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Fish Biodiversity in the Mkuze River

23-26 March 2009

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1. INTRODUCTION

Objectives of the following fish survey:

- Determine fish diversity in the Mkuze River system.
- Determine whether any Pongola fish species have entered into the Mkuze River system.
  [Water is taken out of the Pongolapoort Dam via canals into holding dams, for agricultural irrigation. Outflows from these, results in water from the Pongolapoort Dam infiltrating into the Mkuze River. The two systems are not naturally connected with each other.]

2. STUDY AREA

2.1. Background to Pongola and Mkuze Catchments

According to The Water Wheel (May/Jun 2009), the Pongolapoort Dam (sometimes called the Jozini Dam) was completed in 1973 amidst much controversy. It was built to provide water for irrigation for agriculture on the fertle Makatini Flats adjacent to the Pongola river floodplain. Alternative development options were not explored, due to the belief that development would follow impoundment. The Pongola floodplain, a biologically diverse ecosystem, occurs beneath the dam, providing habitat for a wide variety of organisms and providing resources for the ama-Thonga people. However, the natural system of the floodplain was upset by the building of the dam. Although scientists provided a flow regime from the dam which would maintain the floodplain ecosystem, it has never been put into practice, with negative impacts to the ecosystem and diminished resources to the local people. Today only 300ha of irrigation has been created. The Pongola river arises in Wakkerstroom and descends steeply through much of its catchment until it reaches the Pongola floodplain.

The Mkuze river arises in the Vryheid area, the catchment being in a high precipitation zone (1000mm pa average). The Mkuze river have been investigated for micro hydropower potential, for development of local communities (Barta, 2004). A consideration is the high sediment load in the river which may be detrimental to the hydro equipment. The river below the Mkuze Game Reserve, usually stops flowing during the dry winter months, available water being found in pools in the river bed and a series of pans which form the Mkuze Wetland System. The Mkuze Wetland system and Lake St. Lucia, into which it flows, form the St. Lucia System, which is recognized as a wetland of International Importance (Ramsar Convention, 1992). Lake St. Lucia forms half of the total estuarine area of South Africa (van Vuuren, 2007). According to Goodman (pers. comm.), the Mkuze river used to flow all along the eastern edge of Mkuze Game Reserve. At present it breaks out of its banks on the border and flows into the Nsumo Pan in the reserve, the outflow of which flows back into the Mkuze River. Due to human interventions over the years, (eg. digging canals: to take water to St. Lucia during the dought in the 1960's from Mpempe Pan, and; to take water to Tshanetshe Pan for livestock), the flow of the Mkuzi River below the reserve was

altered, flowing further south than before and resulting in the northern Mkuzi Wetland system not receiving as much water, and becoming drier. The Umsunduzi river (one tributary of the Mkuze river), forms the southern boundary of the reserve. It rarely flows. Overflows from canals built from the Pongolapoort Dam for irrigation, provide an additional source of water for the Mkuzi river.

