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

Monitoring No. 9

Date: 9th – 12th September 2011

Monitoring carried out by:

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On behalf of :
Bujagali Energy Limited (BEL)

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1.0 BACKGROUND

The results reported on were from a monitoring survey No. 9 undertaken between 9 th and 12th September 2011 during construction period of the Bujagali Hydropower Project (BHPP). Two pre-construction, baseline surveys in April 2000 and April 2006 were conducted and so far, during construction phase of the project, eight monitoring surveys have been undertaken i.e. in September 2007, April 2008, April 2009, October 2009, April 2010, September 2010, April 2011 and the present one, in September 2011. 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 addition to the above mentioned studies, a soil pH survey was undertaken on 15th October 2011 in the area behind the reservoir whose filling started a week earlier. The findings of pH status in the catchment of the dam are also contained in this report.

2.0 GENERAL METHODOLOGY AND DATA COLLECTION

2.1. Materials and Methods

For six surveys including the September 2011, 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.

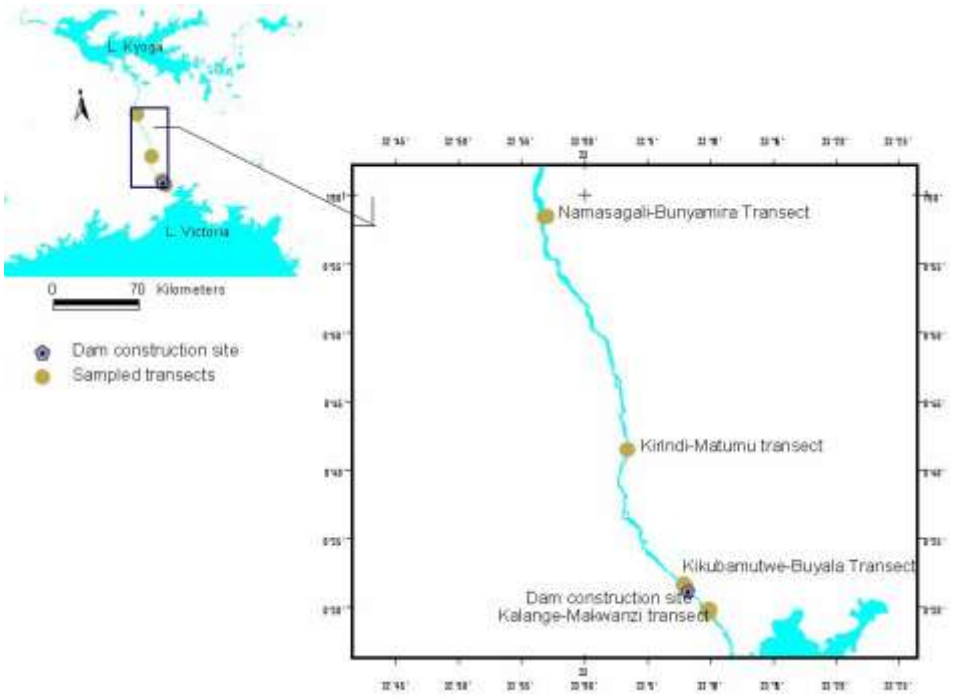

Figure 2.1a *A map showing the Upper Victoria Nile where the BHPP is located and river segments where baseline as well as monitoring samples were taken*



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 (NaFIRRI, April 2006, September 2007, April 2008, April 2009, October 2009, April 2010, September 2010 and April 2011).

Sampling procedures for soil pH

On the 5th of October 2011, soil samples were collected from five sites labelled 1 to 5 (Table 3.1.3) for pH analyses. Sample sites (1 and 3) were areas from which mud materials from jet grouting and stone crushing plants were buried. Soil samples were also

taken from sites 2, 4 and 5 as control comparative areas (i.e. these were natural sites intact from buried mud materials). Site 2 was an area on the western side of the river bank behind site 1 (the old quarry). Site 4 was a garden close to site 2 intercropped with maize and bean plants. Site 5 was a slope of a previously excavated area behind the main office buildings next to site 3.

From each of the sites, soil samples were extracted using a soil excavator from a profile at the top- 0 m, 0.5 m and 1 m. Soil samples were carefully collected, ensuring no contamination from other soils and placed in clean polyethene bags, labeled and delivered to NaFIRRI laboratory for processing of pH.

In the laboratory, triplicate soil samples were crushed to reduce on the clump sizes, weighed 50 g soil sub-sample and transferred into a 1 L graduated glass jar. To this jar 50 ml of freshly distilled water was added and the jar lid closed. The soil water sample mixtures were vigorously shaken for about one minute and left to stand for 5 to 10 minutes to allow all soluble substances to dissolve and the hard parts to sediment. The pH of the solution above the sediment was measured using a pre-calibrated pH meter (Model Cyberscan PD 300 meter; EUTECH waterproof Instruments).

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 at Kalange-Makwanzi and Buyala-Kikubamutwe transects*

Parameter	Site	Monitoring Dates								
		Aug.-08	Sept.-07	Apr.-08	Aug.-08	Oct-08	Aug.-10	Sep.-10	Aug.-11	Sep.-11
Dissolved Oxygen (mg/L)	u/s	4.2	7.2	5.6	4.5	5.9	6.7	5.4	4.8	6.3
	d/s	6.3	7.7	7	7.2	7.2	9.3	7.8	7.1	7.5
	NEMA Std	3	3	3	3	3	3	3	3	3
pH	u/s	7	7.3	8.2	6.7	7.6	6.8	7.1	7.4	7
	d/s	7.4	7.4	7.7	6.8	7.4	7	7	7.3	7
	Upper NEMA Std	8	8	8	8	8	8	8	8	8
	Lower NEMA Std	6	6	6	6	6	6	6	6	6
Temperature (°C)	u/s	26.7	26.1	26.2	26.4	25.7	25.6	24.8	26.4	28.9
	d/s	26.4	25.7	26.9	26.8	25	25.8	25.4	26.9	26.5
	Upper NEMA Std	35	35	35	35	35	35	35	35	35
	Lower NEMA Std	20	20	20	20	20	20	20	20	20
Conductivity (µS/cm)	u/s	118	112	81.1	95.5	96.9	87.3	100	128.6	116
	d/s	88.5	114	82.8	97.6	97.7	86.1	102.4	ND	113.7
Secchi Visibility (m)	u/s	1.9	1.6	1.9	2.2	2.2	2.3	2.2	2.2	ND
	d/s	1.7	1.8	1.8	2.3	1.9	1.9	2.1	2.5	1.5
Total Suspended Solids (mg/L)	u/s	2	2.7	4.2	7.9	3.7	3.5	2.9	3	2.4
	d/s	2	4.2	3.6	5.4	3.6	3.2	2.5	4.9	4.3
	NEMA Std	100	100	100	100	100	100	100	100	100
Oil & Grease (mg/L)	u/s	0.6	0.1	0.003	0.02	0.08	0.04	0.06	0.07	0.1
	d/s	0.9	0.8	0.002	0.06	0.52	0.08	0.08	0.08	0.15
	NEMA Std	10	10	10	10	10	10	10	10	10

Key:
Transect 1 (u/s): Kalange-Makwanzi
Transect 2 (d/s): Buyala-Kikubamutwe

The mean concentrations of dissolved oxygen (DO) at Kalange-Makwanzi, an upstream Transect and Buyala-Kikubamutwe, a downstream Transect were comparable over the monitoring period, with the upstream transect consistently having lower dissolved oxygen compared to the downstream transect (Table 3.1.1). The water was noted to be well aerated, with the current data showing concentrations of over 3 mgL^{-1} in both transects. The 3 mgL^{-1} is the minimum permissible concentration required for survival of most aquatic biota including fish, and is the permissible lower environmental discharge standard by National Environmental Management Authority (NEMA).

The mean pH at both transects was circumneutral and comparable to that of Lake Victoria. This pH, which had a variance of only 0.1 unit, was within the NEMA permissible range of 6 to 8.
Water temperature was comparable with the previous data and was within the permissible NEMA range of 20ºC to 35ºC.
The electrical conductivity of the water was slightly higher at the downstream by 8.7 µS/cm, but was comparable with previous data; this slight deviation was however, within acceptable ranges since the common recordings for unpolluted sites of Lake Victoria waters are around 120 µS/cm.
Water clarity was higher upstream compared to downstream, though had a small margin of 0.3 m. Total suspended solids were slightly higher at the downstream transect compared to the upstream, but were far below the permissible NEMA standard of 100 mg/L throughout the monitoring period. The concentration of oil and grease has generally remained higher downstream than upstream. Despite this observation, the concentration of oil and grease has remained far below the NEMA permissible upper limit of 10 mg/L throughout the monitoring period.

