RIVER HEALTH PROGRAMME

A BIOMONITORING SURVEY OF THE NWANEDZI (NWANEDI) RIVER CATCHMENT, LIMPOPO PROVINCE.

FIELD SURVEY OF 2006 - 2007.

PART 1. FISH, INVERTEBRATES AND ECO-STATUS.

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EXECUTIVE SUMMARY.

The Nwanedzi River Catchment was surveyed by a multi disciplinary team of scientists from Biodiversity and Resource Use Management between September 2006 and May 2007. The team was ably assisted by colleagues from Univen and The Department of Water Affairs and Forestry (DWAF) Polokwane office.

The survey was conducted using standardized River Health Programme monitoring protocols with the objective of providing an assessment of the Eco-Status of the river. Six ecological components were assessed using the following monitoring protocols.

Geomorphology.		Desktop study only.
Fish	(FRAI)	Fish Response Assessment Index.
Invertebrates	(SASS5)	South African Scoring System (version 5), interpreted through the Macro Invertebrate Response Assessment Index (MIRAI)
Riparian Vegetation	(RVI)	Riparian Vegetation Index.
Instream habitat	(HQI)	Habitat Quality Index.
Invertebrate habitat.	(IHAS)	Invertebrate Habitat Assessment System.

The data gathered during this survey, together with this ecological report provide a scientifically credible assessment of the State of the Environment (SOE) of the Nwanedzi River Catchment. All monitoring protocols are recognized as National Indicators for the purposes of SOE reporting on aquatic ecosystems. In addition, the report will provide a valuable baseline for water resource managers in determining the Ecological Reserve of the Catchment and water licensing in terms of the National Water Act (1998).

Results indicate, that the catchment at the time of the survey, has a **High - Moderate** Ecological Importance and Sensitivity (EIS), largely due to the fact that a substantial portion of the upper catchment falls in Nwanedi Reserve, while in the Limpopo Plain, it passes through private nature reserves or game farms.

Management should take note of those issues raised in **Table A,** and take the recommended actions to help conserve this catchment.

The results of this survey have led to an assessment of the Eco Status of the catchment (Tables 16), which at this time places the entire catchment in a “fair” Ecological Category.

Table A. Management recommendations.

ISSUE	ACTION	RESPONSIBILITY
A scientifically motivated Reserve determination has not been addressed for this catchment.	A thorough Reserve should be undertaken as a priority. For this catchment it is likely that the flows should be assessed through an “Intermediate Reserve process”.	Management to inform DWAF, national and regional, that a Reserve should be addressed as soon as possible.

ISSUE	ACTION	RESPONSIBILITY
The status of the provincially scarce fish "*Clarias theodorae*" living in this isolated population is under threat.	The population should be monitored at frequent intervals.	Specialist scientist to draft a project proposal and submit for the 2008 – 2009 period.
Monitoring of the river should be conducted regularly on a 3 yearly basis.	Monitoring should be coordinated accordingly.	Specialist scientist to liaise with monitoring personnel, district personnel and DWAF accordingly.
The abundance of the invasive fish spp. "*Oreochromis niloticus"* in the lower reaches of the river is considered problematic.	The population should be monitored at frequent intervals.	Specialist scientist to draft a project proposal and submit for the 2008 – 2009 period.
The functioning of the fishway on Popallin Ranch Dam should be evaluated to ensure that the structure functions correctly.	A research project should be more thoroughly investigated and initiated.	Specialist scientist to draft a research proposal and submit to Universities for inclusion in the 2008 – 2009 study period.
Report should be distributed to relevant role players.	Distribute to management, reserve managers and DWAF.	Specialist Scientist.
A public information booklet or poster should be considered.	Investigate possibilities with DWAF, RHP and CSIR.	Specialist Scientist to discuss with management, DWAF and monitoring section. A possible project for 2008.

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1. Introduction.

The Nwanedzi River Catchment was surveyed by a multi disciplinary team of scientists from Biodiversity and Resource Use Management between September 2006 and May 2007. The team was ably assisted by colleagues from Univen and The Department of Water Affairs and Forestry (DWAF) Polokwane office.

The survey was conducted using standardized River Health Programme monitoring protocols with the objective of providing an assessment of the Present Ecological State (PES) of the river. Six ecological components were assessed using the following monitoring protocols.

Geomorphology.		
Fish	(FRAI)	Fish Response Assessment Index.
Invertebrates	(SASS5)	South African Scoring System (version 5).
Riparian Vegetation	(RVI)	Riparian Vegetation Index.
Instream habitat	(HQI)	Habitat Quality Index.
Invertebrate habitat.	(IHAS)	Invertebrate Habitat Assessment System.

The data gathered during this survey, together with this ecological report provide a scientifically credible assessment of the State of the Environment (SOE) of the Lephalala Catchment. All monitoring protocols are recognized as National Indicators for the purposes of SOE reporting on aquatic ecosystems. In addition, the report will provide a valuable baseline for water resource managers in determining the Ecological Reserve of the Catchment and water licensing in terms of the National Water Act (1998).

This is the first time that a multi disciplinary survey of the Nwanedzi Catchment has been undertaken by this Department, although there are substantial fish monitoring records from both the University of Limpopo (UL), Univen and the Transvaal Provincial Administration (TPA). No invertebrate surveys have ever been conducted.

Given limited historical data and in line with the Departmental objectives of studying one new catchment per year, until all of the river catchments in the province have been addressed, the Nwanedzi River Catchment was considered to be the highest priority of those remaining unstudied catchments. The study was further motivated in a project proposal dated 25.06.07.

12 sites were addressed during this survey, ranging from the Soutpansberg Mountains to the Limpopo Plain.

2. The study area.

The Nwanedzi River flows in a northerly direction across the far north-eastern portion of Limpopo Province.

The Nwanedzi River rises in the upper Soutpansberg Mountains, where a number of small streams converge at an altitude of approximately 1100m. It grows in stature as it drops through a steep gorge before merging with the Luphephe River inside the Nwanedi Nature

Reserve and forming the Nwanedzi – Luphephe dams. Below the reserve, the river continues in a northerly direction across the Limpopo Plain, before joining the Limpopo River on the Zimbabwe border (on the farm Mulala Drift 83MT) at an altitude of 340m.

The river lies entirely within the Limpopo Water Management Area and lies in quaternary catchments A80H and A80J with a gross area of 1136 km^2 and a Gross Mean Annual Runoff (MAR) of 24.5 $10^6 m^3$ (Midgely *et. al*. 1994)

The Nwanedzi – Luphephe dams are the only significant state dams in the catchment (FSC 19.1 million m^3). However, both Cross Dam and Popallin Ranch Dam are substantial in size. Nwanedzi and Luphephe dams provide a managed release for agriculture to the downstream environment. The rivers above these dams are thought to have been historically perennial under natural conditions, while the Limpopo Plain area was most probably seasonal in all but the wettest of years. The situation remains largely the same at this time, but clearly, flood regimes in the lower river have been impacted by the placement of these dams.

