FOSAF

THE FEDERATION OF SOUTHERN AFRICAN FLYFISHERS

PROCEEDINGS OF THE 12TH YELLOWFISH WORKING GROUP CONFERENCE

JONKERSHOEK
14 – 16 MARCH 2008

Edited by Peter Arderne

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OPENING ADDRESS

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Good morning ladies and gentlemen and a special word of welcome to Kas Hamman and Ernst Baard from CapeNature and Bill Mincher the Vice President of FOSAF. Bill also happens to be one of the founders of the Yellowfish Working Group (YWG). Welcome also to the familiar faces I see in the room, many of whom have been around for a number of conferences. Thank you for your ongoing support. There are also representatives from a number of conservation organisations present. Your organisations perform an important function within the YWG structure and your support is always most encouraging.

This is the 12th Yellowfish Working Group Conference and over these twelve years there is a legacy of interest and participation by a wide scope of individuals and organisations. The conference, as you are all aware, began in an effort to encourage anglers to target indigenous species, concentrating on yellowfish. There has been a shift over time to be more conservation orientated, with a much broader appeal than merely an interest of angling. This was probably the case during the earlier years of the YWG's existence, although research has always played an important role.

In this opening address I will focus on a few issues that I think should set the trend for fruitful discussion and debate for the rest of the conference.

The YWG is largely funded by FOSAF but our membership is a collection of anglers, conservationists, landowners and scientists. This brings to the table a diverse set of values and ideas which is the reason why I think this organisation is so dynamic. We all have one purpose and that is the conservation of our river systems and the fish that inhabit them. As I have already alluded to, the origin the working group has was initially to popularise fishing for "yellows". You must agree that by the number of people fishing for these species on a national scale is quite phenomenal. This goal has been achieved and anyone chancing upon the Vaal on any given day will be astounded at the number of fly fisherman on the water.

The shift of the Working Group has been subtle, towards one that is primarily concerned more with conservation than just angling. Anyone fishing our rivers will understand why the shift has taken place. The condition of our rivers is in a terrible state and they are getting exponentially worse. Mining, agriculture and poor sewage management are three main causes for this sharp decline in the condition of our river systems. A perusal of the River Health reports shows an alarming number of rivers in a poor state. The shift towards conservation is also not unique to the Working Group or to FOSAF, for that matter. I have looked at a number of websites of fishing organisations. They include Bass Masters and Trout Unlimited and all are strongly focused on the conservation of local natural river systems and species because, there also, the systems are declining in their potential to remain sustainable. Something must be done.

The YWG and FOSAF have experienced this shift for the same reason. We are concerned with the condition of our systems and poor management of them, not just for the angler, but because our societies cannot function without a healthy environment. Our aim is, therefore, to

not only look after the interests of the angler, but more importantly, the whole environment. We want to practice our sport in clean, healthy rivers, reservoirs and the sea.

But, how do we change this spiralling cycle of environmental decline in the name of progress. All development planners throw around the issue of sustainability but, if one had to analyse what is really happening, the final conclusion must be that there is no sustainability and that it is all widow dressing by most, if not all, development practitioners. It has become merely a buzzword to use and for them to do what they want to do regardless of the environmental consequences. There is no conservation happening here. Indeed, conservation planning and practice is expensive and everyone is cost conscious, willing to cut costs in any way that is possible. In the end the environment always loses. So, how then, does one inspire change?

At the workshop last year we analysed the threats that face our rivers. These threats can be isolated into three or four main areas of concern; mining action, poor agricultural practices, uncontrolled urban expansion and poor sewage management. The result is habitat destruction and pollution, not only of terrestrial systems, but also aquatic environments. No amount of posters, lectures or school programmes will solve this problem. Only when people become involved at local level to effect change in the most practical way will this change. We urge you, as members of the YWG, to become actively involved in solving problems in your own local environment. Conservation action depends on individuals that actually become involved in real and practical issues.

So then what is the role of the YWG? It is really a forum where we exchange ideas and concerns around issues of river conservation and management. In the end this is not only to secure good fishing but first and foremost, to promote sustainable aquatic environments. It is a forum for exchanging knowledge and ideas. It is also a forum for focusing resources, research in appropriate areas that can lead to the achieving of our lofty objectives of having healthy river systems. The YWG helps us to:

- Pool resources
- Promote better aquatic science
- Promote good conservation practice.

Other than this it is up to us as private individuals, and within our specific organisations, to make a difference at local level. So then, on the ground what are YWG members doing?

- Genetic research on various yellowfish species is helping us understand what is happening with these species and the environments they live in.
- Similarly there are telemetry studies that are helping us understand the movement of fish and this is providing us with information that will allow for appropriate management actions. There is similar work taking place on tigerfish that will also help to understand the ecology and biology of this fish.
- The River Health Programme at provincial level is helping us understand the conservation status of our rivers.
- The idea of river conservancies is growing, and is especially alive and well along the Vaal River where there are more than 600 members.

These might seem like small steps but it is a start and the level of participation by angling organisations and the public is growing.

Finally I would like to thank:

FOSAF Northvaal for their ongoing sponsorship of the YWG.
Frontier Flyfishing for their contributions towards this year's event.
The Table Mountain Fund and Distell (catering & wines)
Bells for the whisky
And Andre Steenkamp for a donation
CapeNature for their personnel and material support. A special thanks to Dean, Martine & Pierre and their staff who have made this happen. Your contribution is greatly appreciated.

I hope you all enjoy a very productive conference where ideas can be shared and grow the notion of sound river management and conservation.

CONSERVATION AGAINST ALL ODDS

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Introduction

Much has been said about the problems regarding the conservation of threatened species in the Western Cape. At first glance there do seem to be insurmountable problems that need to be addressed.

A large human population concentrated in small area between the mountains and the ocean categorizes the Western Cape. Historically there has been massive pressure on resources to sustain agriculture and people. Water has always been a critical resource in short supply. Compared to some of the larger rivers further north, relatively small rivers drain the Western Cape Province. These harbour many endemic species. The fisheries management capacity within the Province is limited.

There is however a great understanding of the need for conservation within private sector. There is a great deal of support for conservation within private sector and the various Government implementing agencies. Conservation based NGOs are abound. There are great funding opportunities within this Province due to the presence of several international funding agencies based in Cape Town. Several Universities exist in the region and students are available to carry out targeted research.

Threats

The major threats to the endemic fish species (and other species alike) are water pollution, water abstraction, water flow management, channel modification, the lack of priority conservation areas with associated management guidelines and the lack of fisheries management in system (Ecological Reserve and River Health are not fisheries conservation programmes).

Management options

To address some of the above issues it is critical to identify priority conservation worthy rivers and develop associated management guidelines. These need to be provided to other Government Departments responsible for the management of water resources and development, e.g. DWAF/DoA/DEA&DP

An intensive fish survey of all rivers in the Western Cape is required to update information pertaining to the distribution and survival of the respective species and populations.

Additional qualified fisheries personnel should be employed to assist with this programme. This is the Province with the most threatened fish species in South Africa.

Additional funding for programmes can be sourced from NGOs

Formal invasive alien fish eradication or management programmes should be developed in association with the related sport fishery sectors (communication is critical).

Specific aquatic conservation areas in critical rivers should be developed. These can be in the form of stewardship agreements or conservation associations. These should receive formal support from conservation agencies in the region.

A formal fisheries programme should be designed and driven by CapeNature. This needs to address the conservation of endemic species as well as the management of alien species.

Way Forward

There is massive support in this region for conservation initiatives. Many of the fish species are however threatened endemic species. To be effective a formal conservation plan must be developed and driven to provide direction and focus for the conservation minded public. CapeNature needs to decide what role it will play and how NGOs and Universities can

contribute to the overall conservation initiative. There is still a window of opportunity to conserve our threatened fish species in the region. Quick, focused actions are however required.

CONSERVATION OF THE BERG-BREEDE WHITEFISH, CLANWILLIAM SAWFIN AND CLANWILLIAM YELLOWFISH.

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Why are the Western Cape indigenous yellowfish species so different?

1. Note that Berg-Breede whitefish *Barbus andrewi* and Clanwilliam sawfin *Barbus serra* are not true yellowfish, unlike the Clanwillliam yellowfish *Labeobarbus capensis*. However, for this paper they are all referred to as "yellowfishes".
2. *Small natural distribution*. Both Clanwilliam yellowfish and sawfin are restricted to a single medium sized catchment.
3. *Very susceptible to alien fish predation*. Where bass are found, these species are either absent or in very low numbers with no small juveniles present.
4. *Found in areas of intensive agricultural production*. Both the Olifants, Berg and Breede River valleys are characterised by intensive farming involving vineyards, deciduous fruits and citrus
5. *Slow growth rates compared to alien fish competitors*. These fishes attain about 6 cm after one year compared to about 12 cm for bass, trout, catfish and carp. Yellowfish mature after 3-4 years wheras alien fishes take 1-2 years. The alien fishes thus have a head start in growth that they keep to maturity.
6. *Numbers of fishes remaining very low, and areas with good recruitment are tiny compared to other yellowfish species*. For example, most anglers regard the Orange-Vaal largemouth yellowfish as under pressure; yet for every 1000 Orange-Vaal largemouth yellowfish in a river within its natural distribution, there is perhaps 1 Berg-Breede whitefish in a river within its natural distribution.

Major threats

1. *Invasive alien fishes* – trout in upper reaches, bass and bluegill in middle reaches, carp and catfish in lower reaches. Simply, there is little room left for the yellowfish, 80% or more of their distribution range is now occupied by alien fishes that prey or compete with them. Fish conservation experts here agree that invasive alien fishes ARE the greatest threat.
2. *Habitat degradation* – bulldozing and canalisation of rivers, instream dams and weirs, excessive water abstraction, pollution. These are serious problems for yellowfishes, but are more localized in time and space. However, they compound the impact of alien fishes, causing a "cocktail of threats" that are driving the threatened W Cape yellowfishes to extinction.
3. *Lack of awareness and interest in the three species*. The vast majority of freshwater anglers in RSA, including the W Cape, have never caught one of these yellowfishes because of their low numbers and inaccessibility.
4. *Insufficient capacities and lack of enforcement* for fish and river management. A growing trend over the last 10-15 years has been the steady erosion of capacity (numbers of staff, trained and skilled staff) at provincial and local government agencies responsible for managing freshwater fishes, rivers and agriculture next to rivers and wetlands. As a consequence, we continue to see key rivers over-abstracted, bulldozed, polluted (often by inadequate water treatment plants) and canalized. CapeNature has 1 dedicated fish scientist for one of our largest provinces that has our countries greatest concentrations of endemic and threatened fishes, including yellowfishes.

Key requirements to improve conservation

1. *Eradication of alien fishes from priority river areas and dams.* This process is underway, with several privately owned dams cleared of carp and bass for yellowfish introduction. The 3 species are only stocked within the river systems where they naturally occur. The CAPE River Rehabilitation project, involving alien fish eradication, has reached the EIA stage.
2. *More environmentally sensitive agricultural practices.* Most important are maintaining buffer areas next to rivers that are at least 35 metres wide so that the riparian zone is not disturbed. Also not abstracting the summer flow of rivers when they are at their lowest flows. And ensuring that instream dams, especially new ones, release ecological flow requirements to maintain downstream ecosystem functioning
3. *Increased awareness and interest* in local yellowfishes by stakeholder groups. This is slowly improving with the recent creation of the W Cape Yellowfish Working Group.
4. *Establishment of yellowfish sanctuaries/conservancies* (Olifants Gorge, Cederberg conservancy, Ratels conservancy, Klein Berg whitefish area) in the 3 river systems

Achievements to date

1. *Legal issues addressed under NEMBA and ordinances.* All 3 species receive additional protection.
2. *Identifying impacts of alien fishes and key rivers for alien fish control* through TMF project. Impacts of smallmouth bass and rainbow trout in the Berg River have been quantified. Priority rivers for alien fish management have been identified across the Cape Floristic Region.
3. *CAPE Alien fish EIA* and other eradication projects in private waters. If these projects proceed, especially the Rondegat River intervention, they are very positive for yellowfish conservation.
4. *Stockings of yellowfish* into dams. This must proceed with caution paying attention to genetic issues and ensuring that dams within the natural distribution ranges of the 3 species are stocked.
5. *Improved angler awareness* through articles in angling magazines, angling books and Piscator
6. *Improved land-owner awareness* through presentations and site visits
7. *Good monitoring of rivers in the W Cape* due to active and well funded River Health Programme in province. The Breede system is being focused on at present.
8. *WRC yellowfish reports.* The national status reports are an excellent starting point for future management of the three species. The technical report, which will be ready towards the end of 2008, will contain highly detailed biological and conservation management information on the 3 species.
9. *WRC Cederberg project.* This project is not focused on yellowfish *per se*, but improved conservation of the Clanwilliam rock catfish will definitely assist the Clanwilliam yellowfish which co-exists in many small rivers.
10. *WWF-SA Cederberg Biodiversity Corridor* freshwater capacitation project. This project is aimed at improving capacity for aquatic stewardship projects in the Cederberg area where Clanwilliam yellows and sawfin are found.

Focal areas for the future

1. *Can't be a "one man show"* – need huge buy in from conservation sector, anglers, land-owners and funders. This is critical – like the Orange-Vaal smallmouth yellowfish is now "loved" and appreciated by thousands of anglers, so too we need to work towards an environment where local indigenous W Cape yellowfishes can be better appreciated.
2. *Need successful stories of rehabilitation* and increased yellowfish numbers, especially in rivers. This is critical – even in the last 10 years the numbers of the 3 species continue to decline because threats still are increasing in magnitude. We need to gain ground for the unique indigenous fishes of the CFR, working hand-in-hand with other stakeholders.
3. *Need to establish an indigenous "yellowfish brand" in the W Cape.* The focus is not "yellowfish" but individual species of yellowfish, especially natural populations, similar to the interest there is for brown trout.
4. *Address research priorities* NB distribution and biology of whitefish, impacts of sharptooth catfish

THE WESTERN CAPE BASS ANGLERS ASSOCIATION'S APPROACH TO CONSERVATION AND SUSTAINABLE USE OF YELLOWFISHES IN THE WESTERN CAPE

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Introduction:

Many thanks for the opportunity to address this conference. I have been requested to attend on behalf of Albert Olivier, the current VP and President of the Western Cape Bass Angling Association, who unfortunately is away in Bloemfontein. My personal involvement with the South African Bass Angling Association started approximately 12 years ago and therefore I have a good understanding and perspective of what our association's current and future visions are.

SABAA (South African Bass Angling Association)

I would like to begin by saying that it has been proven that alien species do have a long-term impact on indigenous species, but in this country it cannot only be blamed on bass when there are other alien species, e.g carp, barbel, etc. We are aware that the smallmouth bass has had impacts in certain sensitive river systems. This has been discussed over the past three years with Dean Impson.

With the above information made available to us, we believe that if we do not work together, there will be no winners at the end of the day, with the loser being our waters and all their species.

Our Association through organized competitive angling within the Western Cape started contributing financially towards Cape Nature approximately 10 years ago, with a donation to assist with the costs of building causeways to contain the bass from the upper reaches of sensitive river systems.

