FOSAF

THE FEDERATION OF SOUTHERN AFRICAN FLYFISHERS

PROCEEDINGS OF THE 15TH YELLOWFISH WORKING GROUP CONFERENCE

CRADLE OF LIFE TOURISM & CONSERVATION CENTRE, BADPLAAS, MPUMALANGA. 18-20 FEBRUARY 2011

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Edited by Peter Arderne

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WELCOME ADDRESS

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Firstly, welcome to all of you who have taken the effort to be here which invariably is at your own expense. A special word of welcome to Wynand who is one of our long time members and supporter of this working group. Also, Pierre, Dean, Paul Fouche who have always been in support of the YWG. It is also good to have Turner back with us after missing out on a few symposia.

We have a very busy workshop this year as opposed to 2010. There are many factors which have contributed to that, but we need not dwell on that. It is always touch and go whether fishing should be made available at the venue of these workshops which is an attraction and an additional element to the conference. I am sorry I missed the afternoon sessions yesterday but fishing just seemed like a better option at the time but I now rue that decision.

The character of the workshop has changed over the years and delegates consist, these days, of more than just a collection of anglers. FOSAF and the YWG (Exco) are happy that the two sessions held on Friday could piggy back on this conference week-end. I hope that something productive comes out of this. For those of you who are unaware of the origins of the YWG and Pierre was one of the founding members, it all started with the conservation departments closing out their legislation and obligations towards trout during the early 1990's. It was Pierre, who at the time, said that all was not lost because there are alternatives open to the fly angler and suggested the pursuit of indigenous species, namely yellowfish. As we now know this initial idea has become hugely successful with many angling shops depending on a Vaal that is fishable (during the summer months) for their businesses to thrive. Let's hope that something as positive as the YWG comes from yesterday's initiative – also an initiative of Pierre. Building on that, and judging by this year's programme this should provide for another very good conference.

The socio-political landscape has change drastically over the ensuing 14 years which can be analysed in terms of the physical, social and political environments. Politically, the existing government departments never fail to disappoint by not fulfilling their legal mandate, choosing rather to follow party political aspirations rather than good governance. In spite of good legislation Departments are now, more than ever, less focused on good environmental management principles. Legislation is not being enforced and conservation, per se, does not appear to receive priority attention in any sphere of government. Our social environment is not that healthy either. Poverty in rural areas is forcing communities to harvest wildlife for their subsistence. While this should not be a problem poor regulation means that harvesting methods are unsustainable. The country's fish stocks are being depleted at an alarming rate, because of this. While we understand the issues around land ownership the current land reform programme is turning productive agricultural land into wastelands with ensuing soil erosion and littering. Instead of productive systems keeping up with demand we are reducing the lands capacity to do so. All of which are having a major impact on our waterways. There is more pollution, habitat destruction and alien invasive species placing greater pressure on the viability of our aquatic environments than ever before. Because of these factors it is possibly time to re-look at the role of the YWG as we embark on the next 14 years of conservation action.

There are very few forums where aquatic scientists can deliberate about their work and direct research into specific directions. The failing River Health Programme and the dearth of

scientists in Conservation Departments is both disappointing and disheartening. Over the past 14 years the YWG has adapted to these changes as well - perhaps unconsciously, at that. Our focus having changed from an angling perspective to that of promoting a more scientific and conservation approach. I would like to think that it is now fulfilling a gap left by formal conservation in that they no longer provide an official forum anymore for the aquatic scientists. So, while angling is no longer the focus of the YWG, conservation matters and good science and networking are. It is here that we share ideas on the conservation of our aquatic environments, identify and debate pertinent research on all topics relating to fish research and management. Progress into this new direction must be seen as positive and is to be encouraged. The YWG really has become 3 things:

1. We still promote angling for yellows, especially with on fly rod.
2. It has become a forum for the conservation and research on matters pertaining to aquatic resources and systems.
3. It is also providing a platform from which FOSAF is able to analyse its own policies on the subject. This is something that we have not consciously done at FOSAF before but we will be bouncing our policies off the members of the YWG in the course of the coming year. It is always good to gain review one's own philosophies from a broader community. FOSAF values the role of the YWG and regards this as one of our most successful projects.

This brings me to the thank you part of my address.

I would like to thank FOSAF for partly sponsoring this event, and for their ongoing sport. I would also like to thank you, the presenters and the delegates who attend this workshop and making it the success it has become. Many of you do attend this using your own funding to get here and this is greatly appreciated. This point alone is a testament to the success of this forum. Thirdly, I would like to thank the Cradle of Life Tourism & Conservation Centre for allowing us access to this venue at such reasonable rates. Finally, a big thank you to Peter Arderne for doing all the arrangements, it is not an easy job.

Lastly I would like to wish you all a productive conference and that you efforts at getting here are worth it.

PROGRESS REPORT FOR THE WESTERN CAPE SINCE THE 2010 YELLOWFISH CONFERENCE

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CAPE Alien Fish Control project

- Aim: to pilot the control of alien fishes in the Cape Floristic Region, so as to save threatened fishes from extinction and restore healthy ecosystem functioning in priority rivers
- Project reported on in several previous Yellowfish Conference Proceedings
- Comprehensive EIA completed in 2009 with positive outcome for project. Selection of rivers appropriate, piscicide with rotenone can be used, pilot river for treatment is Rondegat River
- Substantial funding required to address key aspects of project e.g. weir repair, rotenone treatment
- Aim was to undertake treatment in March 2011, subject to completion of final planning and timeous availability of funds to secure service providers
- Louise Stafford (co-ordinator of the CAPE Invasive Alien Animal Working Group) assumed overall leadership of the project, with Dean Impson being operational manager
- Operational manager completed 8 of 10 Plans to guide and assess treatment completed during reporting period. These plans were written according to the guidelines in *Rotenone Use in Fisheries Management* published by the American Fisheries Society. Plans included a Public Involvement Plan, Communications Plan, Treatment Plan, Fish Relocation Plan and a Site Safety and Security Plan.
- During the reporting period, an independent and detailed pre-treatment monitoring and research project, funded by the Water Research Commission, was started. This project includes fish and aquatic invertebrate experts under the leadership of Dr Olaf Weyl at the South African Institute of Aquatic Sciences (SAIAB). Autumn, Spring and Summer collections of aquatic invertebrate were made and several progress reports have been written.
- Working for Water provided generous funding for approved CAPE IAA projects in 2010, including this project. However, funding was only received at CapeNature in November 2010, and together with a slow procurement process at CapeNature (to appoint service providers), were key factors in preventing a March 2011 treatment.
- CapeNature has been allocated very generous funding of nearly R1 million Rand from WfW for the 2011/2012 financial year which will allow project implementation by February 2012 if funds are received my May 2011.
- CapeNature prepared a draft Rotenone Policy during the reporting period. This policy will be finalized after the Rondegat treatment.
- Cole Grainger, undertook his 4th year research study on the perceptions of trout, bass and conservation stakeholders towards this project for his BSc Conservation Biology degree at the University of Stellenbosch. The aim of this very basic research project was to determine how these stakeholders currently view the project, a year after the EIA had been completed. His research, based on questionnaires received from 87 people, highlighted the following issues:

- Conservation-orientated respondents were more in favour of the project being implemented, understood more clearly the impact of invasive fish species and role of rotenone in reducing this impact in indigenous aquatic communities.
- A sizeable proportion of trout and, to an extent, bass anglers remained skeptical of the project, particularly regarding the use of rotenone. Their perceptions regarding the project have been influenced largely by articles and programmes in the media, and the internet. Several respondents indicated that their current negative attitudes to the project would change with a successful outcome of the project.
- Respondents emphasized the need for excellent pro-active communication from CapeNature via a dedicated website and holding regular meetings with affected angling groups in the W. Cape.

Research

- Sean Marr: PhD at UCT on alien fish impacts and developing a conservation plan for fynbos fishes is nearing completion.
- Jeremy Shelton: PhD started on impacts of trout in SW Cape streams, focusing on the Breede River System
- SAIAB is very active with taxonomic, ecological and further genetic work on Cape Galaxias and redfins *Pseudobarbus*. This exciting work, lead by Dr E Swartz, is showing that the fynbos region is home to a much wider diversity of indigenous fishes than currently recognised, for example the currently recognized 1 species of Cape Galaxias namely *Galaxias zebratus* is a species complex of at least 10 new species!
- Albert Chakona is doing his PhD at Rhodes University through SAIAB on the comparative phylogeograhy of freshwater fish of the Breede River System and adjacent systems. This research included mapping all the fish species in this area, and for the first time will accurately map the current distribution of the Endangered Berg-Breede whitefish in this area.

WC Yellowfish Working Group

- New chairman Gerald Penkler, replaced Leonard Fleming
- See this Proceedings for news on the WCYWG

River Health Programme in the W Cape

- Contract between CapeNature and DWA (in place since 2003) to undertake the RHP in W Cape terminated in March 2010
- DWA developed well capacitated Resource Protection team in W Cape during 2008/9 and no longer needed contract with CapeNature
- State of River report for Breede Water Management Area to be published in April 2011
- State of River Review report for Berg Water Management Area to be published in May 2011
- DWA team focusing on Olifants-Doring River System in 2010/2011. CapeNature will assist with fish surveys.

- The Breede-Overberg Catchment Management Agency became operational during the reporting period – this is the second fully operational CMA in South Africa after the Incomati CMA.

Stockings

- CapeNature has prepared a final draft of a Policy to guide the Utilisation of indigenous freshwater fishes in the W Cape.
- This will guide stockings and other uses of all indigenous fishes in the province.
- CapeNature endorses guidelines of the national YWG in discouraging stockings of indigenous fishes for angling purposes due to elevated risk issues of promoting use and hence movement of such fishes, many of which are threatened and have localized distributions. Its fish permit committee will, however, consider stockings if the motivation has a strong conservation focus in a conservation area (e.g. nature reserve, stewardship site, protected environment) within the current distribution range of the species concerned and / or is a recommended activity for the species in its Biodiversity Management Plan.
- In the last proceedings, CapeNature reported on the proposed development of a large cyprinid management plan. This plan has been discontinued and CapeNature intends to instead focus on developing BMP-S for these fishes, with the first one on Clanwilliam sandfish already started by Dr Bruce Paxton, an independent consultant and funded by the Table Mountain Fund.

Other Aquatic news at CapeNature

- Jeanne Gouws and Dean Impson, aquatic scientists at CapeNature, contributed information to the development of National Freshwater Ecosystem Priority Areas (NFEPA's) and Critical Biodiversity Areas for fish. These areas were finalized during the reporting period and Jeanne is responsible for creating awareness of these areas within CapeNature and amongst key stakeholder organizations (Working for Water, Working for Wetlands, DWA, LandCare etc).
- Martine Jordaan, aquatic technician at CapeNature, is responsible for fish permits, fish surveys of highly threatened species and is leading the development of a BMP-S for the Critically Endangered Barrydale redfin (reported on in this Proceedings).
- CapeNature closed its public aquarium at Jonkershoek recently, because of a lack of capacity and funds to operate it properly.
- CapeNature held a meeting of its Freshwater Angling Forum with angling representatives at the Cape Piscatorial Society offices in Cape Town on 27 October 2010. The well attended meeting discussed various issues of mutual importance (e.g. Rondegat project, catfish invasion in W. Cape) and the need to hold meetings every six months to maintain momentum.

THE WESTERN CAPE CHAPTER OF THE YELLOWFISH WORKING GROUP REPORT: 2010

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ABSTRACT:

The Western Cape YWG is focused on the conservation of the larger species , such as the Clanwilliam yellowfish (*Labeobarbus capensis*), the Clanwilliam sawfin (*Barbus serra*) and the Witvis (*Barbus andrewi*).
In order to remove angling pressure from some of the sensitive rivers, together with Cape Nature, we identified several dams in the Ratels catchment (Groot winterhoek) suitable for stocking* of these species. These dams are for angling only and these fish will not be stocked back into the river systems due to inbreeding concerns.
Cape Nature identified a dam in Paarl that is a potential Witvis (*Barbus andrewi*) sanctuary. Currently it only contains a *Sandelia* species. Samples will be taken by Cape Nature and sent to SAIAB for genetic identification, as they may be from the Berg river. The need for a sanctuary is apparent, as the riverine Witvis is all but extinct. Following identification of the *Sandelia* and scientific motivation, this dam may be stocked in October 2011*.
Habitat destruction, such as the destructive bulldozing of the Hex River, removed the resident and last well known population of riverine Witvis. This is a major concern to YWG, but how to approach it is difficult. Education alone is not enough to stop this type of destruction, as unfortunately if a farmer is faced with losing a crop, the inevitable will occur.
Another major concern is that Clanwilliam yellowfish are being distributed illegally outside of their natural range for angling purposes. Only by awareness and education (a goal of the YWG) will this be stopped.
*Although not covered in the talk, one of the outcomes of the presentation was that before stocking continues a management plan be put in place. Currently the YWG is busy with such a plan for the Clanwilliam yellowfish, which will enable us to reclaim some of its original distribution as well as provide a scientifically sound approach to its conservation.

YELLOWFISH MONITORING IN THE ORANGE-VAAL RIVER SYSTEM AND OORGLOOSKLOOF-KOBEE RIVER SYSTEM WITHIN THE BORDERS OF THE NORTHERN CAPE PROVINCE

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The Orange-Vaal River system is very important for freshwater fish conservation. The indigenous freshwater fish species in the system are exposed to hostile environmental changes, climatic fluctuations, water abstractions, hydrological regime and agricultural activities. The changes in environmental factors such as water quality and depth, water current, food availability and substratum along the river influence the occurrence, abundance and distribution of the fish fauna. During Spring 2010, the fish samples were collected by means of electrofishing and seine netting in order to established their abundance and distribution. Ten sites were sampled in the Orange River and 9 sites were sampled in the Lower Vaal River.

The endemic and vulnerable Vaal-Orange largemouth yellowfish (*Labeobarbus kimberleyensis)* was recorded in low numbers at all of the sampled sites. This can be ascribed to its predatory habits and the fact that it is a very slow grower where sexual maturity in females is reached after eight years and in males after six years. This species requires flowing water in deeper channels and below rapids. It is therefore sensitive to impacts such as increased turbidity and river regulation. It is considered as vulnerable as it is becoming scarce throughout its range. The endemic Vaal-Orange smallmouth yellowfish (*Labeobarbus aeneus)* species prefers clear-flowing waters of large rivers with sandy or rocky substrates and is sensitive to impacts such as increased turbidity and river regulation. This species appeared to be widely abundant in the Orange-Vaal River system.

The yellowfish species in the Orange- Vaal River system coexist with alien fish species such as carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idella)* and Mosquitofish *(Gambusia affinis)*. The Mosquitofish *(Gambusia affinis)* is widely distributed in the Lower Vaal River and its tributaries (Riet and Harts River). The intensive studies that were conducted by Jubb 1967; Benade 1983; Ecosun 2005; Skelton and Cambray 1981; Naesje *et al.* 2007; never recorded this species. It appears to be spreading in the Orange River. The most likely explanation for the appearance of Mosquitofish (*Gambusia affinis)* in the Orange River might be a flooding of Vaal River in the year 2000, 2009 and 2010 since it is abundant in the Lower Vaal River which is the principal tributary of the Orange River. Its distribution in the Orange River is unknown and it is also unknown whether it will pose a potential threat to indigenous fishes.

In the Bokkeveld Plateau in the Nieuwvoudtville area , the Oorlogskloof River plays a pertinent role as a spawning and nursery site for the indigenous fish. It houses indigenous fish species like endangered Clanwilliam sandfish (*Labeo seeberi*), endangered Clanwilliam sawfin (*Barbus serra*), vulnerable Clanwilliam yellowfish *(Labebarbus capensis),* Chubbyhead barb *(Barbus anoplus)* and the translocated Banded tilapia (*Tilapia sparmanni*). Adult populations of Clanwilliam yellowfish were found in the downstream reaches of the Oorlogskloof-Koebee River that joins the main stem Doring River. The majority of indigenous Chubbyhead barb and Clanwilliam yellowfish recorded during the sampling were infested with digenean cysts. Alien Mirror carp (*Cyprinus specularis*) and Banded tilapia (*Tilapia sparmanni*) are stocked in several dams in the area. During the major floods of 2007 in Niewvoudtville area, the dams overflowed and the Banded tilapia ended up reaching the Oorglooskloof River system. Currently it seems not to pose a threat to indigenous fish species. With the effects of environmental factors (climate change, habitat suitability, water

quality, etc) one can predict that the Banded tilapia and other stocked fish like alien Mirror carp (*Cyprinus specularis*) might pose a significance threat to the indigenous fish species.

Major Threats

- ***Alluvial diamond mining***
  -Increase the siltation of the river and destroys the spawning sites of the fish.
- ***Agricultural return flows and Sewage inflows***
  -Decrease the dissolved oxygen which results in massive fish kills
- ***Invasive alien species***
  -Predate on the larval indigenous fish
  -Compete for habitat and food availability
- ***Illegal netting***
  -Destructive method of fishing which catches threatened fish species.
- ***Natural Causes/Floods***
  -During the opening of sluice gates, fish get trapped in pools when the water level subsides and die in isolated pools**.**

In conclusion

The rivers still support high populations of yellowfish species and other indigenous fish.

Recommendation

- Continuation of river awareness campaigns to local communities and schools
- Law enforcement will curb the reduction of the species.
- Fish health assessment, bioaccumulation and parasitological studies should be conducted to establish if the fish do not pose a potential threat to human consumption.
- Genetic studies should be conducted to establish the genetic diversity, ecology and biology of the species.

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STATUS OF YELLOWFISH POPULATIONS AND RIVER HEALTH PROGRAMME IN THE NORTH WEST PROVINCE - 2011

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1 Introduction

Four *Labeobarbus spp.* and *Barbus rappax* occur in four Water Management Areas in the North West province. Little yellowfish specific research is conducted in the province except for the work in the Vaal River. The efforts of the province regarding aquatic monitoring are focused on the River Health Programme, and a summary of results are presented. There is a full report on the River Health Programme available from the author.

Severe pollution and flow threats are experienced in the "work horse" rivers originating in industrial areas, namely the Vaal and Crocodile Rivers, while rural rivers experience problems caused by dams and erratic water release regimes, alien vegetation and limited mining activities. However, there are some near-pristine rivers in the upper reaches and these are of high biodiversity value.

1.1 RHP focus for September 2010 to March 2011:

The main area of focus for the period between September 2010 and March 2011 was the Marico River catchment conservation initiatives. The main environmental constraints since September 2010 were the lack of rain until the flood conditions that prevailed from early December to February 2011. The extremes from no-flow to flood conditions hampered actual biomonitoring activities but provided time for catchment appraisal initiatives. It is also interesting to note that the flood levels determined as part of the Ecological reserve project are indeed the levels reached by specifically the Marico River 1:50 yr floods. Major damage to certain rivers induced by catchment disturbance was noted. Proper catchment management is imperative for the resilience of river ecosystems during flood conditions.

1.1.1 National Freshwater Ecosystem Priority Areas (NFEPA)

The National Freshwater Ecosystem Priority Areas project initiated by SANBI and the CSIR aims to identify areas for ecosystem listing purposes based on aquatic information and the products from this project are available. From an NW RHP perspective it was agreed that biomonitoring planning will focus on areas selected as FEPA's to continue support for the last remaining rivers and support areas in an A/B ecological class. The limitations within the NWRHP (e.g. only an invertebrate specialist available) were also highlighted. The Marico Catchment Conservation initiative was highlighted as a very important strategy to implement the NFEPA process and should form part of a Provincial Conservation Management Strategy for freshwater ecosystems. The other important point was that rehabilitation efforts should be focussed in the FEPA areas.

1.1.2 EWT Healthy Rivers Project and Marico Catchment Conservation Association (MCCA).

The commitment from the EWT Healthy Rivers project to assist the NW-RHP project with monitoring in the Marico catchment with regards to fish monitoring was confirmed at a Marico Catchment Conservation Association (MCCA) meeting held during November 2010. A lot of information regarding this catchment is available on www.maricoeco.org.za. The landowners have established a Marico Catchment Conservation Association (MCCA) and are striving for Biosphere Reserve status. They currently have 20 000 hectares committed to either Nature Reserve (7 000) status or Protected Area (5 000) status and the rest for conservancy.

1.1.3 Working for Water priority areas and species

Another interesting and important workshop was held in January 2011. The workshop title was: Ranking the importance of criteria to use in prioritising quaternary catchments to clear invasive alien plants in NW. The aim of the overall project is to provide a uniform approach for all WfW decisions across the country for priority areas and species identification. The project is allocated to the CSIR (Greg Forsyth and Andrew Wannenburg) who use an Analytical Hierarchy Process to integrate quality and quantity issues using Expert Choice software. The three main biomes (Arid Savanna, Grassland, Moist Savanna) in NW was evaluated separately for priorities (areas and species). The four main priority criteria resulted in: Important water recharge areas,

Aggressive invasive species presence, Improvement of Groundwater or surface water yield areas, Important Ecosystem Areas (National Freshwater Ecosystem Priority Areas) and Grazing Priority Areas. The Department will be informed of the final results that will be available by the end of March 2011.

1.1.4 Future bass studies

The WRC (Water Research Commission) is funding a project to evaluate the invasion of bass (mostly *Micropterus salmoides*?) in the Marico River catchment for eradication purposes. The project leader will be Dr. Olaf Weyl (o.weyl@saiab.ac.za) in collaboration with Peter Kimberg. This project could be valuable to conservation efforts in the catchment area (MCCA and NFEPA). The Department will receive a formal letter regarding this project as soon as the finer details are available. It is envisaged that I will be involved from an aquatic invertebrate perspective to look at the impact of bass on the aquatic macroinvertebrates. The presence of bass in Kaaloog se loop dolomitic eye on the farm Grootfontein was confirmed during the catchment visit during January 2011. The project leader also indicated interest in a study of the population dynamics of *Barbus motebensis*.

2 The NW River Health Programme

The South African River Health Programme (RHP) is a national monitoring structure implemented on a provincial level to determine and report on the ecological condition of rivers systems (DWAF, 2008). Data collected for the RHP are analysed and applied by aquatic conservation programmes. Standardized biological indices are applied at several monitoring sites to determine the ecological condition of rivers throughout the country (Roux, 1997; 2004). Biological data collection and reporting forms a major part of the programme.

The North West team is responsible for biomonitoring in parts of four water management areas (WMA), namely; Crocodile (West) and Marico, Upper-, Middle- and Lower Vaal Water Management Areas. *Labeobarbus kimberleyensis* and *L. aeneus* in the west flowing Vaal River system. *L. marequensis, L. polylepis* and *B. rappax* in the east flowing Marico/Crocodile River system. The WMA's are further subdivided into 7 biomonitoring regions. The Crocodile West and Marico is divided into four biomonitoring areas: Marico and Molopo; Western Crocodile (Elands river and tributaries), Middle Crocodile (Hex and Sterkstroom) and the Eastern Crocodile (Crocodile, Pienaars, Tolwane and tributaries). The Lower, Middle and Upper Vaal each form a separate biomonitoring region.

2.1 Summary of monitoring results

There are currently 179 biomonitoring sites in the North West Province. Various new sites (approximately 35) have been identified on tributaries after the floods of December 2010 to February 2011. These sites will be monitored and included in the RHP in future if the flow conditions are suitable. It is important to note that there are different types of sites and not all of the sites are part of the continuous monitoring programme.

The two main indices currently used in the NW RHP are the Index of Habitat Integrity (IHI) and SASS5. The total number of SASS5 (South African Scoring System version 5) datasets captured to the Rivers Database for the North West Province is 338, of these 303 were collected and captured since 2005 as part of the NWRHP and includes Site Information data. The use of the RHAM for habitat flow relationships looks promising and has been applied at all sites monitored since September 2010. The good rains since December 2010 and subsequent flood conditions have "destroyed" most of my delineated habitat units and benchmarks, even large boulders were moved. All of these sites will have to be revisited and new stable benchmarks secured.

2.2 Monitoring Results and Discussion

The monitoring results from the Ecological Reserve determination process (mostly 2009 and 2010) will be distributed as soon as all of the data analyses and report writing are finalized,

preliminary results are available from the author. The final reports are due in March 2011.The summary of results from the different biomonitoring will be mentioned.

2.2.1 Status of species

Rouhani (2004), in a survey of 10 large dams in the North West Province, recorded *Labeobarbus kimberleyensis* in the Taung dam, *L. aeneus* in the Taung and Koster dams and *L. marequensis* in Lindleyspoort, Vaalkop and Roodekopjes dams. Cochrane (1985) and Koekemoer & Steyn (2005) recorded *L. marequensis* in Hartebeespoort Dam. *Barbus rappax* was recorded in Hartebeespoort, Molatedi, Lindleyspoort, Vaalkop and Roodekopjes dams (Rouhani, 2004).
Labeobarbus kimberleyensis - Vulnerable (VU A1c) (IUCN, 2004).*L. kimberleyensis* is also listed as a Threatened or Protected Species under the regulations of the National Environmental Management: Biodiversity Act.
The other species are not listed, but catch restrictions are imposed.

2.2.2 Upper Vaal Water Management Area-summary

The Mooi River originates in a dolomitic area upstream from Klerkskraal Dam in the Upper Vaal Water Management Area. No releases are being made from the Klerkskraal Dam for the Ecological Reserve. The biological data reflects this and the area upstream from Potchefstroom is in an overall C Ecological category and the IHI category is overall a D, mostly due to old unrehabilitated diamond mines and crop farming. The upper wetlands were identified as an upstream management area that requires action to prevent degradation and threats to other National Freshwater Ecosystem Priority Areas (NFEPA) areas. The Mooi River was identified as a fish sanctuary (FishFSA) area not in an A or B ecological class. The upstream areas of this river must be protected and the ecological reserve implemented.
The Wonderfonteinspruit and Loopspruit are two tributaries of the Mooi River that originate east of the Mooi River. Mine water contamination (including heavy metals and radioactive substances) from the Wonderfonteinspruit is a serious concern. Peat mining takes place in the Gerhard Minnebron wetland; diamond mining and prospecting has taken place in areas below Klerkskraal Dam and has impacted on the riverbed and riparian zone. The Loopspruit SASS5 data indicate serious sewerage pollution and flow problems, the Ecological category is predominantly F. The IHI category is mostly D, return flows from flood irrigation and cattle carcasses dumped in the river were observed. The raising of the Klipdrift Dam in the middle reaches enhances the deterioration by reducing flow events.
Potchefstroom Dam and town are situated in the lower reaches of the Mooi River, adding additional habitat modifications to the river. The SASS5 data indicate a C/D category and a reduction in sensitive taxa, the IHI category is D.
The Vaal River is a heavily utilised system and is impacted by various activities in Gauteng, North West and Free State provinces. The primary impact on the river system is the deterioration of water quality as a result of salinisation and eutrophication of the system, and flow modification. These impacts negatively influence the yellow fish populations in the river. The SASS5 biomonitoring data indicate a low C Ecological category; the water quality deteriorated below Parys during October 2006 and recovered through the Vredefort Dome area, the overall IHI results in a C category. The seasonal flow of the river is heavily impacted by increased return flows and unnatural releases from the barrage area for downstream water users. Aquatic weeds further deteriorate the available habitat for aquatic biota, water hyacinth is of particular concern.

2.2.3 Middle Vaal Water Management Area

This water management area is characterized by seasonal rivers. This water management area is fairly data deficient and difficult to discuss. The dolomitic eyes and associated peat wetlands should be monitored from a wetland conservation perspective, these areas are included in the National Freshwater Ecosystem Priority Areas (NFEPA) areas as important wetlands but not discussed in the current report (the preliminary wetland NFEPA maps are available from the author). The Skoonspruit River originates north of the town of Ventersdorp as a dolomitic eye,

peat wetlands are associated with these upper reaches. The IHI and SASS5 data indicate a high C Ecological category in the upper reaches of the Skoonspruit. The topography is gentle sloping. A wetland system occurs in the middle reaches of the river, in the vicinity of the confluence with the Taaiboschspruit and upstream from the Johan Neser Dam. This area has been identified as an area that should be rehabilitated (RehabFEPA). Water abstraction is a major impact upstream from the Johan Neser Dam. The SASS5 data reflect the water abstraction and thus flow limitations as the Ecological categories are high E/F and C during different biomonitoring surveys. The biomonitoring point at Uraniumville is situated below sewerage treatment facilities, the SASS5 data indicate an E/F category.

2.2.4 Lower Vaal Water Management Area

Wetland areas parallel to the Harts River downstream from Taung are important features of the river system. There are wetlands and pans in the area that should be surveyed especially those parts of the Mareetsane River close to the village Uitkyk. The identified National Freshwater Ecosystem Priority Areas (NFEPA) for this Water Management Area includes: Freshwater Ecosystem Priority Area (FEPA);Fish Sanctuary Area (FishFSA);Rehabilitation Freshwater Ecosystem Priority Area (RehabFEPA) and Upstream management area that requires action to prevent degradation (Upstream).