3.1.2 Nutrient (nitrogen, phosphorus and silica) concentrations

The concentration of ammonium-nitrogen (NH_4-N) has consistently remained low, with the downstream transect registering a relatively higher concentration. Throughout the monitoring period, the concentration of NH_4-N remained far below the NEMA permissible upper limit of 10,000µg/L. The relatively low nitrite-nitrogen (NO_2-N) was attributed to the rapid oxidation of the nitrite species to nitrate-nitrogen, and the concentration during the current survey was comparable with the previous ones. Other than in April 2008, October 2009 and April 2010, the concentration of nitrate-nitrogen (NO_3-N) has remained relatively lower than the permissible NEMA upper limit of 20,000µg/L. The relatively higher concentration of nitrate-nitrogen at the downstream transect was attributed to oxygenation of the lower species of nitrogen (i.e. NH_4-N & NO_2-N) from the upstream transect to nitrates. Though the concentration of Total Nitrogen (TN) was relatively higher at the downstream transect, the difference was minimal and both were less than five times the permissible NEMA upper limit of 10,000µg/L. During this recent survey, the concentration of soluble reactive phosphorus (SRP) was slightly higher at the downstream compared to the upstream transect with a variance of 1.9 µg/L. It is likely that there was a source of SRP above the upstream transect that led to the elevated concentration of this nutrient in the waters. Despite this possibility, the concentration of SRP was by far below the permissible NEMA upper limit of 5,000µg/L. Total Phosphorus (TP) concentration was slightly higher at the downstream transect, but was far below the permissible NEMA upper limit of 10,000µg/L at both transects. Since October 2009, the concentration of Soluble Reactive Silica (SRSi) has continued to drop, though with a relatively higher concentration at the downstream compared to the upstream transect.

Table 3.1.2 *Trends in mean concentrations of nutrients in water at Kalange-Makwanzi and Buyala-Kikubamutwe*

Parameter	Site	Monitoring Dates								
		Sept-08	Sept-11	Sept-08	Sept-08	Oct-08	Sept-10	Sept-10	Sept-11	Sept-11
Ammonium Nitrogen, NH_4-N (P g/L)	u/s	42.3	20.2	79.4	88	186.1	137.2	75.3	58	1.5
	d/s	29.5	24	97.9	79.4	136.6	111.8	68.2	45.8	2
	NEMA Std	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Nitrite-Nitrogen, NO_2-N (Pg/L)	u/s	8.7	9.5	4	3.1	2.9	4.2	7.3	4.7	2.9
	d/s	8.7	2.8	6.1	2.6	3.9	5.3	4.1	4.3	4
Nitrate-Nitrogen, NO_3-N (P g/L)	u/s	12.5	36	146.3	26.4	114.2	120.8	47.4	36.1	46.9
	d/s	12.6	9.4	182.5	35	75.9	148.6	49.2	54.7	68.2
	NEMA Std	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Total-Nitrogen, TN(P g/L)	u/s	1174	2093.5	1925	306.7	2361.7	1046.6	666.7	2196.3	1471.1
	d/s	1192.5	2138.8	2492.3	216.7	2420.5	2991.8	597.3	2103.7	1469.3
	NEMA Std	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Total Phosphorus, TP (P g/L)	u/s	108.6	54.5	58.5	60.3	35.9	186.3	84.6	30.3	22.2
	d/s	100.8	48.7	76.3	47.3	44.7	271.9	88.8	64.1	26.6
	NEMA Std	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Soluble Reactive Phosphorus, SRP (P g/L)	u/s	19	24.2	11.7	6.9	27.3	15.7	21.1	31.6	8.8
	d/s	19.2	27.7	18.9	16.6	32.4	24.8	25.6	20	11.7
	NEMA Std	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Soluble Reactive Silica, SRSi (P g/L)	u/s	319.9	539.7	238.4	501.2	858.5	521.1	265.9	149.6	33.8
	d/s	309.4	530.7	282.8	496.7	846.9	521.7	201.5	68.8	43.8

Key:
Transect 1 (u/s): Kalange-Makwanzi
Transect 2 (d/s): Buyala-Kikubamutwe

3.1.3 Status of Soil pH in the Catchment of Bujagali Hydropower Dam

Soil pH varied within and between sites (Table 3.1.3). At site 1, the surface soils (at 0 m) were moderately acidic with a mean pH of 5.47 whereas at 0.5 m below surface, the mean pH was 6.98, close to the neutral state. At 1.2 m, mean pH was 8.10, which is weakly alkaline, probably due to the buried mud materials. The low acidic soil pH at the surface (pH 5.47) and near neutral conditions at the sub-surface 0.5 m (pH 6.98) are typical of most natural soils in humid tropical areas where pH range between 5 and 7. Mean pH of soil at the surface (0 m) was 7.41 and 7.43 at the sub-surface (0.5 m) at site 3, showing slight alkaline conditions. At the same site at 1 m, mean pH was 6.28, slightly acidic condition. At sites 4, 2 and 5, the mean soil pHs were in the acidic range. At site 4 (the garden), pH ranged from 5.66 to 5.83, indicating moderately acidic conditions. This could be attributed to the presence of decomposing organic matter. At site 5 where the soils were typically reddish brown in colour, the soil pH ranged from 5.67 to 6.64, indicating a moderate to slightly acidic conditions

Table 3.1.3 *Mean and ranges of soil pH from BEL sites, 5th October 2011*

Site	Soil samples	Soil Profile	Sampled Depth (m)	No of samples	Mean pH	Standard deviation	Range	
							Minimum	Maximum
1	Treated mud from jet grouting (Old quarry)	Top soil	0.0	3	5.47	0.04	5.44	5.51
		Sub soil	0.5	3	6.98	0.07	6.90	7.04
		Sub soil	1.2	3	8.10	0.03	7.97	8.32
2	Natural sample near river bank	Top soil	0.0	3	5.84	0.07	5.78	5.91
		Sub soil	0.5	3	5.86	0.19	5.70	6.07
		Sub soil	1.0	3	4.59	0.02	4.56	4.60
3	Treated mud from crushing plant (Borrow pit)	**Top soil**	**0.0**	**3**	**7.41**	**0.02**	**7.40**	**7.43**
		Sub soil	**0.5**	**3**	**7.43**	**0.02**	**7.41**	**7.45**
		Sub soil	**1.0**	**3**	**7.43**	**0.02**	**7.41**	**7.44**
4	Moist mud from garden	Top soil	0.0	3	5.83	0.19	5.62	5.99
5	Control (near borrow pit)	Sub soil	0.0	3	5.66	0.02	5.67	6.64
	Distilled water			**3**	**6.54**	**0.01**	**6.53**	**6.55**

Table 3.1.4 *Explanation of the pH ranges*

pH Classification	Explanation
<3.5	Ultra acid
3.5-4.4	**Extremely acidic**
4.5-5.0	Very strong acid
5.1-5.5	**Strongly acid**
5.6-6.0	Moderately acid
6.1-6.5	**Slightly acid**
6.6-7.3	Neurtral
7.4-7.8	**Slightly alkaline**
7.9-8.4	Moderately alkaline
8.5-9.0	**Strongly alkaline**
>9.0	Very strong alkaline

Adapted from US Department of Agriculture, Natural Resources Conservation Service

According to pH range explanations (Table 3.1.4), observed pH values in the area sampled at the sites where mud materials were buried were alkaline and those that were from areas free of these materials were slightly acidic. These pH conditions conform to normal conditions in a tropical terrain with equatorial climatic conditions.

3.2 Fish Species Composition and Relative Abundance

3.2.1 Catch composition

A total of 8 fish species (haplochromines were taken as a single taxon group) were recorded at the two transects along the river compared to 10 in April 2011, 10 in September 2010 and 11 in April 2010 (Table 4.1). No new species was added to the list of fishes so far recovered from the study transects (Table 4.2). Thus 63 fish species of which 43 are haplochromines have so far been recovered from the two transects.
All recognised keystone species (*Barbus altianalis, Lates niloticus, Mormyrus kannume, Oreochromis niloticus* and the haplochromines) were recovered. *O. niloticus* was recovered only from the upper transect at Kalange while *L. niloticu*s and *M. kannume* and the haplochromines were got at both transects.
Quantities of *O. niloticus* continue to decline probably as a result of fishing pressure. The native tilapiine, *Oreochromis variabilis* which has persisted at Kalange was also recorded from Buyala. The upstream transect Kalange has consistently recorded higher densities of fish (3.36) than Buyala (1.5) fish per net per night. Catch rates and number of species caught upstream were however hampered by closure of water upstream at the existing Nalubaale and Kiira Dams on the first day of sampling, thus allowing little water downstream and leaving many of our nets on dry land. Haplochromines dominated the catch by numbers at both stations and weight at Kalange. *Lates* however dominated by weight at Buyala.
From all gears, 8 (8, 7, 9, 9) species were recorded at Kalange (Transect 1) and 5 (4, 10, 6, 6) at Buyala (Transect 2) (Numbers in brackets are for the number of species caught during the April 2011, September 2010, April 2010 and September 2009 surveys respectively). *B. altianalis, C. gariepinus* and *O. variabilis* were recovered only from Buyala while *O. niloticus* was only caught at Kalange.

3.2.2 The Haplochromines

17 species belonging to 10 genera of haplochromines were recovered during the survey (Table 4.2). The upstream transect - Kalange-Makwanzi yielded a higher haplochromine species diversity (13 species) than Buyala-Kikubamutwe - downstream (6 species).
Over the last five surveys, haplochromine diversity and abundance have consistently been higher at Kalange than Buyala. *Mbipia mbipi* contributing 40.2% of the haplochromines was the commonest haplochromine at the two transects followed by *Astatotilapia brownae* at 24.9%., *Astatotilapia "red dorsum"* 18.3%, *Paralabidochromis "scarlet anal"* 6.2%, *Paralabidochromis rock kribensis* 1.2% The rest of the species each contributed less than 1%.

