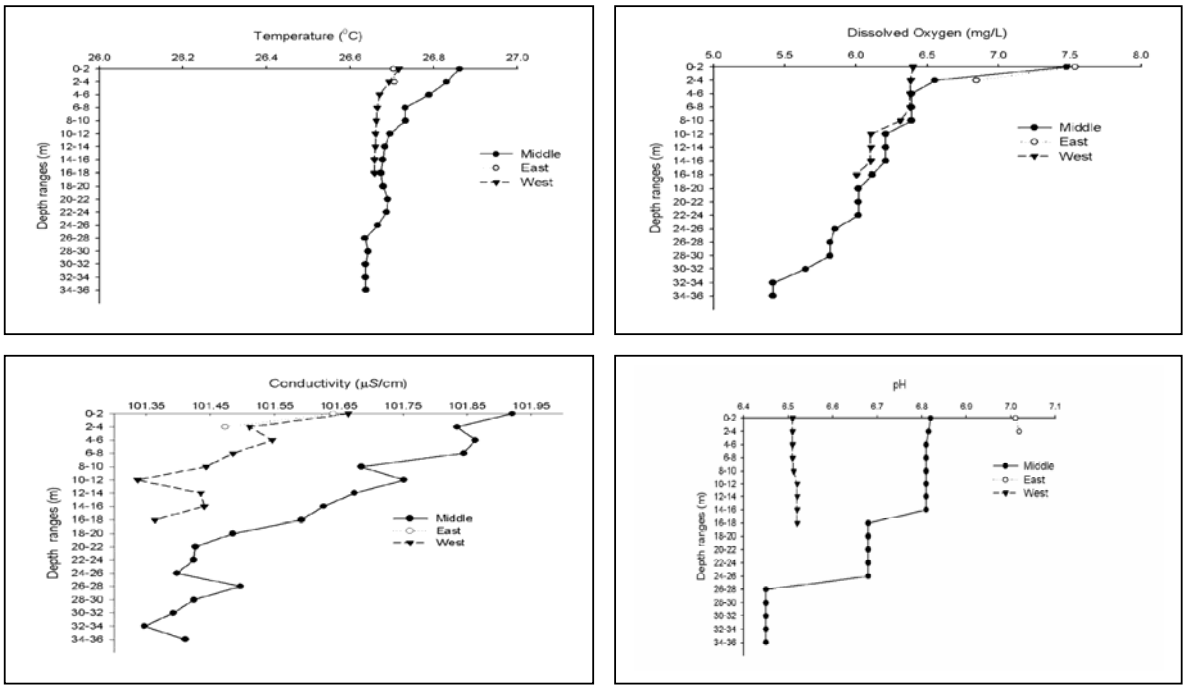

Figure 3.1.2 *Vertical profiles of some physico-chemical parameters in the BEL reservoir*

Vertical profiles for the water column temperature, dissolved oxygen and conductivity in the mid reservoir as determined using a CTD profiler at three separate, varied in depth (Figure 3.1.1). The deepest points sampled in the mid reservoir were in the middle zone and were in the range of 34 to 36 m, while those in the shallow zones were in the depth range of 2 to 4 m in the east, and 16 to 18 m in the west.

The water column exhibited a slight thermal discontinuity between the depths of 6 to 8 m in the middle, and 4 to 6 m in the west, while the east did not show this due to the shallow depth at the sampled site. The water column, at all zones sampled, was well oxygenated down to the bottom. At the deepest point in the mid reservoir, dissolved oxygen showed a discontinuity between 4 and 6 m, and thereafter, there were several minor discontinuities along the water column. Thus, it is likely that there were pockets of algae that existed along the water column hence accounting for the oxygen profiles indicated as a result of varying degrees of photosynthesis. At all sampled sites, surface waters were relatively more oxygenated compared to bottom waters. The middle and therefore the deepest zone had more dissolved oxygen in the surface layers of the water column compared to the eastern and western sampling zones. The well distributed and high dissolved oxygen concentration along the entire water column implied that the reservoir had the capacity to sustain biotic organisms that require ample concentrations of oxygen. Water conductance decreased systematically along the water column, though with several discontinuities especially in the middle and western zones of the mid reservoir. Water pH showed a relatively homogenous profile in the western zone of the mid reservoir, while discontinuities were remarkably noted in the middle zone. In all these four parameters, it was concluded that the period of April 2014 was a season for stratification as noted from the various discontinuities especially in the deepest zone of the reservoir.

3.1.2 Nutrient (nitrogen, phosphorus and silica) concentrations in water

The concentration of ammonium-nitrogen (NH_4-N) was more than ten times higher than what was noted in April 2013 (range 6.1 to 7.6 μg/L in April 2013 Vs 45.2 to 88.9 μg/L in April 2014), but similar to that of September 2013 (Table3.1.2).

Table 3.1.2 *Trends in mean concentrations of nutrients and algal biomass in water at upstream, Kalange-Makwanzi, mid of the reservoir and downstream, Buyala-Kikubamutwe*

Parameter	Site	Monitoring Dates													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Apr-06	Sept. 07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14
Ammonium Nitrogen, NH_4-N (μg/L)	Kalange-Makwanzi	42.3	20.2	79.4	88	186	137.2	75.3	58	1.5	8.7	11.4	7.59	86.92	86.92
	Mid section of the Reservoir										10.5	4.9	7.4	81.74	45.17
	Buyala-Kikubamutwe	29.5	24	97.9	79.4	137	111.8	68.2	45.8	2	10.6	3.2	6.11	87.56	73.32
	NEMA Std	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Nitrite-Nitrogen, NO_2-N (μg/L)	Kalange-Makwanzi	8.7	9.5	4	3.1	3	4.2	7.3	4.7	2.9	5.8	2	10.6	4.53	13.35
	Mid section of the Reservoir										6.3	2.8	10.6	5.35	12.75
	Buyala-Kikubamutwe	8.7	2.8	6.1	2.6	4	5.3	4.1	4.3	4	6.6	3.8	10.46	5.08	13.35
Nitrate-Nitrogen, NO_3-N (μg/L)	Kalange-Makwanzi	12.5	36	146.3	26.4	114	120.8	47.4	36.1	46.9	55.7	20.2	44.79	79.12	74.27
	Mid section of the Reservoir										50.4	18.4	54.72	91.09	140.93
	Buyala-Kikubamutwe	12.6	94	182.5	35	76	148.6	49.2	54.7	61.2	51.5	18.6	55.38	94.65	477.8
	NEMA Std	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Total-Nitrogen, TN (μg/L)	Kalange-Makwanzi	1174	2094	1925	306.7	2,362	1047	666.7	2196.3	1471	1,817.60	2,382.70	1,853.70	2,044.84	1,042.26
	Mid section of the Reservoir										1,606.90	4,337.30	1,335.20	394.05	1,070.04
	Buyala-Kikubamutwe	1193	2139	2492	216.7	2,421	2992	597.3	2103.7	2450	1,464.70	2,485.10	1,594.47	457.54	1,030.36
	NEMA Std	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Total Phosphorus, TP (μg/L)	Kalange-Makwanzi	108.6	54.5	58.5	60.3	36	186.3	84.6	30.3	32.2	65.2	106.4	48.3	50.3	46.1
	Mid section of the Reservoir										41.8	107.6	33.9	57.0	52.7
	Buyala-Kikubamutwe	100.8	48.7	76.3	47.3	45	271.9	88.8	64.1	35.6	107.7	112.0	41.1	48.5	32.7
	NEMA Std	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Soluble Reactive Phosphorus, SRP (μg/L)	Kalange-Makwanzi	19	24.2	11.7	6.9	27	15.7	21.1	31.6	9.8	6.4	20.0	12.7	11.2	12.2
	Mid section of the Reservoir										7	17.6	12.7	10.6	18.9
	Buyala-Kikubamutwe	19.2	27.7	18.9	16.6	32	24.8	25.6	20	11.7	6.6	21.4	12.7	15.6	14.0
	NEMA Std	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Soluble Reactive Silica, SRSi (μg/L)	Kalange-Makwanzi	319.9	539.7	238.4	501.2	859	521.1	265.9	149.6	23.8	176.8	146.9	309.4	406.14	408.24
	Mid section of the Reservoir										268.1	268.5	256.8	458.77	396.38
	Buyala-Kikubamutwe	309.4	530.7	282.8	496.7	847	521.7	201.5	68.8	43.8	248.1	244.6	238.8	432.46	369.38
Chlorophyll-a (µg/L)	Kalange-Makwanzi										5.1	6.3	10.2	12.51	10.01
	Mid section of the Reservoir										5.6	10.1	5.6	13.44	4.26
	Buyala-Kikubamutwe										6	9.7	6	9.27	5.27

However, these high NH_4-N concentrations remained far below the NEMA permissible upper limit of 10,000 μg/L.

Nitrite-nitrogen (NO_2-N) concentration was similar to that recorded in April 2013 (10.5 to 10.6 μg/L), but almost three times that recorded in September 2013 (4.5 to 5.4 μg/L). This relatively low range of NO_2-N concentration was likely due to the rapid oxidation of the nitrite species to nitrate-nitrogen.

Nitrate-nitrogen (NO_3-N) concentration remained relatively lower than the permissible NEMA upper limit of 20,000μg/L, but compared to the September 2013 concentration, April 2014 data showed a 2-fold increase in the mid reservoir and a 5-fold increase in the downstream zone.

Mean concentration of Total Nitrogen (TN) was in a narrow range (1,030.4 to 1,070.0 μg/L), with all zones having less than the permissible NEMA upper limit of 10,000μg/L.

During this April 2014 survey, the mean concentration of soluble reactive phosphorus (SRP) was relatively higher in the reservoir (18.9 μg/L) compared to the upstream (12.2 μg/L) and downstream (14.0 μg/L), though all were far below the permissible NEMA upper limit of 5,000 µg/L.

Mean concentration of Total Phosphorus (TP) was slightly higher in the mid reservoir (52.7 μg/L) compared to the upstream (46.1 μg/L) and the downstream (32.7 μg/L) transects. It was noted that all transects had TP concentration that was far below the permissible NEMA upper limit of 10,000μg/L.

The concentration of Soluble Reactive Silica (SRSi) was in a narrow range (396.4 to 408.2 μg/L) and had a similar range to that noted in September 2013 (406.1 to 458.8 μg/).

Algal biomass (Chlorophyll-a) was slightly lower than what was recorded in September 2013, but similar to that of April 2013, an observation that showed seasonality effects. The slightly low algal biomass in the mid reservoir (4.3 μg/L) was in part attributed to the high concentration of TSS that imparted light limiting conditions for algal production. The high algal biomass at the upstream transect was as a result of direct input from the lake.

3.1.3 Algae and aquatic macrophytes/weeds

Table 3.1.3 *Occurrence of major algal types and the number of species at the three sites, September 2012, April 2013, September 2013 and April 2014*

Major algal Taxonomic groups	Kalange-Makwanzi				Mid section of the Reservoir				Buyala-Kikubamutwe			
	Sept.2012	Apr. 2013	Sept. 2013	Apr. 2014	Sept.2012	Apr. 2013	Sept. 2013	Apr. 2014	Sept.2012	Apr. 2013	Sept. 2013	Apr. 2014
Bluegreen (Cyanopytes)	9	15	12	14	20	14	14	16	19	18	12	15
Green (Chlorophytes)	4	8	6	4	8	7	6	5	7	7	7	5
Diatoms (Bacillariophytes)	4	4	5	2	3	2	3	4	2	5	3	4
Euglenophytes	0	0	0	0	0	1	0	0	1	0	0	
Dinoflagellates	0	0	0	0	0	1	0	0	1	0	0	
Total number of species	**17**	**27**	**23**	**20**	**25**	**30**	**23**	**25**	**30**	**30**	**22**	**24**

Algal taxa (Table 3.1.3) and species composition (Table 3.1.4) were variable at the transects. The blue-greens (Cyanophyta) were the main taxa encountered, then followed by green algae (Chlorophyta) and then diatoms (Bacillariophyta) in that order. Like in the previous survey, Euglenophytes and Dinoflagellates were not encountered during this reporting period. Algal

species richness was higher at the downstream and mid-reservoir transects (25 and 24 species, respectively) than at the upstream one (20 species).

Table 3.1.4 *Major Algal types and species composition at the three sites, September 2012, April 2013, September 2013 and April 2014 (P denotes presence).*

Major algal types/species	Kalange-Makwanzi				Mid section of the Reservoir				Buyala-Kikubamutwe			
	Sept.2012	Apr. 2013	Sept. 2013	Apr. 2014	Sept.2012	Apr. 2013	Sept. 2013	Apr. 2014	Sept.2012	Apr. 2013	Sept. 2013	Apr. 2014
Bluegreen (Cyanopytes)												
Planktolyngbya limnetica		P	P	P	P	P	P	P	P	P	P	P
P.tallingii			P	P	P	P	P	P	P		P	P
P.undulata					P		P		P			
P.contotum					P	P						
P.circumreta		P	P	P	P	P	P	P	P	P	P	P
Aphanocapsa sp	P				P				P			
Aphanocapsa nubilium		P		P		P		P		P		P
Aphanocapsa holistica		P				P		P				
Aphanocapsa elachista			P	P			P	P	P	P		P
Aphanocapsa incerta			P	P		P	P		P		P	
Aphanocapsa holistica	P			P					P	P		P
Aphanocapsa delicatissima	P	P	P	P	P	P	P	P	P	P	P	P
Cylindropermopsis africana		P	P		P	P			P			
Cylindropermopsis cuspis					P							
Cylindrospermopsis raciborskii					P							
Merismopedia tentuszima	P	P	P	P	P	P	P	P	P		P	P
Merismopedia gluaca	P	P			P			P	P	P		
Merismopedia elegans		P				P				P		
Microcystis aeruginosa		P		P		P		P		P		p
Pseudoanabeana					P			P		P		P
Chroococcus limneticus	P	P	P	P	P	P	P	P		P		P
Chroococcus turgidus	P				P							
Chroococcus aphanocapsiodes			P				P		P			
Chroococcus dispersus				P					P		P	
Cyanodyction spp		P				P				P		
Ceolosphaerium kuetzinganianum				P		P	P	P				P
Ceolomoron sp	P		P		P			P				
Anabeanopsis tanganyikae	P	P					P			P	P	P
Anabeana compacta							P		P			
Anabaena floa-sague		P				P						
Anabeana circinalis		P	P	P	P	P	P	P		P	P	P
Romeria spp											P	
Pico Blues					P							
Green (Chlorophytes)												
Actinastrum hantzschii						P						P
Ankistrodesmus fusiformis		P			P			P				
Ankistrodesmus falcatus	P	P	P	P			P	P	P	P	P	P
Ankistrodesmus stegala					P							
Monoraphidium contortum			P	P	P		P		P		P	P
Chodetella	P										P	
Crucigenia fenestrate										P		
Kirchnriella obesa		P	P	P		P	P	P		P	P	
Monorophidium contortum		P				P		P		P		
Cosmorium sp					P				P			
Cloesterium spp (acerosum)			P	P		P	P			P	P	
Stuarastrum sp		P		P	P	P		P	P			
Pediastrum simplex		P	P							P	P	
Pediastrum duplex					P				P			
Scenedesmus acuminatus	P				P		P					
Scenedesmus perforatus		P				P	P			P	P	P
Scenedesmus curvatus									P			
Scenedesmus castato	P								P	P		
Selenestrum ganulata			P									
Dydimocystis spp												P
Oocysistis borgi						P						
Diatoms (Bacillariophytes)												
Navicula gastrum			P			P	P		P	P	P	
Nitzschia nyassae		P				P		P				P
Nitzschia acicularis	P	P	P	P		P	P	P	P	P	P	P
Rhizosolenia victoriae	P								P			
Nitzschia fonticola		P	P		P	P		P	P	P		
Synedra cunnigtonii	P	P	P	P		P	P	P	P	P	P	P
Cyclostephanodiscus spp			P									P
Cyclotella sp	P				P				P			
Euglenophytes												
Euglena acus					P							
Phacus sp									P			
Dinoflagellates												
Glenodinuim sp	P											

Aquatic macrophytes

The major aquatic macrophytes were water hyacinth (*Eichhornia crassipes*), Hippo grass (*Vossia cuspidata*), Duckweed (*Lemna minor*), Water primrose (*Ludwigia* spp.), Bermudagrass (*Cynodon dactylon*), Wondering Jew (*Commelina benghalensis*) and Cattail (*Typha* spp.).

Due to increased water levels, most of the aquatic macrophytes that once existed along the original shores of Kalange-Makwanzi (upstream transect) had disappeared due to submergence. Water hyacinth, a free floating waterweed, dominated the shores, with the highest cover abundance of 1.5ha at Sabawa, while at the rest of the sites, this weed varied between 0.5ha and 0.8ha, and had a total cover abundance of up to 3.2 ha. Other aquatic macrophytes were *Cynodon dactylon* (1.9 ha), *Lemna minor* (0.6 ha), *Ludwigia* spp. (0.4 ha) and V. *cuspidata* (< 0.06 ha).

At Buyala-kikubamutwe, 60% of the river bank had been cultivated down to the highest water mark, and trees such as Eucalyptus had been grown thus leaving little room for establishment of both emergent and floating aquatic macrophytes. Despite this, there was some *V. cuspidata* at Kikubamutwe (0.06 ha) and at Mukigisu (0.31 ha). Water hyacinth only occurred at Mukigisu and covered approximately 0.12 ha. No other macrophytes were found along this transect.