The overall ecological classes and importance of areas from a National perspective requires verification, especially in the more arid zones that have not been surveyed. The approach in this WMA should be biomonitoring where possible and catchment condition assessments for the more arid areas to identify threats and relative pristine areas.

There are major impacts from farming and from diamond mining in the river channels. The Harts River forms part of a major irrigation scheme and water transfers are made from the Vaal River. The Harts River is under severe pressure from untreated sewerage discharges and overflowing sewerage treatment facilities in the Lichtenburg, Biesiesvlei, Sannieshof and Schweizer Reyneke areas. This nutrient enrichment is a direct threat to the ecology of Barberspan Reserve that is also a declared Ramsar site. The artificial canal that connects the Harts River and Barberspan is the point of entry for the polluted water and has changed the hydrology and ecology of this pan. The sites sampled upstream from Barberspan as part of a risk assessment study for NWP&TB indicate dissolved oxygen problems and the SASS data results in a low C/D Ecological category in March 2010. Nutrient plumes from sewerage pollution were observed moving downstream, through water quality analysis, and the oxygen concentration varies from very low to super saturated indicates the high algal activity. The results from the risk assessment done for Barberspan and the Harts River indicate severe sewerage pollution from the Harts River. The unnatural hydrology of Barberspan was discussed and possible rehabilitation and risk aversion strategies (reed beds, closing of canal) were discussed.

The site downstream from Taung Dam is in a B/C Ecological category, no ecological flow releases are made. The situation in and below Taung deteriorates to a C/D Ecological category; sewerage enrichment and urban runoff are contributing factors. The sites upstream from the major irrigation area shows an improvement from the sites in Taung, these sites are in a high C Ecological category.

2.2.5 Crocodile West and Marico Water Management Area (biomonitoring regions separate)

2.2.5.1 Molopo

The Molopo River originates east of Mafikeng from a dolomitic eye and flows through the Mafikeng town complex towards the Botswana border. Water is abstracted directly from the Molopo dolomitic eye for domestic use in Mafikeng. Monitoring and maintaining this dolomitic eye is important from an ecological and social aspect. The extensive peat wetlands and underground water connections do not create ideal SASS5 habitat. The Molopo River is receiving attention from a project initiated as part of an Orange River Basin study from April

2010. The flow requirements and management recommendations for ecological maintenance is under discussion.
The identified National Freshwater Ecosystem Priority Areas (NFEPA) for this Water Management Area includes a Fish Sanctuary Area (FishFSA), spanning from the Molopo eye catchment to Mafikeng. The request by the landowners to declare the dolomitic eye part as the Molopo oog Nature Reserve will assist in conservation efforts if it is declared as a Nature Reserve.
Major water abstractions take place in and downstream of Mafikeng from various dams. No release mechanisms or operating rules exist to release water from the major dams in the system. The sewerage treatment facility upstream from the site D4MOLO-MAFIK is responsible for the very low E/F Ecological category. The Ecological category below Modimola dam (D4MOLO-MODIM) improves to a C. Erosion of the catchment and lack of ecological flow releases impact on the seasonal river reach downstream. The wetland rehabilitation that commenced in 2009 in the vicinity of Modimola dam should assist in the reduction of erosion in this area.

2.2.5.2 Marico River and tributaries

The Marico River catchment comprises the Groot Marico, Klein Marico and Ngotwane Rivers. The Molemane River is a dolomitic tributary of the Klein Marico and forms an extensive wetland (including peat), the site (A3MOLE-OTTOS) at Ottoshoop and situated downstream from a predator farm. The site lacks some of the suitable SASS5 habitat and was in a high C Ecological category.
The Kareespruit below the Zeerust golf course and upstream from the sewerage treatment facility is in a D/ EF Ecological category, the situation deteriorates below the sewerage treatment facility to an E/F class). Raw sewerage discharges and other nutrient inputs have severely deteriorated the water quality in the Klein Maricopoort Dam. These pollution issues have direct implications for the ecological integrity of the NFEPA Marico River and food production by the irrigation farmers.
The main tributaries of the Groot Marico River in the upper reaches are:

- Rietspruit is in a B Ecological category, the lack of habitat prevents this site from reaching an A Ecological category (situated 10m downstream from a dolomitic eye).

- Kaaloog se Loop indicate an A/B Ecological category

- Bokkraal indicates an A/B Ecological category. During November 2010 the Waterfall valley conservation area was launched. This conservation area is situated on the farm Bokkraal, the perennial tributary of the Marico River is of dolomitic origin and supports a unique and conservation worthy active tufa waterfall. The landowners were engaged with during 2005 by the aquatic scientist to commence conservation efforts including alien plant eradication. The landowners subsequently decided to commit themselves to conservation efforts and have opened a hiking trail and mountain bike route and have applied for Nature Reserve status as part of the Marico Catchment Conservation initiative.

- Draaifontein (B Ecological category in the upper reaches and D/E downstream, this is also mainly flow related)

- Van Straatensvlei (B/C Ecological category, some negative impacts from alien vegetation in the wetland areas and dairy farming)

- Polkadraaispruit (The Ecological categories vary between sites but the overall category is a B/C), major impacts include farming and alien plants.

All of the tributaries have been identified as biodiversity special features and have also been included in the targeted river reaches for ensuring that 20% of all types of aquatic ecosystems are conserved. These areas have also been identified as conservation priorities and fish sanctuaries in the SANBI NFEPA project during 2009/2010. The Marico River is also listed as the only free flowing river in the NW and Gauteng and should thus receive conservation attention. The sensitivity and conservation importance of the Marico River catchment is summarised in a report available from the author.
The upper reaches of the Groot Marico River, up and downstream from the town, are in an A category. Water abstraction for irrigation reduces the Ecological category to B/C further downstream. The river downstream from the Groot Marico Bosveld Dam only flows seasonally due to water abstraction (in a D class due to lack of flow). Molatedi Dam and the Tswasa weir are the other water abstraction points. Water is exported to Botswana at the Tswasa weir. The sites A3GMAR-TSWAS and A3GMAR-DERDE are both in B classes during good flow conditions and deteriorate to C Ecological categories when flow is reduced.
The Ngotwane River is also a tributary of the Groot Marico River and is fed by a dolomitic eye close to the town of Dinokana. The dolomitic eye supplies drinking water to the town, the Ecological category downstream from the eye varies according to flow A/B. Downstream at A1NGOT-PUANE, the reduced flow, urban and rural impacts deteriorates the river to a C class.

2.2.5.3 Elands River and tributaries

The Elands River originates south of the town of Swartruggens in an extensive wetland area and flows in a northerly direction and then north east to the Vaalkop Dam. The Elands River low flow season sampling commenced on 18/10/2010. Most of the sites had dried up or stopped flowing by 27/10/2010. The Selons, Koster and Suigsloot were reduced to very low flow or were dry by November 2010. The water quality below Swartruggens is an area of concern due to the sewage treatment facility that is not totally operational at the town. The upper reaches of the catchment are dominated by slate mining activities and in a B/C Ecological category. Sediment from some of the slate mines are not sufficiently retained and cause deterioration to a C/D Ecological category at A2UNSP-TRIBU.
The Swartruggens Dam and Lindleyspoort Dam supply water for domestic, agricultural and mining activities. The situation below Swartruggens Dam and in Swartruggens is in a D/EF Ecological category. The discharges from the Swartruggens sewerage treatment facilities cause nutrient enrichment. The area below Lindleyspoort Dam is intensively used for agriculture and no ecological flow releases are made, resulting in a low C/D Ecological category.
The Selons River is a highly seasonal tributary in the middle reaches. The Koster River is a tributary of the Selons. The Koster Dam does not release ecological flow. The Ecological category upstream from the dam is in a D/EF category, mainly due to flow and nutrient enrichment problems. The Dwarsspruit is an important tributary of the Selons from a fish diversity perspective. The Ecological categories of the Dwarsspruit are B/ high C.
The lower Elands consist mainly of deep sandy pools with very little flow. The water quality has also deteriorated as a result of erosion and high sediment loads occur in the river's middle to lower reaches. *Sesbania* have infested large parts of the river and the resulting deposition of seeds in the Vaalkop Dam basin could potentially create problems.

2.2.5.4 Hex and Sterkstroom Rivers-summary

The Hex River originates south of the Rustenburg complex and flows north to the Vaalkop Dam, The Olifantsnek Dam is situated in the upper reaches of the Hex River. The confluence of the Hex and Klein Hex is in the Olifantsnek Dam. The upper reaches of the Hex River is in a B/ high C Ecological category, the main impacts result from water abstraction and farming activities. The Waterkloofspruit originates in the Kgwasane Mountain Reserve from an important mountain catchment wetland system. The biomonitoring site (A2WATE-WATER) is located close to Rustenburg and indicate a high B Ecological category.

Below Rustenburg heavy infestations of alien vegetation, flow modifications, urban runoff and mining are the major impacts on the river. The area upstream from Bospoort Dam is in an E/F Ecological category, below the dam in a D/ low C. This river is degraded and contributes to water quality problems in Vaalkop Dam.
The Sterkstroom is a tributary of the Crocodile River that has its origin in the Magaliesberg. The upper reaches result in A/B Ecological categories. The upper reaches must be conserved and an Index of Habitat Integrity should be done. The agricultural activities in the vicinity of Buffelspoort Dam reduce the Ecological category to a C. The combination of reduced flow and mining impacts downstream from Buffelspoort Dam results in Ecological categories of D (A2STER-WAAIK) and E/F (A2STER-ZWART). The water quality that enters the Roodekopjes Dam is thus not of a good quality.

2.2.5.5 Crocodile River and tributaries-summary

The Crocodile River originates in Johannesburg, Gauteng and flows in a northerly direction through Hartbeespoort Dam and then north westwards, supplying water to agricultural and mining activities in the North West Province. The general condition of the river is described as highly deteriorated and requires management interventions.
The Crocodile River and tributaries are in a D/EF Ecological category with the exceptions of:

- The Ramogatla tributary at A2RAMO-KLIPK; The Tolwane at A2TOLW-NOOIT; The Pienaars downstream from Klipvoor Dam at A2PIEN-BUFFE.

- The Skeerpoort River and the Magalies River are the only rivers in an A/B Ecological category.

3 Conclusion and management issues

Legislation – New provincial angling license conditions have been gazetted.

Table 1: New bag limits for the North West Province

Species	Bag limit	Minimum size (Fork length)
L. kimberleyensis	Catch and release only	N/A
L. aeneus	2	300mm
L. marequensis	4	300mm
L. polylepis	2	300mm

Research – No yellowfish-specific research is done by NW DACE. J.H. Koekemoer is conducting a Ph.D. study on fish population structures in Hartebeespoort Dam, Lindleyspoort Dam and Koster Dam.
The University of Johannesburg and the Endangered Wildlife Trust are conducting research on yellowfish in the Vaal River.
Intermediate Ecological Reserve determinations are in progress for the all four Water Management Areas in NW (commissioned by DWA).
Action plan & Progress Report - The Conservation Plan for the Crocodile (West) and Marico Rivers will be integrated in provincial biodiversity conservation strategy and bioregional plans.
In general the challenges and opportunities are:
Challenges

- Only one person responsible for project management, implementation, fieldwork, data capture, analysis and reporting. Scientist and support staff are needed to assist with the aquatic invertebrates, habitat integrity, fish monitoring and riparian vegetation monitoring. Application of biomonitoring indices can only be done by experts.

- Official used personal laptop since February 2010 for all Rivers Database capture, workshops and reports and no replacement official laptop until April 2011. Orders for equipment maintenance not processed speedily, waiting since October 2010.

- Low/no flow of rivers in dry seasons and high flow/floods in wet seasons (since December 2010-February 2011), causing a discontinuation in the planned monitoring programme. The floods have also altered the habitat composition and moved benchmarks at various sites, these will have to be reevaluated.

- Server access problems prevented the direct capture to the National Rivers Database, initial problem solved in June 2008 but I have been unable to gain access since October 2010. Private laptop and internet connection was the only basis of running the National Rivers Database.

- Kilometer restrictions during 2007, 2008, 2009, 2010, at least with extra motivations I may exceed the 2500 allotted kilometers during 2011 when required.

- Lack of strong enforcement to prevent further degradation of river systems

- Implementation and monitoring of the Ecological Reserve

Opportunities

- Informed decisions, based on scientific data, can be made on issues related to river- and catchment management and specific links to the NEFEPA project and conservation initiative in the Marico River catchment thus supporting the integration of freshwater and terrestrial conservation planning and actions.

- A reliable database is being developed to support State of Environment reporting in the province.

- Biomonitoring training provided to staff members and other partners (Universities, DWA staff). Introductory exposure provided to NWP&TB officials

- To develop and implement a biomonitoring programme that will support integrated water resource management

Most of the river systems in the Province have been impacted by human activities and therefore the habitat integrity has deteriorated. Most rivers can be considered to be in a moderately to largely modified state (category C to D). Integrity of a largely natural state (category A) is rarely found in the assessed rivers. Improved management and rehabilitation actions are required in the modified rivers to attempt improvements and to prevent further degradation. Conservation actions are required for the largely natural rivers as they support unique biodiversity features and subsequent ecological goods and services.

Another cause for concern is the illegal distribution and stocking of fish species, including yellowfish, as the introduction of *L. aeneus* into Koster Dam clearly illustrates. This practice not only results in the introduction of species alien to specific ecosystems, but can also be a source of genetic pollution and disease.

Man-made impoundments reduce natural spawning sites, which may cause different species to congregate at the remaining suitable sites at the inflow of the river. This can lead to hybridization, as is suspected between *L. aeneus* and *L. kimberleyensis* in Taung Dam.

The continued monitoring and reporting of the status of the aquatic ecosystem in the province is essential in this water scarce area. There are major constraints regarding capacity and skills within

the Provincial Conservation agencies as discussed at the 2010 RHP champions symposium. The main lack of skills was identified as fish biologists, invertebrate specialists and scientific experience to evaluate the results using the various indices developed since 1999. The programme coordinators are concerned about the future of the programme without skilled scientists and the lack of capacity within conservation agencies that used to be the main resource for scientific knowledge regarding the ecological condition of river systems.

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PROVINCIAL REPORT - LIMPOPO PROVINCE -2011

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Introduction

As was stated in the 2010 the *status quo* remains in that no research focussing on yellowfish is carried out in the province. This report will highlight the progress that has occurred in existing projects and indicate what new initiatives are planned or are underway.

1. **Within provincial Environmental Affairs (LEDET)**

   Within the department no change has occurred and the departmental team involved in aquatic work within LEDET still consists of Stan Rodgers and Pierre Fouché who focuses on the Provincial State of the Environment Report and follows RHP protocols. Surveys in the Olifants River during 2010 was again hampered by the high flow. The Department plans to survey the majority of the provincial rivers in the foreseeable future and their planning is indicated in tables 1 and 2.

Table 1: Perennial river surveys

River	Catchment (DWA)	Full Survey	Follow-up Survey	Year
Lephalala	Limpopo	21 sites		2011/2012
Croc/Marico	Limpopo		20 sites	2011/2012
Letaba	Olifants	24 sites		2012/2013
Nwanedi	Limpopo		12 sites	2012/2013
Matlabas	Limpopo		12 sites	2013/2014
Levhuvhu	Limpopo	36 sites		2013/2014
Olifants	Olifants	38 sites		2014/2015
Mokolo	Limpopo		20 sites	2014/2015
Lephalala	Limpopo	21 sites		2015/2016
Croc/Marico	Limpopo	20 sites		2015/2016

Table 2: Temporary rivers

River	Catchment (DWA)	Full Survey	Follow-up Survey	Year
Sand	Limpopo	?		2012
Nzhelele	Limpopo	?		2011

2. **Aquatic research at the two provincial universities.**

2.1 The University of Limpopo (UNILIM).

At UNILIM the Water Research Commission funded project entitled "Environmental and fish Health management in two impoundments in the Olifants River: Flag Boshielo Dam and Phalaborwa Barrage, Limpopo Province with reference to human health risk" is nearing completion and the final report is expected during 2012.

The same team is also involved in Flemish (FLIER) funded multidisciplinary project on the Olifants River of which the pilot project phase has been completed.

2.2 University of Venda (UNIVEN)

2.2.1 Nandoni Dam.

The main survey has been completed and the data is being analysed with the final report that is planned for the end of 2011. Some of the results will be presented at this workshop by Paul Fouché, Jan Roos and Wynand Vlok.

There are however still some surveys planned for the period February to May 2011 to obtain fish specimens for the parasitology.

2.2.2 Shingwedzi River.

The report, by Wynand Vlok and Paul Fouché, has been released and copies have been submitted to the KNP management. A follow-up survey, to establish water quality trends is in the pipeline and it is envisaged that this will be done in 2012.

2.2.3 New projects.

Funding for a project to determine the extent of invasion of the tributaries of the Luvuvhu River by largemouth bass *Micropterus salmoides* (Lacepède, 1802), Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) and the common carp *Cyprinus carpio* (Linnaeus, 1758) has been received from the Research Directorate of the University of Venda. Surveys will start at the beginning of March 2011 and as part of the project it will be investigated whether and to what extent *O. niloticus* has hybridized with the indigenous *O. mossambicus*.

Surveys for a second project, also funded by the University of Venda, that will investigate the source and extent of pollution in the tributaries of the Luvuvhu River upstream of the Nandoni Dam, will also start In March 2011. The idea of this project originated during the Nandoni Dam project when high levels of nutrients were detected in the dam.

3. Other initiatives.

3.1 The biomonitoring exercise on the Nzhelele River in the Maremani Nature Reserve led by Mick Angliss is now in its eighth year and it is hoped that it will continue.

3.2 Dr Wynand Vlok is involved in two Water Research Commission funded projects. Both projects are well advanced and should be completed by the end of the 2011

a) "An assessment of the current diversity of amphibians associated with the major river systems of the Kruger National Park and the physical and chemical factors affecting their distribution". Wynand is the project leader and the University of Johannesburg and Paul Fouche are co-workers.

b) "Conservation of tigerfish, *Hydrocynus vittatus*, in the Kruger National Park, with the emphasis on establishing the suitability of water quantity and quality for the Olifants and Luvuvhu Rivers". This project is done in conjunction with the University of Johannesburg.

4. Co-operation with other institutions.

The Griffiths University of Australia funded Masters (Mphil) student has completed her research on the effect of water releases on the macro-invertebrates in the Mokgalakwena River. She is in the process of writing up her thesis but has presented a poster paper on her findings at the SASAqS conference at Augrabies in June 2010.

KWAZULU-NATAL REPORT

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Introduction

My presentation focuses on the broader environmental issues that collectively shape the niche environment in which all species, including mankind, depend on to procreate, feed, provide cover and ultimately survive in. Many of the factors which currently destabilize our supporting environment are man induced and come at a great cost to both human health and survival. Mankind has created an artificial niche where success is judged on economic performance with monetary and materialistic rewards. This obsession, largely fueled by the over exploitation of finite natural resources, is in direct contrast with the ecological processes of a naturally based world that adjusts slowly to changing circumstances. We should then not be too surprised that we are now facing new unknown giants in the form of climate change, which if left unchecked, has the inherent power to undermine primary production and systematically collapse organisms occurring higher up the food chain, ultimately destroying mankind and civilization in the process. The message is clear, we need to take our foot off the accelerator in terms of transforming landscapes, simplify our lifestyle, have fewer children, accept less reward, decrease our reliance on fossil fuels, barter more frequently, rid ourselves of plastic and recycle, reuse and use alternative sources of natural energy.

Status of the Habitat

At the heart of conserving yellowfish is managing the footprint of land transformation. Currently more than 50% of KwaZulu-Natal is transformed, including large tracts of land dedicated to sugar cane, timber and other agricultural practices, urbanization, mining and water supply. Only 7.9% of KZN is formally protected with only 0.2 % occurring under private reserves, community reserves and stewardship sites, equating to 8.1% of the total landmass in KZN. Of great concern is the rapid increase in land transformation leading to increased isolation and fragmentation of wildlife habitat. The knock-on affect of rapid land transformation is the deterioration of adjoining aquatic ecosystems. To this end Boyd Escott, an Ezemvelo KZN Wildlife's GIS Analyst, has developed a River Health Integrity Index based on the accumulative effects of different land use practices and the most likely outcome on natural aquatic ecosystems. The system is based on the accumulated weightings associated with categorized different land use practices and provides a broad perspective of river health conditions that are likely to prevail in KZN's river catchments. A finer scale resolution of ecosystem health conditions could be established by carrying out river health monitoring. EKZNW currently does not have the resources to fund such a dedicated unit for the whole province. Under the circumstances SASS work is carried out irregularly to survey more localized problems. EKZNW has a most active planning division which draws upon the professional advice of locally based biologists. Through a process of commenting on Environmental Impact Assessments (EIA) forwarded from DAEARD (Department of Agriculture, Environmental Affairs and Rural Development), developing Biodiversity Sector Plans that influence municipalities, and being guided by EKZNW's Systematic Conservation Plan, one can at least be thankful that decisions relating to future developments can be taken in a regulated and ecologically sensitive manner.

Civil society has in recent years also come to the fore in saving the environment. The Duzi Umngeni Conservation Trust (DUCT), an NGO formed several years ago by canoeists concerned about the poor state of the Umngeni and Umsunduzi River, has grown tremendously in both stature and community influence. The sterling work carried out by DUCT's personnel and teams of volunteers has been responsible for nipping many of the potential water related pollution problems in the bud.

Threats

The greatest threat to wildlife are the problems associated with land transformation practices. In conjunction with habitat change, alien invasive species such as the Locariid catfishes can potentially pose a problem for indigenous species including yellowfish which occur at lower altitudes. A survey was carried out in conjunction with Dr Olaf Weyl of SAIAB to investigate the presence of *Pterygoplichthys disjunctivus* in the Nseleni and adjoining Mhlatuze river systems. A juvenile specimen of this species was detected in the Nseleni River suggesting that the species had bred. My suspicion is that this species which originates from the aquarium trade, has been transferred from the Mhlatuze River via an inter basin water transfer scheme into the Nseleni River. Our field survey revealed that the Nseleni River is in a relatively good condition supporting a total of 17 freshwater fish species. It is my opinion that the healthy population of Nile crocodile resident in this system will help keep this new alien invader in check.

We have maintained cordial relations with Eskom relating to the environmental concerns associated with the Ingula Pumped Storage Scheme (IPSS) and Drakensberg Pumped Storage Scheme (DPPS). Allowing water to overflow from Kilburn Dam, the recipient of HEP water released from Sterkfontein Dam, is from EKZNW's environmental perspective, a non-negotiable option unless it can be empirically proven that the integrity of the Thukela System is already heavily compromised by Orange-Vaal species. The presence now of Largemouth Yellowfish in Sterkfontein Dam, and potential colonization of Kilburn Dam on the KZN side of the border with Free State, is a further imperative why water released from Sterkfontein Dam should never connect with the Thukela System. The Thukela system supports a unique strain of KZN Yellowfish in addition to the provincial endemic Tugela Labeo *Labeo rubromaculatus*, the latter a close relative to the Orange-Vaal Labeo *L. capensis*. The risk of hybridisation with both species is high.
Kishaylin Chetty, an environmental officer for Eskom reports that the lower catchment sites have been sampled in and around Kilburn dam. A morphological assessment has also been completed. A genetic analysis is still in progress. A final environmental report is expected from Eskom by the end of March.

In terms of the IPSS development a pressure chamber will finally be constructed at the end of February. The fish will be tested in the chamber during the first two weeks of March. A rotenone risk analysis for Ingula has been completed. The final report is expected in April. The unique population of Chubbyhead Barb *Barbus anoplus* that occurs above a waterfall will be moved to display tanks and housed in Eskom's visitors centre.

Pollution remains an imminent threat in terrains characterized by high levels of land transformation, particularly those areas associated with high levels of urbanization, industrialization and agriculture. Reporting pollution events to responsible authorities has sadly developed into a conundrum with NGO's like DUCT currently being the most pro-active agency dealing with such problems. Pollution levels within the Baynespruit River within the Pietermartzburg district is sometimes so bad that the *E. coli* actually die from the extreme

variations in pH levels. The situation has improved since clearing out alien vegetation in the riparian zone and hiring of community monitors from the neighboring Sobantu community. The eight focus areas of DUCT are:

(1) Solid waste (including plastic bags, bottles, tin cans, animal carcasses) that enters the rivers from a variety of sources including illegal dumping
(2) Faecal waste from broken and blocked sewers and areas under serviced industrial pollution
(3) Invasive alien vegetation along the river banks
(4) Invasive alien vegetation in the water
(5) Bilharzia and other waterborne diseases
(6) Soil erosion and land degradation
(7) Monitoring sand winning operations
(8) Provision of water for the environment (environmental reserve)

A number of river, estuary and industrial conservancies currently form an effective management framework under the auspices of DUCT.

Establishment of Conservancies

A number of eco-tourism ventures benefit from the availability of fishing for indigenous yellowfish. Most of these establishments are independent and occur on the lower Mooi, Bushmans, Thukela and Mkomazi Rivers. "The FOSAF Guide to Flyfishing Destinations" in conjunction with a quick search on the internet will help locate angling destinations.

Stockings

EKZNW avidly supports the FOSAF policy (moratorium) regarding the stocking of yellowfish. This informative policy statement, derived from the collective thought of leading aquatic biologists, has given conservation authorities tasked with permitting the movement of fish species, much needed impetus and direction.

Genetic considerations

The high degree of genetic variability between geographically isolated populations of *L. natalensis* is ample reason enough to curb their movement between river catchments.
Field surveys conducted by EKZNW during 2010 have detected new populations of *L. natalensis*, including a small population in the Mpenjati River occurring at an incredibly low altitude (*ca.* 10 m). A population was also discovered in Lake Nsese during the *P. disjunctivus* survey, also at low altitude in close vicinity to Richards Bay harbour.

Education and awareness

EKZNW supports the moratorium placed on the movement of yellowfish.

Monitoring

No separate monitoring programme is dedicated to *L. natalensis*. Being a ubiquitous species *L. natalensis* regularly occurs in fish surveys throughout the province.

Research

The KwaZulu-Natal Yellowfish is a species whose biology has not been thoroughly researched despite its popularity as a freshwater game fish. It popularity has increased in recent years as being an indigenous alternative to exotic trout that have historically dominated fly fishing the province. It is planned to develop a Biodiversity Species Management Plan – Species (BPM-S) for *L. natalensis* in the province. Further research however needs to be carried on the biology of this species before such a plan can be properly formulated.

CONSERVATION OF YELLOWFISH & OTHER SPECIES
DEKA, ZAMBEZI RIVER, ZIMBABWE

Wayne Sinclair
Sundowner Adventures. Box 13619, Vorna Valley 1686.Email:sundown@iafrica.co.za

Background

I have fished and been involved in the Deka area since 1987 and we have owned Sundowner Zambezi Lodge since 1991.

Geographical Location

Sundowner Zambezi Lodge and the area affected is close to the confluence of Deka and Zambezi Rivers. We are on the middle Zambezi, 70 km down-stream from Victoria Falls and 45 km up- stream from Lake Kariba.
This is an important spawning area for Tigerfish and has an unprecedented variety of endemic fish species.
The area falls within the boundaries of the Zambezi-Kavango Transfrontier Park. This Park has been declared, but there are some final issues that are being resolved with regards to immigration and multi Visa etc.

Large Scale / Upper Zambezi Yellowfish

Although a variety of species occur in this area, my main focus will be on the Largescale yellowfish (*Labeobarbus marquensis*). This species is very similar to the upper Zambezi Yellow fish (*Labeobarbus codrington*) and I am positive that we find both species in this area.
The distribution of the largescale yellow is: Middle and lower Zambezi and the Upper Zambezi Yellow is supposed to be the Zambezi above the Victoria Falls.
On the middle Zambezi the yellowfish co-exist with Manyane Labeo (*Labeo altivelis*) , Upper Zambezi Labeo (*Labeo lunatus*), Chessa (*Distichodus shenga*), Nkupe (*Distichodus mossambicus*) and various bream species.

Habitat

These fish mainly occur in shallow, fast moving water over rocks in mainstream. The Deka area comprises of rocky basalt banks and basalt islands. This is a rapid-pool system, where you have waterfalls or rapids separated by pools. The Deka pool has one set of rapids below it before the river widens to meet Lake Kariba.
The habitat where we find the yellowfish is not ideal for larger tigerfish (but you find many juvenile tigers and still find the odd large tiger). These fish prey mainly on mayfly & dragonfly nymphs, caddis larvae, fresh water snails etc.

