EXECUTIVE SUMMARY

The Sand River was subjected to a systematic biomonitoring survey as part of the Sabie Catchment survey conducted in 1997. The 1997 survey was conducted as part of the Water Research Commission funded, "Mpumalanga Pilot Study". Despite having broad results of the survey published in a State of the River Report in 2001, most detailed reports for the 1997 survey are incomplete.

Northern Province Environmental Affairs undertook a follow up survey of that portion of the Sand River Catchment which falls in the Northern Province during February 2002. This report contains results of the 2002 survey, set against incomplete results of the 1997 survey. Extensive desk top investigations into the ecoregions, geomorphological segments and biological (fish and invertebrate) segments of the study area have now been completed.

A revised site inventory report has been appended to this report as APPENDIX I. The inventory is designed to help as a field guide, which should help standardize field work at each site during future surveys.

Shortfalls in site selection for the 1997 survey have been identified in bulk of this main report.

Due to time constraints, the 2002 field surveys were limited to fish and invertebrate populations only, at 11 sites in the study area.

The results of the 2002 survey indicate that there has been little change in the status of the rivers in the study area since the 1997 survey. Major problems associated with the catchment have been identified.

Red data fish populations and distribution within the catchment are a cause for concern.

Photographic records for the sites monitored in this report are included on a CD, attached to the front cover of this report. APPENDIX J provides a list of all photos appended.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. Introduction.

The Mpumalanga (WRC funded) pilot study, for the development and implementation of the National Aquatic Ecosystem Biomonitoring Programme; sub programme, "The River Health Programme (RHP)", extended over a three year period from 1996 to 1999 and covered the Crocodile, Olifants and Sabie River catchments. The study was conducted by a multi-disciplinary team, comprised of members from Gauteng, Mpumalanga, Northern Province, the Kruger National Park and the Institute for Water Quality Studies. The Sabie River Catchment was subjected to a systematic biomonitoring survey during 1997.

These initial surveys were viewed as essential capacity building exercises, which helped to standardize monitoring protocols between all role players in the catchment. In addition, data gathered during these surveys was used to refine the monitoring protocols for use on a national basis. Inevitably, the results generated from these surveys have provided a strong background against which future monitoring of these catchments may proceed.

Results of the pilot study were published in a State of Rivers Report (SOR) document (March 2001). It should however be noted that a considerable volume of the detailed results have yet to be written up or published.

Nevertheless, the role players participating in the pilot study agreed that each of the catchments should be revisited on a three yearly basis. After a one year delay, the Sabie River Catchment was scheduled for a further survey during 2001. This second level survey was however to be conducted by provincial teams, concentrating on their own areas of responsibility. Figure 1 provides an indication of Northern Province project area for the 2001 survey. The Northern Province has the responsibility of monitoring a relatively small portion of the Sabie River Catchment, restricted to the Sand River Sub-Catchment, from its source in the Northern Drakensberg Mountains to the western border of the Sabie Sand Game Reserve.

The Northern Province Survey was scheduled for November 2001, but due to heavy rains and high flood flows was postponed until February 2002. Several new sites are included within this 2002 monitoring report. However sites in the lower catchment were still inaccessible due to high flows during the time of the survey.

Due to the incomplete nature of the 1997 reports, this 2002 report has been produced with more detail than would otherwise be necessary for a second level survey of this nature. This report is accompanied by a revised site inventory, which addresses all potential (or historical) monitoring sites occurring within the Northern Province section of the Sand River.

The 2002 field survey addressed the fish and invertebrate communities only. However, considerable desk top work has been undertaken in the production of this report, which will facilitate the easy completion of future geomorphological and botanical studies.

2. Participants.

This monitoring survey was conducted by the Northern Province Environmental Affairs "biomonitoring team" comprised of the following members.

Team Leader:	M. Angliss
Assistant:	S. Rodgers
Field Crew:	K.B. Hlongwane
Field Crew:	J. N. Makhubele
Field Crew:	M. Malungani
Field Crew:	M. E. Ngwenya

Figure 1. Map of study area.

.

3. The Sand River Catchment.

The Sand River rises in the Northern Drakensberg Mountains and flows in an easterly direction until it merges with the Sabie River near Skukuza in the Kruger National Park. The Sabie River in turn merges with the Incomati River inside Mozambique.

The most significant tributary to the Sand River is the Mutlumuvi River, which again rises in the Northern Drakensberg Mountains and flows in an easterly direction until it reaches the Sand River at Thulamahaxi. Both the Mutlumuvi and Sand Rivers have many small tributaries in the upper catchment. For the purposes of this study, the Mohlomobe River was examined in the upper Mutlumuvi Catchment while the Motlamogatsana and Sekgamorago Rivers were examined in the upper Sand Catchment.

The Sand River accounts for approximately 20% of the Sabie River Mean annual Runoff. Rainfall ranges between 2000mm in the west and 500mm in the east. Forestry is the dominant land use on the western slopes of the Northern Drakensberg Mountains. Within the Welgevonden Forest area there are few access roads, but many forest tracks. Invasive vegetation is common along rivers in the study area, but particularly so in the mountain forestry areas.

The catchment area falling between the forests in the west and the Sabie Sand Nature Reserve in the east is now densely populated. Most of the population resides in

informal settlements with limited services. Informal gardens and stock grazing are the dominant land use. There is considerable sheet and donga erosion taking place.

The infamous Zoeknog Dam lies within the central Mutshindudi Catchment. Numerous other agricultural dams and one primary water supply dam occur in the study area. However, to date there are no sizeable impoundments in either the Sand or Mutlumuvi rivers. Water is however extracted from the Sand River into the Edinburgh Dam through a canal system. There are some poorly maintained government agricultural schemes which are dependant upon canal fed irrigation water. Citrus and mango crops are the most common.

The population of the catchment is estimated to exceed 400,000 people. Thulamahaxi is the largest town in the catchment. The Sand River Catchment was historically divided by the self governing territories of Lebowa to the west and Gazankulu to the east. The population is predominantly Shangaan. Many Mozambican refugees reside in the study area.

The Sand River is considered to have a history of strong perenniality across the Northern Province study area. However during the 1992 – 1996 drought period, pressures upon the river resulted in the virtual cessation of flow at the Sabie Sand Border. While a preliminary Instream Flow Requirement study for the system has been undertaken, there remains little opportunity to manage flows. Efforts to improve flows in the system are well documented by the "Save the Sand" working group. The Work for Water campaign was active throughout the study area during the 2002 survey period.

River names are obtained from 1:50,000 topographical maps. In this particular study area, names are very confusing and are therefore summarized schematically in Figure 2.

Figure 2: Schematic map of the Sand River Catchment in the Northern Province.

.

4. Monitoring sites of the Sand River Catchment falling within the Northern Province and their placement into homogeneous segments.

Numerous fish monitoring sites have been in use within the study area since 1991. Fish monitoring was undertaken by

- Gazankulu Nature Conservation : Data subsequently captured on the Northern Province Fish Distribution Data Base and
- Weeks et al: Data published in a Water Research Commission Report No. 294/1/96 of 1996
- Transvaal Provincial Administration (Prof. I. Gaigher). Broad distribution maps are available.

Many of these sites met the criteria for biomonitoring sites and were subsequently used in the 1997 pilot study. Table 1. provides a breakdown of sites, which were expected to be included in the 2002 survey. However due to high flows at the time of the survey, three sites were left unsurveyed. They are however included in table 1 and are recommended for future reference.

Table 1. Historical and present monitoring sites of the Northern Province study area.