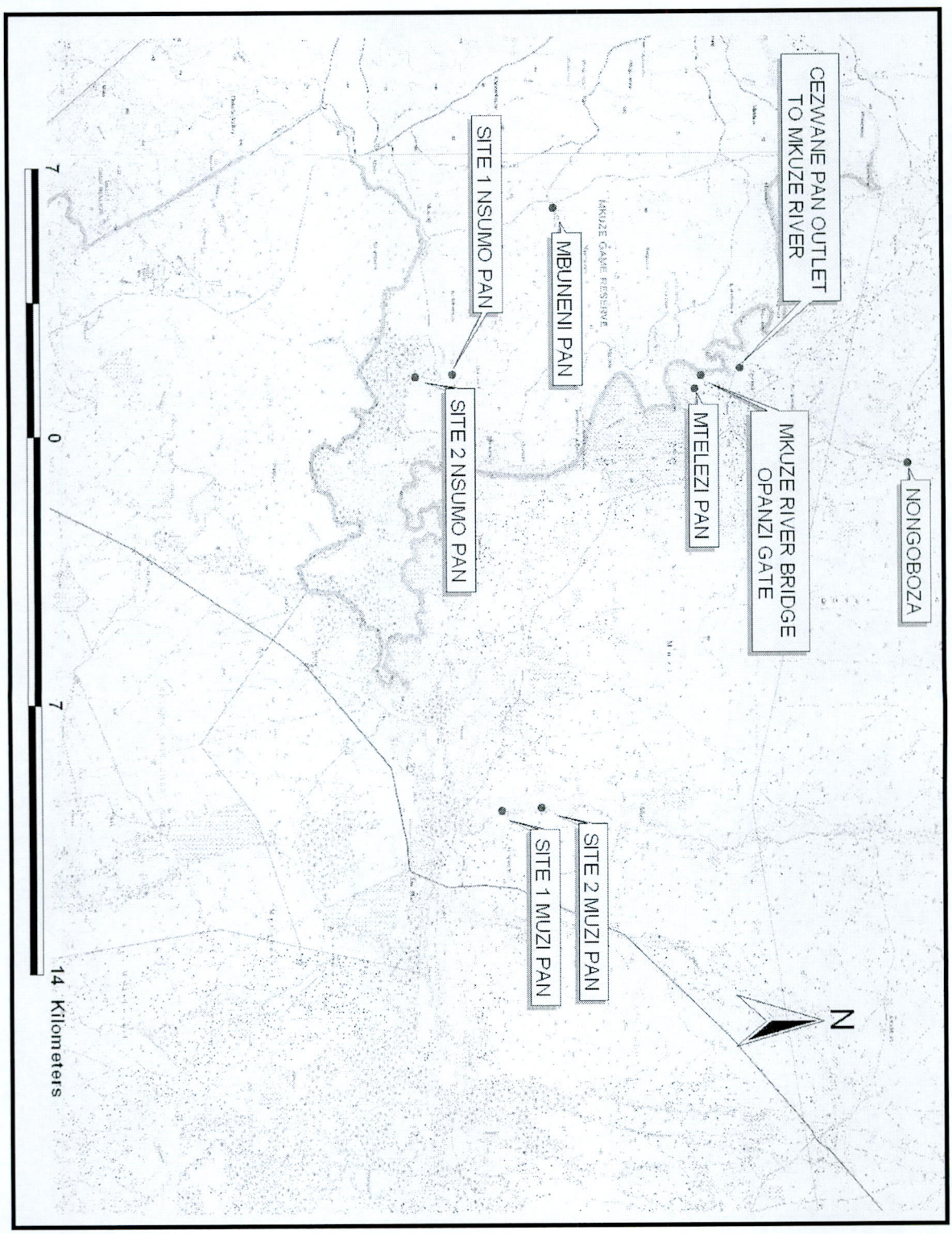

Figure 1a – Sampling Area 1

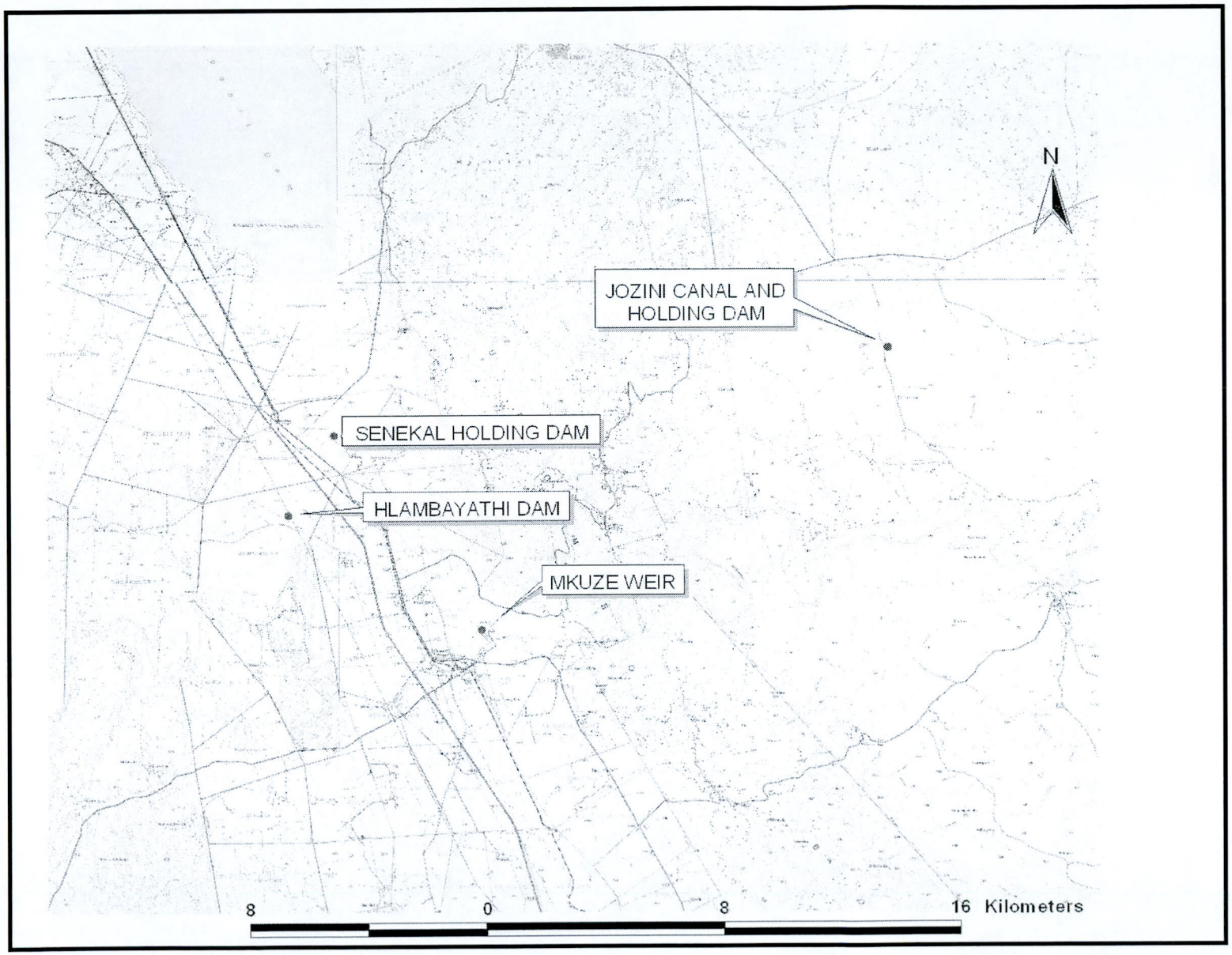

Figure 1b – Sampling Area 2

2.2. Sampling Area

Date of Sampling: 23-26 March 2009

Sampling Team: Rob Karssing, John Craigie, Skhumbuzo Kubheka, Lynne Stone (KZN Wildlife).

Map: See Figures 1a and 1b for maps of the sampling area with the sampling sites.

Sampling Areas: 13 Freshwater bodies in the Mkuze area, including temporary and permanent pans, rivers, dams and holding dams for irrigation purposes and the canal from Pongolapoort Dam. Details of each site is given in the Results section.

General Flow of Water in Sample Area: (See Figure 2 with site numbers indicated in brackets)

During the summer rainfall season the Mkuzi River overflows into various pans and into the St. Lucia wetland system. During the dry winter period, the river stops flowing, with water retained in pools and in pans. Some water flows into the river via canals from the Pongolapoort Dam for irrigation.