There are no major towns in the study area. However there are a substantial number of informal settlements and extensive agriculture (both formal and informal). Game farming is the dominant land use of the lower catchment.

2.1 Ecoregions.

The Nwanedzi River flows through two distinct level 1 ecoregions and a total of 3 level 2 ecoregions as described by Kleynhans et al. 2005 (See Figure 1). Tables 1 – 3 provide the attributes of these Soutpansberg and Limpopo Plain ecoregions.

Table 1. Ecoregion attributes (level 2) for Soutpansberg 2.01, from Kleynhans et al. (2005).

Main Attributes	**Soutpansberg 2.01**
Terrain Morphology: Broad division	Plains; low relief; Lowlands, Hills and Mountains; moderate and high relief; Closed Hills, Mountains; moderate and high relief
Terrain Morphology	Slightly undulating plains; Lowlands with mountains High Mountains
Vegetation types (dominant types in bold) (Primary)	Soutpansberg Arid Mountain Bushveld
Altitude (m a.m.s.l.)	700 to 1700
MAP (mm)	300 to 500
Coefficient of variation (% of annual precipitation)	25 to 34
Rainfall concentration index	>65
Rainfall seasonality	Mid summer
Mean annual temp (°C)	16 to 22
Mean daily max temp (°C) February	24 to 30
Mean daily max temp (°C) July	16 to 22
Mean daily min temp (°C) February	14 to 19
Mean daily min temp (°C) July	4 to 7
Median annual simulated runoff (mm) for quaternary catchment	<5 (limited) to 40

Table 2. Ecoregion attributes (level 2) for Limpopo Plain 1.02. From Kleynhans et. al. (2005).

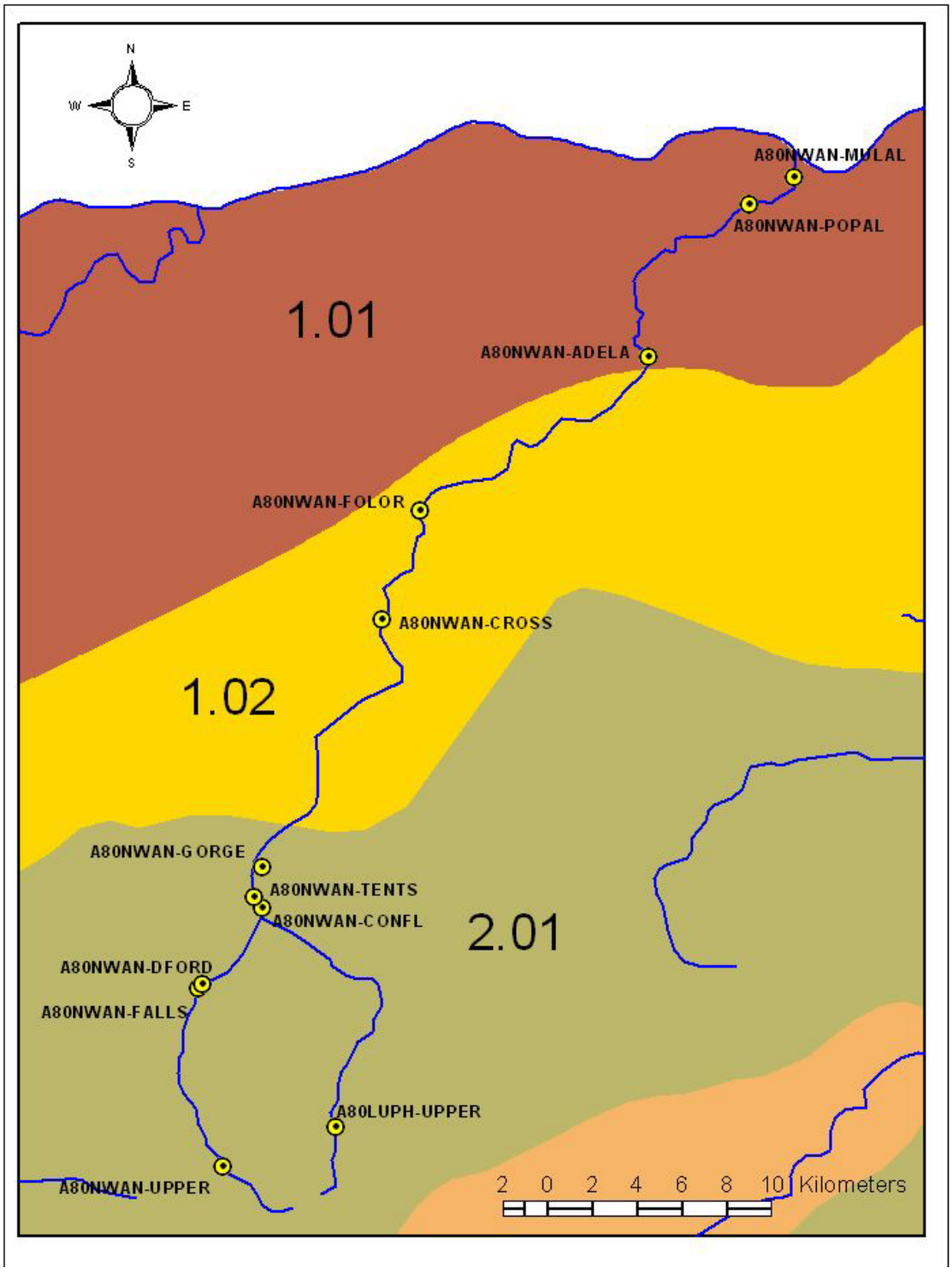
Main Attributes	Limpopo Plain 1.02
Terrain Morphology: Broad division	Plains; low relief; Plains; moderate relief; Lowlands, Hills and Mountains; moderate and high relief; Closed Hills, Mountains; moderate and high relief.
Terrain Morphology	Plains; Slightly undulating plains; Slight irregular plains; extremely irregular plains (almost hilly) (limited); Moderately undulating plains; Lowlands with parallel hills; Lowlands with mountains; High mountains
Vegetation types (dominant types in bold) (Primary)	Sweet Bushveld
Altitude (m a.m.s.l.)	500 to 1300
MAP (mm)	300 to 500
Coefficient of variation (% of annual precipitation)	25 to 39
Rainfall concentration index	60 to >65
Rainfall seasonality	Early to mid summer
Mean annual temp (°C)	18 to 22
Mean daily max temp (°C) February	24 to 32
Mean daily max temp (°C) July	18 to 24
Mean daily min temp (°C) February	16 to 19
Mean daily min temp (°C) July	2 to 7
Median annual simulated runoff (mm) for quaternary catchment	<5 to 40; (40 to 60; 80 to 100 limited)

Table 3. Ecoregion attributes (level 2) for Limpopo Plain 1.01. From Kleynhans et al. (2005).