SITE No.	SURVEY 2002	RHP SITE CODE	SITE NAME	RIVER	LAT (S)	LONG (E)
1	x	X3MOHL-WELGE	Hiking Trail (Mapumaleng)	Mohlomobe	24-44.42'	30-55.21'
2	x	X3MOHL-ZOEKN	Zoeknog 506	Mohlomobe	24-46.021'	30-58.618'
3	x	X3MUTL-VIOLE	Violet Bank	Mutlumuvi	24-45.41'	31-00.26'
4	x	X3MUTL-NEWFO	New Forest	Mutlumuvi	24-45.36'	31-07.65'
5	x	X3MUTL-THULA	Thulamahaxi	Mutlumuvi	24-43.983'	31-12.122'
6	x	X3MOTL-FORES	Forest 1	Motlamogatsana	24-39.751'	30-55.967'
7	x	X3SEKG-FORES	Forest 2	Sekgamorago	24-41.616'	30-55.765'
8	x	X3KLSA-ROOIB	Rooiboklaagte	Klein Sand	24-39.48'	31-05.34'
9	x	X3NWAN-DINGL	Dingleydale crossing	Nwandlamuhari	24-40.736'	31-08.797'
10		X3NWAN-THULA	Thulamahaxi (Shimati)	Nwandlamuhari	24-42.90'	31-12.24'
11	x	X3SAND-ROLLE	Rolle	Sand	24-43.267	31-14.219
12	x	X3SAND-ALLAN	Allandale Plantation	Sand	24-43.90'	31-15.95'
13		X3SAND-DUMFR	Dumfries	Sand	24-45.20'	31-17.50'
14		X3SAND-SSAND	Sabie Sand Border	Sand	24-45.28'	31-20.06'

Biomonitoring methodologies dictate that fish, invertebrates and vegetation populations be evaluated in segments where populations are homogenous along the length of the segment. Since the above biomonitoring sites were selected prior to the development of these methodologies, it is necessary to examine the location of each site against the backdrop of eco-regions, geomorphological zonation and natural fish, invertebrate and vegetation distributions. (In this case, vegetation was not surveyed and will thus be omitted)

4.1 Ecoregions.

The Department of Water Affairs and Forestry have, through consultation, broken the catchment into preliminary level 1 and level 2 ecoregions. (The regions will shortly be subject to refinement) The ecoregions are determined through an assessment of dominant physical and biological characteristics. Figure 3 provides a breakdown of Eco-Regions relevant to this Northern Province study. The State of River Report (WRC report of 2001), provided the following detailed ecoregion characteristics.

Ecoregion 4.03: Great Escarpment Mountains:

The upper escarpment of the Sand River Catchment is dominated by steep slopes, Afromontane Forest (Low and Rebelo, 1996) and limited grasslands. There are no monitoring sites in this ecoregion due to lack of access.

Ecoregion 4.04: Great Escarpment Mountains:

The west facing slopes of the Northern Drakensberg Mountains. (lower escarpment) While naturally regarded as Afromontane Forest (Low and Rebelo, 1996), this area is currently dominated by the exotic plantations of the Welgevonden Forest Area. Altitude ranges from 400 – 500m a.m.s.l. and rainfall varies between 600 and 1200 mm per annum. Temperatures range from 16 – 22^{o}C. Geology includes quartzites, granites, and sandstones.

Ecoregion 5.05: Lowveld:

Considered as lowveld, this area is dominated by Sour Lowveld Bushveld (Low and Rebelo, 1996). However the area is almost entirely de-bushed at the present time. Altitude ranges between 800 and 1000 m. a.m.s.l. and rainfall ranges between 400 – 1200mm per annum. Temperatures range from 16 – 22^{o}C. Geology includes quartzites, granites, and sandstones.

Ecoregion 5.06: Lowveld:

This area of Mixed Lowveld Bushveld (Low and Rebelo, 1996) has an altitude range of between 300 and 600m. a.m.s.l. The area is dominated by plains of medium relief. Rainfall ranges between 400 – 800mm. Temperatures range from 20 – 22^{o}C. Geology includes quartzites, granites, and sandstones.

Eco-Region Map.

4.2 Geomorphological zonation of the Sand River Catchment.

Geomorphology is one of several components used to assess the overall condition of a site. Commonly applied components include invertebrates, fish, riparian vegetation, habitat integrity, water quality, hydrology and geomorphology. Invertebrates, fish and vegetation together give a good picture of the ecological integrity of a site and reflect the condition of the bio-physical habitat, which are described by the remaining components, habitat integrity, water quality, hydrology and geomorphology. Changes to the stream biota must therefore be assessed against a background of possible changes to channel morphology and channel condition. (Rowntree and Ziervogel; 1999)

Rowntree and Wadeson (1999) developed a template which allows one to describe the longitudinal zone through the evaluation of valley form, gradient and characteristic channel features (Table 2).

This classification system may provide a more detailed evaluation of the river than can be obtained from examining eco-region level 2 maps. There should however be considerable correlation between the two.

Thirion (2002) examined the longitudinal profile of the dominant streams of the Sabie Catchment, to determine the longitudinal zones of the rivers. Monitoring sites of the 1997 survey were then placed within this zonation framework. Table 3 provides a breakdown of river zonation applicable to all monitoring sites (past and present) occurring within the Northern Province study area.

Table 2. Geomorphological zonation of river channels (after Rowntree and Wadeson, 1999).

Longitudinal Zone	Macro-reach characteristics			Characteristic channel features
	Valley form	Gradient class	Zone class	
A. Zonation associated with a "normal" profile.				
Source zone	V10	not specified	S	Low gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.
Mountain headwater stream	V1, V3	>0.1	A	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
Mountain stream	V1, V3	0.04 - 0.99	B	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravel in pools. Reach types include cascades, bedrock fall, step-pool. Approximate equal distribution of "vertical" and "horizontal" flow components.

Longitudinal Zone	Macro-reach characteristics			Characteristic channel features
Transitional	V2, V3, V4, V6	0.02 - 0.039	C	Moderately steep stream dominated by bedrock or boulder. Reach types include plain-bed, pool-rapid or pool-riffle. Confined or semi-confined valley floor with limited flood plain development.
Upper foothills	V4, V6	0.005 - 0.019	D	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present.
Lower foothills	V8, V10	0.001 - 0.005	E	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool-riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.
Lowland river	V4, V8, V10	0.0001 - 0.001	F	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.
B. Additional zones associated with a rejuvenated profile.				
Rejuvenated bedrock fall/ cascades	V1, V4	>0.02	A/B/ Cr	Moderate to steep gradient, confined channel (gorge) resulting from uplift in the middle to lower reaches of the long profile, limited lateral development of alluvial features, reach types include bedrock fall, cascades and pool rapid.
Rejuvenated foothills	V2, V3, V4, V6	0.001 - 0.02	D/Er	Steepened section within middle reaches of the river caused by uplift, often within or downstream of a gorge. Characteristics similar to foothills (gravel/cobble-bed rivers with pool-riffle / pool-rapid morphology) but of a higher order. A compound channel is often present with an active channel contained within a macro-channel activated only during infrequent flood events. A limited flood plain may be present between the active and macro-channel
Upland flood plain	V8, V10	<0.005	Fr	An upland low gradient channel, often associated with uplift plateau areas as occur beneath the eastern escarpment.

Table 3. Geomorphological zonation and eco-regions of all monitoring sites occurring within the Northern Province study area. (Modified from Thirion, 2002)

SITE No.	RHP SITE CODE	RIVER	GRADIENT	LONGITUDINAL CLASS	ZONE CLASS	ECO REGION
1	X3MOHL-WELGE	Mohlomobe	0.0631	Mountain Stream	B	4.04
2	X3MOHL-ZOEKN	Mohlomobe	0.008	Upper Foothill	D	5.05
3	X3MUTL-VIOLE	Mutlumuvi	0.008	Upper Foothill	D	5.05
4	X3MUTL-NEWFO	Mutlumuvi	0.008	Upper Foothill	D	5.06
5	X3MUTL-THULA	Mutlumuvi	0.003	Lower Foothill	E	5.06
6	X3MOTL-FORES	Motlamogatsana	0.08	Mountain Stream	B	4.04
7	X3SEKG-FORES	Sekgamorago	0.084	Mountain Stream	B	4.04
8	X3KLSA-ROOIB	Klein Sand	0.012	Upper Foothill	D	5.06
9	X3NWAN-DINGL	Nwandlamuhari	0.008	Upper Foothill	D	5.06
10	X3NWAN-THULA	Nwandlamuhari	0.003	Lower Foothill	E	5.06
11	X3SAND-ROLLE	Sand	0.003	Lower Foothill	E	5.06
12	X3SAND-ALLAN	Sand	0.003	Lower Foothill	E	5.06
13	X3SAND-DUMFR	Sand	0.003	Lower Foothill	E	5.06
14	X3SAND-SSAND	Sand	0.003	Lower Foothill	E	5.06

4.3 Fish segments.

Although fish segments have a lot in common with geomorphological segments, ecological aspects (water temperature as related to altitude, water quality, habitat availability, density dependent population regulating mechanisms, life history strategies etc) play an important role in determining the presence of a fish species in a segment.