Threats

Netting

- Zambians donated nets by International donors and they buy from Indian businessmen
- Insufficient policing by Zim National Parks

Pollution

- Hwange Colliery - Insufficient sludge dams so acid water discharged directly into Deka river

- Pollution from coal coking plant (Chinese) – discharging acid water into the Deka River

Alien invasive species

- Nile Tilapia (*Oreochromis niloticus*)
- Escaped from bream cages in Lake Kariba
- Predates on juveniles of indigenous species
- Aggressive behaviour causes other to lose habitat

Over population of crocodiles

- In 90's there were too many crocodiles re-introduced by the Vic Falls croc farm. Devastating impact on Vundu and other fish species

Challenges

As a result of the **political instability** in Zimbabwe there is a breakdown in the rule of law and this has affected the effectiveness of environmental policy and policing. This includes problems with EIA's not being properly conducted or enforced and insufficient conservation measures

The Deka area has always been very **poor** but the political problem has resulted in **mass unemployment** and forced people from the cities (Bulawayo) to move to the river. This puts more pressure on the river as these people need to rely on the river for food and they strip the land to farm (Causes erosion and land degradation). Poverty and lack of cost effective protein in towns (Hwange & Bulawayo) creates a demand for fish. This in turn creates a problem where unscrupulous entrepreneurs support the **illegal netting** (Done by Zambians). These people purchase the fish from the Zambians to sell in town. In some instances we have found that the Zimbabwe police have been involved in the supporting this trade.

Solutions

We need assistance from conservation authorities, Yellow-fish Working Group, fishing & wild life magazines to put additional pressure on Zimbabwe Department Tourism of Environmental Affairs to conserve the area

The Deka area falls within the Zambezi-Kavango Transfrontier Park. New policies should provide more effective policing and enforcing of conservation

Local Community development programme to raise awareness for fish conservation & tourism. We created a community development tour where guests were taken to visit the local villages, school and clinic. Money was put back into the community and we support the local Makwa school with books and stationery. We continue to train the fishing guides at Sundowner Lodge on fish conservation and fly-fishing techniques so that we can make the destination more appealing for a greater number of environmentally conscious fishing guests.

We have been receiving more support from the local police department to stamp out the corruption, stop illegal netting and illegal fish selling support.

Fishing Research and Development

Last year I took our guides out to work on techniques that could be used to catch Yellowfish, Chessa, Nkupe and mudfish on fly. We found that we were able to catch the fish using: 1) Tandem fly - Vaal style nymphing technique 2) Woolly bugger and muddler minnow (weighted) on a floating line. One of the main challenges we experienced were the Tigerfish attacking the strike indicator. Unfortunately we need a strike indicator to keep the heavily weighted flies above the rocks. Next time a will try fishing the flies with an intermediate fly-line.

THANK YOU TO THE YWG for supporting the Maloney's eye development *objection*

- Objection was successful and the project has been put on hold until:
    - Determination on the ground water has been completed
    - Rand Water can supply a water pipe to the development

THE NATIONAL RIVERS DATABASE FOR THE SOUTH AFRICAN RIVER HEALTH PROGRAMME

Ramogale Sekwele[1], Helen Dallas[2], Pierre Janssens[3], Zinzi Mboweni[1] & Michael Silberbauer[1]

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The National Rivers Database is a data storage and management system developed for the River Health Programme (RHP). The RHP forms a key component of the National Aquatic Ecosystems Health Monitoring Programme (NAEHMP) (DWA 2010), with specific focus on river health assessments and reporting on the ecological state of South African rivers.

The Rivers Database consists of three primary components, namely the Rivers Server, which is a web based application running on internet; Rivers Client, which is a windows application running on a desktop; and the Query Master application (DWA 2010). The River Server's primary role is to provide a real time, centralized repository of data at a national level. It provides a web based interface to manage rivers, users, invertebrate and fish lists, pick lists and site photographs. The Rivers Client application is the primary data entry and viewing application for site and site visit related data. It provides a Data Transfer functionality that allows the site and site visit information to be uploaded from a desktop/laptop to the Rivers Server via the internet in real-time. Furthermore, data that is managed on the Rivers Server and Site and Site Visit related data can be downloaded from the centralized repository on the Server. The Query Master is used to extract data from the Rivers database and both a local version on the Rivers Client and a web version on the Rivers Server are available (DWA 2010).

The Rivers Database is a useful resource for water resource practitioners in general and RHP practitioners in particular. Contributing data to the Rivers Database needs to be prioritised by individuals and institutions, Resource Quality Services also provide a service for capturing of the data onto the Database. More details about the Database is obtainable from the following website: http://www.dwaf.gov.za/iwqs/rhp/database.html

THE DISTRIBUTION, CONSERVATION STATUS AND BLOOD BIOCHEMISTRY OF NILE CROCODILES IN THE OLIFANTS RIVER SYSTEM, MPUMALANGA, SOUTH AFRICA

Dr Hannes Botha[1,2]; Prof Wouter van Hoven[1] and Prof Louis J Guillette Jr.[3,4]

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ABSTRACT

The outlook for Nile crocodiles in the Olifants River does not look optimistic. Since the increase in capacity of the Loskop and Flag Boshielo Dams, the crocodile population was left with no basking or nesting sites and has declined over the past 30 years. Shortly after the Massingire Dam in Moçambique filled to full capacity an estimated 160 crocodiles died in the Olifants River Gorge, a couple of kilometres upstream from the dam. The Olifants River is acknowledged by many experts as one of the most polluted rivers in South Africa and acid mine drainage, industrial pollution and untreated sewage in the river are all contributing to the poor water quality of the river. Further, the Department of Water Affairs and Forestry acknowledge that water demand already exceeds their capacity to supply and that the situation will worsen considerably in the near future.

Aerial surveys of Nile crocodiles in the Olifants River were carried out during December 2005 and November 2009. An average total population of 714 Nile crocodiles were counted and corrected to an estimated 1140 individual crocodiles to eliminate the effects of undercounting. The Kruger National Park and specifically the area of the Olifants River Gorge was found to be one of the preferred habitat areas for crocodiles in the Olifants River as was the Flag Boshielo Dam, the area between the Blyde River and the western boundary of the Kruger National Park and the Olifants River between the Loskop Dam and the Flag Boshielo Dam. Repeated nesting in areas such as the Kruger National Park, the Flag Boshielo Dam and the Olifants River between the Loskop Dam and the Flag Boshielo Dam confirmed that these areas are critically important to the nesting success of Nile crocodiles in the Olifants River. The Elands River was confirmed as an important refuge area for Nile crocodiles in the Groblersdal-Flag Boshielo Dam area of the Olifants River. Surveys revealed an estimated total of only 15 crocodiles in the Loskop Dam and confirmed that no crocodiles in the large (2.1 - 4.0m TL) and very large size class (>4.0m TL) are currently present in the population. Blood biochemistry results indicate that the Olifants River Nile crocodile population probably suffers from chronic inflammation (especially in the Loskop Dam and Olifants River Gorge populations), infectious disease (particularly in the Loskop Dam population but all other sites also showed elevated values), possible inadequate diet and malnutrition (especially during the pansteatitis outbreak of August/September 2008) and are suffering serious immune problems in the Olifants River Gorge. A conservation and management plan is suggested which identifies threats to the continued existence of a viable Nile crocodile population in the Olifants River.

Finally, it is suggested that the conservation status and risk of extinction of Nile crocodiles in the Olifants River be upgraded to the Endangered category since it currently complies to the following criteria; EN A2abce; C2a(i) published in the IUCN Red List Categories and Criteria Version 3.1 (IUCN, 2001).

COAL MINING ON THE HIGHVELD AND ITS IMPLICATIONS FOR FUTURE WATER QUALITY IN THE VAAL RIVER SYSTEM

Professor Terence McCarthy[1], Dr Koos Pretorius[2]
1: School of Geosciences, University of the Witwatersrand, Johannesburg; 2: Director Federation for a Sustainable Environment. Email: d.zoekop@lando.co.za

Introduction

The history of coal mining in South Africa is closely linked with the economic development of the country. Commercial coal mining commenced in the eastern Cape near Molteno in 1864. The discovery of diamonds in the late 1870s led to expansion of the mines in order to meet the growing demand for coal. Commercial coal mining in KwaZulu-Natal and on the Witwatersrand commenced in the late 1880s following the discovery of gold on the Witwatersrand in 1886. In 1879 coal mining commenced in the Vereeniging area and in 1895 in the Witbank area to supply both the Kimberly mines and those on the Witwatersrand.

South Africa began a period of major economic development after World War II. New goldfields were discovered and developed in the Welkom, Klerksdorp and Evander areas; a local steel industry was established with mills being built at Pretoria, Newcastle and Vanderbijlpark; an oil-from-coal industry was established, initially at Sasolburg and later at Secunda; mining of iron, manganese, chromium, vanadium, platinum and various other commodities commenced and expanded; and power stations were erected on the coalfields to supply energy to these developing industries and to the growing urban population in the country. In addition to meeting local needs, coal mining companies began to develop an export market, making South Africa a major international supplier of coal.

Given the long history coal mining, some deposits have been worked out and mines closed. With the closure of mines numerous environmental problems emerged. Extensive research has been done on the causes and extent of the problem, especially under the auspices of the Water Research Commission. In this paper, we draw on the experiences from the Witbank area and particularly the impact mining has had on the quality of water in the Olifants River in order to assess future scenarios in other Highveld river catchments, and especially the Vaal River.

The coalfields

South Africa's coal deposits occur in rocks of the Karoo Supergroup, a thick sequence of sedimentary rocks deposited between 300 and 180 million years ago. The coal seams occur in a division of the Supergroup known as the Ecca Subgroup, which consists of sandstones and mudstones, together with coal seams, which were deposited in large river deltas that entered the ancient Karoo Sea. Although rocks of the Ecca Subgroup are very widespread around the country, conditions suitable for the formation of coal did not occur everywhere, and the coal deposits are fairly restricted, occurring in the main Karoo basin in an arc from Welkom in Free State Province to Nongoma in KwaZulu-Natal, and in several smaller outlying remnants of the Karoo Supergroup (**fig**. **1**). This paper will focus on the Witbank, Ermelo and Highveld coal fields, which contain an estimated 50% of the nation's recoverable coal reserves.

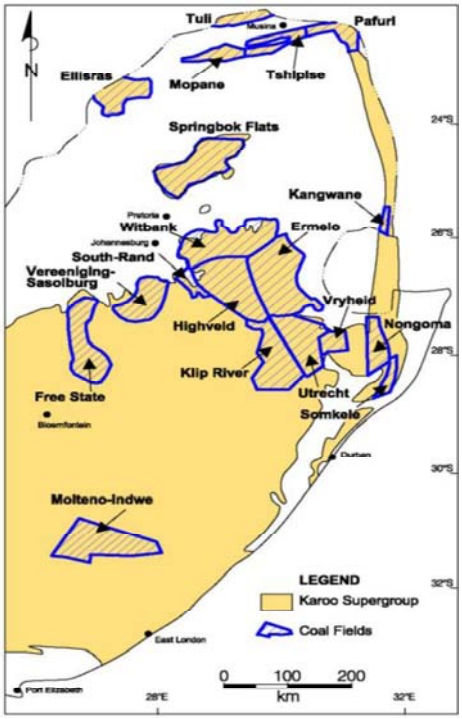

Figure 1. Map showing the distribution of the rocks of the Karoo Supergroup and its coal-bearing regions

Up to eight coal seams are developed in the main Karoo basin (**fig. 2**). The seams outcrop along the northern, northeastern and eastern portions of the Witbank and Ermelo coalfields. They dip gently to the southwest and become thinner so that towards the southwest they become progressively deeper and eventually pinch out (**fig. 3**). The thicknesses of the seams are very variable both within and between coalfields, and range from a few centimeters to over 6m.

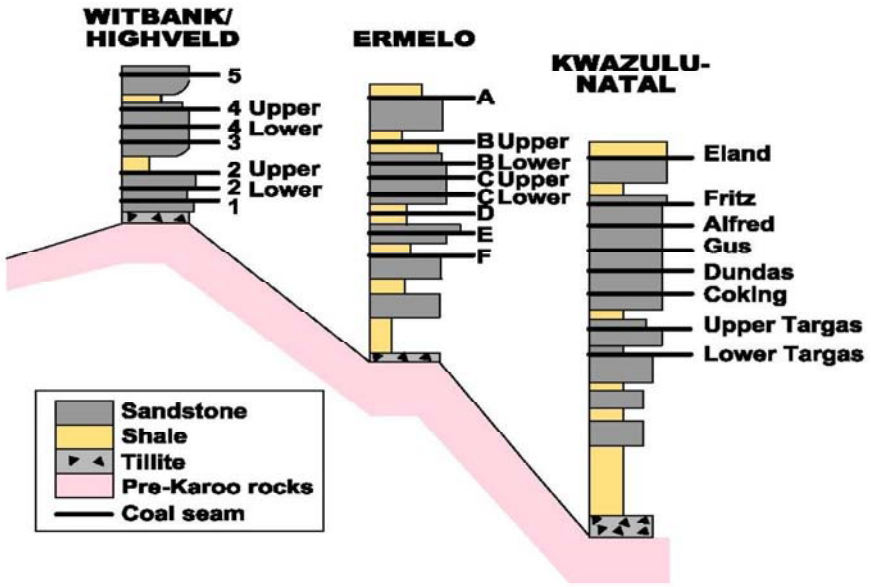

Figure 2. Diagrammatic representation of the coal seams in the main Karoo basin.

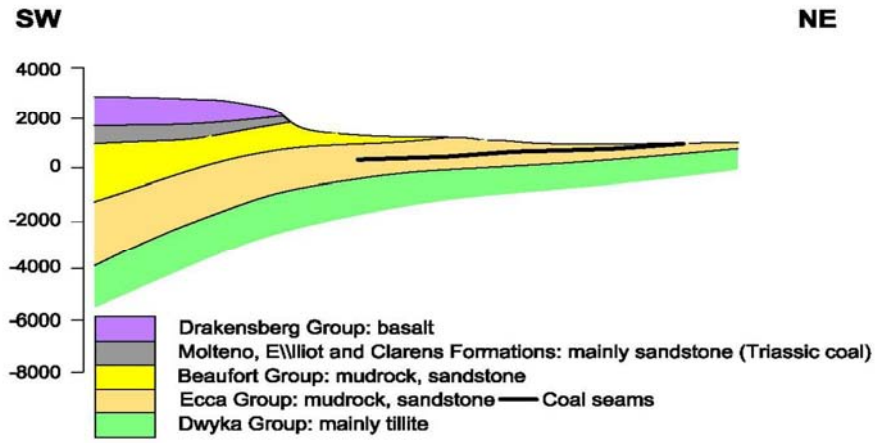

Figure 3. A diagrammatic cross section showing the progressive deepening of the coal seams from outcrop in the NE to their final pinch-out in the SE.

Mining methods

Coal mining methods are briefly discussed as they have important environmental implications. There are three different methods used to extract coal: bord and pillar mining (or room and pillar), longwall mining and opencast mining.

Bord and pillar: in this form of mining only a portion of the coal is extracted, the rest being left in place as pillars to support the overlying rocks. Towards the end of mining, pillars may be partially extracted (pillar robbing) to recover additional coal, but a considerable amount of coal is left in the ground. If sufficient support is left, the roof rocks can remain stable.
Longwall: in this form of mining, the coal is removed entirely and the roof allowed to collapse into the mined out void. The mining face is protected by supports which are moved forward as mining progresses. Collapse causes fracturing of the overlying rocks and can cause subsidence of the surface if mining is shallower than about 200 m depth. In such cases, fractures will extend through to surface.
Opencast: in this form of mining, the soil cover is scraped off and stockpiled, the rocks overlying the coal seam are blasted and removed to one side, and the coal is then extracted. Next, the broken rock is returned to the pit, the site is landscaped, the soil is returned and grass is planted.

Environmental problems

A number of environmental problems have emerged as a result of coal mining. These are best exemplified by the Witbank field, which has experienced a long history of mining.

Underground fires, collapsing ground: Early mines in the Witbank field were shallow and were mined by the bord and pillar method. The coal seams came to outcropp although the actual coal seam outcrop was generally covered by soil. The No 2 seam was a particularly important horizon and

is between 5 and 6 m thick. Only the lower 2 to 3 m was mined as the rest was considered of too low quality. Thus, some 60% of the seam was left in the ground. After closure, the remaining coal in many of the mines caught fire and as the fires burned, the roof rocks collapsed, creating dangerous ground conditions and making the surface unusable (**fig 4** collapsed, burning mine).

Figure 4. A collapsed, burning coal mine.

Acid mine drainage: The most serious environmental problem arising from coal mining is the generation of sulphuric acid as a result of a chemical reaction between an iron sulphide mineral (pyrite) present in the coal and its host rocks and oxygen-bearing water (infiltrated rain water). Under natural conditions, the Karoo rocks have a very low permeability and although acid is generated, the process is extremely slow and other equally slow reactions completely neutralize the acid. However, mining breaks up the rock mass allowing free access of water and the acid-producing chemical reactions proceed faster than the acid can be neutralized. Consequently, the water becomes acidic and toxic to animal and most plant life. The acid water dissolves aluminium and heavy metals (iron, manganese and others), increasing its toxicity (**fig 5**. red water with dead trees; **fig 6**. barren soil; **fig 7**. blue water). Some rock types contain minerals (especially calcium carbonate) that can neutralize such acidity even when produced rapidly, but this is not the case with most of the rocks that host the South African coal.

Figure 5. Acidic, iron-rich water filling a collapsed coal mine.

Figure 6. Barren, sulphate-encrusted soil caused by seepage of acidic water from a flooded coal mine.

Figure 7. The Wilge River during a coal mine-related pollution event in June 2007. The blue colour is believed to be due to the precipitation of aluminium compounds.

Methods have been developed to measure the acid-generating capacity of coal and its associated rocks (generally known as acid-base accounting). The results are expressed as the amount of calcium carbonate (in kg) needed to neutralize the acid produced by one tonne of rock (the Net Neutralizing Potential). Positive values indicate that sufficient carbonate is present in the rock to neutralize the acid (i.e. no acid will be produced), and negative values mean calcium carbonate needs to be added. Results of these tests on Witbank coals and their host rocks are shown in **fig. 8** (ABA diagram). It is evident that both the coal and host rock are net acid producers.

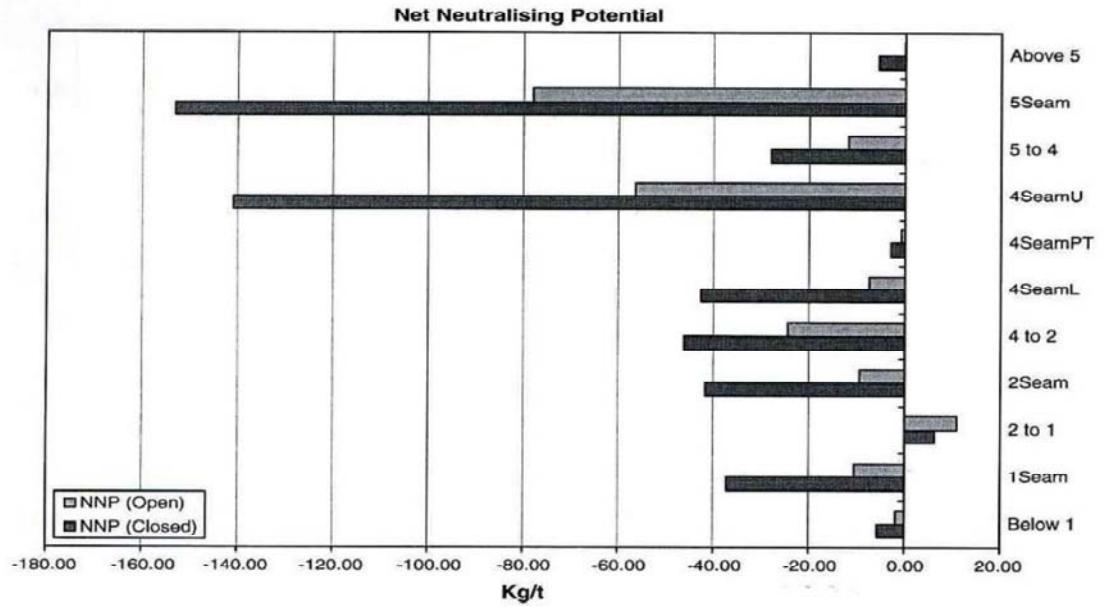

Figure 8. Diagram showing the acid-producing potential of coal seams and their host rocks in the Witbank area.

The mining method used has a significant impact on the acid generated. In bord and pillar mining, only the pillars come into contact with water, and hence acid generation is limited. Collapse of the roof increases the contact area and also facilitates the ingress of rain water, thus increasing acid generation. Consequently, longwall mining results in more acid generation than bord and pillar mining. In opencast mining the rock mass is completely fragmented, maximizing the contact between water and rock, and is therefore the most acid producing mining method.

Acid water produced in the mines may seep out at surface, where further reactions with oxygen occur, precipitating iron and generating yet more acid. This water sterilizes soil that it comes into contact with (**fig. 6**). The water enters rivers, which become acidified, reducing biodiversity to a few particularly hardy species. Neutralization reactions occur as a result of mixing with other neutral water sources, and may result in the precipitation of aluminium (**fig. 7**), which is toxic to fish and possibly other aquatic animals. Ultimately the acidity is neutralized, but the water remains sulphate-rich, typically containing 2000 to 3000 ppm (parts per million) sulphate (the recommended limit for water for human consumption is 200 ppm).

Destruction of groundwater reservoirs: The rolling hills of the Highveld are characterized by abundant seasonal wetlands, perennial and seasonal streams and many fresh to mildly saline pans. This diversity arises because of the unique nature of the groundwater aquifers. The Karoo bedrock strata are generally massive, with very low porosity, except for that provided by occasional fractures. Overlying the bedrock is a weathered zone (termed regolith) in which the rocks are partially or completely decomposed, creating a porous mass. Near the surface of the regolith there is often a hard, impermeable layer (called plinthite) formed by precipitation of material (mainly iron and/or silica compounds). This structure gives rise to three different groundwater aquifers: the first is formed by fractures in the bedrock; the second by the deeper regolith, and the third by the zone above the plinthite layer (perched aquifer). Water is supplied to the aquifers by rainfall, and soaks into the ground to supply the aquifers. Water flowing laterally in

the perched aquifer may emerge on surface to form wetlands high on the hill sides. Infiltrating rain and water seeping from these wetlands supplies the deeper weathered rock aquifer. The aquifers fill with water in the rainy season, and slowly discharge water into streams through the dry season, thus sustaining stream flow throughout the dry season. Fractures in the bedrock also provide some surface water by seepage, but this aquifer appears to be of lesser importance than the regolith aquifers because of its more limited storage capacity. Water quality differs in the different aquifers, being highest in the perched aquifer (<20 ppm dissolved solids), and lowest in the fractured rock aquifer, where the dissolved solid concentration is in the order of hundreds of parts per million.

Mining disturbs the aquifer structure. Bord and pillar creates additional voids in the fractured rock aquifer, but the regolith aquifers remain intact provided there is no collapse of the workings. However, water filling the mine void is of extremely low quality and is detrimental to the environment should it leak out. At the other extreme, opencast mining completely destroys the groundwater aquifers and creates a single, massive aquifer in the mine void. After mine closure, water fills this aquifer to the lowest elevation of the bedrock rim, and additional water entering the void decants over the rim. This water is of extremely low quality. Longwall mining fratures the bedrock, creating additional void spaces and increases both inflow into the void and seepage. The water is of low quality. Once an area has been mined, borehole water from that site will generally no longer be usable for agricultural or domestic use due to its low quality.

Disposal of excess water during mining: The coal mines are not particularly water-rich, and mining activities do consume some water. However, from time to time, operating mines find themselves with an excess of water, often as a result of heavy rains. The water is usually severely contaminated by acid mine drainage, and releasing it into streams can have severe environmental consequences, often resulting in large-scale deaths of fish (due to aluminium poisoning) and other aquatic animals.

Consequences of mining on water quality in the Witbank area

Coal mining has been taking place in the Witbank area for more than a century, and the area is replete with examples of the negative aspects of mining listed above. Many mines are still in production (**fig 9).** Routine analysis of water samples in the Olifants River system which drains the coalfield began long after mining commenced in the area, so there is no record of the quality of river water prior to mining. However, the upper Olifants tributaries that lie outside the mining areas have total dissolved solid (TDS) concentrations in the order of 50 ppm, and probably reflect the pre-mining condition. The water quality in Witbank and Middelburg dams over the last three decades is shown in **figs 10 and 11** respectively. Both show a steady increase in TDS and sulphate concentrations over the past 30 years. Bearing in mind that prior to mining the rivers concerned probably contained about 50 parts per million TDS, mining has resulted in a ten-fold increase. Of greater concern is the fact that the sulphate concentration in the Middelburg Dam now exceeds the maximum recommended concentration for water for human consumption, and is still rising.

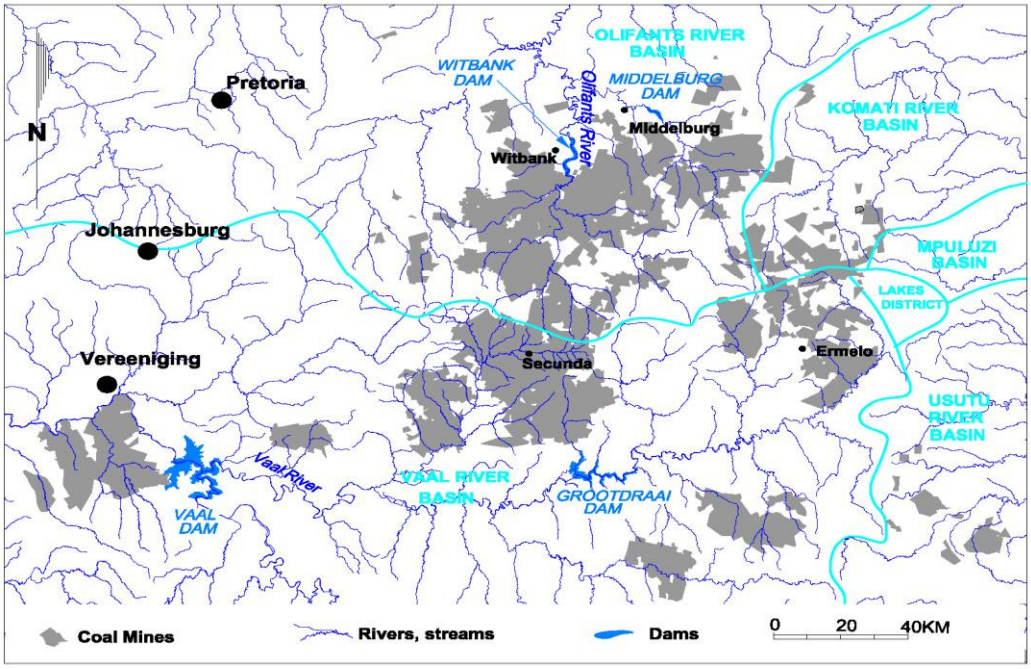

Figure 9. Map showing the distribution of coal mines in the Highveld region in relation to river catchments.

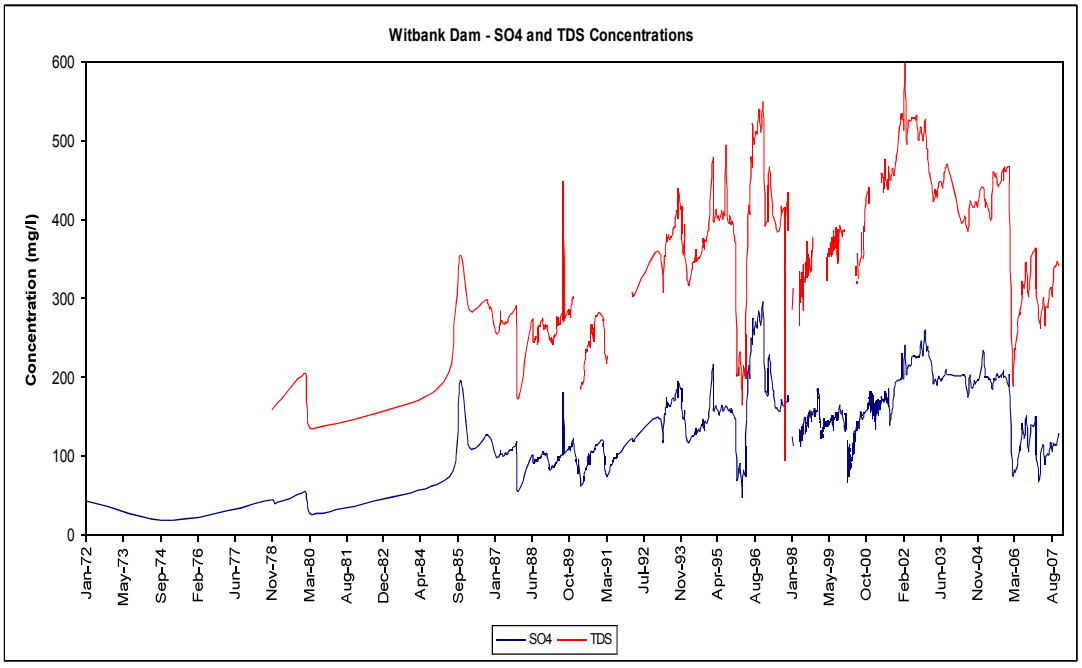

Figure 10. Total dissolved solid (TDS) and sulphate concentrations in Witbank Dam between 1972 and 2007.