Main Attributes	Limpopo Plain 1.01
Terrain Morphology: Broad division	Plains; low relief; Plains; moderate relief; Lowlands, Hills and Mountains; moderate and high relief
Terrain Morphology	Plains; Slightly undulating plains Slight irregular plains; Extremely irregular plains (almost hilly) Lowlands with hills
Vegetation types (dominant types in bold) (Primary)	*Mopane Bushveld*
Altitude (m a.m.s.l.)	100 to 900
MAP (mm)	200 to 400
Coefficient of variation (% of annual precipitation)	30 to 39
Rainfall concentration index	>65
Rainfall seasonality	Early to mid summer
Mean annual temp (°C)	20 to >22
Mean daily max temp (°C) February	28 to 32
Mean daily max temp (°C) July	20 to 26
Mean daily min temp (°C) February	18 to >20

Mean daily min temp (°C) July	4 to >10
Median annual simulated runoff (mm) for quaternary catchment	<5 to 10 (10 to 40 limited)

Figure 1. Study area map of the Nwanedzi River Catchment showing survey sites and ecoregions. (Adapted from Kleynhans et al. 2005)



The sites surveyed.

Table4. Survey sites, RHP site codes and coordinates.

Site No.	Site code	Name of site	Ecoregion	River	South	East	Altitude	Map
1	A80LUPH-UPPER	Luphephe Top (Hobohobo)	2.01	Luphephe	-22.7179	30.4293	1000	2230CB
2	A80NWAN-UPPER	Nwanedzi Top	2.01	Nwanedzi	-22.7336	30.3841	905	2230CB
3	A80NWAN-FALLS	Nwanedzi Waterfall	2.01	Nwanedzi	-22.6613	30.3749	600	2230CB
4	A80NWAN-DFORD	Ford above dam	2.01	Nwanedzi	-22.6615	30.3746	590	2230CB
5	A80NWAN-CONFL	Nwanedzi Confluence	2.01	Nwanedzi	-22.6298	30.3999	532	2230CB
6	A80NWAN-TENTS	Low Bridge at tent camp	2.01	Nwanedzi	-22.6258	30.3966	525	2230CB
7	A80NWAN-GORGE	Gorge Mine Waste	2.01	Nwanedzi	-22.6138	30.3999	500	2230CB
8	A80NWAN-CROSS	Cross Dam	1.02	Nwanedzi	-22.5141	30.4477	480	2230CB
9	A80NWAN-FOLOR	Folowodwe Bridge	1.02	Nwanedzi	-22.4710	30.4633	460	2230AD
10	A80NWAN-ADELA	Police Bridge	1.01	Nwanedzi	-22.4093	30.5549	400	2230BC
11	A80NWAN-POPAL	Popallin Ranch Upper	1.01	Nwanedzi	-22.3480	30.5951	380	2230BC
12	A80NWAN-MULAL	Popallin Ranch Lower	1.01	Nwanedzi	-22.3370	30.6130	375	2230BC

2.3 Geomorphology of the Nwanedzi 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 5).

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.

Table 5. 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.
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.

Longitudinal Zone	Macro-reach characteristics			Characteristic channel features
	Valley form	Gradient class	Zone class	
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 6. Eco-regions and geomorphological zonation of the 2007 Nwanedzi Catchment survey sites (after Rowntree and Wadeson, 1999).

Site number	RHP Site Code	Ecoregion	Altitude	Longitudinal Zonation	Zone Class
1	A80LUPH-UPPER	2.01	1000	Upper foothills	D
2	A80NWAN-UPPER	2.01	905	Upper foothills	D
3	A80NWAN-FALLS	2.01	600	Upper foothills	D
4	A80NWAN-DFORD	2.01	590	Upper foothills	D
5	A80NWAN-CONFL	2.01	532	Upper foothills	D
6	A80NWAN-TENTS	2.01	525	Lower foothills	D
7	A80NWAN-GORGE	2.01	500	Lower foothills	D
8	A80NWAN-CROSS	1.02	480	Lower foothills	E
9	A80NWAN-FOLOR	1.02	460	Lower foothills	E
10	A80NWAN-ADELA	1.01	400	Lowland river	F
11	A80NWAN-POPAL	1.01	380	Lowland river	F
12	A80NWAN-MULAL	1.01	375	Lowland river	F

In the Nwanedzi Catchment, resource unit boundaries, (or reporting units) very closely align with ecoregion boundaries. Geomorphological zones, influences from tributaries and even homogeneous fish segments all confirm this fact. For this reason, the results of this report will be presented in terms of the ecoregions identified above.

NB. Although it is recognized that sites A80LUPH-UPPER and A80NWAN-UPPER lie above distinct waterfall reach breaks, a decision was taken to combine the data for these sites into that of remainder of ecoregion 2.01.

2.4 Site descriptions including anthropogenic impacts.

Site 1. RHP site code: A80LUPH-UPPER
Monitoring segment: Nwan 2.01

The site is located in Guyuni area, north of Thohoyandou. This river, the Luphephe, flows into the Nwanedzi Dam. The site is in the upper reaches of this river, close to the source. This mountain stream averages 2-4m wide and has riffles, rapids and sandy runs. There is also a section of bedrock upstream of the site. There are some undercut banks with occasional vegetation. There were occasional trees along this section close to the stream. It is surrounded by some "lightly" overgrazed areas and cultivated plots right up to the water's edge. There are also many footpaths criss-crossing the surrounding area.

Site 2. RHP site code: A80NWAN-UPPER
Monitoring segment: Nwan 2.01

This site lies in a steep sided valley near to the source of the Nwanedzi river. This river runs into the Nwanedzi dam.
The average width of the stream is 2-5 m wide and has riffles, rapids, sandy riffles and slow moving pools. There are also large boulders, some undercut banks and scattered overhanging vegetation. There are also large riverine trees surviving along the banks of this river. There are small lands in the upper areas on the left bank. There has been large scale deforestation on the right bank up to about 150 meters from the river. There has been fire through this area and the soil in this area is loose and as a result of this is highly susceptible to erosion.

Site 3. RHP site code: A80NWAN-FALLS
Monitoring segment: Nwan 2.01

This site lies in a portion of a steep sided valley where it starts to open out approximately one kilometre downstream of the waterfall. The stream is approximately 8 meters wide and has riffles, rapids, runs, backwaters and abundant instream and marginal vegetation.
The area is still largely un-impacted by direct human activity and visible impacts are caused by flooding.