A fish segment is thus a portion of a river where the fish community remains generally homogenous due to the relative uniform nature of the physical habitat. (Ramm, 1988)

It should be noted that natural barriers may play an important role in causing the fragmentation of fish populations, across what could otherwise have been regarded as a homogenous segment. In some cases, fish may have been artificially transported across such barriers and great care should therefore be taken when assessing the natural range of fish communities. The systematic study of fish distribution thus plays an important role in determining natural distribution ranges.

For the purposes of the study area for the Sand Catchment, detailed fish distribution surveys extend back to the early 1990s. Some earlier work was conducted by Professor Gaigher and the former Transvaal Provincial Administration, but records

were not site specific. (They were related to farm boundaries and geographic quadrants)

Historical records of distribution along the Sand River and Mutlumuvi Catchments are attached in Appendix A and Appendix B. By carefully examining fish population records from the top to the bottom portion of the catchment, it can clearly be seen that 3 distinct population groups are noticeable. There are no known natural physical barriers to fish migration and movement in the catchment, between any of the monitoring sites listed above

Sites for the three segments clearly fall within the above defined ecoregion boundaries.

For the purposes of this study, the three population groups along the Mutlumuvi River will be examined separately to the three groups along the Sand River.

4.4 Invertebrate segments.

Invertebrate segments are less easy to identify than fish segments, largely due to the aerial mobility of the adults of many of the families. Thirion (2000) evaluated the 1997 SASS4 results of the Sand survey through hierarchical agglomerative cluster analysis (based on the presence or absence of families). Identified clusters for the Sand Catchment were.

- Fast flowing , cool clear waters above 800m, equating to the Great Escarpment Mountain Ecoregion of 4.04.
- Mid reaches of the Sand and Mutlumuvi rivers, falling in the range 400 - 800m. a.m.s.l. This reach lies above the confluence of the Sand and Mutlumuvi rivers at Thulamahaxi and approximates to ecoregion 5.05 (Lowveld)
- Foothill gravel sites of the lower reaches below 400m. a.m.s.l. This reach equates to a portion of both ecoregion 5.05 and 5.06 (Lowveld).

4.5 Standardising segments for the study area.

From the above investigation and Table 3 above, it can be seen that the fish communities correspond very closely to both ecoregion and geomorphological zonation.

The invertebrate communities again closely resemble the ecoregion delineation, but with some overlap between the lowveld level 2 ecoregions. Interpretation of SASS scores for ecoregions is currently restricted to Level 1 differentiation. This differentiation has been developed by Thirion (2000) and is based upon reference conditions generated after consideration of distributions in a number of rivers across the region. See Table 13

For the purposes of standardising this report, both fish and invertebrate populations will be evaluated against the ecoregions in which they fall.

5. Site descriptions

Site 1. RHP site code: X3MOHL-WELGE
Monitoring segment: Mut 4.04

The site lies in the Welgevonden Forestry area, close to the Mapumaleng Chalets In the Mohlamobe River.. This mountain stream has a channel of 3 – 5 m width, which is dominated by bedrock rapids and sandy pools. Occasional cobble riffles occur. There are many undercut banks, root wads and snags along this reach. There is very little marginal vegetation. The river is shaded by a dense forest canopy.

Apart from the small bridge at the monitoring site, there are few obvious anthropogenic impacts. Some small exotic plants were noticed.

The riparian vegetation showed signs of flood damage, with several trees lying on their sides.

During the 1997 survey, one specimen of *Anguilla mozambica* was recorded at this site. This is the only record of this truly migratory species in both the 1997 and 2002 surveys of the study area. This was an important find in that it occurred at one of the highest sites in the study area.

Site 2. RHP site code : X3MOHL-ZOEKN
Monitoring segment: Mut 5.05

Site 2 lies in the Mohlomobe River , approximately 2 km upstream of the broken Zoeknog Dam wall. The site lies 100m downstream of a dirt road bridge and the 5 – 10m wide channel is dominated by cobble riffles. The riffles are bordered by sedges and reeds, which provide some marginal habitat. Riparian vegetation is sparse and there is evidence of flood scour along the river banks.

Cattle watering and some car washing were evident at this site.

Site 3. RHP site code : X3MUTL-VIOLE
Monitoring segment: Mut 5.05

This site lies approximately 2km downstream from the collapsed Zoeknog Dam wall in the Mutlumuvi River. The River is a 5 m wide bedrock rapid, with some sandy bars occurring behind rock outcrops. Since the collapse of Zoeknog Dam, this site has undergone considerable modification from both deposition of sediments and scour. The river channel has clearly defined flood terraces, which were very wet at the time of the survey. The terraces are covered in reeds and sedges.

Approximately 200m downstream from the site, a new weir has been constructed. Origins of the weir are uncertain, but it clearly had the following impact on the site.

- Approximately 100 metres of river channel had become inundated in sediments, creating a shallow featureless run above the weir.
- A notch in the weir had been built above a deep crevice in the bedrock, creating a deep waterfall which is now a distinct barrier to fish

movement, even under the strong flows observed on the day of day of the survey.

During the survey, the river in this channel was flowing very strongly. This combined with limited instream cover contributed to poor monitoring results at this site.

Site 4. RHP site code : X3MUTL-NEWFO
Monitoring segment: Mut 5.06

Lying in the Mutlumuvi River, just below its confluence with the Nwarhele River, this site is again impacted by a small weir. However, the weir in question was broken at the time of the survey. Nevertheless a shallow featureless pool remained upstream of the weir. The river at this point is between 15 and 25 m width and the site has diverse habitat. Cobble riffles, bedrock rapids, pools and marginal vegetation occur.

The above weir was constructed by DWAF for the Athurstone water plant. Pumps exist just upstream of the confluence in the Nwarhele river. Some youths were observed angling.

The channel has defined terraces covered in reeds and some good riparian vegetation. Some flood damage was again evident. A number of dirt tracks leading to the weir are showing signs of bad erosion.

Site 5. RHP site code : X3MUTL-THULA
Monitoring segment: 5.06

This site lies just below a dirt road bridge at Thulamahaxi. The anastamosing channel is dominated by bedrock outcrops and dense reed beds interspersed with rapids, gravel riffles, sandy runs and backwater pools.

Being close to Thulamahaxi, the site shows many signs of anthropogenic impact. Large litter dumps were lying adjacent to the river, within the flood line. Children were seen fishing and trucks stop by the bridge to pump water. Cattle drink at the site.

Site 6. RHP site code : X MOTL-FORES
Monitoring segment: Sand 4.04

The highest site in the survey area!

At this site, the Motlamogatsana River is a narrow 3-5m mountain stream. The river is a tributary to the Klein Sand River. The site lies just upstream of a dirt road bridge in the forestry area. The stream has diverse habitat, including cascades, rapids, riffles marginal vegetation and undercut banks.

Many exotic plants occur in the riparian zone. Work for water crews were working at the site at the time of the survey. The bridge gabions were being repaired at the time of the survey and rocks and water were being collected from the river. Distinct footpaths were being created.

Site 7. RHP site code: XSEKG-FORES
Monitoring segment: Sand 4.04

The Sekgamorago River is a 5m wide cobble riffle at this site in the forestry area. Cascades and small bedrock pools occur at the upper extremities of the site. Marginal habitat is limited.

The riparian forest canopy overhangs the river providing shade.

Apart from the bridge and exotic plants, there are no signs of anthropogenic impact and the site is aesthetically very attractive.

Note: Although in separate streams, the close proximity and similar nature of sites 6 and 7, allow them to be treated as one monitoring segment.