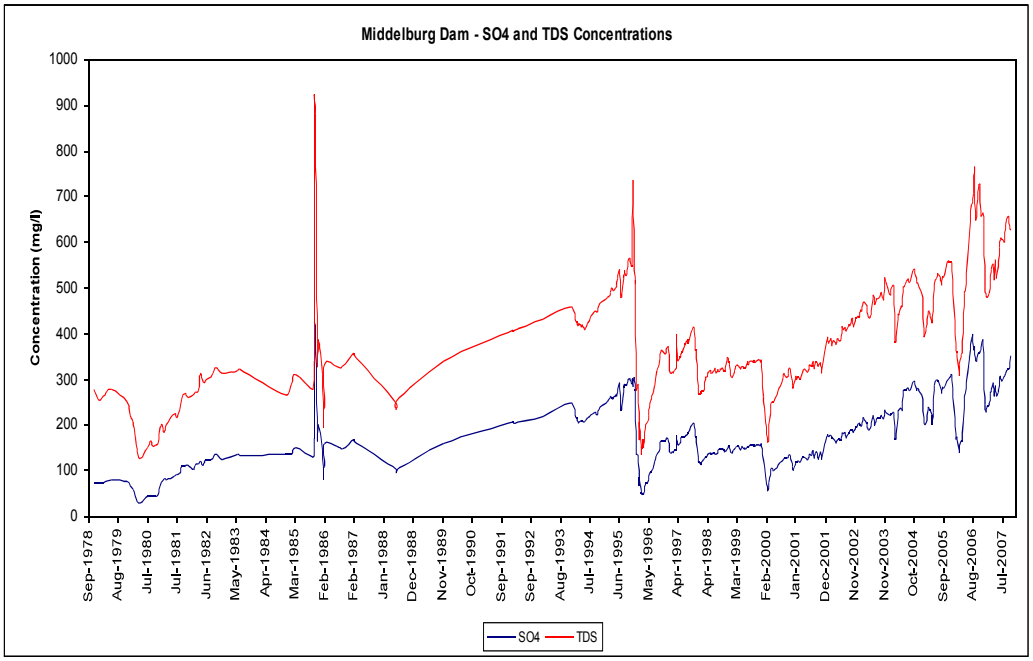

Figure 11. Total dissolved solid (TDS) and sulphate concentrations in Middelburg Dam between 1978 and 2007.

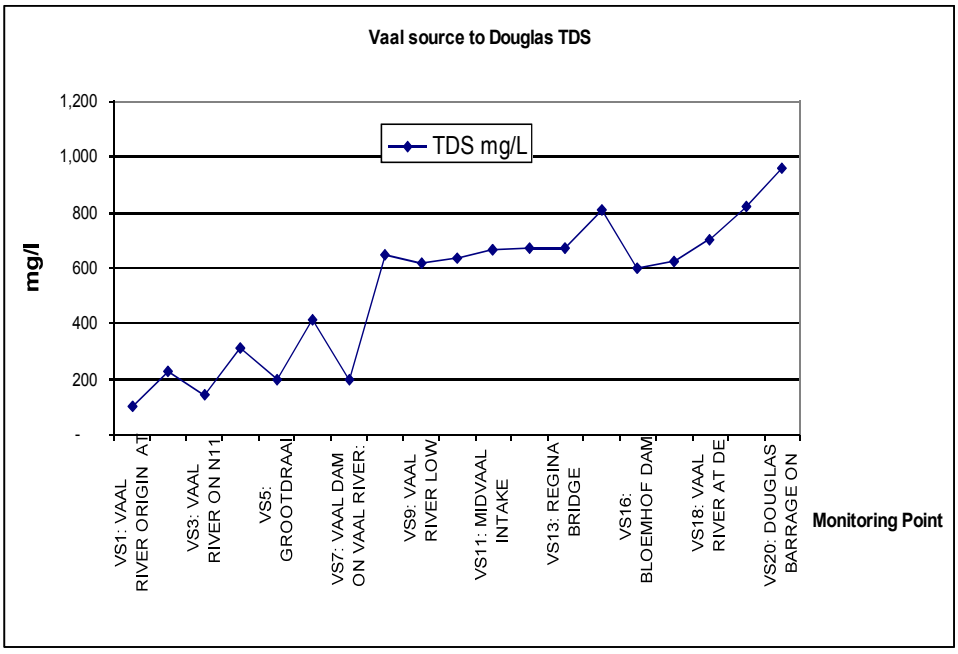

Figure 12. Diagram showing the changing total dissolved solid concentration in the Vaal River.

Water quality in the dams partly obscures the extent of the quality problem because dams tend to improve water quality compared to their inflow. This is because short duration flood events are stored and dilute the dam water, and possibly also because of biological remediation processes operating in dams such as sulphate fixation by anaerobic bacteria in dam sediment. The dilution effect is reflected in the rather jagged appearance of the graphs in **figs. 10 and 11**. Nevertheless, water quality in both dams shows a trend of deterioration over the data period.

Mitigation

Various measures have and are being implemented to try to mitigate the deterioriating water quality in the Oilfants River. In considering the various mitigation options, it is necessary to distinguish between those that are used whilst mines are still operating, and those that will be used after closure. In the latter instance, it is important to bear in mind that the effects of mining, and especially the production of acid mine drainage, is likely to persist for centuries after closure.

Evaporation dams: Some mines faced with the problem of getting rid of severely polluted excess water have resorted to constructing shallow dams where the water is allowed to evaporate. This has also been proposed as a potential solution to the problem of getting rid of polluted water seeping from flooded mines after closure. Such dams have to be completely sealed, requiring a strong plastic membrane liner, and hence the cost of construction of is very high. It is unclear how long such dams will survive after mine closure and what the long term maintenance costs will be (for removal and disposal of accumulated salts, repairing of leaks, protection from vandalism and theft, etc).

Using contaminated water for irrigation: There is currently a research programme in operation examining the use of sulphate-polluted water for crop irrigation. It should be noted that polluted water has to be neutralized before it can be used in this way. Results have been promising, although investigations have shown that the sulphate is accumulating in the soil. This method of mitigation is unlikely to succeed in the long term: either the sulphate will be leached from the soil and will contaminate the ground water, or more likely, given the high evaporation rate over the Highveld, the sulphate will accumulate in the soil forming hard gypcrete cement and severely impacting long term agricultural producivity.

Limiting oxygen ingress into closed mine workings: The continued production of acid mine water depends of a steady supply of oxygen. If the oxygen can be excluded, acid generation will eventually cease. In the case of deeper mines, especially bord and pillar and to a certain extent longwall operations, rapid flooding after closure will ensure rapid consumption of the oxygen. Provided there is no additional inflow, acid production will cease and the water will stratify. Deep groundwater will thereby remain isolated and will not contaminate surface water resources and the near-surface aquifers will continue to function more or less as normal. Whether this situation is attainable in the coalfields has yet to be demonstrated. Mining depth is less than 200 m below surface and the rocks are heavily punctured by exploration boreholes and fractures, and it is likely that after closure and flooding, water will emerge at surface via these openings (when the Randfontein Gold Mine compartment on the West Rand flooded in 2005, polluted water began discharging from a borehole and from natural springs), thereby setting up groundwater circulation that will ensure continued oxygen supply and acid generation in the deeper mining levels.

Acid neutralization: Acidic water seeping from abandoned mines northwest of Witbank was severely polluting the Brugspruit, a tributary of the Olifants River. To address this problem, a system was installed to collect the water and channel it to a treatment plant where the acid was neutralized with sodium hydroxide (the Brugspruit Water Pollution Control Works). This approach could solve the acid problem, but the sulphate problem remains, and is possibly exacerbated by the addition of sodium to the water. There have, however, been maintenance problems with the plant, including theft of essential components, and the plant has been non-functional for extended periods.

Water purification: A consortium of mining companies operating in the Witbank coalfield has addressed the problem of disposing of polluted mine water by constructing a treatment plant to convert it into drinking quality water (the Emalahleni Water Reclamation Plant). The plant utilizes reverse osmosis technology to process 20Ml of water per day. It is operating as designed, but the cost of the water is R10 per cubic metre (including capital amortization), which is R7 more than charged by Rand Water for bulk water. The plant's design life is 20 years, after which it will have to be replaced (construction cost of the plant was R300 million in 2006).

Controlled release: Producing mines in the Olifants River catchment are participating in a programme of collectively managing the release of polluted water in such a way as to keep pollution levels to a minimum. Polluted water is stored on the mines and released in controlled manner at times when there is sufficient runoff to dilute pollutants to acceptable levels. This programme is working successfully, although its efficacy in years of drought has yet to be tested. Managing discharge is only possible while mines are in production, and this approach will not work in the case of closed mines that are leaking polluted water.

Soil protection: Ground water in back-filled opencast mines becomes acidic. Some of this water rises up into the restored soil layer by capillary action and can cause sterilization of the soil. To protect the soil, calcium carbonate is added to the lower part of the replaced soil layer, which neutralizes the acidity. The quantity of calcium carbonate added is nowhere near sufficient to neutralize all of the acid that will be produced in the backfill, as it is assumed that only a small proportion of the acidity will move up into the overlying soil layer.

There are many closed and abandoned mines in the Olifants River catchment which have been polluting the river for decades. The records spanning the last 30 years indicate that the pollution level is still rising. The full effects of mining are yet to come, when the current generation of large opencast mines fills with water and begins to decant. Of the mitigation strategies listed above, only water purification is capable of producing water of a quality equivalent to that which existed prior to mining. The cost of treatment is high, however. It is estimated that water from current mining operations entering the Witbank and Middelburg Dams amounts to 30 million cubic metres per annum and this will rise to 44 million cubic metres by 2030. To treat this water to pre-mining standards would cost R300 million Rands per annum currently, rising to R440 million per annum in 2030 (at present Rand value). What the final discharge of polluted water will be is uncertain but one estimate places it at around 200 million cubic metres per annum, which will cost R2000 million per annum to treat at current Rand value. It is unclear for how long acid generation will continue, but it is likely to persist for hundreds of years. In time, acid generation will decline as pyrite oxidation nears completion. What is also uncertain is how effective the protective calcium carbonate layer in the restored soil will be in the long term. Should this carbonate be consumed or become ineffective (e.g. by carbonate grains becoming coated in calcium sulphate or iron compounds), the soil could become acidified and sterilized, making it highly susceptible to erosion. Rivers and dams downstream of the mining areas could become choked with sediment as the soil and opencast backfill is eroded. Such sterilization of restored soil has already been observed in sections of older opencast operations where insufficient carbonate was added, although the scale of the problem appears to be limited at present.

The Vaal River catchment

Although mining is taking place in the Vaal River catchment (**fig 9**), much of the coal is deep. Many of the mines are still in production and water management is good so pollution levels from coal mining in the catchment generally are low.

The total dissolved solid concentration in the Vaal River rises progressively downstream (**fig 12**). The Klip River, which is heavily polluted by mining and industrial activity on the Witwatersrand, adds significantly to the pollution load. For reasons mentioned above, dams along the river (Grootdraai, Vaal and Bloemhof) have a moderating effect on the pollution levels, but insufficient to prevent the downstream increase in TDS. Water quality in the lower Vaal is relatively poor, and has caused soil salinity problems in the Vaal-Harts irrigation scheme.

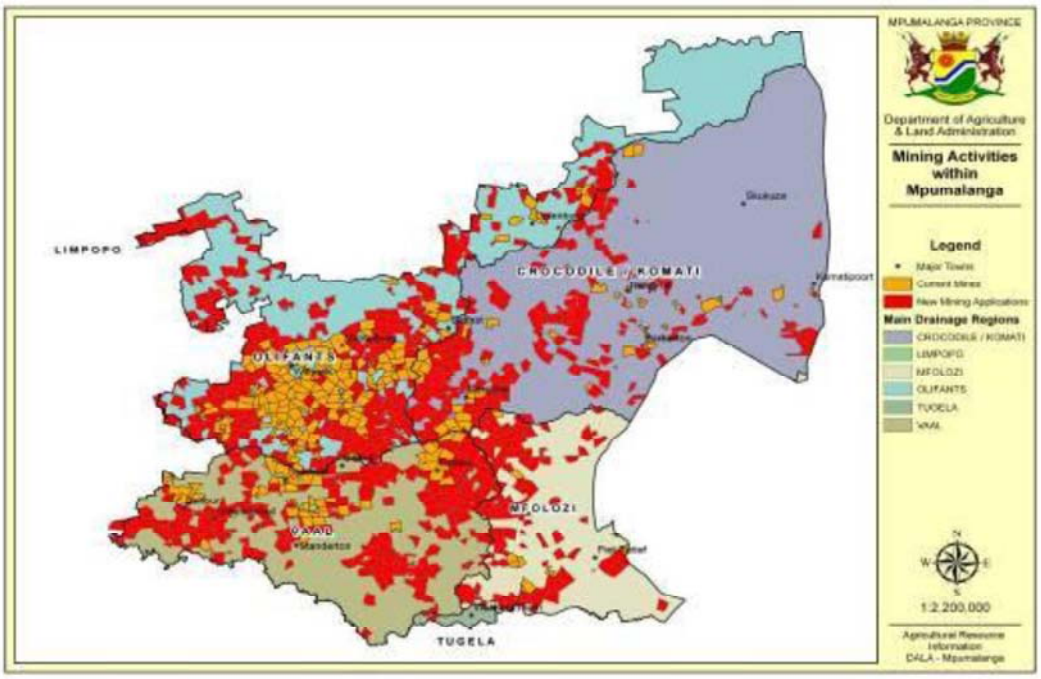

Figure 13. Map showing farms currently under application (red) for mining permits at the Department of Minerals and Energy

A disturbing development is the large number of applications that have been made to open new coal mines in Vaal River catchment. If all of the coal resources of the upper Vaal River basin are exploited, it will result in the undermining of the entire basin from the headwaters to a position downstream of the Vaal dam. In the future, once these mines are closed and commence decanting, it is likely that the water quality in the upper Vaal River will suffer the same problems as the Olifants River system. It can be expected that water quality in the Grootdraai and Vaal Dams will come to resemble that in the Middelburg and Witbank Dams (**figs. 10** and **11**), and the water could ultimately become unfit for human consumption. The effects on downstream users of Vaal River water will be even more serious, as TDS in the lower Vaal River is already very high, even though it rises from a presently low initial base. Pollution in the upper regions will result in extremely high TDS levels in the lower reaches of the river.

Other catchments

Currently, the Mpupuzi and Lakes District catchments are free of mining (**fig. 9**) and the aquatic systems are pristine. Only a few mining permits have been granted in the Usutu Basin, and water quality in this catchment is generally good. However, a large number of applications have been submitted in these areas (**fig. 13**). Should these be granted, these presently pristine river systems will suffer the same fate as the Olifants River catchment.

Conclusions

The South African economy has benefited greatly by the abundant coal resources in the country, but the environmental cost is only beginning to emerge. Experience in the Witbank area, which has seen more than a century of sustained coal mining, provides some insight into what the future consequences might hold. Problems that have emerged include the sterilization of land due to underground fires and surface collapse, and by acidification of soils. By far the most severe problem is water pollution, which is still rising, and the water in the Middelburg Dam is now no longer fit for human consumption. It will continue to deteriorate for the foreseeable future and the Witbank Dam is likely to experience a similar fate.

What does the future hold for the Witbank coalfield? We would like to sketch out a scenario for the future of the coalfield once the coal reserves have been fully exploited and mining has ceased. At this time, perhaps a century from now, all of the mines will be flooded and leaking acid water. In their upper reaches, the rivers will run red (**fig. 5**), and both river and ground water will be undrinkable. Aquatic animal life will be minimal, and only very hardy aquatic vegetation will survive. The rivers will also be choked with sediment. Extensive areas of the region will have become devoid of vegetation due to acidification of the soil (**fig. 6**), setting in motion severe erosion which will strip the soil cover and eat into the backfill of the old opencast workings. The eroded sediment will choke the rivers and all dams will be filled with sediment. In short, the region could become a total wasteland.

This scenario might seem melodramatic and emotive, but are the currently employed mitigation procedures adequate to prevent such a scenario from arising? We believe they are not. Acid water will be generated by the closed mines, making the ground water in the region unpotable. Uncontrollable seeps of this water will become widespread, seriously degrading surface water resources. There is no system either in place or planned to prevent this. Systems such as the Brugspruit Pollution Control Works will not solve the problem. Water resources in the area are currently degrading notwithstanding efforts by the industry to control the problem. The scale of the problem is going to increase enormously in the future as the mines close and water management becomes more difficult. The future costs of water purification will be massive, far greater than any mitigation fund could cover, and will have to be borne by the state. There is also likely to be major loss of future revenue from reduced agricultural potential of mined land, partly due to the loss of ground water resources, but also because of the threat to the soil itself. Whether the current procedures are adequate to protect the soil cover over former opencast mines remains to be seen.

The Olifants River catchment is in trouble, but the most serious long term threat that coal mining poses is to the water resources of the Vaal River basin, which provides drinking water to possibly a third of the country's population. Rivers rising on the escarpment, which supply the lowveld as well as neighbouring southern Mocambique and Swaziland, are also under threat. In the absence of adequate, fail-safe environmental protection procedures, we believe that a moratorium should be declared on new mining applications in all of these catchments until such

time as cumulative impact of mining is fully understood and adequate mitigation can be guaranteed. In addition, there should be a concerted research programme to assess the future impact of current and past mines, to find ways of reducing acid discharge from mines and of passively treating sulphate-rich mine water. If adequate, low cost mitigation procedures cannot be discovered, then no further mining should be permitted in sensitive catchments.

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Slide 1

Slide 2

Slide 3

MWF Objectives

- ***Contributing to the development of legislation, policies, guidelines and standards relevant to wetlands.***
- ***Promoting the co-ordinated implementation and enforcement of national, provincial and local legislation, policies, guidelines and standards relevant to wetlands.***
- ***Formulating and inputting into specific proposals that may have an impact on or have relevance to wetlands through technical input / advice.***
- ***Monitoring activities that may impact on wetlands.***
- ***Facilitating education and awareness programmes relating to wetlands.***
- ***Facilitating the dissemination and sharing of information pertaining to wetlands between the various role players on the Forum as well as the general public.***
- ***Supporting activities and programmes that promote the sustainable use of wetlands.***
- ***Improve stakeholder participation, representation and active involvement on the Forum.***
- ***Facilitate wetland research through identification of needs.***
- *Promote improvement of wetlands through rehabilitation* **(YWG ?)**

Slide 4

Introduction to the MWF

- **MWF was established in 1992 (10 Year Anniversary next year!)**
- **At the time was established to mainly co-ordinate Working for Wetlands Rehabilitation Projects in the Province**
- **Now it performs a more overall Co-operative Wetland Management function**
- **MWF = A Voluntary association of like–minded people (from government, Business, NGO's and the general public) interested in wetlands and wetland conservation in Mpumalanga**
- **Quarterly Meetings (1 Regular Meeting & 1 AGM & Annual Planning Session and 2 Site Visits)**
- **2010/11 Priorities (3 Working Groups) - report back at MWF Meetings**
  - Compliance & Monitoring (WG)
  - Awareness & Education (WG)
  - Wetland Inventory / Mapping (WG)
  - Marketing

Slide 5

What does the MWF do ?

- **Shared Learning**
  - Through **Co-operation / Information Sharing** - Current Issues, Initiatives, best Practices (via e-mail / Wetland Portal / MWF Newsletter)
  - **Field Based (hands-on) Learning** - through **Site Visits** (i.e. Chrissiesmeer, Wakkerstroom, Verloren Vallei, etc.)
- **Wetland Awareness & Education**
  - **Regular e-mails** to MWF Mailing / Distribution List – (Target Audience of ± 370)
  - **Regular MWF Quarterly Newsletters** (all available on MWF web page)
- **Co-operation & Networking**
  - With other relevant Stakeholders / Forums – i.e. Crocodile Catchment Forum / **YWG ?**
  - **DESD Water & Wetlands Working Group** Stakeholder
- **Interested & Affected Party (I&AP)**
  - Wetland & Water Related Issues in Mpumalanga
- **Monitoring & Reporting** – Activities that impact on wetlands / water resources
- **Marketing**
  - **e-mails / Newsletter / Calendar / Events / Exhibitions (i.e. WWD 2011 / DESD)**
  - **Local Media Articles –** i.e. *Lowvelder / Highlands Herald / Panorama / Highveld Tribune*

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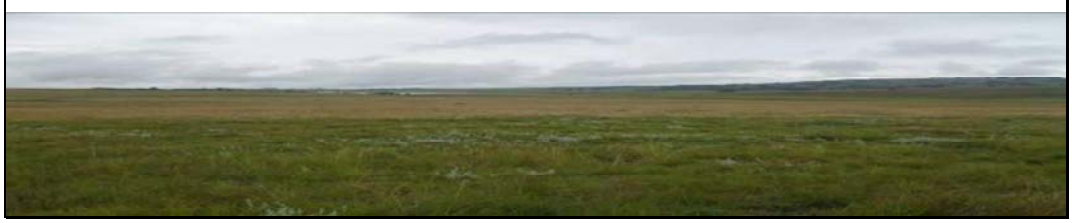
MWF Successes

- **Information Sharing / Communication –** e-mails, Newsletters, Media Articles
- **Active Marketing –** Now recognised Stakeholder (re: Wetlands & Water Issues)
- **Recognised Stakeholder (I&AP) –** Especially (Coal) Mining Activities in the Province e.g. Proposed Provincial 2010 Mining Indaba Stakeholder Engagements, Mining / EIA Applications, etc.
- **Improved Co-operation –** with other similar Interest Groups / Forums / Interested Parties – i.e. Crocodile Catchment Forum (regular MWF feedback slot!) …… and hopefully in future with the **YWG!**
- **Development of Tools**
  - MWF **EIA Comment Template –** Facilitate comments from Forum
  - MWF **Reporting Form – Alleged Unlawful Activities**, e.g. Mining (List of Contact Details of all Relevant Compliance & Enforcement Authorities, i.e. Green, Blue and Brown Scorpions) (available on the MWF web page)
- **National Wetlands Indaba (NWI) –** Provincial Wetland Forum **Discussion / Information Sharing Session** hopefully standing item on programme in future!
- **Wetlands Portal & Discussion Site –** Developed by Marc De Fontaine (Rand Water)



Slide 7

Wetlands Portal

Slide 8

Wetlands Portal Discussion Site

Slide 9

Comparisons – YWG & MWF

YWG	MWF
Voluntary Group of Interested and Concerned Individuals (Aquatic Scientists, Anglers, etc) interested / concerned in conserving Yellowfish (habitat)	Voluntary Association of Like-minded Individuals interested / concerned in Wetland / Water Conservation
Established 1997	Established 2002
Mandated from FOSAF (Angler Driven Conservation)	No (Legal) Mandate (driven by Interested / Concerned Wetlanders)
YWG (Provincial Chapters) – Active!?	MWF WG's (Task Teams) – Inactive!!
Annual YWG Conference – Provincial Chapter Feedbacks	NWI (formerly SAWAG) – Provincial Feedbacks & **Info Sharing Session**!
Funded (FOSAF) (& Funder - projects)	Currently Unfunded (Active Bank Account - Treasurer recently appointed)
Emphasis of Research (Funding)	Emphasis more on Information Sharing / Awareness

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Areas of Future Co-operation ?

- **Shared Learning (Experiences) –** Successes, Lessons Learned, Tools, Challenges, Measures to Overcome, etc. (i.e. MWF Reporting Form, Provincial Information Sharing Sessions at NWI / YWG Conferences!)
- **Liaison & Co-operation** (FOSAF Milestones) **–** e.g. EWT / Highland Crane Group (Mpumalanga Highlands Wetland Study), Eco Care Trust, SAVE & MWF
- **Co-ordinated Effort(s)**
  - **Monitoring / Reporting –** Overlapping areas of Concern i.e. activities that impact on yellowfish habitat / water resources & wetlands e.g. coal mining !!
  - **Action re: Common Issues / Concerns –** i.e. mining, water pollution (AMD), etc.
  - **Stakeholder Engagement –** Share information about and co-ordinate comments on issues of common concern, i.e. activities that impact on water / wetlands & yellowfish habitat ?
- **Web Portal / Discussion Forum !!! –** Assistance !?
- **Result: Closer Working Relationship / Partnership –** YWG & MWF share very similar interests / objectives !? **NB - Need to work closer to achieve common goals!**

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MWF Contacts
Wetlands Portal & Discussion Site: www.wetlands.za.net
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DRAFT EXECUTIVE SUMMARY OF THE WATER RESEARCH COMMISSION REPORT TITLED:

ASPECTS OF THE BIOLOGY AND ECOLOGY OF THE ORANGE-VAAL LARGEMOUTH AND SMALLMOUTH YELLOWFISHES IN THE VAAL RIVER.

Pierre De Villiers[1&2], Gordon O'Brien[3]

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[2]Orange-Vaal River Yellowfish Conservation and Management Association. C/O Cape Nature, Private Bag X5014, Stellenbosch, 7600

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This report documents the outcomes of three Water Research Commission consultancy studies that were carried out between 2006 and 2010 by the University of Johannesburg and River of Life Aquatic Health Services CC. The titles of the consultancies were:

- An assessment of selected biology aspects of the two yellowfish species *Labeobarbus kimberleyensis* and *L. aeneus* from the Orange-Vaal River system, South Africa. (K8/678).
- Effects of flow and temperature on spawning and recruitment of Largemouth (*Labeobarbus kimberleyenis*) and Smallmouth (*L. aeneus*) yellowfish. (K8/803).
- Assessment of selected biological features associated with the breeding biology of the threatened Orange-Vaal River Largemouth yellowfish and the Orange-Vaal River Smallmouth yellowfish from the Orange-Vaal River system. (K8/818).

The combined aims of the study included:

1. Successfully develop the technology to implant radio telemetry tags and to track the two yellowfish species in the Orange-Vaal River system. (K8/678).
2. Determine the home range of *L. aeneus* and *L. kimberleyensis*. (K8/678).
3. Determine how environmental variables (flooding, drawdown and temperature) affect the movement and biological requirements of *L. aeneus* and *L. kimberleyensis* to changing environmental variables. (K8/678).
4. Establish age-length relationships for larval and early juveniles of both species. (K8/803).
5. Use hatch date analysis to determine the timing, duration and frequency of spawning by *L. aeneus* and *L. kimberleyensis* over a single season. (K8/803).
6. Link the above information to the prevailing environmental conditions (temperature and flow) and to identify environmental cues and optimal conditions that promote spawning by the two species. (K8/803).
7. Link the findings of this study to the movement of *L. aeneus* and *L. kimberleyensis* prior to, during and after spawning events. (K8/803).
8. Use this knowledge to guide management and conservation frameworks and provide input to EWR studies currently underway in the Orange/Vaal River system. (K8/803).
9. The aim of this study is to characterise selected biological features associated with the breeding biology of the threatened Orange-Vaal River Largemouth Yellowfish and the Orange-Vaal River Smallmouth Yellowfish in the Vaal River and to produce yellowfish offspring for further scientific studies. (K8/818).

In the study, eight of the nine original aims established were achieved. Aims number six and seven required wild caught Largemouth yellowfish larvae and or fingerlings (>6 months old). Attempts made to collect Largemouth yellowfish larvae and fingerlings within study areas were unsuccessful.

Recent anecdotal observations show that the Largemouth yellowfish populations in the study area may be dominated by different age class cohorts. This suggests that successful recruitments of this species in to the Vaal River do not occur annually. More research on the recruitment of this species into the Vaal River is required. In addition to these aims, some new aims were established for the study and were achieved which included:

10. Assess selected behavioural ecology and biology features of the Vaal River yellowfishes including the daily, seasonal and annual movements, habitat use, migrations and possible territoriality behaviour of species.
11. Assess selected components of the conservation and management approaches adopted for the Vaal River yellowfishes by the Orange Vaal River Yellowfish Conservation and Management Association.
12. Finally, an aim of the study was developed to carry out a regional scale risk assessment of threats to the sustainability of the Largemouth yellowfish populations in the study area making use of the data obtained in this study.

The report itself presents a broad review of the known biology and ecology of the Vaal yellowfishes, including dedicated sections on species identification, taxonomy and notes on the evolutionary and phylogenetic development of the species, as well as the taxonomic history of the yellowfishes. The study then addresses the approaches adopted and the outcomes of three complementary reproduction, early development and growth studies of the Vaal River yellowfishes. These studies included assessments of the artificial reproduction, early development of and age validation of larval and juvenile Vaal River yellowfish. This includes the first documented findings of any formal early development and growth study of a yellowfish in southern Africa. The early development study has allowed for the characterisation of numerous developmental stages that yellowfish undergo which will contribute towards the life-cycle biology and conservation of these species. The work also presents some evidence of new ecological requirements and previously unknown behavioural features of yellowfish in the Vaal River. Finally, the study shows that distinct morphological features of the larvae and juveniles of each species occur. These features can be used to identify wild larvae and juvenile yellowfish. The age validation study showed that both species deposit daily growth rings that can be counted to accurately determine the age of wild caught yellowfish. This can be used to evaluate the importance of the volume, timing and durations of natural flows and other related ecosystem conditions, to ensure that good recruitment of yellowfish into the Vaal River occurs.