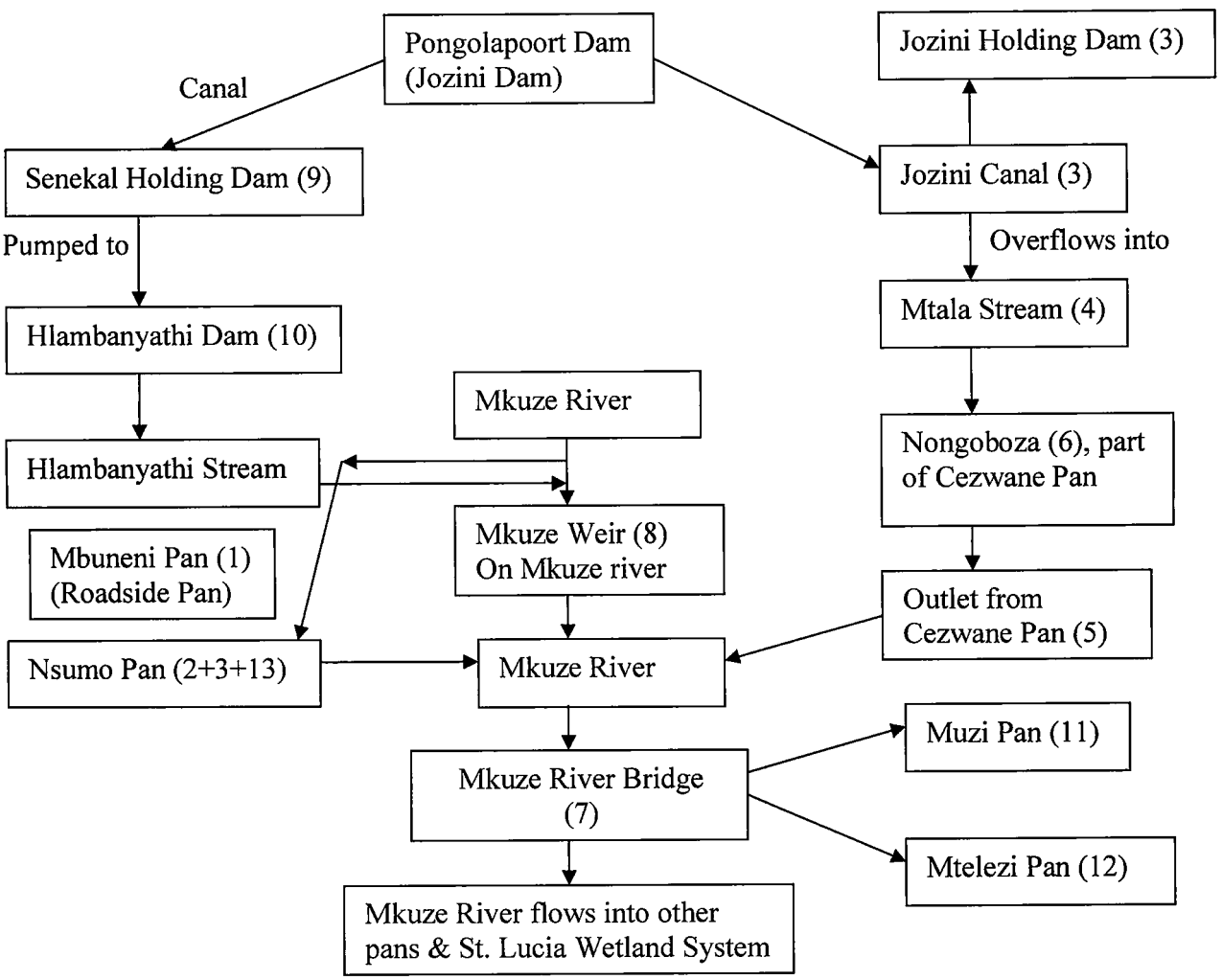

Figure 2. General Direction of Flow in Sample Area

River Zone

The Mkuze river in the sampling area is an example of a lowland river (UNISA, 2007), slow flowing due to reduced gradient, with sedimentation and high turbidity. It has warm water and is nutrient-rich, with many dissolved nutrients. The river alternates from lotic (flowing during the time of summer rainfall) to lentic habitat (pools and pans in the dry winter season). According to Goodman (pers. comm.), due to sedimentation, the river course often finds itself higher up than the surrounding area. When a break occurs in the river bank, the water will take the course of least resistance and change flow to the lower level. This occured when The Mkuzi River was diverted from its banks around the Mkuzi Game Reserve into the Nsumo Pan in the reserve.

Climate

According to Barnes, Ellery & Kindness (2002), the average annual temperature of the area is 21 to 23°C, with hot, wet summers and mild, dry winters. Precipitation varies from 1000 to 1100mm p.a. at the coast to only 600mm p.a. at the base of the Lebombo mountain range. Prior to rains falling in February 2009, there had been a severe drought in the Mkuze area. The vegetation type of the Mkuze Wetland System is known as Coastal Bushveld-Grassland.

3. MATERIALS AND METHODS

3.1. Materials

Electrofishing

- Portable Generator (220v) plus electrofishing probes
- Stopwatch for measuring electrofishing time
- Waders (to protect against bilharzia, and against electrical shocks from electrofisher)
- Nets with long rubber handles (for scooping up stunned fish and protecting against electrical shocks).

Storing captured fish

- 5L plastic container with lid
- Small net for transfer of fish from container into bottle
- Wide-necked plastic bottles (sizes 1 liter and 350ml) half-filled with a 10% formalin mixture (10% formalin and 90% water) and transported in plastic crates.
- Thread tape (Plumbing) for sealing sample bottles.

Recording Information

- A fish expert and fish books for identification of fish
- Fish Data sheets (Appendix A)
- B type pencils to prevent fading of writing
- Paper card for labels (thin paper can disintegrate)

Other

- 15m seine net
- GPS (Trimbel Recon)
- Hanna H1991300 Portable [pH, EC, TDS, Temperature meter
- Hanna H19143 Portable DO Meter
- Boat and oars.
- Packed lunch, water, tick spray, sunscreen, hats, Polaroid sunglasses.

3.2. Methods

Sampling Site Selection.

Members of the sampling team with a knowledge of the area, in consultation with the KZN Wildlife District Conservation Officer, Hannes de Bruyn and staff from Mkuze Game reserve, selected sampling sites. Permission was obtained from private landowners to sample on their property.

Electrofishing

One person operated the electrofisher, while another one or two persons followed the operator from a downstream position, scooping the stunned fish in nets and then transferring them into the container (half-filled with water), held by the fourth person on the bank, (who kept the lid on, making sure the fish did not escape). All persons in the water wore waders. The person on the bank was also the lookout for hippos and crocodiles.

Seine Net

One person held one end of the net, while another person walked out slowly into the water body and then back towards the shore in an arc shape. The two ends of the net were then brought together. Fish captured in the net were then removed by hand into container.

Recording Information

A manual data sheet was filled out at each site (Appendix A). The information was also recorded Trimble GPS. At the office, the data was transferred or downloaded to a spreadsheet, which was in turn downloaded into the KZN Wildlife biodiversity database.