Site 4. RHP site code: A80NWAN-DFORD
Monitoring segment: Nwan 2.01

This site is approximately 200 meters downstream of the Nwanedzi falls site (A80NWAN-FALLS). The area has extensive reed beds though there are still some rapids, riffles and some deep runs. There is a road crossing the area and a small drift crosses the river. The river is approximately 20 meters wide at this crossing.

Site 5. RHP site code: A80NWAN-CONFL
Monitoring segment: Nwan 2.01

This site is at the confluence of the Nwanedzi and Luphephe rivers about 500 meters downstream of the Nwanedzi/Luphephe Dam. The stream is approximately two meters wide after joining. There are riffles, rapids and runs. There are also undercut banks and root wads. Some vegetation does occur on the site though the whole area is shaded by a dense forest canopy.

There is a road with a concrete bridge that has some effect on the flow of water. There are signs of flooding and deposition of sand upstream of this bridge.

Site 6. RHP site code: A80NWAN-TENTS
Monitoring segment: Nwan 2.01

This site is about 300 meters downstream of the confluence site (A80NWAN-CONFL). This site is just upstream of the Ivory Trail Tent Camp. The stream varies in width from 2 – 4 meters and has split into two separate streams just upstream of this site. The streams join at the top end of the site. There are riffles, rapids and some deep runs. There are some undercut banks and root wads as well as instream and marginal vegetation.
There are a lot of signs of severe flooding with scouring and uprooted trees being evident. There is a concrete bridge crossing the river and a road runs along the eastern side of the river. There are alien plants present at this site.

Site 7. RHP site code: A80NWAN-GORGE
Monitoring segment: Nwan 2.01

This site is outside the Nature Reserve and just downstream of the last gorge where the valley has opened out into a large flood plain opposite the farm Gaandrik. The active channel in the upper part of the river is approximately 50 meters wide but narrows down to about 2 meters at the lower end of the reach. There are riffles, rapids, runs as well as some vegetation and a lot of submerged logs. There are also undercut banks and root wads. The wider part of the river is covered in stones which are mostly covered in algae and which at the time of the survey had very slow shallow flow over it.
The riverine vegetation has been severely damaged by removal and burning. There are numerous unproductive lands and roads/tracks in the area. There is also a disused mine which has not been rehabilitated. The surrounding area is very dry with very little ground cover.

Site 8. RHP site code: A80NWAN-CROSS
Monitoring segment: Nwan 1.02

This site is about 100 meters downstream of the Cross Dam. The site is in a narrow gorge and the river has an average width of 3 meters. There are pools on the upper side of a low level bridge as well as rapids, riffles and runs. There are a wide variety of cover types, including stones in current, stones out of current, some gravel, undercut banks and scattered vegetation. Some large trees still occur along this section. There is always some flow in the river due to the release of water for agriculture further downstream.
The area has been seriously impacted by the construction of the dam and an access road as well as the continuing overutilization of the area. The road crosses a low water bridge which also dams up the river, creating a pool with vegetated margins. The river is also used as a fishing site as there are numerous signs of fishermen and their fireplaces. Floods have been reduced in the river though there were high flows during the first visit to the site which had a detrimental effect on the survey.

Site 9. RHP site code: A80NWAN-FOLOR
Monitoring segment: Nwan 1.02

This site is just downstream of the bridge where the Tshipise/Pafuri tar road crosses the Nwanedzi river. The site has rapids, runs, and some deep water. There is a fair amount of overhanging vegetation, though not a lot of instream vegetation. The active channel of the river is about three meters wide though the bank has a stepped flood plain. The banks still have riverine vegetation as well as a lot of scrub. This section of river also receives irrigation water from Cross dam.

This site is impacted on by the bridge as well as traffic stopping in the area and the bush being used as a toilet. There are cultivated fields all along the river in the area.

Site 10. RHP site code: A80NWAN-ADELA
Monitoring segment: Nwan 1.01

This site is downstream of the road bridge which allows access to the Adelaide police station. The site is in a well eroded gulley with a fair amount of vegetation. There are shallow rapids, a few shallow runs and some pools. The stream is approximately five meters wide. There seems to be an anomaly that causes the conductivity to exceed 2000 µS which is found throughout the rest of the river. (Probably from the geological effect of the Tshipise fault) This high conductivity makes the use of an electro shocker impossible. Water from the Cross Dam still flows through this site.
The area around this site is seriously impacted by extensive cultivated fields. These extend to the vegetation margin on the edge of the gully.

Site 11. RHP site code: A80NWAN-POPAL
Monitoring segment: Nwan 1.01

This site is just downstream of the dam on Popallin Ranch. There are some deep pools, runs, limited rapids as well vegetation on the site. There are not a lot of rocky habitats in the water though further downstream there are some bedrock runs. The substrate is dominated by sand. The dam has a major effect on the site as floods cause substantial erosion and previous constructions also impact on flow. There is a fish ladder built onto the dam wall which does offer some refuge to aquatic organisms, although the functionality of the fish ladder is questionable. Most of the water flowing in this section is seepage from the dam.

Site 12. RHP site code: A80NWAN-MULAL
Monitoring segment: Nwan 1.01

This site consists of a low water bridge which also dams up the flow. This results in a large slow-deep pool. There is a small flow of water below this crossing which creates a small rocky rapid with abundant vegetation. There is also abundant vegetation along the banks of the dammed up section. It seems that this dam might dry up during very dry spells.

3. *In Situ* water quality.

Water quality was assessed at each site using hand held meters. Results are presented in table 7. At all sites the water was clear and had a low conductivity, indicating a low salt content. This is indicative of near natural water quality, due to the absence of industry and formal agriculture in the catchment. The low conductivity caused the electro-shocking apparatus to be inefficient.

Table 7. *In situ* water quality results for each site of the 2007 survey.

RHP CODE	Date (mm/dd/yy)	pH	Cond Ms/m	Temp °C	Flow	Clarity
A80LUPH-UPPER	09/14/06	7.00	30.0	20.0	Moderate	Clear
A80NWAN-UPPER	09/14/06	6.80	40.0	20.0	Low	Clear
A80NWAN-FALLS	09/12/06	6.20	70.0	20.0	Low	Clear
A80NWAN-DFORD	05/09/07	6.30	60.0	20.0	Moderate	Clear

RHP CODE	Date (mm/dd/yy)	pH	Cond Ms/m	Temp °C	Flow	Clarity
A80NWAN-CONFL	01/12/06	6.83	114.8	22.9	Moderate	Cloudy
A80NWAN-TENTS	05/11/07	6.60	100.0	20.0	Moderate	Clear
A80NWAN-GORGE	05/09/07	6.60	100.0	20.0	Moderate	Clear
A80NWAN-CROSS	11/15/06	6.90	31.0	25.3	Moderate	Cloudy
A80NWAN-FOLOR	09/13/06	7.20	58.0	25.0	Low	Cloudy
A80 NWAN-ADELA	09/13/06	7.00	>200	25.0	V. Low	Clear
A80NWAN-POPAL	09/15/06	7.80	>200	25.0	V. Low	Clear
A80NWAN-POPAL	05/10/07	7.00	>200	20.0	Moderate	Clear
A80NWAN-MULAL	NO FLOW					

The *In Situ* water quality results indicate that the water quality of the Nwanedzi River is comparable to most lowveld rivers. Only the conductivity in the lower river shows elevated levels. This abrupt rise in the salt load may be attributed to the geological influence of the Tshipise Fault. Also in this area, there are a significant number of un-rehabilitated mine dumps, lying in close proximity to the river, which could be contributing towards this impact.