The next section of the report presents the outcomes of the first ecological behavioural assessment, carried out on Vaal River yellowfish using biotelemetry methods. This section details previously unknown behavioural biology and ecology features of the Vaal River yellowfishes. Specific findings include features of the daily, seasonal and annual movements, home ranges, habitat use, migrations and possible territoriality behaviour of Vaal River yellowfishes. In this part of the study, a database of information has been generated that can be used in the future to evaluate the consequences of changing environmental conditions in the Vaal River.

The study is completed with an assessment of components of the conservation and management of Vaal River yellowfishes. This includes a review of a socio-economic value assessment of Yellowfish in the Vaal River, and a study to address the possible impacts of angling on yellowfish populations in the Vaal River. This information, along with the historically known biology and ecology of the Vaal River yellowfishes and new information generated in this study was used to carry out a simplified regional scale risk assessment of the threats to Largemouth yellowfish in the Vaal River. This risk assessment shows that currently the excessive use of the resources of the Vaal River is threatening the continued viability of these species. In addition, if management plans are not developed and implemented to

balance between the use and protection of the resources of the Vaal River, there is a high probability that the conservation status of the Largemouth yellowfish will increase to endangered status.

This study has successfully developed our understanding of these three areas of the biology and ecology of the Vaal River yellowfishes, and demonstrates the value of this information in the conservation and management fishes in southern Africa.

In consideration of the outcomes of this study the following recommendation are made:

- The reproduction experiments showed that both of the Vaal River yellowfishes can relatively easily be cultured under artificial conditions. Outcomes show however that it is difficult to condition Largemouth Yellowfish in artificial environments. We recommend that a monitoring exercise be carried out in an artificial environment where the conditioning process and behavioural changes of both Largemouth and Smallmouth yellowfishes can be assessed.
- The study shows that distinct morphological features of the larvae and juvenile yellowfish from a set of adult broodstock of each species occur. If consistent, these features can be used to identify wild larvae and juvenile yellowfish. We recommend that an evaluation study be carried out to confirm that these morphological features are consistent and can be used to identify wild yellowfish in the Vaal River.
- The role that that flow plays in the recruitment of *L. aeneus* and *L. kimberleyensis* in the Vaal River is not well understood, but there is evidence that both species depend on optimal flow and temperature conditions for successful reproduction. Following from this study, which is an important preliminary step to aging wild-caught larval *L. aeneus* and *L. kimberleyensis,* a dedicated study that addresses the recruitment of yellowfishes into the Vaal River should be carried out.
- The behavioural monitoring study showed that biotelemetry methods can effectively be implemented to monitor the behaviour of yellowfishes in riverine ecosystems in South Africa. The study produced a range of new behavioural biology and ecology features of both of the Vaal River yellowfishes. Although valuable many of the behavioural events cannot be unexplained. We recommend that the biotelemetry monitoring work on yellowfish in the Vaal River be continued, and expanded on into the Orange System and lentic ecosystems in the catchment.
- The outcomes of the simplified regional scale risk assessment show that some of the Largemouth yellowfish populations in the Vaal River may currently be unsustainable. In addition, this assessment suggests that the population structures and recruitment of juveniles into populations can be good indicators of the health of populations. In accordance, we recommend that an assessment of the Largemouth yellowfish population structures and recruitment of juvenile yellowfish into the populations should be carried out.

HISTORICAL PATTERNS OF CONNECTIVITY AMONG *LABEOBARBUS NATALENSIS* POPULATIONS

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Introduction

The presentation addressed two components of the ongoing genetic research on the South African yellowfish species: (1) The overall pattern of *Labeobarbus* diversity based on mitochondrial DNA (mtDNA) and (2) the pattern of mtDNA variation in the KwaZulu-Natal yellowfish *L. natalensis* and analyses to understand the potential underlying processes generating this diversity.

Pattern of *Labeobarbus* diversity

The analysis included all the unique mtDNA sequences (102 unique maternal alleles) revealed from previous screening of diversity in: (1) *L. aeneus* and *L. kimberleyensis* from the Upper and Lower Orange for the YWG/AngloGold Ashanti report (23 alleles; Bloomer *et al.* 2006); (2) *L. polylepis* from the Phongola, Assegai, Nkomati, Crocodile, Elands and Ngodwana Dam for a WRC report with Gordon O'Brien (refs; 35 alleles) and additional material from the Bloubankspruit (six alleles); (3) *L. natalensis* from throughout KZN as part of the ongoing study carried out for the YWG and the provincial authorities (see further details in the section below; 32 alleles), as well as a few sequences available for *L. capensis* from the Clanwilliam Olifants River in the Western Cape (one allele) and *L. marequensis* form the Crocodile-West Marico (11 alleles).

From the unrooted phylogenetic tree (Figure 1), the following can be observed:
There are five distinct lineages corresponding with the described species; *L. capensis* appears to be most closely related to *L. natalensis,* and *L. polylepis* to *L. aeneus*/*L. kimberleyensis*. *L. marequensis* is the most distinct but some *L. polylepis* alleles (from the Bivane (9), Assegai (1), Elands (1) and Phongolo (2)) and *L. natalensis* (one allele from the White Umfolozi) group closer to *L. marequensis* than to the other small-scaled species. The morphology of these specific samples should be looked at as some of these may represent fish that have been moved between different systems.

Observations for the different species include: (1) As previously reported mtDNA cannot distinguish between *L. aeneus* and *L. kimberleyensis*. There is a distinct group of *L. aeneus* sequences from the Lower Orange. (2) There are a number of distinct lineages within *L. polylepis*: Nkomati/Elands, Assegai/Phongolo, Bloubankspruit. In addition, samples from the Bivane and a few from other rivers are highly distinct and groups separately from the main *L. polylepis* lineages. There are also two highly distinct sequences from the Phongolo grouping on their own. (3) Variation within *L. natalensis* is geographically highly structured. (4) The relationships within *L. marequensis* need further investigation, as well as the relationship between the large-scaled and small-scaled species.

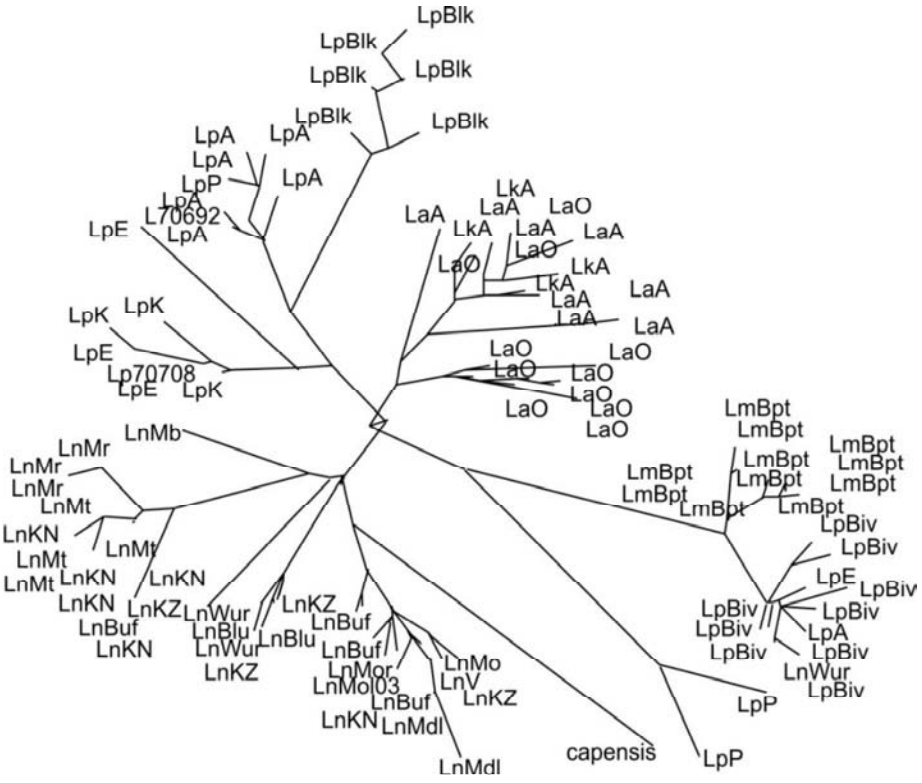

Figure 1 Phylogenetic tree showing the relationship between all the unique mitocondrial DNA alleles identified from six yellowfish species to date (Ln = *natalensis*; Lp = *polylepis*; La = *aeneus*; Lk = *kimberleyensis*; Lm = *marequensis* and *capensis*)

Labeobarbus natalensis **diversity**

As can be seen from the tree above the variation in *L. natalensis* is geographically highly structured. The results from an allele network mapped onto the sampling locations (results not shown), indicate that:

There are six distinct groups of alleles or so-called lineages: (1) The Tugela, its tributaries and some neighbouring rivers, (2) the Mkuze/Umfolozi, (3) the Buffalo/Mkuze, (4) the Mbokodweni, (5) the Mkomazi and (6) the Mzimkulu/Mtumvuna. A statistical analysis supports the proposed barriers to gene flow with the rivers in the south of the province as the most isolated (lineage 6 followed by 4 and 5; there is also a significant barrier between lineages 1 and 2). Both lineages 1 and 3 have been collected from the Buffalo near Vryheid and this area would be important to sample more intensively.

What's next?

More detailed analyses of all the within-species patterns should be conducted and the mtDNA results contrasted with variation at a few nuclear gene loci. Preliminary analysis of nine sequences of the nuclear *rhodopsin* gene has not revealed any variation among distinct *L. natalensis* samples. One should, however, be cautious with this interpretation as the duplicated loci in these hexaploid species may represent functional and non-functional copies. These could have different patterns of mutation.

Several manuscripts will be prepared for publication, including the *L. aeneus/kimberleyensis*, *L. polylepis* and *L. natalensis* research.

A funding application will be submitted to support the development of fine scale genetic markers (such as microsatellite loci, widely used in human and animal forensics and population genetic studies). These markers are crucial to investigate the potential occurrence and impact of interspecific hybridization.
Additional future projects should be developed in collaboration with all the conservation authorities and researchers investigating the biology and ecology of the different species.

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THE DEVELOPMENT OF A BIODIVERSITY MANAGEMENT PLAN (BMP-S) FOR THE ORANGE-VAAL LARGEMOUTH YELLOWFISH (*LABEOBARBUS KIMBERLEYENSIS*)

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The National Environmental Management: Biodiversity Act 2004(Act No.10 of 2004) (NEMBA) and the Threatened and Protected Species Regulations allow for the compilation and gazetting of Biodiversity Management Plans for Species (BMP-S). This process will motivate for the conservation of the Orange-Vaal Largemouth Yellowfish (*Labeobarbus kimberlyensis*) (Gilchrist & Thompson, 1913) and outline the activities required to implement the conservation strategies required for this species.

The Endangered Wildlife Trust has undertaken to draft the NEMBA Biodiversity Management Plan for *L. kimberleyensis*, one of three BMPs currently being undertaken for freshwater fish species in South Africa. This process is being undertaken on behalf of the Orange-Vaal River Yellowfish Conservation and Management Association and will collate the available information to create a framework for the long-term conservation of the species. The BMP (S) is in the draft phase and will be circulated to all identified stakeholders for comment in 2011.

The Orange-Vaal Largemouth Yellowfish is endemic to the Orange-Vaal River system and although it is widespread, it is less abundant locally than the Orange-Vaal Smallmouth Yellowfish (*L. aeneus*). It is an apex predator with a relatively slow growth rate and population numbers appear to be declining. The conservation status of the species is classified as Near Threatened (recently changed from vulnerable) and it is more demanding than *L. aeneus* which makes it a flagship species. It requires flowing water in deeper channels and good water quality, which makes it a good indicator species. Threats to the species include: over abstraction of water during the dry winter months, polluted waters in the main channel, illegal netting, inadequate fisheries management, angling pressure, inter-basin transfers (genetic hybridisation) and alien fish invasions (particularly grass carp). It supports huge recreational angling and fly-fishing industries, valued at R133 000 000 per season (in the Vaal) and catch (revive) and release angling practices are being promoted. In the past, conservation measures that were implemented were the establishment of conservancies and nature reserves along river and dam and building of hatcheries and fish stocking (such as the Salmon hatcheries in USA).

The purpose of the BMP(S) is to put forward conservation objectives for *L. kimberleyensis* and outline the necessary implementation measures. Considering the population trends, habitat and utilisation pressures; a comprehensive management plan is needed to link conservation objectives and role players and this is a iterative management planning process, which is to be revised five years after approval.

The vision statement or desired state is defined as: "Through the implementation of this BMP (S), it is envisaged that the long-term survival and proliferation of this species will be ensured, together with a significant improvement of the general riverine environment of the Orange-Vaal River System. This effort will contribute toward the conservation of an important freshwater fish species and its habitat and will ensure sustained provision of clean and safe water for future human generations".

The anticipated outcomes of the BMP(S) are an updated database of stakeholders and role-players, an increased awareness of Yellowfish conservation amongst stakeholders, a comprehensive list of conservation objectives, an accepted implementation strategy, clarity and acceptance of roles and responsibilities amongst role players and realistic targets set for re-evaluation after five years.

The methodology of the BMP(S) will follow previous BMP(S) formats and the Norms and Standards for BMP(S):

- Review of relevant documents, agreements and policies
- Literature review
- Consultation with experts
- Identification of an implementation body (OVRYCMA)
- Stakeholder analysis
- Completion of BMP (S) draft
- Circulation to stakeholders for comment
- Submission of BMP (S) to Minister for approval
- Annual progress report
- Five year evaluation

Monitoring and evaluation will be based on the measurable outcomes as determined in Action Plan and will be the responsibility of OVRYCMA. DEA and EWT will facilitate the review of the monitoring report in collaboration with OVRYCMA and recommendations to amend and adapt the plan will be made where necessary.

At this stage, the relevant literature is being reviewed, the implementing and monitoring body has been established (OVRYCMA) and the BMP (S) is in first draft phase. Still to be undertaken is the stakeholder analysis and stakeholder engagement (30 days min). The second draft must then be sent to all implementing parties for validation (60 days), after which the final draft will be submitted to the minister for approval.

A workshop was held on 10th January 2011 at Kirstenbosch in Cape Town to share insights and experiences from the BMP process to date and deal with any technical questions. Some of the outcomes of the workshop are detailed below:

1. The BMP(S) is a dynamic working document and the draft will keep evolving before being gazetted
2. Implementation of the action plan can start while BMP (S) is out for comment or review
3. Species do not require IUCN status for BMP (S) but are prioritised based largely on utilisation pressure/potential, occurrence and recovery potential. There are currently no prioritisation guidelines in the regulations and it was suggested that SANBI take this up. At the moment it is first-come-first-serve and DEA will process BMP (S) as they are received
4. It is important to specify the "desired state" or "vision" of the BMP (S) in order to have a set goal to work towards
5. The Largemouth Yellowfish BMP S is a very ambitious undertaking and will present considerable challenges
6. A suggestion was made to divide the Orange-Vaal River system into management units, addressing the threats separately and layering the action plan to manage each discrete unit
7. Preferable to compile a generic and comprehensive action plan for the entire system to deal with over-arching issues of riverine management

The Biodiversity Management Plan for the Orange-Vaal Largemouth Yellowfish will be a crucial step towards securing the sustainability and integrity of this freshwater fish species and will contribute towards future management interventions of this kind.

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INITIATING A BIODIVERSITY MANAGEMENT PLAN FOR SPECIES (BMP-S) FOR THE BARRYDALE REDFIN

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1. Introduction

The rivers of the Cape Floristic Region (CFR) have a fish fauna characterized by relatively low species diversity but a high degree of endemism and the conservation status of many of these species is a cause of great concern. According to a recent report on the conservation status of aquatic fauna of Southern Africa by the International Union for the Conservation of Nature (IUCN), there are presently at least five Critically Endangered fish species in CFR urgently requiring conservation action to prevent functional extinction of the species. There are however, several difficulties that impede the effective conservation and management of threatened fish species in the broader CFR. These include limited capacity in conservation agencies, a lack of public awareness regarding the value of native fish and the threats posed to them, and insufficient enforcement of environmental laws.

Recent legislation such as the National Environmental Management: Biodiversity Act (Act 10 of 2004) has undoubtedly improved the legal framework for fish conservation initiatives in two major ways. Firstly, the Alien Invasive Species (AIS) regulations (promulgated in 2007) has provided a legislative tool through which the threat of alien fish invasions can be better managed and secondly, the promulgation in 2009 of the Norms and Standards for Biodiversity Management Plans for Species (BMP-S) has provided for the development of species specific management plans. These are critical for the effective conservation of the indigenous fish of the CFR as it is necessary to provide best management practices for each individual species as the combination of factors threatening each species may be different. There is also a strong stakeholder consultation component to the BMP-S process which ensures stakeholder support and buy-in, and ensures consistency and transparency in the process. The first Biodiversity Management Plan for Species (BMP-S) for the Western Cape will be developed for Barrydale redfin in a collaborative project between CapeNature and the South African Institute of Aquatic Biodiversity (SAIAB).

2. Why the Barrydale redfin needs a Biodiversity Management Plan (BMP-S)

In a study of the phylogenetic relationships of South African redfin species, Swartz (2005) illustrated that Burchell's redfin (*Pseudobarbus burchelli*) that occur in the Breede and associated river systems in the Western Cape Province is a species complex consisting of three genetically distinct lineages. These are a lineage that is widespread in the Breede, Duiwenhoks and Goukou River systems (*Pseudobarbus* sp. "burchelli Breede"), a lineage that occurs in the Heuningnes River system on the Agulhas Plain (*Pseudobarbus* sp. "burchelli Heuningnes") and a lineage that is restricted to the Tradouw catchment in the lower section of the Breede River system (*Pseudobarbus* sp. "burchelli Tradouw"), hereafter referred to as the Barrydale redfin.
The middle reaches of the Tradouw River and its major tributary, the Huis River, comprise the entire current distribution of the Barrydale redfin, indicating the extremely limited natural distribution range of this species (Swartz, 2005). The most recent IUCN species assessment indicated that the Barrydale redfin, along with four other redfin species is Critically Endangered

and is at risk of extinction if conservation interventions to protect this species are not implemented with urgency (Tweddle *et al.*, 2009; Swartz and Impson, 2007). Historical survey data suggest that the species' distribution have dramatically shifted and contracted in recent years as a result of a number of threats. These include excessive and often unregulated water abstraction for both domestic and agricultural use, instream habitat modification due to unsound agricultural practices such as bulldozing and removal of the riparian vegetation, diffuse and point-source pollution, and especially the presence of alien fish species (Chakona and Swartz, unpublished data). The array of ecological threats in the Tradouw River and its tributaries is typical of many CFR rivers and therefore this river is a good model system for guiding future conservation interventions.

In addition to the conservation status of the Barrydale redfin, a number of management criteria also played a role in selection of this species. One of these is the initiation of the National Freshwater Ecosystems Priority Areas (NFEPA) project in 2008. This project is a three year partnership project led by the South African National Biodiversity Institute (SANBI) and the Council for Scientific and Industrial Research (CSIR). It aims to identify a national network of freshwater conservations areas and to explore institutional mechanisms for their implementation. One of the NFEPA products that have been produced thus far is a map indicating fish sanctuary areas for critical populations of all indigenous fish species in South Africa. The Tradouw catchment was chosen as a fish sanctuary due to the uniqueness of the Barrydale redfin, its threatened status and the importance of the riverine habitats in the catchment for the survival of the species. Linking to this, the Breede-Overberg Catchment Management Agency (BOCMA) catchment management strategy is in the process of being developed. CapeNature has contributed significantly to the conservation component of this strategy and there is thus an opportunity of ensuring that the conservation priorities highlighted by the species specialists is incorporated into the catchment management strategy at an early stage.

3. Aim and objectives of the BMP-S

3.1 Aim

To produce a Biodiversity Management Plan for Species (BMP-S) for the Barrydale redfin that addresses all known threats to the species as well as identifying management recommendations and implementing agents for mitigating the effects of these threats. The desired state for the species is the stabilization of population numbers and potentially downgrading it from Critically Endangered to Endangered within a realistic period of time. The project also aims to evaluate how new biodiversity legislation (such as NEMBA) and conservation planning projects (such as the NFEPA project) could affect catchment management of water resources. The project will serve as a case study for promoting municipal and local stakeholder participation in river rehabilitation, and finally, the project will assess best practices for alien species management in sensitive catchments.

3.2 Objectives

a) To accurately determine the present distribution of this species in its natural known distribution range and, through comparing it with historical data, determine the population trend.

b) To identify and prioritize threats to the Barrydale redfin and its associated habitat through an inclusive stakeholder participation process.

c) To identify short term interventions to stabilize the redfin population and prevent a further decline in population size.

d) To ensure the implementation of longer-term conservation measures for the Barrydale redfin in its present distribution range in order to secure the long term survival of the species and to promote population recovery throughout the historical range.

3.3 Anticipated outcome of the BMP-S

Recovery of the Barrydale redfin and its associated habitat to such an extent that the long-term survival of the species is secure, leading to a downgrade of its formal conservation status within five years of implementing the management plan. In the process the ecological integrity of associated species assemblages and processes will be improved and continued ecological goods and services in the Tradouw River catchment will be ensured.

4. Methodology

Broadly summarized, the process that is being followed is described below:

- Identifying the need for a BMP-S for the species, followed by consulting with species specialists, obtaining funding if applicable and compiling a background report
- Disseminating the background report to stakeholders
- Hosting a formal BMP-S workshop for all stakeholders and incorporating information from this meeting into the background report
- Incorporating all relevant comments from the BMP-S workshop into the background report, resulting in a draft BMP-S document.
- Circulating the draft BMP-S document to all stakeholders for final comments
- Submitting the finalised BMP-S to the Minister for approval & publication in the Government Gazette
- Once the BMP-S has been approved, the Minister will appoint a lead agency for implementation of the BMP-S

5. Progress and way forward

5.1 Background work conducted in 2010:

- Prioritized the fish conservation needs for the Western Cape – Barrydale redfin identified as top priority.
- Identified the need for BMP-S to be developed for Barrydale redfin
- Identified core planning team – initial meeting and field visit undertaken in April 2010 (CN & SAIAB)
- Funding: Submitted WRC proposal at end of May 2010 – unsuccessful in November 2010
- Literature review & compiling of background report: started in middle of June 2010
- Fieldwork: survey of historical distribution range of species proposed for 2011 – data to be compared to historical data from Swartz & Chakona. Fieldwork will involve

contacting relevant riparian landowners and other stakeholders to introduce concept of BMP-S & identification of threats and management recommendations.

- Concept of BMP-S communicated to stakeholders present at BOCMA reference group meetings in 2010.

Work to be conducted in 2011:

- Fieldwork needed to determining distribution ranges of alien species – to include dam surveys in upper catchment (proposed for March/April 2011)
- Genetic study: not applicable as redfin genetics intensively studied in 2 PhD studies (Swartz, 2005; Chakona, unpublished)
- Completion of background report at end of Feb 2011 for presentation to stakeholder group. The meeting is scheduled for 23 March 2011 at Grootvadersbosch Nature Reserve and the stakeholder invitation will be sent out at the end of February.
- Draft BMP-S to be finished for comment at end of May 2011 (proposed date) – 60 day comment period required by law
- Submission of completed BMP-S document to Minister for approval & publishing in Government Gazette in August 2011(proposed date)
- Appointment of lead agency and establishment of Conservation Forum to implement action identified in BMP-S once the document is approved.

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AN OVERVIEW OF CONSERVATION PLANNING INITIATIVES IN SOUTH AFRICA: PRIORITISING INDIGENOUS AND ALIEN YELLOWFISH POPULATIONS FOR CONSERVATION AND ECONOMIC USE

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Introduction

South Africa is a world leader in the field of conservation planning and several organisations are contributing to national and regional plans. Historically, conservation planning focussed more on terrestrial ecosystems, but aquatic ecosystems are receiving more and more attention due to the multitude of threats that are impacting on them. Three recently completed projects will have a major influence on how we prioritise freshwater ecosystems in general and freshwater fish species conservation in the near future. The first was the International Union for Conservation of Nature (IUCN) assessment of the conservation status of all southern African fish species completed in 2009 (Tweddle *et al.*, 2009), followed by mapping of list 3 category 2 alien fish species for the new National Environmental Management: Biodiversity act (NEM:BA; Swartz, 2010), and finally mapping of freshwater ecosystems (including freshwater fish sanctuaries) for the National Freshwater Ecosystems Priority Areas project (NFEPA; Nel *et al.*, 2009). The yellowfish species featured prominently in all three projects as flagship species for conservation and utilized species of economic importance and the products will be made available online in due course.

National Environmental Management: Biodiversity act (NEM:BA)

Mapping of proposed alien yellowfish zones where certain activities around yellowfish fisheries management will be allowed was completed last year (Swartz and Weyl, 2010; Swartz, 2010). The South African Institute for Aquatic Biodiversity (SAIAB) did the mapping on behalf of the South African National Biodiversity Institute (SANBI) and the Department of Environmental Affairs (DEA) with the help of fish experts, provincial nature conservation authorities and fisheries stakeholders around the country. These maps are now awaiting a public participation process before final maps can be approved for legislation. Alien populations of only two yellowfishes (*Labeobarbus capensis* and *L. aeneus*) and one large barb (*Barbus serra*) were included in the mapping process, which suggests that all the other species will be managed as naturally occurring indigenous fisheries only. Credit must therefore go to the policies of the Yellowfish Working Group and most provincial conservation authorities that maintained that yellowfish angling should only promoted for indigenous populations. There are, however, some exceptions that had to be accommodated. The inter-basin water transfer scheme that connects the Gariep Dam (Orange River system) with the Great Fish and Sundays River systems allows a continuous inflow of *L. aeneus*, which will make it virtually impossible to manage for conservation authorities. The main stem areas and surrounding catchments of the Great Fish and Sundays River systems have therefore been mapped as a zone where *L. aeneus* can be managed as an alien fishery (including activities such as movement within the zone). CapeNature has requested very restricted alien zones for *L. capensis* and *B. serra* in the Olifants River system, because most of the proposed areas have been stocked with these species before, and it was felt that it could provide at least a few venues where the Cape species could be caught without placing more pressure on the threatened river populations. The general agreement, however, seems to be that no more alien zones will be established for Cape species and that the attention will shift towards

rehabilitating natural populations for future expansion of fisheries potential. Indigenous fish zones are not specifically dealt with in NEM:BA, but the following is recommended:

1) No fish movements should be done due to possible mixing of historically isolated lineages.
2) If farm dams have to be stocked, it should be done from the nearest point where the outflow will reach a river.
3) If yellowfish do not occur in the local catchment, serious consideration should be given to the possibility of not allowing stocking, because alien populations could be established.
4) Farm dams should generally not be promoted for yellowfish stocking and the focus should be on promoting yellowfish and flagship species for indigenous river fisheries.
5) Genetic studies should be done (as part of an impact assessment) if there are very good reasons why a remote stocking should be considered (e.g. saving a species or a unique genetic lineage from extinction) and the reasons should be properly justified.

International Union for Conservation of Nature (IUCN) conservation status assessment

All the yellowfish and large barb species that are of interest to anglers in South Africa have been assessed in the latest IUCN conservation status assessment (Tweddle *et al.*, 2009; www.iucnredlist.org). The conservation status of the yellowfish species have been relatively stable, but there is concern about *B. andrewi* that recently lost its last river population. Other changes in conservation status were mainly due to better availability of information or better interpretation of IUCN criteria (see Table 1).

Table 1. IUCN conservation status of yellowfish and large barb species from South Africa (go to www.iucnredlist.org for more information).

Common name	**Scientific name**	**Conservation status**
Largescale yellowfish	*Labeobarbus marequensis*	Least Concern
Smallscale yellowfish	*Labeobarbus polylepis*	Least Concern
KZN yellowfish	*Labeobarbus natalensis*	Least Concern
Smallmouth yellowfish	*Labeobarbus aeneus*	Least Concern
Largemouth yellowfish	*Labeobarbus kimberleyensis*	Near Threatened
Clanwilliam yellowfish	*Labeobarbus capensis*	Vulnerable
Bushveld papermouth	*Barbus mattozi*	Least Concern
Clanwilliam sawfin	*Barbus serra*	Endangered
Whitefish	*Barbus andrewi*	Endangered

National Freshwater Ecosystem Priority Areas (NFEPA) project

Populations of one yellowfish (*L. capensis*) and two large barbs (*B. serra* and *B. andrewi*) were mapped as national fish sanctuaries, because these species are considered threatened according to IUCN critieria (see above). This was done under the leadership of SAIAB with fish experts from around the country for the NFEPA project that is led by the Council for Scientific and Industrial Research (CSIR) and SANBI. The Olifants River system has several important fish sanctuaries, but particularly the upper Olifants, Oorlogskloof, Biedou and Driehoeks-Matjies catchments are seen as critical catchments where *L. capensis* and *B. serra* still breed successfully. The Hex River was the only place where *B. andrewi* still occurred in a riverine habitat. Their disappearance from this river due to bulldozing now only leaves a few dams where this species can still be found. The Hex and other streams were therefore mapped as possible rehabilitation

zones to help the recovery of this species, which will hopefully allow anglers to someday catch them in rivers again.