Preserving captured fish

Fish were removed from container with small net. Preserved specimens were placed in bottles with the formalin solution. As a precaution, bottle tops were applied immediately to prevent fish from splashing formalin into the eyes. If this happens, the eye must be flushed with water for 15 minutes (Protea Chemicals – Cape, 2007). Once the fish had been subdued, threading tape was applied to bottles to prevent leakage during transport. A label was then written on card giving the site name, date, time, sampling methods and times spent sampling. Water quality measurements were sometimes also recorded on the label, together with the number of each species retained or returned to the water.

Water Tests

TDS (Total Dissolved Solids)

This is the amount of solids dissolved in water, mainly minerals, measured in ppm (parts per million) and is dirctly related to Electrical Conductivity.

EC (Electrical Conductivity)

This is the ability of water to conduct electrical current, and is directly related to the TDS. Salts dissolve in water and form ions that conduct electricity. Distilled water has no dissolved salts and thus has an EC of 0. EC is also related to water temperature – the higher the temperature, the higher the EC (2-3% increase in EC per 1 degree Celsius increase of water temperature).

pH

This is a value between 0 and 14 with 7 being neutral. The higher the hydrogen ions (H^+) concentration in water, the lower the pH (ie. the more acidic). The lower the hydrogen ions (H^+) concentration in water, the higher the pH (ie. the more alkaline).

4. RESULTS

4.1. Site Data

(See Table 1)

Table 1 – Site Data

Site	Location	Date+Time	GPS Points	Description	Method	General
1	**Mbuneni** Roadside pan Mkuze Game Reserve (GR)	2009/03/23 03:48:37pm	-27.63270°S 32.26287°E	Small, shallow, muddy, ephemeral pan approximately 30cm deep, in sunny position	Electrofishing: 7 min. 9 secs.	No Fish Collected. Mud Substrate
2	**Drainage line leading into Nsumo Pan** (Mkuze GR)	2009/03/23 04:34:02pm	-27.65661°S 32.30156°E	Shaded by trees. Clear water, approximately 30cm deep	Electrofishing: 2 min. 11 secs.	No Fish Collected. Mud Substrate
3	**Jozini canal and holding dam** (Mkuze district)	2009/03/24 09:07:17am	-27.52063°S 32.16626°E	Holding dam in the Mkuze district that stores water fed from the Pongolapoort Dam	Electrofishing: Canal (3 mins.) Dam (3 mins.). 2 net hauls in holding dam.	Mud Substrate
4	**Mtala Stream** headwater below canal (Mkuze district)	2009/03/24 09:42:28am	-27.52054°S 32.16665°E	Outflow from Ponglapoort Dam that leads into Mkuze system (From Site 3).	Electrofishing: 5 mins.	Mud and clay substrate
5	**Cezwane Pan outlet** to Mkuze River (Mkuze district)	2009/03/24 2:18:46pm	-27.58974°S 32.30031°E	Electrofished upsteam and downstream of road causeway.	Electrofishing: 14 mins.	Deep sand/mud substrate
6	**Nongoboza**, above bridge (Mkuze district)	2009/03/24 02:13:28pm	-27.55062°S 32.32286°E	Permanent pan	Seine Net – 1 Haul. High conductivity unsuitable for electrofishing	Sand substrate
7	**Opanzi Gate, Mkuze River Bridge** (Mkuze district)	2009/03/24 03:37:27pm	-27.59868°S 32.30203°E	River upstream of road bridge, outside Opanzi gate, Mkuze Game reserve	Electrofishing: 5 mins.	Sand substrate
8	**Mkuze Weir** (Mkuze district)	2009/03/25 09:38:12am	-27.60557°S 32.04324°E	Electrofished in river below weir, plus a net haul in river and in weir.	Electrofishing: River (10 mins) Seine Net: River (10 mins) Weir (No Fish)	Sand Substrate
9	**Senekal holding dam** (Mkuze district)	2009/03/25 01:30:50pm	-27.54641°S 31.99849°E	Long, rectangular holding dam for irrigation of sugar cane (approx. 4 ha.)	Seine Net: 3 hauls in opposite corners of dam next to road.	Mud substrate See Figures 4 & 5

10	**Hlambanyathi Dam** (Mkuze district)	2009/03/25 03:52:38pm	-27.57063°S 31.98465°E	In Private Nature Reserve. Miminal vegetation around dam due to fluctuating water level of irrigation dam.	Electrofishing: 3 mins. Seine Net – 2 hauls	See Figures 3, 6 and 7
11	**Muzi Pan** (Mkuze district) **Site 1**	2009/03/26 10:28:59	27.64547°S, 32.40393°E	Permanent Pan. Sampled on eastern shore.	Electrofishing: 10 mins.	Mud Substrate
	Muzi Pan Site 2	2009/03/26 12:56:03pm	-27.63618°S, 32.40320°E	Permanent Pan. Sampled in little bay	Electrofishing: 18 mins. Seine Net Haul: 1 from bank. 1 from boat (no fish captured).	Mud Substrate See figures 9 and 10
12	**Mtelezi Pan** (Mkuze district)	2009/03/26 02:41:16pm	-27.60033°S 32.30506°E	Roadside pan	Electrofishing: 5 mins (no fish captured).	Mud Substrate
13	**Nsumo Pan** (Mkuze Game Reserve) Sampling 1	2009/03/23 04:30pm	-27.66528°S 32.30206°E	Shallow water on edge of pan next to road.	Electrofishing: 2 mins .Electrofisher not functioning correctly	Mud and sand Substrate
	Nsumo Pan (Mkuze Game Reserve) Sampling 2	2009/03/26 03:44:54pm	-27.66528°S 32.30206°E	Shallow water on edge of pan next to road.	Electrofishing: 10 mins. Seine Net: 1 Haul	Mud and sand Substrate