At the mid reservoir transect as was at the downstream transect, common aquatic macrophytes were absent. The only ones encountered were water hyacinth (0.62 ha) and *V. cuspidata* (0.08 ha). Water hyacinth was found at Bujjagali site (0.08 ha), Kyabirwa site (0.05 ha) and Buloba site (0.65 ha). Due to the remarkable rise in the water level as a result of damming, terrestrial plants including trees that were along the river banks had disappeared due to submergence. Other than water hyacinth that was occasionally encountered, the river shores and banks were l devoid of most aquatic macrophytes. Emergents such as *Cyperus papyrus, Ludwigia* sp., *Commelina banghalesis* and *Cynodon dactylon* were rare.

3.2 Zooplankton (Water column micro-invertebrates)

Species diversity and distribution trends

The zooplankton community composition remained comparable with earlier observations made in April 2006, April 2012, September 2012, April 2013 and September 2013 (Table 3.2.1). Four species of Copepoda (*Thermocyclops neglectus, Thermodiaptomus galeboides, Tropocyclops confinnis, T. tenellus*), three of Cladocera (*Bosmina longirostris, Ceriodaphnia cornuta, Diaphonosoma excisum*,) and two of Rotifera (*Brachionus angularis, Keratella tropica*) were recovered in all the three study sites. Three cladoceran species: *Daphnia longispina, D. lumholzi* and *Macrothrix* sp. and one rotifer species *Brachionus bidentatus* were only recovered once and in small proportions. The remaining species were intermittently recovered in the three study sites. The highest contributors of species richness/diversity in all the three sections of the study area (upstream, mid reservoir and downstream) were Copepoda and Rotifera with 8, 7, 6 and 7, 8, 4 respectively compared with 2, 2, 2 for Cladocera. Total species richness was highest and similar in the upstream and mid reservoir sites (17 species) and declined to 12 in the downstream site (Table 3.2.1). A general decline in species numbers across the three study sites was noted in comparison with the records of the previous survey.

Table 3.2.1. *Numerical abundance (ind. m^{-2}) of zooplankton species at three sites of BEL, April 2014*

Taxa	Species	Kalange-Makwanzi						Mid section of the Reservoir					Buyala-Kikubamutwe					
		Apr-06	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14	Apr-06	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14
Copepoda	*Thermocyclops incisus*		55		180		404	510				876	54	69			449	135
	Mesocyclops sp.	555	217	173	359	339	472	225	63	505	45	1,752	77	361		55	90	
	Thermocyclops emini	1,213	222	94	1,123	229	606		259	2,403	1,619	741	22	208			180	
	Tropocyclops confinnis	2,458	402	582	3,440	1,702	9,791	1,021	660	7,087	7,223	4,446	177	985	356	1,600	1,412	1,038
	Thermodiaptomus galeboides	3,649	1,586	550	1,255	671	3,705	827	1,218	4,087	3,288	4,514	423	1,156	451	1,077	954	1,201
	Thermocyclops neglectus	6,086	3,648	1,258	7,204	5,259	9,364	2,835	1,077	6,160	8,950	13,002	197	1,216	906	343	1,392	1,324
	Harpacticoida						157				22							28
	Tropocyclops tenellus	8,585	4,498	1,336	11,497	11,497	14,574	4,871	762	11,147	12,279	8,892	1,201	5,927	802	5,636	3,133	4,660
	Cyclopoid copepodite	46,139	13,604	20,749	55,645	19,959	109,719	17,786	14,194	72,754	72,754	49,111	8,449	8,482	12,214	19,679	23,349	20,567
	Calanoid copepodites	6,808	1,401	1,808	4,436	1,305	10,038	2,843	2,122	9,234	5,731	4,244	531	1,724	859	2,487	595	2,964
	Nauplius larvae	109,016	56,689	17,165	110,662	73,062	354,935	72,696	14,108	229,029	142,430	202,539	27,844	25,701	12,670	99,546	48,792	161,277
Total copepods		**184,509**	**82,322**	**43,715**	**195,801**	**114,023**	**513,765**	**103,614**	**34,463**	**342,406**	**254,341**	**290,117**	**38,975**	**45,829**	**28,258**	**130,423**	**80,346**	**193,194**
Total copepod species		**6**	**7**	**6**	**7**	**6**	**8**	**6**	**6**	**7**	**7**	**7**	**7**	**7**	**4**	**5**	**7**	**6**
Cladocera	*Daphnia lumholtzi*												9					
	Daphnia longispina		42															
	Macrothrix sp.												20					
	Chydorid sp.	29						42					7	37				
	Daphnia lumhortzi (helm.)	243	23		108			14		36	56		17					67
	Ceriodaphnia cornuta	58	23	63	1,118	808	2,223	147	181	584	584	1,087		203	89	45	79	83
	Diaphanosoma excisum	287	462		1,292	382	135	297	94	921	685	2,358		190	73	674	557	337
	Moina micrura	679	361	63	1,934	90	808	497	118	932	659	606	28	227	31	67	31	
	Bosmina longirostris	859	254	31	444	606	180	330	212	564	1,329	269	213	319	110		528	28
Total cladocerans		**2,155**	**1,165**	**157**	**4,896**	**1,886**	**3,346**	**1,327**	**605**	**3,037**	**3,313**	**4,320**	**294**	**976**	**303**	**786**	**1,195**	**515**
Total cladoceran species		**6**	**6**	**3**	**5**	**4**	**4**	**6**	**4**	**5**	**5**	**4**	**6**	**5**	**4**	**3**	**4**	**4**
Rotifera	*Asplanchna* sp.							22	55		55							
	Ascomorpha sp.							42	24								135	
	Euclanis sp.	19		16		106		28	24	225	247			14		90		
	Brachionus falcatus				45	584		33		90			11					
	Filinia longiseta	116	23		264			42	16	797	269					355		
	Polyarthra sp.	204							79		76							
	Filinia opoltensis	19	37		145		202	180	39	712		741			16	225		67
	Brachionus forticula				135		90				168							
	Brachionus bidentatus									34								
	Brachionus calyceforous	165	18	79			180	14	39		539		68	37		135		
	Keratella cochlearis	173	74			269		164	24	258	707	202	30	83	16		404	
	Trichocerca cylindrica	105	92	267		204		333	487	292	1,219	606	13		168	262		
	Brachionus angularis	213	46		90	494	719	164	55		319	404	95	97	131		79	1,078
	Hexathra sp.				45					67								
	Lecane bulla	289	379	534	835	1,763	1,033	732	409	2,439	2,550	2,088	79	166	419	337	1,060	
	Lecane luna					135	449			1,880	657	404				269	808	
	Synchaeta sp.	617	587	550	853	649		644	487	1,758	1,072	876	42	291	634	748	865	935
	Keratella tropica	565	240	346	1,506	849	5,142	752	330	3,734	1,278	2,156	659	647	346	1,054	638	2,457
Total rotifers		**2,485**	**1,496**	**1,792**	**3,918**	**5,053**	**7,815**	**3,150**	**2,068**	**12,286**	**9,156**	**7,477**	**997**	**1,335**	**1,730**	**3,475**	**3,989**	**4,537**
Total rotiferan species		**11**	**9**	**6**	**9**	**9**	**7**	**13**	**13**	**12**	**13**	**8**	**8**	**7**	**7**	**9**	**7**	**4**
Total abundance		**189,149**	**84,983**	**45,664**	**204,615**	**120,962**	**524,926**	**108,091**	**37,136**	**357,729**	**266,810**	**301,914**	**40,266**	**48,140**	**30,291**	**134,684**	**85,530**	**198,246**

Abundance patterns

The greatest contributor to numerical abundance was Copepoda (193,193- 513,765 ind m^{-2}) and the least contributor was Cladocera (515-4,311 ind. m^{-2}). Total numerical abundance ranged from 198,245 ind. m^{-2} to 524,926 ind. m^{-2}. These trends were comparable with results of the previous surveys. The notable contributing copepod species were *T. neglectus, T. confinnis* and T. *tenellus*, although the highest values were from the copepod development stages (i.e. copepodites: 23,531-119,756 ind. m^{-2} and naupliys larvae:161,277 - 354,935 ind. m^{-2}). This trend also was comparable to the May 2012 & September 2012, April 2013 and September 2013 survey data (Table 3.2.1). Copepoda had peak abundance at the upstream site and declined progressively through the reservoir to the downstream site. Only Cladocera had a minor peak value at the reservoir (4,311 ind. m^{-2}). This trend was at variance with previous trends, which showed peak abundance of total zooplankton values at the reservoir.

Discussion

The community composition data for the five study periods (April 2006, May 2012, September 2012, April 2013, September 2013 and April 2014 indicates occurrence of nearly the same zooplankton species belonging to three taxonomic categories (Copepoda, Cladocera and Rotifera). The species assemblage is generally similar to that of Lake Victoria where the River Nile originates. Comparison of the of the zooplankton composition with those of the past surveys pre- and post- reservoir composition data indicates that community composition has remained more or less stable following and after creation of the hydropower dam and reservoir, which suggests continuity of stable environment conditions (at least for the zooplankton community) or high adaptive capacity of the zooplankton community to change from running water to standing water at the reservoir. As zooplankton have been reported to provide over 70% of the diet of the pelagic *Rastrineobola argentea* in Lake Victoria (Mwebaza-Ndawula 1998) the occurrence of these organisms in relatively high abundance (>100,000 ind. m^{-2}) means potential for a pelagic fishery.

Although the data still shows a rotifer-driven species richness, this role is shared with Copepoda in the present survey (Table 3.2.1). This observation underscores the ecological importance of Copepoda by showing that the group can drive zooplankton community both in terms of species richness as well as numerical abundance. The observed shift of the abundance peak from the reservoir to the upstream site (Table 3.2.1) requires evaluation for consistency and this will be done through subsequent surveys. In spite of community changes seen in the present survey, the data still demonstrates the stability of the zooplankton community over time (years of study) and space (the 3 study sites) in view of radical transformation involving creation of the reservoir heralding change from riverine (running water) to a more or less lake (standing water) conditions .

It is clear that zooplankton community abundance is heavily dependent on copepods especially, Cyclopoid copepods. The most contributing copepod species and groups have remained the same over the survey years, namely *Thermocyclops neglectus, Tropocyclops tenellus, T. confinnis* and juvenile stages of Copepoda: copepodites and nauplius larvae (Table 3.2.1). The present observations do not deviate significantly from those of the previous surveys, and those previously made on Lake Victoria and work Upper Victoria Nile (Mwebaza-Ndawula *et al*. 2005). High concentrations of these species offer promise for a fishery in the study area.

3.3 Benthic macro-invertebrates

Table 3.3.1 *Trends of benthic density and number of species of macroinvertebrates at upstream-Kalange-Makwanzi, mid-section of the reservoir and downstream, Buyala-Kikubamutwe*

Taxa	Species	Kalange-Makwanzi								Mid section of the Reservoir					Buyala-Kikubamutwe							
		Apr-06	Sep-07	Apr-08	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14	Apr-06	Sep-07	Apr-08	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14
Gastropoda (Water snails)	*Bellamya unicolor*	33	173	5	33			299				4	154	23	98	126	11	42	65	285	14	296
	Melanoides tuberculata	28	107	257	14	19	5	19				77	5	33	33	224	100	121	33	33	9	5
	Biomphalaria choanomphala		14	5				9		2			7	9		19	11		5			25
	Anisus natalensis																	5				
	Gyraulus sp.				5									5						47		
	Segmentorbis sp.										3							47	9	23		
	Gabbia humerosa		79	5			5	23				4	5				121	1,027	677	135		33
	Bulinus sp	5	9	5									12	5	5	5	5		19	65		
	Choanomphala			14						2		4				19	11		5	9	5	
	Pila ovata		5	5						7							5			5		
Total Gastropoda density		**66**	**387**	**296**	**52**	**19**	**10**	**350**	**0**	**11**	**3**	**89**	**183**	**75**	**136**	**393**	**264**	**1242**	**813**	**602**	**28**	**359**
Number of Gastropod species		**3**	**6**	**6**	**3**	**1**	**2**	**4**		**2**	**1**	**4**	**5**	**5**	**3**	**4**	**6**	**5**	**6**	**8**	**3**	**4**
Bivalvia (Clams/mussels)	*Byssanondota parasitica*	79	145	252	61	75	42	121	14	23	95	686	380	159		19	63	317	9	117	733	801
	Corbicula africana	56	126	182	47	219	514	98	222	5	25	196	44	47	65	131	205	65	28	79	56	581
	Caelatura sp	149	93	229	79	79	47		124	9	20	28	23	23	37	61	63	37	5	5	47	44
	Pisidium victoriae		5			9											32	19	5			
	Mutela sp				5	5			7						5	5	16					
	Sphaerium victoriae	5	51	14					14	2			2			19		23			5	14
	Sphaerium stuhlmanni				9			9		5	146	18	2					9	5			
	Aspantharia sp	9	9	5	5	5	5		5					5	5							
	Etheria eliptica																5	5				
Total Bivalvia density		**298**	**429**	**682**	**206**	**392**	**608**	**228**	**386**	**44**	**286**	**928**	**451**	**234**	**112**	**235**	**384**	**475**	**52**	**201**	**841**	**1440**
Number of Bivalvia species		**4**	**5**	**4**	**5**	**6**	**4**	**4**	**6**	**4**	**4**	**4**	**5**	**4**	**3**	**4**	**5**	**6**	**5**	**3**	**4**	**4**
Diptera (Midge larvae)	Chironominae	271	331	238	201	47	117	191	5	201	73	98	26	19	84	56	58	84	9	75	37	27
	Tanipodinae	19	33	23	5	14	33	37	19		8	42	42		23	42	5	26		14	56	56
	Chaoborus sp	9	23	9	9		28	70	196			53	47	5	5	5		65			23	40
	Ceratopogonidae	5	14		65				5							5						
	Psychodidae												5									
Total dipteran density		**304**	**401**	**270**	**280**	**61**	**178**	**298**	**225**	**201**	**81**	**193**	**120**	**24**	**112**	**108**	**63**	**175**	**9**	**89**	**116**	**123**
Number of dipteran types		**4**	**4**	**3**	**4**	**2**	**3**	**3**	**4**	**1**	**2**	**3**	**4**	**2**	**3**	**4**	**2**	**3**	**1**	**2**	**3**	**3**
Oligochaeta (water worms)	*Nais sp*		5	5	14			28				11	16			33	11	9			19	56
Ostracoda (seed shrimps)								9		229			7								5	
Hirudinea (Leeches)																			5			
Decapoda (Fresh water shrimps)	*Caridina nilotica*		5		5			5		7	3		5			5	32				5	14
Ephemeroptera (May Flies)	*Povilla adusta*	19	163	9	28		14	0		5	3	144	245	28	5	9	63	28	5	37	9	5
	Baetis sp.	5	9	0	0						3				23	5			5			
	Caenis sp.	19	75	19	5			5				7		23		9	26	37	9	313		
	Cloeon sp.														37				9	9		
	Leptophlebidae		14										5							5	9	
	Trichorythidae		89										19					5		19		
Total Ephemeroptera density		**43**	**350**	**28**	**33**	**0**	**14**	**5**		**5**	**6**	**151**	**269**	**51**	**65**	**23**	**89**	**70**	**28**	**383**	**18**	**5**
Number of ephemeropteran types		**3**	**5**	**2**	**2**	**0**	**1**	**1**		**1**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**2**	**4**	**5**	**2**	**1**
Odonata (Dragon/damsel Flies)	*Hagenius sp.*	19		9		5			7		3			5	5			5	5			
	Gomphoides sp.	5		5												19						
	Libellulidea	9	33	0	5		14	5		2		18	2			5	37	5	5	14		2
	Coenagrion sp.														5		5					
	Protoneuridae		9	9																		
Total odonates density		**33**	**42**	**23**	**5**	**5**	**14**	**5**	**7**	**2**	**3**	**18**	**2**	**5**	**10**	**24**	**42**	**10**	**10**	**14**	**0**	**2**
Number of odonate types		**3**	**2**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**
Trichoptera (Caddis Flies)	Hydropsychidae												257	5		19	16	5		9		
	Brachycentridae																	2				
	Psychomyiidae		2				5				3	4	7					5			14	
	Leptoceridae						5	9								2	3			5		
Total Tricoptera density			**2**				**10**	**9**	**0**		**3**	**4**	**264**	**5**		**21**	**19**	**12**		**14**	**14**	**0**
Number of tricopteran types			**1**				**2**	**2**	**0**		**1**	**1**	**2**	**1**		**2**	**2**	**3**		**2**	**1**	**0**
Hemiptera (True bugs)	Nepidae	0	0	5	0																	
Coleoptera (Beetles)	Elmidae	0	5	0	0	0																
Total benthic macro-invertebrate density (ind.m-2)		744	1626	1309	595	477	834	937	618	499	385	1394	1317	394	435	842	904	1993	917	1303	1046	1999

The overall abundance estimates of macro-benthos in this survey were generally similar to those observed in the preceding survey. The mollusk types, the bivalves (the clams and mussels) and gastropods (water snails), and the insect larvea (mainly dipteran larvae) remained the most predominant groups of macro-benthos (Table 3.3.1). At the upstream (Kalange-Makwazi transect), no snails were recovered. The mean densities for respective samplings from September 2007, to date (April 2014) were 383, 275, 9, 350 and 0 ind. m^{-2} (Table 3.3.1). Similar trend was observed in the mid reservoir where 88, 182 and 75 ind. m^{-2} were realized for, April 2013, September 2013 and April 2014 respectively. Contrast was observed at the downstream (Buyala-Kikubamutwe transect), the total mean density of snails rose from 28 ind. m^{-2} in the previous (Sept. 2013) to 358 ind. m^{-2} in current one, April 2014. Meanwhile, the claims/ mussels registered a decline in total mean densities in the mid reservoir (from 928 to 453 then to 233 ind. m^{-2} for April & September 2013 and April 2014 respectively), but there was an increase realized at the upstream and downstream transects (Table 3.3.1).

