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

Monitoring No. 11

Date: 04th – 09th September 2012

Monitoring carried out by:

National Fisheries Resources Research Institute (NaFIRRI)
P.O. Box 343, Jinja, Uganda
Tel: 256-43-120384
Fax: 256-43-120192
Email: firi@firi.go.ug, director@firi.go.ug

On behalf of :
Bujagali Energy Limited (BEL)

Date of Report November 2012

1.0 BACKGROUND

Bujagali hydropower dam construction is now completed and a reservoir behind the dam has been created, extending all the way up to Kalange-Makwanzi, an upstream transect. During the 10th monitoring survey-April 2012, a third transect was established in the mid of the reservoir where it runs up to 30 m deep and sampled similarly as at the two original sampling transects, Kalange-Makwanzi and Buyala-Kikubamutwe for comparative purposes.
This monitoring survey No. 11 undertaken between 4th and 9th September 2012 is the second one to be conducted after completion of construction of Bujagali Hydropower Dam. 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 biannual monitoring surveys have been conducted 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 also included.

2.0 GENERAL METHODOLOGY AND DATA COLLECTION

2.1. Materials and Methods

For eight surveys including one during September 2012, 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 transect 1, 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.

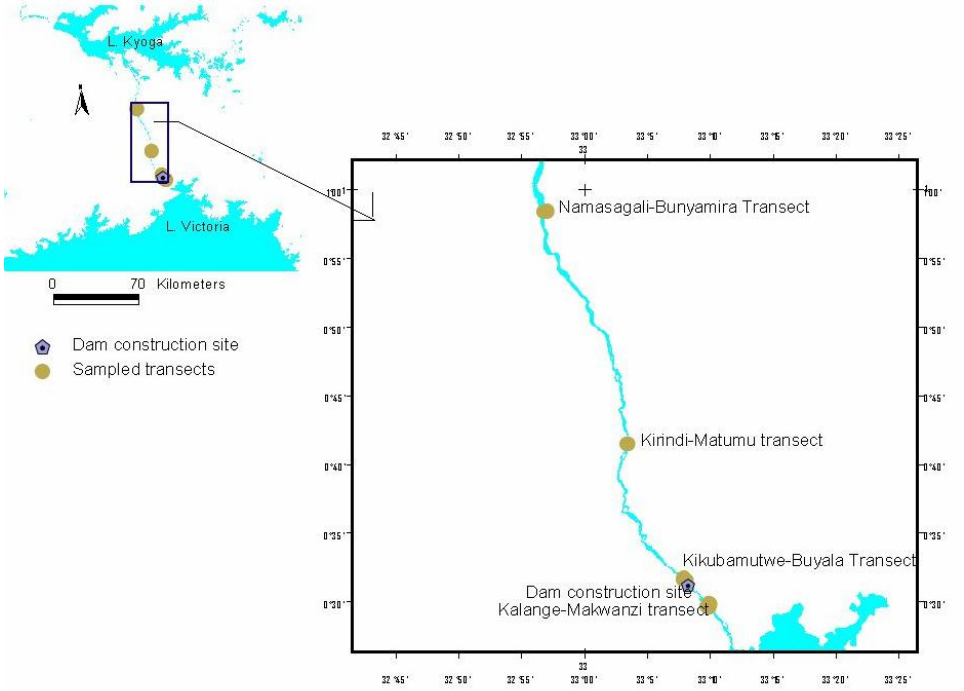


Figure 2.1a *A map showing the Upper Victoria Nile where the BHPP is located and river segments where baseline as well as monitoring samples were taken*

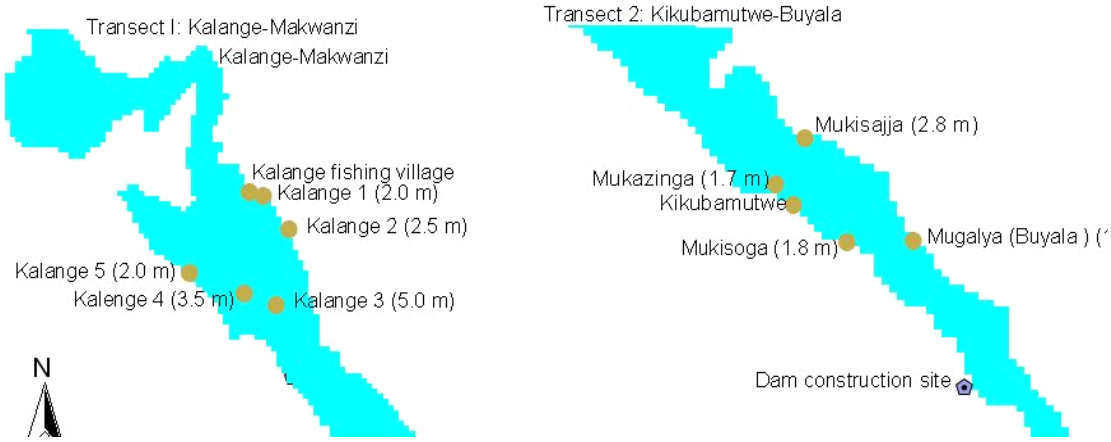


Figure 2.1b *Detailed maps of the two sampled transects: Transect 1 = Kalange-Makwanzi and Transect 2 = Buyala-Kikubamutwe and associated locations on the Upper Victoria Nile.*

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, labeled, plastic sample bottle. Species identification was done with the help of available published taxonomic keys (Boxshall & Braide1991; 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
		Apr-06	Sept. 07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12
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**
	Mid section of the Reservoir										5.2	6.4
	Buyala-Kikubamutwe	**6.3**	**7.7**	**7**	**7.2**	**7.2**	**9.3**	**7.8**	**7.1**	**7.5**	**7.5**	**5.9**
	NEMA Std	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**
	Mid section of the Reservoir										8.2	7.5
	Buyala-Kikubamutwe	**7.4**	**7.4**	**7.7**	**6.8**	**7.4**	**7**	**7**	**7.3**	**7**	**8.2**	**7.4**
	Upper NEMA Std	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
Temperature (°C)	**Kalange-Makwanzi**	**26.7**	**26.1**	**26.2**	**26.4**	**25.7**	**25.6**	**24.8**	**26.4**	**24.9**	**25.3**	**25.9**
	Mid section of the Reservoir										26.1	25.4
	Buyala-Kikubamutwe	**26.4**	**25.7**	**26.9**	**26.8**	**25**	**25.8**	**25.4**	**26.9**	**26.5**	**26.1**	**25.3**
	Upper NEMA Std	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
Conductivity (µS/cm)	**Kalange-Makwanzi**	**103**	**112**	**81.1**	**95.5**	**96.9**	**87.3**	**100**	**128.6**	**105**	**92.3**	**90.0**
	Mid section of the Reservoir										97.4	95.0
	Buyala-Kikubamutwe	**88.5**	**114**	**82.8**	**97.6**	**97.7**	**86.1**	**102.4**	**N/D**	**113.7**	**94.8**	**100.0**
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**
	Mid section of the Reservoir										1.7	2.1
	Buyala-Kikubamutwe	**1.7**	**1.8**	**1.8**	**2.3**	**1.9**	**1.9**	**2.1**	**2.5**	**1.3**	**1.4**	**1.5**
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**
	Mid section of the Reservoir										3.6	3.3
	Buyala-Kikubamutwe	**2**	**4.2**	**3.6**	**5.4**	**3.6**	**3.2**	**2.5**	**4.9**	**4.3**	**3.2**	**2.8**
	NEMA Std	100	100	100	100	100	100	100	100	100	100	100
Oil & Grease (mg/L)	**Kalange-Makwanzi**	**0.6**	**0.1**	**0.003**	**0.02**	**0.08**	**0.04**	**0.06**	**0.07**	**0.1**	**0.17**	**0.18**
	Mid section of the Reservoir										0.21	0.17
	Buyala-Kikubamutwe	**0.9**	**0.8**	**0.002**	**0.06**	**0.52**	**0.08**	**0.08**	**0.08**	**0.13**	**0.22**	**0.18**
	NEMA Std	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) have continued being comparable over the monitoring period. However, the downstream transect had significantly lower dissolved oxygen compared to what was upstream and a third transect in the middle in the reservoir. Despite these spatial variations, the waters at the downstream transect and in the reservoir were well aerated since all sites had values above the National

Environment Management Authority (NEMA) minimum of 3 mgL^{-1}, concentration required for survival of most aquatic organisms including fish.

Way up in the reservoir at the upstream transect mean pH was neutral (7.1), at the transect in the middle of the reservoir pH was 7.5 and at the downstream transect it was 7.4. The pH at all sites was within the NEMA permissible range of 6 to 8.

Water temperatures were also comparable with the previous data and were within the permissible NEMA range of 20ºC to 35ºC.

Electrical conductance increased by 5 units at the downstream transect recording up to 100 µS/cm and at the upstream, it was 90 µS/cm. This slight variation in electrical conductance was however, within acceptable ranges of unpolluted sites of Lake Victoria waters which are ≤ 120µS/cm.

Upstream and midstream in the reservoir, water clarity was similar and recorded up to 2.1m compared to that downstream that measured 1.5 m.

In the reservoir, the concentration of total suspended solids (TSS) varied from 3.1mg/L at the upstream to 3.6mg/L in the mid section down to 2.8 mg/L at the downstream transect. This trend could be attributed to settling of solids in the reservoir. Despite the observed variation, the concentration of TSS was far below the permissible NEMA standard of 100 mg/L.

The concentration of oil and grease was relatively constant (~ 0.18 mg/L) at the three sampling zones, and remained far below the NEMA permissible upper limit of 10 mg/L.

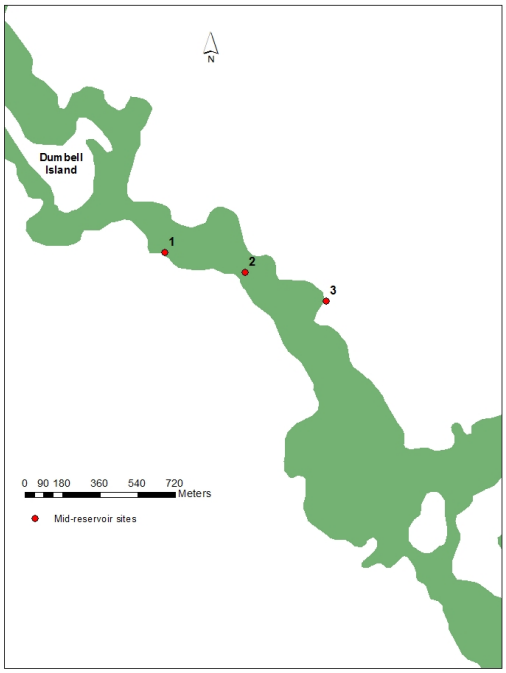


Figure 3.1.1 *Sampled points (1, 2, 3) on the section of the river where depth profiles of temperature, dissolved oxygen, pH, conductivity were taken.* (*NB: Base map used was before dam construction*)