At our Bi Annual General Meeting, on the 10th February 2008 we confirmed that our association will work with Nature Conservation and will only relocate or stock bass with the required permits. This applies to all members of our association. We also appointed Erwin Schroeder as official Conservation Officer to work with Nature Conservation on projects that may require manpower and/or financial assistance from our association. We have promoted this conservation initiative through the Bass Africa Magazine and believe that we are on the correct path to success, thanks to people such as Erwin Schroeder, Pierre de Viliers and Dean Impson. If Nature Conservation could indicate their immediate concerns of sensitive rivers, we will attempt to get this message out to not only our members, but also the social anglers, this could be achieved through the Bass Africa Magazine.

The bass-angling facet generates a tremendous amount of revenue on a national basis and this cannot be ignored. Our anglers are passionate about this sport as

many other anglers from other facets surely are. We have committed to working with Dean; with the understanding that there are certain public waters we believe are essential to the continuation of our sport on a national basis.

We have already and will continue to offer our assistance to Nature Conservation in the eradication of bass from certain sensitive river systems (e.g. Hex River System) and endorse the original concept of "zonation" as discussed at the inception of FAF (Fresh Water Angling Forum) meetings setup almost three years ago. The "zonation" of certain public waters will allow for what I believe would be the buy-in by the pessimists out there. Thus we can achieve a "win/win" situation by working with Nature Conservation, assisting them in sensitive areas, whilst they assist us to improve our existing bass stocks within these defined dams and water systems.

In short, we have inherited the current situation from our forefathers and the best we can do now is manage what we have in the interests of all parties concerned. Cape Nature Conservation has showed us how they are prepared to assist us in improving our waters for bass anglers and we will continue to assist them wherever and whenever possible.

PROMOTING WESTERN CAPE YELLOWFISHES AS ANGLING SPECIES: THE JONKERSHOEK FLY FISHING EXPERIENCE

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It all started in 2005. Jonkershoek Flyfishing had been running for three years with our client base growing each year in winter with excellent trout fishing on fly, but dwindling badly in the heat of summer. Temperatures in our little valley hit 42 degrees in summer with our dam water temperature going as high as 28 degrees…now no self-respecting trout is going to be even vaguely active in that heat. I'd been nagging Dean Impson for a while for permission to stock Bass and various other popular warm water sport fish, but to no avail. He suggested we stock whitefish, which he said we could collect from the Brandvlei dam. We organised a few collection trips and managed to stock our bottom dam with 80 fish and the second dam with only 20. That was the last we saw of them…

That is until a buxom, beautiful young German lady came along to the fishery one day in May for her first attempt at flyfishing. After some careful coaching she hooked into a fish right up against the bank and in true beginner style, whipped it out the water before it had half a chance to give an account of itself. She was disappointed it wasn't a trout, but after much explaining I got her to realise what a special fish it was to catch, though I still think she probably thought I was just trying to put on the charm.

A few months passes and finally we began to see the whitefish again, patrolling the dam in a large dark school just below the surface. I was fishing one evening with a good friend of mine having fun catching trout on a New Zealand style dry fly and nymph rig when suddenly he called over "I've got a witvis…" "Kak!" I shouted back… "No, I swear" he says. So I sprint off around the dam and low and behold he did have a witvis. So fell the second Jonkershoek Whitefish (all were released).

2007 was however a bit different with a number of people catching and being broken up by whitefish around the one to one and a half kilo in size. Though these were either caught by careful selective fishermen or by careless folk caught unawares and unprepared for the super quick takes and fast runs. We built a spawning bed and observed fish displaying signs of spawning behaviour in November, but have not yet seen any signs of fry.

From a commercial fishery point of view did it solve our quiet summer problem? Thus far no, these fish are still far too selective and tricky for a commercial fishery such as ours. We would very much like to look at some of the other yellowfish. Western Cape species such as the Sawfin or Clanwilliam yellowfish as these were once bred here at the Jonkershoek hatchery and, from experience, are far more aggressive takers of the fly. The concern though is - what threat or damage would these fish cause should they get into our local Eerste river? Trout are becoming increasingly expensive to stock with and, given high recent temperatures are becoming even more difficult and non viable to keep in a commercial fishery set-up. Offering three indigenous fish species at Jonkershoek has real potential to educate and expose local flyfishers to these magnificent local fish.

MISSION AND VISION OF THE WESTERN CAPE YELLOWFISH WORKING GROUP

Talk by Kevin Cox
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Background

Concerned flyfishers and officials from CapeNature have had several meetings since 2007 to find methods to improve the conservation of the indigenous yellowfishes of the Western Cape. The three species are the Berg-Breede whitefish *Barbus andrewi*, the Clanwilliam sawfin *Barbus serra* and the Clanwilliam yellowfish *Labeobarbus capensis*. The establishment of a local chapter of the National Yellowfish Working Group was recommended as a logical step forward. The Group has not yet been established formally and can be regarded as a loose association of interested participants. At a recent meeting of the W Cape YWG, participants proposed the following Vision, Mission and Objectives for the group.

1. *Suggested Vision*: The WC YWG would like to achieve tangible improvements in the conservation status and awareness of the three indigenous yellowfish species to the province.

2. *Suggested Mission*: The WC YWG, through substantially increased membership and participation; as well as landowner and corporate involvement and support, will secure improved riparian, instream and stillwater habitat management of yellowfish waters and sustainable and productive angling for the three indigenous yellowfish species.

3. *Suggested Key Objectives of the WC YWG*:

    - To substantially increase membership at an affordable annual subscription
    - Identify, secure and stock waters for members
    - Identify, secure and stock waters as yellowfish sanctuaries
    - Buy-in and support from other angling groups (artlure and bait anglers)
    - Using media to educate stakeholders about the value of our yellowfishes
    - Identify projects that will improve conservation, awareness and utilization of yellowfishes
    - Secure a viable funding base to achieve our objectives
    - Increasing our knowledge of distribution, conservation status, biology and ecology of the three species
    - Identify and secure priority yellowfish waters for conservation purposes
    - Market the indigenous yellowfish brand to the benefit of the fishes and users

Conclusion

The Group has perhaps the greatest challenges of all Yellowfish chapters, in that it must focus on three yellowfish species that are the most threatened and fishing for them is not readily available. This makes marketing the species difficult. In addition, overcoming the threats they face are huge, but not insurmountable, obstacles. The popular and technical Yellowfish Status Reports will be excellent tools to guide the future strategies and actions of the WC YWG. It is imperative that anglers, angling clubs, riparian landowners and conservation authorities work closely together to identify important and achievable projects, that improve the conservation of the three species.

REHABILITATION OF THE KLEIN BERG RIVER, WESTERN CAPE WITH FOCUS ON THE BERG-BREEDE WHITEFISH

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The Klein Berg Mountain Catchment area is a sub-catchment of the larger Berg River system within the Western Cape Province; and is approximately 39 000 hectares in size. The catchment currently supplies the following registered water users with purified water fit for household purposes: Wolseley, Tulbagh, the City of Cape Town and several nearby West Coast towns. The majority of water produced by the catchment is stored in the Voëlvlei Dam, one of the largest dams in the south-western Cape, which currently receives water from two main sources via canals. The first canal from the Vier en Twintig River supplies excellent quality water as the entire catchment of the river above the canal off-take is in an almost pristine state. The site is a declared Wilderness area, State Forest and World Heritage site; and is managed by CapeNature as the Groot-Winterhoek Wilderness Area and Heritage site.

The second canal that feeds Voëlvlei Dam is from the Klein Berg River and most of the water quality issues in the dam are due to elevated nutrient levels in this river. The reason for the inferior water quality is that, while the upper mountainous catchments are in a good condition, the tributaries that feed the Klein Berg River must flow through intensively farmed land and two towns before entering the canal. In the last 7 to 8 years, Cape Town City Council has noted a substantial decline in water quality, probably related to inadequate treatment at the water treatment plant in Tulbagh and an increase in intensive agriculture (and hence greater fertilizer use). Water quality issues have lead to a reduction of production output of the Voëlvlei water purification plant and a higher cost of treating the water. This is due to algal blooms, which are the result of the elevated nutrient levels.

One of the largest contributors to negative impacts on the catchment is the mismanagement and/or poor management of riparian zones, dams and wetlands. Most riparian zones are invaded with invasive alien plant species with densities in excess of 75% or more. Healthy riparian zones play a critical role in intercepting excess nutrients and stabilizing and protecting riverbanks. Wetlands, that would have purified the water, have been damaged or function poorly because of inappropriate management.

All dams, bar one, in the valley are infested with invasive alien fish. Carp are a particular problem because of their impact on water quality. They have reached pest proportions in Voëlvlei Dam because of the recent illegal introduction of sharptooth catfish and the subsequent decline of a once substantial smallmouth bass population.

In terms of natural functioning, the majority of the catchment has been negatively impacted upon. Injudicious farming practices in the valley add to the situation, where cultivation and grazing is done right up to the rivers' edge in contravention of the Water Act as well as the CARA Act. The practice of bulldozing rivers, to protect agricultural lands planted too close to the river, is common and it is widely known that the catchment is over-allocated and over - abstracted by both legal and illegal means.

This is a typical scenario of the many river catchments in the country, due to the environmentally insensitive old Water law.

It was realized that to solve water quality as well as quantity issues in Voëlvlei Dam, management practices for the Klein Berg Catchment had to be revisited and improvements from current practices investigated. An integrated approach towards management of the catchment was required between all the stakeholders and the concept of the Klein Berg catchment rehabilitation project was born.

One of the primary projects identified was the restoration of ecosystem function of the Klein Berg River system so as to improve water yield and quality. To achieve this, catchment experts and stakeholders have identified the following steps:

1. Alien vegetation must be cleared from all riparian zones and wetland areas.
2. Damaged riparian zones must be identified that require re-planting of local indigenous vegetation.
3. As a large and threatened locally indigenous fish, the Berg-Breede whitefish *Barbus andrewii* could be considered not only as an excellent indicator species for ecosystem quality but also should be used as a flagship species for landowners and government organisations to rally around.

Therefore ecosystem restoration and the re-introduction of whitefish into the valley must go hand in hand. One cannot re-introduce such a threatened species, which went locally extinct due to the impacts of alien fishes and poor river management, without first addressing the reasons for its disappearance.

The project proposes to remove alien fish species from the Klein Berg catchment (especially carp and catfish) with the co-operation and support of local landowners and angling groups. This should improve ecosystem functioning for a charismatic species, the whitefish, which could improve tourism and be used as a marketing tool for the environmental recovery of the Klein Berg valley. The ecological recovery of the system will be monitored by the W Cape River Health team and will be of substantial economic benefit to the Western Cape, through improved supply of higher quality water to Voëlvlei Dam.

REHABILITATION OF THE RATELS RIVER CATCHMENT AND ITS PROMOTION AS A YELLOWFISH FLYFISHERY

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Situation assessment

The Ratels River is a small perennial tributary of the upper Olifants River that is a priority for freshwater fish conservation work. In its upper reaches the river is very small (1-2m wide) and shallow, whereas bedrock pools interspersed with shallow riffles and rapids dominate the river in its middle and lower reaches. The river has two important waterfalls from a fish distribution perspective, the top waterfall at Beaverlac farm being the uppermost distribution limit for indigenous fishes, whilst the lower waterfall near to its confluence with the Olifants River is a barrier to the alien smallmouth bass and bluegill found below. Between the two waterfalls on Beaverlac farm, a popular tourist resort, are large numbers of threatened indigenous fishes, namely the Vulnerable Clanwilliam redfin *Barbus calidus*, the Endangered Clanwilliam sawfin *Barbus serra* and the Vulnerable Clanwilliam yellowfish *Labeobarbus capensis*. The river is a particularly important refuge for sawfin. The river is growing in popularity amongst small-stream flyfishing enthusiasts due to its beauty, clear waters and numerous sawfin. These are caught on a catch and release basis. The owners of Beaverlac farm are very aware of the importance of their property in terms of river and fish conservation.

The mountainous catchment of the Ratels River is mainly under private land-ownership and is managed by the Ratels River conservancy which was established in 2002. The Conservancy has 18 members and meets at quarterly intervals. However, the catchment is under growing pressure from invasive alien plants (primarily pines and black wattle) and agricultural and resort development. River flow and water quality during the dry summer months appears to be declining due to excessive abstraction at this time and the river stops flowing in parts of its upper catchment. Farming of berries for the export market has become a major activity in the catchment since 2000. Other types of farming include proteas for the flower market and citrus and deciduous fruits. Beaverlac farm has become a major tourist venue on weekends and during public holidays and has on average about 300 visitors per weekend during the peak season (September to April).

The catchment has at least 10 dams, one is situated on the Ratels River at its source; the remainder are on its tributaries. Rainbow trout *Oncorhynchus mykiss* have regularly been stocked into several dams for recreational fishing since the 1980's, including Zuurvlakte Dam at the source of the Ratels River. Clanwilliam yellowfish and sawfin from lower down the catchment were also stocked into this dam by CapeNature staff in 1993 to promote an interest in indigenous species. At this stage, CapeNature's guidelines with regard to indigenous fish stocking (i.e. appropriate areas) were more flexible than currently. Clanwilliam yellowfish from the Clanwilliam yellowfish hatchery were stocked into Grootfontein Dam in the late 1990's and Clanwilliam sawfin and Clanwillian redfin were stocked into Temptation Dam in 2007. Carp *Cyprinus carpio* were illegally stocked into 5 dams on the catchment over the last three decades and if they escape, when the dam overflows after heavy rain, can invade the upper Olifants River to Clanwilliam Dam.

Interaction between CapeNature and the Conservancy regarding fish issues

The author has had two meetings with the conservancy regarding fish and river conservation issues. Conservancy members were informed of the conservation value of the Ratels River in

terms of fish conservation and were invited to an awareness day on the lower river at Beaverlac in early 2007. This day was well attended by members of the Western Cape Yellowfish Working Group and a conservancy member's (Richard Carrlson) dam, Temptation Dam, was stocked with sawfin and Clanwilliam redfins from the Ratels catchment. This event greatly increased awareness of fish issues in the river and established goodwill between the landowner and CapeNature. Conservancy members at both meetings were also informed of problems in the catchment – alien fish and plant invasions and excessive water abstraction from the river in summer. In return, conservancy members willingly shared information about alien fishes in their dams. This interaction provided CapeNature with confirmation that several dams in the catchment had carp. CapeNature stressed the need to eradicate carp, before they escaped from dams during flooding and invaded the highly sensitive upper Olifants catchment. Conservancy members with alien fishes expressed their willingness to have alien fishes eradicated and share the costs of a rotenone application. The conservancy share CapeNature's vision of promoting the conservancy as a yellowfish zone and clearing the catchment of alien plant species. Most landowners with dams highlighted the need to replace alien fishes with local yellowfishes, and use these fishes to generate some tourism income through angling. The Ratels valley is the closest area to Cape Town where anglers can catch Clanwilliam yellows and sawfin in the Olifants-Doring catchment. Several conservancy members have small farms that are not agriculturally productive and are increasingly dependent on tourism as a source of income. The author advised conservancy members that financially viable eco-tourism is dependent on a healthy environment – hence the need to eradicate invasive alien plants, better manage alien fishes and sustainably use natural resources, especially water.