Table 3.2.1 *Fish species recorded overtime at upstream (Kalange-Makwanzi) 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
				Apr. 2004	Sep. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011
Bagridae	*Bagrus docmak*	Catfish/(Sumutundu)	u/s		P			P				
			d/s		P		P					
Centropomidae	*Lates niloticus*	Nile perch/Mputa	u/s	P	P	P	P	P	P	P	P	P
			d/s	P	P	P	P	P	P	P	P	P
Characidae	*Brycinus jacksonii*	(Nsuga)	u/s									
			d/s	p								
	B. sadleri	(Nsuga)	u/s	p								
			d/s									
Cichlidae	*Oreochromis niloticus*	Nile tilapia/(Ngogo - kikati)	u/s	P	P	P		P			P	P
			d/s	P	P	P	P	P		P		
	O. leucostictus	Black tilapia/(Ngogo)	u/s	P	P							
			d/s	P	P		P					
	O. variabilis	Tilapia/(Ngogo)	u/s	P	P	P	P	P	P	P	P	
			d/s	P	P		P			P	P	P
	Tilapia zillii	Red-belly tilapia/(Ngogo)	u/s	P	P	P	P	P	P	P	P	
			d/s	P	P	P	P	P		P		
	Haplochromines	(Nkojo)	u/s	P	P	P	P	P	P	P	P	P
			d/s	P	P	P	P	P	P	P	P	P
Clariidae	*Clarias gariepinus*	Mudfish/ (Mala)	u/s			P	P					
			d/s			P	P		P			P
Cyprinidae	*Barbus altianalis*	Barbel fish/ (Kisinja)	u/s	P	P	P	P		P			
			d/s	P	P	P	P		P	P		P
	B. paludinosus	Barbel fish/ (Kisinja)	u/s									
			d/s	P								
	Labeo victorianus	(Ningo)	u/s									
			d/s		P					P		
	Rastrineobola argentea	Silver fish/(Mukene)	u/s							P		
			d/s	P	P		P			P		
Cyprinodontidae	*Aplocheilichthys pumilus*	Gandusia	u/s									
			d/s		P							
Lepidosirenidae	*Protopterus aethiopicus*	Lungfish (Mamba)	u/s						P			
			d/s				P					
Mochokidae	*Synodontis afrofischeri*	Tiger fish (Nkulungo)	u/s	P	P	P	P	P	P	P	P	P
			d/s		P	P	P	P	P	P		P
	S. victoriae	Tiger fish (Nkulungo)	u/s			P		P	P		P	
			d/s									
Mormyridae	*Mormyrus kannume*	Elephant snout fish (Karubihana)	u/s	P	P	P	P	P	P	P	P	P
			d/s	P	P	P	P	P	P	P	P	P
Total No. of species			u/s	10	10	10	8	9	9	7	8	5
			d/s	11	13	8	12	6	6	10	4	7

Key:
Transect 1 (u/s): Kalange-Makwanzi
Transect 2 (d/s): Buyala-Kikubamutwe

Table 3.2.2 *Haplochromine species recorded over time at the upstream (Kalange – Makwanzi) and downstream (Buyala – Kikubamutwe) transects.*

Genus	Species name	Site	Monitoring dates								
			1	2	3	4	5	6	7	8	9
			Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011
Astatoreochromis	*A. alluaudi*	u/s	P	P	P	P	P	P	P	P	P
		d/s	P	P	P	P	P			P	
Astatotilapia	*A. brownae*	u/s	P	P	P	P	P	P	P	P	P
		d/s		P	P	P	P	P	P	P	P
	A. "cylindrical"	u/s			P						
		d/s									
	A. "elongate"	u/s	P	P	P	P	P	P	P		
		d/s			P		P			P	
	A. "purple dorsum"	u/s		P							
		d/s									
	A. "red dorsum"	u/s				P	P		P		P
		d/s					P	P	P		
	Astatotilapia sp.	u/s			P	P	P			P	
		d/s		P	P	P	P				P
Gaurochromis	*Gaurochromis sp*	u/s		P							
		d/s									
Haplochromis	*H. lividus*	u/s									P
		d/s									
Harpagochromis	*H. guiarti*	u/s	P	P	P	P	P		P	P	P
		d/s	P		P	P	P		P		
	H. serranus	u/s									
		d/s	P								
Labrochromis	*L. humilior*	u/s		P							
		d/s									
Lithochromis	*Lithochromis sp*	u/s		P		P	P				
		d/s					P				
Lipochromis	*L. microdon*	u/s					P				
		d/s									
	L. parvidens	u/s			P			P			
		d/s							P		
Mbipia	*M. mbipi*	u/s	P	P	P	P	P	P	P	P	P
		d/s	P	P	P	P	P	P	P	P	P
Neochromis	*N. "elongate"*	u/s									
		d/s						P			
	N. greenwoodi	u/s	P							P	
		d/s		P							
	N. rufocaudalis	u/s		P	P	P	P	P	P	P	
		d/s		P							
Paralabidochromis	*P. "black para"*	u/s				P			P		
		d/s			P						P
	P. cyaneus	u/s									
		d/s	P								
	P. "earthquake"	u/s	P				P			P	
		d/s	P								
	P. flavus	u/s									
		d/s					P				P
	P. rock kribensis	u/s					P				P
		d/s									
	P. "scarlet anal"	u/s	P						P	P	P
		d/s					P				
	P. "yellow"	u/s									
		d/s	P								
	Paralabidochromis sp	u/s	P								
		d/s	P	P	P						
Prognathochromis	*P. "shovel mouth"*	u/s	P	P			P	P	P	P	P
		d/s				P			P		
Psammochromis	*P. aelocephalus*	u/s		P					P		
		d/s		P					P		
	P. riponianus	u/s	P	P	P	P	P		P	P	
		d/s	P		P		P		P		
Ptyochromis	*P. sauvagei*	u/s	P		P		P			P	P
		d/s	P		P				P		
Pundamilia	*P. "black"*	u/s		P	P	P	P	P	P	P	P
		d/s					P	P			
	P. "orange anal"	u/s		P							
		d/s									
	P. "orange tail"	u/s		P						P	
		d/s									
	P. "red tail"	u/s	P			P					
		d/s				P					
	Pundamilia sp	u/s		P							
		d/s									
Xystichromis	*X. phytophagus*	u/s	P			P		P	P		
		d/s									P
Unindentified	Haplochromines	u/s				P					
		d/s									
Total Number of Species		u/s	15	16	12	14	16	9	14	15	11
		d/s	11	8	10	9	12	5	9	3	6

Key:
Transect 1 (u/s): Kalange-Makwanzi
Transect 2 (d/s): Buyala-Kikubamutwe

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 higher upstream in Kalange (3.36) than downstream at Buyala (1.5). By weight, rates were essentially similar (102g) both upstream and downstream. At both transects, haplochromines recorded the highest rates in numbers (10.6 upstream and 1.4 downstream).By weight the haplochromines dominated upstream (246g) while *Synodontis afrofischeri* dominated downstream (17.4g) (Tables 4.3. and 4.4). Catches were generally poor during this survey; they declined from 4.54 to 3.36 upstream but slightly improved to 1.5 from 0.95 compared to the last survey in April 2011. Popular commercial fish species in the river i.e. *Mormyrus kannume*, *B. altianalis* and *O. niloticus* have continued to perform poorly (0.1, 0.01 and 0.01 by numbers respectively).

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 remained at 63. All large sized fish species expected at these transects have been recovered. Figure 4.1 indicates that further species recovery is unlikely.

Table 3.2.3 *Catch rates (numbers) of fish species caught over time by gillnets at the upstream (Kalange-Makwanzi) and downstream (Buyala-Kikubamutwe) transects*