Though not recorded at the upstream, *Bellamya unicolor* remained the most abundant snail species in the mid reservoir and downstream transects respectively with 75 and 358 ind. m^{-2}. Decreasing density of *Gabbia humerosa* was recorded at the downstream from highest 1027 ind. m^{-2} in April 2013 to 0 ind. m^{-2} in September 2013 and 33 ind. m^{-2} in the recent April 2014 sampling survey. As in the preceding surveys, *Byssanodonta parasitica, Corbicula africaca* and *Caelatura* spp., dominated the bivalves. A mean density of 801 ind. m^{-2} of ***B. parasitica*** was recorded at the downstream transect during this survey and 733 ind. m^{-2} in the preceding sampling. In the mid reservoir, a mean density of 159 ind. m^{-2} was registered compared to 380 ind. m^{-2} in the September 2013 monitoring survey. For ***C. africana*** a similar rise in population at all sites was observed, having mean density of 581 ind. m^{-2} at downstream transect and 222 ind. m^{-2} at upstream one. Unlike in the preceding survey where no *Caelatura* spp. was recovered at the upstream transect, its mean density of 124 ind. m^{-2} was registered during the present survey. In the mid reservoir and downstream transects, mean densities of 23 and 44 ind. m^{-2} were recorded respectively (Table 3.3.1).

The mayflies (*Povilla adusta* and *Caenis* sp), midges (chironomids and chaoborids) and Odonates (*Hagenius* sp) were among the insect types registered. Among these, *Chaoborus* sp. is the only group that exhibited a density of more than 100 ind. m^{-2} during this survey. The mean density of ***P. adusta*** of 28 ind. m^{-2} was recorded from the med reservoir. Chironomids (Chironominae and Tanypodinae) realized a total mean density at the downstream (63 ind. m^{-2}). Compared to the September 2013 survey, the overall mean density of macrobenthos at the upstream (Kalange-Makwazi) slightly increased to 938 ind. m^{-2} from 831ind. m^{-2} in April 2013. However during this survey, overall mean density decreased to 626 ind. m^{-2} from 938 ind. m^{-2}. Same trend occuured at the mid reservoir transect (ie 387 ind. m^{-2} in the current survey from 1317 ind. m^{-2} obtained in September 2013) . The increase was shown at the downstream (Buyala-Kikubamutwe) from 910 ind. m^{-2} to 1303 ind. m^{-2} then to 1046 ind. m^{-2} to 2000 ind. m^{-2} from the previous three surveys to current one respectively (Table 3.3.1).

Discussion

The trend and pattern of benthic macro-invertebrates distributions between the upstream and mid reservoir transects do not vary significantly. Gastropods exhibited the highest densities both at the upstream (350 ind. m^{-2}) and mid reservoir (182 ind. m^{-2}) in September 2013; these densities dropped in the current sampling to 0 and 75 ind. m^{-2} respectively. In this same period, very low density of 28 ind. m^{-2} was observed at the downstream. Bivalves on the other hand exhibited highest densities during April 2013 at the upstream and mid reservoir transects, thereafter, the densities dropped. The densities however have risen at the downstream transect (Table 3.3.1). Similar trends were observed in dipteran abundance. The similarity in the trend between the upstream and mid reservoir could probably be due to similarity in the water –reservoir-like prevailing conditions as a result of the dam.
Apart from the dominant species of snails - *B. unicolor; M. tuberculata* and *G. humerosa*, the other species of importance: *Biomphalaria choanomphala* and *Bulinus sp*. were recorded particularly in the mid reservoir. Their existence causes fear in those areas as they are responsible for transmission of schisitosomes (Mendahl-Barth, 1957). Their population need be monitored as these can be indicators of the existence of bilharzias.
Although, mean densities of *P. adusta* 380 ind.m^{-2} *and Hydropsychidae* 257 ind.m^{-2} had been recorded in the mid reservoir in the previous survey, they were not realised in this the present one. These insect types are good water quality indicators where by their presence is of importance.

3.4 Fish Species Composition and Relative Abundance

3.4.1 Catch composition

With haplochromines taken as a single species group, a total of 11 fish species were recorded at the three transects along River Nile in April 2014 compared to 10 in September 2013 and 11 in April 2013 (Table 3.4.1). A total of 5 species were recorded from the upstream station (Kalange) 6 from both the mid reservoir (Bujagali) and 7 from the downstream (Buyala).

All keystone species Nile perch (*Lates niloticus),* Nile tilapia *(Oreochromis niloticus),* Ssemutundu (*Bagrus docmak),* Elephant snout fish (*Mormyrus kannume)* and the haplochromines) were recovered during this survey. Nile perch and *the haplochromines* were recovered from all the three transects sampled while the native tilapiine *Oreochromis variabilis*, was recorded from the mid reservoir and downstream transects. The Nile tilapia (*Oreochromis niloticus*) *Tilapia zillii*, and *Barbus altianalis* were each only recovered from Buyala-Kikubamutwe transect. *Bagrus docmac* and the mormyrid *Gnathonemus longibardis* were only recorded from the mid reservoir while *S. afrofischeri* was recorded from upstream and downstream transects. *Synodontis victoriae* was only recorded from upstream.

The highest densities of fish by numbers were at the Downstream transect Buyala (74.0%), followed by Kalange transect (16.7%) and least from the reservoir (9.3%). The haplochromines which have been dominant by numbers at all stations, were overtaken by *S. afrofischeri* in upstream transect while Nile perch dominated the mid reservoir as in the September 2013 survey. Haplochromines were the most dominant in the downstream transect. However, by weight *S. afrofischeri* was dominant upstream, the elephant snout fish in the mid reservoir and *haplochromines* downstream.

Species recovered from all gears were, 5 (8,8, 8, 8, 8, 8, 7) species were recorded at Kalange (Transect 1) 6 (7, 8, 7, 10) in the main reservoir and 7 (7,7, 7, 8, 5, 4, 10) at Buyala (Transect 2) The numbers in brackets are for the number of species caught during the surveys of September 2013, April 2013, September 2012, April 2012, September 2011, April 2011 and September 2010 surveys respectively (Figure 3.4.1).

3.4.2 The Haplochromines

A total of 12 species belonging to 6 genera of haplochromines were recovered during the survey (Table 3.4.2). The downstream transect yielded the highest haplochromine species diversity (8 species) followed by the upstream transect (5 species) and the mid reservoir recorded 3 species.

Over the last 7 surveys, the highest haplochromine diversity and abundance were recorded at downstream transect (Buyala) unlike when the upstream transect dominated. Numerically, the most dominant genus was *Astatotilapia* contributing 90.8% followed by Psammochromis (4.3%), Paralabidochromis (1.6%), Mbipia (1.1%), Astatoreochromis (0.9%), Harpagochromis (0.9%), and Neochromis (0.5%). By weight, Astatotilapia still dominated the catch, contributing 83.1%.

Table 3.4.1 *Fish species recorded overtime at upstream (Kalange-Makwanzi), mid of the reservoir and downstream (Buyala-Kikubamutwe) transects.*

Family names	Scientific names	English names/local names (Luganda)	Sites	Monitoring Dates												
				1	2	3	4	5	6	7	8	9	10	11	12	13
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012	Apr. 2013	Sep. 2013
Bagridae	*Bagrus docmak*	Catfish/(Semutundu)	Kalange-Makwanzi		P			P								
			Mid section of the Reservoir										P	P	P	P
			Buyala-Kikubamutwe		P		P								P	P
Centropomidae	*Lates niloticus*	Nile perch/Mputa	Kalange-Makwanzi	P	P	P	P	P	P	P	P	P	P	P	P	P
			Mid section of the Reservoir										P	P	P	P
			Buyala-Kikubamutwe	P	P	P	P	P	P	P	P	P	P	P	P	P
Characidae	*Brycinus jacksonii*	(Nsoga)	Kalange-Makwanzi													
			Mid section of the Reservoir													
			Buyala-Kikubamutwe	p												
	B. sadleri	(Nsoga)	Kalange-Makwanzi	p												
			Mid section of the Reservoir													
			Buyala-Kikubamutwe													
Cichlidae	*Oreochromis niloticus*	Nile tilapia/(Ngege -kibati)	Kalange-Makwanzi	P	P	P		P			P	P	P			
			Mid section of the Reservoir												P	
			Buyala-Kikubamutwe	P	P	P	P	P		P			P	P	P	P
	O. leucostictus	Black tilapia/(Ngege)	Kalange-Makwanzi	P	P											
			Mid section of the Reservoir													
			Buyala-Kikubamutwe	P	P		P									
	O. variabilis	Tilapia/(Ngege)	Kalange-Makwanzi	P	P	P	P	P	P	P	P		P	P	P	P
			Mid section of the Reservoir										P			
			Buyala-Kikubamutwe	P	P		P			P	P	P	P			
	Tilapia zillii	Red-belly tilapia/(Ngege)	Kalange-Makwanzi	P	P	P	P	P	P	P	P		P	P	P	P
			Mid section of the Reservoir										P		P	P
			Buyala-Kikubamutwe	P	P	P	P	P		P			P	P		
	Haplochromines	(Nkejje)	Kalange-Makwanzi	P	P	P	P	P	P	P	P	P	P	P	P	P
			Mid section of the Reservoir										P		P	P
			Buyala-Kikubamutwe	P	P	P	P	P	P	P	P	P	P	P	P	P
Clariidae	*Clarias gariepinus*	Mudfish/ (Male)	Kalange-Makwanzi			P	P							P	P	
			Mid section of the Reservoir										P	P		
			Buyala-Kikubamutwe			P	P		P			P				P
Cyprinidae	*Barbus altianalis*	Barbel fish/ (Kisinja)	Kalange-Makwanzi	P	P	P	P		P				P			
			Mid section of the Reservoir										P	P	P	
			Buyala-Kikubamutwe	P	P	P	P		P	P		P	P		P	
	B. paludinosus	Barbel fish/ (Kisinja)	Kalange-Makwanzi													
			Mid section of the Reservoir													
			Buyala-Kikubamutwe	P												
	Labeo victorianus	(Ningu)	Kalange-Makwanzi													
			Mid section of the Reservoir													
			Buyala-Kikubamutwe		P					P						
	Rastrineobola argentea	Silver fish/(Mukene)	Kalange-Makwanzi							P						
			Mid section of the Reservoir													
			Buyala-Kikubamutwe	P	P		P			P						
Cyprinodontidae	*Aplocheilichthys pumilu*	Gambusia	Kalange-Makwanzi													
			Mid section of the Reservoir													
			Buyala-Kikubamutwe		P											
Lepidosirenidae	*Protopterus aethiopicus*	Lung fish (Mamba)	Kalange-Makwanzi						P							
			Mid section of the Reservoir													
			Buyala-Kikubamutwe				P									
Mochokidae	*Synodontis afroftischeri*	Tiger fish (Nkolongo)	Kalange-Makwanzi	P	P	P	P	P	P	P	P	P	P	P	P	P
			Mid section of the Reservoir										P		P	P
			Buyala-Kikubamutwe		P	P	P	P	P	P		P	P	P	P	P
	S. victoriae	Tiger fish (Nkolongo)	Kalange-Makwanzi			P		P	P		P			P	P	P
			Mid section of the Reservoir										P	P		P
			Buyala-Kikubamutwe											P		
Mormyridae	*Mormyrus kannume*	Elephant snout fish (Kasulubana)	Kalange-Makwanzi	P	P	P	P	P	P	P	P	P	P	P	P	P
			Mid section of the Reservoir										P	P	P	P
			Buyala-Kikubamutwe	P	P	P	P	P	P	P	P	P	P	P		
Total No. of species			Kalange-Makwanzi	10	10	10	8	9	9	7	8	5	8	8	8	6
			Mid section of the Reservoir										10	7	8	7
			Buyala-Kikubamutwe	11	13	8	12	6	6	10	4	7	8	7	7	7

Table 3.4.2 *Haplochromine species recorded over time at the upstream (Kalange – Makwanzi) mid of the reservoir and downstream (Buyala – Kikubamutwe) transects*.

Genus	Species name	Site	Monitoring dates												
			Apr 2006	Sep 2007	Apr 2008	Apr 2009	Sep 2009	Apr 2010	Sep 2010	Apr 2011	Sep 2011	Apr 2012	Sep 2012	Apr 2013	Sep 2013	Apr 2014
Astatoreochromis	*A. alluaudi*	Kalange-Makwanzi	P	P	P	P	P	P	P	P	P	P	P	P	P	P
		Mid section of the Reservoir														
		Buyala-Kikubamutwe	P	P	P	P	P			P						P
Astatotilapia	*A. brownae*	Kalange-Makwanzi	P	P	P	P	P	P	P	P	P	P	P	P	P	P
		Mid section of the Reservoir										P				P
		Buyala-Kikubamutwe		P	P	P	P	P	P	P	P	P	P	P	P	P
	A. "cylindrical"	Kalange-Makwanzi			P											
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
	A. "elongate"	Kalange-Makwanzi	P	P	P	P	P	P	P							
		Mid section of the Reservoir										P				
		Buyala-Kikubamutwe			P		P			P						
	A. "purple dorsum"	Kalange-Makwanzi		P								P				P
		Mid section of the Reservoir														
		Buyala-Kikubamutwe												P	P	
	A. "red dorsum"	Kalange-Makwanzi				P	P		P		P		P			
		Mid section of the Reservoir														
		Buyala-Kikubamutwe					P	P	P							P
	Astatotilapia sp.	Kalange-Makwanzi			P	P	P			P				P	P	
		Mid section of the Reservoir												P	P	
		Buyala-Kikubamutwe		P	P	P	P				P			P	P	P
Gaurochromis	*Gaurochromis sp*	Kalange-Makwanzi		P												
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
Haplochromis	*H. Iris/ua*	Kalange-Makwanzi									P					
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
Harpagochromis	*H. guiarti*	Kalange-Makwanzi	P	P	P	P	P		P	P	P	P				
		Mid section of the Reservoir														
		Buyala-Kikubamutwe	P		P	P	P		P			P	P			P
	H. serranus	Kalange-Makwanzi														
		Mid section of the Reservoir														
		Buyala-Kikubamutwe	P													
Labrochromis	*L. humilior*	Kalange-Makwanzi		P												
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
Lithochromis	*Lithochromis sp*	Kalange-Makwanzi		P		P	P									
		Mid section of the Reservoir														
		Buyala-Kikubamutwe					P									
Lipochromis	*L. microdon*	Kalange-Makwanzi					P									
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
	L. parvidens	Kalange-Makwanzi			P			P								
		Mid section of the Reservoir														
		Buyala-Kikubamutwe							P			P				
Mbipia	*M. mbipi*	Kalange-Makwanzi	P	P	P	P	P	P	P	P	P	P	P			
		Mid section of the Reservoir										P			P	
		Buyala-Kikubamutwe	P	P	P	P	P	P	P	P	P	P	P		P	P
Neochromis	*N. "elongate"*	Kalange-Makwanzi										P				
		Mid section of the Reservoir														
		Buyala-Kikubamutwe						P								
	N. greenwoodi	Kalange-Makwanzi	P							P						
		Mid section of the Reservoir														
		Buyala-Kikubamutwe		P												
	N. rufocaudalis	Kalange-Makwanzi		P	P	P	P	P	P	P		P				
		Mid section of the Reservoir										P			P	P
		Buyala-Kikubamutwe		P												
Paralabidochro	*P. "black para"*	Kalange-Makwanzi				P			P			P				
		Mid section of the Reservoir														P
		Buyala-Kikubamutwe			P						P					
	P. cyaneus	Kalange-Makwanzi														
		Mid section of the Reservoir														
		Buyala-Kikubamutwe	P													
	P. "earthquake"	Kalange-Makwanzi	P				P			P						
		Mid section of the Reservoir														
		Buyala-Kikubamutwe	P													
	P. flavus	Kalange-Makwanzi														
		Mid section of the Reservoir														
		Buyala-Kikubamutwe					P				P					
	P. rock-kribensis	Kalange-Makwanzi					P				P					
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
	P. "scarlet anal"	Kalange-Makwanzi	P						P	P	P	P				P
		Mid section of the Reservoir														
		Buyala-Kikubamutwe					P									
	P. "yellow"	Kalange-Makwanzi														
		Mid section of the Reservoir														
		Buyala-Kikubamutwe	P													
	Paralabidochromis sp	Kalange-Makwanzi	P													
		Mid section of the Reservoir														P
		Buyala-Kikubamutwe	P	P	P											
Prognathochrom	*P. "shovel mouth"*	Kalange-Makwanzi	P	P			P	P	P	P	P	P				
		Mid section of the Reservoir														
		Buyala-Kikubamutwe				P			P			P	P			
Pseudocrenilabrus	*P. aelocephalus*	Kalange-Makwanzi		P					P							
		Mid section of the Reservoir														
		Buyala-Kikubamutwe		P					P							
	P. ripponianus	Kalange-Makwanzi	P	P	P	P	P		P	P		P	P			
		Mid section of the Reservoir												P		P
		Buyala-Kikubamutwe	P		P		P		P				P	P	P	P
Ptyochromis	*P. sauvagei*	Kalange-Makwanzi	P		P		P			P	P	P				
		Mid section of the Reservoir														
		Buyala-Kikubamutwe	P		P				P					P		
Pundamilia	*P. "black"*	Kalange-Makwanzi		P	P	P	P	P	P	P	P					
		Mid section of the Reservoir														
		Buyala-Kikubamutwe					P	P								
	P. "orange anal"	Kalange-Makwanzi		P												
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
	P. igneopinnis	Kalange-Makwanzi										P				
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
	P. macrocephala	Kalange-Makwanzi										P				
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
	P. "orange tail"	Kalange-Makwanzi		P						P						
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
	P. pundamilia	Kalange-Makwanzi										P				
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
	P. "red tail"	Kalange-Makwanzi	P			P										
		Mid section of the Reservoir														
		Buyala-Kikubamutwe				P										
	Pundamilia sp	Kalange-Makwanzi		P												
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
Xystichromis	*X. phytophagus*	Kalange-Makwanzi	P			P		P	P							
		Mid section of the Reservoir														
		Buyala-Kikubamutwe									P					
Unidentified	Haplochromines	Kalange-Makwanzi				P										
		Mid section of the Reservoir														
		Buyala-Kikubamutwe														
Total Number of Species		Kalange-Makwanzi	15	10	12	14	16	9	14	15	11	14	4	3	3	5
		Mid section of the Reservoir										4		2	3	3
		Buyala-Kikubamutwe	11	8	10	9	12	5	9	3	6	4	8	5	5	8
		Total									14	17	8	6	7	12