The Dilemma: to stock or not to stock fishes into the upper catchment?

This issue was debated at length on the Sunday workshop after the conference. There were differences of opinion amongst participants, varying from the puristic conservation approach i.e. no fishes in dams above the top waterfall, to a more feasible long-term approach of allowing the stocking of fishes indigenous to the Ratels catchment.

CapeNature's guiding principle regarding fish stocking, enforced under most circumstances since the mid 1990's, is to only stock fish species into dams that are naturally or legally present in the catchment area. If a river area is naturally fishless, such as the Salt River in the southern Cape is (excluding eels), then applications to stock fishes are generally not supported (as was an application to stock trout several years back). However, being a conservation organization, CapeNature needs to "apply its mind" to the issues at hand. Hence, indigenous fish were stocked above a waterfall barrier at Bushmanskloof Private Nature Reserve in the Cederberg, following an impact assessment.

The options for the stocking of dams in the Ratels catchment above the top waterfall seem three-fold. Table 1 highlights these options and the advantages and disadvantages of each option. It is clear that each alternative has its disadvantages; what is important is that an alternative is chosen that has the best long-term likelihood of success in terms of the overall ecological health of the catchment and its primary river.

Table 1: Alternatives for stocking indigenous fishes into the upper part of the Ratels River catchment, Cederberg

Option	Advantages	Disadvantages
Do nothing – leave the dams as they are	-minimum expense	-alien and indigenous fish may escape from dams and invade river above waterfall -carp can escape and invade upper Olifants River -carp degrade water quality in dams -opportunity to promote entire catchment as yellowfish zone is lost
Remove fish from all dams in catchment above top waterfall	-no risk of fish escaping from dams -river above waterfall can be conserved as an invertebrate zone if alien plants and summer abstraction are better managed	-reality is that fish will be stocked into 1 or more dams at some stage in the future – what species will be stocked (smallmouth bass?) -conservancy members want some type of fish, preferably indigenous, in their dams - loss of recreational fishing income in these dams -opportunity to promote entire catchment as a yellowfish zone is lost -expensive, as some dams are large making chemical treatment expensive
Stock dams above top waterfall with indigenous fishes	-dams can be used to establish indigenous fish refuges and a larger more viable yellowfish zone -more conservancy members can benefit from recreational fishing -better buy-in and long-term support from conservancy members for catchment rehabilitation projects -impact of indigenous fishes, if they escape from dams, will be restricted to the upper catchment – they will not impact on the indigenous fishes between the two waterfalls	-indigenous fish may invade part of the upper Ratels River (especially deeper pools) and could threaten some aquatic invertebrates -criticism of action by conservation purists and anglers already critical of CapeNature

In Summary

The decision to stock more indigenous fishes into the Ratels catchment is not a straightforward one. What is most important is having an ecologically healthy river and catchment. It is likely that some compromises will need to be made as 90% of the catchment is privately owned, including the very source of the river which has a dam with fish. If the decision is taken to stock more indigenous fishes, then a monitoring and research programme should be launched to quantify any changes in aquatic invertebrates and freshwater fish in the Ratels River above the upper waterfall. It is clear that carp must be eradicated from dams in the catchment as soon as possible to prevent their future escape and invasion of the upper Olifants River.

IMPACTS OF INVASIVE FISH ON INDIGENOUS FISH ASSEMBLAGES

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This paper presents a broad summary of the impacts of invasive fish on indigenous fish assemblages, focussing on fish assemblages, such as those found in the Cape Fynbos region, which did not historically include predominantly piscivorous fish.

Introduction

It is important for researchers, conservation officials and fishery managers to understand the impact of introduced, and mostly invasive, fish species on the indigenous fish assemblages of the area into which these fish are introduced. This understanding helps researchers and managers predict the outcomes of the fish introductions. The collapse of many large-scale fisheries has occurred as a result of the introduction of freshwater fish into systems where they originally did not occur. The most widely publicised is the collapse of the Lake Victoria fishery following the introduction of the Nile Perch and the Nile Tilapia (Achieng 1990, Goldschmidt et al. 1993, Goudswaard et al. 2002, 2008). The current fish assemblage of Lake Victoria is primarily made up of these two introduced species with the more than 600 original cichlid species having largely been extirpated from the lake (Achieng 1990, Goldschmidt et al. 1993, Goudswaard et al. 2002, 2008).

In the Cape Floristic Region (CFR), introduced freshwater fish have decimated indigenous fish assemblages and have extirpated them from an estimated 99% of their original distributions (Hamman 2008). The species responsible for this massive elimination of indigenous species are largely black basses (smallmouth, largemouth and spotted bass), trout (rainbow and brown) and, more recently, sharptooth catfish. Other species introduced to the CFR have also had an impact on the indigenous fish assemblages in many ways. This paper presents a description of the impacts of these species on indigenous fish assemblages in order to communicate to researchers and fishery managers the implications of introducing fish to natural watercourses.

Freshwater Fish Invasions

A species needs to overcome a number of barriers in order to establish in a new area and ultimately become invasive. A concept that can be represented in a simplified model (Figure 1) (Richardson et al. 2000, Copp et al. 2005). Each of the vertical lines represents a barrier that the fish species needs to pass in order to establish a self-sustaining population (naturalisation) and subsequently spread through the river network to be classified as an invasive species.

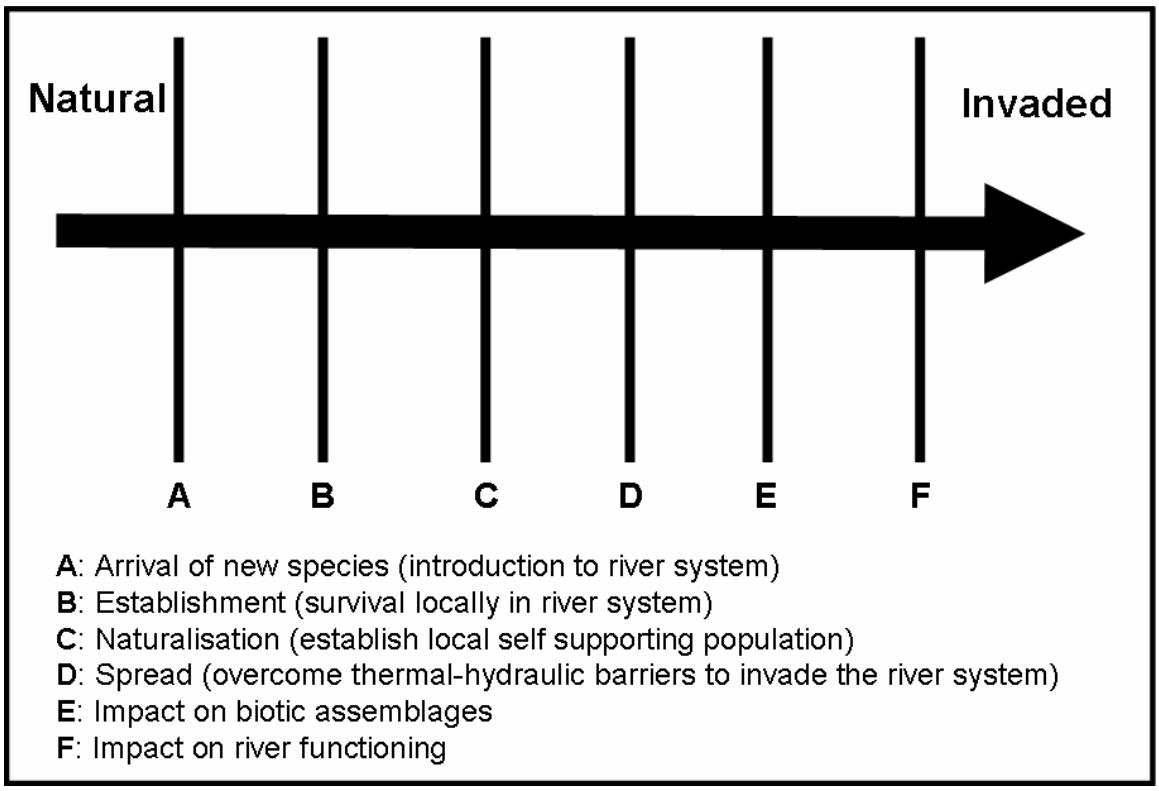

Figure 1: Model reflecting the barriers a species needs to overcome in order to become an invasive species (Adapted from Moyle and Light (1996), Richardson et al (2000) and Copp et al. (2005))

For freshwater fishes, the arrival of a new species to a new environment is currently, and to a large extent historically (last 200 years), a result of human activities (Casal 2006). Once an introduced fish species has become established, it will begin affecting the local biotic communities as a competitor or predator. In systems where the native species are not adapted to the presence of fish predators, the impact of piscivorous fish will be significant (Cox and Lima 2006).

Impact of introduced species

Typically, a population of introduced fish is small and, in successful cases, increases with successful recruitment to reach the carrying capacity of the environment into which it has been introduced. A typical representation of the increase in population density of an introduced species is presented in Figure 2. The population density follows the typical sigmoidal growth curve, tapering off when approaching the carrying capacity of the river system (Choquenot et al. 2004).

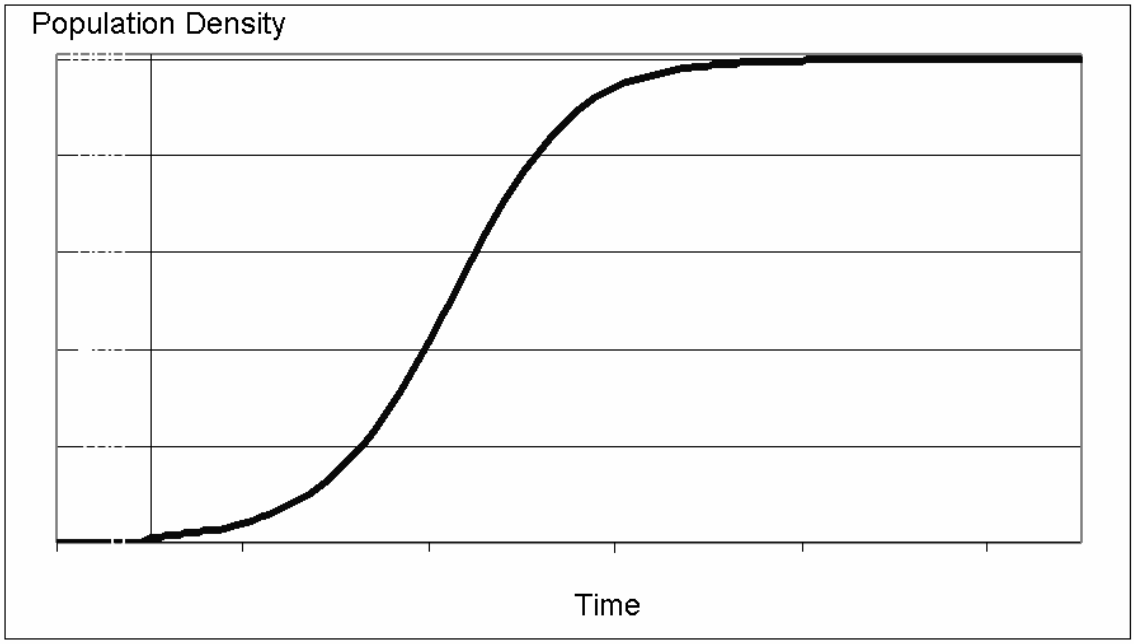

Figure 2: Model reflecting the increase in population density of successful introduced species over time

Some species have an immediate impact on the ecosystem into which they have been introduced, even at low densities (line A in Figure 3) while other species only start exerting noticeable impacts on the ecosystem after they have exceeded a minimum threshold density (line C in Figure 3) (Bomford and Tilzey 1997).

Competition and Predation

Invasive fish can affect indigenous fish assemblages in two ways: directly through predation or indirectly through competition. The rate and degree of impact is determined by the nature of the interaction between the two species. The impact can vary from marginal, where the introduced species co-exists with the indigenous species, or devastating, where the indigenous species is totally eliminated by the introduced species.

In addition to competition and predation, other impacts such as the introduction of parasites of diseases may affect an indigenous fish assemblage but these are not considered further in this paper.

Competition

The effect of competition by an introduced species on the indigenous assemblage is dependent on a number of interacting factors. Competition for food is the most significant factor, as the superior competitor will out-compete the inferior, obtaining the highest-value food. The degree of dietary overlap between the species will determine the degree of this impact. Research has shown that in some cases, individuals of the less competitive species are forced into less favourable habitat, or shift their foraging time from day to night in the presence of superior competitors (Flecker and Townsend 1994, Townsend 2003).

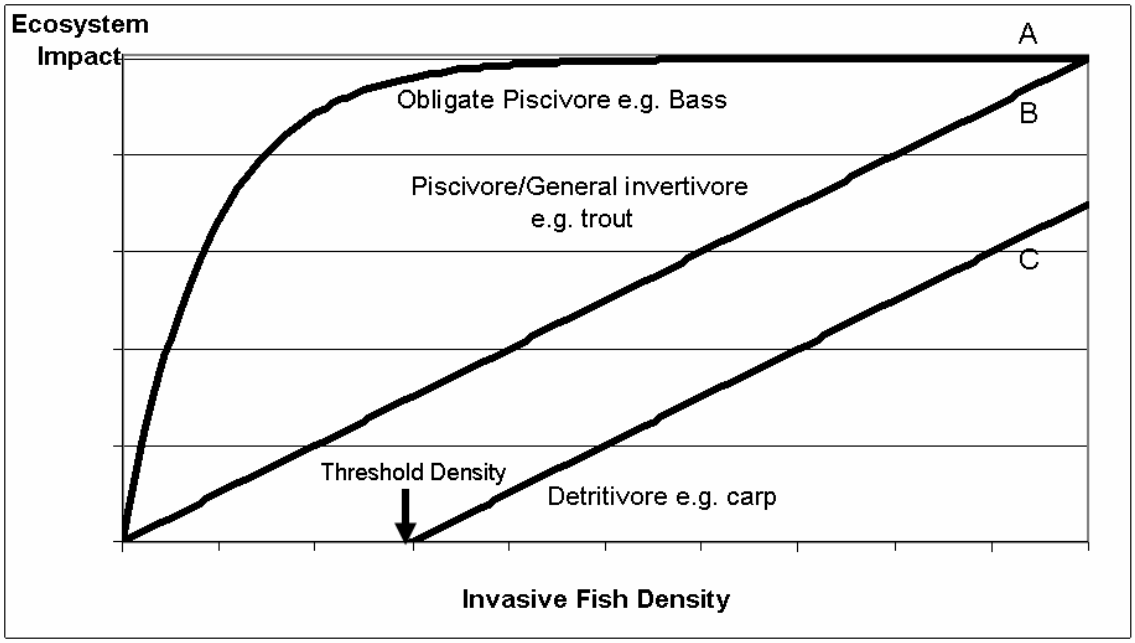

Figure 3: Model reflecting the impact of introduced species on an ecosystem with increasing population density; Line A represents an introduced species that has an immediate drastic impact on the indigenous assemblage; Line B represents a species having a linear impact; and Line C represents a species which only has an impact after having established to a threshold density in the new environment (Bomford and Tilzey 1997).