4. Fish.

4.1 Historical fish distribution.

The expected species list of fish for the Nwanedzi Catchment (Table 8) was developed by taking historical data for the river into consideration and by applying expert knowledge of fish distributions and habitat preferences from neighbouring catchments. Historical fish distribution records are on the Limpopo Province Fish Distribution Data Base (updated August 2007) and extend as far back as 1968. Additional reports are on hand from Hecht *et al* (1980) and van der Waal (1997 and 2001)

No comprehensive Ecological Reserve study has ever been conducted on the Nwanedzi River and this report will therefore provide the fist assessment on the status of fauna and flora of the wider river catchment.

34 Indigenous species of fish are expected to occur in the catchment. Two species of exotic fish are thought to occur, although none were recorded during this survey.

Table 8. **Developed indigenous fish species list, using new and historical data, for the Nwanedzi River, Nwanedzi-Luphephe Dam and Popallin Ranch Dam.**

X = Present, AN = Anecdotal.

SPECIES	RIVER SURVEYS				DAM SURVEYS		
	TPA 1968	HECHT 1980	vd WAAL 1997	RODGERS 2006/7	**NWANEDZI** HECHT 1980	**POPALLIN** vd WAAL 2001	**POPALLIN** RODGERS 2007
AAEN	X						
ALAB		X			**X**		
AMOS	X	X		X			
AURA		X	X	X			
BAFR						**X**	
BANN	X						
BEUT		X	X	X	**X**		
BIMB	X						**AN**
BLIN		X	X	X	**X**		
BPAU	X	X	X	X	**X**		
BRAD	X	X	X	X	**X**		
BTOP	X			X			
BTRI	X	X	X	X	**X**	**X**	
BUNI	X	X	X	X	**X**		
BVIV	X	X	X	X			
CGAR	X	X	X	X	**X**	**X**	**X**
CPAR	X			X			
CPRE		X	X	X			
CTHE		X					
HVIT							**AN**
LCYL	X	X	X	X	**X**		
LMAR	X	X	X	X	**X**		**X**
LMOL	X		X	X	**X**	**X**	
LROS						**X**	**X**
MACU	X	X	X	X	**X**	**X**	**X**
MBRE	X			X	**X**	**X**	
MMAC		X	X	X	**X**		
OMOS	X	X	X	X	**X**	**X**	**X**
PPHI	X	X	X	X	**X**		
PWES		X	X	X	**X**		
SINT	X	X		X	**X**		**AN**
SZAM							**AN**
TREN				X	**X**	**X**	**AN**
TSPA		X	X	X	**X**		
34	**20**	**22**	**19**	**25**	**20**	**9**	**10**

Table 9. Scientific, English and abbreviated names for 34 indigenous fish expected to occur within the Nwanedzi Catchment. (Names from Skelton, 2001 and 2002)

Species	**Abrev.**	**English Common Name**
Amphilius Uranoscopus	Aura	Common Mountain Catfish
Anguilla Bengalensis Labiata	Alab	African Mottled Eel
Anguilla Mossambica	Amos	Longfin Eel
Awaous Aeneofuscus	Aaen	Freshwater Goby
Barbus Afrohamiltoni	Bafr	Hamilton's Barb
Barbus Annectens	Bann	Broadstriped Barb
Barbus Eutaenia	Beut	Orangefin Barb
Barbus Lineomaculatus	Blin	Line-Spotted Barb
Barbus Paludinosus	Bpau	Straightfin Barb
Barbus Radiatus	Brad	Beira Barb
Barbus Toppini	Btop	East Coast Barb
Barbus Trimaculatus	Btri	Threespot Barb
Barbus Unitaeniatus	Buni	Longbeard Barb
Barbus Viviparus	Bviv	Bowstripe Barb
Brycinus Imberi	Bimb	Imberi
Chiloglanis Paratus	Cpar	Sawfin Rock Catlet
Chiloglanis Pretoriae	Cpre	Shortspine Rock Catlet
Clarias Gariepinus	Cgar	***Sharptooth Catfish***
Clarias Theodorae	Cthe	Snake Catfish
Hydrocynus Vittatus	Hvit	Tigerfish
Labeo Cylindricus	Lcyl	Redeye Labeo
Labeo Molybdinus	Lmol	Leaden Labeo
Labeo Rosae	Lros	Rednose Labeo
Labeobarbus Marequensis	Lmar	Largescale Yellowfish
Marcusenius Macrolepidotus	Mmac	Bulldog
Mesobola Brevianalis	Mbre	River Sardine
Micralestes Acutidens	Macu	Silver Robber
Oreochromis Mossambicus	Omos	Mozambique Tilapia
Petrocephalus Wesselsi	Pwes	Churchill
Pseudocrenilabrus Philander	Pphi	Southern Mouthbrooder
Schilbe Intermedius	Sint	Silver Catfish
Synodontis Zambezensis	Szam	Brown Squeaker
Tilapia Rendalli	Tren	Redbreast Tilapia
Tilapia Sparrmanii	Tspa	Banded Tilapia

Table 10. Scientific, English and abbreviated names for 2 exotic fish expected to occur within the Nwanedzi Catchment. (Names from Skelton, 2001 and 2002)

SCIENTIFIC NAME	ABREV	ENGLISH COMMON NAME
Cyprinus carpio	Ccar	Carp
Oreochromis niloticus	Onil	Nile Tilapia

4.2 Fish survey 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 that 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 circular nylon net, 1.6m radius, with 12mm mesh size. Cast nets can be used by an individual in any habitat, that is clear of snags and obstructions.

Most fish caught were identified at site and returned to the river alive. A small number of fish from a few sites were kept for a reference collection. The collection will in due course be lodged with the South African Institute for Aquatic Biodiversity. (SAIAB)

When possible, individual fish were examined for parasite loads.

The habitat at the site was categorized, 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 categorized 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 utilized 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).

Slow Deep Water = > 0.5 meters. Fast water = > 0.3 m/sec.
Fast Deep Water = > 0.3 meters.

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.

4.2 Application of the Fish Response Assessment Index (FRAI)

The FRAI is an index which has recently been developed by Dr. Kleynhans of the Institute for Water Quality Studies (IWQS) of DWAF for Ecostatus determination (Kleynhans, 2007).