3.2.3 Catch rates / biomass estimates

Catch rates (catch/net/night) was used to determine relative abundance of fish species during the monitoring. Catch rates (by numbers) were highest upstream at Buyala(6.8) and lowest in the main reservoir (0.9) fish per net per night (Table 4.1) while by weight, rates were highest at Buyala (199.4g) and lowest at (Kalange) (Table 4.3). Haplochromines recorded the highest catch rates both by numbers (16.5) and weight (299.2g) at Buyala. *S. afrofischeri* recorded the highest rates both by numbers (1.5 and weight (46.3g) at the upstream transects (79.5 fish/net/night and 2668g/net/night). By weight, the elephant snout fish dominated the catch from the main reservoir (80.1g) followed by Nile perch (17.8g) However, in the overall catch rates, haplochromines dominated in numbers (6.2 fish/net/night) and weight (98.5g/net/night).
The catch rates for haplochromines reduced from 18.5 fish/net/night recorded in the previous survey of September 2013 to 6.2 fish /net/night in the survey of April 2014. Catch rates have increased from 8.7 to 18.5 haplochromines per net per night. The overall catch rate by numbers at the upstream transect reduced from 26.9 to 1.5 fish/net/night; 10.2 to 0.9 fish/net/night in the main Reservoir and 16.8 to 6.8fish per net per night at the downstream transect

3.2.4 Fish species recovery

The haplochromines that had been previously disturbed by the changes in their habitats (from lotic to lentic) have started to recover. Species recovery in the main reservoir increased where three haplochromine species were recorded compared to two in April-May, 2013 and to zero (0) in September 2012. These environmental changes are also manifested in numbers and quantities of haplochromines recovered from the upstream transect Kalange where only three haplochromine species were caught compared to 14 in April 2012.

Since the April 2010 survey, the number of species so far recorded has remained at 63 therefore there has been no new species added to the species list. The resurgence of the haplochromines in the main reservoir has been noted. All keystone fish species expected at these transects have been recovered. Further colonisation of this reservoir by new species is to be monitored.

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Table 3.4.3 *Catch rates (numbers) of fish species caught over time by gillnets at the upstream (Kalange-Makwanzi), mid of the reservoir and downstream (Buyala-Kikubamutwe) transects*

Family name	Scientific Species name	English names/local names (Luganda)	Site	Monitoring dates													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012	Apr. 2013	Sep. 2013	Apr. 2014
Bagridae	*Bagrus docmak*	Catfish/(Semutundu)	Kalange-Makwanzi		0.03			0.08									
			Mid section of the Reservoir										0.03	0.1	0.38	0.4	0.1
			Buyala-Kikubamutwe		0.07		0.04								0.08	0.1	
Centropomidae	*Lates niloticus*	Nile perch/Mputa	Kalange-Makwanzi	0.19	3.1	3.32	2.3	9.76	0.32	0.58	1.13	0.15	2.83	0.5	1.62	0.7	0.1
			Mid section of the Reservoir										3.06	0.7	1.08	4.2	0.3
			Buyala-Kikubamutwe	1.12	1.68	1.86	2.29	2.57	0.35	0.4	0.16	0.72	0.83	0.2	0.85	1.5	0.6
Characidae	*Brycinus jacksonii*	(Nsoga)	Kalange-Makwanzi														
			Mid section of the Reservoir														
			Buyala-Kikubamutwe	0.04													
	B. sadleri	(Nsoga)	Kalange-Makwanzi	0.04													
			Mid section of the Reservoir														
			Buyala-Kikubamutwe														
Cichlidae	*Oreochromis niloticus*	Nile tilapia/(Ngege -kibati)	Kalange-Makwanzi	0.04	0.33	0.1		0.2			0.01	0.01	0.02				
			Mid section of the Reservoir												0.08		
			Buyala-Kikubamutwe	0.07	0.41	0.04	0.04	0.1		0.1			0.19	0.04	0.38	0.2	0.3
	O. leucostictus	Black tilapia/(Ngege)	Kalange-Makwanzi	0.04	0.09												
			Mid section of the Reservoir														
			Buyala-Kikubamutwe	0.06	0.08												
	O. variabilis	Tilapia/(Ngege)	Kalange-Makwanzi	0.17	0.91	0.43	0.45	1.52	0.06	0.17	0.19		0.09	0.04	0.31	0.2	
			Mid section of the Reservoir										0.03				0.01
			Buyala-Kikubamutwe	0.13	0.08		0.17			0.02	0.02	0.03	0.03				
	Tilapia zillii	Red-belly tilapia/(Ngege)	Kalange-Makwanzi	0.1	0.17	0.17		0.17	0.04	0.1	0.13		0.09	0.09	0.13	0.1	
			Mid section of the Reservoir										0.05	0.05	0.25	0.5	
			Buyala-Kikubamutwe	0.88	0.46	0.04	0.43	0.1		0.04			0.16	0.16			1
	Haplochromines	(Nkejje)	Kalange-Makwanzi	9	10.46	6.63	19.04	15.5	5.83	4.5	12.7	10.6	11.1	0.4	11.8	2.5	
			Mid section of the Reservoir										0.25		0.5	5.8	
			Buyala-Kikubamutwe	16.83	4.27	6.36	8.32	6.47	0.78	1.62	2.05	1.36	6.13	2.3	13.8	47.2	
Clariidae	*Clarias gariepinus*	Mudfish/ (Male)	Kalange-Makwanzi			0.03	0.17							0.01	0.08		
			Mid section of the Reservoir										0.02	0.03			
			Buyala-Kikubamutwe	0.01		0.25	0.07		0.03			0.02				0.1	
Cyprinidae	*Barbus altianalis*	Barbel fish/ (Kisinja)	Kalange-Makwanzi	0.02	0.1	0.17	0.03		0.01				0.02				
			Mid section of the Reservoir										0.06	0.1	0.38		
			Buyala-Kikubamutwe	0.1	0.11	0.04	0.04		0.01	0.01		0.02	0.02		0.15		0.01
	Barbus paludinosus	Barbel fish/ (Kisinja)	Kalange-Makwanzi														
			Mid section of the Reservoir														
			Buyala-Kikubamutwe	0.04													
	Labeo victorianus	(Ningu)	Kalange-Makwanzi														
			Mid section of the Reservoir														
			Buyala-Kikubamutwe		0.09					0.02							
Lepidosirenidae	*Protopterus aethiopicus*	Lung fish (Mamba)	Kalange-Makwanzi						0.01								
			Mid section of the Reservoir														
			Buyala-Kikubamutwe				0.04										
Mochokidae	*Synodontis afrofischeri*	Tiger fish (Nkolongo)	Kalange-Makwanzi	0.21	0.63	0.08	0.42	1.46	0.46	0.33	0.13	0.38	4.75	1.8	53.8	79.5	1.5
			Mid section of the Reservoir										0.75		1.5	1.5	
			Buyala-Kikubamutwe		0.27	1.09	0.37	3.58	0.28	0.1		1.07	0.06	3.7	2.5	0.5	0.1
	S. victoriae	Tiger fish (Nkolongo)	Kalange-Makwanzi			0.08		0.21	0.29		0.17			0.1	3.25	1.3	0.1
			Mid section of the Reservoir										0.05	0.04		1.8	
			Buyala-Kikubamutwe											0.1			
Mormyridae	*Gnathonemus longibarb*	Kasulubana	Kalange-Makwanzi														
			Mid section of the Reservoir											0.04			0.1
			Buyala-Kikubamutwe														
	Mormyrus kannume	Elephant snout fish (Kasulubana)	Kalange-Makwanzi	0.32	0.8	1.83	0.7	0.08	0.23	0.18	0.22	0.04	0.33	0.1	0.46	0.5	0.01
			Mid section of the Reservoir										0.82	0.9	1.46	2.7	0.3
			Buyala-Kikubamutwe	0.68	0.86	2.25	0.39	0.38	0.15	0.25	0.18	0.17	0.02	0.1	0.15		
OVERALL RATES			Kalange-Makwanzi	2.89	5.48	4.39	7.54	10.01	2.87	2.41	4.54	3.36	8.2	1.3	23.6	26.9	1.5
			Mid section of the Reservoir										4.4	1.8	4.2	10.2	0.9
			Buyala-Kikubamutwe	6.45	3.28	3.91	3.71	4.28	0.81	1.21	0.95	1.5	3.1	2.3	6.6	16.8	6.8

Table 3.4.4 *Catch rates (weight (g) of fish species caught over time by gillnets at the Upstream,Kalange – Makwanzi; mid of the reservoir and downstream, Buyala-Kikubamutwe*

Family name	Scientific Species name	English names/local names (Luganda)	Site	Monitoring dates													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012	Apr. 2013	Sep. 2013	Apr. 2014
Bagridae	*Bagrus docmak*	Catfish/(Semutundu)	Kalange-Makwanzi		37.53			28.58									
			Mid section of the Reservoir										14.1	27.7	835	136	
			Buyala-Kikubamutwe		22.50		0.6.93								13.8	19.1	4
Centropomidae	*Lates niloticus*	Nile perch/Mputa	Kalange-Makwanzi	15.75	271.27	371.00	114.13	250.84	49.44	35.86	11.6	8.6	156	63.3	141	77.7	9.3
			Mid section of the Reservoir										198	140	532	538	17.8
			Buyala-Kikubamutwe	108.21	107.79	159.07	111.00	171.43	28.81	39.28	16.4	44.5	30.2	18	36.8	94.8	22.7
Characidae	*Brycinus jacksonii*	(Nsoga)	Kalange-Makwanzi														
			Mid section of the Reservoir														
			Buyala-Kikubamutwe	3.25													
	B. sadleri	(Nsoga)	Kalange-Makwanzi	0.75													
			Mid section of the Reservoir														
			Buyala-Kikubamutwe														
Cichlidae	*Oreochromis niloticus*	Nile tilapia/(Ngege -kibati)	Kalange-Makwanzi	1.80	7.42	28.93		20.08			0.5	6.7	1.2				
			Mid section of the Reservoir												9.2		
			Buyala-Kikubamutwe	4.53	0.18	3.93	0.93	5.05		0.83			5.8	1.7	205	7.4	29.9
	O. leucostictus	Black tilapia/(Ngege)	Kalange-Makwanzi	3.67	6.61												
			Mid section of the Reservoir														
			Buyala-Kikubamutwe	5.75	6.75												
	O. variabilis	Tilapia/(Ngege)	Kalange-Makwanzi	33.54	49.04	63.30	44.73	82.76	14.87	19.54	26.1		18.4	8.7	122		
			Mid section of the Reservoir										1.7				5.4
			Buyala-Kikubamutwe	11.58	12.08		8.17			4.04	11.5	13.6	8.1				20.3
	Tilapia zillii	Red-belly tilapia/(Ngege)	Kalange-Makwanzi	6.92	15.65	21.65		7.92	7.71	32.17	21		10.1	2.8	18.8		
			Mid section of the Reservoir										7.2		21.3	10.5	
			Buyala-Kikubamutwe	81.85	19.08	7.33	42.26	7.90		2.71			6.1	2.1		32	38.9
	Haplochromines	(Nkejje)	Kalange-Makwanzi	303.92	191.92	168.08	534.33	383.24	167.67	113.11	160	246	168	8.5	219	33.8	15.5
			Mid section of the Reservoir										4.1		22.5	113	113
			Buyala-Kikubamutwe	284.88	51.27	206.00	187.05	167.90	15.78	40.38	37.7	15.3	86.9	32.3	226	697	299
Clariidae	*Clarias gariepinus*	Mudfish/ (Male)	Kalange-Makwanzi			6.27	69.33							8.9	100		
			Mid section of the Reservoir										9.4	48.7			
			Buyala-Kikubamutwe	9.20		52.93	89.36		33.58			3.1				139	
Cyprinidae	*Barbus altianalis*	Barbel fish/ (Kisinja)	Kalange-Makwanzi	19.27	403.33	501.13	7.27		2.31				0.6				
			Mid section of the Reservoir										51.3	199	266		
			Buyala-Kikubamutwe	48.88	22.93	95.57	9.36		4.03	5.73		12.8	0.3		408		8.2
	Barbus paludinosus	Barbel fish/ (Kisinja)	Kalange-Makwanzi														
			Mid section of the Reservoir														
			Buyala-Kikubamutwe	0.50													
	Labeo victorianus	(Ningu)	Kalange-Makwanzi														
			Mid section of the Reservoir														
			Buyala-Kikubamutwe		38.91					14.80							
Lepidosirenidae	*Protopterus aethiopicus*	Lung fish (Mamba)	Kalange-Makwanzi						15.92								
			Mid section of the Reservoir														
			Buyala-Kikubamutwe				26.21										
Mochokidae	*Synodontis afrofischeri*	Tiger fish (Nkolongo)	Kalange-Makwanzi	10.92	49.50	4.58	14.92	56.79	59.63	18.75	7.2	28.8	61.1	64.2	1543	2668	46.3
			Mid section of the Reservoir										15.6		62.5	61	
			Buyala-Kikubamutwe		19.09	30.64	10.42	111.58	12.89	2.38		17.4	1.3	87.3	45	18	3.8
	S. victoriae	Tiger fish (Nkolongo)	Kalange-Makwanzi			12.50		17.92	39.33		28.1			7.3	278	108	5.2
			Mid section of the Reservoir										6.8	3.6		236	
			Buyala-Kikubamutwe											9.6			
Mormyridae	*Gnathonemus longibarbis*	Elephant snout fish (Kasulubana)	Kalange-Makwanzi														
			Mid section of the Reservoir														8
			Buyala-Kikubamutwe														
	Mormyrus kannume	Elephant snout fish (Kasulubana)	Kalange-Makwanzi	110.16	250.47	511.47	95.75	14.72	49.01	77.49	39.7	7.5	44.5	27.7	114	57.6	9.5
			Mid section of the Reservoir										158	156	238	643	80.1
			Buyala-Kikubamutwe	217.37	89.54	175.64	185.00	51.62	9.22	33.36	15.6	15.9	1.3	7.8	209		
OVERALL RATES			Kalange-Makwanzi	242.00	473.90	635.87	299.47	296.77	212.59	185.74	141	102	290	132	1116	1076	55.3
			Mid section of the Reservoir										443	573	1920	1449	115
			Buyala-Kikubamutwe	502.77	137.22	257.05	241.69	170.83	82.81	104.11	49.9	102	73	68.6	955	499	200

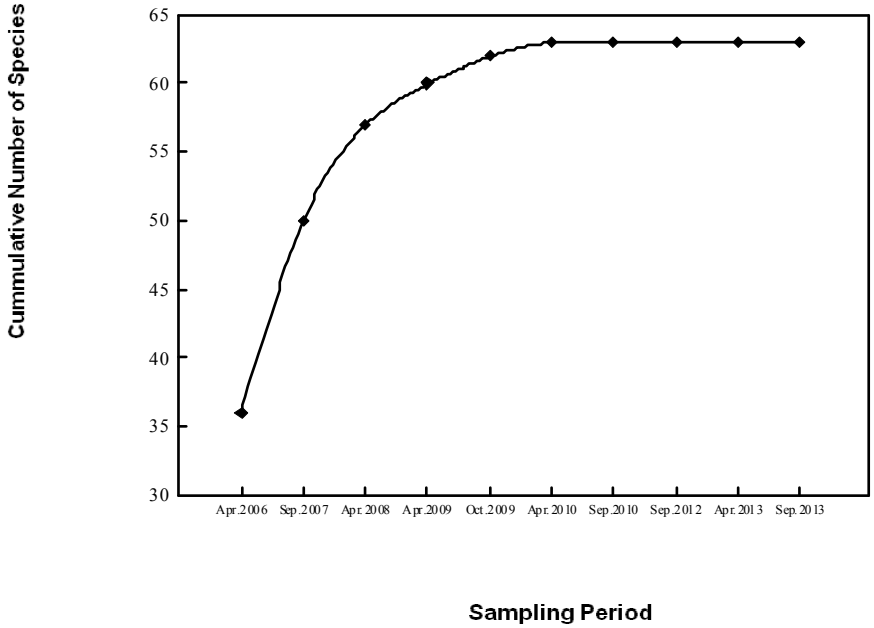

Figure 3.4.1 Cumulative *number of fish species recovered from the study transects on the Upper Victoria Nile between April 2006 and April 2014.*

3.5 The Food and Trophic Ecology of the Fishes

In the survey of April 2014, fish (99.9%) dominated by haplochromine cichlids (78.6%) was the main prey of *L. niloticus* in Kalange-Makwanzi transect. The other prey item included chironomids (0.1%). Dominance of fish prey especially the haplochromines was also observed in the survey of September 2013 (Table 3.5.1).