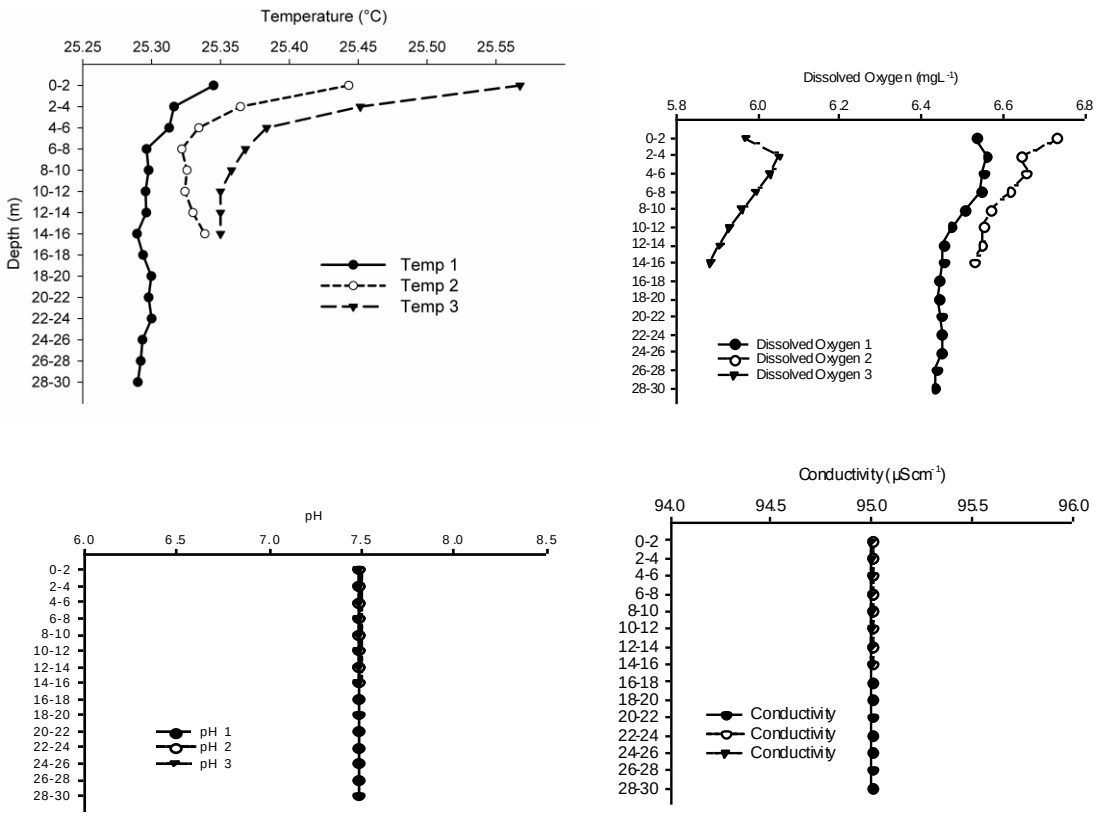


Figure 3.1.2 *Vertical profiles of some physico-chemical parameters in the BEL reservoir*

Vertical profiles for the water column temperature, dissolved oxygen, pH and conductivity in the reservoir were determined using a CTD profiler at three separate locations, code named 1, 2 & 3 (Figure 3.1.1) that varied in depth (Figure 3.1.2).

The deepest points sampled in the reservoir were in the range of 28 to 30m, while those in the shallow zones were 14 to 16m deep. Surface waters were relatively warmer than bottom zones and the deeper zones were relatively cooler than the shallower ones. Deeper waters were relatively more homogenous with reference to temperature compared to the shallower zones. The zone of the thermocline (temperature discontinuity) was between 4 and 10m.

The water column, irrespective of the zones sampled, was well oxygenated, with the lowest concentration being 5.9 mg/L of dissolved oxygen. Surface waters were relatively more oxygenated compared to bottom waters. This implies the reservoir has the capacity to sustain biotic organisms that require ample concentrations of oxygen.

The water column was also homogenous in relation to both pH and water conductivity irrespective of the zone and depth sampled i.e. pH was 7.5 and water conductance was 95 μScm^{-1}. This homogeneity was attributed to the stream currents that continuously mixed the water column thus resulting in absence of vertical variability.

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

The concentration of ammonium-nitrogen (NH_4-N) has consistently remained low, with minimal deviations at the three zones and far below the NEMA permissible upper limit of 10,000µg/L.

The concentration of nitrite-nitrogen (NO_2-N) during the current survey was lower than that of April 2012, but comparable with the previous ones. The relatively low nitrite-nitrogen (NO_2-N) was attributed to the rapid oxidation of the nitrite species to nitrate-nitrogen.

The concentration of nitrate-nitrogen (NO_3-N) remained lower than the permissible NEMA upper limit of 20,000μg/L, and slightly decreased in the downstream direction probably due to reduced flows hence enhanced uptake by algae.

Total Nitrogen (TN) concentration was highest in the mid section of the reservoir (~ 1.7 times) compared to that in the two transects, though all zones had less than the permissible NEMA upper limit of 10,000μg/L.

During this September 2012 survey, the concentration of soluble reactive phosphorus (SRP) was slightly lower at the mid section of the reservoir (17.6 µg/L) compared to the upstream (20.0 µg/L) of it and downstream (21.4 µg/L), but all were far below the permissible NEMA upper limit of 5,000 µg/L. The SRP concentration was similar to those of September 2007, September 2009 and September 2010.

Total Phosphorus (TP) concentration increased downstream but with no significant differences, and all sites had TP concentration that was far below the permissible NEMA upper limit of 10,000μg/L. The concentration of Soluble Reactive Silica (SRSi) was more in the mid section of the reservoir (268.5 μg/L). At the upstream of the reservoir, silica concentration was less than at the downstream transect by , ~100 μg/L.

Algal biomass (Chlorophyll-a) was higher in the reservoir (10.1±5.8 μg/L) due to reduced flows hence a longer residence time that allows algal development. At the downstream transect, algal biomass was higher that at the upstream of the reservoir, attributed to flashing from the reservoir.

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
		Apr-06	Sept. 07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12
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
	Mid section of the Reservoir										10.5	4.9
	Buyala-Kikubamutwe	29.5	24	97.9	79.4	137	111.8	68.2	45.8	2	10.6	3.2
	NEMA Std	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
	Mid section of the Reservoir										6.3	2.8
	Buyala-Kikubamutwe	8.7	2.8	6.1	2.6	4	5.3	4.1	4.3	4	6.6	3.8
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
	Mid section of the Reservoir										50.4	18.4
	Buyala-Kikubamutwe	12.6	94	182.5	35	76	148.6	49.2	54.7	61.2	51.5	18.6
	NEMA Std	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	2093.5	1925	306.7	2,362	1046.6	666.7	2196.3	1471.1	1,817.60	2,382.70
	Mid section of the Reservoir										1,606.90	4,337.30
	Buyala-Kikubamutwe	1192.5	2138.8	2492.3	216.7	2,421	2991.8	597.3	2103.7	2450.3	1,464.70	2,485.10
	NEMA Std	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
	Mid section of the Reservoir										41.8	107.6
	Buyala-Kikubamutwe	100.8	48.7	76.3	47.3	45	271.9	88.8	64.1	35.6	107.7	112.0
	NEMA Std	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
	Mid section of the Reservoir										7	17.6
	Buyala-Kikubamutwe	19.2	27.7	18.9	16.6	32	24.8	25.6	20	11.7	6.6	21.4
	NEMA Std	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
	Mid section of the Reservoir										268.1	268.5
	Buyala-Kikubamutwe	309.4	530.7	282.8	496.7	847	521.7	201.5	68.8	43.8	248.1	244.6
Chlorophyll-a (µg/L)	Kalange-Makwanzi										5.1	6.3
	Mid section of the Reservoir										5.6	10.1
	Buyala-Kikubamutwe										6	9.7

3.1.3 Algae and aquatic macrophytes/weeds

In the mid section of the reservoir, 34 species of algae were encountered, 30 were recorded in the downstream transect and 17 at the upstream transect in the reservoir (Table 3.1.3).

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

Taxonomic group	Kalange-Makwanzi	Mid section of the Reservoir	Buyala-Kikubamutwe
Bluegreen (Cyanopytes)	9	20	19
Green (Chlorophytes)	4	7	7
Diatoms (Bacillariophytes)	4	6	2
Euglenophytes	0	1	1
Dinoflagellates	0	0	1
Total number of species	**17**	**34**	**30**

Algal groups encountered were the blue-greens (Cyanophyta), greens (Chlorophyta), diatoms (Bacillariophyta), euglonophytes (Euglenophyta) and dinoflagellates (Dinoflagellata) (Table 3.1.4).

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

Major algal types/species	**Kalange-Makwanzi**	**Mid section of the Reservoir**	**Buyala-Kikubamutwe**
Bluegreen (Cyanopytes)			
Planktolyngbya limnetica		**P**	
P.tallingii		**P**	**P**
P.undulata		**P**	**P**
P.contotum		**P**	
P.limnetica		**P**	**P**
P.circumreta		**P**	**P**
Aphanocapsa sp	**P**	**P**	**P**
Aphanothecae			**P**
Aphanocapsa incerta			**P**
Aphanocapsa holistica	**P**		**P**
Aphanocapsa delicatissima	**P**	**P**	**P**
Cylindropermopsis africana		**P**	**P**
Cylindropermopsis cuspis		**P**	
Cylindrospermopsis racibosskii		**P**	
Merismopedia teniussima	**P**	**P**	**P**
Merismopedia gluaca	**P**	**P**	**P**
Pseudoanabeana		**P**	
Chroococcus limneticus	**P**	**P**	
Chroococcus turgidus	**P**	**P**	
Chroococcus aphanocapsiodes			**P**
Chroococcus dispersus			**P**
Ceolomoron sp	**P**	**P**	
Anabeanopsis tanganyikae	**P**		
Anabeana sp			**P**
Anabeana circinalis		**P**	
Pico Blues		**P**	
Green (Chlorophytes)		6	
Ankistrodesmus fusiformis		P	
Ankistrodesmus falcatus	P		P
Ankistrodesmus stegala		P	
Monoraphidium contortum		P	P
Chodetella	P		
Cosmorium sp		P	P
Stuarastrum sp		P	P
Pediastrum duplex		P	P
Scenedesmus acuminatus	P	P	
Scenedesmus curvatus			P
Scenedesmus sp	P		P
Diatoms (Bacillariophytes)			
Navicula gastrum			P
Nitzschia acicularis	P		P
Rhizosolenia victoriae	P		P
Nitzschia fonticola		P	P
Synedra cunnigtonii	P		P
Cyclotella sp	P	P	P
Euglenophytes			
Euglena acus		P	
Phacus sp			P
Dinoflagellates			
Glenedinuim sp	P		

Due to reduced flow rate and high water levels at the in the reservoir, most of the original shore macrophytes, other than the emergent growth forms (e.g. *Vossia cuspidata*) were no more as a result of submergence. Relatively stable waters had resulted into more water hyacinths that dominated the shores, with a cover abundance that varied between 35 and 50% at various locations. The emergent *V.cuspidata* was frequently encountered and its cover abundance was in the range of 10 to 30%. *Phragmintes* sp, another emergent macrophyte, was occasional in occurrence and only found at Makwanzi with a cover abundance of 25%. Vegetation on small islands at this transect had withered due to flooding.

Apart from water hyacinth that was a common feature in sheltered nooks and stable waters, aquatic macrophytes had not established along the shores of the reservoir hence the banks were still devoid of any water plants. Water hyacinth constituted between 40 and 90% of aquatic macrophytes along the shores of the reservoir, with others being *Vossia cuspidata* (5%) and *Leersea hexadra* (5%). Along the shores of the reservoir were some terrestrial herbs and shrubs, with the original aquatic vegetation along the original river bank submerged and in most cases eroded away due to the remarkable rise in the water level as a result of the impoundment.

As a result of regulation of water flows at the new dam, the composition of shoreline macrophytes at the downstream transect had not significantly changed from that observed in 2007 during the initial survey. Approximately three quarters of the river bank had been cultivated down to the shoreline thus leaving little room for establishment of aquatic plants.