The index assesses the status of fish populations which are present under existing conditions in relation to those which could be expected under natural conditions. The index follows a dedicated spreadsheet format and rule based model.

The methodology has now provided a logical and standardized approach for the interpretation of system health based on fish assemblages. The FRAI has subsequently been adopted for both State of Environment Reporting (SOER) biomonitoring assessments for river health as well as for the reserve determination process.

The index assesses fish assemblages in terms of the following criteria.

- Flow-depth class metrics.
- Flow modification metrics.
- Cover metrics.
- Health/condition metrics.
- Introduced species metrics.

At each stage in the procedure, motivations for the scores are appended to the spreadsheets by way of comment boxes. Assessments of the fish populations against each of the above are calculated and then, based on expert judgment and prevailing conditions, are weighted and ranked prior to the calculation of an overall index score. The index score is interpreted as a percentage of natural, to provide an interpretation of the Ecological Category (EC).

Descriptive templates for the PES remain unchanged from the earlier FAII interpretation and for completeness are attached as tables 7 and 8.

Detailed FRAI results are contained in APPENDIX B. (Electronic format)

Table 11. FRAI assessment classes. (Adapted from Kleynhans; 1997)

Class	Description of Generally Expected Conditions	FRAI 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 12. 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

4.4 Fish survey results.

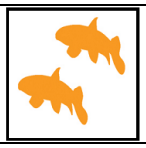
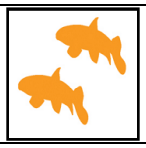
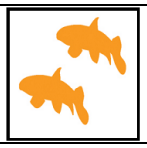
Detailed fish survey results, habitat assessments, sampling effort and the calculation of FRAI are attached as APPENDIX B. Summarized results are presented here.

Table 13. Species expected and recorded (in yellow) in each ecoregion.

2.01	1.02	1.01
Alab	Alab	Alab
Amos	Amos	Amos
Aura	Blin	Bafr
Beut	Bpau	Bann
Blin	Brad	Brad
Bpau	Btop	Btop
Btri	Btri	Btri
Buni	Buni	Buni
Bviv	Bviv	Bviv
Cgar	Cpar	Bimb
Cpar	Cgar	Cpar
Cpre	Lcyl	Cgar
Cthe	Lmol	Gcal
Lcyl	Lmar	Hvit
Lmar	Mmac	Lcon
Lmol	Mbre	Lcyl
Macu	Macu	Lmol
Mmac	Omos	Lros
Omos	Pwes	Lrud
Pphi	Pphi	Lmar
Pwes	Sint	Mmac
Sint	Tspa	Mbre
Tspa	11 / 22	Macu
20 / 23		Omos
		Pphi
		Sint
		Szam
		Tren
		12 / 28

Table 14. Summarized results for each ecoregion. (REF APPENDIX B)

NATURAL	A
GOOD	B/C
FAIR	C/D
POOR	E/F

	NWANEDZI RIVER		
	Soutpansberg 2.01	Limpopo Plain 1.02	Limpopo Plain 1.01
FRAI (%)	77.2	62.7	42.1
EC: FRAI	C	C	D
			

4.5 Discussion.

The upper Nwanedzi and Luphephe. rivers: Ecoregion 2.01

A total of 7 sites were visited in this ecoregion, providing a high confidence to the results obtained. The ecoregion extends from the source zone to the confluence of the Nwanedzi and Luphephe rivers below the dam wall.

Although 19 out of a possible 22 fish species were recorded, abundances and frequency of occurrence for all species were generally low. While one eel (*Anguilla mossambica*) was caught below the dam wall at the confluence, no migratory fish were recorded at the remaining four sites above the dam and it is likely that both eel species are now extinct in that reach above the dam.

Three rheophilic fish species were recorded above the dam, (*Amphilius uranoscopus, Barbus eutaenia* and *Chiloglanis pretoriae*) confirming the perenniality of this reach, while only one species, (*Chiloglanis pretoriae*) was recorded below the dam.

The continued presence of the isolated population of the snake catfish (*Clarias theodorae*) was reconfirmed above the dam, where 3 specimens were caught. However, no specimens were caught at previously known localities below the dam wall. The long term existence of this "provincially scarce" species is worrying and regular monitoring of the population should be considered.

Without doubt, the Nwanedzi – Luphephe dams are providing a strong refuge for hardy species in that reach above the dam, while outflows from the dams are maintaining a healthy environment immediately downstream. In addition, the presence of the Nwanedi Reserve is limiting direct anthropogenic impacts from fishing and other activities on the resource.

The middle Nwanedzi River: Limpopo Plain 1.02

A total of 2 sites were surveyed in this ecoregion, with 11 out of a possible 22 species being recorded. Results should be viewed with moderate confidence. Abundances and frequency of occurrence of those species recorded are thought to be fair.

Only one species, an eel, which was thought to occur here may have been lost (*Anguilla bengalensis labiata*).

While one eel (*Anguilla mossambica*) was caught at least 10 other fish species are known to make migrations in flood conditions, either for breeding purposes or to take up available habitat.

No fully rheophilic species were expected, but four semi rheophilic species were abundant. The majority of the species which were recorded are considered to be hardy, non flow dependent species.

The presence on the Nwanedzi – Luphephe dams upstream, Popallin Dam downstream and Cross Dam within this reach, provides for some refuge for most species present, while contributing to the fragmentation of the system for migratory fish.

<u>The lower Nwanedzi River: Limpopo Plain 1.01</u>

A total of 4 sites were visited, but the lowest site at Mulala Drift was dry and could not be surveyed. Two sites were surveyed on Popallin Ranch, one on the dam itself using gill nets only and the second site just below the dam wall. Gillnetting proved very unsatisfactory due to an abundance of crocodiles. Alternative survey methods were abandoned for the same reason. Catch results of the remaining two sites were therefore supplemented through discussions with anglers and residents who provided reliable anecdotal information on species present. Nevertheless, anecdotal information was only available for easy to identify angling targets and not for the smaller fish species.

A total of 12 out of a possible 28 species were confirmed present, but these were all larger species which were caught by net and reported by anecdotes. It is however reasonable to assume that all expected species for this ecoregion could still occur here, if only during periods of good flow.

The presence of the highly invasive exotic fish spp. *Oreochromis niloticus* in Popallin Ranch Dam, was confirmed by reserve managers. The status of this population requires further investigation.

Given the available data, the FRAI result of a D class river for this ecoregion should be viewed with low confidence. Nevertheless, it is recognized that impacts on the flow regime and from the sizeable dams will distort fish populations away from what is considered natural. In addition, the capability of the downstream Limpopo River to act as an area of refuge for the Nwanedzi River has diminished in recent years due to regulated flow regimes in all of its tributaries. Abundances and frequency of occurrences will be the most affected factors of fish communities at this time.