Figure 3 – Crocodile taking an interest in the samplers, near Seine Net Haul 2
(L. Stone, Hlambanyathi Dam, 25 March 2009)

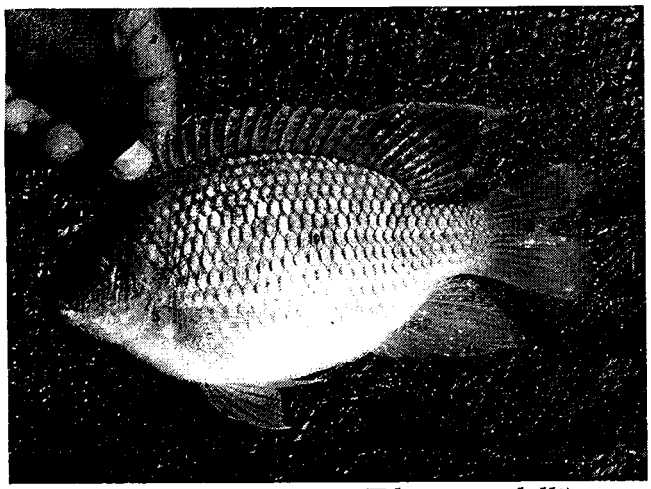

Figure 4 - Redbreast Tilapia *(Tilapia rendalli)*
(J.Craigie, Senekal Holding Dam, 25 March 2009)

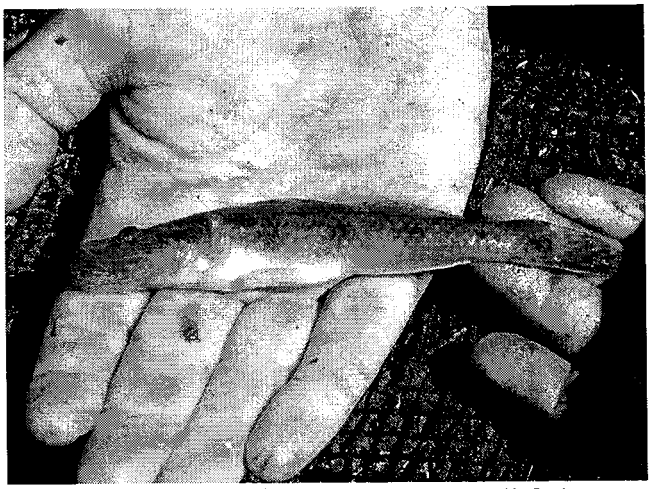

Figure 5 - River Goby *(Glossogobius callidus)*
(J.Craigie, Senekal Holding Dam, 25 March 2009)

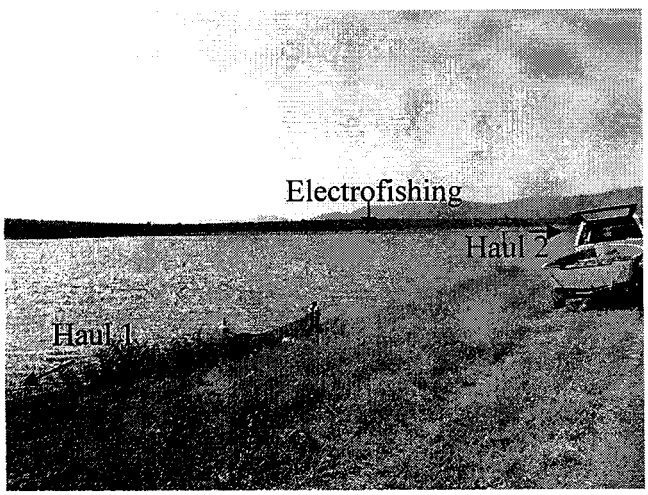

Figure 6 - Standing on Hlambanyathi dam wall.
(L. Stone, Hlambanyathi Dam, 25 March 2009)