3.2 Zooplanton (Water column micro-invertebrates)

The zooplankton community composition remained comparable with observations made earlier in April 2006 and April 2012 (Table 3.2.1**)**. The copepod species richness was comparable for upstream and reservoir sites for the April 2006 and April 2012 data (6-7) but declined considerably (7 to 4 species) in the September downstream data. Cladoceran species number showed a general decreasing trend from upstream through the reservoir to the downstream sites from April 2006 through May 2012 to September 2012. Notably the variation in species number between upstream, downstream and the reservoir in September 2012 was within very narrow limits (3-4). Comparison of the May 2012 and September 2012 data showed a decline from 6 to 3, 6 to 4 and 5 to 4 at upstream, reservoir and downstream sites. Rotiferan species number for September 2012 increased from 6 upstream to 13 at the reservoir, decreasing to 7 downstream. Comparison of the reservoir data for May and September 2012 showed similarity in species numbers (13).
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Table 3.2.1. *Numerical abundance (ind. m^{-2}) of zooplankton species at three sites of BEL, September 2012.*

Taxa	Species	Kalange-Makwanzi			Mid section of the Reservoir		Buyala-Kikubamutwe		
		Apr-06	Apr-12	Sep-12	Apr-12	Sep-12	Apr-06	Apr-12	Sep-12
Copepoda	*Thermocyclops incisus*		55		510		54	69	
	Mesocyclops sp.	555	217	173	225	63	77	361	
	Thermocyclops emini	1,213	222	94		259	22	208	
	Tropocyclops confinnis	2,458	402	582	1,021	660	177	985	356
	Thermodiaptomus galeboides	3,649	1,586	550	827	1,218	423	1,156	451
	Thermocyclops neglectus	6,086	3,648	1,258	2,835	1,077	197	1,216	906
	Tropocyclops tenellus	8,585	4,498	1	4,871	762	1,201	5,927	802
	Cyclopoid copepodite	46,139	13,604	13,604	17,786	14,194	8,449	8,482	12,214
	Calanoid copepodites	6,808	1,401	1,808	2,843	2,122	531	1,724	859
	Nauplius larvae	109,016	56,689	17,165	72,696	14,108	27,844	25,701	12,670
Total copepods		184,511	82,323	43,715	103,613	34,463	38,975	45,828	28,258
Total copepod species		6	7	6	6	6	7	7	4
Cladocera	*Daphnia lumholtzi*						9		
	Daphnia longispina		42						
	Macrothrix sp.						20		
	Chydorid sp.	29			42		7	37	
	Daphnia lumhortzi (helm.)	243	23		14		17		
	Ceriodaphnia cornuta	58	23	63	147	181		203	89
	Diaphanosoma excisum	287	462		297	94		190	73
	Moina micrura	679	361	63	497	118	28	227	31
	Bosmina longirostris	859	254	31	330	212	213	319	110
Total cladocerans		2,156	1,165	157	1,326	605	293	976	303
Total cladoceran species		6	6	3	6	4	6	5	4
Rotifera	*Asplanchna* sp.				22	55			
	Ascomorpha sp.				42	24			
	Euclanis sp.	19		16	28	24		14	
	Brachionus falcatus				33		11		
	Filinia longiseta	116	23		42	16			
	Polyarthra sp.	204				79			
	Filinia opoliensis	19	37		180	39			16
	Brachionus calyceforous	165	18	79	14	39	68	37	
	Keratella cochlearis	173	74		164	24	30	83	16
	Trichocerca cylindrica	105	92	267	333	487	13		168
	Brachionus angularis	213	46		164	55	95	97	131
	Lecane bulla	289	379	534	732	409	79	166	419
	Synchaeta sp.	617	587	550	644	487	42	291	634
	Keratella tropica	565	240	346	752	330	659	647	346
Total rotifers		2,485	1,498	1,792	3,148	2,068	997	1,336	1,730
Total rotiferan species		11	9	6	13	13	8	7	7
Total abundance		189,151	84,986	45,664	108,088	37,136	40,266	48,140	30,291

Abundance patterns

The common copepod species with higher numerical abundance were *Thermocyclops neglectus* and *Tropocyclops tenellus*; a trend which is comparable to the April 2012 data (Table 3.2.1). Similarly, the three juvenile stages of copepods i.e. copepodites and nauplius larvae were common and with high numerical abundance in the 3 field sites between April 2006 through April 2012 to September 2012. April-to-September 2012 copepod data of total abundance showed a general decrease from upstream through reservoir to downstream i.e. 184,509 to 43,715; 103,614 to 34,463 and 45,829 to 28,258 ind. m^{-2} respectively (Table 3.2.1). Cladoceran abundance data showed a similar trend i.e.

1,100 to 157; 1,300 to 605 and 970 to 300 ind. m^{-2} respectively. However, rotiferan data showed a decrease in upstream and downstream sites i.e. 1,500 to 1,790 and 1,300 to 1,700 ind. m^{-2}, while reservoir data indicated a decrease from 3,100 to 2.608 ind. m^{-2}. Total cladoceran abundance estimates were generally lower than those of copepods and rotifers and this trend is comparable to earlier observations.

Total abundance data for the study periods April 2006, April 2012 and September 2012 showed a general decrease from 189,100 through 84,900 to 45,600 ind. m^{-2} in the upstream site. A similar decreasing trend was observed in the mid section of the reservoir in April 2012 and September 2012 sampling dates i.e. from 108,000 to 37,100 ind. m^{-2}. For the downstream site, there were no marked differences in abundance between the three sampling dates (i.e. 40,250 through 48, 140 to 30 300 ind. m^{-2}). It was also noted that the September 2012 density estimates were the lowest in all the three field sites i.e. 45,660 ind. m^{-2} (compared to 189,150 and 84,660 for April 2006 and April 2012 in the upstream site), 37,100 ind. m^{-2} (compared to 108,000 for April 2012 in the reservoir) and 30,300 ind. m^{-2} (compared to 40,260 and 48,150 ind. m^{-2} in the downstream site).

Lower copepod species at the downstream site observed in September 2012 (Table **3.2.1**) represents a deviation from all previous records but it is not clear whether it is a seasonal development or an incidental occurrence. Since copepods are key drivers of zooplankton density trends in both Lake Victoria (Mwebaza-Ndawula 1998) and Upper Victoria Nile (Mwebaza-Ndawula *et al*. 2005) subsequent data collections will likely determine the true seasonal trend of copepods and associated ecological implications. If the observed higher rotifer species richness at the reservoir (13 species) in both April and September 2012 turns out to be a consistent pattern (to be confirmed by subsequent data collections), this phenomenon could then be treated as a community response to running water (lotic) conditions at upstream and downstream sites compared to relatively standing water (lentic) of the reservoir, which probably allows greater development of aquatic organisms in general compared to running water in the upstream and downstream sites.

Density estimates for September 2012, as in the two previous surveys, clearly show the dominant role of copepods in both the reservoir and the upstream /downstream sites. The low total density estimates for September 2012 (Table **3.2.1**) at all the three field sites may be indicative of seasonal changes in the zooplankton community due to environmental factors such as nutrients in relation to food supply and/or quality, planktivore pressure and others. While the April 2012 density record for total zooplankton abundance (108,069 ind. m^{-2}) was considered favourable for fish production in the reservoir, the September2012 estimate (37,136 ind. m^{-2}) is an order of magnitude low and may therefore imply unfavourable ecological implications for fishery production in the reservoir. Nonetheless, such fluctuations are quite common in dynamics of natural resources due to changes in some environmental variables; as such the changes only become worrisome when they persist in the environment.

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-12	Sep-12	Apr-06	Sep-07	Apr-08	Apr-12	Sep-12
Gastropoda (Water snails)	*Bellamya unicolor*	33	173	5	33				98	126	11	42	65
	Melanoides tuberculata	28	107	257	14	19			33	224	100	121	33
	Biomphalaria choanomphala		14	5			2			19	11		5
	Anisus natalensis											5	
	Gyraulus sp.				5								
	Segmentorbis sp.							3				47	9
	Gabbia humerosa		79	5							121	1,027	677
	Bulinus sp	5	9	5					5	5	5		19
	Pila ovata		5	5			7				5		
Total Gastropoda density		66	387	282	52	19	9	3	136	374	253	1242	808
Number of Gastropod species		3	6	6	3	1	2	1	3	4	6	5	6
Bivalvia (Clams/mussels)	*Byssanondota parasitica*	79	145	252	61	75	23	95		19	63	317	9
	Corbicula africana	56	126	182	47	219	5	25	65	131	205	65	28
	Caelatura sp	149	93	229	79	79	9	20	37	61	63	37	5
	Pisidium victoriae		5			9					32	19	5
	Mutela sp				5	5			5	5	16		
	Sphaerium victoriae	5	51	14			2			19		23	
	Sphaerium stuhlmanni				9		5	146				9	5
	Aspantharia sp	9	9	5	5	5			5				
	Etheria eliptica										5	5	
Total Bivalvia density		298	429	682	206	392	44	286	112	235	384	475	52
Number of Bivalvia species		4	5	4	5		4		3	4	5	6	
Diptera (Midge larvae)	Chironominae	271	331	238	201	47	201	73	84	56	58	84	9
	Tanipodinae	19	33	23	5	14		8	23	42	5	26	
	Chaoborus sp	9	23	9	9				5	5		65	
	Ceratopogonidae	5	14		65					5			
Total dipteran density		304	401	270	280	61	201	81	112	108	63	175	9
Number of dipteran types		4	4	3	4		1		3	4	2	3	
Oligochaeta (water worms)	*Nais sp*		5	5	14					33	11	9	
Ostracoda (seed shrimps)							229						
Hirudinea (Leeches)													5
Decapoda (Fresh water shrimps)	*Caridina nilotica*		5		5		7	3		5	32		
Ephemeroptera (May Flies)	*Povilla adusta*	19	163	9	28		5	3	5	9	63	28	5
	Baetis sp.	5	9	0	0			3	23	5			5
	Caenis sp.	19	75	19	5					9	26	37	9
	Cloeon sp.								37				9
	Leptophlebidae		14										
	Trichorythidae		89									5	
Total Ephemeroptera density		43	350	28	33		5	6	65	23	89	70	28
Number of ephemeropteran types		3	5	2	2		1	2	3	3	2	2	4
Odonata (Dragon/damsel Flies)	*Hagenius sp.*	19		9		5		3	5			5	5
	Gomphoides sp.	5		5						19			
	Libellulidea	9	33	0	5		2			5	37	5	5
	Coenagrion sp.								5		5		
	Protoneuridae		9	9									
Total odonates density		33	42	23	5	5	2	3	10	24	42	10	10
Number of odonate types		3	2	3	1	1	1	1	2	2	2	2	2
Trichoptera (Caddis Flies)	Hydropsychidae									19	16	5	
	Brachycentridae											2	
	Psychomyiidae		2					3				5	
	Leptoceridae									2	3		
Total Tricoptera density			2					3		21	19	12	
Number of tricopteran types			1					1		2	2	3	
Hemiptera (True bugs)	Nepidae	0	0	5	0								
Coleoptera (Beetles)	Elmidae	0	5	0	0								
Total benthic macro-invertebrate density (ind.m-2)		744	1626	1295	595	477	497	385	435	823	893	1993	912

Nine species of water snails have been recorded over the monitoring period (Table 3.3.1). The most common water snails are: *Bellamya unicolor and Melanoides tuberculata.* These snails are also common in Lake Victoria. *B. unicolor's* highest density of 173 ind. m^{-2} was recorded upstream in 2007. It was not recovered in the new reservoir even at the old upstream site. The highest density of *M. tuberculata* was 224 ind. m^{-2} downstream in 2007. In the mid of the reservoir three snail species (*Biomphalaria choanomphala, Pila ovate and Segmentorbis sp)* have been encountered.

Similarly, nine species of bivalves have been recorded at the sampling sites. The most common of these included *Byssanodonta parasitica, Corbicula Africana and Caelatura* sp. and have occurred at both upstream and downstream sites over the monitoring period.

For the insect types, mayfly nymphs, mainly *Povila adust*a and *Caenis* sp were encountered at the upstream and downstream transects. In the reservoir, P. *adusta* was the only mayfly registered. The caddis flies occurred at the downstream transect for sampling periods 2007, 2008 and 2012. The true fly larvae included the Chironomidae, Chaoboridae and Ceratopogonidae but of these, the chironomids were the most common and occurred in all transects including the reservoir at a density of 201 ind. m^{-2}. The chaoborids were absent downstream in 2008 and were missing the reservoir during this survey. The aquatic worms were recorded at both the upstream and downstream transects during the sampling dates in 2007, 2008 and 2012. They were absent in the reservoir.. The density of seed shrimps at 229 ind.m^{-2} was the highest of all the benthos in the reservoir.