Site 8. RHP site code: X3KLSA-ROOIB
Monitoring segment: Sand 5.05

The site lies just below a bridge in the Klein Sand River near Champagne Citrus Estates. Typically (for a bridge site) there is extensive bedrock, interspersed with sand and gravel runs. There are very few loose cobbles. The anastamosing channel holds dense reed beds.

Clear terraces exist and the riparian vegetation is relatively intact.

Some small tracks lead to the water and there are signs of cattle watering. Erosion from the roadside and bridge is the most noticeable impact.

Site 9. RHP site code: X3NWAN-DINGL
Monitoring segment: Sand 5.06

Lying either side of a bridge in the Nwandlamuhari River near Dingleydale, this site is again dominated by bedrock and an anastamosing channel. There are limited gravel runs, but limited loose cobble. The site does however have extensive marginal vegetation in the form of reed beds and many backwater pools. Snags, roots and undercut banks abound.

Marginal vegetation is relatively intact.

The site was heavily utilized as a washing and swimming venue on the day of the survey. Some youths were angling (with considerable success). Solid waste, predominantly washing debris is of concern. The river banks are also used for toilet purpose. Some small tracks exist along the river banks.

Site 11. RHP site code: X3SAND-ROLLE
Monitoring segment: SAND 5.06

The site lies beneath both a road bridge and a rail bridge at Rolle, in the Sand River, just below the confluence with the Mutlumuvi River. The 30 – 50m wide

anastamosing channel is dominated by bedrock outcrops, sand bars with dense reed beds and backwater pools. The macro channel exceeds 100m in width at this point. No loose cobble was found at all. Some gravel runs were evident. There are extensive undercut banks and root wads.

Despite the close proximity of the town, numerous roads and bridges, the site shows little evidence of litter, bathing or washing. Some succulent exotic plants occur. The Riparian zone is largely denuded of vegetation and the macro channel banks show considerable signs of erosion.

Strong flows prevented the monitoring of traditional deep water monitoring habitats at this site. The large diversity of habitats did however permit a successful survey.

Site 12. RHP site code: X3SAND-ALLAN
Monitoring segment: Sand 5.06

The site lies in the Sand River just behind Allandale Agricultural estates. The macro channel at this point exceeds 150m width, while the active channel was approximately 50m width. The site is dominated by sand and gravel runs with occasional bedrock outcrops. Deep in-channel backwaters occur around the bedrock. Reeds provided limited marginal vegetation at the time of the survey.

Since 1991, this site has shown considerable in-channel variability, due to its sandy nature.

At the time of the 2002 survey, only the limited marginal habitats could be sampled. No substrate habitats could be sampled due to strong flows.

The site lies close to the agricultural project, but is afforded considerable protection by the presence of the project and the fence line. The riparian vegetation is in a relatively intact condition, but some cutting of trees has occurred since the 1997 survey.

A Working for Water crew were at the site during the survey.

6. In situ water quality.

Temperature, pH and conductivity were measured at each of the monitoring sites, using hand held instruments.

Table 4. Temperatue, pH and conductivity recorded at each of the monitoring sites. Date and weather are also shown .

SITE NO	SEGMENT	DATE	PH	CONDUCTIVITY µS/CM	TEMPERATURE ^{O}C	WEATHER
1	Mut 4.04	13.02.02	7.8	20	20	Hot & Overcast
2	Mut 5.05	13.02.02	7.8	40	24	Hot & Overcast
3	Mut 5.05	13.02.02	7.8	40	28	Hot & Clear
4	Mut 5.06	13.02.02	7.8	100	24	Hot & Overcast
5	Mut 5.06	12.02.02	8	100	25	Mild & Overcast
6	Sand 4.04	11.02.02	7.8	40	20	Hot & Clear
7	Sand 4.04	11.02.02	8	30	19.5	Hot & Clear
8	Sand 5.06	14.02.02	7.6	90	24	Hot & Clear
9	Sand 5.06	12.02.02	8	80	29	Hot & Clear
11	Sand 5.06	12.02.02	7.9	100	31	Hot & Overcast
12	Sand 5.06	12.02.02	7.5	110	28	Hot & Clear

The water quality results fall entirely within the norms of the province, and have no significant variation upon records from previous surveys.

7. Fish.

7.1 Fish monitoring methods.

Fish were gathered using the following techniques.

- Electro - shocking apparatus: a two to three man operation, whereby fish are stunned using AC electric current. The stunned fish are collected in hand held scoop nets positioned downstream. The method is suited to shallow (< 1m depth) swift flowing water over assorted substrates. Also useful around snags, undercut banks and in heavily vegetated but shallow pools.

- Seine net: a net measuring 15m length by 3.5m deep, with 12mm knotless nylon netting. The net is pulled through the water by 2 - 4 people, and fish are collected in a central bag. Suitable for deep pools which are clear of snags.

- Small seine net: a small piece of seine netting attached to two wooden poles. This two man net measures 2m by 1.5m deep, and again has 10 mm mesh. The net is useful for sampling in small pools, but is particularly designed for use under and amongst overhanging and marginal vegetation.

- Cast or throw net: a 1.6m radius, circular nylon net, with 12mm mesh size. Cast nets can be used by an individual in any habitat which is clear of snags and obstructions.

Most fish caught were identified at site and returned to the river alive. (An extensive reference collection of fish from the Sand River Catchment has already been supplied to the JLB Smith Institute.

When possible, individual fish were examined for parasite loads.

The habitat at the site was categorised, and where possible individual habitats sampled. The effort used to catch fish in each habitat at each site was recorded. However, in the upper catchment, the narrow channel of the river often resulted in efforts being combined for multiple habitats.

Fish habitat is categorised into four velocity depth classes, and allocated a subjective score based upon their abundance using a five point scale. (Kleynhans 1997)

Fast Deep (F/D); Fast Shallow (F/S); Slow Deep (S/D); Slow Shallow (S/S)
(0=Absent; 1=Rare; 2=Sparse; 3=Moderate; 4=Extensive)

The same scale is utilised to assess the availability of cover types for each velocity depth class. Four cover types are assessed.
(Overhanging vegetation; Undercut bank and root wads; Substrate; Aquatic macrophytes).

Deep water = > 0.3 metres; Fast water = > 0.3 m/sec.

Each site was subjected to exhaustive searches using the most appropriate collecting techniques, given the prevailing flow conditions. At all sites, multiple habitats were sampled. At all sites, habitats of similar velocity depth classes and cover types were sampled at different localities.

Table 5. Scientific, English, Afrikaans and abbreviated names for fish expected to occur within the Northern Province study area of the Sand River Catchment. (confirmed records from 1991) (Names from Skelton, 1993)

Species	English Common Name	Afrikaans	ABB
Amphilius natalensis	Natal mountain catfish	Natalse bergbaber	Anat
Anguilla bengalensis labiata	African mottled eel	Afrika-bontpaling	Aben
Anguilla mossambica	Longfin eel	Geelbek-paling	Amos
Barbus annectens	Broadstriped barb	Breestreep-ghieliemientjie	Bann
Barbus brevipinnis	Shortfin barb	Kortvin-ghieliemientjie	Bbre
Barbus eutaenia	Orangefin barb	Oranjevlerk-ghieliemientjie	Beut
Barbus marequensis	Largescale yellowfish	Grootskub-geelvis	Bmar
Barbus paludinosus	Straightfin barb	Lynvin of Moeras-ghieliemientjie	Bpau
Barbus radiatus	Beira barb	Beira-ghieliemientjie	Brad
Barbus toppini	East coast barb	Ooskus-ghieiemientjie	Btop
Barbus trimaculatus	Threespot barb	Driekol-ghieliemientjie	Btri
Barbus unitaeniatus	Longbeard barb	Longbaard-ghieliemientjie	Buni
Barbus viviparus	Bowstripe barb	Boogstreep-ghieliemientjie	Bviv
Chiloglanis anoterus	Pennant-tailed rock catlet	Wimpelstert-suierbekkie	Cano
Chiloglanis paratus	Sawfin rock catlet	Saagvin-suierbekkie	Cpar
Chiloglanis swierstrai	Lowveld suckermouth	Laeveldse suierbekkie	Cswi
Clarias gariepinus	Sharptooth catfish	Sterkpandbaber	Cgar
Glossogobius callidus	River goby	Rivier-dikkop	Gcal
Labeo cylindricus	Redeye labeo	Rooioog-moddervis	Lcyl
Labeo molybdinus	Leaden labeo	Loodvis	Lmol
Labeo rosae	Rednose labeo	Rooineus-moddervis	Lros
Labeo ruddi	Silver labeo	Silwer-moddervis	Lrud
Marcusenius macrolepidotus	Bulldog	Snawelvis	Mmac
Mesobola brevianalis	River sardine	Riviersardyn	Mbre
Micralestes acutidens	Silver robber	Silwer-rower	Macu
Oreochromis mossambicus	Mozambique tilapia	Bloukurper	Omos
Petrocephalus catostoma	Churchill	Stompkoppie	Pcat
Pseudocrenilabrus philander	Southern mouthbrooder	Suidelike mondbroeier	Pphi
Serranochromis meridianus	Lowveld largemouth	Laeveld-kurper	Smer
Schilbe intermedius	Silver catfish	Silwerbaber	Sint
Tilapia rendalli	Redbreast tilapia	Rooiborskurper	Tren