In Buyala-Kikubamutwe transect, the diet of Nile perch during the survey of April 2014 comprised mostly of fish (92.8%). The fish prey included Haplochromines (62.3%), *Rastrineobola argentea* (Mukene) (1.1%) and unidentifiable fish material (29.4%). The non-fish prey included Caridina (2.6%), Odonata (2.6%) and unidentifiable insect material (1.9%). The dominance of fish, especially the haplochromines in this transect, was also observed in the previous surveys of September 2013.

In the mid-reservoir, *Caridina* was the main prey (70.4%) for Nile perch during the survey of April 2014. Other food items included Nile perch (3.7%), *Mukene* (3.7%, ostracods (14.3%) unidentifiable insect material (7.4%). Dominance of *Caridina* in the diet of *L. niloticus* in the mid-reservoir was also observed in the previous survey of September 2013. However in the survey of April 2013, Mukene dominated the diet of Nile perch in the mid-reservoir.

In the survey of April 2014, *Oreochromis variabilis* was recorded from all the three transects. In Kalange-Makwanzi, the diet of the species comprised of Algae (65.4), insects (detritus (14.0%), insects (11.1%), zooplankton (8.0%) and water plants (1.5%).

The algae included blue-green algae (46.6%), diatoms (11.5%) and green algae while the insect prey included Odonata (9.5%), Ephemeroptera,(0.2%), chironomids (0.4%) and unidentifiable insect material. However, in the survey of September 2013, the diet of *O. variabilis* in the same transect was dominated by detritus. In April 2013, blue green algae were the dominant food item.

In Buyala-Kikubamutwe, O. *variabilis* had ingested algae (65%) and detritus (30%), water plants (3%) and unidentifiable insect material (2%). The algae comprised of blue-green algae (50%), diatoms (8%) and green algae (7%).

In the mid-Reservoir, algae (77%), detritus (20%) and water plants (3%) were the food items identified from the guts of *O. variabilis* examined in the survey of April 2014. The algae included blue-green algae (55%), diatoms (15%) and green algae (7%)

In April 2014, *Oreochromis niloticus* was recorded from Kalange-Makwanzi and Buyala-Kikubamutwe. In Kalange-Makwanzi, the diet of *O. niloticus* was composed of water plants (37.5%) detritus (28.8%), algae (16.3%) and insects (17.5%). The algae comprised of blue-green algae (11.8%), diatoms (3.8%) and green algae (0.8%) while the insect prey included Ephemeroptera (15%) and unidentifiable insect material (2.5%).

In Buyala-Kikubamutwe, the diet of *O. niloticus* comprised of algae (78.2%), detritus (16.6%) aquatic plants (5%) and unidentifiable insect material (0.1%). However, in the previous survey of September 2013, the diet was dominated by aquatic plants while, in the survey of April 2013, *O. niloticus* from the same transect had ingested mostly insects dominated by Ephemeroptera nymphs. The variation in the diet of *O. niloticus* is attributed to seasonal differences in the availability of the food items of the species

During the survey of April 2014, *M. kannume* was only recorded from Kalange-Makwanzi and the mid-reservoir. In Kalange-Makwanzi, the species had ingested only chironomids while in the mid-reservoir, the diet was comprised of insects (89.1%), Caridina (10.6%) and molluscs (0.3%). The insect prey included chironomids (44%), Ephemeroptera (13%), Odonata (5.1%) and unidentifiable insect materials (27%). The dominance of insects in the diet of *M. kannume* in these transects was also observed in the previous survey of September and April 2013,

In April 2014 survey *Synodontis afrofischeri* was only recorded from Kalange-Makwanzi and Buyala-Kikubamutwe. In Kalange-Makwanzi, the diet of the species comprised of insects (63.6%) and molluscs (36.4%). The insect prey included chironomids (40.9%) and unidentifiable insect material (22.7%).

In Buyala-Kikubamutwe, insects (97.1%) and molluscs (2.9%) were the food items recorded from the guts of *S. afrofischeri* in April 2014. Dominance of insects in the diet of the species was also observed in the previous surveys of September 2013 and April 2013 in the two transects (Table 3.5.1).

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Table 3.5.1 *Dominant food types of common fish species caught over time at the upstream (Kalange - Makwanzi), mid of the reservoir and downstream (Buyala-Kikubamutwe) Transects*

Family name	Secientific Species name	English/local (Luganda) name	Site	Monitoring dates													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012	Apr. 2013	Sep. 2013	Apr. 2014
Bagridae	*Bagrus docmac*	Semutundu	Kalange-Makwanzi (upstream of the reservoir)										FR		E	E	
			Mid section of the Reservoir										SYN	CAR	SYN	CAR	FR
			Buyala-Kikubamutwe (downstream)													FR	
Centropomidae	*Lates niloticus*	Nile perch/ (Mputa)	Kalange-Makwanzi (upstream of the reservoir)	FR	HAP	HAP	HAP	FR	HAP	HAP	HAP	HAP	HAP	ODT	LN	HAP	HAP
			Mid section of the Reservoir										RAS	CAR	RAS	CAR	CAR
			Buyala-Kikubamutwe (downstream)	FR	CAR	FR	CAR	ODT	RAS	RAS	CHR	HAP	FR	CRB	HAP	HAP	HAP
Cichlidae	*Oreochromis niloticus*	Nile tilapia/ (Ngege-Kibati)	Kalange-Makwanzi (upstream of the reservoir)	E	HPM	BGA	HPM	E	E	DTR	IR	DETR	MOL				HPM
			Mid section of the Reservoir												CHAO		
			Buyala-Kikubamutwe (downstream)	E				E	DTR	E	DETR		INS	EPH	EPH	HPM	BGA
	O. variabilis	(Ngege)	Kalange-Makwanzi (upstream of the reservoir)	BGA	GRA	BGA	HPM	GRA	BGA	BGA	BGA	EPH	BGA	BGA	BGA	DETR	BGA
			Mid section of the Reservoir														BGA
			Buyala-Kikubamutwe (downstream)	BGA	E		HPM				E	E	BGA				BGA
	Tilapia zillii	Red-belly tilapia /(Ngege)	Kalange-Makwanzi (upstream of the reservoir)	MOL	HPM	E		E	IR	HPM	IR		EPH	E	HPM		ODT
			Mid section of the Reservoir										INS		E	E	
			Buyala-Kikubamutwe (downstream)	HPM	CAR	E	HPM	E	HPM	HPM			EPH	HPM		HPM	HPM
Clariidae	*Clarias gariepinus*	Mudfish/(Male)	Kalange-Makwanzi (upstream of the reservoir)			FR	FR				EPH			E	MOL	MOL	
			Mid section of the Reservoir										EPH	EPH			
			Buyala-Kikubamutwe (downstream)			HAP	EPH		E			CHR				EPH	
Cyprinidae	*Barbus altianalis*	Barbelfish/(Kisinja)	Kalange-Makwanzi (upstream of the reservoir)	E	INS	INS	INS		MOL	E	IR	CHR	DETR				
			Mid section of the Reservoir										INS	MOL	MOL		
			Buyala-Kikubamutwe (downstream)	E	INS	INS			E	MOL		CHR			MOL		E
Mochokidae	*Synodontis afrofischeri*	Tigerfish/(Nkolongo)	Kalange-Makwanzi (upstream of the reservoir)	CHR	EPH		CAR	CHR	EPH	CHR	EPH	INS	MOL	EPH	EPH	CHR	CHR
			Mid section of the Reservoir										INS		CHR	EPH	
			Buyala-Kikubamutwe (downstream)		CHR	CHR	INS	CHR	INS	CHR		INS		EPH	INS	EPH	CHR
Mormyridae	*Mormyrus kannume*	Elephant Snoutfish/(Kasulubana)	Kalange-Makwanzi (upstream of the reservoir)	INS	EPH	EPH	INS	EPH	EPH	EPH		CHR	EPH	CHR		EPH	CHR
			Mid section of the Reservoir										EPH	EPH		EPH	CHR
			Buyala-Kikubamutwe (downstream)	INS	EPH	INS	EPH	CHR	CHR	INS	EPH	INS	E	ODT			

Food types: *HAP = Haplochromines, FR = Unidentifiable fish remains, CAR = Caridina nilotica, MOL = Mollusk, BGA = Blue-green algae, GRA = Green algae, EPH = Ephemeroptera, INS = Unidentifiable insect material, HPM = High plant material (water weeds), E = Empty stomachs, ODT = Odonata*

3.3.1 Maturity and Breeding

During the survey of April 2014, the highest intensity of fish breeding was recorded from Kalange-Makwanzi (6 out of 7 species) followed by Buyala-Kikubamutwe (4 out of 6 species) and the mid-reservoir (1 out of 4 species). In Kalange-Makwanzi, breeding activity was recorded in *T. zillii* (57.1%), *S. afrofischeri* (54.8%), *O. variabilis* (46.2%), *M. kannume* (25%), *Synodontis victoriae* (25%) and *O. niloticus* (6.7%). In Buyala-Kikubamutwe, breeding intensity was highest in *S. afrofischeri* (16.7%), followed by *O. variabilis* (11.1%), *O. niloticus* (10.5%) and *T. Zillii* (6.1%). In the mid-reservoir, breeding was only recorded in *M. kannume* (61.9%). The higher fish breeding intensity in Kalange-Makwanzi was also observed in September 2013; an indication that the area could be a breeding ground (Table 3.5.2)

All the specimens of *Lates niloticus* examined, both from the experimental and commercial catches were immature.

Table 3.5.2 *Proportion (%) of breeding fishes over time among commonly encountered fish species at the upstream (Kalange-Makwanzi), mid of the reservoir and downstream (Buyala-Kikubamutwe) Transects*

Family name	Secientific Species name	English/local (Luganda) name	Site	Monitoring dates													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012	Apr. 2013	Sep. 2013	Apr. 2014
Bagridae	*Bagrus docmac*	Semutundu	Kalange-Makwanzi (upstream of the reservoir)										FR		E	E	
			Mid section of the Reservoir										SYN	CAR	SYN	CAR	FR
			Buyala-Kikubamutwe (downstream)													FR	
Centropomidae	*Lates niloticus*	Nile perch/ (Mputa)	Kalange-Makwanzi (upstream of the reservoir)	FR	HAP	HAP	HAP	FR	HAP	HAP	HAP	HAP	HAP	ODT	LN	HAP	HAP
			Mid section of the Reservoir										RAS	CAR	RAS	CAR	CAR
			Buyala-Kikubamutwe (downstream)	FR	CAR	FR	CAR	ODT	RAS	RAS	CHR	HAP	FR	CRB	HAP	HAP	HAP
Cichlidae	*Oreochromis niloticus*	Nile tilapia/ (Ngege-Kibati)	Kalange-Makwanzi (upstream of the reservoir)	E	HPM	BGA	HPM	E	E	DTR	IR	DETR	MOL				HPM
			Mid section of the Reservoir												CHAO		
			Buyala-Kikubamutwe (downstream)	E				E	DTR	E	DETR		INS	EPH	EPH	HPM	BGA
	O. variabilis	(Ngege)	Kalange-Makwanzi (upstream of the reservoir)	BGA	GRA	BGA	HPM	GRA	BGA	BGA	BGA	EPH	BGA	BGA	BGA	DETR	BGA
			Mid section of the Reservoir														BGA
			Buyala-Kikubamutwe (downstream)	BGA	E		HPM				E	E	BGA				BGA
	Tilapia zillii	Red-belly tilapia /(Ngege)	Kalange-Makwanzi (upstream of the reservoir)	MOL	HPM	E		E	IR	HPM	IR		EPH	E	HPM		ODT
			Mid section of the Reservoir										INS		E	E	
			Buyala-Kikubamutwe (downstream)	HPM	CAR	E	HPM	E	HPM	HPM			EPH	HPM		HPM	HPM
Clariidae	*Clarias gariepinus*	Mudfish/(Male)	Kalange-Makwanzi (upstream of the reservoir)			FR	FR				EPH			E	MOL	MOL	
			Mid section of the Reservoir										EPH	EPH			
			Buyala-Kikubamutwe (downstream)			HAP	EPH		E			CHR				EPH	
Cyprinidae	*Barbus altianalis*	Barbelfish/(Kisinja)	Kalange-Makwanzi (upstream of the reservoir)	E	INS	INS	INS		MOL	E	IR	CHR	DETR				
			Mid section of the Reservoir										INS	MOL	MOL		
			Buyala-Kikubamutwe (downstream)	E	INS	INS			E	MOL		CHR			MOL		E
Mochokidae	*Synodontis afrofischeri*	Tigerfish/(Nkolongo)	Kalange-Makwanzi (upstream of the reservoir)	CHR	EPH		CAR	CHR	EPH	CHR	EPH	INS	MOL	EPH	EPH	CHR	CHR
			Mid section of the Reservoir										INS		CHR	EPH	
			Buyala-Kikubamutwe (downstream)		CHR	CHR	INS	CHR	INS	CHR		INS		EPH	INS	EPH	CHR
Mormyridae	*Mormyrus kannume*	Elephant Snoutfish/(Kasulubana)	Kalange-Makwanzi (upstream of the reservoir)	INS	EPH	EPH	INS	EPH	EPH	EPH		CHR	EPH	CHR		EPH	CHR
			Mid section of the Reservoir										EPH	EPH		EPH	CHR
			Buyala-Kikubamutwe (downstream)	INS	EPH	INS	EPH	CHR	CHR	INS	EPH	INS	E	ODT			

3.6. THE COMMERCIAL FISHERY

3.6.1 Fishing effort in the fishery

Fishing is an important socio-economic activity of communities riparian to the River Nile system. However, (Gup, 1994) describes damming and the associated hydropower development projects as cataclysmic events in the life history of a river ecosystem because the flow of water, sediments, nutrients, energy and biota may be altered; hence modifying the ecological functioning processes of a river system. Dam construction on the river may have environmental concerns arising from alterations that need mitigation measures to ensure proper river ecosystem functioning and prevent loss of aquatic biota, particularly fish. Few tolerant fish species may be able to survive in altered or stressed environments/habitats. The effects of Dam construction on downstream areas and flood plains, particularly on the biological and human subsystems have been described by authors such as Saha, 1981; Scudder,1973,1980; Davies, 1979 on River Zambezi; William and Howard, 1977 on River Kafue in Zambia; Hughes 1983, 1984 on River Tana in Kenya; Watti, 1981 on River Senegal.

Trends in stocks and yield of natural fish populations have been assessed by estimating variations in fishing effort and catchability coefficients, a measure of fishing mortality (Arreguín-Sánchez, 1996). These trends in fishing effort and catches have been assessed on the upper Victoria Nile before, during and after Bujagali dam construction project. In similar studies, Tolmazin (1979) attributed reduced fish yields in the Black Sea and the Sea of Azov to impoundments on the Danube, Dnieper, and Dniester rivers in Europe. Therefore, fishery yield is useful in guiding formulation of sustainable management advice alongside development projects like dam construction.

Since September 2012, the numbers of fishing boats have gradually increased at Kalange-Makwanzi and mid reservoir sites. Surveys between April 2009 and April 2012 experienced a fluctuation in the overall number of fishing boats across all the three sites rose from 30 to 65 boats. During the April 2014 survey, the number of fishing boats (Table 3.6.1) at Kalange-Makwanzi and mid reservoir increased from… in the previous survey to. 27 and from ….to 44 boats respectively. At Buyala-Kikubamutwe, the boats (20) declined by 50%. The increase in numbers of fishing boats at Kalange-Makwanzi and mid reservoir sites may be attributed to the improved catches that are synonymous with the rainy periods and probably the lake-like conditions of the two sites where water is no-longer fast flowing as is the case with the downstream site at Buyala-Kikubamutwe. Fishers always tend to migrate from one station to another in search for better catches and whenever catches increase; there is always an influx of fishers into the fishing enterprise. At the worst scenario however, fishers will respond to bad fishing seasons (low catches) by withdrawing their boats and fishing inputs from the waters and this has been evidenced in the previous surveys. Evidence from earlier studies in other parts of the world (Fry, 1965), shows that the downstream sites (tail waters) fisheries below the Table Rock and Taneycomo dams on the White River (Missouri, USA) and Clearwater Dam on the Black River (Missouri, USA) registered more fishing effort per unit area as it has always been case with the downstream site (Buyala-Kikubamutwe) except in the current

survey where the number of boats recorded were exactly a half the highest number of fishing boats ever recorded (September, 2013). Despite this scenario experienced in April 2014, (Jackson 1985) suggests that dams can enhance some riverine fisheries particularly with respect to tail waters (downstream) where fishes tend to concentrate as a result of the attractive foraging opportunities there, as well as seasonal congregations of migratory fishes.