3.4 Fish Species Composition and Relative Abundance

3.4.1 Catch composition

A total of 12fish species (haplochromines were taken as a single taxon group) were recorded at the three transects along the river compared to 11 in April 2012, 8 in September 2011 and 10 in April 2011 (Table 3.4.1). 8 species were recorded from the upstream station at Kalange, 7 from the main reservoir and 7 species from the downstream at Buyala.
All recognised keystone species (*Barbus altianalis, Lates niloticus, Mormyrus kannume, Oreochromis niloticus* and the haplochromines) were recovered. *L. niloticus, M. kannume* and *Synodontis victoriae* were recovered from all transects sampled. *Oreochromis variabilis* (Kalange) and *O. niloticus (Buyala),* and *Bagrus docmak, B. Altianalis and Gnathonemus longibarbis* (main reservoir) were each recovered from only one transect.
Quantities of *O. niloticus* continue to decline probably as a result of fishing pressure. The native tilapiine *Oreochromis variabilis* has persisted at Kalange. The upstream transect Kalange which has consistently been recording higher densities of fish, this time recorded lowest catches by numbers. 25% of the fish caught were recorded in Kalange, 34 in the main reservoir and 41 at Buyala. Likewise haplochromines which have been dominant by numbers at all stations, were overtaken by *Synodontis afrofischeri* both upstream and downstream and *M. kannume* in the main reservoir. By weight, *L. niloticus* was dominant upstream, B. altianalis in the main reservoir and S. afrofischeri downstream.

From all gears, 8 (8, 8, 8, 7) species were recorded at Kalange (Transect 1) 7 (10) in the main reservoir and 7 (8, 5, 4, 10) at Buyala (Transect 2) (Numbers in brackets are for the number of species caught during the April 2012, September 2011, April 2011 and September 2010 surveys respectively).

3.4.2 The Haplochromines

8 species belonging to 4 genera of haplochromines were recovered during the survey (Table 3.4.2). The downstream transect Buyala-Kikubamutwe yielded the highest haplochromine species diversity (8 species). The reservoir recorded no haplochromine while the upstream transect - Kalange-Makwanzi had 4 species.
Over the last five surveys, haplochromine diversity and abundance have consistently been highest at Kalange. *Astatotilapia brownae* contributing 70.8% of the haplochromines was the commonest haplochromine at the two stations followed by both *Mbipia mbipi* and *Astatotilapia "red tail"* each contributing 6.2%. The rest of the species each contributed less than 5%.

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
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012
Bagridae	*Bagrus docmak*	Catfish/(Semutundu)	Kalange-Makwanzi		P			P						
			Mid section of the Reservoir										P	P
			Buyala-Kikubamutwe		P		P							
Centropomidae	*Lates niloticus*	Nile perch/Mputa	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
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											
			Buyala-Kikubamutwe	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
			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
			Mid section of the Reservoir										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
			Mid section of the Reservoir										P	
			Buyala-Kikubamutwe	P	P	P	P	P	P	P	P	P	P	P
Clariidae	*Clarias gariepinus*	Mudfish/ (Male)	Kalange-Makwanzi			P	P							P
			Mid section of the Reservoir										P	P
			Buyala-Kikubamutwe			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
			Buyala-Kikubamutwe	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 pumilus*	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 afrofischeri*	Tiger fish (Nkolongo)	Kalange-Makwanzi	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	P	P
	S. victoriae	Tiger fish (Nkolongo)	Kalange-Makwanzi			P		P	P		P			P
			Mid section of the Reservoir										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
			Mid section of the Reservoir										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
			Mid section of the Reservoir										10	7
			Buyala-Kikubamutwe	11	13	8	12	6	6	10	4	7	8	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										
			1	2	3	4	5	6	7	8	9	10	11
			Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012
Astatoreochromis	*A. alluaudi*	Kalange-Makwanzi	P	P	P	P	P	P	P	P	P	P	P
		Mid section of the Reservoir											
		Buyala-Kikubamutwe	P	P	P	P	P			P			
Astatotilapia	*A. brownae*	Kalange-Makwanzi	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	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	
		Mid section of the Reservoir											
		Buyala-Kikubamutwe											
	A. "red dorsum"	Kalange-Makwanzi				P	P		P		P		P
		Mid section of the Reservoir											
		Buyala-Kikubamutwe					P	P	P				
	Astatotilapia sp.	Kalange-Makwanzi			P	P	P			P			
		Mid section of the Reservoir											
		Buyala-Kikubamutwe		P	P	P	P				P		
Gaurochromis	*Gaurochromis sp*	Kalange-Makwanzi		P									
		Mid section of the Reservoir											
		Buyala-Kikubamutwe											
Haplochromis	*H. lividus*	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
	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	
		Buyala-Kikubamutwe	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	
		Buyala-Kikubamutwe		P									
Paralabidochromis	*P. "black para"*	Kalange-Makwanzi				P			P			P	
		Mid section of the Reservoir											
		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	
		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											
		Buyala-Kikubamutwe	P	P	P								
Prognathochromis	*P. "shovel mouth"*	Kalange-Makwanzi	P	P			P	P	P	P	P		
		Mid section of the Reservoir											
		Buyala-Kikubamutwe				P			P			P	P
Psammochromis	*P. aelocephalus*	Kalange-Makwanzi		P					P				
		Mid section of the Reservoir											
		Buyala-Kikubamutwe		P					P				
	P. riponianus	Kalange-Makwanzi	P	P	P	P	P		P	P		P	P
		Mid section of the Reservoir											
		Buyala-Kikubamutwe	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				
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		
Unindentified	Haplochromines	Kalange-Makwanzi				P							
		Mid section of the Reservoir											
		Buyala-Kikubamutwe											
Total Number of Species		Kalange-Makwanzi	15	16	12	14	16	9	14	15	11	14	4
		Mid section of the Reservoir										4	
		Buyala-Kikubamutwe	11	8	10	9	12	5	9	3	6	4	8
		Total									14	17	8

3.2.3 Catch rates / biomass estimates

Catch rates i.e. catch per net per night was used to determine relative abundance of fish species from transects under survey. Catch rates by numbers were highest upstream in Kalange (8.2) and lowest downstream at Buyala (3.1) (Table 3.4.1). By weight, rates were highest in the reservoir (443g) (Table 3.4.3). Haplochromines recorded the highest rates in both numbers and weight (11.1 and 167.5g respectively.) upstream. The reservoir recorded the lowest quantities of haplochromines. Colonization of the reservoir by haplochromines is in the initial phase. Of the 4 species recorded from this station, 3 of them are known rock dwelling species. This ideal rock habitat was created by the blasting and embankment during dam construction. The presence of large sized species *Bagrus docmak, Barbus altianalis* and *Mormyrus kannume* is responsible for the dominance by weight in the reservoir. Catches were generally better upstream during this survey than the previous one. At the two sites where comparative data exists, overall catch rates increased from 3.36 to 8.2 fish upstream and from 1.5 to 3.1 downstream. By weight however the rates increased upstream (102 to 290g) but declined downstream (102 to 73g).

3.2.4 Fish species recovery

No new fish species was recovered during this survey. The total number of species so far recorded from the two transects previously under investigation remained at 63. All large sized fish species expected at these transects have been recovered. Figure 3.4.1 indicates that further species recovery is unlikely. The reservoir created has so far registered 10 species. Further colonisation of this reservoir by new species is to be monitored in subsequent surveys.

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 Apr. 2006	2 Sep. 2007	3 Apr. 2008	4 Apr. 2009	5 Sep. 2009	6 Apr. 2010	7 Sep. 2010	8 Apr. 2011	9 Sep. 2011	10 Apr. 2012	11 Sep. 2012
Bagridae	*Bagrus docmak*	Catfish/(Semutundu)	Kalange-Makwanzi		0.03			0.08						
			Mid section of the Reservoir										0.03	0.1
			Buyala-Kikubamutwe		0.07		0.04							
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**
			Mid section of the Reservoir										3.06	0.7
			Buyala-Kikubamutwe	1.12	1.68	1.86	2.29	2.57	0.35	0.4	**0.16**	**0.72**	**0.83**	**0.2**
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											
			Buyala-Kikubamutwe	0.07	0.41	0.04	0.04	0.1		0.1			**0.19**	**0.04**
	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**
			Mid section of the Reservoir										0.03	
			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**
			Mid section of the Reservoir										0.05	0.05
			Buyala-Kikubamutwe	0.88	0.46	0.04	0.43	0.1		0.04			**0.16**	**0.16**
	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**
			Mid section of the Reservoir										0.25	
			Buyala-Kikubamutwe	16.83	4.27	6.36	8.32	6.47	0.78	1.62	**2.05**	**1.36**	**6.13**	**2.3**
Clariidae	*Clarias gariepinus*	Mudfish/ (Male)	Kalange-Makwanzi			0.03	0.17							**0.01**
			Mid section of the Reservoir										0.02	0.03
			Buyala-Kikubamutwe	0.01		0.25	0.07		0.03			**0.02**		
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
			Buyala-Kikubamutwe	0.1	0.11	0.04	0.04		0.01	0.01		**0.02**	**0.02**	
	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 (Nkulongo)	Kalange-Makwanzi	0.21	0.63	0.08	0.42	1.46	0.46	0.33	**0.13**	**0.38**	**4.75**	**1.8**
			Mid section of the Reservoir										0.75	
			Buyala-Kikubamutwe		0.27	1.09	0.37	3.58	0.28	0.1		**1.07**	**0.06**	**3.7**
	S. victoriae	Tiger fish (Nkulongo)	Kalange-Makwanzi			0.08		0.21	0.29		**0.17**			**0.1**
			Mid section of the Reservoir										0.05	0.04
			Buyala-Kikubamutwe											**0.1**
Mormyridae	*Gnathonemus longibarbis*	Kasulubana	Kalange-Makwanzi											
			Mid section of the Reservoir											0.04
			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**
			Mid section of the Reservoir										0.82	0.9
			Buyala-Kikubamutwe	0.68	0.86	2.25	0.39	0.38	0.15	0.25	**0.18**	**0.17**	**0.02**	**0.1**
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**
			Mid section of the Reservoir										4.4	1.8
			Buyala-Kikubamutwe	6.45	3.28	3.91	3.71	4.28	0.81	1.21	**0.95**	**1.5**	**3.1**	**2.3**