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THE LIMNOLOGY AND WATER QUALITY OF THE RECENTLY CONSTRUCTED NANDONI DAM IN THE LIMPOPO PROVINCE WITH SPECIAL REFERENCE TO THE STATUS OF THE LOWVELD LARGESCALE YELLOWFISH (*LABEOBARBUS MAREQUENSIS*).

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Abstract

1. Introduction.

In Africa, the harvesting of fish from the reservoirs is an important food source for rural communities, particularly those living close to the water bodies (Kapetsky *et al.,* 1984). South Africa is an arid country and depends on man-made reservoirs to supply water for human consumption, industries, and irrigation. In addition inland fisheries based in these reservoirs can provide an essential contribution to local and regional economies, sustaining livelihoods and constitute important source of recreation (Smith *et al*., 2005). The lack of a fishing history in communities, the lack of species with high fisheries potential, inadequate fisheries policies and lack of direct fisheries development can negatively impact on any proposed fishing indusdtry (Weyl *et al*., 2007). According to King (1995) a major component of fishery assessment is to determine the status of the resource and to establish safe levels for sustainable exploitation. Traditionally commercial and subsistence fishing have often been contributing factors in the collapse of a large number of inland fisheries (Cooke and Cowx, 2006; Allen *et al*., 2005). Fishery surveys in South African reservoir have focused on estimating fish biomass and the fisheries potential of a variety of inland reservoirs (Ellender, 2008). The main aim of fisheries assessment is to determine the status of the resource and it establishes safe levels for sustainable exploitation (King, 1995). Because length and weight data provide statistics that are cornerstones in fishery research and management, the number and size of fish available in a population can be used to determine the potential for recreational, subsistence or commercial fishery (Naesje *et al*., 2004). In addition detailed assessment of the catch per unit effort (CPUE) and size selectivity can provide information for future management and conservation of fish species such as yellowfish (Ellender, 2008).

The Nandoni Dam is situated southeast of the town of Thohoyandou in the Limpopo Province and has a full supply surface area of 1 650 ha and a maximum depth of 38m. Based on its size and geographical position the dam is ideally situated for both the commercial harvesting of fish and aquaculture. Such activities should however be well managed and *in lieu* of that, a fisheries management plan should be drawn up. This management plan should be based on knowledge of the fishery potential of the dam which in turn is based on sound knowledge on basic aspects which includes the dynamics of the fish community in the dam, the limnology of the dam and the effect of the quality of the water supply to the dam. A proposal to investigate the abovementioned aspect was submitted to the Water Research Commission (WRC), funding was received and the project commenced late in 2009. At this point in time the fieldwork of the project has been completed and the final report is being prepared.

2. Materials and methods.

Sites were selected that would represent the conditions at the inflow and in the main water body of the dam. At the selected sites the *in situ* water quality assessment included measurement of total dissolved solids (TDS), pH, temperature, dissolved oxygen (DO) concentration and electrical conductivity (EC) using handheld Eutech meters. Secchi disc readings were taken and the water depths were determined with a Hummingbird fishfinder. Water samples for chemical analyses and total suspended solids (TSS) determination were collected below the surface. The samples were analysed in the laboratory for PO_4-P, NO_3-N, NO_2-N and NH_4 using a Merck Pharo spectrophotometer. At site 1, the deepest point of the dam, the oxygen profile was determined at 1m intervals using a handheld Hannah oxygen meter with a 30 m probe. In addition the temperature, pH, electrical conductivity and TDS were determined with handheld Eutech meters in water samples collected at 1m depth intervals with a van Dorn sampler.
Fish were collected monthly at four sites, sites 2 to 5, using a fleet of multifilament gill nets consisting of a series of five nets, each 30m long and 1,8m deep, with the following stretched mesh sizes: 28, 45, 73, 93 and 118 mm. The nets were set during late afternoon and removed early the next morning. When clearing the nets the lengths and mass of all the fish caught were determined on site.

3. Results.

The first survey was done in September 2009 and the sites have been surveyed sixteen times up to December 2010. Twelve sites were selected for the main Water Research Commission (WRC) funded project (Figure 1) and in this report only sites 1 to 5 and 10 to 12 are included. A brief description, which shows the availbility of fish habitat and general conditions, of each of the selected sites is provided in Table 1.

Figure 1: The sites in the Nandoni Dam selected for the Water Research Commission project. Site 1: Deep water limnology, Sites 2, 3, 4 and 5: Limnetic sites, Sites 6, 7 and 9: Littoral sites, Sites 10, 11 and 12: Inlet sites, Site 17: outlet site.

Table 1: Brief descriptions of the selected sites in Nandoni Dam.

Site no	Brief description of site
1	The site is situated at the safety cable close to the dam wall and the water depth is *ca* 38m.
2	Situated in a bay on the southern shore. The depth varies between 4 and 5 m. Based on the surrounding littoral zone the substrate is mud. There are no big trees. A small stream flows into the bay.
3	Situated on the southern shore, upstream of site 2. Large dead trees are abundant and the substrate is mud and sediment. When the dam is full the littoral zone of this site consists of an extended shallow area with stands of *Dichrostachys cinerea* and tall grasses. The average depth at the netting area is 6 to 8m
4	On the northern shore of the dam. Large dead trees and shrubs are abundant and boulders occur in the substrate. The depth where netting was done varies from 4 to 10m.
5	On the northern shore in a bay that is an inundated river bed with large dead trees and boulders that forms a small "island". Water depth varies between 4 and 8 m.
10	Where the Mvudi River enters the dam. The depth varies from 2 – 4 m. It has a well developed littoral zone and a few dead trees.
11	Where the Dzindi River enters the dam. The depth varies from 2 – 4 m.
12	High up in the Luvuvhu River. The depth varies from 2 – 6m.

The summer temperatures, recorded in February 2010, shows a depth profile of site 1 where there is not a typical thermal stratification but where there is a gradual temperature decrease with depth (Figure 2A) There is however some indication of an increased decline after a depth of 7 meters which could be construed as a thermocline. In winter, during the July 2010 survey, there was no real difference between the surface and bottom temperatures which indicates that the

water-column was probably fully mixed or isothermal (Figure 2A). The dissolved oxygen concentration on the other hand shows distinct layering with a well oxygenated upper layer of *ca* 5 meters, followed by a transitional zone, the oxycline, where a sharp drop in the oxygen concentration occurs between 5 and 10 meters. Finally low oxygen concentrations were recorded below 10 m (Figure 2B).

Figure 3A shows that at site 1 the pH levels recorded during the September 2010 were generally higher than during the February survey. In both surveys there was a decline in the pH as the depth increased with a sharp decline at a depth exceeding 7 meters occurring in the September survey. At a depth exceeding 10 meters the pH level of both surveys were similar. The total dissolved solids recorded in the February 2010 survey showed a distinct increase occuring at a depth of 7 meters.

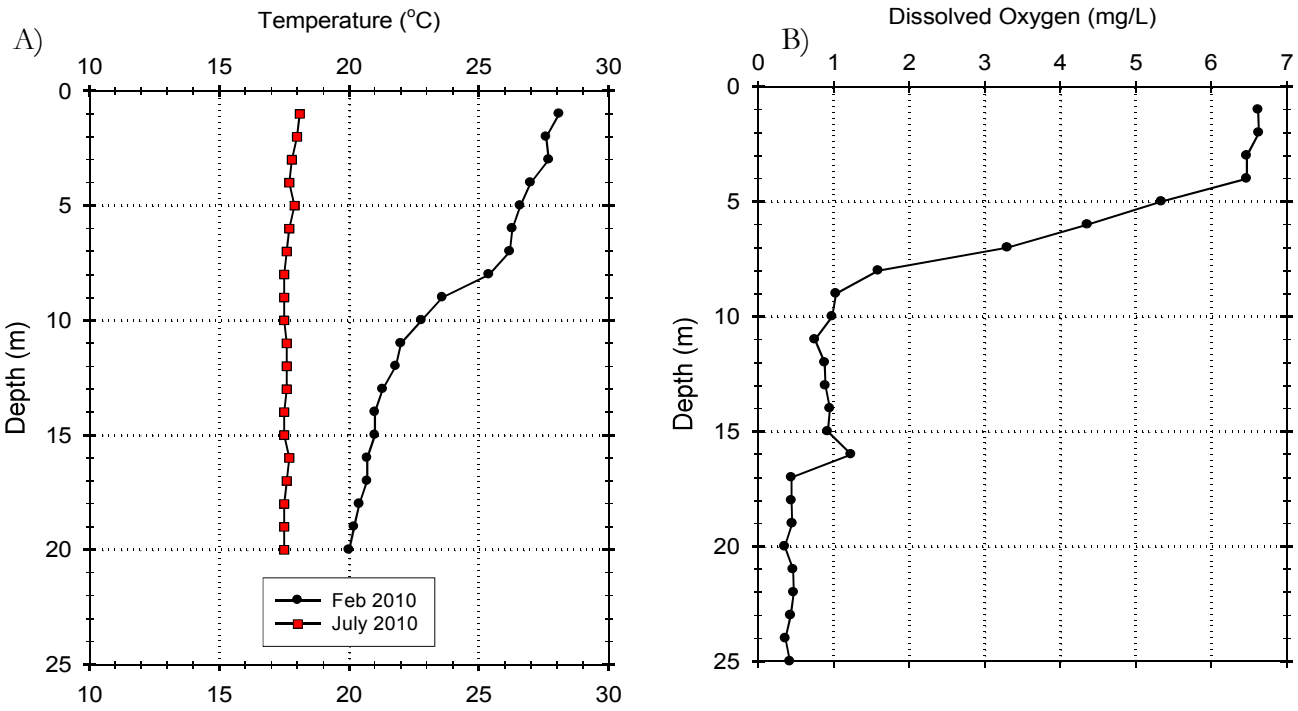

Figure 2: A) The temperature depth profiles observed in February and July2010 at site 1.
B) The dissolved oxygen depth profile in February 2010 at site 1.

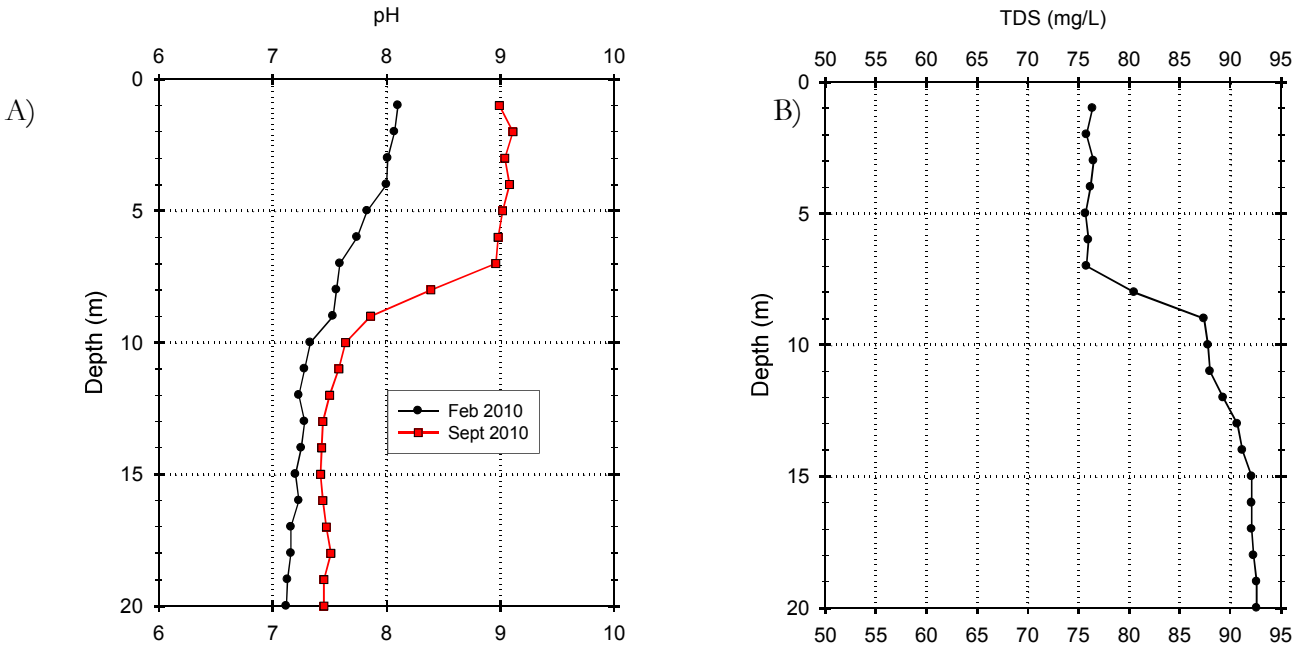

Figure 3: A) The pH depth profile observed in February and September 2010 at site 1 B) The TDS depth profile observed in February 2010 at site 1.

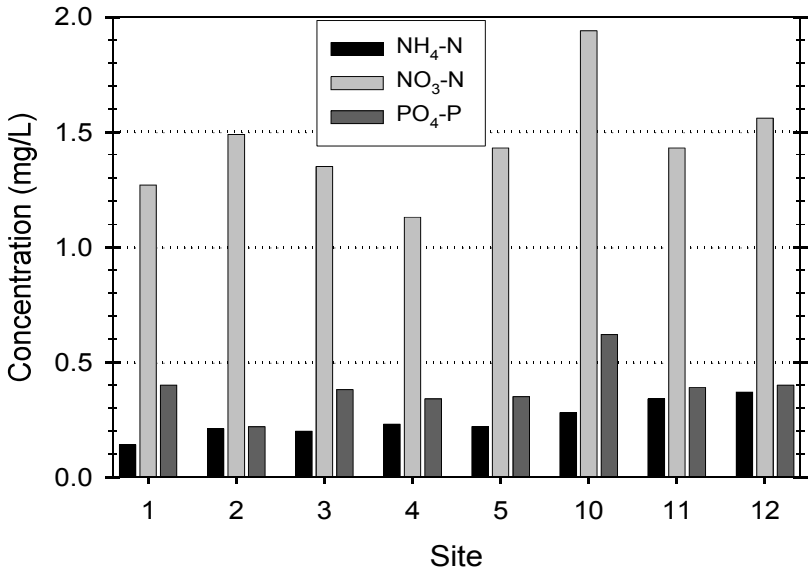

Figure 4: Average concentrations of ammonium, nitrate (including nitrite) and phosphate at sites 1 to 5 and 10 to 12 in the Nandoni Dam during study period September 2009 to November 2010. F

Figure 4 shows that the phosphate and ammonium concentrations were higher at the three inflow sites, sites 10 to 12, that at sites 1 to 5. In addition the nitrate concentrations at site 10 was higher than at sites 1 to 5. In general the chemical water quality of sites 10 to 12 was lower than at sites 1 to 5. A similar trend was observed with regard to the total suspended solids (Figure 5). In addition lower Secchi disc readings were recorded at the inflow sites (Figures 6 and 7). Table 2 shows that pH and TDS values at the inflow sites were different from the sites in the dam and that the values at the latter sites correlated with those recorded at site 1. The oxygen concentrations recorded are also shown in table 2 and the high values recorded at inflow sites should be noted.

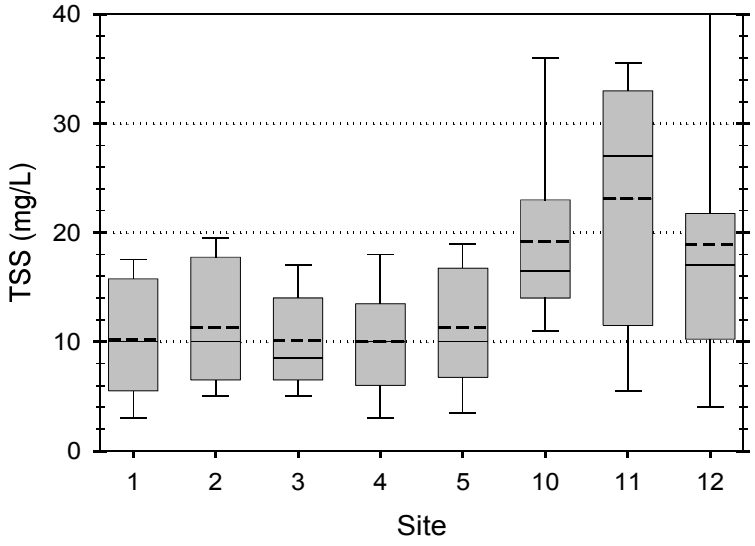

Figure 5: Box plot of Total suspended solids (TSS, mg/L) of sites 1 to 5 and 10 to 12 for the study period September 2009 to November 2010.

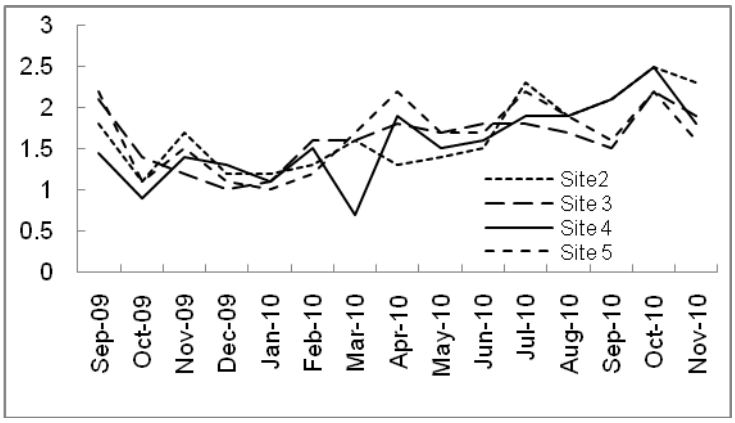

Figure 6: Secchi disc readings (m) at sites 2, 3, 4 and 5, 10 in Nandoni Dam recorded during the period September 2009 to November 2010.

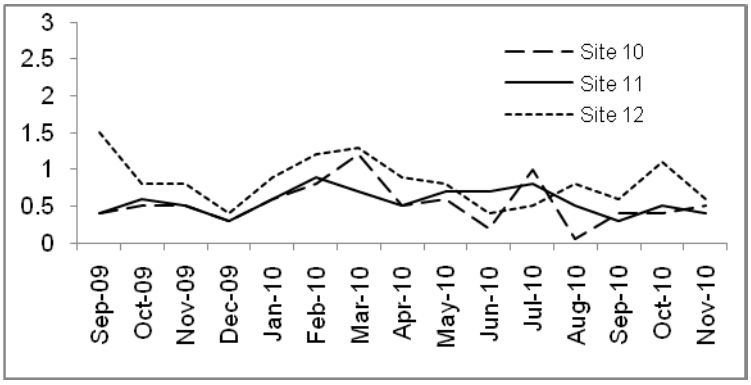

Figure 7: Secchi disc readings (m) at the inflow sites (10,11 and 12) in Nandoni Dam recorded during the period September 2009 to November 2010.

Table 2: The *in situ* parameters measured at sites 2, 3, 4, 5, 10, 11 and 12 in the Nandoni Dam during the period September 2009 to November 2010.

Survey period	Time of survey	Site 2	Site 3	Site 4	Site 5	Time of survey	Site 10	Site 11	Site 12
pH									
Sept	9 – 10	8.73	8.95	8.73	8.81	13	10.3	10.3	9.32
Oct	13 - 14	7.33	8.65	8.63	8.7	12	9.41	8.6	9.16
Nov	16 – 17	8.14	8.24	8.14	8.47	9	8.2	8.3	9
Dec	13 – 14	8.72	8.49	8.73	9.0	12	8.77	9.63	8.84
Jan	16 – 17	8.61	8.6	8.28	8.72	12	9.28	9.45	9.37
Feb	16 – 17	8.29	8.82	8.47	8.24	12	9.12	9.18	9.16
March	14 – 16	7.44	8.47	8.05	8.62	13	9.75	10.3	9.17
April	14 – 16	7.66	7.25	7.45	7.71	15	7.95	7.3	7.4
May	14 - 16	6.75	7.73	6.78	7.17	15	9.02	9.13	8.82
June	14 - 16	7.01	7.36	7.01	7.43	15	9.78	9.74	9.12
July	14 - 16	7.23	8.05	7.14	7.81	15	9.63	9.56	9.5
August	14 - 16	8.22	8.57	8.28	8.12	10	9.04	9.13	8.72
Sept	14 - 16	8.81	7.3	9.14	9.67	12	9.04	9.56	9.46
Oct	14 - 16	8.14	8.66	8.62	8.84	12	9.13	9.84	9.36
Nov	14 - 16	8.27	8.59	8.48	8.48	14	9.46	10.03	9.65
Dissolved Oxygen (mg/l)									
Sept	9 – 10	10.15	9.4	10.15	10.75	13	19.8	19.8	8.01
Oct	13 - 14	8.09	7.59	8.65	8.73	12	13.99	8.88	7.67
Nov	16 – 17	8.09	8.32	7.79	8.02	9	12.7	9	8.23
Dec	13 – 14	8.21	7.62	8.05	9.34	12	9.55	8.96	10.45
Jan	16 – 17	6.34	7.98	6.21	7.98	12	8.08	7.28	9.04
Feb	16 – 17	7.52	7.72	7.6	8.04	12	8.03	9.25	8.7
March	14 – 16	6.59	8.34	7.6	8.02	13	12.74	9.1	10.92
April	14 – 16	7.07	7.86	6.81	7.36	15	7.22	6.9	7.12
May	14 - 16	7.37	8.97	7.04	8.25	15	9.86	8.89	9.6
June	14 - 16	5.42	6.02	5.54	5.86	15	16.9	18.47	15.79
July	14 - 16	8.29	9.55	8.87	8.6	15	15.73	17.52	15.41
August	14 - 16	10.25	10.7	10.51	10.64	10	13.2	13.2	9.79
Sept	14 - 16	9.96	9.49	9.74	9.4	12	12.6	13.12	13.9
Oct	14 - 16	8.83	9.39	9.47	8.75	12	18.46	17.92	17.44
Nov	14 - 16	9.9	9.26	7.91	6.21	14	12.7	12.5	11.3

Table 2 (cont.) : The *in situ* parameters measured at sites 2, 3, 4, 5, 10, 11 and 12 in the Nandoni Dam during the period September 2009 to November 2010.

TDS (mg/l)									
Sept	9 – 10	79.4	79.2	79.5	79.7	13	89.2	85.4	78.0
Oct	13 - 14	81.2	81.5	82.1	82.4	12	88.2	87.3	80.9
Nov	16 – 17	82.8	83.7	82.11	83.5	9	88.2	86.4	80.9
Dec	13 – 14	79.3	78.2	79.1	79.3	12	75.7	75.7	76.5
Jan	16 – 17	77.6	77.6	76.9	77.6	12	73.6	73.3	69.9
Feb	16 – 17	75.7	74.5	75.9	75.4	12	71.3	71.2	66.7
March	14 – 16	69.5	69.3	71.3	69.2	13	68.6	76.5	71.0
April	14 – 16	68.4	67.1	67.8	66.9	15	56.5	57.2	63.4
May	14 - 16	65.1	64.6	64.9	64.6	15	64.1	64.2	62.5
June	14 - 16	68.7	68.4	68.1	67.9	15	65.3	65.2	64.0
July	14 - 16	70.1	69.6	70.0	69.6	15	67.8	67.7	67.9
August	14 - 16	69.8	69.6	69.8	69.5	10	68.4	67.7	68.6
Sept	14 - 16	68.9	69.8	68.9	69.1	12	70.3	74.9	74.4
Oct	14 - 16	69.3	69.7	69.6	69.6	12	75.0	72.1	69.9
Nov	14 - 16	68.7	69.2	69.0	69.8	14	74.3	72.6	72.0

Twelve fish surveys were conducted in September 2009 to November 2009 and from January to August 2010. During these surveys twelve species were collected and figure 8 shows that *Schilbe intermedius* was the most abundant at more than 74 % of the total catch, followed by *Oreochromis mossambicus* at close on 19 % and *Labeobarbus marequensis* at just over 3.5% (Figure 8). Although *S. intermedius* dominated and *O. mossambicus* is prefered by the local fishermen all three species were regarded in this project as potential candidates for a fisheries industry. A total number of 2 350 specimens were collected with the largest number of specimens collected at sites 2 and 4. The number of fish collected at the sites showed seasonal trends (Table 3). It is however of some concern that the numbers of the majority of species declined during the survey.

Figure 9 shows that the fork lengths of the total number of *L. marequensis* collected ranged from 160 to 420 mm and figure 10 shows a typical cyprinid length:mass ratio when a trendline is fitted to a scatter plot. The number of *L. marequensis* collected at the sites differed with majority of specimens collected at sites 2 and 4 (Table 4). The population structure of the specimens collected at site two contained specimens of all the size classes collected with specimens from the 251 to 260mm fork length class dominating at more than 16% of the total of specimens collected. At site 4 no specimens shorter than 220mm were collected and fish of the fork length class 311 to 320 dominated.

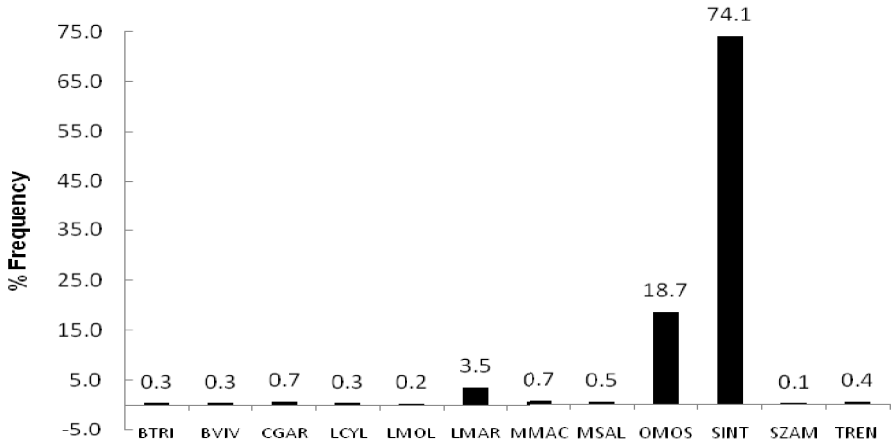

Figure 8: The number of fish, presented as a percentage of the total number, collected at sites 2, 3,4 and 5 in Nadoni Dam during the period September 2009 to August 2010. (BTRI: *Barbus trimaculatus*, BVIV: *Barbus viviparus,* CGAR: *Clarias gariepinus,* LMAR: *Labeobarbus marequensis,* LCYL: *Labeo cylindricus,* LMOL: *Labeo molybdinus,* MSAL: *Micropterus salmoides*, OMOS: *Oreochromis mossambicus,* SINT:*Schilbe intermedius,* SZAM*: Synodontis zambezensis,* TREN: *Tilapia rendalli.*

Table 3: The seasonal trends observed in the number of fish collected at sites2, 3, 4 and 5 in the Nandoni Dam during the period September 2009 to August 2010.

Species	Sep	Oct	Nov	Jan	Feb	March	April	May	Jun	Jul	Aug	Tota
Barbus trimaculatus	1	1	6									8
Barbus viviparus		1	7									8
Clarias gariepinus	1	2	1			3	7		2			16
Labeo cylindricus			1		1	1			3	2		8
Labeobarbus marequensis	5	32	17	7		2		2	5		3	73
Labeo molybdinus		1		1		3						5
Marcusenius macrolepidotus	1	2	7	1					6			17
Micropterus salmoides	3	1	2	1	2	1	1					11
Oreochromis mossambicus	13	101	80	50	95	41	26	11	16	3	8	440
Schilbe intermedius		156	248	262	107	175	654	68	36	11	16	1742
Synodontis zambezensis		1	1									2
Tilapia rendalli			1	1	3	1	2		2			10

Table 4: The number of fish collected in the gill nets at sites 2, 3, 4 and 5 at Nandoni Dam during the period September 2009 to August 2010.