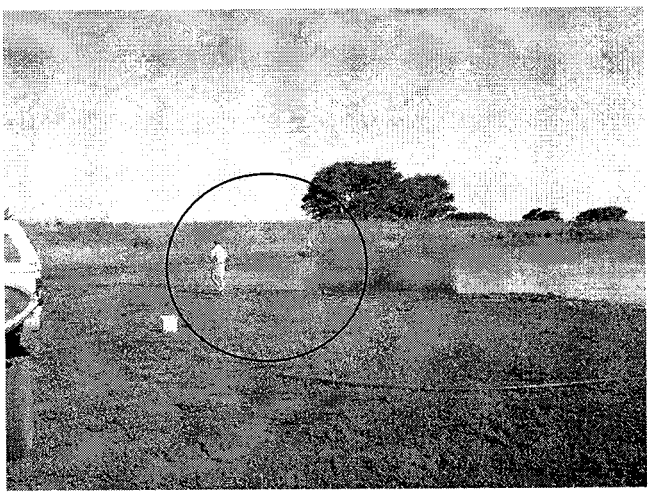

Figure 7 – Seine Net Haul 2
(L. Stone, Hlambanyathi Dam, 25 March 2009)

Figure 9 – Seine net haul from bank of pan.
(L. Stone, Muzi Pan, 26 March 2009)

Figure 10 – Seine net haul from boat.
(L. Stone, Muzi Pan, 26 March 2009)

4.2. **Fish Diversity** (See Table 2)

Table 2 – Fish Diversity

	Jozi	Mtal	Cezw	Nong	Opan	Weir	Sene	Hlam	Muzi	NP
Fish Species Site	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**13**
Barbus paludinosus (Straightfin Barb)			2	2		1			6*	*
Barbus toppini (East Coast barb)			2			3				*
Barbus trimaculatus (Threespot Barb)	1			*	2	8		2/A	1	1*
Barbus viviparus (Bowstripe Barb)										11
Brycinus lateralis (Astriped Robber)			3		2	1				1
Clarias gariepinus (Sharptooth Catfish)			2						3	*
Glossogobius callidus (River Goby)	1			*		1	2/6	2/A	4*	3*
Glossogobius giuris (Tank Goby)	1									
Labeo cylindricus (Redeye Labeo)	1									
Labeo molybdinus (Leaden Labeo)				*		3			1	2*
Mesobola brevianalis (River Sardine)	4					1		3/A	2*	2
Oreochromis mossambicus (Mozambique Tilapia)	1	2	7			4				1*
Pseudocrenilabrus philander (Southern Mouthbrooder)	1	2	2	*		1			3*	5
Tilapia rendalli (Redbreast Tilapia)	2/A			2		3	1	2/A	2/A	7
Tilapia sparrmanii (Banded tilapia)										*

(Note: 2/6 = 2 Retained, 6 Returned; 3 = 3Retained; A = Abundant, *=collected during 1995 sampling)

See Appendix B for images and distribution for each of the above species.

4.3. **Water Tests** (See Table 3)

Table 3 – Water Tests

Water Test										
Water Temperature (°C)	27.1		26.4	30.9	28.6	23.8	28.1	27.8	29.9	28.1
pH	8.2		7.30	7.83	8.33	8.42	8.44	8.56	8.2	7.9
Conductivity (µS/cm)	503		825	1590	939	947	309	460	588	680
TDS (ppm)	256		412	795	472	473	154	230	293	340
Site	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**13**

5. DISCUSSION

5.1. Fish Diversity

According to Skelton (2001), most of the fish species collected (see Table 1), prefer quiet, slow-moving waters with lots of vegetation. Exceptions are: *Glossogobius giuris* (Tank Goby) which prefers quiet, sandy waters (only found at Site 3 [Jozini holding dam]); *Labeo cylindricus* (Redeye Labeo) which prefer clear, running water (only found at Site 3); *Mesobola brevianalis* (River Sardine) which prefers flowing rivers with rocks (found at Site 3 and 10 [Hlambanyathi Dam]). These three exceptions all occurred in holding dams. *Labeo molybdinus* (Leaden Labeo) prefer deep pools, but will graze algae from firm surfaces (occurs at sites 6,8,11 and 13). Both *Mesobola brevianalis* and *Labeo molybdinus* were found at some sites during a previous survey (Pike, 1995). (See Table 1).

5.2. Comparison to previous survey

Pike (1995) carried out an investigation of the fish assemblance at Mkuze with the following results.

Cezwana Pan:

Seven different mesh size gill nets were set overnight and a cast net was used from a boat. Fish were caught in 63mm, 76mm, 102mm and 114mm nets.

Muzi Pan:

Gill nets were set during the day and a cast net used from the boat. Fish were caught in the 114mm gill net.

Nsumo Pan:

A seine net was used.