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 Apr. 2006	2 Sep. 2007	3 Apr. 2008	4 Apr. 2009	5 Sep. 2009	6 Apr. 2010	7 Sep. 2010	8 Apr. 2011	9 Sep. 2011	10 Apr. 2012	11 Sep. 2012
Bagridae	*Bagrus docmak*	**Catfish/(Semutundu)**	Kalange-Makwanzi		37.53			28.58						
			Mid section of the Reservoir										14.1	27.7
			Buyala-Kikubamutwe		22.50		0.6.93							
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**	**156.2**	**63.3**
			Mid section of the Reservoir										197.6	139.8
			Buyala-Kikubamutwe	108.21	107.79	159.07	111.00	171.43	28.81	39.28	**16.4**	**44.5**	**30.2**	**18**
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											
			Buyala-Kikubamutwe	4.53	0.18	3.93	0.93	5.05		0.83			**5.8**	**1.7**
	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**
			Mid section of the Reservoir										1.7	
			Buyala-Kikubamutwe	11.58	12.08		8.17			4.04	**11.5**	**13.6**	**8.1**	
	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**
			Mid section of the Reservoir										7.2	
			Buyala-Kikubamutwe	81.85	19.08	7.33	42.26	7.90		2.71			**6.1**	**2.1**
	Haplochromines	**(Nkejje)**	Kalange-Makwanzi	303.92	191.92	168.08	534.33	383.24	167.67	113.11	**160**	**246**	**167.5**	**8.5**
			Mid section of the Reservoir										4.1	
			Buyala-Kikubamutwe	284.88	51.27	206.00	187.05	167.90	15.78	40.38	**37.7**	**15.3**	**86.9**	**32.3**
Clariidae	*Clarias gariepinus*	**Mudfish/ (Male)**	Kalange-Makwanzi			6.27	69.33							**8.9**
			Mid section of the Reservoir										9.4	48.7
			Buyala-Kikubamutwe	9.20		52.93	89.36		33.58			**3.1**		
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	198.7
			Buyala-Kikubamutwe	48.88	22.93	95.57	9.36		4.03	5.73		**12.8**	**0.3**	
	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 (Nkalongo)**	Kalange-Makwanzi	10.92	49.50	4.58	14.92	56.79	59.63	18.75	**7.2**	**28.8**	**61.1**	**64.2**
			Mid section of the Reservoir										15.6	
			Buyala-Kikubamutwe		19.09	30.64	10.42	111.58	12.89	2.38		**17.4**	**1.3**	**87.3**
	S. victoriae	**Tiger fish (Nkalongo)**	Kalange-Makwanzi			12.50		17.92	39.33		**28.1**			**7.3**
			Mid section of the Reservoir										6.8	3.6
			Buyala-Kikubamutwe											**9.6**
Mormyridae	*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**
			Mid section of the Reservoir										157.5	155.7
			Buyala-Kikubamutwe	217.37	89.54	175.64	185.00	51.62	9.22	33.36	**15.6**	**15.9**	**1.3**	**7.8**
OVERALL RATES			Kalange-Makwanzi	242.00	473.90	635.87	299.47	296.77	212.59	185.74	**141**	**102**	**290**	**131.5**
			Mid section of the Reservoir										443	572.8
			Buyala-Kikubamutwe	502.77	137.22	257.05	241.69	170.83	82.81	104.11	**49.9**	**102**	**73**	**68.6**

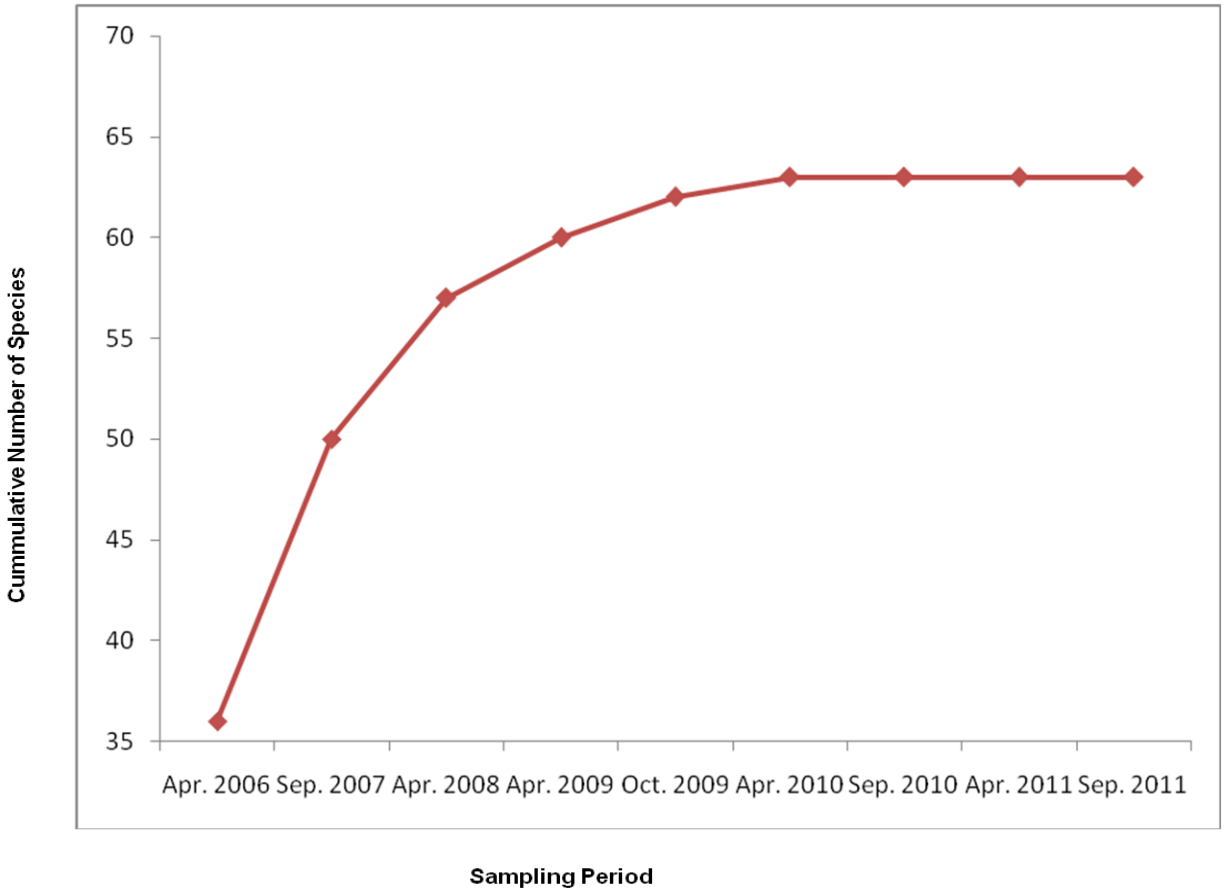


Figure 3.4.1 Cumulative *number of fish species recovered from the study transects on the Upper Victoria Nile between April 2006 and September 2012.*

3.5 The Food and Trophic Ecology of the Fishes

In September 2012, survey the diet of *Lates niloticus* was dominated by insects (93.6%) comprising of Odonata nymphs (53.1%) and unidentifiable insect material (40, 5%). Other prey items included juvenile Nile perch (4.2%) and unidentifiable fish material. The results contrast from those of previous surveys in which the diet of Nile perch from the same transect has always been dominated by fish dominated by Haplochromines. In the reservoir, *Caridina* (86.2%) was the dominant food item for Nile perch. Other prey items included *Rastrineobola argentea*/Mukene (8.2%) and juvenile Nile perch (5.1%). In the previous survey of April 2012, fish (50.5%) dominated by Mukene (50%) was the dominant prey of Nile perch caught in the reservoir.

Crabs (69.9%) was the dominant food ingest by Nile perch in Transect 2 during the survey of September 2012. Other food items included fish (23.1%) and *Caridina* (7.7%). In the previous survey of April 2012, Nile perch from the same transect ingested only fish dominated by haplochromine cichlids. Observations indicate a change in the diet of Nile perch from dominance by fish in the previous surveys to invertebrates i.e. insects, *Caridina* and crabs.

Algae (73%) dominated by blue-green algae was the major food for *Oreochromis variabilis* in Transect 1 in the survey of September 2012. Other food types included (detritus 20%) and chironomids (7%). The dominance of algae in the diet of *O. variabilis* was also observed in the previous survey of April 2012 in the same transect and in Transect 2. There were no specimens of *O. variabilis* recorded from the reservoir and Transect 2 in September 2012 survey.

In the survey of September 2012, *Oreochromis niloticus* was only recorded from Transect 2 and had ingested only Ephemeroptera nymphs. In the previous survey of April 2012 the species from the same transect had ingested a variety of food items dominated by molluscs (90%). There were no specimens of *O. niloticus* recorded from Transect 2 and the Reservoir in the survey of September 2012.

In September 2012, *M. kannume* was recorded from all transects surveyed. In Transect 1 the species had ingested insects (95.2%) and *Caridina* (4.8%), The insects included chironomids (45.7%), Odonata (40%) and Ephemeroptera (9.8%). The dominance of insects in the diet of M. kannume was also observed in the survey of April 2012 survey although in the previous survey Ephemeroptera were the most dominant insect prey. In the Reservoir, *M. kannume* also ingested insects (93.2%), ostracods (4.5%) and *Caridina* (2.3%). The insect prey comprised of Ephemeroptera (65.5%), chironomids (22.5%), chaoborids (2.3%) and unidentifiable insect material (1.1%). The diet of the species in the Reservoir is similar to what was observed the previous survey of April 2012. Odonata nymphs (98.1%) and molluscs (1.9%) were the only food items identified from the stomach contents of *M. Kannume* caught in Transect 2 in the survey of September 2012.

Synodontis afrofischeri was only recorded from Transects 1 and 2 during the surveys of September 2012. The food items identified from the stomach contents of *S. afrofischeri* from Transect 1 included insects (97.8%), mollusc (1.6%) and *Caridina* (0.6%). The insects comprised of Ephemeroptera (40.3%), Odonata (32.3%) and chironomids (25.2%). However, in the previous survey of April 2012, the diet of *S. afrofischeri* from the same transect1 was dominated by molluscs In Transect 2, the species ingested insects (98.7%) molluscs (0.7%) and *Caridina* (0.6%) in the survey of September 2012. In April 2012 survey *S. afrofischeri* from the same transect had empty stomachs.

Food of dominant fish species in the reservoir

In Transect 2, only 2 out of the 7 fish species examined were in breeding condition during the September 2012 survey. The species in breeding condition included *Mormyrus kannume* (33.3%) and *Synodontis afrofischeri* (35.3%). A low breeding intensity of fish species in the same transect was also observed in the previous survey of April 2012 although it was higher in September 2011 survey in which five fish species out of the seven encountered in the transect were in breeding condition. In the Reservoir, three out of the six fish species examined in the survey of September showed some signs of breeding activity. The species included *Bagrus docmac* (25%), *Barbus altianalis* (50%),

and *Mormyrus kannume* (44.2%). The current observations are similar to those recorded in the previous survey of the Reservoir in April 2012. During the survey of September 2012 in Transect 2, three fish species out of the five examined showed signs of breeding and these included *M. kannume* (33.3%), *S. afrofischeri* (12.5%) and *S. victoriae* (50%). In the previous survey of April 2012, no breeding activity was observed in the species encountered in the transect although in September 2012 breeding activity was observed in three species out of the six recorded from the same transect. All the specimens of *Lates niloticus* recorded from the experimental catches were found to be immature. However, in the previous survey of April 2012, one specimen of *L. niloticus* out of the one hundred specimens recorded from the Reservoir, was in breeding condition.