The mode of feeding also influences the degree of impact of competition. Species with similar ways of feeding, e.g. drift feeding (trout and Clanwilliam redfin), will directly compete for the same food items. Here, the more aggressive, or faster reacting, or larger species would outcompete other species. The impact of the more adept rainbow trout on native char in Japan is an example of such an interaction (Baxter et al. 2007).

Many factors influence the degree of interaction between individuals of different species, including the complexity of the habitat. For example, in an open gravel or sand substrate very little cover is available for the less competitive species to evade the superior competitor. In a complex habitat, such as a well-vegetated river or palmiet bed, there is abundant cover for the less competitive species to avoid the superior competitor. Behavioural interactions, such as aggressiveness, determine the outcome of competitive interactions.

Competition extends to reproduction, in the form of breeding sites. The degree of overlap between the reproductive strategies of the species and the selection of suitable breeding habitat further determines the degree of impact of introduced competitors. In the CFR, most of the indigenous species are summer spawners (only *Galaxias* spawn in winter) and most of the summer spawners are free spawners with no parental care (only Cape kurper is a brood guarder). Most of the introduced species are summer-spawning brood-guarders (black basses, bluegill, tilapiines) or winter spawners (trout). Despite breeding at the same time of year, however, competition for breeding habitat is not a significant factor in competition between introduced and indigenous fish species in the CFR.

Species recognised only as competitors have significant impacts on the recruitment of indigenous populations by preying on their eggs, larvae or juveniles. The degree of impact on

recruitment will depend on the trophic level of the introduced species. Studies have shown that, for instance, as little as 6% predation on juveniles can reduce recruitment to the indigenous fish stock to the extent that it is eliminated without juveniles being detected in the stomach contents of the introduced species (Meffe 1985). Persistent recruitment failure, or increased juvenile mortality usually results in the extirpation of the indigenous species even at low levels of egg, larvae or juvenile predation.

The impact of competition on indigenous fish assemblages will depend on the magnitude of the interaction. Globally, introduced fish have had negative impacts on the ecosystems into which they have been introduced. It is very rare that a freshwater fish introduction has resulted in a positive environmental impact, but some introductions have only marginal affect on indigenous species. A hypothetical model representing the impact of competition between introduced and indigenous fish assemblages is presented in Figure 4. Marginal impact occurs when the two species do not directly compete for resources but the presence of the introduced species reduced reproductive success and thus recruitment (Line A in Figure 4) e.g. the impact of trout on the nocturnal rock catlets. When the competition affects a population detrimentally, such as direct competition for food and reproductive resources this results in the indigenous species being relegated to marginal habitat as a result of the introduced species being a superior competitor. The indigenous population will decline to a level lower than the carrying capacity of the environment for that species (Line B in Figure 4). Competition for food and reproductive resources may affect the indigenous species to an extent that it is ultimately extirpated from the invaded reaches (Line C in Figure 4). A number of cases of competition causing the extinction of indigenous fish species as a result of the introduction of a superior competitor have been recorded from North America and New Zealand.

Predation

Naïvety of indigenous species has been reported as a major factor where indigenous assemblages have not evolved in the presence of piscivorous fishes (Cox and Lima 2006). These species generally lack the ability to recognize predator and do not engage in predator avoidance when a predator is present (Nannini and Belk 2006, Ylonen et al. 2007). This factor has been cited as being responsible for the decimation of the small cyprinid species of the Cape Floristic Region by introduced bass.

The predator strategies of capture, e.g. lurking ambush or active pursuit, determine the efficiency of the introduced species. For riverine species, active pursuit is more energy efficient than lurking ambush. In lakes, the lurking ambush is more energy efficient than active pursuit. This explains why smallmouth bass (active pursuit) are more efficient predators in rivers and largemouth bass (lurking ambush) are more successful in lakes. Physical factors such as gape limitation limit the size of the food items that can be taken (Claessen et al. 2002). Smallmouth bass are limited to taking prey individuals up to 120mm body length. Thus a reach invaded by smallmouth bass will support fish only larger than 120mm. Since all the indigenous species of the Cape Floristic region are less than 10mm as larvae, smallmouth bass become a biological filter, preventing recruitment. Only the large cyprinids of the Cape Floristic Region (Clanwilliam yellowfish, sawfin, whitefish and Clanwilliam sandfish) grow to be more than 120mm; bass-invaded reaches thus contain ageing populations of these larger species, which are finally extirpated through lack of recruitment.

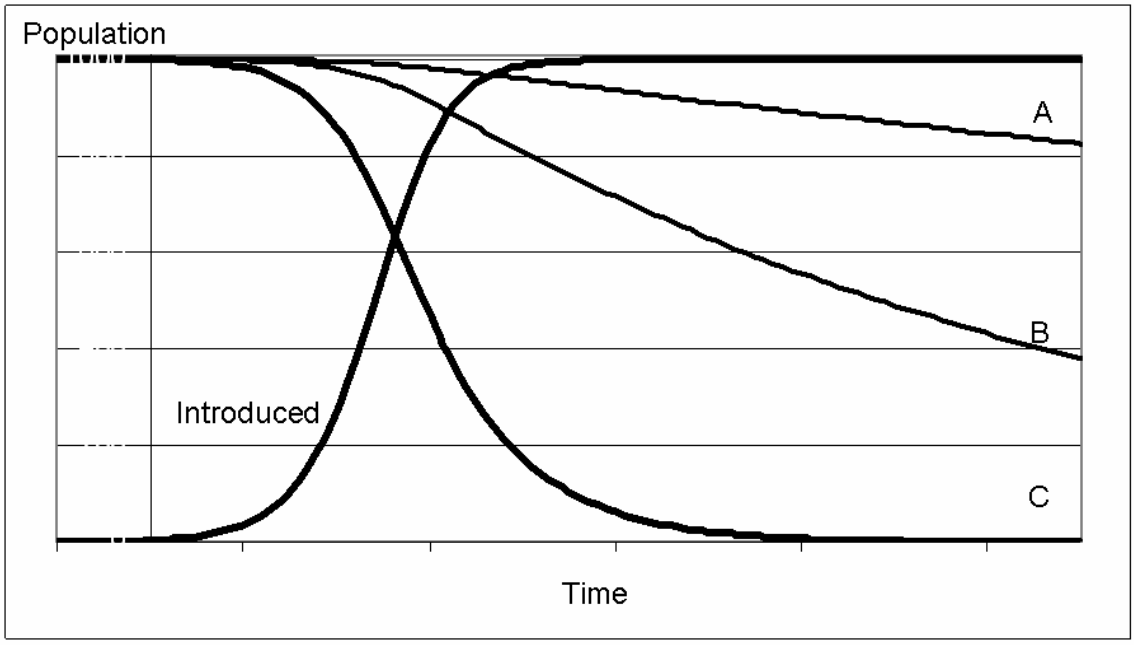

Figure 4: Hypothetical model reflecting the impact on indigenous fish population density of an introduced species at different levels of competition. Line A -competition between introduced and indigenous species has minimal impact on the indigenous species, Line B - competition has a moderate impact on the indigenous species, and Line C - competition has a significant impact on the indigenous species.

The extent to which the introduced species comes into contact with the indigenous species is determined by habitat cover, habitat complexity and the behavioural overlap between the species (Crowder and Cooper 1982, Dewey et al. 1997). Indigenous species that specialise in a particular type of habitat, e.g. fast water, may not be exposed to predation by introduced species which do not favour such habitat. Nocturnal species may avoid diurnal predators. An example of nocturnal species surviving invasion is seen in the rock catlet population which coexists with smallmouth bass in the Jan Dissels River when the remainder of the indigenous assemblage has been extirpated by the invasion of this river by smallmouth bass.

Predator density plays an integral role in maintaining the dominance of introduced fish in many rivers in the CFR. Smallmouth bass are frequently the only species present, having extirpated all indigenous fish from reaches where they occur. This results in a low bass biomass, frequently less than 10% of the fish biomass in uninvaded reaches where indigenous fish are present. During the invasion process the bass biomass is higher as it is sustained by the indigenous fish present. Once the indigenous fish have been extirpated, the streams can only support a small number of bass; the equivalent of an underwater desert.

The impact of predation on indigenous fish populations depends on the predatory species introduced. Bass have different impacts from those of trout, although both are classified as piscivorous in scientific literature. The hypothetical impact of introduced predacious fish on indigenous fish assemblages is presented in Figure 5, which could be read in two ways. Firstly, Figure 5 represents the impact of a single species (e.g. smallmouth bass) on different fish species within a specific fish assemblage - Line A represents *Pseudobarbus* redfins, Line B *Galaxias,* Line C larger cyprinids (yellowfish, whitefish, sawfin and sandfish) and Line D rock catlets. Secondly, Figure 5 could be interpreted as the impact of different introduced fish species on indigenous fish species e.g. for *Pseudobarbus* redfins, Line A represents the impact of smallmouth bass, line B the impact of largemouth bass, and Line C of trout.

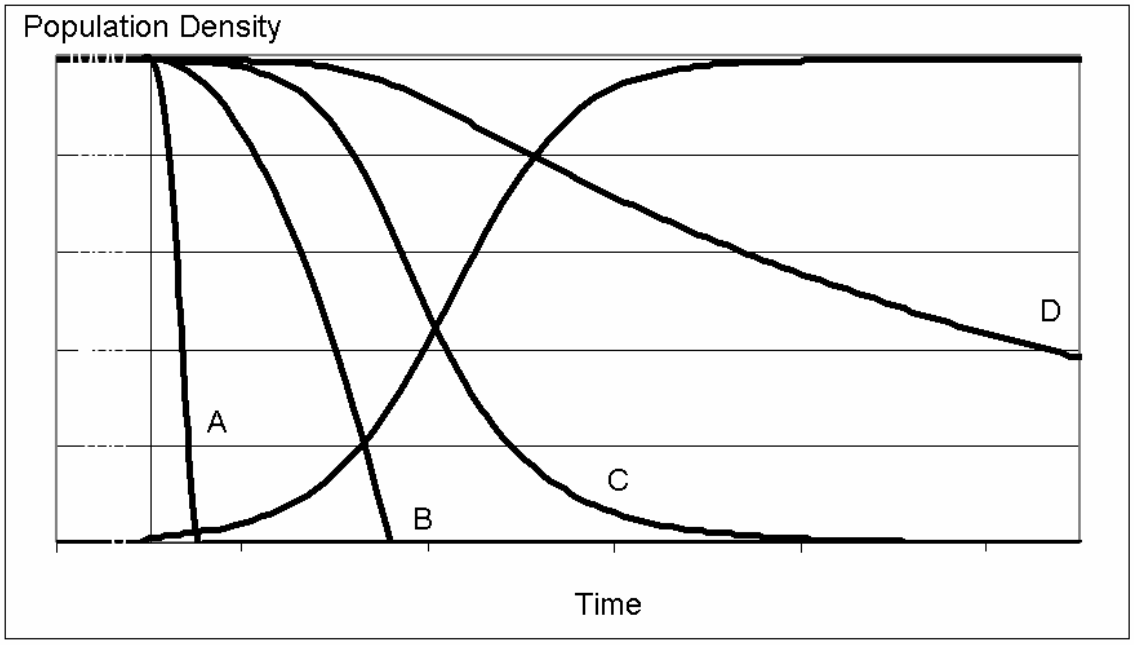

Figure 5: Hypothetical model reflecting the impact on indigenous fish population density of an introduced species at different levels of predation. Line A - a naïve species e.g. *Pseudobarbus* redfins which are rapidly extirpated by bass; Line B - a small species with limited predator avoidance; Line C - a large species whose recruitment is consumed by an introduced species e.g. yellowfish in the presence of bass; and Line D - a species that utilises behavioural (e.g. rock catlets -nocturnalality) or habitat specialisation (e.g. fast riffles) to avoid predation.

The result is clear: predacious fish have a devastating impact on indigenous fish assemblages. Of the natural water courses of the Cape Floristic region that are invaded by introduced fishes, most are invaded by smallmouth bass and the indigenous fishes have been restricted to relictual populations surviving above waterfalls or other barriers. It is clear that rehabilitation of the rivers of the Cape Floristic Region is required to secure the long-term persistence of the unique freshwater fish assemblages.

Rehabilitation of invaded systems

The rehabilitation of invaded systems involves the removal of the species that has resulted in the decline in indigenous fish assemblages. This can be very controversial, especially when popular angling species such as trout are involved. Habitat restoration has been proposed as an alternative to the removal of problem species but habitat restoration alone will not remove the limiting factor to the recovery of the indigenous fish population – the presence of the

introduced fish species. Studies in the USA have shown that habitat restoration may improve the conditions for introduced species, which flourished and so prevented the recovery of the indigenous assemblages (Cowx and van Zyll de Jong 2004). Many pristine rivers in the CFR have been invaded by introduced fish species and the indigenous species have been totally extirpated. No amount of habitat restoration will restore the indigenous species without first addressing the presence of introduced species.

Considering a species like smallmouth bass, which has a large impact at low population densities, a greater than 90% reduction in the density of the species is required to reduce the ecosystem impact of this species to 50% of the current impact of this species (Figure 6). To maintain the ecosystem impact at this level, the removal of this species in required in perpetuity. In order to restore the indigenous fish assemblages, especially the smaller cyprinid species (redfins and barbs), the total removal of the invasive species is required. Without complete removal, the population of the invasive species will again follow the population growth curve presented in Figure 2.