Family name	Scientific Species name	English name/local name (Luganda)	Site	Monitoring dates								
				1	2	3	4	5	6	7	8	9
				Apr. 2004	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011
Bagridae	*Bagrus docmak*	Catfish/(Sumatundu)	u/s		0.03			0.08				
			d/s		0.07		0.04					
Centropomidae	*Lates albiticus*	Nile perch/Mpota	u/s	0.19	3.1	3.32	2.3	9.76	0.32	0.58	1.13	0.15
			d/s	1.12	1.68	1.86	2.29	2.57	0.35	0.4	0.16	0.72
Characidae	*Brycinus jacksonii*	(Nunga)	u/s									
			d/s	0.04								
	B. sadleri	(Nunga)	u/s	0.04								
			d/s									
Cichlidae	*Oreochromis albiticus*	Nile tilapia/(Nguga - lekati)	u/s	0.04	0.33	0.1		0.2			0.01	0.04
			d/s	0.07	0.41	0.04	0.04	0.1		0.1		
	O. leucostictus	Black tilapia/(Nguga)	u/s	0.04	0.09							
			d/s	0.06	0.08							
	O. variabilis	Tilapia/(Nguga)	u/s	0.17	0.91	0.43	0.45	1.52	0.06	0.17	0.19	
			d/s	0.13	0.08		0.17			0.02	0.02	0.03
	Tilapia zillii	Red-belly tilapia/(Nguga)	u/s	0.1	0.17	0.17		0.17	0.04	0.1	0.13	
			d/s	0.88	0.46	0.04	0.43	0.1		0.04		
	Haplochromines	(Nkujju)	u/s	9	10.46	6.63	19.04	15.5	5.83	4.5	12.7	10.6
			d/s	16.83	4.27	6.36	8.32	6.47	0.78	1.62	2.05	1.36
Clariidae	*Clarias gariepinus*	Mudfish/ (Malu)	u/s			0.03	0.17					
			d/s	0.01		0.25	0.07		0.03			0.02
Cyprinidae	*Barbus altianalis*	Barbed fish/ (Kisinja)	u/s	0.02	0.1	0.17	0.03		0.01			
			d/s	0.1	0.11	0.04	0.04		0.01	0.01		0.02
	Barbus gabelinensis	Barbed fish/ (Kisinja)	u/s									
			d/s	0.04								
	Labeo victorianus	(Nsugu)	u/s									
			d/s		0.09					0.02		
Lepidosirenidae	*Protopterus aethiopicus*	Lung fish (Mamba)	u/s						0.01			
			d/s				0.04					
Mochokidae	*Synodontis afrofischeri*	Tiger fish (Nkulungu)	u/s	0.21	0.63	0.08	0.42	1.46	0.46	0.33	0.13	0.38
			d/s		0.27	1.09	0.37	3.58	0.28	0.1		1.07
	S. victoriae	Tiger fish (Nkulungu)	u/s			0.08		0.21	0.29		0.17	
			d/s									
Mormyridae	*Mormyrus kannume*	Elephant snout fish (Kasulukuma)	u/s	0.32	0.8	1.83	0.7	0.08	0.23	0.18	0.22	0.04
			d/s	0.68	0.86	2.25	0.39	0.38	0.15	0.25	0.18	0.17
OVERALL RATES			u/s	2.89	5.48	4.39	7.54	10.01	2.87	2.41	4.54	3.36
			d/s	6.45	3.28	3.91	3.71	4.28	0.81	1.21	0.95	1.5

Key:
Transect 1 (u/s): Kalange-Makwanzi
Transect 2 (d/s): Buyala-Kikubamutwe

Table 3.2.4 *Catch rates (weight (g)) of fish species caught over time by gillnets at the upstream (Kalange - Makwanzi)*

Family name	Scientific Species name	English names/local names (Luganda)	Site	Monitoring dates								
				1	2	3	4	5	6	7	8	9
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011
Bagridae	*Bagrus docmak*	Catfish/(Semotondo)	u/s		37.53			28.58				
			d/s		22.50		0.6.93					
Centropomidae	*Lates nilotica*	Nile perch/Mpota	u/s	15.75	271.27	371.00	114.13	250.84	49.44	35.86	**11.6**	**8.6**
			d/s	108.21	107.79	159.07	111.00	171.43	28.81	39.28	**16.4**	**44.5**
Characidae	*Brycinus jacksonii*	(Nnoga)	u/s									
			d/s	3.25								
	B. sadleri	(Nnoga)	u/s	0.75								
			d/s									
Cichlidae	*Oreochromis niloticus*	Nile tilapia/(Ngege - kibati)	u/s	1.80	7.42	28.93		20.08			**0.5**	**6.7**
			d/s	4.53	0.18	3.93	0.93	5.05		0.83		
	O. leucostictus	Black tilapia/(Ngege)	u/s	3.67	6.61							
			d/s	5.75	6.75							
	O. variabilis	Tilapia/(Ngege)	u/s	33.54	49.04	63.30	44.73	82.76	14.87	19.54	**26.1**	
			d/s	11.58	12.08		8.17			4.04	**11.5**	**13.6**
	Tilapia zillii	Red-belly tilapia/(Ngege)	u/s	6.92	15.65	21.65		7.92	7.71	32.17	**21**	
			d/s	81.85	19.08	7.33	42.26	7.90		2.71		
	Haplochromines	(Nnejje)	u/s	303.92	191.92	168.08	534.33	383.24	167.67	113.11	**160**	**246**
			d/s	284.88	51.27	206.00	187.05	167.90	15.78	40.38	**37.7**	**15.3**
Clariidae	*Clarias gariepinus*	Mudfish/ (Male)	u/s			6.27	69.33					
			d/s	9.20		52.93	89.36		33.58			**3.1**
Cyprinidae	*Barbus altianalis*	Barbel fish/ (Kinioja)	u/s	19.27	403.33	501.13	7.27		2.31			
			d/s	48.88	22.93	95.57	9.36		4.03	5.73		**12.8**
	Barbus paludinosus	Barbel fish/ (Kinioja)	u/s									
			d/s	0.50								
	Labeo victorianus	(Ningo)	u/s									
			d/s		38.91					14.80		
Lepidonicenidae	*Protopterus aethiopicus*	Long fish (Mumba)	u/s						15.92			
			d/s				26.21					
Mochokidae	*Synodontis afrofischeri*	Tiger fish (Nkolongo)	u/s	10.92	49.50	4.58	14.92	56.79	59.63	18.75	**7.2**	**28.8**
			d/s		19.09	30.64	10.42	111.58	12.89	2.38		**17.4**
	S. victorian	Tiger fish (Nkolongo)	u/s			12.50		17.92	39.33		**28.1**	
			d/s									
Mormyridae	*Mormyrus kannuma*	Elephant snout fish (Kasokibura)	u/s	110.16	250.47	511.47	95.75	14.72	49.01	77.49	**39.7**	**7.5**
			d/s	217.37	89.54	175.64	185.00	51.62	9.22	33.36	**15.6**	**15.9**
OVERALL RATES			u/s	242.00	473.90	635.87	299.47	296.77	212.59	185.74	**141**	**102**
			d/s	502.77	137.22	257.05	241.69	170.83	82.81	104.11	**49.9**	**102**

Key:
Transect 1 (u/s): Kalange-Makwanzi
Transect 2 (d/s): Buyala-Kikubamutwe

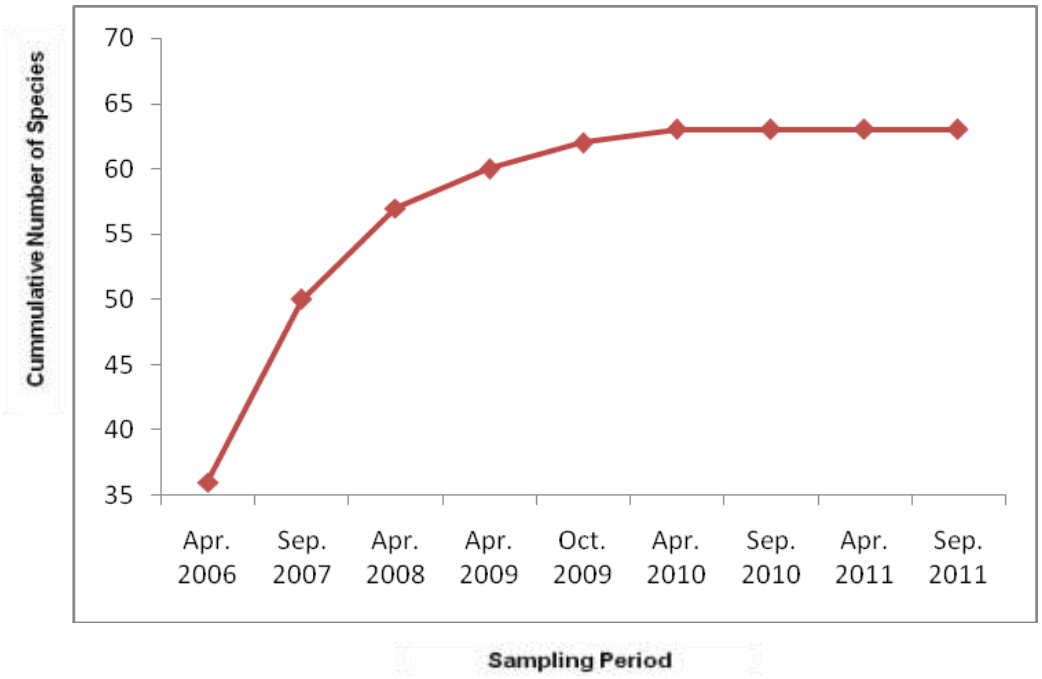

Figure 3.2.1 Cumulative *number of fish species recovered from the study transects on the Upper Victoria Nile between April 2006 and September 2011.*

3.3 The Food and Trophic Ecology of the Fishes

In this survey, September 2011, *Lates niloticus* (Nile perch) from Kalange-Makwanzi Transect ingested mostly fish (98.6%) of which 75.7 % were haplochromines (75.7%) and 22.9% were unidentifiable fish material. Odonata nymphs occurred as rare prey items by 1.4 %. Similarly, the diet of Nile perch in Buyala-Kikubamutwe Transect was dominated by fish as prey items by 76.7 %, The major fish preyed on were haplochromines (50%), followed by *Rastrineobola argentea* (24.3%) and unidentifiable fish material (2.4%). Odonata nymphs and unidentifiable insect material constituted 4.3 % and 19.0 % respectively. The dominance of fish prey in diet of Nile perch in Kalange-Makwanzi was also observed in the previous surveys of April 2011 and September 2010. Contrary, in Buyala-Kikubamutwe, insects were the major food item in the diet of Nile perch in April 2011 and in September 2010, *R. argentea* contributed significantly to the diet. *Caridina nilotica* which was a major food items for Nile perch in Kalange-Makwanzi in September 2010 was not encountered in the diet of Nile perch in the surveys of April 2011 and September 2011. The change in diet with time may be related to the availability and relative abundance of the prey items. *L. niloticus* has the capability of adjusting its feeding habits to take advantage of the most abundant food source. The absence of *Caridina* from the stomachs in the present survey reflects their scarcity in the area sampled.