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	Seciestific Species name	English/local (Luganda) name	Site	Monitoring dates										
				1	2	3	4	5	6	7	8	9	10	11
				Apr. 2005	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011	Apr. 2012	Sep. 2012
Bagridae	*Bagrus docmac*	Semutundu	Kalange-Makwanzi (upstream of the reservoir)										FR	
			Mid section of the Reservoir										SYN	CAR
			Buyala-Kikubamutwe (downstream)											
Centropomidae	*Lates niloticus*	Nile perch/ (Mputa)	Kalange-Makwanzi (upstream of the reservoir)	FR	HAP	HAP	HAP	FR	HAP	HAP	HAP	HAP	HAP	ODT
			Mid section of the Reservoir										RAS	CAR
			Buyala-Kikubamutwe (downstream)	FR	CAR	FR	CAR	ODT	RAS	RAS	CHR	HAP	FR	CRB
Cichlidae	*Oreochromis niloticus*	Nile tilapia/ (Ngege-Kibati)	Kalange-Makwanzi (upstream of the reservoir)	E	HPM	BGA	HPM	E	E	DTR	IR	DETR	MOL	
			Mid section of the Reservoir											
			Buyala-Kikubamutwe (downstream)	E				E	DTR	E	DETR		INS	EPH
	O. variabilis	(Ngege)	Kalange-Makwanzi (upstream of the reservoir)	BGA	GRA	BGA	HPM	GRA	BGA	BGA	BGA	EPH	BGA	BGA
			Mid section of the Reservoir											
			Buyala-Kikubamutwe (downstream)	BGA	E		HPM				E	E	BGA	
	Tilapia zillii	Red-belly tilapia /(Ngege)	Kalange-Makwanzi (upstream of the reservoir)	MOL	HPM	E		E	IR	HPM	IR		EPH	E
			Mid section of the Reservoir										INS	
			Buyala-Kikubamutwe (downstream)	HPM	CAR	E	HPM	E	HPM	HPM			EPH	HPM
Clariidae	*Clarias gariepinus*	Mudfish/(Male)	Kalange-Makwanzi (upstream of the reservoir)			FR	FR				EPH			E
			Mid section of the Reservoir										EPH	EPH
			Buyala-Kikubamutwe (downstream)			HAP	EPH		E			CHR		
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
			Buyala-Kikubamutwe (downstream)	E	INS	INS			E	MOL		CHR		
Mochokidae	*Synodontis afrofischeri*	Tigerfish/(Nkulongo)	Kalange-Makwanzi (upstream of the reservoir)	CHR	EPH		CAR	CHR	EPH	CHR	EPH	INS	MOL	EPH
			Mid section of the Reservoir										INS	
			Buyala-Kikubamutwe (downstream)		CHR	CHR	INS	CHR	INS	CHR		INS		EPH
Mormyridae	*Mormyrus kannume*	Elephant Snoutfish/(Kasulubana)	Kalange-Makwanzi (upstream of the reservoir)	INS	EPH	EPH	INS	EPH	EPH	EPH		CHR	EPH	CHR
			Mid section of the Reservoir										EPH	EPH
			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

In April 2012 survey, the fish breeding intensity in Transect 1was lower (3 out of 8 species) when compared to observations of September 2011 survey in which five fish species out of the seven encountered in the transect were in breeding condition (Table 3.3.2). In *O. niloticus, O. variabilis*, *B. altianalis*, S. *afrofischeri* and *M. kannume*, the proportion of breeding adults was high (>50%) in comparison to the other species examined in the same transect. In Transect 2 no breeding was observed in the in the six species encountered in the survey of April 2012 although in the survey of September 2011I breeding was recorded in three species (*S. afrofischeri*, *B. altianalis* and *O.variabilis*) out of the six species examined. Higher breeding intensity in the Upstream when compared to the Downstream transect was also observed in the previous surveys of April 2011 and September 2011. All the specimens of *Lates niloticus* recorded from the experimental catches were found to be immature. Similar observations were made in the previous surveys.

The proportions of the mature fishes that were in breeding condition in the reservoir were generally low (< 50%) as indicated in Table 3.3.2**.** Breeding was recorded in all the species examined except *C. gariepinus* which was immature. Breeding intensity was highest in *B. docmac* (50%) and *B. altianalis* (50%), then *M. kannume* (25%), *S. afrofischeri* (6.7%) and *L. niloticus* (1%).

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	Scientific Species name	English/local (Luganda) name	Site	Monitoring dates										
				1	2	3	4	5	6	7	8	9	10	11
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2012	Apr. 2012	Sept. 2012
Bagridae	*Bagrus docmac*	Semutundu	Kalange-Makwanzi (upstream of the reservoir)											
			Mid section of the Reservoir										50	25
			Buyala-Kikubamutwe (downstream)											
Centropomidae	*Lates niloticus*	Nile perch/ (Mputa)	Kalange-Makwanzi (upstream of the reservoir)											
			Mid section of the Reservoir										1	
			Buyala-Kikubamutwe (downstream)											
Cichlidae	*Oreochromis niloticus*	Nile tilapia/ (Ngege-Kibati)	Kalange-Makwanzi (upstream of the reservoir)			71.4			50	54.5	38.5	70		
			Mid section of the Reservoir											
			Buyala-Kikubamutwe (downstream)											
	O. variabilis	(Ngege)	Kalange-Makwanzi (upstream of the reservoir)	12.5		22.2	55.2		50	38.1	46.3	50		
			Mid section of the Reservoir											
			Buyala-Kikubamutwe (downstream)									100		
	Tilapia zillii	Red-belly tilapia /(Ngege)	Kalange-Makwanzi (upstream of the reservoir)							83.3	42.9		33.3	33.3
			Mid section of the Reservoir											
			Buyala-Kikubamutwe (downstream)	7.1	25	100								
Clariidae	*Clarias gariepinus*	Mudfish/(Male)	Kalange-Makwanzi (upstream of the reservoir)								**100**			
			Mid section of the Reservoir											
			Buyala-Kikubamutwe (downstream)											
Cyprinidae	*Barbus altianalis*	Barbelfish/(Kisinja)	Kalange-Makwanzi (upstream of the reservoir)	100	100	80	100		64.7		**64.3**	100		
			Mid section of the Reservoir										50	50
			Buyala-Kikubamutwe (downstream)	12.5	100	100				100		100		
Mochokidae	*Synodontis afrofischeri*	Tigerfish/(Nkolongo)	Kalange-Makwanzi (upstream of the reservoir)	20	100		70	91.7	90	88.9	**100**	87.5	7.9	35.3
			Mid section of the Reservoir										6.7	12.5
			Buyala-Kikubamutwe (downstream)		75	36.4	50	100	100	100		100		
Mormyridae	*Mormyrus kannume*	Elephant Snoutfish/(Kasulubana)	Kalange-Makwanzi (upstream of the reservoir)	44.1	58.3	43.5	23.8	50	56.7	72.2	**59.3**	50	17.6	33.3
			Mid section of the Reservoir										25	44.2
			Buyala-Kikubamutwe (downstream)	37.5	41.7	27.1	54.5	33.3		33.3	**18.8**	20		33.3

3.6. THE COMMERCIAL FISHERY

3.6.1 Fishing effort in the fishery

Variation in fishing effort and catchability coefficients (a measure of fishing mortality) has been used to assess trends in stocks of natural fish populations for decades (Arreguín-

Sánchez, 1996). Assessment of dynamics in fishing effort has provided a firm basis to investigate periodic yield from the fishery the upper Victoria Nile alongside the dam construction project. The relationship between fishing effort and fishery yield has been explored along the process. Fishery yield in turn guides formulation of management advice. Changes in the numbers of fishing fleet in a given system reflect the migratory nature of fishers that go with trends in catches. Fishers will always move to areas rumoured to have higher catches. During the survey conducted in September 2012, the number of fishing boats upstream at Kalange-Makwanzi increased from 15 in April 2012 to 20 in September 2012. A major decline in the number of fishing boats was noted at the downstream transect at Buyala-Kikubamutwe from 34 April 2012 to 19 in the current survey (Table 3.4.1). There are observable changes within the upper and downstream transects, however, the total number of active fishing boats in the two transects do not appear to have significantly changed for the last 5 surveys over the past two years (September 2010 – September 2012). Apart from April 2012 survey during which the number of boats sored to a record 65 probably due to opening of the reservoir to fishers, the numbers have since dropped to about 50 in the current survey. The big drop in the number of boats is mainly downstream that could probably be associated to initial exposure of diverse rocky habitats downwards following closure of water to build the reservoir with associated increase in lucrative rocky fishing grounds. The drop is also evident in catch rates especially of *Mormyrus* and *Barbus.*

There has however, been emergence of a new basket trap fishery downstream targeting *Mormyrus* that is marketed life to fishers on lake Victoria and Kyoga as bait in the longline fishery. A total of 11 boats with an estimated 56 traps were recorded at the downstream transect.

The number of gillnets has dropped across all the sites including the reservoir while the longline hooks are on the increase (Table 3.6.1). The number of long lines hooks increased more than tenfold from about 70 in April 2012 to 800 in this survey at Kalange-Makwanzi. The reservoir had no long line hooks which could suggest the one boat recorded last survey could have shifted further upstream, that brings the question whether Kalange is not now part of the reservoir (Panel of Environment al and Social Experts report, Sept 2012). The other dominant fishing gears e.g. Cast nets and hand lines increased also decreased upstream and downstream over the same period. No monofilaments were recorded both upstream and downstream except on the reservoir. The boats targeting Mukene at both transects were more prominent on the reservoir. Horizontal migrations of fishers along the river with their fishing boats and gears appear to be the main causes of fluctuations in these indicators of fishing effort at the two study sites. Information generated from this survey indicates there are migrations even across the dam site through lifting boats over land downstream and vice versa.

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
Number of fishing boats	Kalange-Makwanzi	9	10	7	22	18	23	23	18	32	15	20
	Mid section of the Reservoir										16	13
	Buyala-Kikubamutwe	13	17	23	26	32	23	15	12	15	34	19
Number of boats using gillnets	Kalange-Makwanzi		9	7	10	6	7	13	6	8	9	9
	Mid section of the Reservoir										13	3
	Buyala-Kikubamutwe		7	18	7	6	1	2		1	4	2
Number of boats using long line hooks	Kalange-Makwanzi		1	2	3	1	2	2	0	2	1	4
	Mid section of the Reservoir										1	0
	Buyala-Kikubamutwe		10	8	6	6	13	6	3	7	10	7
Number of boats using cast nets	Kalange-Makwanzi					5	4	1	1	5	1	0
	Mid section of the Reservoir										0	0
	Buyala-Kikubamutwe			1	6	3	1	1	3	0	7	2
Number of boats using Hand line hooks	Kalange-Makwanzi			7	9	5	4	2	6	8	3	3
	Mid section of the Reservoir										1	7
	Buyala-Kikubamutwe			15	9	14	9	2	2	3	12	5
Number of boats using scoop nets	Kalange-Makwanzi					1	6	4	4	4	1	2
	Mid section of the Reservoir										6	3
	Buyala-Kikubamutwe			2	1	1		1	2	1	1	0
Number of fishing gears by mesh size												
Gillnets - ?2½"	Kalange-Makwanzi		3			1			4		2	0
	Mid section of the Reservoir										0	0
	Buyala-Kikubamutwe			1		10		2			0	0
Gillnets 3"	Kalange-Makwanzi					3	1	6			8	0
	Mid section of the Reservoir										0	4
	Buyala-Kikubamutwe			1	4			9			10	0
Gillnets 3½"	Kalange-Makwanzi		3			1	1	4		5	16	0
	Mid section of the Reservoir										0	3
	Buyala-Kikubamutwe			25							3	11
Gillnets 4"	Kalange-Makwanzi		30		21	8	2	26	20	20	10	0
	Mid section of the Reservoir										0	0
	Buyala-Kikubamutwe		20	4			1			13	0	0
Gillnets 4½"	Kalange-Makwanzi			21	5			2	2	12	4	0
	Mid section of the Reservoir										0	0
	Buyala-Kikubamutwe		3	12		6	1				0	0
Gillnets 5"	Kalange-Makwanzi		2	25	12	1					1	0
	Mid section of the Reservoir										14	0
	Buyala-Kikubamutwe		5	47						5	0	0
Gillnets 5½"	Kalange-Makwanzi											0
	Mid section of the Reservoir											0
	Buyala-Kikubamutwe											0
Gillnets 6"	Kalange-Makwanzi							4		8		2
	Mid section of the Reservoir										22	0
	Buyala-Kikubamutwe			5	18	15						0
Total gillnets	Kalange-Makwanzi		38	46	38	20	24	42	28	43	41	2
	Mid section of the Reservoir										36	7
	Buyala-Kikubamutwe		28	99	22	37	4	11		18	13	11
Long line hooks	Kalange-Makwanzi		300	330	550	200	650	280		500	70	800
	Mid section of the Reservoir										50	0
	Buyala-Kikubamutwe		510	445	277	180	380	142	110	482	525	420
Beach seines	Kalange-Makwanzi											
	Mid section of the Reservoir											
	Buyala-Kikubamutwe			1								
Cast nets	Kalange-Makwanzi					5	4	1	1	5	1	0
	Mid section of the Reservoir										0	0
	Buyala-Kikubamutwe			1	6	3	1	1	3		7	2
Hand line hooks	Kalange-Makwanzi			91	105	124	26	3	18	88	35	4
	Mid section of the Reservoir										6	14
	Buyala-Kikubamutwe			394	97	152	32	16	8	5	51	24
Scoop nets	Kalange-Makwanzi					1	6	4	4	4	1	2
	Mid section of the Reservoir										6	3
	Buyala-Kikubamutwe			2	1	1		1	2	1	1	0
Monofilament nets	Kalange-Makwanzi										0	29
	Mid section of the Reservoir										21	0
	Buyala-Kikubamutwe										0	0
Traps	Kalange-Makwanzi											0
	Mid section of the Reservoir											0

3.6.2. Fish catch composition and catch rates

Eight fish species including *Bagrus docmak, Lates niloticus, Oreochromis variabilis, Tilapia zillii, Barbus altianalis, Synodontis afrofscheri, Mormyrus kannume,* and *Clarias gariepinus*, were landed at Transect 1 (Kalange-Makwanzi). The downstream transect recorded 3 species less than the upstream transect. The numberof species recorded from the reservoir were similar to those upstream transects further strengthening the notion of uniformity.