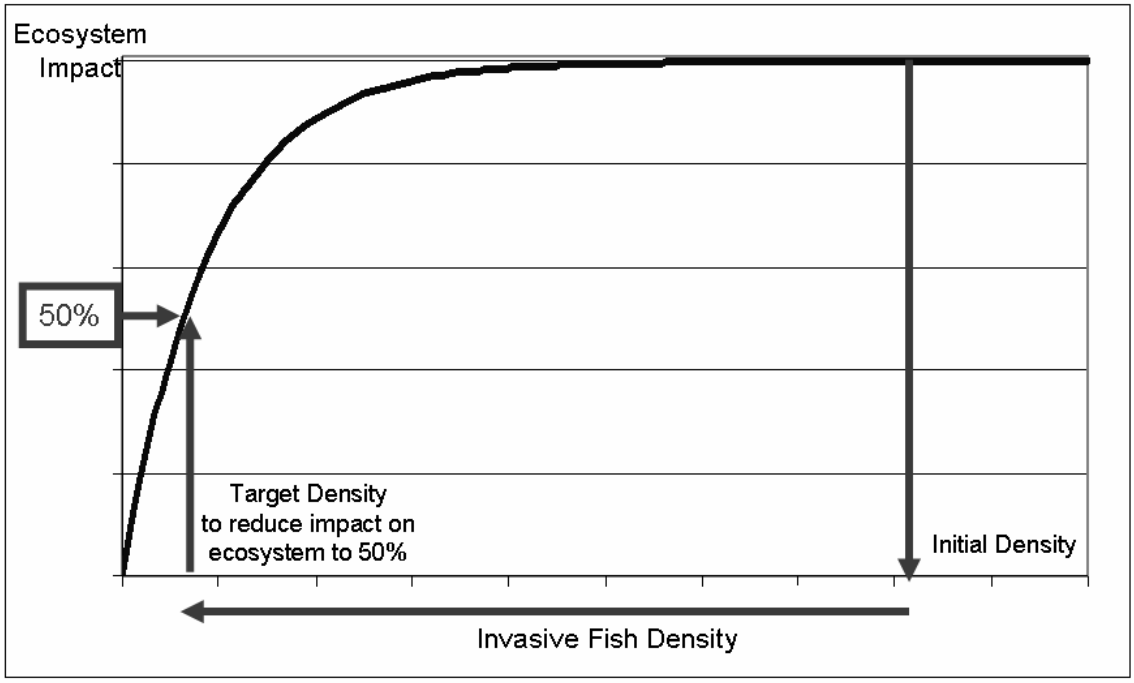

Figure 6: Model reflecting the extent of eradication required to reduce the level of impact on the ecosystem of an invasive species to 50% of the current level

At the various stages of the invasion process (Figure 1), different strategies for introduced species control are required. It is best to prevent introduction of non-indigenous fish species and this should be the aim of conservation agencies (IUCN 2000). When an introduction is reported, it is most efficient to remove all the fish before the species becomes established and naturalised in the new system. In these early stages, eradication of the introduced species is the most efficient means of dealing with the invasion (Figure 7) (IUCN 2000). This highlights the need for an "*Early Detection-Rapid Response*" system for the conservation agency to actively deal with new invasions. An Early Detection-Rapid Response system requires an information collection system, which recognises new invasions, and a response authority that is adequately supported financially to be effective.

Once the newly introduced species begins to spread through a system, control of the expansion of this species in the new system is required (Figure 7). Barriers are the most effective means of ensuring that the introduced species does not expand its range unhindered.

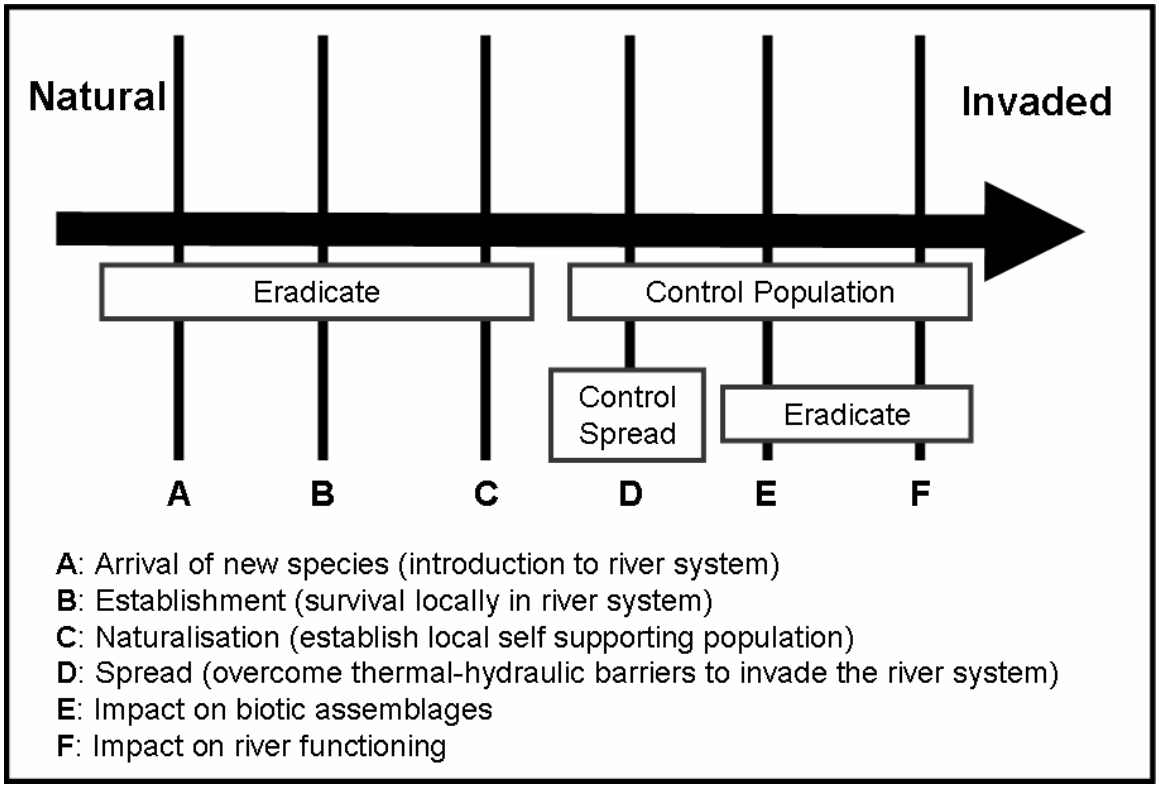

Figure 7: Introduced species response strategies appropriate for the various stages of the invasion process.

Barriers do have their drawbacks as they sever the longitudinal connectivity of the river system. Temporary barriers which can be installed to prevent further invasion need to be developed to improve the control of the expansion of introduced species until the population can be eradicated. Once the invasion has reached its full potential, the only method of rehabilitating the river is to eradicate the introduced fish species from the river, one reach at a time. With more than 99% of the river in the Cape Floristic region invaded, removal of introduced fish from even 10% of these would help conserve the indigenous fish assemblages in perpetuity without impacting on recreational angling activities.

During the initial stages of an introduction, mechanical removal, including netting and electrofishing, or chemical treatment by a piscicide (if the introduction is localised) can be employed. The total removal of the founder population is required. While the densities are low and the population localised, such removal techniques are effective. Once the densities increase and the invaded area increases, mechanical removal becomes less effective, but may be the method of choice if there are still large stocks of indigenous fish species. Once the invasion has matured and the indigenous assemblage replaced by an introduced assemblage, the use of piscicides is the most cost-effective method for rehabilitating the biotic assemblage of the invaded river reach, but this must be approached with the due diligence and duty of care required to ensure no net loss of indigenous species from the system.

Barriers to Eradication of Invasive Fish Species

In order to rehabilitate a river reach to a more natural state, the introduced fish species need to be eradicated totally. In order to achieve this eradication, a number of barriers need to be traversed (Figure 8). These barriers are not biological, but economic and socio-political. Before eradication can be attempted, a viable eradication technique is necessary. This eradication technique should result in the total eradication of the invasive species from treated river reaches and should provide mechanisms for the subsequent exclusion of the invasive species, thus preventing re-invasion of the reach. An example of an eradication technique would be the use of a piscicide (e.g. rotenone or antimycin A) to eradicate all fish from a selected river reach which is bounded by a barrier (e.g. weir or waterfall) at the lower limit of the intervention zone. Prior to eradication, rescue populations of indigenous species (fish, frog and invertebrates) would be established to restock the rehabilitated reach after the intervention. Rehabilitation of a river is not a simple exercise and a detailed plan is required to ensure that the rehabilitation is conducted with the minimal impact on the non-target taxa. An EIA would be performed prior to intervention to identify specific species which need rescue populations.

Costs of Alien Fish Removal

To close this paper, I would like to provide a comparative cost (fiscal) for various eradication techniques. For mechanical removal such as electrofishing and netting, the cost of removing an additional individual increases as the population density of the organism in the rehabilitation area decreases (Choquenot et al. 2004). There is a base cost of maintaining a rehabilitation team in the field (indicated by the shaded block in Figure 9). The space between the base cost and the line represents the cost of removing an individual at the population density. As the density of the target organisms decreases (by the removal of individuals) the cost to remove further individuals increases. The total cost of removal is the area under the removal line (Bomford and Tilzey 1997). For rehabilitation using piscicides, the cost of removal is a single value for the intervention as it is independent of the density of the target organisms. Literature indicates that the effort required to remove smallmouth bass from a small stream in the USA was in the order of 800 hours backpack electrofishing per 100m of river (Knapp and Matthews 1998). Taking into account that a backpack electrofishing team consists of at least 5 members per 2m of river width, this can be converted into the cost of the eradication.

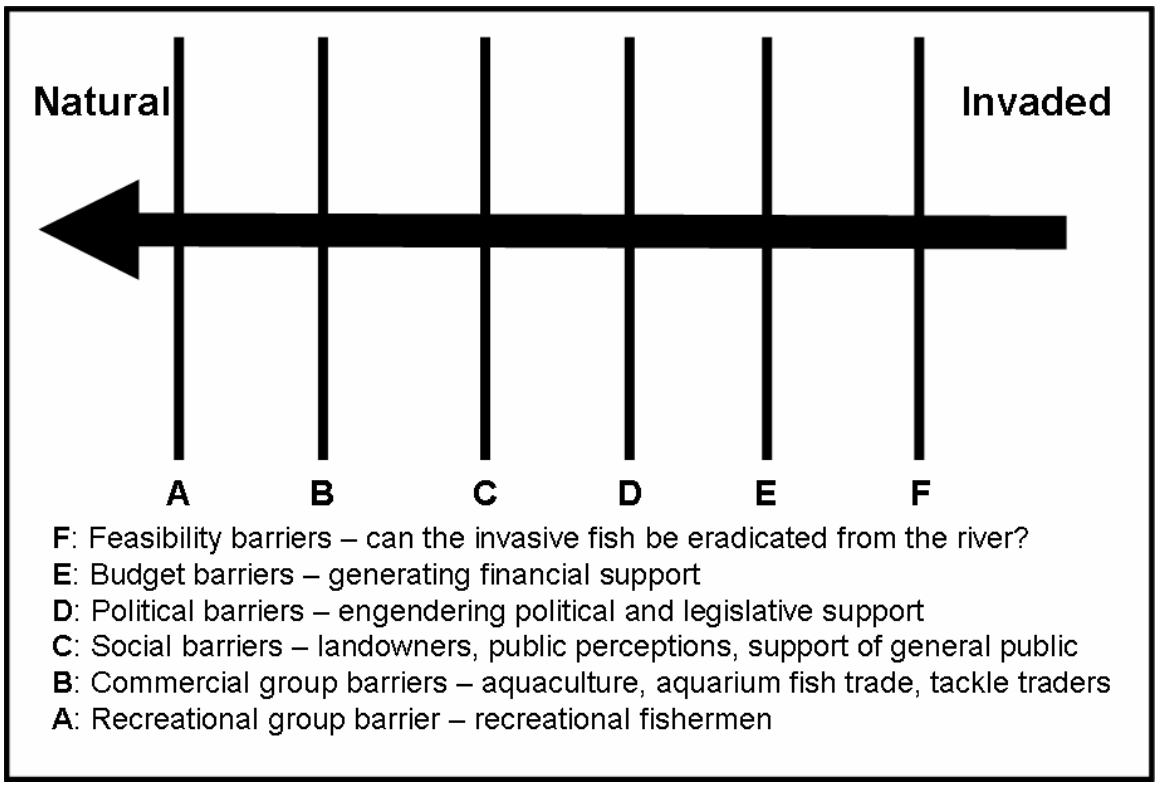

Figure 8: Model reflecting the increase in population density of an introduced species over time

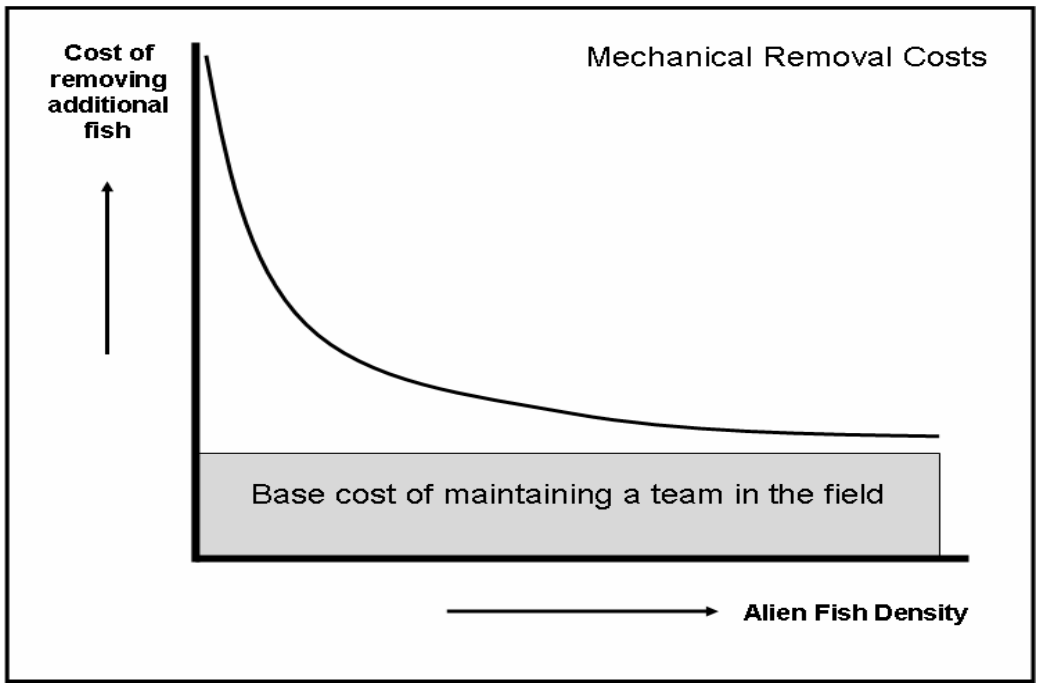

Figure 9: Model reflecting the increase in population density of an introduced species over time (Bomford and Tilzey 1997, Choquenot et al. 2004)

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FLOW AND HABITAT REQUIREMENTS OF SAWFIN (*BARBUS SERRA*) AND CLANWILLIAM YELLOWFISH (*LABEOBARBUS CAPENSIS*)

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1.1 INTRODUCTION

The findings of a WRC funded study of sawfin (*Barbus serra*) and Clanwilliam yellowfish (*Labeobarbus capensis*) in the Driehoeks River, Western Cape that was conducted between 2004 and 2006 are summarised here. The primary objective of this study was to describe and quantify the habitat and flow requirements of the two species, with a focus on the early life stages and spawning requirements.

1.2 HABITAT SELECTION BY SAWFIN

Habitat Suitability Criteria (HSC) were used to describe the hydraulic (velocity and depth) as well as substratum habitat utilisation by Clanwilliam sawfin and Clanwilliam yellowfish. The study included all life stages and behaviours of both species. No reproductive activity by Clanwilliam yellowfish was observed and spawning and larval habitat could therefore not be described. An example of HSC produced for sawfin is shown in Figure 1. Larval sawfin measuring between 5-20 mm TL selected very shallow slackwaters (<0.15 m) along river shorelines and the edges of sandbars for the first 30 days post-hatching (Figure 1). Older juvenile sawfin (> 30 days old) began exhibiting schooling behaviour and migrated several kilometres downstream. These sawfin, (21-75 mm TL) made use of slightly deeper inshore bays (< 0.5 m) during the day. Adult spawning although measured current speeds at the spawning sites were highly variable due to turbulence (0.3-0.8 m s^{-1}). They selected shallow riffles with swifter currents and gravel and cobble substrata. Significant differences were found between larval, juvenile and adult life stages, as well as between species. The differences between life stages are so marked that they could be considered as separate 'ecological species'.