In September 2011 survey, *Oreochromis variabilis* from Kalange-Makwanzi had ingested only insects (Ephemeroptera). However, in the previous surveys of April 2011 and

September 2010, algae dominated by blue-greens were the major food in the diet of the species, in addition to detritus, water plants, insects and zooplankton. Variation in diet of *O. variabilis* is due to seasonal changes in abundance of the food items ingested by the species. Specimens of *O. variabilis* from Transect 2 had empty stomachs.

The diet of *Oreochromis niloticus* in Kalange-Makwanzi in the September 2011 survey comprised mainly of detritus (32.1%), Ephemeroptera (26.6%), water plants (21.5%) and blue-green algae (10%). Other food items recorded in small quantities included green algae, diatoms, zooplankton, chironomids, and molluscs. The observations are similar to those of the previous surveys of April 2011 and September 2010 in the same transect.

Insects, comprising of chironomids (50%) and unidentifiable insect material, were the only prey ingested by *Mormyrus kannume* in Kalange-Makwanzi in the survey of September 2011. Dominance of insect prey in the diet of the species in the same transect was also observed in the previous surveys of April 2011 and September 2010. In Buyala-Kikubamutwe, *M. Kannume* ingested only insects comprising of Ephemerroptera (28.6%), chironomids (7.1%), Odonata (14.3%) and unidentifiable insect material (50%). However, in the previous survey of April 2011, *M. Kannume* from Buyala-Kikubamutwe also ingested fish and molluscs in addition to the dominant insect prey. This indicates flexibility in the feeding habits of *M. Kannume*.

The diet of *S. afrofischeri* from Kalange-Makwanzi in the September 2011 survey comprised of chironomids (40%) and unidentifiable insect material (60%). In April 2011, the diet of the species from the same transect was dominated by Ephemeroptera nymphs in addition to chironomid larvae. In Buyala-Kikubamutwe, chironomids (25%), Odonata nymphs (16.7%) and unidentifiable insect material (58.3%) were the food items ingested by *S. afrofischeri* in the survey of September 2011. Thus insects are still the major prey ingested by *S. afrofischeri* in the two transects.

Table 3.3.1 *Dominant food types of common fish species caught over time at the upstream (Kalange - Makwanzi) 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
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011
Centropomidae	*Lates niloticus*	Nile perch/ (Mputa)	u/s	FR	HAP	HAP	HAP	FR	HAP	HAP	HAP	HAP
			d/s	FR	CAR	FR	CAR	ODT	RAS	RAS	CHR	HAP
Cichlidae	*Oreochromis niloticus*	Nile tilapia/ (Ngege-Kibuti)	u/s	E	HPM	BGA	HPM	E	E	DTR	IR	DETR
			d/s	E				E	DTR	E	DETR	
	O. variabilis	(Ngege)	u/s	BGA	GRA	BGA	HPM	GRA	BGA	BGA	BGA	EPH
			d/s	BGA	E		HPM				E	E
	Tilapiazilli	Red-belly tilapia (Ngege)	u/s	MOL	HPM	E		E	IR	HPM	IR	
			d/s	HPM	CAR	E	HPM	E	HPM	HPM		
Clariidae	*Clarias gariepinus*	Mud fish (Male)	u/s			FR	FR				EPH	
			d/s			HAP	EPH		E			CHR
Cyprinidae	*Barbus altianalis*	Barbel fish (Kisinja)	u/s	E	INS	INS	INS		MOL	E	IR	CHR
			d/s	E	INS	INS			E	MOL		CHR
Mochokidae	*Synodontis afrofischeri*	Tiger fish (Nsulungu)	u/s	CHR	EPH		CAR	CHR	EPH	CHR	EPH	INS
			d/s		CHR	CHR	INS	CHR	INS	CHR		INS
Mormyridae	*Mormyrus kannume*	Elephant Snout fish (Kamilobwa)	u/s	INS	EPH	EPH	INS	EPH	EPH	EPH		CHR
			d/s	INS	EPH	INS	EPH	CHR	CHR	INS	EPH	INS

Key:Transect 1 (u/s): Kalange-Makwanzi
Transect 2 (d/s): Buyala-Kikubamutwe

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 September 2011 survey, five fish species out of the seven encountered in Kalange - Makwanzi were in breeding condition. 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 April 2011 survey, more fish species (seven) had mature adults in breeding condition. In Buyala-Kikubamutwe, breeding was only recorded in three species (*S. afrofischeri, B. altianalis* and *O.variabilis*) out of the six species examined. High breeding intensity in the Upstream when compared to the Downstream transect was also observed in the previous surveys of April 2011 and September 2010. All the specimens of *Lates niloticus* recorded from the experimental catches were found to be immature. Similar observations were made in the previous surveys (Table 3.3.2).

Table 3.3.2 Proportion *(%) of breeding fishes over time among commonly encountered fish species at the upstream (Kalange-Makwanzi) 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
				Apr. 2006	Sep. 2007	Apr. 2008	Apr. 2009	Sep. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011
Centropomidae	*Lates niloticus*	Nile perch/ (Mputa)	u/s	0	0	0	0	0	0	0	0	0
			d/s	0	0	0	0	0	0	0	0	0
Cichlidae	*Oreochromis niloticus*	Nile tilapia/ (Ngege-Kibati)	u/s	0	0	71.4	0	0	50	54.5	38.5	70
			d/s	0				0		0	0	
	O. variabilis	(Ngege)	u/s	12.5	0	22.2	55.2	0	50	38.1	46.3	50
			d/s	0	0		0			0	0	100
	Tilapia zillii	Red-belly tilapia/(Ngege)	u/s	0	0	0		0	0	83.3	42.9	
			d/s	7.1	25	100	0	0		0		
Clariidae	*Clarias gariepinus*	Mudfish(Male)	u/s			0	0				**100**	
			d/s			0	0		0			0
Cyprinidae	*Barbus altianalis*	Barbelfish/(Kisinja)	u/s	100	100	80	100		64.7	0	**64.3**	100
			d/s	12.5	100	100			0	100		100
Mochokidae	*Synodontis afrofischeri*	Tigerfish(Nkolongo)	u/s	20	100		70	91.7	90	88.9	**100**	87.5
			d/s		75	36.4	50	100	100	100		100
Mormyridae	*Mormyrus kannume*	Elephant Snoutfish/(Kasulubaru)	u/s	44.1	58.3	43.5	23.8	50	56.7	72.2	**59.3**	50
			d/s	37.5	41.7	27.1	54.5	33.3	0	33.3	**18.8**	20

Key:Transect 1 (u/s): Kalange-Makwanzi
Transect 2 (d/s): Buyala-Kikubamutwe

3.4. THE COMMERCIAL FISHERY

3.4.1 Fishing effort in the fishery

There was a four hold increase in the number of fishing boats upstream at Kalange-Makwanzi from a record 18 in April 2011 to 32 this survey. Likewise, the number of active fishing boats downstream at Buyala-Kikubamutwe increased by 25% from 12 April 2011 to 15 in the current survey (Table 3.4.1). The number of fishing boats downstream at Buyala-Kikubamutwe has retained the number recorded there in September 2010. There are observable changes within the upper and downstream transects however the total number of boats in the two transects appear to have no significant change over time a possibility of migration of fishers between the transects Fishers also appear to have been attracted to this area by incentives of the dam construction project which included free fishing boats and gears around 2008 and 2009. They may have reverted to the original businesses they were doing before as catch rates reduced and the given nets and boats aged. There are no signs of new boats entering the fishery. Gillnets remained the main fishing gear upstream at Kalange-Makwanzi where one third of the boats used the gear. Downstream at Buyala-Kikubamutwe the use of gillnets was insignificant while long lines and hand lines remained to be the dominant

gear in use and was used by more than three quarters of the fishing boats. The large gillnets of 6 inch mesh size supplied earlier by Bujagali Energy Limited (BEL) to the fishers at Buyala-Kikubamutwe were no longer in use. BMUs attribute their limited use to their low catches, an indication of lower stocks of large fishes.

At the upstream transect (Kalange-Makwanzi), about 70% of gillnets used were of ≥4 inch and the rest were 3.5 inches unlike ≤2.5 inch mesh encountered in the consecutive previous 4 surveys. At the downstream transect (Buyala-Kikubamutwe) all the 18 gillnets used were of ≥4 inch size. At the upstream transect (Kalange-Makwanzi), the total number of gillnets more or less doubled between the April 2011 and the current survey to the level it was in October 2010 while the number of long line hooks increased from 0 in April 2011 to almost more or less double the number in October 2010 in this survey (table 3.4.1) and a fourfold increase in long lines from between April 2011 and this survey at Buyala-Kikubamutwe. The other dominant fishing gears e.g. Cast nets and hand lines increased by five fold in the same period. The number of hand line hooks however reduced substantially at Buyala-Kikubamutwe. The boats targeting Mukene at both transects were not operational during this survey. 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.