7.2 Application of the Fish Assemblage Integrity Index (FAII) to determine the present ecological state of the fish communities of the Sand River Catchment in the Northern Province study area. (Kleynhans; 1997) (RHP series)

Through professional judgement, a review of Table 5 and Appendix A, allows one to reconstruct the hypothesised fish community for each of the ecoregions under natural conditions. (provided in Table 6) Such a reconstruction takes into account the distribution of the species in other catchments, their habitat preferences, availability of habitats, and an assessment of the temperature and water quality tolerances of the species.

7.3 Calculation of the FAII.

The FAII is a function which compares the expected FAII scores to the observed. The observed FAII score is expressed as a percentage of the expected, to arrive at a relative FAII rating.

FAII(Relative) = FAII(obs)/FAII(exp) x 100

Where FAII(Exp) = T (A(exp)+F(exp)+H(exp))/3

And where FAII(obs) = T (A(obs)+F(obs)+H(obs))/3

T = Intolerance rating
A = Abundance
F= Frequency of occurrence
H= Health rating.

Dr. Kleynhans has developed a dedicated spreadsheet programme which calculates the FAII per segment, providing the following information is provided.

Manipulation of data, to provide the following information is attached as APPENDICES.

Intolerance: Attached as APPENDIX C.

The intolerance ratings are a combined assessment of the trophic specialisation of the species, its habitat specialisation, its sensitivity to water quality, and its dependence upon flowing water. Intolerance is rated on a 5 point scale, where 1 is a tolerant species, while 5 is an intolerant species.

Angliss, Kleynhans et al (1999) reviewed the intolerance (or sensitivity ratings) and cover preferences of each species of fish occurring within the Crocodile, Sabie and Olifants rivers. From this report, the sensitivity or intolerance scores for all of those fish expected from the Sand Catchment may be extracted.

Abundance: Attached as APPENDIX D.

Observed abundance of each species is calculated by assessing the catch data for each site, to generate a standardized catch per unit effort for each species. Where more than one method was employed at the site, results are based upon the method yielding the highest result. Where more than one site exists in a segment, the CPUE is calculated by averaging that of the sites.

Expected abundance of species is estimated, based upon available information and professional judgement. In this regard, extensive catch data is available which allows the abundance factor to be used with confidence.

A standard Electro shocking effort = 20 minutes per site
A standard small seine net effort = 2 efforts per site
A standard large seine net effort = 3 efforts per site
A standard cast net effort = 20 throws per site

1 - 5 individuals per standard monitoring effort = 1 (Rare)
6 - 15 individuals per standard effort = 3 (Moderate Abundance)
15 individuals per standard effort = 5 (Abundant)

Frequency of occurrence: Attached as APPENDIX E.

Frequency of occurrence refers to the regularity at which a species can occur in the given zone.

Expected frequency is again based on historical data and professional judgement.

Occurrence at <34 % sites in segment = 1 (Infrequent Occurrence.)
Occurrence at 34 - 66 % of sites in segment = 3 (Frequent Occurrence).
Occurrence at >67% of sites in segment = 5 (Widespread Occurrence.)

Health rating: Attached as APPENDIX F.

The occurrence of sick, deformed or parasite laden fish at each site is noted. The percentage of fish of each species affected determines the score. Where more than one site occurs in a segment, the score is calculated as a percentage of the total number of fish encountered.

1 = Frequency of affected fish > 5%
3 = Frequency of affected fish 2 – 5 %
5 = Frequency of affected fish <2%

Thus based on the equation "**FAII(Relative) = FAII(obs)/FAII(exp) x 100",** Kleynhans (1997) developed a descriptive template which places the index scores into FAII classes. (Table 7) FAII classes in turn can be compared against the the more generic template which describes the present ecological state and the ecological management class of a river system., and which fits all monitoring indices. (Table 8)

Table 6. FAII assessment classes. (From Kleynhans; 1997)

Class	Description of Generally Expected Conditions	FAII Score (Percent of total)
A	Unmodified, or approximates natural conditions closely.	90 - 100
B	Largely natural with few modifications. A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modification.	80 - 89
C	Moderately modified. A lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at the lower end of this scale.	60 - 79
D	Largely modified. A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderately intolerant species. Impairment of health may become more evident at the lower end of this class.	40 - 59
E	Seriously modified. A strikingly lower than expected species richness and general absence of intolerant and moderately intolerant species. Impairment of health may become very evident.	20 - 39
F	Critically modified. An extremely lowered species richness and an absence of intolerant and moderately intolerant species. Only tolerant species may be present with a complete loss of species at the lower end of the class. Impairment of health generally very evident.	0 - 19

Table 7. A descriptive template for the Ecological Management Classes (EMC) of river systems. (From Kleynhans; 1997)

CLASS: MANAGEMENT CLASSES:	MANAGEMENT CLASSES: DESCRIPTION OF PERCEIVED CONDITIONS
WITHIN DESIRED RANGE	
A: UNMODIFIED OR LARGELY NATURAL.	The natural abiotic template should not be modified. The characteristics of the resource should be determined by unmodified natural disturbance regimes. There should be no human induced risks to the abiotic and biotic maintenance of the resource. The supply capacity of the resource will not be used.
B: LARGELY NATURAL WITH FEW MODIFICATIONS	Only a small risk of modifying the natural abiotic template and exceeding the resource base should be allowed. Although the risk to the well being and survival of especially intolerant biota (depending on the nature of the disturbance) at a very limited number of localities may be slightly higher than expected under natural conditions, the resilience and adaptability of the biota must not be compromised. The impact of acute disturbances must be totally mitigated by the presence of sufficient refuge areas.
C: MODERATELY MODIFIED	A moderate risk of modifying the abiotic template and exceeding the resource base may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may generally be increased with some reduction of resilience and adaptability at a small number of localities. However, the impact of local and acute disturbances must at least partly be mitigated by the presence of sufficient refuge areas.
D: LARGELY MODIFIED	A large risk of modifying the abiotic template and exceeding the resource base may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may be allowed to generally increase substantially with resulting low abundances and frequency of occurrence, and a reduction of resilience and adaptability at a large number of localities. However, the associated increase in abundance of tolerant species must not be allowed to assume pest proportions. The impact of local and acute disturbances must at least to some extent be mitigated by refuge areas.
OUTSIDE DESIRED RANGE	
E: SERIOUSLY MODIFIED	The losses of natural habitats and basic ecosystem functions are extensive.
F: CRITICALLY MODIFIED	Modifications have reached a critical level and the system has been modified completely, with an almost complete loss of natural habitats

7.4 Results of the fish surveys.

Table 8. The developed species list for each of the ecoregions of the Mutlumuvi and tributaries with species recorded during the 2002 survey