1.3 MODELLING HYDRAULIC HABITAT

The primary of objective of this component of the study was to evaluate the suitability of a 2-D hydraulic modelling programme – River2D (Blackburn and Steffler 2002; University of Alberta 2002) – for simulating the habitat of Clanwilliam yellowfish and sawfin. This component of the study formed part of a collaboration with a related WRC Project "Ecohydraulic modelling in river systems" (WRC Report No. 1508/1/07; Hirshowitz *et al.* 2007) that aimed to investigate a range of alternative methods – including 2-D hydraulic modelling – for predicting the impacts of flow modification on habitat-defining hydraulic conditions in rivers. The HSC derived for Clanwilliam yellowfish and sawfin described in Section 1.2 were combined with the simulated depths and velocities generated by River2D and measured substratum particle sizes into Combined Suitability Indices (CSIs). An example of the output of these models for adult Clanwilliam yellowfish and sawfin larvae is shown in Figure 2. There was a strong spatial correspondence between adult yellowfish positions and the highest CSI values predicted by River2D (Figure 2a). CSI values predicted for larval Clanwilliam sawfin ranged between 0-0.8 and most of the most suitable locations were predicted to be along the marginal slackwaters immediately downstream of the riffle. There was a good spatial correspondence (visual association) between the highest CSI values and surveyed larval fish positions (Figure 2b).

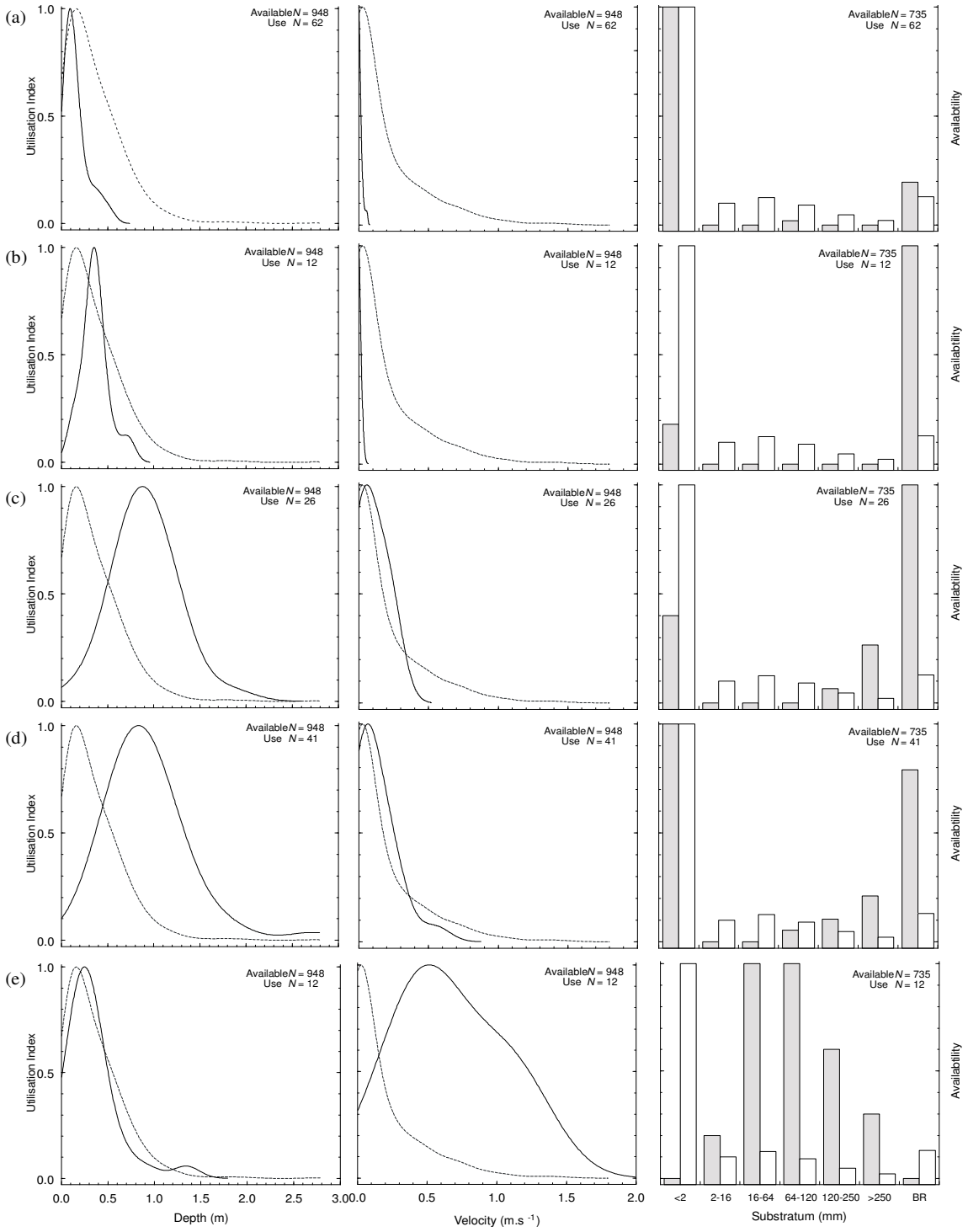

Figure 1 HSC produced for sawfin. Kernel-smoothed density distributions of depth (m) and velocity (m s^{-1}) (broken lines = availability, solid lines = use) and frequency distributions of substratum utilisation (open bars = availability, shaded bars = use) for (a) 5-20 mm TL; (b) 21-75 mm TL; (c) 76-150 mm TL; (d) >150 mm TL and (e) spawning sawfin.

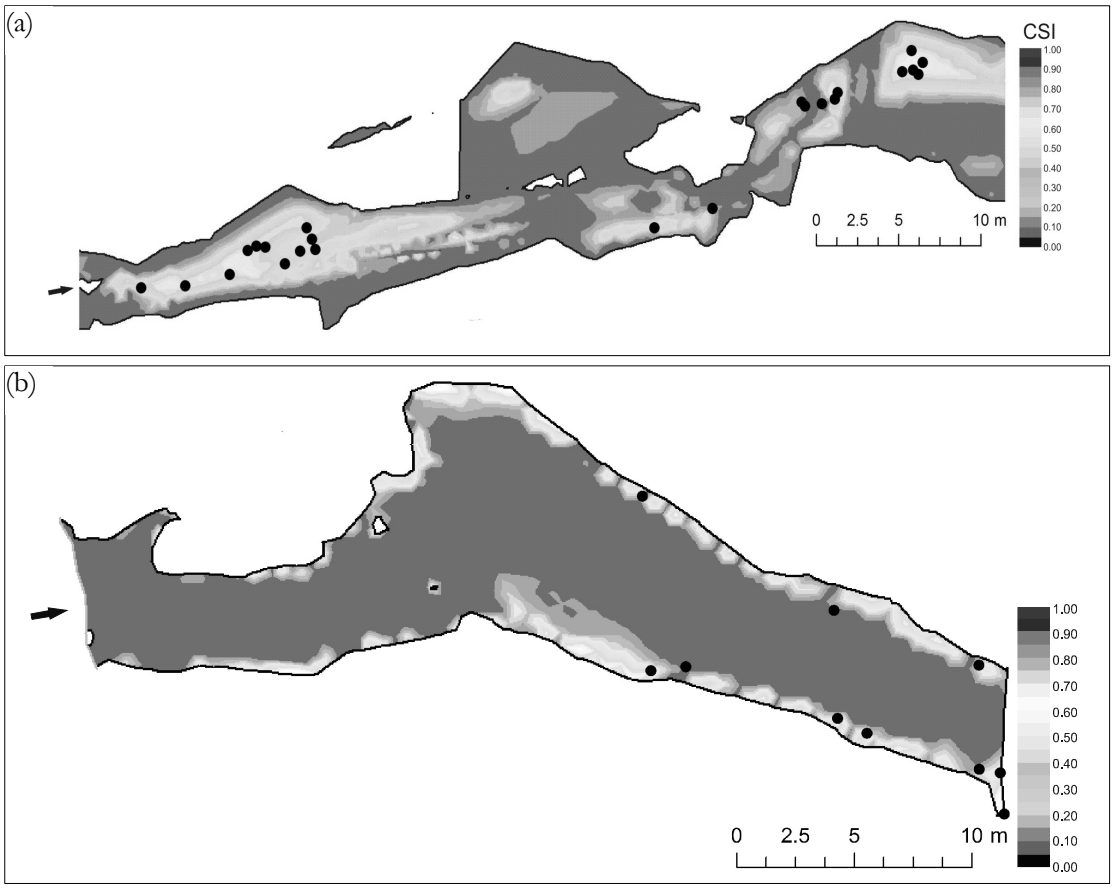

Figure 2 Two hydraulic models outputs of two sites produced for (a) adult Clanwilliam yellowfish and (b) larval sawfin. The graded shades represent Combined Suitability Indices (CSI) and the black circles actual fish positions surveyed in during the course of fieldwork. The arrow shoes the direction of the current

1.4 TEMPERATURE AND FLOW REQUIREMENTS OF SPAWNING SAWFIN

The primary objective of this component of the study was to examine how environmental conditions in the Driehoeks River, in particular river discharge and water temperature, influenced the timing, frequency and duration of spawning by sawfin by means of spawning date analysis. In addition to river flow and temperature: water temperature, barometric pressure, mean daily wind speed and solar radiation were also measured. The study focussed on sawfin since Clanwilliam yellowfish did not spawn for two years running.

Spawning commenced 50 days later in 2005 than 2004, although the length of the reproductive season in both years was similar (approximately three months). Despite the late start in 2005, temperatures in September and October were comparable between the two years, the predominant difference being the larger floods and higher base flows in 2005. This suggests that the 2005 higher flows played a role in delaying spawning for the earlier part of the reproductive season.

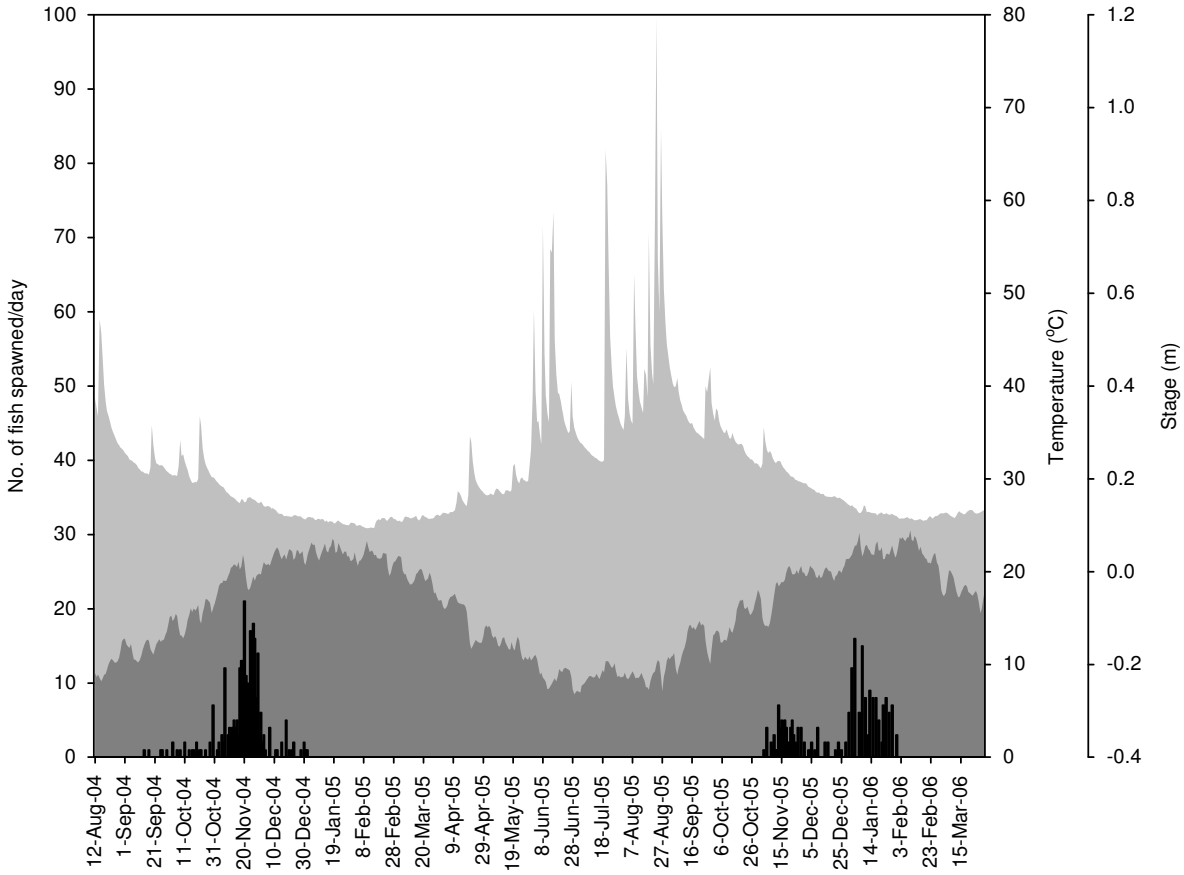

Figure 3 Distribution of spawning events over the course of the study period 2004-2006: spawning distribution (black bars), temperature (dark grey) and river stage (light grey).

There was no evidence that flood events (spring freshets) prior to or before peak spawning periods cued spawning as has been hypothesised for Clanwilliam yellowfish (Cambray et al. 1997; King et al. 1998). Sawfin therefore commence spawning towards the end of the high flow season on the recession limb of the winter flow hydrograph after the final floods and once temperatures start rising. In this way they are able to take advantage of the higher flows before the flow drops too low and hydraulic conditions at the spawning sites become unsuitable.

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THE IMPACT OF INVASIVE SMALLMOUTH BASS ON THE FOOTHILL RIVER ECOSYSTEMS IN THE CAPE FLORISTIC REGIONS.

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Presented by Sean Marr to Yellowfish Working Group at Jonkershoek, Western Cape, on the 21st of March 2008. This work has been published in part (Lowe *et al.* 2008) with further manuscripts in preparation.

Introduction

The exceptional biodiversity of the Cape Floristic Region (CFR) is under increasing threat from habitat destruction and fragmentation by agricultural and urban development, invasion by introduced alien species and the potential effects of global warming. The freshwater ichthyofauna of the CFR represents a hotspot of endemism, with 16 of the 19 currently described indigenous species being regionally endemic (Impson *et al.* 2002). Fifteen of the indigenous species are listed as threatened, nine of these being considered endangered or critically endangered (Baillie and Groombridge 1996). Although the region is relatively species-poor with respect to fish, new species are currently being recognized as a result of genetic studies (Swartz *et al.* 2007).

The freshwater invertebrate fauna of the CFR shows high levels of endemism and diversity: approximately two-thirds of the species of the CFR are endemic to the region and represent one-third of South Africa's freshwater invertebrate species (Wishart and Day 2002). There are doubtless many species yet to be described and the conservation status is known for but a few species.