Table 3.4.1. *The trend in numbers of fishing boats and fishing gears, upstream (US) at Transect 1 (Kalange-Makwanzi) and downstream (DS) at Transect 2 (Buyala-Kikubamutwe) from April 2006 to September 2011*.

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-10
Number fishing boats	US	9	10	7	22	18	23	23	18	32
	DS	13	17	23	26	32	23	15	12	15
Number of boats using gillnets	US		9	7	10	6	7	13	6	8
	DS		7	18	7	6	1	2		1
Number of boats using long line hooks	US		1	2	3	1	2	2	0	2
	DS		10	8	6	6	13	6	3	7
Number of boats using cast nets	US					5	4	1	1	5
	DS			1	6	3	1	1	3	0
Number of boats of boats using Hand line hooks	US			7	9	5	4	2	6	8
	DS			15	9	14	9	2	2	3
Number of boats using scoop nets	US					1	6	4	4	4
	DS			2	1	1		1	2	1
Number of fishing gears by mesh size										
Gillnets - 72½"	US		3			1			4	
	DS			1		10		2		
Gillnets 5"	US					3	1	6		
	DS			1	4			3		
Gillnets 5½"	US		3			1	1	4		5
	DS			25						
Gillnets 4"	US		30		21	8	2	26	20	20
	DS		20	4			1			13
Gillnets 4½"	US			21	5			2	2	12
	DS		3	12		6	1			
Gillnets 5"	US		2	25	12	1				
	DS		5	47						5
Gillnets 5½"	US									
	DS									
Gillnets 6"	US							4		8
	DS			5	18	15				
Gillnets >6"	US									
	DS			4						
Total gillnets	US		38	46	38	20	24	42	28	43
	DS		28	99	22	37	4	11		18
Long line hooks	US		300	330	550	200	650	280		500
	DS		510	445	277	180	380	142	110	482
Beach seines	US									
	DS			1						
Cast nets	US					5	4	1	1	5
	DS			1	6	3	1	1	3	
Hand line hooks	US			91	105	124	26	3	18	88
	DS			394	97	152	92	16	8	5
Scoop nets	US					1	6	4	4	4
	DS			2	1	1		1	2	1

3.4.2. Fish catch composition and catch rates

Ten fish taxa including *Bagrus docmak, Lates niloticus, Oreochromis niloticus, Oreochromis variabilis, Tilapia zillii, Barbus altianalis, Synodontis afrofscheri, Mormyrus kannume, Clarias gariepinus* and Haplochromines, were landed at Transect 1 (Kalange-Makwanzi). Unlike the only one previous survey, when all the species encountered at Transect 1 were the same recoded at Transect 2 (Buyala-Kikubamutwe) (Table 3.4.2) only six were recorded in this survey. Although haplochromines appear in insignificant proportions in the catch at the two landing sites, they are mainly harvested for bait to catch the large predatory Nile perch and *Bagrus*.

The current survey showed slight increase of catch rates for four key commercial fish species i.e. *B. docmak, O. niloticus, O. variabilis,* and *M. kannume* at Upstream transect (Kalange-Makwanzi) compared with the April 2011 survey. However, a decrease of catch rates of two main commercial species (*L. niloticus* and *B. altianalis* was also noted at Kalange-Makwanzi over the same period. On the other hand, the catch rates of three key commercial species (*Bagrus docmak, O. niloticus* and *Mormyrus kannume*) caught downstream at Buyala-Kikubamutwe decreased between the April 2011 and the current survey with an increase in *L. niloticus* and *B. altianalis* in the same period. Late niloticus recorded the highest ever recorded catch rate in both transects of about (3.6 kg/boat/day).

Comparison of catch rates of key commercial fish species in the current survey with the last survey in a similar season September 2010 showed a large decrease upstream at Kalange-Makwanzi. For instance, *L. niloticus* catch rates decreased from 0.76 to 0.11kg/boat/day; *M. kannume* (2.0 to 0.7 kg/boat/day) and *B. altianalis* (2.9 to 0.3 kg/boat/day) however a notable increase for *O. niloticus* (0.1 to 1.27 kg/boat/day) was noted. With exception of the decrease in catch rates of *O. niloticus* the key commercial species recorded increases in catch rates in and compared to September 2010 at the downstream transect (Buyala-Kikubamutwe).

Apparently there is no clear trend of fish catch rates at both the upstream and downstream transects. This scenario could be attributed to the continuous change in fishing gears that tend to target different fish species and/or sizes of fish. 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 unlike in the current survey where most of the key commercial species recorded lower catch rates compared all the earlier surveys. However the overall fisheries production could have been affected by inactivity of the Mukene fishers in both transects. Unlike earlier surveys most key commercial fish species indicated an increase in catch rates downstream compared to upstream.

Table 3.4.2 *Trend of fish catch rates (kg/boat/day) with all gears pooled, of the main fish taxa, upstream (US), at Transect 1 (Kalange-Makwanzi) and downstream (DS), at Transect 2 (Buyala-Kikubamutwe) from September 2007 to September 2011.*

Family	Species/taxa	Transect	Monitoring Period							
			Sep. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011
Bagridae	*Bagrus docmac*	US	0.85	0.71	0.4	0.77	0.88	0.15	0.89	0.5
		DS	0.59	0.1	0.85	0.71	0.17	0.86	0.83	0.16
Centropomidae	*Lates niloticus*	US	1.11	1.36	0.78	2.12	0.68	0.76	0.52	0.11
		DS	0.52	0.15	1.01	0.79	1.3	0.32	1.97	3.52
Clariidae	*Dinotopterus jacksonii*	US								
		DS								
	Dinotopterus sanlarii	US								
		DS								
Cichlidae	*Oreochromis niloticus*	US	1.5	1.05	0.86	2.21	1.16	0.1	0.48	1.77
		DS	0.12	0.68	0.95	0.14		0.14	0.34	0.02
	Oreochromis leucostictus	US			0.01	0.13	0.01			
		DS								
	Oreochromis variabilis	US	1.25	1.45	1.44	0.32	1.05	0.62	0.25	0.61
		DS				0.86	0.25	0.1	1.67	
	Tilapia zillii	US	0.32	0.9	0.25	1.04	0.21	0.22		0.12
		DS	0.06	0.32		0.01	0.15	0.04		
	Haplochromines	US	0.22		0.02	0.04	0.01	0.01	0.01	0.15
		DS		0.1		0.01		0.02	0.1	0.01
Claridae	*Clarias gariepinus*	US	0.05	1.22	0.13	0.07		0.04		0.22
		DS		0.25	0.13					
Cyprinidae	*Barbus altianalis*	US	2.52	6.72	3.92	5.11	2.27	2.87	1.66	0.28
		DS	2.72	0.35	1.17	0.54	2.1	1.52	1.13	2.92
	Barbus paludinosus	US								
		DS								
	Labeo victorianus	US								
		DS								
	Rastrineobola argentea	US					11.4	2.96	34.5	
		DS		1.02	5.3			3.05	58	
Cyprinodontidae	*Aplocheilichthys pumilus*	US								
		DS								
Lepidosirenidae	*Protopterus aethiopicus*	US		0.19	0.06		0.05	0.42		
		DS								
Mochokidae	*Synodontis afrofischeri*	US	0.04		1		0.02	0.01		0.01
		DS	1				0.01			
Mormyridae	*Mormyrus kannume*	US	2.21	6.72	2.55	0.45	1.31	2.15	0.25	0.7
		DS	0.28	0.31	0.25	0.19	0.39	0.06	1.04	0.61

3.4.3. Estimates of total fish catches

The total monthly catch estimates at Transect 1 reduced from 4.1 t in April 2011 to 2.8 t in the current survey (Table 3.4.3). Comparing the similar period (September 2010) with the current survey (September 2011), there was almost a twofold reduction from 5.0 t to 2.8 t over a period of one year. The contribution of Mukene (*R. argentea*) which had considerable impact on overall estimates in April 2010 and April 2011 was not captured in this survey because the canoes were not in operation at the time of the survey. However, comparing with September 2010, there was an increase from 2.0 t to 3,3 t. There was also slight increase in the total monthly catch estimates at Transect 2 from 3.2 t in April 2011 to 3.3 t in the current survey. Although there was a reduction in monthly

fish catches at upstream transect over the same period of the previous year (April 2011), the catches at the downstream transect over the two similar periods are comparable.