No truly rheophilic species are expected to occur in this predominantly seasonal section of river. Many of the species expected here, move to take up available habitat during high flow,

while 8 species are considered to be semi- rheophilic in that they require flowing water for breeding purposes.

It was noted that a semi functional fish ladder had been constructed on the Popallin Ranch Dam wall. It is thought that some aspects of the fish ladder could use some modification and it is therefore recommended that the dam be revisited in moderate flow conditions to assess its current functionality.

5. The invertebrate survey.

5.1 Invertebrate survey methods.

The survey for invertebrates was based upon methods developed for Biomonitoring, utilizing the SASS5 protocols (Dickens and Graham 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 cognizance of available habitat both up and down stream a distance of 100 meters)

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 sites are totaled to yield the SASS5 score. The average score of all of the taxon 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 Invertebrate Habitat Assessment System (IHAS) score sheet was also utilized and total scores obtained.

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

The method of collecting macro invertebrates utilizes 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. Sampling times are indicated on the score sheet.

5.2 Interpreting SASS5 results using MIRAI.

SASS5 results were analyzed, by using the recently developed "Macro Invertebrate Response Assessment Index" (MIRAI). MIRAI methodologies were described by Ms. C.Thirion of DWAF, in Kleynhans et al 2005. Results are then interpreted in terms of the generic frameworks as described in table 12.

The following text is adapted from the above manual.

" The determination of aquatic invertebrate EC is essentially based on:

- An interpretation of the environmental requirements, preferences and intolerances of Invertebrate taxa constituting the natural assemblage in a particular river delineation, and
- Their responses to changes in habitat conditions as brought about by changes in driver components.

MIRAI is used to determine the Invertebrate EC. It is done by integrating the ecological requirements of the invertebrate taxa in a community or assemblage and their response to modified habitat conditions.

Although MIRAI can be determined using information collected during a standard SASS survey (Dickens and Graham 2001), it can also be determined using more detailed information. The aim of the MIRAI, is to provide a habitat based cause and effect foundation to interpret the deviation of the benthic invertebrate community (assemblage) from the reference condition. This does not preclude the calculation of SASS scores if required. However, the recent tendency is to use the MIRAI even for RHP purposes.

Information required for the application of the MIRAI

a) Establish Reference Conditions

There are two methods for determining the list of taxa expected to occur under natural (reference) conditions

- A minimally impacted site in the same level II ecoregion and geomorphological zone with similar habitat can be used as a reference site, and information from this reference site can be used to compile a reference list of taxa for the area under consideration.
- In the absence of a suitable reference site, information from similar sites in different rivers as well as any historical information available can be used do compile a derived reference list of taxa expected under reference conditions. A thorough knowledge of the area under consideration is essential in order to compile a suitable referenced list. The presence/absence of taxa within a different river the same ecoregional context can be used to derive reference presence in the river delineation being considered.

b) Site selection

One of the most important factors in selecting a sampling site is the aim of the study. A site selected for the River Health Programme (RHP) aimed at determining the state of a river may differ from a site selected for a reserve study. Whatever the main aim of the study, the site should at least have suitable habitat for the benthic macro-invertebrates. The site should be either representative of the river delineation or should represent a critical section of the river (i.e a section of the river that will stop flowing before the rest of the river). Reserve sites are usually compromise sites between the different disciplines involved. A site that is suitable for invertebrates may be too complex to model accurately, while a site preferred by the hydraulician, may not provide suitable habitat for the biota.

An "ideal" macro-invertebrate site would be a site at which all or most of the invertebrate biotopes are present. This means that the site would have Stones-in–current, Stones-out-of-current, Vegetation-in-current, Vegetation-out-of-current, Sand, Gravel and Mud. In addition to a variety of biotopes, the biotopes will also be of good quality and quantity. As an

absolute minimum the site should have at least either a stony biotope or a vegetation biotope, in current.

When dealing with strictly alluvial rivers that are characterized by a sandy bottom, it is important that there is enough vegetation present to provide adequate habitat for the invertebrates. Moving sand (in current) is such an inhospitable habitat for invertebrates that it often is nearly devoid of life.

c) Data collection

Before the site visit and actual sampling it is important to collect all available invertebrate data for the river. This will include a literature survey as well as a search on the rivers database and contacting specialists that have worked in the area previously. This background information will assist in setting the reference condition and if there were recent information available will help to have greater confidence in the present state of the invertebrate community.

d) Habitat assessment

The main aim of a habitat assessment is to evaluate the template on which the invertebrates exist. An organism can only occur at a site if suitable habitat exists, it is therefore essential to assess not only the habitat quality and quantity, but also the diversity of available biotopes.
"

The index assesses invertebrate assemblages in terms of the following criteria.

- Flow modification metrics.
- Habitat / Cover metrics.
- Water quality metrics.
- Connectivity and seasonality.

.

Assessments of the invertebrate populations against each of the above metrics are calculated and then, based on expert judgment and prevailing conditions, are weighted and ranked prior to the calculation of an overall index score. The index score is interpreted as a percentage of natural, to provide an interpretation of the Ecological Category (EC).

5.3 MIRAI results.

Detailed SASS5 and MIRAI results are attached as APPENDIX C.

Table 15. Summarized MIRAI results for each ecoregion. (REF APPENDIX C)

NATURAL	A
GOOD	B/C
FAIR	C/D
POOR	E/F

	NWANEDZI RIVER		
	Soutpansberg 2.01	Limpopo Plain 1.02	Limpopo Plain 1.01
MIRAI (%)	69.2	62.3	56.97
EC: MIRAI	C/D	C/D	C/D

5.4 Invertebrate discussion.

The entire Nwanedzi Catchment lies in a "Fair" Ecological Category based on the invertebrate communities. The assessment reflects the current situation, as can be expected, given the domestic and agricultural impacts, prevailing flow modifications and system connectivity.

The upper and middle catchments offered very diverse habitats in which to conduct SASS5. Although invertebrate communities are relatively diverse here, the above impacts have resulted in low abundances and frequency of occurrences of many invertebrate families.

Once again, the results for the lower river (Limpopo Plain 1.01) should be viewed with a moderate – low confidence. The limited number of sites surveyed in this dominantly seasonal river, when combined with relatively limited sampling habitat, cause this result to be viewed with caution.

6. The Eco Status and Ecological Importance and Sensitivity (EIS) of the Nwanedzi Catchment.

The Eco Status of a catchment is determined by assessing all of the abiotic and biotic metrics (on a scale of 0 – 5) and applying a weighting to each, in order to provide an overall assessment of the condition of the catchment.

The EIS is an indication of the level of protection that a river should receive. High meaning it should be protected to a natural or good state and low, meaning it has less conservation value or is already impacted and that the resource may be further utilized.