MUT 4.04		MUT 5.05		MUT 5.06	
Expected	**Present**	**Expected**	**Present**	**Expected**	**Present**
ANAT	P	ANAT	P	ANAT	
AMOS		ABEN		ABEN	
BBRE		AMOS		AMOS	
BEUT		BANN		BANN	P
CANO		BBRE	P	BEUT	P
		BEUT	P	BMAR	P
		BMAR	P	BPAU	
		BPAU		BRAD	
		BRAD		BTOP	
		BTRI	P	BTRI	P
		BUNI		BUNI	
		BVIV		BVIV	P
		CANO	P	CANO	P
		CPAR		CPAR	P
		CGAR	P	CSWI	P
		LCYL		CGAR	P
		LMOL		GCAL	
		MMAC		LCYL	
		MBRE		LMOL	P
		MACU		LROS	
		OPER		LRUD	
		OMOS		MMAC	
		PCAT		MBRE	P
		PPHI		MACU	P
		SMER		OPER	P
		SINT		OMOS	P
		TREN		PCAT	
				PPHI	P
				SMER	
				SINT	
				TREN	P

Table 9. The fish species list developed for each of the ecoregions of the Sand River and tributaries with species recorded during the 2002 survey

SAND 4.04		SAND 5.05		SAND 5.06	
Expected	**Present**	**Expected**	**Present**	**Expected**	**Present**
ANAT	P	ANAT		ANAT	P
AMOS		ABEN		ABEN	
BBRE		AMOS		AMOS	
BEUT		BANN		BANN	
CANO	P	BBRE	*N*	BEUT	
		BEUT	*o*	BMAR	P
		BMAR	*t*	BPAU	P
		BPAU		BRAD	P
		BRAD	*s*	BTOP	
		BTRI	*u*	BTRI	P
		BUNI	*r*	BUNI	P
		BVIV	*v*	BVIV	P
		CANO	*e*	CANO	P
		CPAR	*y*	CPAR	P
		CGAR	*e*	CSWI	
		LCYL	*d*	CGAR	P
		LMOL		GCAL	P
		MMAC		LCYL	
		MBRE		LMOL	P
		MACU		LROS	
		OPER		LRUD	
		OMOS		MMAC	
		PCAT		MBRE	P
		PPHI		MACU	P
		SMER		OPER	P
		SINT		OMOS	P
		TREN		PCAT	
				PPHI	P
				SMER	
				SINT	P
				TREN	P

FAII Result Summary for all monitoring segments are presented in APPENDIX G

Table 10. Summarised FAII results for all segments.

SEGMENT	FAII (REL SCORE)	FAII CLASS	SPECIES EXPECTED	SPECIES RECORDED
Mut 4.04	37.68	E	5	1
Mut 5.05	38.88	E	27	7
Mut 6.06	62.42	C	31	17
Sand 4.04	63.19	C	5	2
Sand 5.05	No sites surveyed			
Sand 5.06	56.57	D	31	19

7.5 Discussion of fish results:

This critical part of the process needs to be motivated carefully, as erroneous data here can cause severe disruption to the final FAII score.

Due to the good longitudinal connectivity of the catchment and the relatively small scale of the catchment, there is little reason to believe that fish populations in the Mutlumuvi fork should differ to those in similar ecoregions of the sand fork. The developed fish distribution list is therefore identical in each ecoregion.

7.5.1 Mut 4.04 FAII Class E
Sand 4.04 FAII Class C

Fish populations in the upper mountain catchment of Mut 4.04 and Sand 4.04 are difficult to assess.

- There are only two historical records of fish distribution for each of the three sites occurring in this region.
- Only one site was assessed in Mut 4.04, while two were assessed in Sand 4.04.
- The FAII is always problematic when dealing with fish communities with very low numbers of species present.
- *Amphilius natalensis* is the only species of fish to have been recorded at all three sites on all occasions. Single records for *Chiloglanis anoterus, Barbus brevipinnis, and Anguilla mossambica* have been made. *Barbus eutaenia* has not been recorded, but is commonly found alongside *Chiloglanis anoterus* and *barbus brevipinnis.*
- *Barbus brevipinnis* has recently been classified as a red data species and note should be taken of this curious distribution.
- With the exception of *Anguilla mossambica*, all species occurring in this upper reach are regarded as sensitive and flow dependant. In the presence of such a small community, the absence of one species can seriously impact upon the FAII score. One species present in Mut 4.04 gave an FAII class of E, while 2 species present in Sand 4.04 gave an FAII class of C.

- A second red data species, *Opsaridium peringueyi,* was recorded in the lower reaches of the river, and has on occasion been found in streams of this order in other catchments. In this case it is suspected to be at the limit of its distribution in this segment. In the absence of more records, its presence must be discounted.

Given that these 5 species should be present in this mountain region, but that only two species were recorded in this survey across 3 sites, it is worrying that the fish populations in this mountain region may be under threat. Significant populations of *Chiloglanis anoterus*, *Barbus brevipinnis and Barbus eutaenia* were recorded at the site above the Zoeknog Dam. (site 2) The upstream Mohlamobe River passes alongside a forestry track before reaching the uppermost site. (no 1). There are no obvious reach breaks and no obvious reasons can be given for the absence of these expected fish species. It may therefore be the case that all three mountain sites are at the very extremity of the distribution of all of these species with the exception of *Amphilius natalensis*. If this is indeed the case, then it would be inappropriate to include all but *Amphilius natalensis* in these segments. For this reason, the expected frequency of occurrence and the expected abundance of the species are scored low. Nevertheless the FAII score for the Mut 4.04 seems abnormally low, given the apparently good habitat, water quality and connectivity of this site.

The confirmed record of the migratory eel, *Anguilla mossambica* in this reach is not unexpected. However, degradation of the middle and lower catchment, together with the placement of large dams in the system within Mozambique, are likely to limit the ongoing presence of this fish.

The classification of Mut 4.04 in the FAII class E, is therefore problematic at this time. More intensive fish surveys should be undertaken within this upper catchment region. The classification of Sand 4.04 in the FAII class C appears more appropriate.

Management objectives for both Mut 4.04 and Sand 4.04 could realistically be achieved for a Class B river.

7.5.2 Mut 5.05 FAII Class E

Apart from the clear absence of sites in segment Sand 5.05, there are no obvious problems with the developed species list for segments Mut 5.05. (and consequently Sand 5.05)

Despite long term monitoring records, there have been no recordings of the *Tilapia sparrmanii* (banded tilapia). This area falls within the natural distribution range of this common cool water fish and its absence cannot readily be explained.

The temperate water species of *Barbus radiatus*, *Ciloglanis paratus*, and *Serranochromis meriadianus* are at the extremity of their distribution in this segment, but confirmed records of their distribution are on hand. They are therefore included in the fish assemblage.

Site 2 above the Zoeknog Dam site and Site 3 below Zoeknog Dam yielded very few of the expected species for this segment. Abundances at site 2 were also greater than at site 3.

The poor quality of substrate habitat at site 3, which has been compounded in the past by the failure of Zoeknog Dam contributes towards these results. The presence of a new weir at site 3 is also creating a barrier to migration in all but the highest of flows.

It would currently appear that the presence of the red data fish species, *Barbus brevipinnis* is now confined to a very short reach of the catchment above this new weir.

Site 2 and site 3 are in close proximity to each other, in a steepened section of segment Mut 5.05. Neither site 2 nor site 3 offered" slow flow depth classes" and as such the communities associated with theses habitats are unlikely to be recorded at these sites.

Two alternatives are recommended for future surveys.

- Find additional sites in Mut 5.05 downstream of the weir.
- Break Mut 5.05 into two segments. The first representing the steepened section around Zoeknog Dam and the second below the Weir where more diverse habitats have been noted.

The severe degradation resulting from Zoeknog Dam, with continuing erosion problems suggest that it will be difficult to set an Ecological Management Class higher than Class D for Mut 5.05.

7.5.3 Sand 5.05

Although segment Sand 5.05 is very short, the absence of monitoring sites in this segment is a serious flaw to this monitoring survey. This situation has arisen due to the fact that inadequate background work was conducted prior to the 1997 survey. The dependence of the 1997 survey upon existing fish monitoring sites led to this short coming. Sadly, in the absence of more detailed information and feedback from the 1997 survey, the shortcomings of the earlier survey were duplicated in the 2002 survey. If background work had been done beforehand, this situation would not have arisen. At least two sites need to be identified in this segment.