One of the greatest threats to the biodiversity of the CFR is the spread of invasive species. The impacts of alien invasive fish on South African rivers are not well understood. There are 16 species of introduced fishes in the CFR alone with smallmouth bass (*Micropterus dolomieu*) being one of the most successful invaders (Impson *et al.* 2002). *M. dolomieu* was first introduced into the Western Cape in 1937 and to the Olifants River in 1943 (Harrison 1953). Since then, *M. dolomieu* has become established in all the major river systems in the Western Cape (de Moor & Bruton 1988), eliminating indigenous fish species from the river reaches they have invaded such that indigenous fishes are now largely confined to smaller tributaries and headwaters, often above waterfalls that have prevented the upstream spread of invasive fishes (Gaiger *et al.* 1980). *M. dolomieu* has been implicated in the decline of six endemic species in the Olifants River (de Moor & Bruton 1988) amongst others (Impson *et al.* 2002) and several observations and studies have noted the lack of co-occurrence of bass and smaller indigenous fishes (Harrison 1953, Skelton 1993, Christie 2002 (pers. com.), Shelton 2003 (pers. com.), Woodford, 2005) or the young of larger indigenous fishes (Woodford 2005). In South Africa to date, however, no studies have investigated the impacts of *M. dolomieu* at multiple trophic levels.

Studies from other countries have shown that invasive fish can exert impacts on river ecosystems by changing the abundance, composition or behaviour of grazing invertebrates, leading to changes in autochthonous production and the rate of nutrient turnover (Flecker and Townsend 1994, McIntosh and Townsend 1996, Diehl *et al*., 2000, Simon *et al.* 2004). In their native range, *Micropterus sp.* have been shown to have a profound influence on river ecosystems by influencing their fish prey (Power and Matthews 1983). Lakes invaded by *Micropterus sp.* have shown depletion of fish prey and negative consequences for resident predatory fish. The ecosystem-wide impacts of invasive fishes are difficult to predict and depend on the life history of the invader, the structure of the invaded community and the environment's physical characteristics. The mechanisms of impact may be complex and cascade across ecosystem boundaries affecting the riparian and terrestrial systems (Baxter *et al*., 2004; Knight *et al*., 2005).

The purpose of the studies presented in this paper was to investigate whether *M. dolomieu* influences river communities of the CFR beyond those already documented for indigenous fish species. Information regarding the responses of the indigenous communities to invasion will contribute to motivation for conservation and prioritisation of action to safeguard rivers threatened by freshwater fish invasions that are so extensive in the region.

Key Questions

Do bass influence native ecosystems beyond the established impact on indigenous fish?
What are the mechanisms of any impacts?

Study Sites

Three rivers were studied in the region: The Rondegat River and Ratels River in the Cederberg, both tributaries of the Olifants River; and the Witte River in the Limietberg, a tributary on the Breede River.

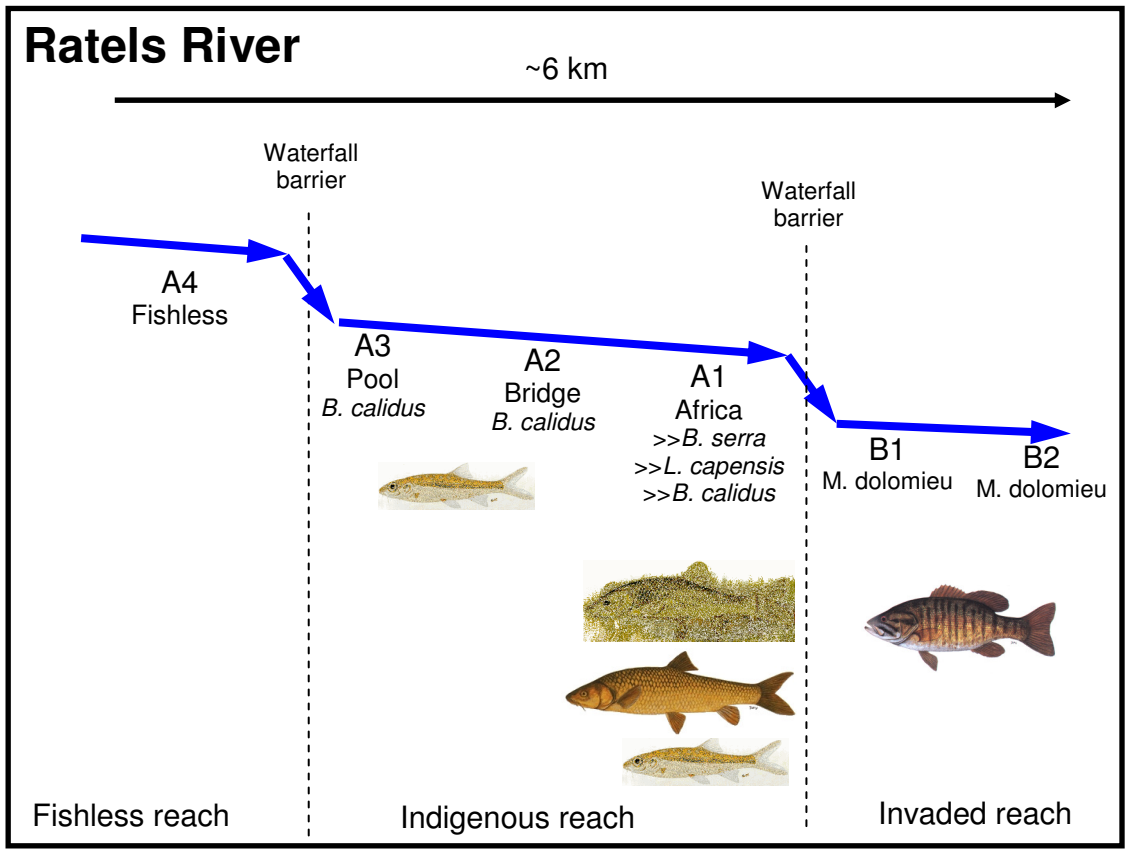

Figure 1: Diagram showing the three zones of the Ratels River and relative position of the sample sites on the Ratels River, Cederberg

Ratels River

Three zones were recognised for this study: a historically fishless zone, a zone containing indigenous species (Clanwilliam redfin, Clanwilliam yellowfish and sawfin), and a zone invaded by smallmouth bass (Figure 1). Six sample sites were established, one in the fishless zone, three in the indigenous species zone and two in the invaded zone.

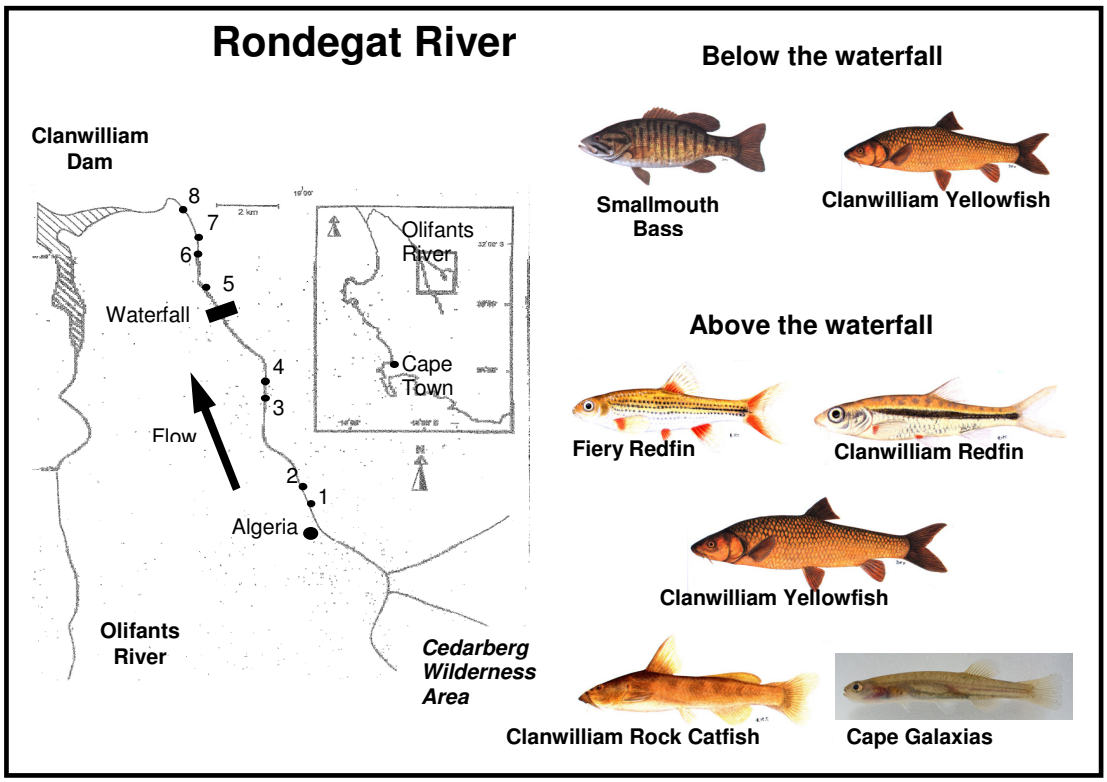

Figure 2: Diagram showing the two zones of the Rondegat River and relative position of the sample sites on the Rondegat River, Cederberg

Rondegat River

Two zones were recognised for this study: a zone containing indigenous species (Clanwilliam redfin, Clanwilliam yellowfish, Clanwilliam rockcatlet, fiery redfin and Cape galaxias), and a zone invaded by smallmouth bass which holds a population of Clanwilliam yellowfish (Figure 2). Eight sample sites were established, Four in the indigenous species zone and four in the invaded zone.

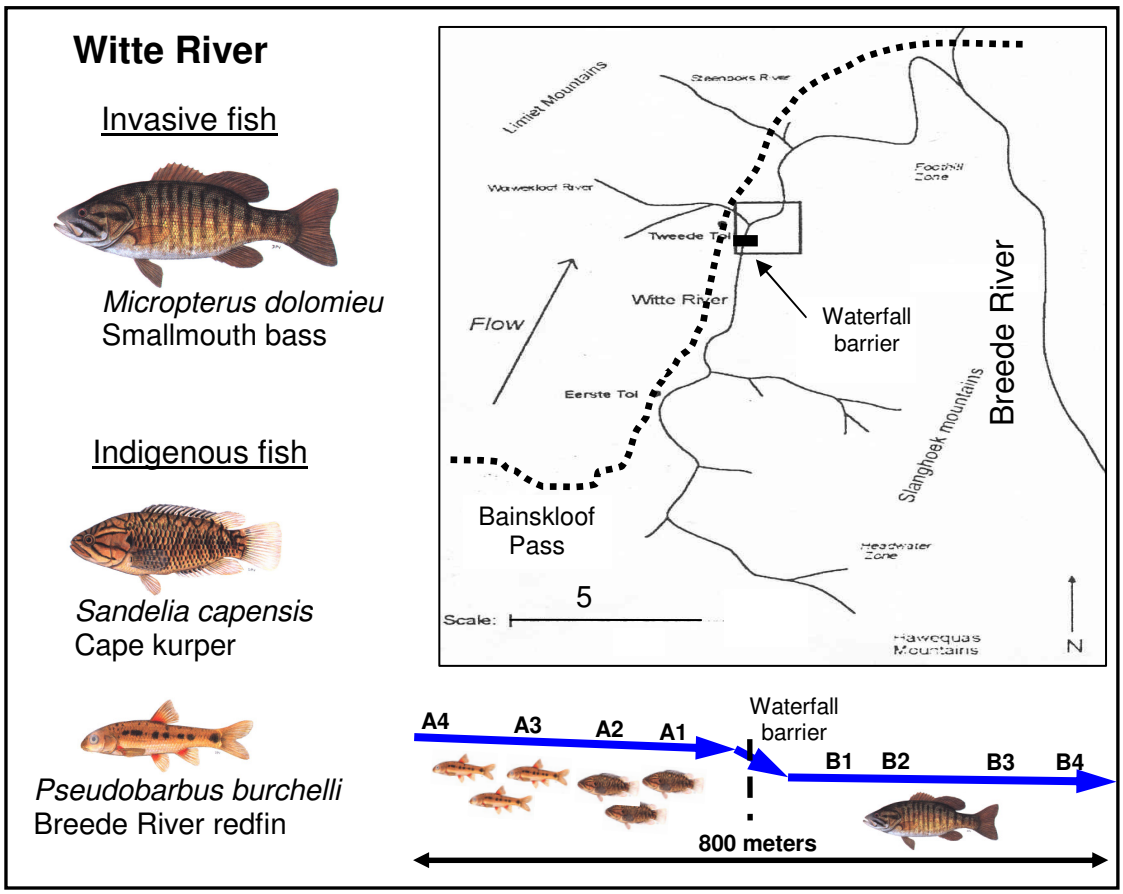

Figure 3: Diagram showing the two zones of the Witte River and relative position of the sample sites on the Witte River, Bainskloof

Witte River

Two zones were recognised for this study: a zone containing indigenous species (Breede River redfin and Cape kurper), and a zone invaded by smallmouth bass (Figure 3). Eight sample sites were established, four in the indigenous species zone and four in the invaded zone. Longfin eels are known to occur in both zones and Cape galaxias were also observed in both zones.

Methods

Seasonal samples of the following were collected and analysed:

Fish: collected for length/weight measurements and for gut content analysis by hand and seine nets (small fishes), rod and line fishing (bass) and electroshocking (all species). Abundance/biomass estimates by 3-pass electrofishing and/or snorkel surveys.

Invertebrates: kick sampling (benthos and marginal vegetation), box sampling (benthos), individual stone sampling, drift sampling, foraging behaviour by observation and light trapping for flying adults. Identification was to family or genus and functional feeding group (FFG). Biomass was calculated from known biomass of individual taxa.

Algae: scrubbed from stone surfaces and measured for chlorophyll A.

Physical characteristics: Water chemistry, shading from plants, banks and valley sides, benthic composition, proportion of marginal vegetation, discharge.

Analysis: Multivariate analysis of similarity (PRIMER) was used for invertebrate community composition analysis. Univariate statistics (both parametric and nonparametric for paired or

unpaired samples, where appropriate) were used to analyse differences between sites for individual taxa or algal abundance.

Results and discussion

In all three rivers only large representatives of the larger cyprinids (yellowfish and sawfin on the Ratels River; yellowfish on the Rondegat River) or eels (Witte River) were observed in reaches invaded by bass. [Note that the whitefish historically occurred in the Witte River but have been extirpated by the invading smallmouth bass.] The total biomass of fish at invaded sites compared to sites with indigenous fish was reduced by 9-fold on the Rondegat River (with the exception of one pool, Table 1), an equivalent amount on the Ratels River and by approximately 40% on the Witte River (abundances presented in Table 2). Few fish and crabs were found in bass stomachs although these items contributed a large proportion of the total biomass of the bass diet relative to their abundance. The low abundance of fish in bass diets is likely due to the bass populations being established on all three of the rivers for several decades and the fact that bass have eradicated their preferred prey. Woodford *et al.* 2005 showed a lack of young yellowfish at sites on the Rondegat River where older yellowfish co-occurred with bass.