Gillnets remained the commonest fishing gears at Kalange-Makwanzi and mid reservoir sites, registering 20 and 15 boats respectively during this survey. Buyala-Kikubamutwe site, only one boat had gillnets (Table 3.6.1). During this April 2014 survey, boats with handline hooks were 16 in the mid reservoir, 5 at Buyala-Kikubamutwe and 1 at Kalange-Makwanzi. Unlike in the previous surveys, 8 boats had longline hooks and 2 boats had cast nets, all of them recorded at Kalange-Makwanzi. As in the previous survey, eight boats had scoop nets were at the mid reservoir. At Kalange-Makwanzi site, small seines were used to harvest *Rastrineobola argentia* (Mukene).

In the September 2013 and current surveys, basket traps remained restricted only to Buyala-Kikubamutwe transect. 14 of the 20 boats recorded at this site had basket traps targeting mainly *Mormyrus kannume* which is marketed and used as live bait for the Nile perch, *Clarias gariepinus* and *Protopterus aethiopicus* on other water systems like lakes Victoria and Kyoga. However, the number of boats using basket traps dropped by 53.3% from the September, 2013 survey (Table 3.6.1).

The highest number of gillnets (118), were recorded in the mid reservoir, 57 at Kalange-Makwanzi and 10 at Buyala-Kikubamutwe. Overall, the number of gillnets arose by 55.7% increase from the previous September 2013 survey. The highest increase was observed at the mid reservoir transect i.e. a 72% increase from the September 2013. at Buyala-Kikubamutwe transect, a 20% decrease was recorded– down from 12 to 10 gillnets (Table 6.4.1). The mesh sizes of gillnets used ranged between 2'' and 5''. The 4'' mesh size was the most dominant (77.3%) of all gillnets.

As recorded in the previous surveys, the upstream transect registered the highest number of long line hooks (1360), representing an increase of 36.8% from 860 in the September 2013 survey. There were no long line hooks encountered at both the Reservoir and the Downstream transects. Unlike in the long line hook fishery, hand line hooks were highest (69) representing 90.8% up from zero in the previous survey at the Reservoir, followed by the Downstream transect (five hooks- remained stable) representing 6.6% and then the Upstream station that showed a very big decline from 26 hooks in September 2013 to two hooks (2.6%) in the April 2014 survey.

Although illegal, monofilament gillnets were recorded at all the three sites. During this survey, 460 basket traps at Buyala-Kikubamutwe were recorded. They were 461 in the September 2013 survey (Table 3.6.1). The relative stable numbers of basket traps used at the downstream transect is attributed to the high catch per unit of effort for those gears targeting the species and the improved prices for the species. The high demand for bait to support exploitation of other fisheries (*Lates niloticus*, *Protopterus aethiopicus* and

Clarias gariepinus) on lakes Victoria and Kyoga is probably the major factor contributing to this. The main question that however remains unanswered is the sustainability of *Mormyrus kannume* fishery as bait, given that the fishers target the young and smaller sizes of this species.

Fishermen shift between fishing gears in response to seasonal variations in catches of the target species. Thus, fishers can use a particular fishing gear when catches of the target species is high and can abandon it when catches go down. According to Hovgard and Lassen, 2000, the type of fishing gear used by fishermen at a particular fishing ground is influenced by the target fish species, the cost of fishing unit, the catch per unit of effort (CPUE), the habitat and the suitability of the gear with respect to that particular site.

Table 3.6.1. *The trend in numbers of fishing boats and fishing gears, upstream at Kalange-Makwanzi, mid-section of the reservoir and downstream at Buyala-Kikubamutwe*.

Number of common gears in use	Transect	Monitoring dates													
		Apr-06	Sep-07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14
Number of fishing boats	Kalange-Makwanzi	9	10	7	22	18	23	23	18	32	15	20	19	24	27
	Mid section of the Reservoir										16	13	18	27	44
	Buyala-Kikubamutwe	13	17	23	26	32	23	15	12	15	34	19	28	40	20
Number of boats using gillnets	Kalange-Makwanzi		9	7	10	6	7	13	6	8	9	9	7	12	15
	Mid section of the Reservoir										13	3	4	12	20
	Buyala-Kikubamutwe		7	18	7	6	1	2		1	4	2	7	3	1
Number of boats using long line hooks	Kalange-Makwanzi		1	2	3	1	2	2	0	2	1	4	6	5	8
	Mid section of the Reservoir										1	0	0	5	
	Buyala-Kikubamutwe		10	8	6	6	13	6	3	7	10	7	0	5	
Number of boats using cast nets	Kalange-Makwanzi					5	4	1	1	5	1	0	3	3	2
	Mid section of the Reservoir										0	0	0	2	
	Buyala-Kikubamutwe			1	6	3	1	1	3	0	7	2	0	2	
Number of boats using Hand line hooks	Kalange-Makwanzi			7	9	5	4	2	6	8	3	3	1	3	1
	Mid section of the Reservoir										1	7	3	0	16
	Buyala-Kikubamutwe			15	9	14	9	2	2	3	12	5	2	5	5
Number of boats using traps	Kalange-Makwanzi														
	Mid section of the Reservoir														
	Buyala-Kikubamutwe												20	30	14
Number of boats using scoop nets	Kalange-Makwanzi					1	6	4	4	4	1	2	3	2	
	Mid section of the Reservoir										6	3	12	8	8
	Buyala-Kikubamutwe			2	1	1		1	2	1	1	0	0		
Number of fishing gears by mesh size															
Gillnets - ≤2½"	Kalange-Makwanzi		3			1			4		2	0	0	1	11
	Mid section of the Reservoir										0	0	0		8
	Buyala-Kikubamutwe			1		10		2			0	0	12		
Gillnets 3"	Kalange-Makwanzi					3	1	6			8	0	0	10	4
	Mid section of the Reservoir										0	4	0	16	5
	Buyala-Kikubamutwe			1	4			9			10	0	0	0	0
Gillnets 3½"	Kalange-Makwanzi		3			1	1	4		5	16	0	0	0	1
	Mid section of the Reservoir										0	3	0	12	7
	Buyala-Kikubamutwe			25							3	11	3	0	0
Gillnets 4"	Kalange-Makwanzi		30		21	8	2	26	20	20	10	0	0	18	35
	Mid section of the Reservoir										0	0	0	5	98
	Buyala-Kikubamutwe		20	4			1			13	0	0	0	0	10
Gillnets 4½"	Kalange-Makwanzi			21	5			2	2	12	4	0	0	0	3
	Mid section of the Reservoir										0	0	0	0	0
	Buyala-Kikubamutwe		3	12		6	1				0	0	0	12	
Gillnets 5"	Kalange-Makwanzi		2	25	12	1					1	0	0	0	3
	Mid section of the Reservoir										14	0	0	0	0
	Buyala-Kikubamutwe		5	47						5	0	0	0	0	0
Gillnets 5½"	Kalange-Makwanzi											0	0	0	0
	Mid section of the Reservoir											0	0	0	0
	Buyala-Kikubamutwe											0	0	0	0
Gillnets 6"	Kalange-Makwanzi							4		8		2	2	8	0
	Mid section of the Reservoir										22	0	0	0	0
	Buyala-Kikubamutwe			5	18	15						0	9	0	0
Total gillnets	Kalange-Makwanzi		38	46	38	20	24	42	28	43	41	2	8	37	57
	Mid section of the Reservoir										36	7	0	33	118
	Buyala-Kikubamutwe		28	99	22	37	4	11		18	13	11	24	12	10
Long line hooks	Kalange-Makwanzi		300	330	550	200	650	280		500	70	800	687	860	1360
	Mid section of the Reservoir										50	0	0	70	
	Buyala-Kikubamutwe		510	445	277	180	380	142	110	482	525	420	0		
Beach seines	Kalange-Makwanzi														
	Mid section of the Reservoir														
	Buyala-Kikubamutwe			1											
Cast nets	Kalange-Makwanzi					5	4	1	1	5	1	0		3	2
	Mid section of the Reservoir										0	0		2	
	Buyala-Kikubamutwe			1	6	3	1	1	3		7	2		2	
Hand line hooks	Kalange-Makwanzi			91	105	124	26	3	18	88	35	4		26	2
	Mid section of the Reservoir										6	14			69
	Buyala-Kikubamutwe			394	97	152	32	16	8	5	51	24	2		
Scoop nets	Kalange-Makwanzi					1	6	4	4	4	1	2	3	5	5
	Mid section of the Reservoir										6	3	12	8	8
	Buyala-Kikubamutwe			2	1	1		1	2	1	1	0	0	2	
Monofilament nets	Kalange-Makwanzi										0	29	15		38
	Mid section of the Reservoir										21	0	13	3	113
	Buyala-Kikubamutwe										0	0	0		4
Traps	Kalange-Makwanzi											0	0		
	Mid section of the Reservoir											0	0		
	Buyala-Kikubamutwe											56	151	461	460

3.6.2. Fish catch composition and catch rates

Overall, 13 fish species belonging to seven families were recorded along the three transects *(Table 3.6.2).* The species included *L. niloticus, O. niloticus, O. variabilis, T. zillii, B. docmak, B. altianalis,* Haplochromines*, P. aethiopicus, M. kannume, C. gariepinus, Synodontis victoriae, Synodontis afrofischeri* and *Rastrineobola argentea.* The Upstream transect, Kalange-Makwanzi registered the highest number (11) of species, where *C. gariepinus, O. leucostictus* and *B. altianalis* were only encountered. Ten species were recorded in the mid reservoir and 5 at Buyala-Kikubamutwe. At the three transects, 4 species (*L. niloticus, O. niloticus, M. kannume* and *S. afrofischeri*) were the most predominant ones. *B. docmak, R. argentia, T. zillii and O. variabilis* occurred in the mid reservoir and Kalange-Makwanzi but not in the Buyala-Kikubamutwe transect. Haplochromine species were recorded in the mid reservoir and at Buyala-Kikubamutwe transect. *R. argentia*, which previously (e.g. April 2012 to April 2013) was prominent at the three sites, was recorded at Kalange-Makwanzi and mid reservoir stations only during this survey. In the previous survey (September 2013) as well as the current one, Kalange-Makwanzi supported the highest diversity of fish species.

During the April 2014 survey, catch rates, the CPUE (kg/boat/day) for *L. niloticus, O. niloticus* and *M. kannume* declined at the three transects (Table 3.6.2).) At Kalange-Makwanzi and mid reservoir respectively, *R. argentea* (Mukene catch rates were 24 and 22 kg/boat/day. At Kalange-Makwanzi transect, the catch rates for B*. altianalis* was 9.8 kg/boat/day and *for C. gariepinus* was 3.8 kg/boat/day. Catch rates of other species were relatively stable at the three transects. This overall increase in the catch rates for most of the species at the sites during the current survey coincided with the rainy season.

CPUE results for *M. kannume* from the current survey at mid reservoir and Buyala-Kikubamutwe transects were comparable to those recorded in the previous survey of September 2013. They dropped by 50% at Kalange-Makwanzi transect (i.e. 1.4 to 0.7 kg/boat/day). The rapid expansion of basket traps to target *M. kannume* for bait in the longline hook fisheries of *L. niloticus*, *C. gariepinus* and *P. aethiopicus* on lakes Victoria and Kyoga and the associated returns from these fisheries, partly explain the high CPUE of *M. kannume* in the mid reservoir and Buyala-Kikubamutwe transects. In this survey (April 2014), Buyala-Kikubamutwe transect registered the lowest CPUE of 2.0 kg/boat/day for *L. niloticus* from 4.9 kg/boat/day registered in September 2013. It was also observed that catches for *L. niloticus* at the mid reservoir increased by 24% (i.e. 1.9 to 2.5 kg/boat/day) while at Kalange-Makwanzi transect, they decreased by 13%.

Table 3.6.2 *Trend of fish catch rates (kg/boat/day) with all gears pooled, of the main fish taxa the upstream at Kalange-Makwanzi, mid of the reservoir and downstream at Buyala-Kikubamutwe.*

Familiy	Species/taxa	Transect	Monitoring Period												
			Sep. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012	Apr. 2013	Sep. 2013	Apr. 2014
Bagridae	*Bagrus docmac*	Kalange-Makwanzi	0.05	0.21	0.4	0.27	0.08	0.15	0.09	0.5	0.53	0.9	0.46	0.8	1
		Mid section of the Reservoir									0.18	6	0.2	1.1	0.9
		Buyala-Kikubamutwe	0.39	0.1	0.03	0.21	0.17	0.06	0.83	0.16	0.94	1	0.5	1.4	
Centropomidae	*Lates niloticus*	Kalange-Makwanzi	1.11	1.36	0.78	2.12	0.64	0.76	0.52	0.11	1.79	1.8	1.56	2.9	2.5
		Mid section of the Reservoir									0.43	3.5	0.81	1.9	2.5
		Buyala-Kikubamutwe	0.52	0.15	1.01	0.79	1.3	0.38	1.97	3.58	1.41	1.5	0.56	4.9	2
Characidae	*Brycinus jacksonii*	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
	Brycinus sadleri	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
Cichlidae	*Oreochromis niloticus*	Kalange-Makwanzi	1.5	1.03	0.86	2.81	1.16	0.1	0.48	1.27	0.06		0.6	0.6	1.2
		Mid section of the Reservoir									0.3	0.3	0	0.6	1.9
		Buyala-Kikubamutwe	0.18	0.64	0.95	0.14		0.14	0.84	0.02	0.16	0.6	0.2	4.1	0.2
	Oreochromis leucostictus	Kalange-Makwanzi			0.01	0.13	0.01								
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
	Oreochromis variabilis	Kalange-Makwanzi	1.25	1.43	1.44	0.88	1.03	0.68	0.23	0.61	0.65	0.4	0.66	1.7	2
		Mid section of the Reservoir									0.48	0.1	0		0.3
		Buyala-Kikubamutwe				0.06	0.25	0.1	1.67						
	Tilapia zillii	Kalange-Makwanzi	0.88	0.9	0.23	1.04	0.21	0.22		0.12	0.39	0.1	0.11	0.9	1.1
		Mid section of the Reservoir									1.13	0.1		0.8	0.5
		Buyala-Kikubamutwe	0.06	0.38		0.01	0.15	0.04					0.02	0.5	
	Haplochromines	Kalange-Makwanzi	0.22		0.02	0.04	0.01	0.01	0.01	0.15	0.03			0.1	
		Mid section of the Reservoir									0.01				0.1
		Buyala-Kikubamutwe		0.1		0.01		0.02	0.1	0.01				0.6	0.2
Clariidae	*Clarias gariepinus*	Kalange-Makwanzi	0.08	1.22	0.18	0.07		0.04		0.22	1.77	0.5	0.18	3.5	3.8
		Mid section of the Reservoir									1.35				
		Buyala-Kikubamutwe		0.83	0.18								0.03		
Cyprinidae	*Barbus altianalis*	Kalange-Makwanzi	2.88	6.72	3.98	5.11	2.27	2.87	1.66	0.28	6.05	0.1	0.24	1.2	9.8
		Mid section of the Reservoir									0.95			0.5	
		Buyala-Kikubamutwe	2.72	0.35	1.17	0.54	2.1	1.58	1.13	2.98	1.4	1.5			
	Barbus paludinosus	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
	Labeo victorianus	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
	Rastrineobola argentea	Kalange-Makwanzi					11.4	2.96	34.5			43	43		24
		Mid section of the Reservoir									115	23.5	4.29		22
		Buyala-Kikubamutwe		1.92	5.3			3.05	50						
Cyprinodontidae	*Aplocheilichthys pumilus*	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
Lepidosirenidae	*Protopterus aethiopicus*	Kalange-Makwanzi		0.19	0.06		0.05	0.48			0.05		0.05		
		Mid section of the Reservoir													
		Buyala-Kikubamutwe											0.04		
Mochochidae	*Synodontis afrofischeri*	Kalange-Makwanzi	0.04		0		0.02	0.01		0.01	0.2				0.3
		Mid section of the Reservoir									0.06			0.5	0.1
		Buyala-Kikubamutwe	0				0.01							0.1	
Mormyridae	*Mormyrus kannume*	Kalange-Makwanzi	2.21	6.77	2.93	0.43	1.84	2.03	0.25	0.7	5.47	1.5	1.35	1.4	0.7
		Mid section of the Reservoir									1	4.7	0.96	3.4	3.3
		Buyala-Kikubamutwe	0.28	0.31	0.23	0.19	0.39	0.06	1.04	0.61		2.3	4.07	4.3	3.2

3.63. Estimates of total fish catches

The total monthly catch estimates at Buyala-Kikubamutwe transect significantly decreased from 6.9 tonnes (t) in September 2013 to 3.6 t in April 2014 (Table 3.6.3). Over the same period, the gross monthly catch at Kalange-Makwanzi and mid reservoir transects registered significant increases from 2.1 t to 36.6 t and 1.6 t to 40.6 t, respectively. Catch increase was observed for *O. niloticus* (0.1 t to 2.4 t) at the mid-reservoir transect and *B. docmak* (1.3 t to 3.7 t) at the Kalange-Makwanzi transect. In the mid reservoir, gross monthly catches of *B. docmak* (upstream) and *L. niloticus* remained fairly comparable to that recorded in September 2013 but *O. niloticus* increased from 0.1

to 2.4 t. At Buyala-Kikubamutwe, catches of L. *niloticus* and *O. niloticus* from the previous suvrvey to the present one declined from 4.5 to 1.2 t and 1.1 to 0.1 t respectively. At all the three sites, *M. kannume* monthly catches increased. Increase in the total monthly catches at Kalange-Makwanzi and mid-reservoir transects either for individual fish species or total fish catch probably was due increased fishers and fishing gears (Table 3.6.1). At Buyala-Kikubamutwe transect on the other hand, total monthly catches for individual fish species as well as combined catch decreased.