Data from Sand 5.05 would be invaluable for assessing the true impact of the collapsed Zoeknog Dam in Mut 5.05.

7.5.4 Mut 5.06 FAII Class C

The presence of 16 of a potential 31 fish species recorded in Mut 5.06 account for the observed FAII class.

There are a number of species which should occur in segment 5.06 with regularity but were either missed or seldom encountered during this survey. The *Labeo spp* were in unusually low abundance. In addition, *Chiloglais swierstrai* was seldom

encountered, despite the ideal sandy habitats occurring here. Difficult survey conditions alone cannot account for the absence of these species.

The red data species *Serranochromis meridianus* has not been recorded in either of the 1997 or 2002 surveys of this reach.. While not of immediate concern, there absence should again be noted. A brief stopover at Edinburgh Dam revealed a healthy population of these fish during the 2002 survey.

Given the pressures on the Mutlumuvi Catchment an EMC C would appear a realistic objective at this time.

7.5.5 Sand 5.06 FAII Class D

19 of a potential 31 species were recorded in this reach, but abundances were low. The absence of *Chiloglanis swierstrai* and 3 *Labeo spp* is again of concern. Habitats for these fish in this segment are ideal. Nevertheless, their absence based upon one survey should not cause alarm. Abundances for all species were low during the 1997 survey.

While the Sand River has been flowing strongly since the 2000 floods, the river has been subjected to serious flow reduction through abstraction for agriculture and domestic purposes over previous years. In addition, there is strong evidence of subsistence fishing by the sizeable local community. Fortunately, the connectivity of the system to the downstream Kruger Park and upstream tributaries mean that populations are likely to recover if the pressures are removed.

The current class D river upstream of the Sabie Sand Reserve and the Kruger National Park is not acceptable. Management should strive to improve the management class of this segment to at least a class C river.

8. Invertebrates.

8.1 Invertebrate Monitoring Methods.

The survey for invertebrates was based upon methods developed for Biomonitoring, utilising the SASS5 protocols (Dickens et al. 2001). (South African Scoring System version 5)

During this survey, the biomonitoring protocols were followed correctly, to obtain valid SASS5 scores. All available habitats were sampled. (Taking cognisance of available habitat both up and down stream a distance of 100 metres)

The SASS5 protocol requires that invertebrate abundances be recorded for each habitat type to family level only. Each family recorded has a predetermined sensitivity rating (score). All scores for the site are totalled to yield the SASS5 score. The average score of all of the families recorded (ASPT) provides an indication on the number of sensitive, high scoring species represented in the total score.

SASS5 scores must thus be rated in terms of the Average Score Per Taxon (ASPT) and available habitat. In this regard, the Habitat Quality Index (HQI) was applied. The Integrated Habitat Assessment (IHAS) score sheet was also utilised and total scores obtained. However IHAS scores were not manipulated to provide refined SASS5 scores. The IHAS methodology is still under considerable review and there has been little attempt to fine tune the methodology in the lowveld. Scores are thus reflected for future reference only.

Abundances were also recorded and are presented in the following tables. Invertebrates were recorded to family level only and returned to the river alive.

SASS4 protocols were developed in detail by Thirion et al. (1995). During 2001 a workshop took place to upgrade SASS4 to SASS 5. The results were documented by Dickens et al. (2001) The method of collecting macro invertebrates utilises a fine mesh net (1mm nylon) measuring 30 cm x 30 cm. Bottom substrates are disturbed through kicking (kick sampling) and invertebrates collected downstream. Vegetation is sampled by sweeping the net to and fro. A typical SASS5 score sheet is attached with results of the survey in Appendix H. Sampling times are indicated on the score sheet.

Thirion (2000) has produced a template which interprets SASS4 (leading to SASS5 scores) and the ASPT in terms of the Present Ecological State (PES) following the same classification hierarchy as indicated in Tables 7. Habitat scores are currently being interpreted for inclusion into this framework.

8.2 Invertebrate results.

Table 11. Summarised SASS 5 Results. Date format DD-MM-YY.

SITE	1	2	3	4	5	6	7	8	9	11	12
Surveyor	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss
Date	13.02.02	13.02.02	13.02.02	13.02.02	12.02.02	11.02.02	11.02.02	14.02.02	12.02.02	12.02.02	12.02.02
TAXON	Survey Score	Survey Score	Survey Score	Survey Score	Survey Score	Survey Score	Survey Score	Survey Score	Survey Score	Survey Score	Survey Score
Turbellaria							3				
Annelida											
Oligochaeta	1			1							
Leeches	3										
Crustacea											
Potamonautidae	3	3	3			3	3	3	3	3	
Aytidae				8	8			8	8	8	8
Palaemonidae											
Hydracarina	8	8		8		8					8
Plecoptera											
Perlidae					12						
Ephemoptera											
Baetidae 1sp											
2sp	6						6	6		6	
>2sp		12	12	12	12	12			12		12
Caenidae		6		6	6	6					
Ephemeridae											
Heptageniidae	13	13		13	13	13	13	13	13	13	13
Leptophlebiidae	9				9						

SITE	1	2	3	4	5	6	7	8	9	11	12
Surveyor	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss
Date	13.02.02	13.02.02	13.02.02	13.02.02	12.02.02	11.02.02	11.02.02	14.02.02	12.02.02	12.02.02	12.02.02
Oligoneuridae	15	15		15	15	15		15	15	15	
Tricorythidae	9	9		9		9	9	9			
Odonata											
Chlorocyphidae			10	10						10	
Chlorolestidae		8						8			8
Coenagriidae					4			4		4	4
Aeshnidae	8	8				8	8				
Corduliidae				8				8	8		
Gomphidae		6	6	6	6	6	6	6	6	6	6
Libellulidae		4	4	4	4			4	4	4	
Hemiptera											
Belostomatidae					3			3		3	3
Corixidae						3					
Gerridae	5	5	5	5		5	5		5	5	
Naucoridae		7		7	7			7	7	7	7
Nepidae					3						
Notonectidae				3					3	3	3
Pleidae										4	
Veliidae	5	5	5	5	5	5	5	5	5	5	5
Trichoptera											
Hydropsychidae 1sp			4		4			4	4		
2sp		6		6							
>2sp	12					12	12				
Philopotamidae	10										
Cased caddis											

SITE	1	2	3	4	5	6	7	8	9	11	12
Surveyor	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss	Angliss
Date	13.02.02	13.02.02	13.02.02	13.02.02	12.02.02	11.02.02	11.02.02	14.02.02	12.02.02	12.02.02	12.02.02
Lepidostomatidae	10	10		10	10			10	10	10	
Leptoceridae	6	6		6	6	6	6	6	6	6	6
Coleoptera											
Dytiscidae				5	5	5			5		5
Elmidae		8		8	8				8	8	8
Gyrinidae		5	5	5	5	5	5	5	5	5	5
Haliplidae	5				5	5					
Hydrophilidae						5					5
Diptera											
Athericidae	10			10						10	
Ceratopogonidae							5				
Chironomidae	2	2		2							
Simuliidae	5	5	5	5				5			
Tabanidae		5				5					
Tipulidae	5				5	5					
Gastropoda											
Ancylidae		6		6							
Thiaridae					3			3	3		3
Pelecypoda											
Corbiculidae					5						
SASS5 SCORE	150	162	59	183	163	141	86	132	130	135	109
No. of families	21	23	10	26	24	20	13	20	19	20	17
Score/taxon (ASPT)	7.14	7.04	5.90	7.04	6.79	7.05	6.62	6.60	6.84	6.75	6.41
IHAS	77	66	58	85	79	83	80	75	42	62	54
HQI	100	110	65	104	116	124	112	89	78	93	81

Table 12 Description of SASS5 condition classes. (Adapted from Thirion 2001)