Asterisks (*) in Table 1 indicate fish caught during this sampling. See Site 6 (Nongoboza, which is part of Cezwane pan), Site 11 (Muzi pan) and Site 13 (Nsumo pan) in Table 1 above.

Banded tilapia *(Tilapia sparrmanii)*, which favour shallow, well-vegetated pans (Skelton 2001), were not collected in the current sample. Out of 10 species collected by Pike, 9 were collected in the current sample.

5.3. Fish alien to the sampling area

Two of the fish species collected do not naturally occur in the Mkuze area:

- Redbreast tilapia *(Tilapia rendalli)*, has its traditional southern-most limit at Pongola and Lake Sibaya, however it has been translocated throughout KZN and the highveld region from hatcheries for weed control.
- Red-eye labeo *(Labeo cylindricus)* has the Pongola as it southern-most limit. It was only found at Site 3 (Jozini holding dam), and thus, to the best of our knowledge, has not yet infiltrated into the Mkuze River. They may not be able to adapt to the still, vegetated, alkaline waters with a high TDS that are found in the pans.

If fish from the Pongola system did infiltrate into the Mukze system, they would be prevented from migrating further upstream, due to the barrier of the Mkuze Falls.

5.4. Water Quality

Waters in the Mkuzi River and the pans have an extremely high conductivity. (See explanation under Materials and Methods). According to Barta (2004) there is a high sediment load in waters at the catchment, which would also contribute to a high EC. Suspended sediment in the Mkuze River, evapotranspiration in the warm climate, warm waters and and pans which are isolated from other water bodies for part of the year, contribute to these high scores. The pH is also high, averaging around 8, which indicates alkalinity. Other solutes eg. chloride, calcium and magnesium are also present in the system due to evapotranspiration (Barnes et al, 2002).

Fish occuring here would be naturally adpated to these environmental conditions.

The EC scores at the holding dams (Sites 3, 9 and 10) are much lower. It is debatable whether the Pongola fish species are adaptable to the high EC that is found in the pans.

5.5. Sampling Methods

The high resistance of the water (due to high EC) caused electrofishing equipment to malfuction on a number of occasions.

5.6. Threats to the Mkuzi River System

Upstream Water demand

Leads to reduced flow into the system.

Pollution

Water drawn from the Pongola or Mkuzi river systems for irrigation, is associated with fertilization of crops which leads to eutrophication of rivers and estuaries.

Canals

Excavation of canals from the Mkuze River have resulted in a change of course of the Mkuze River, drawing water away from the wetland system and short-circuiting the cleansing function of the wetland.

Deterioration of the catchment

Inferior agricultural practices, would lead to erosion which would result in silting of pans and estuaries, decreasing holding capacity and smothering organisms.

Depletion of fish stocks

Due to overfishing

6. RECOMMENDATION

Gill nets would have been more appropriate for the deep water sections of the pans. Gill nets, however, are unselective, cause damage to fish and are illegal in the KZN province, thus under the circumstances are not recommended. The main method used was electrofishing, which did not always function well due to high conductivity. Casting nets could be used in future. The boat could also have been used to take the seine net out to deeper waters before returning to shore. Testing could also be done in the Tshnetshe and Mpempe pans, due to the altered flow of the Mkuze river.

7. CONCLUSION

Most fish collected during this survey, are to be expected in this area. Exceptions are Redbreasted tilapia *(Tilapia rendalli)* (which have been translocated throughout South Africa) and Redeye labeo *(Labeo cylindricus)* (of which there was only one specimen found in the Jozini holding dam (Site 3)). Indications are that the Pongola fish species have not infiltrated and established in the Mkuze system despite the presence of the canal from the Pongolapoort Dam. The integrity of the Mkuze system seems to be intact due to the diversity of fish found (90% of fish from Pike's investigation were collected in the current sample.) Fish specimens have been sent to SAIAB (South African Institute for Aquatic Biodiversity) in Grahamstown to confirm their identification. The data will also be fed into KZN Wildlife's biodiversity database.

8. ACKNOWLEDGEMENTS

Grateful thanks to:

Hannes de Bruyn (District Conservation Officer, Lebombo), for taking us to Mkuze Weir.

Lance van der Bank and Dennis Kelly at Mkuze Game Reserve, for hosting us.

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Rob Karssing, John Craigie and Skhumbuzo Kubheka (KZN Wildlife), for including me on the Field Trip.

Mark Graham (Ground-Truth) for directing me to extra reading material.

Special thanks to Rob Karssing for encouragement and help with the project.

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Interview with Dr. P. Goodman from KZN Wildlife on 25 June 2009, regarding the change of flow of the Mkuze river.

10. Appendices

10.1. Appendix A: Example of Datasheet for collecting data at each site

10.2. Appendix B: Fish images and distribution (Skelton, 2001)