Table 3.4.3 *Trends of total monthly fish catch estimates (kg), upstream (US), at Transect 1 (Kalange-Makwanzi) and downstream (DS) atTransect 2 (Buyala-Kikubamutwe) between September 2007 and September 2011.*

Family	Species/Taxa	Transect	Monitoring dates							
			Sep. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr 2010	Sept. 2010	Apr. 2011	Sept. 2011
Bagridae	*Bagrus docmac*	US	11.3	33.1	182.5	68.4	52.8	59.8	33.9	355.1
		DS	198.3	67.6	28.4	191.6	189.9	25.8	195.3	73.5
Centropomidae	*Lates niloticus*	US	232.6	212.4	361.5	532.2	422.1	383.1	193.1	78.3
		DS	263.5	89.2	741.2	787.8	840.6	163.5	463.5	1612.5
Characidae	*Brycinus jacksonii*	US					-	-		
		DS					-	-		
	Brycinus sadleri	US					-	-		
		DS					-	-		
Cichlidae	*Oreochromis niloticus*	US	315	162.1	395.6	785.7	765.1	39.9	179	7.5
		DS	93.5	378.5	696.7	124.4	-	68.2	197	987.8
	Oreochromis leucastictus	US			3.5	32.4	6.6	-		
		DS			-		-	-		
	Oreochromis variabilis	US	261.7	224.1	665.3	221.8	679.4	271.2	623.6	434.9
		DS			-	52.3	161.7	43	53.9	
	Tilapia zillii	US	185.8	140.6	107.4	261.5	138.5	87.7	88.9	87.7
		DS	28.3	227.1	-	5	97	17.2	52.9	2.1
	Haplochromines	US	46.8		7.9	9.8	6.6	4	4.68	108.3
		DS		62.2	-	7.5	-	8.6	28.5	3
Clariidae	*Clarias gariepinus*	US	17.8	191.5	88.9	17	-	16		
		DS		538.1	135.5		-	-		159
Cyprinidae	*Barbus altianalis*	US	605.8	1,053.18	1,837.68	1,282.58	1,497.28	1,144.58	436.4	288.6
		DS	1388.3	218.9	863.2	482.8	1,357.98	679.7	266.6	1301
	Barbus paludinosus	US					-	-		
		DS					-	-		
	Labeo victorianus	US					-	-		
		DS					-	-		
	Rastrineobola argentea	US		1,243.88	-		6,463.88	2,189.58	2,152.88	
		DS			2,873.78		-	988.4	1,968.88	
Cyprinodontidae	*Aplocheilichthys pumilus*	US					-	-		
		DS					-	-		
Lepidosirenidae	*Protopterus aethiopicus*	US		38.5	25.4		33	191.4		
		DS			-		-	-		
Mochochidae	*Synodontis afrofischeri*	US	8.1		1.8		13.2	4		18.4
		DS	8.6		-		6.5	-		
Mormyridae	*Mormyrus kannume*	US	463.6	1,068.18	1,352.58	186.9	1,213.68	889.5	389.6	588.1
		DS	141.7	183.9	178.3	169.2	252.2	25.8	57.8	276
TOTAL		US	2148.5	3,187.48	5,821.88	3,238.38	11,298.98	5,848.48	4,897.38	2882
		DS	2114.2	3,888.38	5,585.88	1,748.78	2,825.88	2,884.28	3,247.88	3315.6

3.4.4. Estimates of total beach value of the catch

The gross value of the fish landed at transects 1 and 2 in the current survey was estimated at UShs 6.6 million and UShs 20.0 million respectively (Table 3.4.4). This was approximately one and a third the overall gross value estimated in April 2010 at the Upstream transect and about four fold increase for the downstream transect (4.4 m to 20.0 m respectively).

Table 3.4.4. *Trend of monthly gross value of fish catches (shs) at Transect 1 (Kalange-Makwanzi) and downstream (DS) at Transect 2 (Buyala-Kikubamutwe) between Septermber 2007 and April 2011.*

Family	Species/Taxa	Transect	Monitoring dates							
			Sep. 2007	Apr. 2008	Apr. 2009	Oct. 2009	Apr. 2010	Sep. 2010	Apr. 2011	Sep. 2011
Bagridae	*Bagrus docmac*	US	10,313	74,417	912,450	136,800	158,400	104,676	101,790	1,065,257
		DS	100,800	152,093	97,541	431,200	109,900	45,173	505,942	661,500
Centropomidae	*Lates niloticus*	US	66,602	336,182	640,702	997,705	759,700	549,553	868,725	274,000
		DS	415,276	141,247	2,223,704	1,087,573	1,821,328	296,450	1,100,988	12,255,000
Characidae	*Brycinus jacksonii*	US								
		DS								
	Brycinus sadleri	US								
		DS								
Cichlidae	*Oreochromis niloticus*	US	370,535	240,015	553,823	776,226	1,530,200	83,741	179,000	2,269.43
		DS	111,172	560,620	1,045,083	186,667		126,485	196,900	18,750
	Oreochromis leucastictus	US			5,198	32,376	13,200			
		DS			-					
	Oreochromis variabilis	US	245,286	378,091	960,656	277,385	1,358,800	650,786	623,610	1,159,790
		DS		-	-	78,400	161,700	103,253	53,900	
	Tilapia zillii	US	170,908	161,368	161,123	167370	277,000	175,457	88,920	175,314
		DS	26,067	260,740	-	7,467	97,000	34,418	52,920	4,200
	Haplochromines	US	46,846	-	2,356	4,902	3,300	2,991	3,744	54,154
		DS		62,189	-			6,453	19,600	1,500
Clariidae	*Clarias gariepinus*	US	17,769	284,350	86,240	17,100		31,901		635,886
		DS		799,034	270,947			-		
Cyprinidae	*Barbus altianalis*	US	670,221	1,660,815	3,215,889	1,923,750	2,245,800	1,823,982	872,820	501,429
		DS	1,505,215	332,592	1,366,671	801,522	2,580,010	1,083,347	799,600	6,705,000
	Barbus paludinosus	US								
		DS								
	Labeo victorianus	US								
		DS								
	Rastrineobola argentea	US		-	-		2,352,823	894,417	1,222,200	
		DS		216,418	1,436,842			415,671	1,568,000	
Cyprinodontidae	*Aplocheilichthys pumilus*	US								
		DS								
Lepidosirenidae	*Protopterus aethiopicus*	US		15,231	38,115		23,100	350,914		
		DS		-	-			-		
	Synodontis afrofischeri	US	1,615	-	550		9,900	1,994		10,400
		DS	113	-	-		-	-		
Mormyridae	*Mormyrus kannume*	US	328,240	977,422	1,327,914	89,110	1,743,943	1,160,277	389,610	450,082
		DS	100,300	169,522	170,310	338,408	201,760	36,999	14.4	331,200
TOTAL		US	2,236,250	4,127,892	7,912,939	4,422,724	10,476,246	5,830,689	4,050,469	6,595,705
		DS	2,379,023	2,690,454	6,611,098	3,731,317	4,971,698	2,148,249	4,377,904	19,977,150

The aggregated average unit cost price for the key commercial fish species at Transects 1 and 2, with comparable records from 2006 to 2011 surveys generally showed continuously increasing trend up to October 2009 survey (Table 3.4.5). However, apart from M. Kannume whose average price only slightly increased average price of all the other key commercial species doubled and were higher than highest ever recorded in October 2009 survey. The increase in price could be associated with the overall current inflation but also an increase in mean sizes of the fishes harvested mostly by long lines and the larger sized nets that attract high prices.

Table 3.4.5. *Trends of the mean unit prices (shs/kg) of the most common fish species at the beach level along the upper Victoria Nile between April 2006 and April 2011.*

Species/Taxa	Monitoring Dates								
	Apr-06	Sep-07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11
Lates niloticus	900	1576	1583	2188	2423	2000	1813	9286	6429
Oreochromis niloticus	750	1189	1481	1409	1189	2000	2100	1000	2500
Barbus altianalis	800	1113	1577	1666	2250	1722	1594	2250	4000
Mormyrus kannume	786	708	922	983	1416	1910	1433	667	986
Oreochromis variabilis	550	937	1687	1450	1957	1929	2400	1000	2667

3.4.5 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 3.4.6). During this survey, the average monthly catch per boat at the downstream transect was higher (221 kg/boat/month) more than double that of the upstream (89 kg/boat/month) but was still lower than that of April 2011 (329 kg/boat/month). The general reduction in catches could be possibly due to the non capture of Mukene in both transects while the observed improvement in catch in transect 2 is largely due to capture of large sized fish by the long line hooks.

Table 3.4.6 *Trend of monthly total catches and revenue of individual fishing units at Transect 1 (Kalange-Makwanzi) and downstream (DS) at Transect 2 (Buyala-Kikubamutwe) between September 2007 and April 2011.*

Parameter rate	Site	Monitoring Dates							
		Sep-07	Apr-08	Apr-09	Oct-09	Apr-10	Sep-10	Apr-11	Sep-11
Total catch (Kg/boat/month)	US	215	444	228	180	418	219	467	89
	DS	124	190	212	55	123	194	929	221
Total revenue (Shs/boat/month)	US	223,625	589,698	959,679	245,707	988,009	253,508	298,445	206,118
	DS	199,943	117,150	254,273	116,604	216,161	143,217	410,225	1,391,810

3.4.6 Socio-economic aspects of the fishery

Non-commercial uses of fish

At the upstream transect, on average 2.1 kg (approximately 60% of the catch) and 3.0 kg (about 46%) at Transect 2, was retained by fishers for domestic consumption (Table 3.4.7). This quantity compared to the average catch, it is a substantial proportion of the catch and may imply that fishing at the two sites is not entirely for commercial purposes

but for subsistence as well and makes direct nutritional contribution to the families of the fishers.