The current survey showed slight increase of catch rates for three key commercial fish species i.e. *L. niloticus, B. docmak,* and *O. niloticus*, at Upstream transect (Kalange-Makwanzi) compared with the April 2012 survey. On the other hand, the catch rates of *Mormyrus kannume* caught downstream at Buyala-Kikubamutwe and on the reservoir increased significantly probably due to the expansion of the basket trap fishery for bait.

Comparison of catch rates of key commercial fish species in the current survey with the last survey in a similar season September 2011 showed a large increase upstream at Kalange-Makwanzi. For instance, *L. niloticus* catch rates increased from 0.11 to 1.80kg/boat/day; *M. kannume* (0.70 to 1.50 kg/boat/day) and *B. docmak* (0.50 to 0.90 kg/boat/day) however a notable decrease for *O. niloticus* (0.61 to 0.40 kg/boat/day) was noted.

Results from the current survey indicate a general increase in fish catch rates at the upstream transect and a decrease at the downstream. This could be associated to changes in water levels at both the sites. There has been a general increase at the upstream site following the raising of water levels upstream in the course of building the reservoir. This is evidenced in the high catches of fishes that like high and fast moving waters like *B. altianalis* and existence of large sized hooks in the upstream and reservoir areas. Throughout all the surveys conducted at Transects 1 and 2 since September 2007, the fish catches at Kalange-Makwanzi have been characterised by higher species numbers and higher overall catch rates at both transects unlike in the current survey where most of the key commercial species recorded lower catch rates downstream compared all the earlier surveys.

Table 3.6.2 *Trend of fish catch rates (kg/boat/day) with all gears pooled, of the main fish taxa at the upstream, 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
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
		Mid section of the Reservoir									0.18	6
		Buyala-Kikubamutwe	0.39	0.1	0.03	0.21	0.17	0.06	0.83	0.16	0.94	1
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
		Mid section of the Reservoir									0.43	3.5
		Buyala-Kikubamutwe	0.52	0.15	1.01	0.79	1.3	0.38	1.97	3.58	1.41	1.5
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	
		Mid section of the Reservoir									0.3	0.3
		Buyala-Kikubamutwe	0.18	0.64	0.95	0.14		0.14	0.84	0.02	0.16	0.6
	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
		Mid section of the Reservoir									0.48	0.1
		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
		Mid section of the Reservoir									1.13	0.1
		Buyala-Kikubamutwe	0.06	0.38		0.01	0.15	0.04				
	Haplochromines	Kalange-Makwanzi	0.22		0.02	0.04	0.01	0.01	0.01	0.15	0.03	
		Mid section of the Reservoir									0.01	
		Buyala-Kikubamutwe		0.1		0.01		0.02	0.1	0.01		
Clariidae	*Clarias gariepinus*	Kalange-Makwanzi	0.08	1.22	0.18	0.07		0.04		0.22	1.77	0.5
		Mid section of the Reservoir									1.35	
		Buyala-Kikubamutwe		0.83	0.18							
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
		Mid section of the Reservoir									0.95	
		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
		Mid section of the Reservoir									115	23.5
		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	
		Mid section of the Reservoir										
		Buyala-Kikubamutwe										
Mochochidae	*Synodontis afrofischeri*	Kalange-Makwanzi	0.04		0		0.02	0.01		0.01	0.2	
		Mid section of the Reservoir									0.06	
		Buyala-Kikubamutwe	0				0.01					
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
		Mid section of the Reservoir									1	4.7
		Buyala-Kikubamutwe	0.28	0.31	0.23	0.19	0.39	0.06	1.04	0.61		2.3

3.63. Estimates of total fish catches

The total monthly catch estimates at Transect 1 increased from 4.5 t in April 2012 to 3.3 t in the current survey (Table 3.4.3). Comparing the similar period (September 2011) with the current survey (September 2012), the total monthly landing at the upstream transect were comparable while a 50% reduction is noted at the downstream transect from 3.3 to 1.3 t over a period of one year. The contribution of Mukene (*R. argentea*) that was only 30

captured at the reservoir in the current survey influenced the total production of the reservoir. However, there was market reduction in Mukene catch from 15.4 t in April to 2.6 in the current survey. This drop could be related to the seasonal nature of Mukene fishing that utilizes light to attract and concentrate fish in darkness and is thus influenced by the lunar cycle. It is only *M. kannume* that is landed to a magnitude of 0.8 t at the downstream transect, which illustrates the importance of the basket trap fishery at this transect. The only problem is that this fishery harvests young fish for bait and little for consumption that could easily cause nutritional problems.

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. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr 2010	Sept. 2010	Apr. 2011	Sept. 2011	Apr. 2012	Sept. 2012
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
		Mid section of the Reservoir									68.4	481.5
		Buyala-Kikubamutwe	198.3	67.6	24.4	191.6	109.9	25.8	195.3	73.5	396.7	128.6
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
		Mid section of the Reservoir									163.1	348.7
		Buyala-Kikubamutwe	263.5	89.2	741.2	707.8	840.6	163.5	463.5	1612.5	592.7	117.1
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	
		Mid section of the Reservoir									112.8	25.5
		Buyala-Kikubamutwe	93.5	378.5	696.7	124.4	-	60.2	197	907.8	70	10.3
	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
		Mid section of the Reservoir									184.2	8.0
		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
		Mid section of the Reservoir									429.5	6.4
		Buyala-Kikubamutwe	28.3	227.1	-	5	97	17.2	52.9	2.1		
	Haplochromines	Kalange-Makwanzi	46.8		7.9	9.8	6.6	4	4.68	108.3	6.7	
		Mid section of the Reservoir									3.5	
		Buyala-Kikubamutwe		62.2	-	7.5	-	8.6	24.5	3		
Clariidae	*Clarias gariepinus*	Kalange-Makwanzi	17.8	191.5	80.9	17	-	16			467	109.2
		Mid section of the Reservoir									515.5	
		Buyala-Kikubamutwe		538.1	135.5		-	-		159	-	-
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
		Mid section of the Reservoir									362.7	
		Buyala-Kikubamutwe	1388.3	210.9	863.2	482.8	1,357.90	679.7	266.6	1341	515.5	209.4
	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
		Mid section of the Reservoir									13,128	1,480.5
		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	
		Mid section of the Reservoir										
		Buyala-Kikubamutwe			-		-	-				
Mochochidae	*Synodontis afrofischeri*	Kalange-Makwanzi	8.1		1.8		13.2	4		10.4	52.8	
		Mid section of the Reservoir									22.9	
		Buyala-Kikubamutwe	0.6		-		6.5	-				
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
		Mid section of the Reservoir									381.8	374.7
		Buyala-Kikubamutwe	141.7	183.9	170.3	169.2	252.2	25.8	57.8	276		
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
		Mid section of the Reservoir									15,417.20	2,625.2
		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

3.6.4. Estimates of total beach value of the catch

Just like the monthly catch rates, the gross beach value of the fish landed at transects 1 and the landing site on the reservoir were estimated as UShs 7.5 and 3.8 million respectively (Table 3.4.4). The downstream transect at Buyala-Kikubamutwe recorded a six fold reduction from the value estimated in September 2011 to the current survey (20 m to 3.6 m respectively, Table 3.4.4). apart from Nile perch that attracts high price due to industrial processing for export market, its only *M. kannume* that fetches well over 2 million shillings at beach level at the DS transect, further strengthening the importance of the bait fishery. Overall, the monthly income to fishers at all landing sites in the study area has gone back to its level prior to impoundment (pre-September 2011).

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	Apr.2013
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
		Mid section of the Reservoir									226,200	1,564,791
		Buyala-Kikubamutwe	180,880	152,093	97,541	431,200	109,900	45,173	585,942	661,500	1,312,000	450,000
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
		Mid section of the Reservoir									447,400	746,126
		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
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	
		Mid section of the Reservoir									256,300	76,526
		Buyala-Kikubamutwe	111,172	560,620	1,045,083	186,657		126,485	196,980	18,750	159,000	30,857
	Oreochromis leucostictus	Kalange-Makwanzi			5,198	32,376	13,200					
		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
		Mid section of the Reservoir									402,000	23,914
		Buyala-Kikubamutwe		-	-	78,400	161,700	103,253	53,900			
	Tilapia zillii	Kalange-Makwanzi	170,908	161,368	161,123	167370	277,000	175,457	88,920	175,314	241,000	265,586
		Mid section of the Reservoir									1,000,000	19,131
		Buyala-Kikubamutwe	26,067	260,740	-	7,467	97,000	34,418	52,920	4,200		
	Haplochromines	Kalange-Makwanzi	46,846	-	2,356	4,902	3,300	2,991	3,744	54,154		
		Mid section of the Reservoir										
		Buyala-Kikubamutwe		62,189	-			6,453	19,600	1,500		
Claiidae	*Clarias gariepinus*	Kalange-Makwanzi	17,769	284,350	86,240	17,100		31,901		635,886	1,131,500	327,600
		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
		Mid section of the Reservoir									1,001,000	633,000
		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
		Mid section of the Reservoir									2,863,600	945,000
		Buyala-Kikubamutwe		216,418	1,436,842			415,671	1,568,000			
Cyprinodontidae	*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	
		Mid section of the Reservoir										
		Buyala-Kikubamutwe		-	-			-				
	Synodontis afrofischeri	Kalange-Makwanzi	1,615	-	554		9,900	1,994		10,400	52,000	4,992
		Mid section of the Reservoir									22,900	
		Buyala-Kikubamutwe	113	-	-		-	-				
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
		Mid section of the Reservoir									518,000	374,657
		Buyala-Kikubamutwe	100,300	169,522	170,310	338,488	201,760	36,999	14.4	331,200		2,105,357
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
		Mid section of the Reservoir									7,987,000	3,750,146
		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

The aggregated average unit cost price for the key commercial fish species at Transects 1 and 2 plus the reservoir, indicate that the unit price in the current survey is comparable to

the previous one (Table 3.4.5). However, all the prices of the major commercial species show a slight increase between April and September although some are much lower than September 2011. The slight increase in mean price could indicate a general increase in the national price index as result of inflation.

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 September 2012.*

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
Lates niloticus	900	1576	1583	2188	2423	2000	1813	3286	6429	2750	2785
Oreochromis niloticus	750	1189	1481	1409	1189	2000	2100	1000	2500	2300	3000
Barbus altianalis	800	1113	1577	1666	2250	1722	1594	2250	4000	2760	3370
Mormyrus kannume	786	708	922	983	1416	1310	1433	667	986	1400	1825
Oreochromis variabilis	550	937	1687	1450	1357	1929	2400	1000	2667	2200	2860

3.6.5 Estimated total catches and revenue of individual fishing units

The estimated mean monthly catch and revenue per fishing unit have consistently been higher upstream at Kalange-Makwanzi than downstream at Buyala-Kikubamutwe throughout all surveys from September 2007 to April 2011 (Table 3.6.6) but in the two last two previous surveys (September 2011 and April 2012) the DS transect recorded higher catches than the US. During this survey, the average monthly catch per boat at the downstream transect again higher at the US transect (144 kg/boat/month) more than double that of the DS (66 kg/boat/month). The fishers on the reservoir recorded higher catch rates per boat per day than DS and US fishers probably due to existence of Mukene.