Site no.	Site 2	Site 3	Site 4	Site 5	Total
Total no of fish collected	722	525	660	427	2340
Barbus trimaculatus	3	4	1		8
Barbus viviparus	2	5	1		8
Clarias gariepinus	10	1	4	1	16
Labeo cylindricus	5	2	1		8
Labeobarbus marequensis	41	9	27	6	73
Labeo molybdinus		3	1	1	5
Marcusenius macrolepidotus	8	2	6	1	17
Micropterus salmoides	5	2	4		11
Oreochromis mossambicus	119	168	54	99	440
Schilbe intermedius	524	342	558	318	1742
Synodontis zambezensis			1	1	2
Tilapia rendalli	5	3	2		10
Number of species	10	11	12	7	

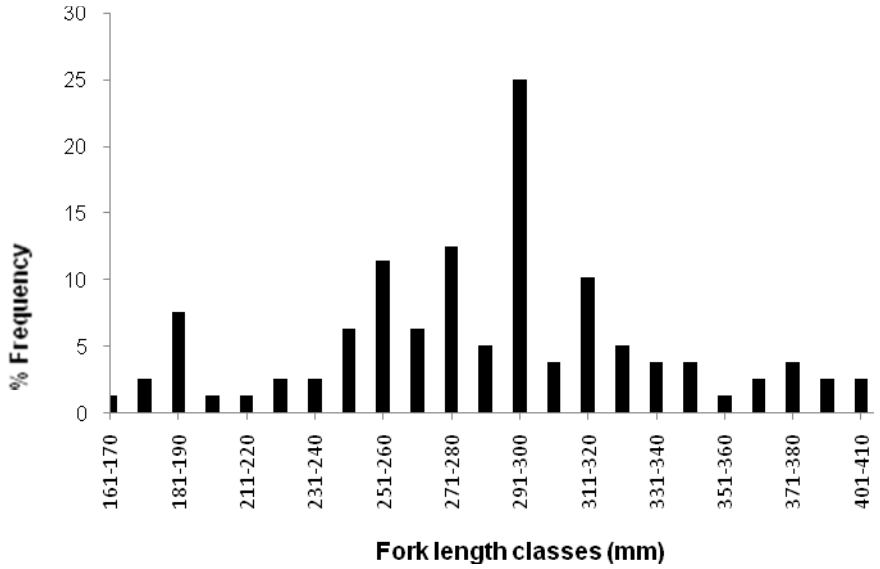

Figure 9: The population structure *of Labeobarbus marequensis* collected during the period September 2009 to August 2010 in the Nandoni Dam.

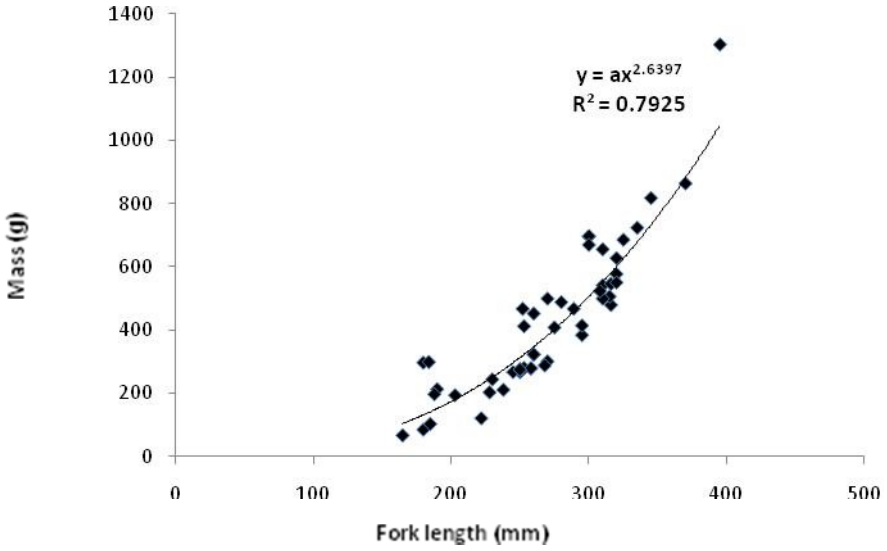

Figure 10: The length mass relationship observed in *Labeobarbus marequensis* collected in the Nandoni Dam during the period October 2009 to August 2010

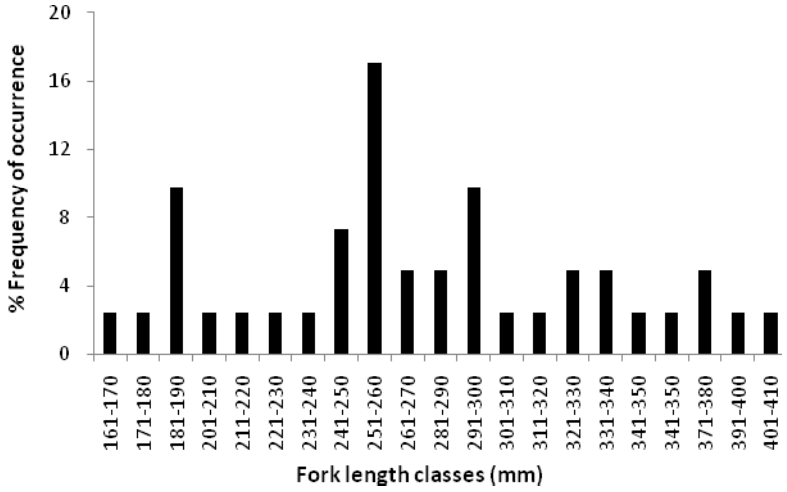

Figure 11: Population structure of *Labeobarbus marequensis* collected during the period October 2009 to August 2010 at site 2 in the Nandoni Dam.

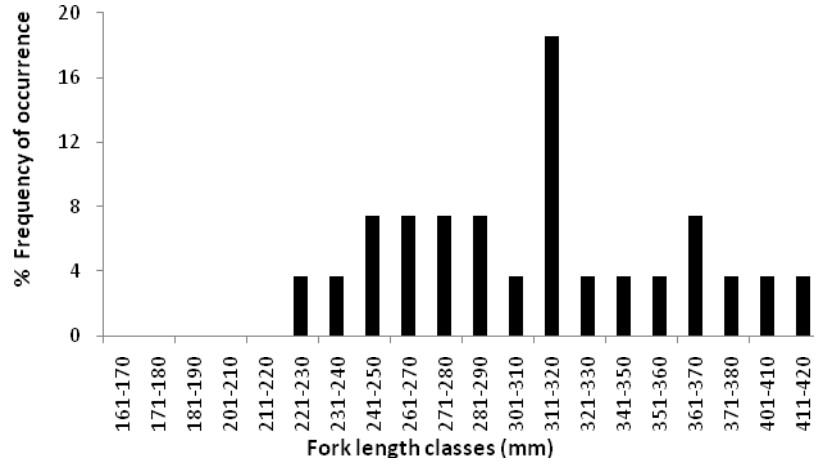

Figure 12: Population structure of *Labeobarbus marequensis* collected during the period October 2009 to August 2010 at site 4 in the Nandoni Dam.

4. Discussion.

Conditions recorded at site 1 showed that some degree of stratification existed during the summer survey. The radiant energy that is absorbed by the water is converted into heat energy, and this is stratified in the water-column, being greatest at the surface. This heating and in particular the temperature strarification and turnover, as was observed in the winter survey, are among the most fundamental features of the aquatic environment. As was shown in the results definitive oxygen stratification was observed at the site. The high oxygen in the surface layer can ascribed to photosynthesis by algae and gas exchange with the atmosphere. This oxygen is well mixed condition in the upper 5 m. The low oxygen in the layer below 10 m can be ascribed to high rates of decomposition of organic material and poor mixing conditions. Oxygen is essential for all forms of aquatic life, including those organisms responsible for the self-purification processes in natural waters. In unpolluted surface waters, dissolved oxygen concentrations are usually close to saturation. Dissolved oxygen concentrations below 5 mg/ℓ can be described as hypoxic conditions and cause physiological stress in fish and invertebrates. Depletion of oxygen in deep waters, as was observed at site 1, indicates the onset of anoxia which results in the re-mobilisation of phosphorus and other elements from lake sediments..

The pH of an aquatic ecosystem is important because it is closely linked to biological productivity. Although the tolerance of individual species varies, pH values between 6.5 and 8.5 usually indicate good water quality and this range is typical of most major drainage basins of the world. The pH values in the surface water at site 1 ranged between 8 and 9 (Figure 3A). These high pH values are probably due to high photosynthetic activity by phytoplankton which in this case consists of the microscopic free-floating algae. Phytoplankton assimilates carbon dioxide that lowers the carbonic acid and consequently increases the pH values. The relatively low pH values in the deeper layers at site 1 are ascribed to the decomposition of organic matter that release CO_2 and formation of carbonic acid that result in lower pH values. The high pH values recorded at sites 10 to 12 which in many instances exceeded a value of 9 and sometimes exceeded 10 is a clear indication of problems, such as algal blooms, that exist in these rivers. The possibility of looming algal blooms is supported by the high oxygen levels that were recorded at these inflow sites.

The type and concentration of suspended matter controls the turbidity and transparency of the water. Suspended matter consists of silt, clay, fine particles of organic and inorganic matter, soluble organic compounds, plankton and other microscopic organisms. The total suspended TSS is a measure of the amount of material suspended in water. Generally an important feature of many South African reservoirs is the high turbidity caused by the presence of suspended silt. However, the TSS in the surface water of sites 1 to 5 in the Nandoni Dam was relatively low with mean values that ranged between 10 and 12 mg/ℓ. The sites at the inflow, sites 10 to 12, had higher values with mean TSS values that ranged between 19 and 23 mg/ℓ (Figure 6). These values can be regarded as low and to some extent are comparable to a clear water system like Katse Dam. The low TSS concentrations at sites 1 to 5 resulted in deep light penetration with Secchi disc readings that ranged between 1 and 2.5 m. This creates a favourable underwater light climate, or euphotic zone, for normal algal growth. Water bodies that have high transparency values typically have good water quality. The higher TSS concentrations recorded at sites 10 to 12 are responsible for the low Secchi disc readings, that were in general less than 1m, recorded at sites 10 to 12.
Salinity is an indication of the concentration of dissolved salts in a body of water. At site 1 the total dissolved salt (TDS) concentrations were relatively low in the upper layer, with a mean of 76 mg/ℓ . This comparable with unpolluted systems, however, the TDS increased significantly below 7 m. The high TDS in the layers is ascribed to mineralisation of organic matter and a build-up of salts because of poor mixing (Figure. 3B). Although a TDS concentration less than 195 mg/ℓ is generally considered to be acceptable for all the major uses of water, increased values can indicative of pollution that is occurring. At the inflow sites, and in particular at site 10, high values similar to those in the deeper layers of site 1 were recorded. These high levels could result from upstream pollution. At sites 2 to 5 TDS values similar to the upper layer of site 1 was recorded.

Nutrients are elements essential to life and inorganic nutrients provide the chemical constituents on which the entire food web is based. Ammonia arises mainly from the breakdown of nitrogenous organic matter in the system. In addition ammonium is a common pollutant and one of the nutrients that contribute to eutrophication. Ammonia (NH_3) is also toxic to many organisms and in particular fish. The average ammonium nitrogen (NH_4-N) concentrations at sites 1 to 5 ranged between 0.14 and 0.23 mg/ℓ and these are within acceptable levels. However, the ammonium concentrations at the inflow sites were significantly higher and ranged between 0.28 and 0.37 mg/ℓ which is within the tolerable range. The average nitrate concentrations at sites 1 to 5 ranged between 1.13 and 1.49 mg/ℓ which is regarded to be within an acceptable range, which falls below 1.50 mg/ℓ. However, the inflow concentrations were higher and ranged from 1.43 – 1.94 mg/ℓ and falls within the tolerable range (>1.50 mg/ℓ). The phosphate concentrations at all the sites were very high and ranged 0.22 and 0.62 mg/ℓ which places them in the unacceptable range with values higher than 0.125 mg/ℓ. The high concentration of 0.62 mg/ℓ at inflow site 10 indicates serious pollution at this point that could lead to eutrophic conditions in Nandoni Dam. The sources of pollution should be traced. Phosphorus and nitrogen are considered to be the primary drivers of eutrophication of aquatic ecosystems, where increased nutrient concentrations lead to increased primary productivity and algal blooms.

Although *L. marequensis* is only the third most abundant species in the dam and the numbers are low the population structure, particularly at site 2, is healthy with specimens in the majority of the size classes. The population structure is typical of specimens found in dam and agrees with the findings of previous studies by Gaigher (1969), Fouché *et al.* (2005) and Fouché (2009) who indicated that the large specimens of *L. marequensis* were usually present in deep slow flowing water and smaller specimens in fast flowing shallow water. The absence of specimens with fork lengths shorter 160mm might be of some concern but could partly be ascribed to the mesh sizes

of the nets used where the smallest stretched mesh size used was 28 mm and site selection. Surveys by Fouché (2009) have identified sites upstream of the dam in both the Luvuvhu and Dzindi Rivers (Figure 13) where specimens with fork lengths shorter than 160 was abundant (Table 5).

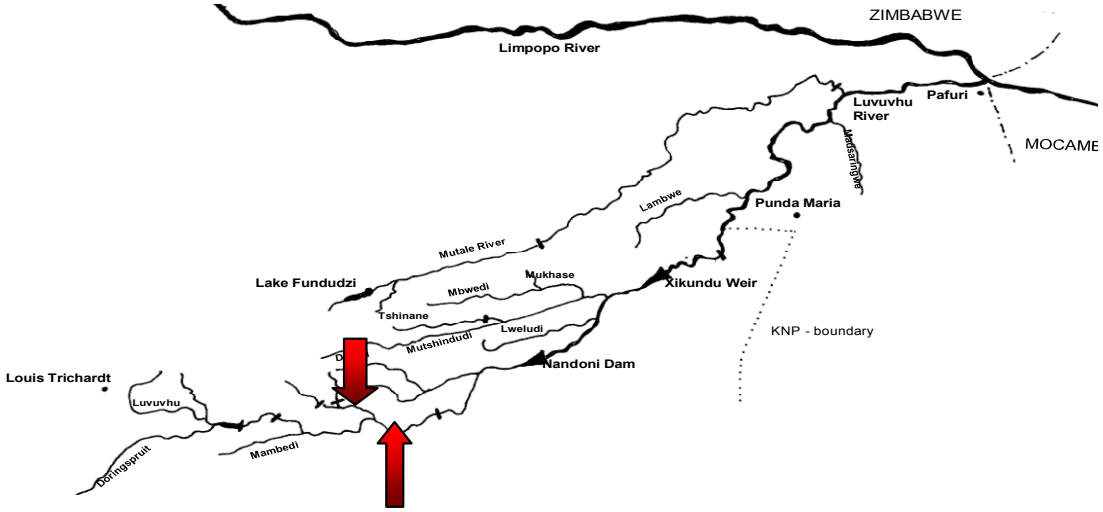

Figure 13: A sketchmap of the Luvuvhu River and tributaries where the *L. marequensis* breeding sites at Tshino and in the Dzindi River are indicated (Adapted from Fouché, 2009). The arrows point at the breeding sites.

Table 5: Presence of specimens of the different stanzas *Labeobarbus marequensis* collected in the period July to October 2007 in the identified "areas" related to breeding at two sites in the Luvuvhu River system (Adapted from Fouche, 2009). The abbreviations for the hydraulic biotopes are: B = breeding area, RI = riffle, RA = rapid, SP = shallow pool, P = pool. The stanzas identified are: 2 = 51 – 80mm, 3 = 81 – 100mm, 4 = 101 – 120mm , 5 = 121 – 150mm, 6 = 151 – 200mm. Stanza 1 was subdivided in J_1 = 11 - 20mm, J_2 = 21 – 30 mm and 1 = 31 – 50mm.

Site name	Velocity depth class	Hydraulic Biotope	July 2007	August 2007	Septembe r 2007	October 2007
Tshino (Luvuvhu River)	SS	**B**				J_1
	FS	RI				2
	FS	RI			J_2, 1	
	FS	RI	J_2, 1			
	FS	RA	J_2, 1	1,2		
	SS	SP		J_2	J_2, 1	
Crocodile Ventures (Dzindi River)	SS	**B**		J_2	J_2	
	FS	RI	1,2		2	J_2
	SS	SP	1,2		1	
	FD	RA	2		1	2
	FS	RI	1,2		1,2	
	SS	**B**		1		J_2
	SD	P			6	3,5,6
	SS	**B**	J_2, 1			

5. Conclusions

The surface water in Nandoni Dam was well oxygenated, however, very low oxygen concentrations (<1 mg/ℓ) prevail in the deep waters (depths more than 10 m). Oxygen is required for the metabolism of aerobic organisms, and it influences inorganic chemical reactions. The surface water in Nandoni Dam were characterised by low dissolved salts (mean, <100 mg/ℓ) and low suspended solids (mean, <12 mg/ℓ), thus a favourable underwater light climate for algal growth.Decomposition of organic material at the lake bottom waters resulted in low oxygen and pH levels and relatively high salt concentrations. The nutrient concentrations were generally acceptable; however, the very high phosphate concentrations at the inflow sites is a matter of concern and could lead to cyanobacterial blooms. Toxic blooms pose a serious threat to human health and aquatic biota. The inflow sites (10, 11 & 12) show generally poorer water quality, especially site 10 that contribute to nutrient enrichment of the dam.

6. Acknowledgements.

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SUSTAINABLE UTILISATION OF ANGLING RESOURCES IN THE PONGOLAPOORT DAM, WITH SPECIFIC REFERENCE TO THE HEALTH OF SELECTED SPECIES

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INTRODUCTION

Conservation of natural aquatic systems of South Africa can only be achieved through the proper management of our aquatic biodiversity. Included in this management, and in many cases depending on it, is the sustainable utilisation of natural resources through non-destructive system utilisation practices, which offer sufficient social and economic returns to the stakeholders. A management plan for sustainable utilisation can only be successful if it is based on sound scientific data.

The health of organisms that reside in a system can indicate the overall health of that system (Adams et al*.,* 1993). Fish in general, and fish that are higher up on the food chain in particular, can be useful indicators of the health of a particular system (Adams et al*.,* 1993). The fish's position on the food chain allows for the effects of secondary chronic symptoms to be shown (Adams et al*.,* 1993). Fish in their natural environment are always subjected to various stressors such as low dissolved oxygen, temperature fluctuations, increased sediment load and limited food availability. The addition of anthropogenic impacts (such as water extraction, sewage treatment, and mining activities) to the system will only increase the stress that the fish are under which will ultimately affect the health of the fish (Adams et al*.,* 1993). When an organism is under stress, energy is required to deal with that stress and therefore energy is diverted away from primary functions such as growth and reproduction and is used to deal with the stress effects (Adams et al*.,* 1993). Depending on the severity of the stress the fish may not be able to cope and will show signs of the effects of stress such as diseases, reduced growth and limited reproduction, as well as being prevented from withstanding other additional stresses (Adams et al*.,* 1993).

The Pongolapoort Dam is located near the town of Jozini in northern KwaZulu-Natal. It is one of the few places in South Africa where one can angle for the tigerfish *Hydrocynus vittatus*. The Pongolapoort Dam is surrounded by the Pongola Game Reserve and many fishing lodges and hunting camps. The town of Pongola receives 517 mm of rainfall annually, with the majority of the rainfall falling in the summer months. Pongola receives the highest rainfall in January and the lowest in June. The average midday temperature coincides with the average rainfall figures, with January being the hottest month with an average temperature of 31°C, and June and July the coldest months of the year with an average temperature of 24°C. The dam was planned to supply irrigation water to 40 000 to 50 000 hectares of farm land. Apart from boosting the farming potential in the surrounding area, the then government hoped to stabilise the frontiers bordering Mozambique and Swaziland.

Recreational fishermen target two main species of fish in the Pongolapoort Dam, the first being the tigerfish, *Hydrocynus vittatus,* which belongs to the family Alestidae. This popular angling species are often described as voracious and fierce predators that prefer warm, well-oxygenated water of major African rivers and lakes such as the Zambezi River flowing into Lake Kariba. In South Africa they occur in the east-flowing rivers such as the Olifants, Letaba and the Luvuvhu Rivers with the Phongolo River flowing into the Pongolapoort Dam and the Phongolo floodplain making up the most southern population of *H. vittatus* (Gagiano, 1997; Skelton, 2001). In South Africa, *H. vittatus* has been placed on the threatened and protected species (TOPS) list

by the Department of Environmental Affairs and Tourism (DEAT, 2007). This was probably largely due to the population decline due to pollution, water extraction and the construction of dams and weirs (Steyn et al., 1996). The construction of dams and weirs prevents the movement of fish downstream during the colder months and the return to the spawning areas during the warmer months.

The second highly targeted species is the sharptooth catfish, *Clarias gariepinus*, which is a member of the Clariidae, The Clariidae represents the African and Asian catfishes. *Clarias gariepinus* is probably the most widely distributed fish in Africa (Skelton, 2001). *Clarias gariepinus* is completely omnivorous and can consume any organic matter as well as being excellent scavengers and will hunt for food, even capable of hunting in packs, herding and trapping smaller fish species. The diet of *C. gariepinus* consists of fish, frogs, small birds and reptiles, snails, crabs and shrimps, and are even able to sieve plankton if necessary (Skelton, 2001).

The aim of the study was to determine the health status of the two major angling species from the Pongolapoort Dam using the Fish Health Assessment Index (FHAI) and a Histology Based Health Assessment Index.

MATERIALS AND METHODS

Fish sampling and necropsy procedures

Fish were sampled during the course of 2009 and 2010 (Ezemvelo KZN Wildlife Permit Number 4896/2008), and were captured using standard recreational angling techniques. Live fish were transported in 96 ℓ aerated Coleman cooler boxes to a nearby field laboratory within 1 h after capture and anaesthetised with a 32 mg/ℓ solution of clove oil (1:9 ratio clove oil mixed with ethanol) (Anderson et al., 1997; Meka and McCormick, 2005). Each specimen was weighed (total weight) and the total, standard and fork lengths were recorded. These measurements were used to calculate a condition factor (Carlander, 1969) for each specimen.

Blood (2 mℓ) was collected from the dorsal aorta at the posterior region of the lateral line using a sterile 38.1 mm, 21 gauge needle and a 1 mℓ syringe. Blood samples were transferred to 4 mℓ heparinised vacutainers and centrifuged at 3 000 $r \cdot min^{-1}$ for 15 min. Plasma was transferred to 2 mℓ cryo-tubes and stored in liquid nitrogen prior to the total plasma protein determination. The plasma samples were prepared using a total protein kit (Roche) and analysed in triplicate using a universal micro-plate reader (Biotek micro-plate reader, 540 nm wave lengths). Blood was also collected in capillary tubes and centrifuged for 10 min at 3 000 $r \cdot min^{-1}$ for the determination of the haematocrit and leukocrit.

Each fish was examined macroscopically to identify any external abnormalities, ecto-parasites, and injuries. Anaesthetised fish were sacrificed by severing the spinal cord anterior to the dorsal fin (procedure approved by the Ethics Committee, Faculty of Science, University of Johannesburg, 2009).

Tissue sampling for histology

Gill, liver, and kidney samples were fixed in 10% neutrally buffered formalin solution for 48 h and the testis and ovary samples were fixed in Bouins solution for 24 h. Following fixation samples were washed in tap water and dehydrated in a series of increasing ethanol concentrations (30% - 50% - 70%). The tissue samples were prepared for histological analysis using standard techniques (Humason, 1962). Samples were stained with haematoxylin and eosin (H&E) using a rapid H&E staining protocol (Van Dyk et al., 2008).

Histological analysis

Samples were analysed with the aid of light microscopy (Leica DMLS – ICCA Leica Microsystems, Shanghai, China). A semi-qualitative histological assessment protocol (Van Dyk et al., 2009a), adapted from Bernet et al. (1999), was used to quantify histological alterations observed in the selected target organs. Histological alterations were assessed according to five reaction patterns: circulatory disturbances (CD), regressive changes (RC), progressive changes (PC), inflammation (I) and tumours (T). The semi-quantitative results were used to calculate a

Liver Index (I_L), Gill Index (I_G), Kidney Index (I_K), Testis Index (I_T) and/or Ovary Index (I_O) for each specimen. These index values were used to classify the severity of the histological response using the Van Dyk et al. (2009a) classification system which is based on the scoring scheme by Zimmerli et al. (2007).

- Class 1 (Index <10) Normal tissue structure with slight histological alterations
- Class 2 (Index 10 – 25) Normal tissue structure with moderate histological alterations
- Class 3 (Index 26 – 35) Pronounced alterations of organ tissue
- Class 4 (Index >35) Severe alterations of organ tissue

RESULTS

Blood parameters, necropsy, HAI and gross body indices

Mean total plasma protein levels for the tigerfish was 60.4 ± 10.4 mg·dℓ^{-1} for 88.5% of specimens were within the normal range of 30 mg·dℓ^{-1} – 69 mg·dℓ^{-1} while 11.5% of the samples were above (≥70 mg·dℓ^{-1}). Mean total plasma protein levels for the sharptooth catfish were 60.7 mg·dℓ^{-1} ± 23.5 mg·dℓ^{-1} but the values were within the normal range.

Normal range for mean haematocrit levels is 30%– 45%. Sixty percent of the tigerfish samples fell within this range, while 8.3% of the samples were above (>45%) and 31.7% of the samples were below. The haematocrit value for the sharptooth catfish all fell within the normal range. The leukocrit levels of both the tigerfish and the sharptooth catfish were below 4.0% which is considered normal.

External macroscopic abnormalities were also identified in tigerfish. Skin aberrations were visible in 17.2% of the samples. Fins of 13.3% of specimens had mild active erosion but with no haemorrhage or infection present. 8.3% of fish had discoloured gills. No external abnormalities were identified for the eyes, however the 3.7% of the samples had opercula damage. A macroscopic investigation of the visceral organs showed focal discolouration of the liver in 26.6% of fish and 4.7% of the sample group had inflamed kidneys, while the spleen and hindgut had no visible macroscopic abnormalities.

External abnormalities that were identified in the sharptooth catfish included fin erosion (16.0%) and skin lesions (5.0%). One specimen appeared to be blind in one eye. The macroscopic examination of the visceral organs showed fatty livers in 21.0% and discolouration of the liver in 16.0% of the fish. Kidney abnormalities observed included swollen kidneys (21.0%) and the presence of parasitic cysts in the anterior region of the kidney (10.5%). Enlarged spleens (< 0.23%) were recorded in 5.2% of the samples.

Tigerfish histopathology

Liver histopathology

Liver alterations identified included intercellular oedema, granular degeneration of the cytoplasm, vacuolation within hepatocytes, pleomorphism of the hepatocyte nuclei and foci of lymphocyte infiltration. Regarding the cytoplasmic characteristics of the hepatocytes, 83.0% had eosinophillic cytoplasms and the remaining 17.0% had granular cytoplasms. The tigerfish liver samples fell within Class 1.

Kidney histopathology

These included dilation of the glomerulus capillaries and vacuolation and hyaline droplet degeneration of the renal tubule epithelium. The mean Kidney Index (I_K) fell within Class 1.

Gill histopathology

The gills were more affected compared to the other organs in terms of the number of alterations observed. Alterations identified included telangiectasia of the secondary lamella, congestion, rupture of pillar cells and hyperplasia of the gill epithelium. The gills had the highest number of abnormalities compared to the other organs. Although the mean I_G fell within Class 1.

Sharptooth catfish histopathology

Liver histopathology

The liver samples showed macrovesicular steatosis (26%), melano-macrophage centres (MMCs) (84%), nuclear pleomorphism (11%) and glycogen-type vacuolation (16%). The mean Liver Index (I_L) fell within Class 2

Kidney histopathology

The kidney samples showed vacuolation (32%) and eosinophilic cytoplasm (16%) of the renal tubules, an increase in the number of MMCs (79%) and an increase in the Bowman's space (21%) The mean Kidney Index (I_K) was classified as Class 1

Gill histopathology

The alterations identified in the gills included telangiectasia (31%), epithelial hyperplasia (84%), branching of secondary lamellae (16%) and 5.2% of the gill samples exhibited fusion of the secondary lamellae. The mean Gill Index (I_G) fell within Class 1.

Testis histopathology

The histological assessment showed that MMCs were present in 46% samples but only 5.2% showed an increase in these structures. The mean Testis Index (I_T) was placed in Class 1.

Ovary histopathology

The only histopathological alteration identified in the ovaries was the presence of MMCs in 67% of the samples. None of the samples were noted to have an increase of this histological alteration. The mean Ovary Index (I_O) for were within Class 1.

Conclusion

In terms of the parameters assessed for this study, the results showed no major external abnormalities of the fish and/or macroscopic lesions of the selected target organs. The semi-quantitative histological assessment of the selected target organs also showed no severe cellular alternations. According to the classification system used, the organ indices of the tigerfish and the sharptooth catfish from the Pongolapoort Dam fall mainly in Class 1, indicating normal tissue structure with slight histological alterations.

South Africa is a country with scarce water supplies and it is imperative to conserve all water bodies and protect them against anthropogenic effects. South Africa has a social and legal responsibility not to pollute the water in the dam as it flows into our neighbouring states and into the Phongolo floodplain. The Pongolapoort Dam is home to a threatened and protected species, the tigerfish, and local communities use the dam for drinking water and food production. It is therefore important to monitor the Pongolapoort Dam to ensure that it is kept in a healthy state for all stakeholders.

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HOW CAN ANGLING CATCH DATA INFORM THE DEVELOPMENT AND APPROPRIATE MANAGEMENT OF OUR RECREATIONAL FISHERIES?

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Introduction

The management of any fishery typically involves the development and enforcement of regulations aimed at protecting the resources of the fishery such that sustainable exploitation is achieved (Zabel et al., 2003). Fisheries management relies on data collected by scientists which is then used to formulate recommendations based on population assessments as well as through investigation of factors affecting survival and growth of these populations (Smith et al., 1999). These recommendations are then passed on to decision-makers who implement regulations and associated policies for the fishery, often but not always after consultation with the fishery resource users (Jentoft, 1989).