Table 3.4.7. *Trends of the average weight of fish (kg/boat/day) retained by fishers for domestic use between September 2007 and April 2011. 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
US	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%)
DS	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%)

Fishery related jobs

Fishing remained the most prominent job engaging 25 persons Transects 1 and 30 at Transect 2 in September 2011 (Table 3.4.8). 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 Transect 1 in the current survey (30 women and 6 men) than at Transect 2 (5 women only). Transect 1 has higher catch rates and is near the urban centre therefore having higher number of fish mongers than the more remote transect 2. There fishery related jobs did not change at all during the April 2011 and September 2011.

Table 3.4.8. *The numbers of people by gender (Male/ Female) engaged in different jobs at landing sites at Transect 1 (Kalange-Makwanzi) and downstream (DS), at Transect 2 (Buyala-Kikubamutwe) between April 2006 and April 2011*

Job description	Transect	Sex	Monitoring Dates								
			Apr-06	Sep-07	Apr-08	Apr-09	Oct. 09	Apr. 10	Sep. 10	Apr. 11	Sep. 11
Boat builders/repairers	US	M	2	1	3	3	3	1	2	3	3
		F									
	DS	M	5	2	4	2	2	3		1	1
		F									
Food vendors	US	M				1	1	2	4	1	1
		F	4	3	5	4	2	4		3	3
	DS	M									
		F		2							
Net repair(s)	US	M			5	4	4		3	5	5
		F									
	DS	M		2		1			3		
		F									
Cleaner fish landing	US	M									
		F									
	DS	M									
		F									
Fisher(s)	US	M	57	20	32	43	37	30	38	25	25
		F									
	DS	M	26	30	42	47	46	30	34	30	30
		F									
Fish trader(s)	US	M	11	3	2	3	6	4	4	6	6
		F	12	9	13	10	20	16	16	30	30
	DS	M	5	2		2	2	2	2		
		F	8	2		4	3	5	5	5	5
Fish processor(s)	US	M									
		F									
	DS	M			3						
		F			5						
Fish cleaner	US	M									
		F									
	DS	M									
		F									
Chairperson landing	US	M	1	1	1	1	1	1	1	1	1
		F									
	DS	M		1	1	1	1	1	1	1	1
		F									
BMU committee member(s)	US	M				6		4	5		
		F				3		5	4		
	DS	M				4	2	2	3	3	3
		F				2	1				
Landing site askali	US	M	1								
		F									
	DS	M									
		F									

3.5 SCHISTOSOMIASIS, RIVERBLINDNESS AND SANITATION STUDIES

3.5.1 Parasitological analysis of bilharzias in humans

A total of 108 stool samples were collected from 345 people. Of the 108 samples, 22 people (20.3%) were infected with Schistosomiasis (Table 3.5.1). All infections were of intestinal type of Schistosomiasis called *Schistosoma mansoni*.
Infection with Schistosomiasis at Kalange_Makwanzi transect rose from 16 to 18 % and at Buyala-Kikubamutwe from 18.6 to 21.8 %. None of the 108 samples tested positive for *Schistosoma haematobium*, a urinary type of Shistosomiasis.

Table 3.5.1 *Trend of Schistomiasis infection prevalence and intensity, schistosomiasis vector numbers, coliform counts among sample of people at Kalange-Makwanzi and Kikubamutwe-Buyala during monitoring survey April 2006 to September 2011*

Parameter	Variety	Site	Monitoring dates								
			April 06	Sept. 07	April. 08	April 09	Oct. 09	April. 10	Sept 10	April. 11	Sept 11
Schistosomiasis Prevalence	*Mansoni*	U/S	55	46	56	28	49	21	21.8	18	16
		D/S	48	45	48	22	55	19	16.7	18.6	21.8
	Haematobium	U/S	0	0	0	0	0	0	0	0	0
		D/S	0	0	0	0	0	0	0	0	0
Schistosomiasis Intensity	*Mansoni*	Light	52	68.8	59	35	77	83	86	87	86.3
		Moderate	38	27.5	32	12	4	17	13.6	16	13.7
		Heavy	18	11.8	18	3	4	0	0	0	0
Prevalence by water contact	*Mansoni*	Fishing	71.4	90.0	68	62	79	62	31.4	21.9	24
		Fetching water	18.1	38.0	36.6	38.9	48	0	6.5	14.3	28
		Bathing/swimming	78	93.0	94.5	94.8	85	15	18.6	28	48
		Fish mongers	68	42.8	16.6	15	33	8	14.3	6	14
Snail Species abundance	*Bulinus sp.*	U/S	18	21	14	8	25		19	37	85
		D/S	13	11	58	8	85		9	61	18
	Biomphalaria sp.	U/S	22	51	26	25	28		65	182	33
		D/S	11	9	65	74	122		62	88	68
	Others	U/S	127	59	51	135	87		181	456	81
		D/S	58	57	52	188	91		118	58	67
Coliforms in water	Shallow	U/S	288	75	65	185	15	58	58	48	78
		D/S	58	87	75	188	18	87	28	82	81
	Deep	U/S	48	18	45	15	1	1	1	1	2
		D/S	18	21	78	22	1	1	1	1	1

Since April 2010 to present, heavy intensity has remained nil. The majority of infected people at both sites had light intensity of 86.3. This suggests that the worm load in infected people is declining.

Transmission of Schistosomiasis through predisposal to water by fishing still remains high at 24 %. It was 21.9 % during April 2011 and 31.4% in September 2010. Predisposal to the disease through water fetching shows an increase in infection from 0 % in April

2010 to 6.5% in September 2010, 14.5% in April 2011 and 20 % during this monitoring period.

3.5.2 Snail vector abundance

Of the vector snail species, *Bulinus sp*, at Kalange transect accounted for 25.4% of the total snails caught and 43.4 % of all vector snails collected at both transects. Considering the last three sampling periods, *Bulinus sp* at the upstream transect has showed an upward trend in abundance while *Biomphalaria sp* numbers have reduced.

At the downstream transect, two vector snail specimens of *Biomphalaria sp* were found with Cercaria. One *Bulinus sp* at each of the transects shed cercaria. This coupled with prevalence figures indicate that active transmission is taking place. Total snail abundance from the two transects dropped by more than 50% to a figure found before April 2011.

3.5.3 Faecal coliforms

Water from the deep middle part of the river has consistently remained low (colony per 10mls of water) with coliforms over the monitoring period compared to that from the shallow human-water contact points which had heavy contamination of 70 and 81 colonies per 100mls upstream and downstream, respectively. Ten colonies and above are indicative of urgent need for health interventions to reduce the threat of disease and considered unsafe for human consumption. The micro-organisms of medical importance were predominantly *Salmonella sp* and *Shigell*a *sp.*

3.5.4 River-blindness vectors

To date, no medically important species of *Simulium sp.* (Black flies or commonly called Mbwa flies) have been found, implying the risk of transmission of river blindness (Onchocerciasis) is non-existent. Interviews with locals (10) suggested that there is an increase in the presence of *Glossina* flies (Tsetse fly). This will need further investigation.

4.1 CONCLUSIONS AND RECOMMENDATIONS

4.1.2 Conclusions

Most water quality parameters (pH, Dissolved oxygen, Total phosphorus, Total nitrogen, Total suspended solids, Oil and grease) conformed to NEMA discharge standards. Though water quality parameters e.g. conductivity, water clarity, and soluble reactive silica lack discharge standards for NEMA, they were similar to values observed in Lake Victoria.

2. River-blindness has not been detected since monitoring started. A downward trend of Schistosomiasis infection has been observed, probably due to BEL intervention of mass chemotherapy that has been provided to patients.

3. The composition of food organisms for keystone fish species in the two transects has remained stable except for the absence of *Caridina* and Mukene as key food items of the fish species in the April 2011 survey; they were major food items for the species in the previous surveys, especially in the Downstream transect.

4. April is a breeding season for most of the species encountered in the Upper Victoria due to the fact that a lower proportion of breeding adults was observed among most of the fish species examined in October 2009 when compared to the April 2009 and April 2008 surveys.

5. Fish species diversity has remained fairly constant upstream but has declined as indicated by catch per unit of effort from 1.21 in September 2010 to 0.95 fish per net per night in April 2011.

6. The list of fish species expected from the two transects appears to have been exhausted and new recoveries are least expected.

7. The popular table-fish species (*O. niloticus, B. altianalis* and *M. kannume*) were most affected by the decline due to possible overexploitation.

8. The number of fishing boats increased from 18 in April 2011 to 32 in September 2011 and number of gears increased e.g. long lines increased from 280 in September 2010 to 500 in September 2011, cast nets increased from 18 in April 2011 to 88 in September 2011

4.1.2. Recommendations

1. With the filling of the reservoir and flooded areas further upstream, surveys for assessing baseline conditions as new habitats emerge in such areas will have to be conducted and subsequently monitored.

2. Regular monitoring is essential in determining the direction in which the quality of the water is heading to so that corrective environmental management measures can be designed to correct any negative change.

3. Future monitoring surveys should reveal how different fish populations are coping with changes and provide insight into changes in the ecological and biological status of the keystone fish species due to dam construction.

4. Mass chemotherapy and behaviour change communication should be continually strengthened at both banks to avoid the risk of recurrence of heavy intensities of Schistosomiasis infection.

5. The local people reported occurrence of Tsetse flies in their areas. This needs to be investigated and specific recommendations made



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