CLASS	BIOTIC MODIFICATION RELATIVE TO CURRENT BEST ATTAINABLE CONDITION	DESCRIPTION	SASS5 SCORE (%OF REFERENCE CONDITION)	ASPT VALUE (% OF REFERENCE CONDITION
A	Unimpaired	Community structures and functions comparable to the best situation to be expected. Optimum community structure (composition and dominance) for stream size and habitat quality.	90 – 100 80 - 89	Variable >90
B	Minimally impaired	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged	80 – 89 70 – 79 70 - 89	<75 >90 75 – 90
C	Moderately impaired	Community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.	60 – 79 50 – 69 50 – 79	>75 60 - 75
D	Largely impaired	Fewer families present than expected, due to loss of most intolerant forms. Basic ecosystem functions have changed.	50 – 59 40 – 49	<60 Variable
E	Seriously impaired	Few aquatic families present, due to loss of most intolerant forms. An extensive loss of basic ecosystem functions has occurred.	20 – 39	Variable
F	Critically impaired	Few aquatic families present, with high densities of organisms, then dominated by a few taxa. Only tolerant organisms present.	0 - 19	Variable

Table 13. HQI, SASS5 and ASPT values per Ecoregion as an indication of biotic condition. (Adapted from Thirion 2000)

GREAT ESCARPMENT MOUNTAINS (GEM)				
HQI	SASS4	ASPT	CONDITION	CLASS
TBC	161-180; >180	>7; >6	EXCELLENT	A
TBC	141-160; 161-180	>6; 6-7	VERY GOOD	B
TBC	91-140	>5.5	GOOD	C
TBC	61-90	<6	FAIR	D
TBC	30-60	VARIABLE	POOR	E
TBC	<30	VARIABLE	VERY POOR	F
LOWVELD AND LEBOMBO MOUNTAINS (LOW)				
TBC	141-160; >160	>7; >6	EXCELLENT	A
TBC	106-140; 106-160; 131-160	>7; 6-7; 5-6	VERY GOOD	B
TBC	76-105; 106-130	>5; 5-6	GOOD	C
TBC	61-75	4-6	FAIR	D
TBC	30-60	VARIABLE	POOR	E
TBC	<30	VARIABLE	VERY POOR	F

Table 14. Segment classification based on observed SASS 5 scores.

SITE	SCORE	ASPT	SEGMENT	SASS REGION	SITE CLASS	SEGMENT CLASS	CLASS DESCRIPTION
1	150	7.14	Mut 4.04	GEM	B	B	Very good
2	162	7.04	Mut 5.05	LOW	B	C	Good
3	59	5.9	Mut 5.05	LOW	E		
4	183	7.04	Mut 5.06	LOW	A	A	Excellent
5	163	6.79	Mut 5.06	LOW	A		
6	141	7.05	Sand 4.04	GEM	B	C	Good
7	86	6.62	Sand 4.04	GEM	D		
8	132	6.6	Sand 5.06	LOW	B	B	Very good
9	130	6.84	Sand 5.06	LOW	B		
11	135	6.75	Sand 5.06	LOW	B		
12	109	6.41	Sand 5.06	LOW	C		

8.3 Discussion.

A total of 48 families were recorded representing 14 orders of invertebrates.

The SASS4 protocol is very useful in determining short term and seasonal changes to river systems. The ability of invertebrates to re colonise a river in a matter of weeks, combined with their short life cycles cause this protocol to be very useful in monitoring impacts and seasonal changes. SASS5 is frequently conducted 3 times per annum per site to build up a clear picture of invertebrate family cycles.
A one off study such as this provides a broad assessment for the particular time of year only. Trends in the system can clearly not be identified through a one off survey.

Nevertheless, where sites coincide with the 1997 survey conducted by Thirion, the scores obtained during the 2002 survey correlate closely to scores obtained in the 1997 survey. This may indicate that there has not been a significant reduction in the status of the rivers since that time. Multiple follow up surveys are recommended.

Through an examination of the results, it can be noted that site 3, below Zoeknog Dam, and site 7, a high mountain stream had low SASS scores. These scores are most certainly due to low habitat diversity combined with the clear evidence of a recent flood event (less than 2 weeks prior).

9. Conclusions.

The following conclusions and recommendations may be drawn from this survey.

- The sand is a naturally perennial river. Future biomonitoring exercises should, where possible be timed to allow for the thorough survey of all currently identified sites in the catchment.
- Given that background work has been completed, one additional site should be identified in Mut 4.04. A further site should be identified in Mut 5.05 below the newly identified weir and at least 2 sites should be identified in Sand 5.05.
- Vegetation (Riparian Vegetation Index) and geomorphology (Geomorphological Index) should be monitored in future surveys.
- Planning for the extra time involved with these additional tasks and sites should be conducted well in advance.
- Both fish and invertebrate populations remain in a similar condition as was observed in the 1997 survey. Abundances of organisms has if anything improved.
- The distribution and status of the red data fish populations occurring in the catchment should be noted.
    - *Opsaridium peringueyi* was recorded at two sites close to Thulamahaxi during te 2002 survey. No records were made during 1997.
    - *Barbus brevipinnis* appears to be restricted to a short reach of Mut 5.05 above Zoeknog Dam. The population appears to be stable at this time.
    - While ever present in Edinburgh Dam, *Serranochromis meridianus* has not benn found in the rivers of the Northern Province portion of the catchment in either of the two most recent surveys.
    - Thresholds of Poential Concern, (TPC's) for these populations should be considered with some urgency.
- Subsistence fishing, together with other catchmnent issues may be depleating the number of large fish found in the catchment, which will have an adverse effect on future recruitment.
- General veld condition in ecoregions 5.05 and 5.06 are of concern. The poor status, when combined with the degrading riparian zone is leading to highly accelerated erosion in places.
- Solid waste including faecal matter is a serious concern along the river at Thulamahaxi. Faecal matter is again an issue of concern at Dingleydale, where large numbers of children were observed playing in the river.

10. References.

Angliss, M. K. 1999. A fish intolerance index and habitat preferences of fish species in the Crocodile, Sabie and Olifants Rivers. Workshop report, Skukuza, 3 - 5 May 1999. Compiled by M. K. Angliss, Northern Province Department of Agriculture Land and Environment.

Dickens, C and M. Graham. 2001. South African Scoring System (SASS) Version 5. Rapid Bioassessment Methods for Rivers. Umgeni Water, P. O. Box 9, Pietermaritzburg, 3200, South Africa.

Kleynhans, C. J. 1997. An exploratory investigation of the instream biological integrity of the Crocodile River, Mpumalanga, as based on the assessment of fish communities. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.

Kleynhans, C. J. 1999. The development of a fish index to assess the biological integrity of South African rivers. ISSN 0378-4738 = Water SA Vol. 25 No. 3 July 1999.

Low, A. B. and Rebelo, A. G. (Eds) (1996). Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism, Pretoria.

National Aquatic Ecosystem Biomonitoring Programme (NAEBP) Reports 1 - 7. Custodians; Department of Water Affairs and Forestry, Department of Environmental Affairs and Tourism and The Water Research Commission.

Northern Province Department of Agriculture and Environment; Fish Distribution Data Base, updated January 2001.

Thirion, C., A. Mocke and R. Woest, 1995. Biological monitoring of streams and rivers using SASS4. A user manual. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.

Thirion, C. 1998. An exploratory investigation of the instream biological integrity of the Crocodile River, Mpumalanga, as based on the assessment of macroinvertebrate communities. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.

Thirion C. (in Prep) Biomonitoring results of the Sabie Sand Catchment.

Ramm, A. E., 1988. The community degradation index: A new method for assessing the deterioration of aquatic habitats. *Water Res*. **22** 293-301

Rowntree, K. M. and Wadeson, R. 1999. An index of stream geomorphology for the assessment of river health. Field manual for channel classification and condition assessment.

Rowntree, K. M. And Ziervogel, G. 1999. Development of an index of stream geomorphology for the assessment of river health. NAEBP Report Series No 7. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.

Skelton, P. H. 1993. A complete guide to freshwater fishes of Southern Africa. Southern Book Publishers (Pty) Ltd. P. O. Box 3103, Halfway House, 1685.