Although, fishery yields increase with rise in fishing inputs up to a point of maximum sustainable yield (MSY), beyond which, further increase in fishing inputs results into diminishing returns. The fish yield increases observed during this survey could be due to a rainy season, associated with abundant food resources. Unlike in September 2013, Mukene (*R. argentea*) catches were this survey recorded in the commercial fisheries at both the Kalange-Makwanzi and mid-reservoir transects.
Basket traps targeting *M. kannume* for bait partly accounts for their high total catches at Buyala-Kikubamutwe and mid-reservoir transects. Sustainability of this fishery must be addressed since fishers target the young/juvenile fish for bait. The high market prices for these young live fish only fetches money in a short term, in the long-term the fishery based on this species may collapse because fish are not allowed to reproduce, leading to reduction in fish stocks.

Table 3.6.3 *Trends of total fish catch estimates (kg), upstream at Kalange-Makwanzi, mid-section of the reservoir and downstream at Buyala-Kikubamutwe*

Family	Species/Taxa	Transect	Monitoring dates											
			Sep. 200	Apr. 200	Apr. 200	Oct. 2009	Apr 2010	Sept. 2010	Apr. 2011	Sept. 2011	Apr. 2012	Sept. 2012	Apr. 2013	Sept. 2013	Apr. 2014
Bagridae	*Bagrus docmac*	Kalange-Makwanzi	11.3	33.1	182.5	68.4	52.8	59.8	33.9	355.1	139.8	381.7	267.7	130.9	376.8
		Mid section of the Reservoir									68.4	481.5	74.5	187.1	1,133.4
		Buyala-Kikubamutwe	198.3	67.6	24.4	191.6	109.9	25.8	195.3	73.5	396.7	128.6	397.0	360.8	
Centropomidae	*Lates niloticus*	Kalange-Makwanzi	232.6	212.4	361.5	532.2	422.1	303.1	193.1	78.3	473.6	870.7	948.7	3,940.2	1,950.1
		Mid section of the Reservoir									163.1	248.7	305.7	347.1	3,183.1
		Buyala-Kikubamutwe	263.5	89.2	741.2	707.8	840.6	163.5	463.5	1612.5	592.7	117.1	449.6	452.3	1,200.0
Characidae	*Brycinus jacksonii*	Kalange-Makwanzi					-	-							
		Mid section of the Reservoir													
		Buyala-Kikubamutwe					-	-							
	Brycinus sadleri	Kalange-Makwanzi					-	-							
		Mid section of the Reservoir													
		Buyala-Kikubamutwe					-	-							
Cichlidae	*Oreochromis niloticus*	Kalange-Makwanzi	315	162.1	395.6	705.7	765.1	39.9	179	7.5	14.6			96.6	950.0
		Mid section of the Reservoir									112.8	25.5	0.0	102.3	2,392.8
		Buyala-Kikubamutwe	93.5	378.5	696.7	124.4	-	60.2	197	907.8	70	10.3	161.6	1,069.2	120.0
	Oreochromis leucostictus	Kalange-Makwanzi			3.5	32.4	6.6	-							
		Mid section of the Reservoir													
		Buyala-Kikubamutwe			-		-	-							
	Oreochromis variabilis	Kalange-Makwanzi	261.7	224.1	665.3	221.8	679.4	271.2	623.6	434.9	172.6	352.0	380.4	273.2	1,515.7
		Mid section of the Reservoir									184.2	8.0			314.8
		Buyala-Kikubamutwe			-	52.3	161.7	43	53.9						
	Tilapia zillii	Kalange-Makwanzi	185.8	140.6	107.4	261.5	138.5	87.7	88.9	87.7	103.5	96.2	62.4	146.9	803.8
		Mid section of the Reservoir									429.5	6.4	0.0	13.9	650.7
		Buyala-Kikubamutwe	28.3	227.1	-	5	97	17.2	52.9	2.1			16.8	13.9	
	Haplochromines	Kalange-Makwanzi	46.8		7.9	9.8	6.6	4	4.68	108.3	6.7		0.2	7.9	
		Mid section of the Reservoir									3.5				88.2
		Buyala-Kikubamutwe		62.2	-	7.5	-	8.6	24.5	3				166.3	93.0
Clariidae	*Clarias gariepinus*	Kalange-Makwanzi	17.8	191.5	80.9	17	-	16			467	109.2	102.8	554.4	2,870.6
		Mid section of the Reservoir									515.5				
		Buyala-Kikubamutwe		538.1	135.5		-	-		159	-	-	23.9		
Cyprinidae	*Barbus altianalis*	Kalange-Makwanzi	605.8	1,053.10	1,837.60	1,282.50	1,497.20	1,144.50	436.4	200.6	1,597.80	30.0	141.7		
		Mid section of the Reservoir									362.7			190.1	7,501.8
		Buyala-Kikubamutwe	1388.3	210.9	863.2	482.8	1,357.90	679.7	266.6	1341	515.5	209.4		89.1	
	Barbus paludinosus	Kalange-Makwanzi					-	-							
		Mid section of the Reservoir													
		Buyala-Kikubamutwe					-	-							
	Labeo victorianus	Kalange-Makwanzi					-	-							
		Mid section of the Reservoir													
		Buyala-Kikubamutwe					-	-							
	Rastrineobola argentea	Kalange-Makwanzi		1,243.80	-		6,463.80	2,109.50	2,152.80			1,105.7			18,371.9
		Mid section of the Reservoir									13,128	1,480.5	1,627.6		27,706.5
		Buyala-Kikubamutwe			2,873.70		-	980.4	1,960.00						
Cyprinodontidae	*Aplocheilichthys pumilus*	Kalange-Makwanzi					-	-							
		Mid section of the Reservoir													
		Buyala-Kikubamutwe					-	-							
Lepidosirenidae	*Protopterus aethiopicus*	Kalange-Makwanzi		30.5	25.4		33	191.4			12		26.4		
		Mid section of the Reservoir													
		Buyala-Kikubamutwe			-		-	-							
Mochochidae	*Synodontis victoriea*	Kalange-Makwanzi													
		Mid section of the Reservoir													251.9
		Buyala-Kikubamutwe												26.4	
Mochochidae	*Synodontis afrofischeri*	Kalange-Makwanzi	8.1		1.8		13.2	4		10.4	52.8		31.9		229.6
		Mid section of the Reservoir									22.9			89.1	125.9
		Buyala-Kikubamutwe	0.6		-		6.5	-						13.2	300.0
Mormyridae	*Mormyrus kannume*	Kalange-Makwanzi	463.6	1,060.10	1,352.50	106.9	1,213.60	809.5	389.6	500.1	1,444.10	357.6	783.2	214.1	562.6
		Mid section of the Reservoir									381.8	374.7	365.5	605.2	4,156.0
		Buyala-Kikubamutwe	141.7	183.9	170.3	169.2	252.2	25.8	57.8	276		842.1	3,248.0	1,135.2	1,900.0
TOTAL		Kalange-Makwanzi	2148.5	3,107.40	5,021.80	3,238.30	11,291.90	5,040.40	4,097.30	2842	4,484.50	3,308.1	3,141.0	2,066.0	36,626.2
		Mid section of the Reservoir									15,417.20	2,625.2	2,400.4	1,559.0	40,633.1
		Buyala-Kikubamutwe	2114.2	3,001.30	5,505.00	1,740.70	2,825.80	2,004.20	3,247.00	3315.6	1,647.30	1,309.3	4,468.7	6,850.0	3,613.0

3.6.4. Estimates of total beach value of the catch

Four major commercial fish species were *L. niloticus*, *M. kannume*, *O. niloticus* and *S. afrofischeri* at all the three transects. Besides these 4 species at Kalange-Makwanzi and mid reservoir, Mukene and *B. docmak* featured prominently in the commercial cathes. At Kalange-Makwanzi, *B. altianalis* and *C. gariepinus* featured but not the the other transects. During the April 2014 survey, a monthly gross beach value of 138.6 million Uganda shillings from 80.9 tonnes of fish catch was accrued from the three sites, a 58% improvement in value from that recorded in September 2013 (Table 3.4.4). Kalange-Makwanzi with a monthly catch of 36.6 t, fetched the highest monthly gross beach value of 69.8 million shillings, a nine-fold increase from the previous September 2013 survey beach value of 7.4 million. The high revenue amounts recorded at this transect were due to the existence of high value fish species like *B. altianalis, O. variabilis* and *C. gariepinus* absent at the mid-reservoir and Buyala-Kikubamutwe transects.

The monthly beach values at the mid-reservoir transect tremendously increased by a 12-fold from 4.2 in September 2013 to 49.8 million shillings in April 2014. Improvements in monthly catches and beach gross values were registered at Kalange-Makwanzi and mid-reservoir transects but not at Buyala-Kikubamutwe one where these declined by 47 and 59% from 6.9 to 3.6 t and 46.7 to 19.1 million shillings respectively. The decrease in monthly catches and beach value at Buyala-Kikubamutwe were attributed to the reduction in number of fishing boats from 40 boats during the September 2013 survey to 20 during the present one. Additionally, the engagement in live bait fishery of *M. kannume* could have undermined high value due to overall lower weights because of the small-sized (juveniles) fish caught.

Mean prices per kilogram weight of fish recorded during September 2013 and April 2014 surveys fluctuated (Table 3.6.5). The mean prices for *L. niloticus* increased by 12%, that of *O. niloticus by* 34% and so was *O.variabilis.* Mean prices for M. *kannume, B. docmak, B. altianalis and C. gariepinus* declined. The mean prices determine and reflect the dynamic nature of fisheries depending on seasonality, demand and quantities of catch landed.

Table 3.6.4. *Trend of monthly gross value of fish catches (shs) upstream at Kalange-Makwanzi; mid of the reservoir and downstream at Buyala-Kikubamutwe*

Family	Species/Taxa	Transect	Monitoring dates												
			Sep. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr. 2010	Sep.2010	Apr.2011	Sep.2011	Apr.2012	Sep.2012	Apr.2013	SEP.2013	SEP.2014
Bagridae	*Bagrus docmac*	Kalange-Makwanzi	10,313	74,417	912,450	136,800	158,400	104,676	101,790	1,065,257	462,400	1,365,321	802,998	349,184	2,548,060
		Mid section of the Reservoir									226,200	1,564,791	230,418	966,735	2,455,806
		Buyala-Kikubamutwe	180,880	152,093	97,541	431,200	109,900	45,173	585,942	661,500	1,312,000	450,000	1,488,853	1,443,200	
Centropomidae	*Lates niloticus*	Kalange-Makwanzi	66,602	336,182	644,702	997,785	759,780	549,553	868,725	274,040	1,299,000	3,294,523	2,189,276	1,771,868	9,165,457
		Mid section of the Reservoir									447,400	746,126	1,089,138	1,239,445	12,398,184
		Buyala-Kikubamutwe	415,276	141,247	2,223,704	1,887,573	1,821,328	296,450	1,100,908	12,255,000	1,625,400	385,714	2,248,492	15,760,800	8,400,000
Characidae	*Brycinus jacksonii*	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
	Brycinus sadleri	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
Cichlidae	*Oreochromis niloticus*	Kalange-Makwanzi	374,535	240,015	553,823	776,226	1,530,200	83,741	179,010	2,269.43	33,200			117,144	3,606,416
		Mid section of the Reservoir									256,300	76,526		307,395	7,178,510
		Buyala-Kikubamutwe	111,172	560,620	1,045,083	186,667		126,485	196,980	18,750	159,000	30,857	323,208	2,138,400	360,000
	Oreochromis leucostictus	Kalange-Makwanzi			5,198	32,376	13,200								535,846
		Mid section of the Reservoir													
		Buyala-Kikubamutwe			-										
	Oreochromis variabilis	Kalange-Makwanzi	245,206	378,091	964,656	277,305	1,358,800	650,786	623,610	1,159,794	376,400	1,048,522	1,024,216	724,086	6,365,852
		Mid section of the Reservoir									402,000	23,914			787,117
		Buyala-Kikubamutwe		-	-	78,400	161,700	103,253	53,900						
	Tilapia zilli	Kalange-Makwanzi	170,908	161,368	161,123	167370	277,000	175,457	88,920	175,314	241,000	265,586	149,851	365,310	2,712,721
		Mid section of the Reservoir									1,000,000	19,131		277,992	1,626,709
		Buyala-Kikubamutwe	26,067	260,740	-	7,467	97,000	34,418	52,920	4,200				278,080	
	Haplochromines	Kalange-Makwanzi	46,846	-	2,356	4,902	3,300	2,991	3,744	54,154				3,960	
		Mid section of the Reservoir													44,079
		Buyala-Kikubamutwe		62,189	-			6,453	19,600	1,500					46,500
Clariidae	*Clarias gariepinus*	Kalange-Makwanzi	17,769	284,350	86,240	17,100		31,901		635,886	1,131,500	327,600	256,865	2,772,000	8,611,813
		Mid section of the Reservoir									1,248,900				
		Buyala-Kikubamutwe		799,034	270,947			-							
Cyprinidae	*Barbus altianalis*	Kalange-Makwanzi	674,221	1,660,815	3,215,809	1,923,750	2,245,800	1,823,982	872,820	501,429	4,411,000	75,056	481,904	855,360	22,505,538
		Mid section of the Reservoir									1,001,000	633,000		267,300	
		Buyala-Kikubamutwe	1,545,215	332,592	1,366,671	801,522	2,580,010	1,083,347	799,680	6,705,000	1,623,300				
	Barbus paludinosus	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
	Labeo victorianus	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
	Rastrineobola argentea	Kalange-Makwanzi		-	-		2,352,823	894,417	1,722,240			514,286			12,247,912
		Mid section of the Reservoir									2,863,600	945,000	813,815		18,890,816
		Buyala-Kikubamutwe		216,418	1,436,842			415,671	1,568,000						
Cyprinodontida	*Aplocheilichthys pumilus*	Kalange-Makwanzi													
		Mid section of the Reservoir													
		Buyala-Kikubamutwe													
Lepidosirenidae	*Protopterus aethiopicus*	Kalange-Makwanzi		15,231	38,115		23,100	350,914			36,000		52,690		
		Mid section of the Reservoir													
		Buyala-Kikubamutwe		-	-			-					63,844		
	Synodontis victoriae														440,786
	Synodontis afrofischeri	Kalange-Makwanzi	1,615	-	554		9,900	1,994		10,400	52,000	4,992			344,473
		Mid section of the Reservoir									22,900				251,878
		Buyala-Kikubamutwe	113	-	-		-	-							600,000
Mormyridae	*Mormyrus kannume*	Kalange-Makwanzi	328,240	977,422	1,327,914	89,110	1,743,943	1,160,277	389,610	450,082	1,959,800	572,083	1,391,402	415,900	1,153,409
		Mid section of the Reservoir									518,000	374,657	749,354	1,149,000	5,699,629
		Buyala-Kikubamutwe	100,300	169,522	170,310	338,488	201,760	36,999	14.4	331,200		2,105,357	24,360,327	11,352,000	9,658,333
TOTAL		Kalange-Makwanzi	2,236,254	4,127,892	7,912,939	4,422,724	10,476,246	5,830,689	4,850,469	6,595,785	10,003,000	7,467,968	7,162,475	7,434,812	69,797,498
		Mid section of the Reservoir									7,987,000	3,750,146	2,882,725	4,208,684	49,064,515
		Buyala-Kikubamutwe	2,379,023	2,694,454	6,611,098	3,731,317	4,971,698	2,148,249	4,377,944	19,977,150	4,720,000	3,604,929	28,484,724	46,733,280	19,064,833

Table 3.6.5. *Trends of the mean unit prices (shs/kg) of the most common fish species at the beach level along the upper Victoria Nile between April 2006 and April 2014.*

Species/Taxa	Monitring Dates													
	Apr-06	Sep-07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14
Lates niloticus	900	1576	1583	2188	2423	2000	1813	3286	6429	2750	2785	3063	3830	4363
Oreochromis niloticus	750	1189	1481	1409	1189	2000	2100	1000	2500	2300	3000	2250	2278	3429
Barbus altianalis	800	1113	1577	1666	2250	1722	1594	2250	4000	2760	3370	3400	3750	3000
Mormyrus kannume	786	708	922	983	1416	1310	1433	667	986	1400	1825	3886	4600	2635
Oreochromis variabilis	550	937	1687	1450	1357	1929	2400	1000	2667	2200	2860	2692	2650	4045
Bagras docmak													3950	3028
Clarias gariepinus													5000	3000

3.6.5 Estimated total catches and revenue of individual fishing units

The mean monthly catches for April 2014 were highest at the Kalange-Makwanzi transect, increasing 13-fold from the September 2013 estimate and 12-times at the mid-reservoir transect (Table 3.6.6). Mean monthly catches Buyala-Kikubamutwe declined by 50% declined (Table 3.6.6) due to low catch rates for main target fish species like *L. niloticus, B. docmak,* O. *niloticus. M. kannume* at this transect was mainly targeted for bait. Improvement in mean catches at Kalange-Makwanzi and mid-reservoir transects was probably due to presence of *O. variabilis, B. altianalis, C. gariepinus* and *R. argentia* which missed at Buyala-Kikubamutwe. Despite improvements in the mean monthly at Kalange-Makwanzi and mid-reservoir transects, revenue declined comparing April 2014 and September 2013 surveys.