The Eco Status and the EIS of each reporting unit are assessed in detail in APPENDIX D by following a rule based model as described by Kleynhans *et al* (2005)

Summarized results are presented in table 16 and 17.

Table 16. Summarized Eco Status, showing scores and weightings for each metric of each ecoregion, from a rule based model developed by Kleynhans *et al* (2005)
Score: 0 = No impact, 5 = High impact

RIVERS & ECOREGIONS	Bed modification		Flow modification		Introduced instream biota		Inundation		Riparian/Bank condition		Water quality modification		DESKTOP HABITAT INTEGRITY	Desktop Invertebrate Rating		Desktop Fish rating		INSTREAM EC%	INSTREAM EC	Desktop Vegetation Rating		ECOSTATUS %	ECOSTATUS EC	CONFIDENCE
Nwanedzi and Luphephe rivers. Soutpansberg 2.01	1	85	1	85	0	95	1	85	2	50	1	85	80.83	3	50	3	50	61.4	C/D	2	70	63.5	**C**	4.0
Nwanedzi River. Limpopo Plain 1.02	2	70	2	70	1	85	3	50	2	70	2	70	69.17	3	50	2	70	63.1	C	3	50	58.7	**C/D**	4.0
Nwanedzi River. Limpopo Plain 1.01	2	70	2	70	3	50	2	70	2	70	2	70	66.67	3	50	3	50	55.6	D	3	50	53.7	**D**	4.0

Table 17. EIS assessments for each ecoregion. From a rule based model developed by Kleynhans *et al* (2005) Score: 0 = No importance, 5 = Very high importance.

Rivers (Report unit).	Description	2007 Score	2007 Conf	2007 EIS SCORE (MEDIAN)	EIS	Comments
Nwanedzi and Luphephe Rivers. Soutpansberg 2.01	Diversity of habitat types	3	4			Wetlands, waterfalls and mountain streams.
	Importance of conservation & natural areas	3	4			Important mountain catchment and wetlands. Nwanedi reserve.
	Intolerant (flow & flow related water quality)	4	4			Aura, Cpre, Beut, mayflies and caddisflies.
	Migration route/corridor	3	4			Important link from Limpopo to mountains. Eels present.
	Rare & endangered	2	4			Cthe, cycads.
	Refugia	2	4			Numerous streams providing refuge to all. Dam provides refuge for river.
	Sensitivity to water quality changes	3	4			All fish and inverts require good quality.
	Sensitivty to flow changes	3	4			Aur, Cpre, Beut, Cthe, mayflies and caddisflies.
	Species/Taxon Richness	3	4			19/22 fish recorded, 39/42 inverts recorded.
	Unique (endemic, isolated, etc.)	2	4	3.0	**HIGH**	Cthe
Nwanedzi River. Limpopo Plain 1.02	Diversity of habitat types	3	4			Pools, rapids, riffles, gorge
	Importance of conservation & natural areas	2	4			Tail end of Nwanedi Reserve.
	Intolerant (flow & flow related water quality)	2	4			Cpre,
	Migration route/corridor	2	4			Lowveld to mountain. Eels.
	Rare & endangered	2	4			Crocodiles (Cross dam)
	Refugia	2	4	2.0	**MODERATE**	For lowveld

Rivers (Report unit).	Description	2007 Score	2007 Conf	2007 EIS SCORE (MEDIAN)	EIS	Comments
	Sensitivity to water quality changes	2	4			Cpre, Cpar, Cthe, Mayflies, Caddisflies.
	Sensitivty to flow changes	2	4			Cpre, Cpar, Mayflies, Caddisflies.
	Species/Taxon Richness	3	4			16/23 fish and 33/44 inverts recorded.
	Unique (endemic, isolated, etc.)	1	4			Cthe (possible)
Nwanedzi River Limpopo Plain 1.01	Diversity of habitat types	2	4			Pools, dams, gravel riffle, sandy runs.
	Importance of conservation & natural areas	2	4			Private game farms along limpopo confluence.
	Intolerant (flow & flow related water quality)	1	4			Cpar
	Migration route/corridor	2	4			Lowveld to mountain. Eels.
	Rare & endangered	1	4			Crocodiles.
	Refugia	2	4			Refuge for Limpopo.
	Sensitivity to water quality changes	2	4			Temperature in pools.
	Sensitivty to flow changes	2	4			Labeo spp., Cpar and Lmar.
	Species/Taxon Richness	3	4			12/28 fish recorded. 22/45 inverts recorded
	Unique (endemic, isolated, etc.)	1	4	2	**MODERATE**	Hippo.

7. Management recommendations.

Table 18. Management recommendations.

ISSUE	ACTION	RESPONSIBILITY
A scientifically motivated reserve determination has not been addressed for this catchment.	A thorough Reserve should be undertaken as a priority. For this catchment it is likely that the flows should be assessed through an "Intermediate Reserve process".	Management to inform DWAF, national and regional, that a Reserve should be addressed as soon as possible.
The status of the provincially scarce fish "*Clarias theodorae*" living in this isolated population is under threat.	The population should be monitored at frequent intervals.	Specialist scientist to draft a project proposal and submit for the 2008 – 2009 period.
Monitoring of the river should be conducted regularly on a 3 yearly basis.	Monitoring should be coordinated accordingly.	Specialist scientist to liaise with monitoring personnel, district personnel and DWAF accordingly.
The abundance of the invasive fish spp. "*Oreochromis niloticus"* in the lower reaches of the river is considered problematic.	The population should be monitored at frequent intervals.	Specialist scientist to draft a project proposal and submit for the 2008 – 2009 period.
The functioning of the fishway on Popallin Ranch Dam should be evaluated to ensure that the structure functions correctly.	A research project should be more thoroughly investigated and initiated.	Specialist scientist to draft a research proposal and submit to Universities for inclusion in the 2008 – 2009 study period.
Report should be distributed to relevant role players.	Distribute to management, reserve managers and DWAF.	Specialist Scientist.
A public information booklet or poster should be considered.	Investigate possibilities with DWAF, RHP and CSIR.	Specialist Scientist to discuss with management, DWAF and monitoring section. A possible project for 2008.

8. Conclusions.

The results of this survey have led to an assessment of the Eco Status of the catchment (Table 15), which at this time places the entire catchment in a "fair" Ecological Category. The upper catchment is considered to have a High Ecological Importance and Sensitivity (EIS), while below the Nwanedzi Dam the EIS is Moderate. (Table 16)

Given the impacts and drivers within this catchment have been stable for many years, it is thought unlikely that the status of the catchment will change substantially in the near future. However, the status of specific fish communities within this catchment give cause for concern and the situation should be monitored more closely.

Management should take note of those issues raised in table 17 and support and take the recommended actions to help conserve this catchment.

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