This classical approach to fisheries management, which is commonly implemented in commercial fisheries, has limitations where the appropriate management of inland recreational fisheries is concerned. As it requires data collected through scientific survey methods e.g. gill- and seine nets, electrofishing, it is often logistically unfeasible to investigate large numbers of recreational fisheries which are located over a wide geographical area. Furthermore, such surveys can lead to conflict with recreational anglers who, no matter the benefits to the fishery that may arise from scientific assessments, view certain survey methods, in particular those leading to the death of individuals, as detrimental to their fishery. Additionally, while information provided by direct population assessments is very important in informing management decisions for any fishery, it should not be the only criteria by which fisheries are developed and subsequently managed (Pomeroy and Berkes, 1997). In South Africa there is a lack of knowledge regarding different user groups and their interests in inland fisheries which is compounded by the fact that there is currently no institutional framework or policy governing the use and management of inland fisheries (Weyl et al., 2007; McCafferty et al., 2010). Recent developments have seen the inland fisheries function transferred to the Department of Agriculture, Forestry and Fisheries (DAFF) which implies increased efforts to develop South African inland fisheries to achieve national policy objectives such as food security and poverty alleviation. However, this process is not without complication as existing information on whom uses these resources, when and how they are utilised is limited and the relationships between different sectors e.g. recreational and subsistence fishers is ill-defined (Weyl et al., 2007; Ellender, 2009; McCafferty et al., 2010). These factors are crucial in developing management protocols which are in the interests of the resource users yet are often not considered when purely scientific survey information is utilised.

A more comprehensive approach to managing recreational fisheries should include information provided by the user groups i.e. the anglers themselves and this is often available in the form of competition catch records. The following paper aims to describe the relevance of angling catch records for future development and management of South African inland recreational fisheries.

Freshwater Recreational Angling in South Africa

Recreational angling in South Africa can be broadly subdivided into two categories: the formal sector, which comprises individuals/members affiliated to or belonging to an organised body such as a club, and the informal sector that comprises social anglers that are not linked to any organised body (Leibold and van Zyl, 2008; John Pledger, President, South African Sport Anglers and Casting Confederation SASACC). The formal sector is multi-faceted and highly organised (see figure 1). The activities of formal anglers affiliated to organised angling bodies are quantifiable and therefore allow for scientific investigation. It is the highly structured nature of organised angling which provides a framework by which information can be disseminated to scientists – information in the form of catch records from organised angling competitions. Catch records provide a highly useful source of data which is available for a wide variety of dams across South Africa, often over several seasons, and is often highly accurate due to the competitive nature of organised angling events. This information can form a valuable part of contextualising existing fishery resource use in South Africa, providing answers as to which dams and which species are important to the sport and therefore influencing future decisions regarding the management of recreational fisheries.

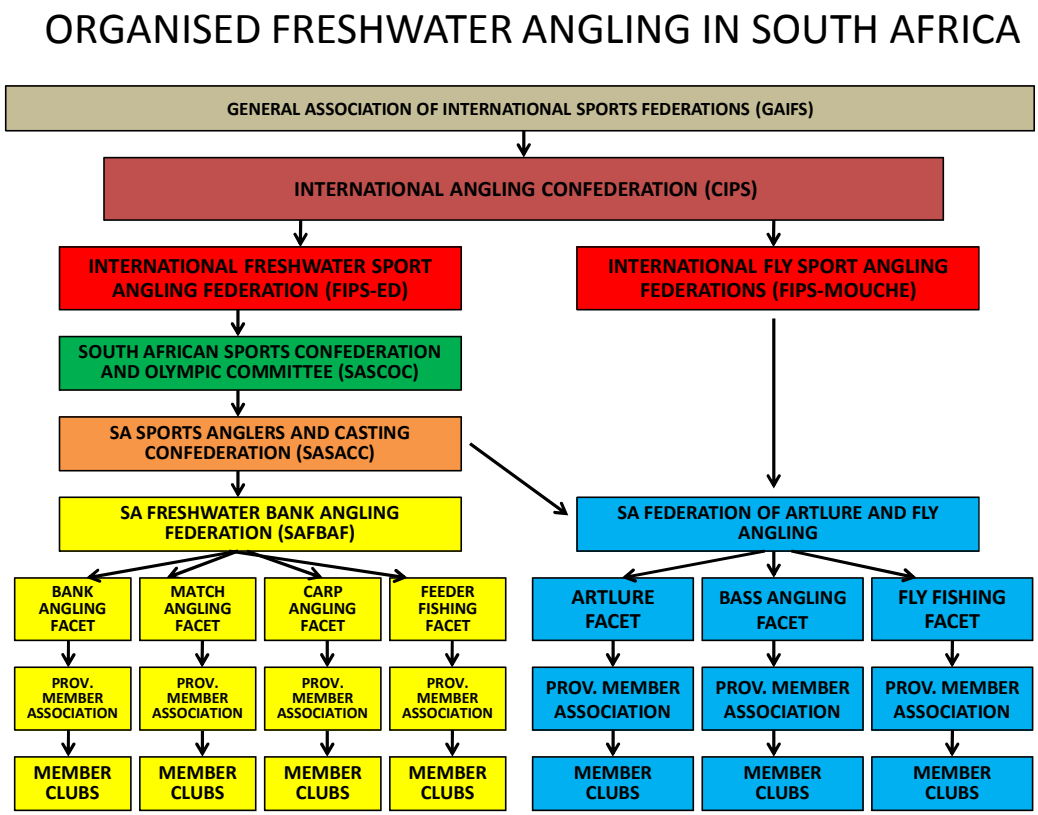

Figure 1: Structure of organised freshwater angling in South Africa (adapted from South African Sport Anglers and Casting Confederation (SASACC) Constitution: Annexure B).

Ranking Important Recreational Fisheries

Angling catch records provide an indication of the level of use of different impoundments. The frequency with which angling competitions are held on a particular body of water indicate its importance to the recreational angling sector (Dr. Ernst Swartz, South African Institute of Aquatic Biodiversity, *pers. comm.*., 2010). In addition, the level of competition at which the events are held – be they club, provincial, national – provide an indication of that fishery's importance. A dam which supports high-tier competitive events is of higher importance to the sector than a dam which supports fewer, lower-tier competitions. With catch records we can therefore formulate indices which rank the importance of different dams to recreational anglers, an important process given the DAFF development mandate.

Catch records can also be used to highlight the importance of different species to the recreational sector by providing information on which species are targeted most frequently, and in which fisheries these species are most commonly targeted. This is of importance given DAFF's conservation mandate – if a species does fall under the DAFF directive; management needs to consider whether the current recreational utilisation of the species is sustainable (McCafferty et al., 2010). Information regarding important angling species can then be linked to important angling dams – if a species is a significant target of a recreational fishery on an important angling dam, should management not be geared towards maintaining existing fishery resource use instead of a drive for development of a harvest-based fishery to achieve policy objectives such as food security?

Catch Data and Fisheries Development

Assessing the potential of different dams for various levels of development typically involve the use of empirical models which allow the scientist to obtain an estimate of potential fish yield in the absence of fisheries survey data (Ryder, 1965; Oglesby, 1977; Matuszek, 1978). These estimates have great potential in determining if a dam is productive enough to develop a fishery. There are several empirical models, the most oft-cited of which is the morpho-edaphic index (MEI) – a simple calculation by which the mean depth of an impoundment is divided by the measured total dissolved solids (TDS) (Ryder, 1965). Given the nature of organised angling which is conducted on a number of impoundments over a wide geographic scale, obtaining such parameters is logistically unfeasible. For the purposes of determining the potential of fisheries situated over a large area, it is therefore necessary to select a model which incorporates easily obtainable parameters. An empirical model which utilises the more readily obtainable parameters altitude, rainfall, and surface area has achieved >80% success in predicting fish yield from an impoundment (MRAG, 1995). These predictions of yield can then be tested through correlation with catch rates calculated from angling catch records. Catch rate is determined by estimating catch-per-unit effort (CPUE) indices i.e. the number of fish caught by an angler over a certain time period. If a correlation is observed between the *predicted* fish yield as calculated by the empirical model and catch rates recorded by anglers, the predictive yield model can then be applied to dams which have similar rainfall, altitude and surface area parameters. Therefore, the development potential of different dams which do not currently support fisheries can be investigated in the absence of direct scientific survey methods or angler catch records based on a prediction of potential fish yield.

How does fisheries development proceed from here?

The development of a new fishery on an impoundment needs to take into account several factors:

- Is there any current utilisation of the resource? In order to avoid conflict, information concerning existing resource users and the nature of their utilisation needs to be incorporated into future development plans. For example, a proposed recreational fishery

on an impoundment may be in conflict with a group of subsistence fishermen who utilise the resource (McCafferty et al., 2010; Weyl et al., 2010).

- What species are present in the impoundment? Development needs to consider the trade-off between developing a recreational or harvest-based fishery and, in cases where an impoundment supports populations of valued recreational fisheries, objectives for the fishery need to be viewed in light of the benefits that may arise from a recreational fishery e.g. tourism and job creation or a harvest-based fishery e.g. food security (Weyl et al., 2010).
- Are there any endangered species within the impoundment? This is of obvious importance from a conservation perspective and should influence development decisions. If a dam supports an endangered species a harvest fishery may be unsustainable and development may favour a recreational catch-and-release based fishery.
- The National Environmental Management: Biodiversity Act (NEM:BA). This is an important piece of legislation which places constraints on the harvesting/stocking of different species in different areas. The zones outlined in the NEM:BA may limit the development of recreational fisheries depending on the species concerned e.g. the development of a trout fishery may not be legal if fish are stocked into a water body outside of the zones delimited by this act (Swartz, 2009).
- Level of infrastructure. Fisheries development should consider factors such as the distance of a dam from human settlement and its surrounding facilities. If a dam is isolated and located far from a community, development could favour a recreational fishery – anglers are often prepared to travel long distances for good angling. Conversely, if the dam is surrounded by a rural community decisions regarding its development need to be carefully considered in order to avoid conflict – the interests of local people need to be considered in development plans (Weyl et al., 2010).

To conclude, increasing pressure to develop fisheries in order to achieve national policy objectives means there is a need for recreational anglers to provide information, in the form of competition catch records with which scientists can determine current utilisation practices, predict the potential of different dams for fisheries development, and provide management recommendations which take the interests of anglers into account.

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REPORT ON THE AQUATIC CONSERVATION MEETING – FRIDAY MORNING SESSION

AIM:
A meeting was arranged to discuss aquatic conservation priorities and to investigate the available capacity within Provincial and National Conservation Departments to implement conservation measures required to conserve these national assets. The meeting was convened and chaired by Pierre de Villiers from CapeNature.

SUMMARY OF PROCEEDINGS
Aquatic Conservation Priorities
The meeting was started with a round of introductions. Representatives from all the Provincial Conservation Departments were present while representatives from the National Department of Water Affairs and South African National Parks Board were also present. Various research institutions were represented as well as the South African Institute for Aquatic Biodiversity (SAIAB).

It was noted that the South African National Biodiversity Institute (SANBI) in association with SAIAB and stakeholders was in the process of developing a national list of priority aquatic conservation areas. While this was accepted as a great process it was noted that the actual conservation of these aquatic priorities would need to take place at a local level. In many cases Provincial Conservation Departments will actually carry out the conservation initiatives. It was noted that partnerships between the various Authorities and Research Institutions and NGOs was possible.

Available capacity
It was noted that in most instances there was only a single aquatic Scientist or Manager responsible for aquatic conservation in each Province. Water resources within the country's borders and their associated habitats form part of functional riverine systems that support South African society. The fact that there is very little capacity available to actually carry out this crucial conservation and management work is seen as a major shortcoming in South Africa. It was agreed by all that this is a crucial issue that needs to be addressed at a National level.

In many instances experienced scientists and managers have retired and no new personnel have been employed. Institutional memory is being lost each day. South Africa cannot afford this.

Process forward
While all the attendees supported the need for additional staff and a focused process aimed at conserving the aquatic priorities, it was noted that this process needs to be driven. It cannot be left up to the individuals in the various Provinces and National Departments. Pierre de Villiers was nominated to take the matter further – possibly to Working Group I for Biodiversity Conservation (DEA). It was noted that SAIAB is primarily a research orientated Institution and so could not drive this process.

Aquatic Conservation issues in South Africa
Generally all Provinces required updated surveys of rivers. Much of the data is now old and outdated. The National River Health Programme in association with the Provincial Conservation

Departments has a major role to play in this process. Partnerships will need to be developed between Departments and Institutions.
It was noted that a process aimed at identifying the 1:100 year flood line as the "water course" defined in several of the Acts is an important process. The conservation of this riparian zone will assist in maintaining the functionality of a river. The aim would be to keep development (including ploughed lands) out of this zone as well as developing grazing best practice within this zone. The removal of invasive alien plants within this zone should become a priority. The stabilizing of the banks after the removal of the invasive alien plants is crucial. The calculation of the Ecological Reserve and the implementation thereof is also crucial.

Public participation aimed at informing the public about the aquatic priorities is important. This process needs to be driven and needs to be inclusive. A great deal will need to be done at a Provincial and Local level. There are capacity constraints in this regards. The ability to conserve and manage the required permitting systems involved with the conservation of the aquatic priority areas is reliant upon the capacity of the various Provincial Conservation Departments. If there is no immediate improvement in this capacity (staff, training, funding, etc.) it will be very difficult if not impossible to conserve the aquatic priority areas and species.

A great deal of research into the various closely related species is required. In many cases new species are not being correctly identified. Species may be lost in the near future. Research into the relationship between ground water and surface water is crucial. Limnologists need to carry out research within the large number of dams in the country – fisheries potential and an Outcome 10 based green economy. The impact of pollution on indigenous fish species needs to be worked on (chemical and hormonal). Diseases associated with aquaculture may negatively impact on indigenous species. Invasions of alien fish species need to be monitored – Catfish in the Western Cape and Nile Tilapia in Limpopo Province. Illegal use of gillnets is a reoccurring problem. In general it was noted that the ability of the various Conservation Departments to implement effective compliance monitoring programmes is minimal. Massive numbers of fish and other aquatic species are being imported as part of the aquarium trade. The risks are unknown in many cases. It was noted that a previous National Invasive Alien process lead by Dr. Preston, had proposed a Risk Assessment protocol. It would be good to re-evaluate this document.

Way forward
It was noted that this had been an important meeting. It has become crucial that all aquatic scientists and managers meet on a regular basis in order to share experiences. In this way South Africa can retain some form of Intuitional memory. Pierre de Villiers was thanked for calling the meeting and it was suggested that he take the matter further. The final aim should be to employ a National Aquatic Conservation Co-coordinator to drive this process into the future.

Pierre de Villiers

REPORT ON THE YELLOWFISH RESEARCH WORKSHOP- FRIDAY AFTERNOON SESSION

Introduction:
This is a brief summary of the short workshop held on 18 February 2011 at the YWG annual meeting at Badplaas.
Researchers and conservation representatives gave a short overview of the following:

- Historic research carried out on yellowfish
- Current research on yellowfish
- Needs with regard to research – yellowfish in particular, but also on a larger, system scale.
    - It was decided that people will list their priorities and give ideas on when it should be implemented

Outcomes of the discussions:

- Researchers and conservation bodies will compile a wish list/province and prioritize.
- This will be posted to YWG website – separated into:
    - Provincial
    - National projects/programmes.
- Use a reference group or steering committee in management of the projects. This will give guidance and help with best possible practices and procedures and ensure best possible results are achieved with limited resources.
- Circulate TOR and proposal to YWG for inputs and expertise comments.
- Scientists and institutions must list expertise and best practices and post to web site.
- Ensure implementation happens and ensure information from projects can address species and system needs.
- Reports must be sent to mangers at different levels and in such a format as to assist in implementation. It must be a short and concise summary of the project.

Dr Wynand Vlok

The workshops programme can be separated into two major sections, the regional report back and the scientific/conservation papers. We have dispensed of (for now) the workshop at the end of proceedings because of time constraints and the recommendations that emerge from the papers during the workshop provides for enough issues requiring a response.

The workshop commenced with the regional reports. These are traditionally presented by officials from the Provincial Conservation agencies but not all the provinces send officials to the conference. In such cases an individual who works, or does research, in that region may provide some insights relevant to the province, for example, the Eastern Cape.

Regional Reports

The reports from each region have become increasingly depressing over the past few years. Most of the issues facing river conservation were raised during this session as did most of the recommendations that are provided at the end of this report. The main issues raised are:

- Conservation Departments are not taken seriously by other provincial and national departments.
- Conservation departments have lost their capacity to regulate the natural/wildlife resources in their respective provinces (poor and outdated legislation and bad or no law enforcement).
- There is very little in the line of coordination between provinces with regard to aquatic research and monitoring.
- There has been a complete collapse of the River Health Programme at provincial level.

Figure 1: Most of the monitoring of rivers in the Limpopo Province is being carried out by the Aquatic section of the University of the North.

The main threats raised in this session were:

- Agriculture: Abstraction for irrigation purposes and the leaching of herbicides and fertilizer back into the river systems.
- Mining: Especially for coal in the Mpumalanga Highlands, Kwazulu as well as in the Limpopo Province.
- Sewage: There is a complete lack of proper sewage management local authorities throughout the country by.
- Illegal fishing/poaching is putting pressure on urban and rural sections of the country's fish resources. Many edible species have become locally threatened because of overharvesting (poaching) as most often harvesting is taking place without a permit.
- There are few or no aquatic scientists in conservation departments and as a result there is no aquatic research/monitoring/management taking place.
- Departments keep on changing their name, structure, personnel. To make matters worse the conservation component keeps on being moved between departments (at provincial level). There is thus no longer any continuity and no management/regulatory momentum.
- Conservation departments have very little funding with which to operate efficiently, at all levels.
- Provincial legislation and permitting systems are outdated or nonexistent and poorly resourced. There is little or no law enforcement as a result of this and departments are not fulfilling their legal mandate in terms of local, national and constitutional obligations.
- There is very little inter-provincial cooperation and as a result there are conflicting actions between the provinces. This is confusing to landowners, concessionaires, farmers and anglers alike.

Scientific Papers

The scientific papers covered a wide range of topics that varied between the ecological condition and threats to the Olifants and Vaal rivers, genetic work on the Natal Scaly, research on the large and smallmouth yellowfishes in the Vaal River, conservation of the Cape Redfins, a presentation on the Mpumalanga Wetlands Forum, a report by the Department of Water Affairs on the river health programme and Adopt a River campaign.

Figure 2: Management plans are being developed for the Redfins in the Western Cape streams.

The programme by the CapeNature to rehabilitate the mountains streams was debated at length during this session. One of the points raised was that the conditions of the EIA stated that management plans for each river, to be rehabilitated, should be in place before rehabilitation actions are undertaken. These management plans are taking a while to complete and is the reason why there are project delays.

Part of this discussion raised the issue of stocking of dams with indigenous species for angling purposes. The delegates at the workshop were divided on this issue with one group completely against stocking because control of the movement of fish is lost and movement between waters without permission could lead to hybridization – a principle to guard against in conservation management. The other group argued that this would happen anyway and that it would be best to have controlled stocking. Attention was drawn to the fact that no matter what was decided at this forum (the YWG) fish management would be dependent on the local conservation ordinance. To this CapeNature added that no stocking would take place in the absence of management plans for specific species and that the plans would provide conditions for the breeding and movement of specific fish species.

The main issues that arose during the scientific session:

- The country's river systems are being invaded by alien fish like the *Oreochromis niloticus* which are hybridising with indigenous *Oreochromis* species. Aquaculture is largely to blame for this.
- The construction of dams is affecting the genetics of fish but the impact of this has yet to be quantified. This is because populations are being isolated between impoundments thus reducing interconnectivity between populations along the length of the river system.
- Dam flows are not regulated enough to provide for ecological flows and which also disrupts the breeding cycle and the general ecological behaviour of the yellowfish.
- Water schemes inadvertently lead to the transfer of fish outside of their natural home ranges which also leads to hybridization. Fish that are endemic to one system are alien in another and have the same negative impact as any other introduced species. Seldom are these impacts positive from an ecological stand point.
- The movement, and subsequent stocking of waters (rivers and dams), is still a problem with certain hatcheries blatantly violating regulations in this regard. Angling organisations and clubs are also guilty of this and the provincial conservation agencies have no control over such practices.
- There is very little enforcement of existing legislation by the Conservation Authorities.

Proposed Actions

A number of actions were identified during the course of the workshop and these will be captured in the workshop summary of the proceedings (refer pages). These actions may not necessarily apply to the YWG or FOSAF but also to the various delegates in their respective work environments and not necessarily under the banner of the YWG.

- The YWG should raise its concern to all conservation Departments but in particular to the Gauteng Department of Nature Conservation expressing a concern at the dearth of aquatic scientists in their organisations.
- An effort should be made by scientists to get anglers and landowners involved in river monitoring. The mechanics of this was not explored in detail.
- The public should be made aware of the condition of the rivers in their region. A board reflecting the river status in accordance with the SASS score (RHP programme) should be displayed at vantage points that are visible to the passing public. Again, the mechanics of this was not discussed. The idea was to highlight ways of making the public more aware of the poor condition of the Countries Rivers.
- There needs to be an action plan for river monitoring with a central place for all data to be kept. SAIAB seemed the most likely place for this to happen. The importance of the RHP was highlighted and an effort should be made to reinstitute this programme at national level.
- The general feeling was expressed that the environment lobby should be more proactive in coming up with projects instead of being reactive by merely opposing development projects as they become public through the EIA process.
- The YWG should network with like minded organisations like the Mpumalanga Wetland Form on a more proactive basis.
- There was consensus that the rehabilitation of the Western Cape stream (Rondegat) should continue as this project will provide valuable information about best practice guidelines for river rehabilitation. There is currently not enough information or skill in this country and in this field at the moment.
- The YWG should revisit its mission, aims, goals and objectives in the light of a fast changing socio-political environment.
- The FOSAF (YWG portal) website should be used by aquatic scientists as a central point to keep everyone up to date with existing scientific work which is being undertaken in the country.

Conclusion

This year's conference was a great success with a number of recommendations and ideas coming to the fore over the two day period. Some of these ideas must be considered for actioning by the YWG, FOSAF and individuals in their work environment. The YWG would, however, be happy to assist with the coordination of most of what was proposed.

The support expressed by FOSAF and the Northvaal chapter for the YWG was appreciated by delegates who attended the conference. There is no other forum in the country for aquatic scientists where the exchange of information about river conservation can take place. The YWG has provided a valuable platform for this happen.

Peter J Mills
YWG Chairman
28th February 2011

FOSAF FLYFISHING MILESTONES

Since its inception FOSAF (Federation of Southern African Flyfishers) has led and continues to lead a series of initiatives of benefit to fly fishing in particular and to the aquatic environment as a whole. Including:

- Negotiating with Government and Provincial Authorities on the situation in the Cape where angling for trout was deregulated. As a result of these negotiations and discussions, suitable arrangements have been worked out between the Cape Department of Nature Conservation and the Cape Piscatorial Society who now control these waters.
- Publishing an official journal which has grown into the popular bi-monthly magazine Fly Fishing. A magazine that, although we no longer have a financial interest in, continues to play a role in disseminating FOSAF communications to our members and the fly fishing public in general.
- Making donations to various organisations for research projects of benefit to flyfishing. These include cost effective breeding of trout, genetic selection and breeding tigerfish, and research on population genetics of yellowfish.
- Holding discussions with timber companies to promote flyfishing as a sport and to obtain concessions for fly fishers on their land or waters.
- Organising flyfishing expositions which have been held in Grahamstown, Barkly East, Stutterheim, King William's Town and Somerset East.
- Liaising with Provincial trout hatcheries and authorities regarding the breeding and stocking of trout.
- Organising a tour of prominent international flyfishers to South Africa to promote the sport of flyfishing and local flyfishing opportunities as a tourist attraction.
- Rendering advice and guidance to authorities and anglers concerning the ethics and discipline of trout fishing.
- Supporting the efforts of the Eastern Cape Chapter which has facilitated cost effective methods for rearing trout as well as researching and recommending the merits and value of stocking remote areas with trout fry.
- Assisting in funding and obtaining displays for the flyfishing section of the Knysna Angling Museum.
- Making important submissions to government on white papers on Forestry, Water Affairs and Environmental Affairs.
- Hosting a watershed workshop entitled "TROUT '94" where 33 presenters from government departments, researchers and other interested parties produced papers from which 61 issues emerged which were handled at a further workshop in August '95 and resulted in the formulation of FOSAF Policy Guidelines in 1996.
- Negotiating with the Mpumalanga Parks Board to prevent the de-regulation of the protection of trout waters which now have protection as flyfishing waters. Providing advice and guidance on the debate which resulted in permission being granted for the stocking of trout in Wakkerstroom.
- Producing and publishing the first comprehensive guide on flyfishing venues in Southern Africa, The Nedbank Guide to Flyfishing Venues in Southern Africa in 1996 with four subsequent editions published with sponsorship from Nedbank. This was a milestone in the promotion of and association with fly fishing by major sponsors.
- Obtaining a sponsored vehicle from Samcor for the Dept. of Ichthyology and Fisheries Science at Rhodes University in Grahamstown, for work on behalf of the Eastern Cape Chapter of FOSAF.

- Holding Trout '97 Workshop and developing proceedings on small scale breeding of trout, weed control, stocking strategies, managing high and low intensity fisheries and improving the productivity of man-made impoundments in Mpumalanga.
- Commissioning, also in 1997, a study on the economic benefits on flyfishing in South Africa by a researcher at Stellenbosch University, and a major market research project by Markinor in 2001.
- Founding the Yellowfish Working Group (YWG) to uplift the status of this magnificent indigenous freshwater game fish as an angling species and to promote its conservation, protection and re-habilitation. The first National YWG Conference was held in 1997 and subsequently conferences are held on an annual basis.
- Producing the highly acclaimed report State of the Yellowfish in South Africa - 2007 with sponsorship from the Water Research Commission, the Department of Environmental Affairs and Tourism and the River Health Programme. This was followed by the Technical Report of 2008.
- Providing guidance and encouragement for the development of flyfishing facilities in all provinces of which the very successful Wild Trout Association of the Eastern Cape is a good example.
- Making financial contributions to conservation departments such as the CapeNature to help fund the attendance of scientific officers at international conferences important to flyfishers.
- Liaising and co-operating with other NGO's with similar interests such as the Endangered Wild Life Trust, Eco Care Trust and Save the Vaal Environment.
- Instituting FOSAF Exemplary Service Awards. These have been awarded to Prof Kadar Asmal for his Working for Water Project, to Dr Louis Wolhuter and Garth Brook for their contribution in the production of the Nedbank Guide to Flyfishing Venues in Southern Africa, to Dr Douglas Hey of CapeNature for his massive contribution to conservation and to Andy Lawlor for pioneering work on introducing paraplegics to fly fishing. Other notable recipients are Fred Croney, Ed Herbst, Bill Barnes, Pierre de Villiers, Dave Rorke, Brian von Holdt, Bill Bainbridge, Dean Impson, Harvey Venter, Jake Alletson, Theo van Niekerk, Mark Yelland, Thomas du Toit , Trevor and Sue Babich and Andre and Moira van van Winkel and Bob Crass.
- Co-operating with the Endangered Wildlife Trust and the Highland Crane Group by funding and advising on workshops on the situating of eco friendly dams and assisting with the pioneering Mpumalanga Highlands Wetland Study with a project cost of R100 000.
- Assisting the Free State Chapter with the stocking of the Swartwater impoundment that produced the incredible 18lb. 2½oz. Rainbow trout caught by Mike Posthumous.
- Assisting a faculty member of Stellenbosch University to attend a conference in Australia to present a paper on small development programmes for aquaculture in South Africa.
- Providing funding to the Wild Trout Association and Rhodes University for their Geographical Information System project to help to manage fly fishing waters and provide useful information to anglers.
- Providing funding to the KwaZulu-Natal Chapter of FOSAF and the School of Environment and Development to assess and develop the potential of fly fishing in the Underberg district with community-based resource management strategies.
- Sponsoring renowned international anglers and authors Darrel Martin (USA) and Taff Price (UK) to fish for our indigenous yellowfish and saltwater species and promote South African flyfishing in the international press.
- Developed a FOSAF Website that provides up-to-date reports on angling conditions and other vital environmental and fly fishing news throughout the country.

- Initiating in 2001, through the Yellowfish Working Group, a major study on the population genetics of the two Orange-Vaal yellowfish species. This study was undertaken mainly with funding by AngloGold-Ashanti and Lesotho Highlands Authority while much of the initial sampling was undertaken by YWG volunteers. The study was finalized in 2007 and these findings have led to other organizations carrying out similar studies on other yellowfish species.
- Helping job creation by supporting the Highlands Academy, set up to train previous disadvantaged youngsters as fly fishing guides.
- Publishing various papers and bulletins including The Yellowfish Working Group Newsletter and The Tippet (a general newsletter to FOSAF members) as well as various pamphlets of interest to fly fishermen in general.
- Publishing a popular series of books titled Favoured Flies & Select Techniques of the Experts, Volumes 1 to 5.
- Launched in late 2010 the FOSAF Guide to Flyfishing Destinations which replaced the very successful Nedbank Guide series.