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
Total catch (Kg/boat/month)	Kalange-Makwanzi	215	444	228	180	418	219	467	89	47	144
	Mid section of the Reservoir									307	389
	Buyala-Kikubamutwe	124	130	212	55	123	134	329	221	275	66
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
	Mid section of the Reservoir									1,227,000	883,296
	Buyala-Kikubamutwe	139,943	117,150	254,273	116,604	216,161	143,217	410,225	1,331,810	1,098,000	187,657

3.6.6 Socio-economic aspects of the fishery

Non-commercial uses of fish

At the upstream transect, on average 1.2 kg (approximately 20.4% of the catch) was retained by fishers for domestic consumption (Table 3.4.7). None of the fishers sampled on the reservoir and DS had part of the catch retained for domestic consumption. This

suggests a shift in the nutritional contribution of the fisheries to the families of the fishers on the reservoir and DS. This is explained by the major fisheries at the two sites; the mukene fishery (generally processed for animal feed industry) and the bait fishery targeting other major lakes for the reservoir and DS respectively.

Table 3.6.7. *Trends of the average weight of fish (kg/boat/day) retained by fishers for domestic use between September 2007 and September 2012. 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
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%)
Mid section of the Reservoir									1.5 (50 %)	
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%)	

Fishery related jobs

Fishing remained the most prominent job engaging 25 persons at US transect, 9 at DS transect and 13 in the reservoir in September 2012 (Table 3.6.8). Fishing was exclusively a male activity. On the other hand, the women dominated fish mongering and food vending. Like in the previous surveys, more fish traders were encountered at US transect in the current survey (16 women and 2 men) than at the DS transect (5 women and 1 man). US transect has higher catch rates and is near the urban centre therefore having higher number of fish mongers than the more remote DS transect. Other fishery related jobs show only very slight change between the September 2011 and September 2012.

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
Boat builders/repairers	Kalange-Makwanzi	M	2	1	3	3	3	1	2	3	3	2	2
		F											
	Mid section of the Reservoir	M											
		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
		F	4	3	5	4	2	4		3	3	3	3
	Mid section of the Reservoir	M											
		F											2
	Buyala-Kikubamutwe	M										3	3
		F		2									
Net repair(s)	Kalange-Makwanzi	M			5	4	4		3	5	5	3	3
		F											
	Mid section of the Reservoir	M											
		F											
	Buyala-Kikubamutwe	M		2		1			3			6	6
		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
		F											
	Mid section of the Reservoir	M											13
		F											
	Buyala-Kikubamutwe	M	26	30	42	47	46	30	34	30	30	15	9
		F											
Fish trader(s)	Kalange-Makwanzi	M	11	3	2	3	6	4	4	6	6		
		F	12	9	13	10	20	16	16	30	30		
	Mid section of the Reservoir	M											
		F											
	Buyala-Kikubamutwe	M	5	2		2	2	2	2				
		F	8	2		4	3	5	5	5	5		
Fish processor(s)	Kalange-Makwanzi	M										2	2
		F										15	15
	Mid section of the Reservoir	M											
		F											
	Buyala-Kikubamutwe	M			3							1	1
		F			5							5	5
Fish cleaner	Kalange-Makwanzi	M											
		F											
	Mid section of the Reservoir	M											
		F											
	Buyala-Kikubamutwe	M											
		F											
	Kalange-Makwanzi	M	1	1	1	1	1	1	1	1	1	1	1
		F											
		M											

3.7SCHISTOSOMIASIS, 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 and downstream, Kikubamutwe-Buyala. For comparative purposes, given the extent of the reservoir, a third transect was established in the mid reservoir where it runs up to 30 m deep and sampled similarly as at the other two transects.

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										
			April.06	Sept. 07	April. 08	April.09	Oct. 09	April. 10	Sept.10	April.11	Sept.11	Apr.12	Sep.12
Schistosomiasis Prevalence	*Mansonii*	Kalange-Makwanzi (upstream of the reservoir)	53	46	56	28	49	21	21.8	16	18	18.6	17
		Mid section of the Reservoir										20.5	16.5
		Buyala-Kikubamutwe (downstream)	48	43	40	22	33	19	16.7	18.6	21.8	19.6	20
	Haematobium	Kalange-Makwanzi (upstream of the reservoir)	0	0	0	0	0	0	0	0	0	0	0
		Mid section of the Reservoir										0	0
		Buyala-Kikubamutwe (downstream)	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
		Moderate	50	27.5	32	12	4	17	13.6	15	13.7	18.1	33
		Heavy	18	11.8	10	3	4	0	0	0	0	6.2	0
Prevalence by water contact	*Mansonii*	Fishing	71.4	94.4	60	68	79	62	31.4	21.9	24	28	27.8
		Fetching water	18.1	38.4	36.6	30.9	48	0	6.5	14.3	20	20.5	18
		Bathing/swimming	70	93.4	54.5	54.8	63	15	18.6	20	46	20.4	23
		Fish mongers	60	42.8	16.6	15	33	8	14.3	5	14	13.3	11
Snail Species abundance	*Bulinus sp.*	Kalange-Makwanzi (upstream of the reservoir)	10	21	14	8	23		19	37	85	17	251
		Mid section of the Reservoir										11	30
		Buyala-Kikubamutwe (downstream)	13	11	50	8	83		9	51	18	3	5
	Biomphalaria sp.	Kalange-Makwanzi (upstream of the reservoir)	22	31	26	25	20		63	182	33	26	26
		Mid section of the Reservoir										68	67
		Buyala-Kikubamutwe (downstream)	11	9	65	74	122		62	80	60	200	167
	Others	Kalange-Makwanzi (upstream of the reservoir)	127	39	51	135	67		101	455	81	8	72
		Mid section of the Reservoir										13	15
		Buyala-Kikubamutwe (downstream)	50	37	52	188	91		118	96	57	71	105
Coliforms in water	Shallow	Kalange-Makwanzi (upstream of the reservoir)	200	73	63	105	15	50	50	48	70	57	60
		Mid section of the Reservoir										79	80
		Buyala-Kikubamutwe (downstream)	50	87	73	100	10	87	80	82	81	82	76
	Deep	Kalange-Makwanzi (upstream of the reservoir)	40	10	43	15	1	1	1	1	2	79	80
		Mid section of the Reservoir										1	1
		Buyala-Kikubamutwe (downstream)	10	21	70	22	1	1	1	1	1	6	1

A total of 88 stool samples were collected from a population of 518 people. Of the 88 samples, 16 people (18.2%) were infected with Schistosomiasis. All infections were by the intestinal type of Schistosomiasis (*Schistosoma mansoni*).

Infection with Schistosomiasis was higher at the downstream site (20%) and lowest at the reservoir (Dam wall) transect (16.7%). None of the 88 samples tested positive for *Schistosoma haematobium*, a urinary type of Schistosomiasis.

Schistosomiasis prevalence has continued to reduce over the sampling period and at the downstream transect, it has levelled. The intensity of infection has remained light at 67%, slightly lower than what was observed during the last monitoring of infected patients. No Heavy intensity of infection was encountered. While heavy intensity seems to be under control, moderate intensity rose abit.

Fishing has remained the biggest predisposing factor to Schistosomiasis infection contributing to 27.8%, followed by bathing and swimming at 23%. Fish mongers had the lowest predisposition to the disease at 11%. As a corporate, social responsibility and ethical consideration, patients with the disease were treated under Directly Observed Treatment (DOTs).

Snail Vector abundance

Of the vector snail species, *Bulinus sp*, shot up at the upstream site Kalange transect accounting for 87.7% of the total *Bulinus sp* snails collected from the three transects. *Biomphalaria sp* abundance of up to 167 ind.m^{-2} at the downstream transect of Kikubamutwe is of concern because six of them shed Cercaria. At the upstream site, six *Bulinus sp* and two *Biomphalaria sp* shed cercaria. Cercaria shedding by the snails is an indicator of active transmission is taking place.

Faecal coli forms

At the shallow upstream site, 60 colonies per ml of faecal coliforms were measured while 80 colonies per ml in the mid of the reservoir were recorded. A comparable record of 76 Colonies per ml was measured at the downstream transect. Water from the deepest part of the reservoir registered low coliform count of 1 colony per 10 mls 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

No medically significant species of blackflies were detected in the area. 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. Therefore the risk of river blindness (onchocerciasis) is currently nil.

3.8.1 Conclusions

1. Fish species diversity and catch rates (by numbers) have declined upstream between April and September 2012.
2. The list of fish species expected from this section of the river (Upper Victoria Nile) appears to have been exhausted and new recoveries are least expected.
3. The reservoir created by the Bujagali Dam appears to have caused the apparent improvement in catches of table-fish species upstream. Popular species (*B. altianalis* and *M. kannume*) have been quickly established and their biomass is on the increase especially in the main reservoir next to the dam thus supporting a thriving local fishery.
4. Haplochromine species are yet to inhabit the reservoir. Species that were originally in these waters are on their way out. There could be a recolonisation of the reservoir by appropriately suitable haplochromine species.
5. The diet of Nile perch in Transect 1 has changed from dominance of haplochromine cichlids in the previous surveys to insects dominated by Odonata in the survey of September 2012. The change in diet of the species is attributed to scarcity of haplochromines in transect as reflected in the data recorded from the experimental gillnet catches of September 2012 (Refer to section on Fish Species Diversity). Similar changes were observed in the diet of *B. docmac* from a piscivorous diet in the survey of April 2012 to an insectivorous diet observed in September 2012.
6. Breeding intensity of keystone fish species was lower in September 2012 than in the previous survey of April 202 in all transects sampled. This was attributed to seasonal variations in the breeding cycles of the fish species
7. The community of zooplankton at the reservoir, upstream and downstream of the dam has ecological features comparable to the Lake Victoria community from which the Nile originates. Based on ecological resilience observed in Lake Victoria coupled with high species richness and numerical abundance, this community offers potential to support vibrant pelagic and other non-pelagic fisheries in the reservoir while maintaining the riverine fisheries in the upstream and downstream sites as well.
8. There was an increase of *Bulinus sp* at the upstream transect.
9. Other than water conductance, water clarity, soluble reactive silica, and algal biomass (Chl-a) whose environmental discharge standards are not given, the rest of the parameters conform to NEMA discharge standards.

3.8.2 Recommendations

1. The process of colonization of the main reservoir by fish species seems not yet complete. Entry in the reservoir fishery should still be restricted until more information on fish stocks in this water body is available.
2. Continue monitoring surveys until a clear picture especially on the fate of haplochromines in the main reservoir is established and to determine the response of the keystone fish species to habitat modifications resulting from the filling up of the Reservoir.

3. Regular environment monitoring of the dam is useful for early detection of water quality and biotic changes for timely institution of remedial measures.
4. The problem of disposal of faecal matter around the reservoir should be addressed urgently through appropriate health education and establishment of latrines.
5. There is need to intensify the control efforts especially the mass drug administration and health education in order to get the prevalence of Schistosomiasis dropping again. *Biomphalaria sp* vector abundance is unchanged and therefore we may have to consider sampling further downstream to rule out seasonal variations.
6. The monitoring campaign should be continued for at least one more year (2 sampling periods.

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Journal of environmental management **ISSN** 0301-4797 **CODEN** JEVMAW 2004, vol. 72, n°3, pp. 189-194 [6 page(s) (article)] (26 ref.)

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