Table 3.6.6 *Trend of monthly total catches and revenue of individual fishing units upstream at Kalange-Makwanzi, the mid-section of the reservoir and downstream at Buyala-Kikubamutwe*

Parameter rate	Site	Monitoring Dates												
		Sep-07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14
Total catch (Kg/boat/month)	Kalange-Makwanzi	215	444	228	180	418	219	467	89	47	144	158	103	1,356
	Mid section of the Reservoir									307	389	150	79	924
	Buyala-Kikubamutwe	124	130	212	55	123	134	329	221	275	66	154	343	181
Total revenue (Shs/boat/month)	Kalange-Makwanzi	223,625	589,698	359,679	245,707	388,009	253,508	298,445	206,118	188,500	418,986	7,162,475	7,434,812	2,585,093
	Mid section of the Reservoir									1,227,000	883,296	2,882,725	4,208,684	1,131,216
	Buyala-Kikubamutwe	139,943	117,150	254,273	116,604	216,161	143,217	410,225	1,331,810	1,098,000	187,657	28,484,724	46,733,280	953,242

3.6.6 Socio-economic aspects of the fishery

Non-commercial uses of fish

At the mid-reservoir transect, fish retained for domestic consumption at beach level increased to 5.4 Kg in September 2013 from 0.1 (Table 3.6.7) but has declined to 0.5 kg during the current survey. At Kalange-Makwanzi transect, 1.3 Kg was retained for domestic consumption during this survey unlike in the September 2013 one. At Buyala-Kikubamutwe, no fish was retained for domestic consumption this April 2014 survey and

the previous one (Table 3.6.7). The quantity of fish retained at both the Upstream (1.3 kg) and mid-reservoir (0.5 kg) represents 2.7% and 1.6% respectively of the total catch landed. The absence of fish retained for domestic consumption at the downstream transect is consistent with low gross monthly catch (3613 t) and to much of the catch being composed of juvenile *M. kannume* sold as bait for exploitation of other fisheries (e.g. *L. niloticus, C. gariepinus, e.t.c.*). Additionally, the large sized *L. niloticus* caught at the site was sold to factory agents for processing and value addition and exported to foreign markets. Absence of fish for domestic consumption could lead to malnutrition disorders among the riparian communities especially the children.

Table 3.6.7 *Trends of the average weight of fish (kg/boat/day) retained by fishers for domestic use between September 2007 and April 2013. In brackets the weight of fish retained is expressed as a percentage of the overall average weight of fish caught per boat.*

Sites	Monitoring dates												
	Sep-07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-10	Apr-12	Sep-12	Apr-13	Sep-13	Apr-14
Kalange-Makwanzi	0.3 (2.9%)	1.1 (5.5%)	0.4 (3.7%)	3.5 (27.1%)	2.2 (11.8%)	1.5 (16.8%)	1.4 (30.7%)	2.1 (60.0%)	1.2 (12.8%)	1.2 (20.4%)	0.1 (2.58%)		1.3 (2.72%)
Mid section of the Reservoir									1.5 (50 %)		0.1 (1.1%)	5.4 (3.3 %)	0.5 (1.55 %)
Buyala-Kikubamutwe	0.7 (16.9%)	0.1 (2.1%)	0 (0%)	1.4 (71.8%)	1.3 (29.7%)	0.8 (16.5%)	1.2 (23.8 %)	3.0 (45.8%)	0.8 (14.4%)		0.2 (3.2%)		

Fishery related jobs

As of April 2014, 187 people were employed in fishing and other fishing related activities in the study area (Table 3.6.8). Fishing was the most prominent job in which 106 people (56.7%) were engaged, dominated by males with only one woman at Kalange-Makwanzi involved as a fisher. The April 2014 survey, people engaged directly or indirectly in the fishery related jobs dropped by 22.1% from 240 that were recorded in September 2013.

The mid reservoir transect attracted the highest number of fishers and Buyala-Kikubamutwe, the least. Fish trade came close to fishing in having high number of people (31) employed, majority (80.6%) of whom were women. There were 15 fish traders respectively at Kalange-Makwanzi and mid-reservoir transects. Only one trader was registered at Buyala-Kikubamutwe. This state of affairs in fish trade was attributed to the wide range of fish species, relatively high catches and good prices of the catch landed at the two transects. Food vending employed 7 people in the entire study area, representing 3.7% of the entire population engaged in fishing and the auxiliary activities (Table 3.6.8). One boat builder was recorded at the mid-reservoir. No boat repairer was recorded at mid-reservoir and Buyala-Kikubamutwe transects. Relatively old canoes are used. The number of boat builder/repairers was stayed the same at Kalange-Makwanzi. Absence of boat builders/repairers and the use of old, leaking canoes by fishers at the reservoir and downstream transects puts their safety on water at risk. This is also an indication of low returns from fishing. In terms of BMU membership, there was a fair proportion of women in representation on the executive committees and considering that women have started engaging directly in fishing activities, their numbers may increase in the future.

Table 3.6.8 *The numbers of people by gender (Male/ Female) engaged in different jobs at landing sites upstream at Kalange-Makwanzi, mid of the reservoir and downstream and downstream at Buyala-Kikubamutwe*

Job description	Transect	Sex	Monitoring Dates													
			Apr-06	Sep-07	Apr-08	Apr-09	Oct. 09	Apr. 10	Sep. 10	Apr. 11	Sep. 11	Apr. 12	Sep. 12	Apr. 13	Sep. 13	Apr. 14
Boat builders/repairers	Kalange-Makwanzi	M	2	1	3	3	3	1	2	3	3	2	2	3	3	3
		F														
	Mid section of the Reservoir	M														1
		F														
	Buyala-Kikubamutwe	M	5	2	4	2	2	3		1	1	3	3			
		F														
Food vendors	Kalange-Makwanzi	M				1	1	2	4	1	1	1	1		1	2
		F	4	3	5	4	2	4		3	3	3	3	2	5	2
	Mid section of the Reservoir	M												1	1	
		F											2	4	3	3
	Buyala-Kikubamutwe	M										3	3		2	
		F		2												
Net repair(s)	Kalange-Makwanzi	M			5	4	4		3	5	5	3	3	7	5	6
		F														
	Mid section of the Reservoir	M														
		F														
	Buyala-Kikubamutwe	M		2		1			3			6	6		3	
		F														
Cleaner fish landing	Kalange-Makwanzi	M														
		F														
	Mid section of the Reservoir	M														
		F														
	Buyala-Kikubamutwe	M														
		F														
Fisher(s)	Kalange-Makwanzi	M	57	20	32	43	37	30	38	25	25	25	25	25	42	39
		F													1	1
	Mid section of the Reservoir	M											13	24	49	51
		F														
	Buyala-Kikubamutwe	M	26	30	42	47	46	30	34	30	30	15	9	28	72	15
		F														
Fish trader(s)	Kalange-Makwanzi	M	11	3	2	3	6	4	4	6	6		2	1	1	2
		F	12	9	13	10	20	16	16	30	30		16	9	16	13
	Mid section of the Reservoir	M											2	1	1	3
		F											5	1	1	12
	Buyala-Kikubamutwe	M	5	2		2	2	2	2				1		1	1
		F	8	2		4	3	5	5	5	5		3	6	5	
Fish processor(s)	Kalange-Makwanzi	M														
		F													3	3
	Mid section of the Reservoir	M														
		F														2
	Buyala-Kikubamutwe	M			3							1	1			
		F			5							5	5			
Fish cleaner	Kalange-Makwanzi	M														
		F														
	Mid section of the Reservoir	M														
		F												1	1	
	Buyala-Kikubamutwe	M														
		F														
Chairperson landing	Kalange-Makwanzi	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		F														
	Mid section of the Reservoir	M												1	1	1
		F														
	Buyala-Kikubamutwe	M		1	1	1	1	1	1	1	1	1	1	1	1	2
		F														
BMU committee member(s)	Kalange-Makwanzi	M				6		4	5			7	7	5	5	7
		F				3		5	4			2	2	1	3	2
	Mid section of the Reservoir	M												5	3	3
		F												3	1	
	Buyala-Kikubamutwe	M				4	2	2	3	3	3	4	4	4	4	10
		F				2	1					1	1	1	3	2
Landing site askali	Kalange-Makwanzi	M	1										1	1	1	
		F														
	Mid section of the Reservoir	M														
		F														
	Buyala-Kikubamutwe	M											1	1	1	
		F														

3.7 SCHISTOSOMIASIS, RIVERBLINDNESS AND SANITATION STUDIES

3.7.1 Parasitological analysis of bilharzias in humans

Sampling for parasitological prevalence and intensity of Bilharziasis infection were maintained at Kalange-Makwanzi (an upstream transect), mid-reservoir and downstream (Buyala-Kikubamutwe).

Table 3.7.1 *Trend of Schistomiasis infection prevalence and intensity, schistosomiasis vector numbers, coliform counts among sample of people at Kalange-Makwanzi, mid of the reservoir and Kikubamutwe-Buyala*

Parameter	Variety	Site	Monitoring dates														
			Apr.06	Sept. 07	Apr. 08	Apr.09	Sept. 09	Apr. 10	Sept.10	Apr.11	Sept.11	Apr.12	Sept.12	Apr.13	Sept.13	Apr.14	
Schistosomiasis Prevalence	*Mansonii*	Kalange-Makwanzi	53	46	56	28	49	21	21.8	16	18	18.6	17	25	20	19.6	
		Mid section of the Reservoir										20.5	16.7	18.5	20	13	
		Buyala-Kikubamutwe	48	43	40	22	33	19	16.7	18.6	21.8	19.6	20	17.5	18.6	16.4	
	Haematobium	Kalange-Makwanzi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Mid section of the Reservoir										0	0	0	0	0	
		Buyala-Kikubamutwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Schistosomiasis Intensity	*Mansonii*	Light	32	60.8	59	35	77	83	86	87	86.3	75	67	79.2	83.3	90.5	
		Moderate	50	27.5	32	12	4	17	13.6	15	13.7	18.1	33	16.7	16.6	9.5	
		Heavy	18	11.8	10	3	4	0	0	0	0	6.2	0	4.1	0	0	
Prevalence by water contact	*Mansonii*	Fishing	71.4	94.4	60	68	79	62	31.4	21.9	24	28	27.8	25.8	32	38.9	
		Fetching water	18.1	38.4	36.6	30.9	48	0	6.5	14.3	20	20.5	18	17.6	16.6	9.1	
		Bathing/swimming	70	93.4	54.5	54.8	63	15	18.6	20	46	20.4	23	34	20	42	
		Fish mongers	60	42.8	16.6	15	33	8	14.3	5	14	13.3	11	18	14.2	10	
Snail Species abundance	*Bulinus sp.*	Kalange-Makwanzi	10	21	14	8	23		19	37	85	17	251	20	8	6	
		Mid section of the Reservoir										11	30	10	7	4	
		Buyala-Kikubamutwe	13	11	50	8	83		9	51	18	3	5	7	21	8	
	Biomphalaria sp.	Kalange-Makwanzi	22	31	26	25	20		63	182	33	26	26	47	16	20	
		Mid section of the Reservoir										68	67	67	46	45	
		Buyala-Kikubamutwe	11	9	65	74	122		62	80	60	200	167	22	51	44	
	Others	Kalange-Makwanzi	127	39	51	135	67		101	455	81	8	72	39	68	222	
		Mid section of the Reservoir										13	15	63	131	100	
		Buyala-Kikubamutwe	50	37	52	188	91		118	96	57	71	105	87	84	42	
Coliforms in water	Shallow	Kalange-Makwanzi	200	73	63	105	15	50	50	48	70	57	60	60	96	92	
		Mid section of the Reservoir										79	80	94	80	80	
		Buyala-Kikubamutwe	50	87	73	100	10	87	80	82	81	82	76	80	94	90	
	Deep	Kalange-Makwanzi	40	10	43	15	1	1	1	1	2	79	80	80	80	5	
		Mid section of the Reservoir										1	1	5	5	3.1	
		Buyala-Kikubamutwe	10	21	70	22	1	1	1	1	1	6	1	1	1	4	

A total of 121 stool samples were collected from 450 people. Of the 121 samples, 21 people (17.3%) were infected with Schistosomiasis, a small decline from the previous sampling. All infections were by the intestinal type of Schistosomiasis (*Schistosoma mansoni*).

Infection with Schistosomiasis was higher at the Kalange-Mkwanzi transect (19.6%) and lowest at the mid-reserviour transect (13%). None of the 121 samples tested positive for *Schistosoma haematobium,* the urinary type of Schistosomiasis.

The upstream transect showed stagnation while the other two transects seem to show a slight decrease compared to the previous sampling. These figures are lower than those of April of 2013 though they show only a slight decrease.

The majority of infected persons at all sites had light intensity (90.5%) up from 83.3% while heavy intensity was still to 0% moderate intensity also dropped to 9.5%, this indicates that the medications being given are gaining more acceptance and are being effective in bringing down worm loads.

The consistent increase in light intensity accompanied zero heavy intesity may be as a result of ongoing schistosomiasis control efforts using praziquantal for mass drug administration which is now accepted by the community and is effectively reducing worm loads.

Bathing/ Swimming fishing remained the biggest predisposing factors to Schistosomiasis infection contributing to 42% and 38.9% of the population tested while fetching water for domestic use had the lowest predisposition to the disease at 9.1%.
This result will help focus current behaviour change communication (BCC) efforts towards the casual swimmers and fishermen to help further bring down prevalence and intensity of infection.

As a corporate social responsibility and ethical consideration, all residents found to be positive were treated under directly observed treatment (DOTs) by the sanitation team.

Status of snail vectors

Vector snail species namely *Bulinus sp* and Biomphalaria *sp* showed a slight decrease in abundance except at the upstream transect where the *Biomphalaria sp* numbers increased only slightly

The biggest increase was in the abundance of the snail *lymnaea* spp. This is a snail which may act as a host for human *Fasciola hepatica* which more than doubled in number at the upstream transect. Though rare in Uganda, transmits Fascioliasis, a parasitic infection caused by *Fasciola hepatica*, which is also known as "the common liver fluke" or "the sheep liver fluke." A related parasite, *Fasciola gigantica*, also can infect people.

Biomphalaria sp was the more abundant vector snail species accounting for 29.1% of the total sample while *Bulinus sp* was only 3.6% of the total sample showing a slight decline

in the percentage of vector snails at 29.6% of total sample collected. It is significant to note that while the abundance on non-medically important snails went up, the vector snail abundance went down though only slightly.
In this and previous surveys, no vector snail specimens (*Biomphalaria sp* and *Bulinus sp)* picked at the three transects shed Cercaria. This indicates low transmission.

Faecal coli forms

Shallow human-water contact points upstream (92 colonies per ml), Reservoir (80 colonies per ml) and downstream (90 Colonies per ml) showed heavy contamination though with a slight reduction, this shows a high risk level. Water from the deep middle part of the lake had a lower coli form count of 3.1-4 colonies per 10 mls of water, indicating high dilution and in this case a moderate risk level (1-10 colonies per 10 ml of water);
Water with ten colonies per ml and above is considered unsafe for human consumption. The micro-organisms of medical importance were predominantly *Salmonella sp* and *Shigell*a *sp.*

Blackfly/*Mbwa Fly* Sampling

Medically important species of *Simulium* flies mostly live in sheltered areas of the river/stream in fast moving waters where they breed on crabs and Twigs depending on their species and sub species. During this sampling, none were detected either by human landing catches or by examination of crabs.

3.8. CONCLUSIONS AND RECOMMENDATIONS

3.8.1 Conclusions

1. Composition, species richness and abundance estimates and trends of the zooplankton community over the sampling period are comparable to those found in Lake Victoria, showing that the creation of the reservoir has not disrupted the ecological stability of the river.
2. No new species recoveries on the list were recorded. The list of fish species expected from this section of the river (Upper Victoria Nile) seems to have been exhausted.
3. In the mid-reservoir, the biomass of keystone species (*L. niloticus, B. docmak* and *M. kannume*) has reduced when compared to previous surveys of April and September 2013. This is attributed to increase in fishing activities' in the main reservoir by the local fishers

4. In the April 2014 survey, haplochromines were the main dietery prey of Nile perch at Kalange-Makwanzi and Buyula-Kikubamutwe whereas in the mid reservoir, *Caridina nilotica* dominated the diet of the species. The dominance of haplochromines in the diet of Nile perch was also observed in the previous survey of September 2013.
5. *Bagrus docmac* was only recorded from the mid-reservoir and its diet was dominated by fish as in April 2013 although in September 2013 the species fed predominantly on *Caridina*. The diet of other keystone species in April 2014 was similar to the observations made in the previous surveys.

6. Breeding intensity of keystone fish species in Kalange-Makwanzi was higher in April 2014 as in September 2013 than in the mid reservoir and Buyula-Kikubamutwe, an indication that the area could be a breeding ground

3.8.2 Recommendations

1. Given the observed stability and ecological roles of the zooplankton community, protective management need to be maintained to preserve the community for continued ecological benefits with respect to the water environment quality, the fish community as well as biodiversity concerns.

2. Fishing and other activities of the communities need to be properly monitored and regulated for a sustainable future fishery based on the created reservoir and other sections of the river. Entry in the reservoir fishery should still be restricted until more information on fish stocks in this water body is available.

3. Regular environment monitoring of the dam is useful for a clear picture especially on the fate of haplochromines in the mid-reservoir to determine the response of the keystone fish species and detect water quality and other biotic changes for timely institution of remedial measures.

4. Mass drug administration and health education should continue in order to get the prevalence of Schistosomiasis to drop further.

5. Though not currently a public health problem, the increase in *lymeaea* vector species abundance at the reservoir will require further and close monitoring.

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