Table 1: Average mass (grams) of fish species per site over three sampling occasions.

site	*Austroglanis gilli*	*Barbus calidus*	*Pseudobarbus phlegethon*	*Labeobarbus capensis*	*Micropterus dolomieu*	Average total mass/site (SD)
1	150	574	31	1725	0	2480 (1484)
2	182	171	7	25	0	385 (93)
3	508	195	42	666	0	1410 (180)
4	218	201	22	693	0	1134 (380)
5	0	0	0	10626	85	10711 (7455)
6	0	0	0	158	0	158 (178)
7	0	0	0	0	122	122 (75)
8	0	0	0	0	111	111 (77)

Table 2: Impact of smallmouth bass in the Witte River, Bainskloof (Shelton 2003)

Species	No. above waterfall	No. below waterfall
Breede River Redfin	1667	4
Cape Kurper	353	2
Smallmouth Bass	0	13

Gut content analysis shows that aquatic invertebrates are highly abundant in the guts of both bass and indigenous fish but that the specific taxa (at family or genus level) of these invertebrates differ markedly. The total biomass of benthic invertebrates (excluding crabs) consumed at sites with bass was far lower than at sites with indigenous fishes on both the Witte (Figure 4) and Rondegat Rivers. Extensive observations show that plant material ingested by the indigenous fishes is a consequence of by-catch when targeting invertebrates living within the algal or detritus matrix rather than deliberate grazing.

These results suggest that the predation pressure on most aquatic insects is much reduced at sites without indigenous fishes i.e. in fishless zones or where bass have invaded and extirpated indigenous fish.

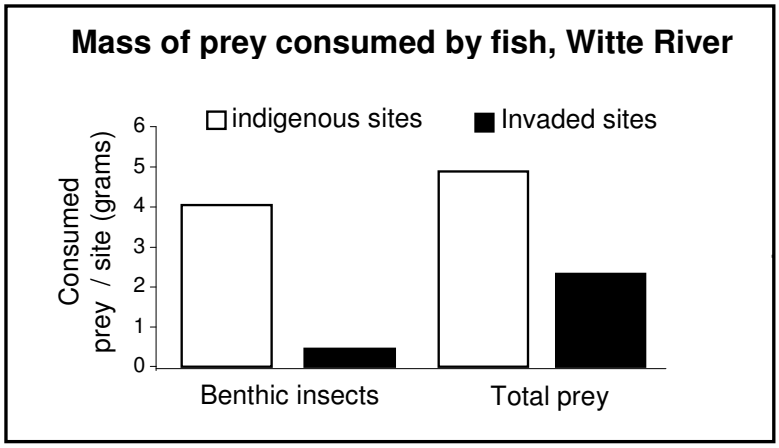

Figure 4: Comparison between the mass of prey consumed by fish in the indigenous fish and invaded zones of the Witte River.

The impact of bass invasion on the invertebrate community shows a consistent generalised pattern on all three rivers: Invertebrate communities show significant dissimilarities between invaded and non-invaded reaches as determined by multivariate analysis of community structure (Figure 5). However, the specific impact on individual taxa is variable between the three rivers. The impact is also habitat dependent, with invertebrate communities from most benthic substrates, with the exception of fine sediments and sand, being most consistently affected. Invertebrates in pools are more strongly affected than those in faster flowing water, which possibly acts as a refuge from predation due to the energetic demands on fish feeding at high velocities, as shown in other studies (Schlosser & Ebel 1989). Invertebrate communities in marginal vegetation appear to be buffered to some extent from changes in fish predation pressure although some taxa (including Baetidae) were still in far greater abundance at bass-invaded or fishless sites. Habitat complexity has previously been shown to reduce impacts of native and invasive fish (Power 1992). The most consistent effects are reductions of grazing invertebrate taxa that frequent the upper surfaces of stones. Changes in the invertebrate community at sites invaded by bass compared to those with indigenous fishes were only apparent from early to late summer on the Witte River (November to April). In winter and spring (May to September) few fish were seen at any site on the Witte River and low temperatures and high, scouring flows 'reset' the river ecosystem.

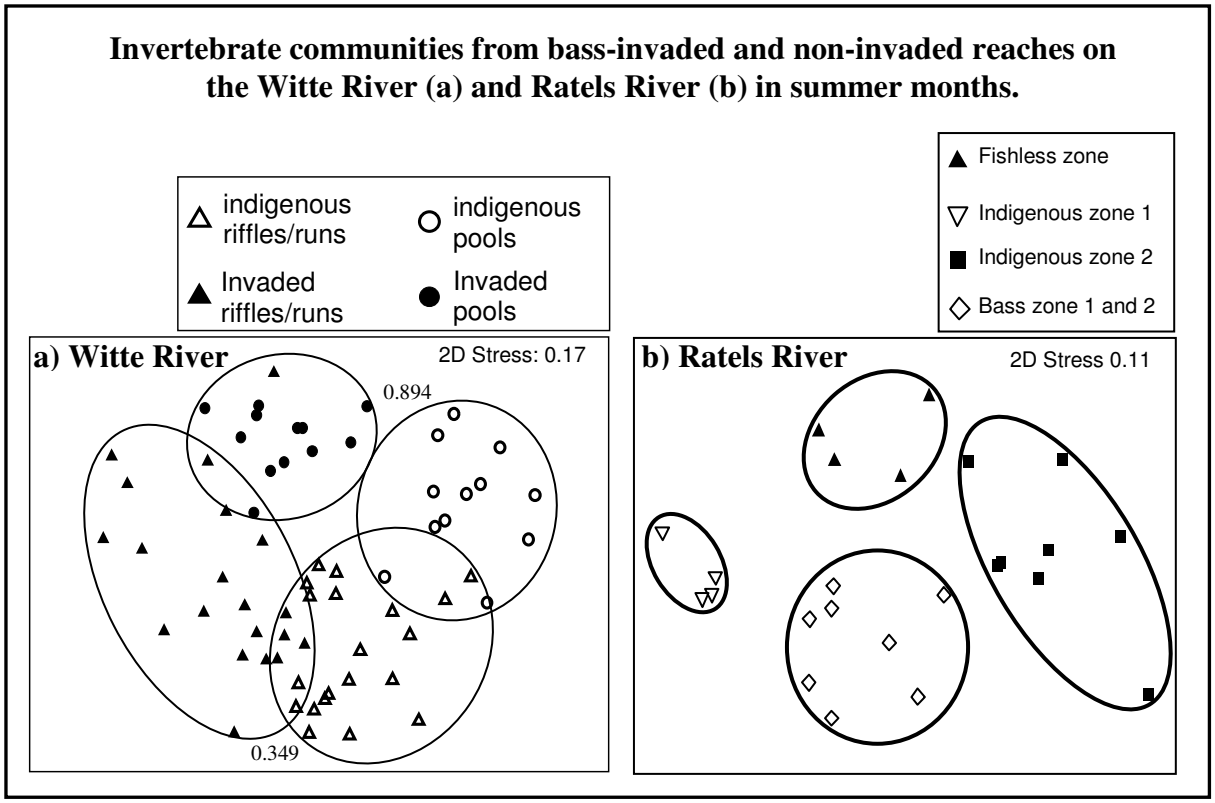

Figure 5: Comparison between the invertebrate communities in the indigenous fish and invaded zones of a) the Witte River, and b) the Ratels River.

The abundances of invertebrates on rocks in the Witte River are presented in Figure 6 with Baetidae and Simuliidae showing significantly greater densities at bass-invaded sites than at sites with indigenous fishes. In still water (pools) cased trichoptera larvae were also significantly greater at invaded sites. The densities of most other taxa were higher at non-invaded sites with Shannon diversity (H') being significantly higher at these sites.

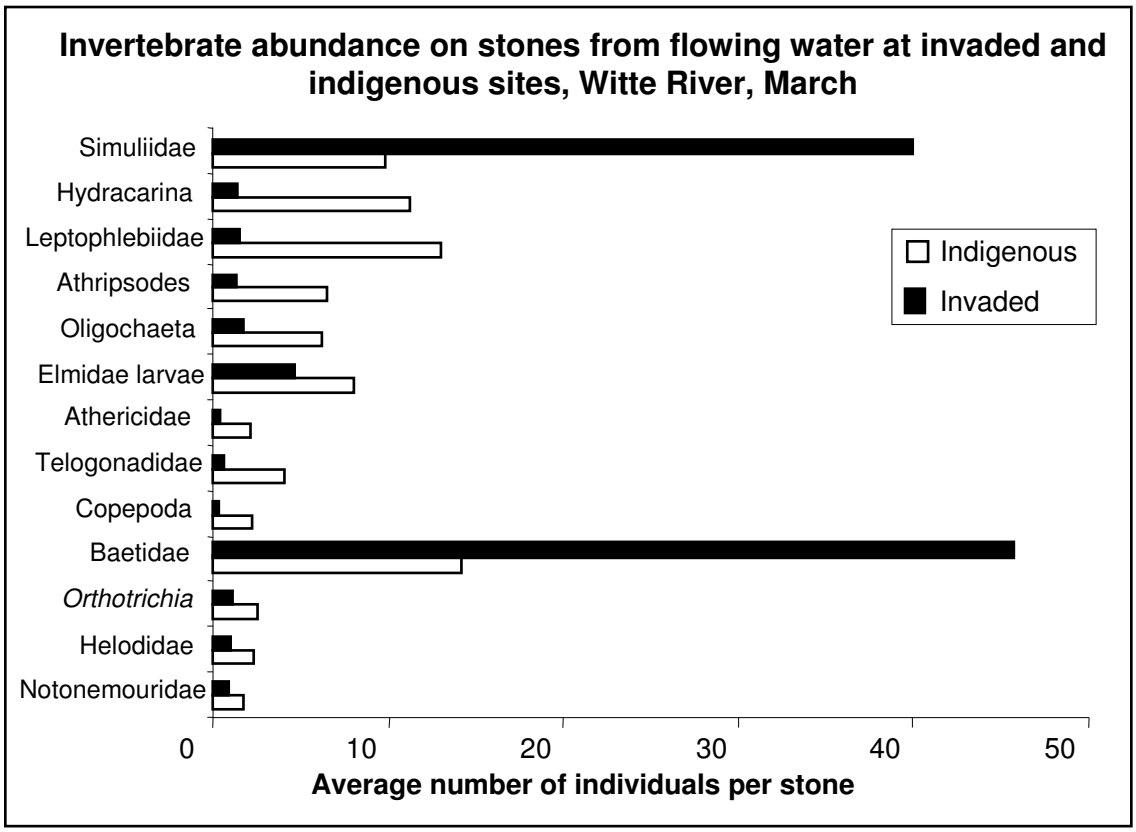

Figure 6: Comparison between the macroinvertebrate abundance on stones in flowing waters in the indigenous fish and invaded zones of the Witte River.

It is likely that in non-invaded reaches, high predation intensity on stone-surface grazing and scraping insect taxa by indigenous fishes relative to bass, suppresses the competitively dominant taxa (such as the larvae of Baetidae, Leptocerid trichoptera and Simuliidae). Upon invasion by bass and extirpation of indigenous fishes, these dominant invertebrate competitors out-compete other taxa which use the algal food resource with subsequent effects throughout the invertebrate community (Figure 7).

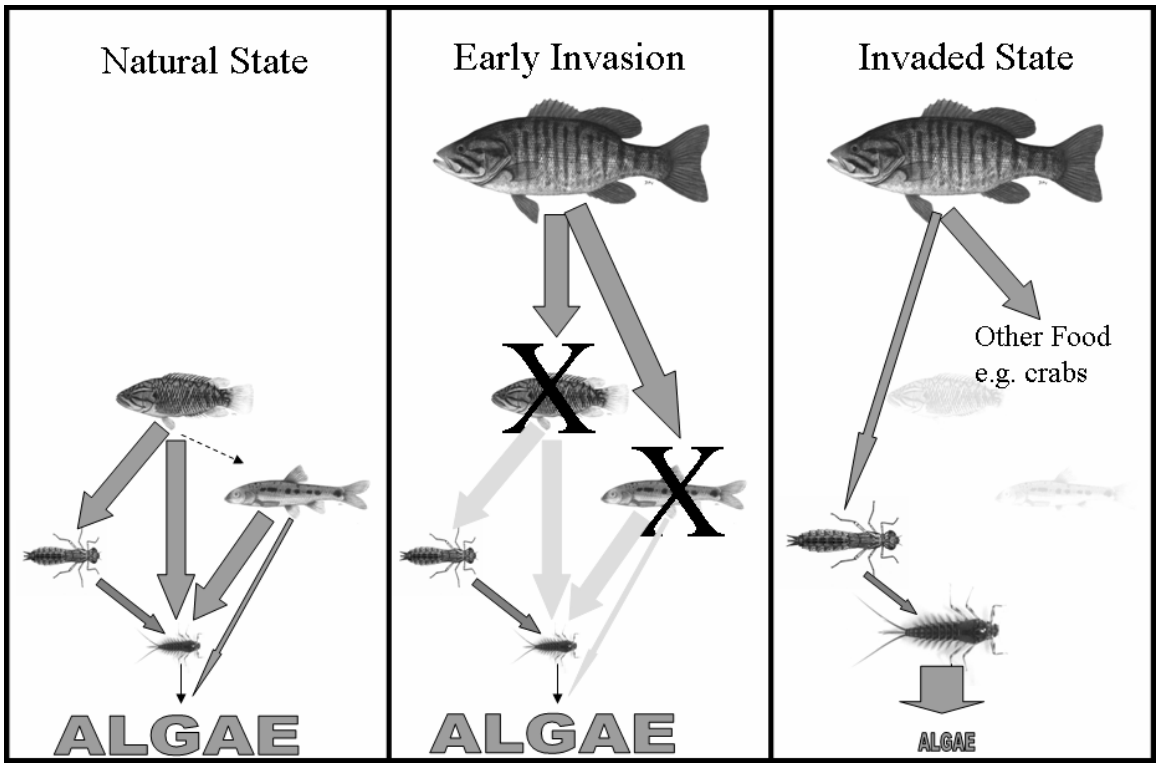

Figure 7: Succession of trophic level impacts following the invasion of smallmouth bass in the Witte River. Prior to invasion, the indigenous kurper and redfin exercise strong top down control on the invertebrate assemblages. Early in the invasion process, the indigenous fish species are extirpated by bass predation releasing the predation pressure on the invertebrate assemblage. A few species begin to dominate the invertebrate assemblage and the algal biomass in the invaded zone is reduced significantly.

The behaviour of invertebrates was also different between the two reaches on the Witte River. Behaviour was not studied on the other two rivers. Drifting Baetidae were significantly more dense in the water column at bass-invaded sites (Figure 8) even after correction for the higher benthic densities at these sites, as shown in Figure 6. Drifting behaviour was approximately 5-fold higher at invaded sites. Insectivorous fish have been shown to suppress drift activity and it is likely that the release from predation at invaded sites accounts for the altered behaviour. The foraging behaviour of cased trichoptera larvae (corrected for relative density between reaches) was also increased at invaded sites in March, but not in September, and may also be a response to reduced predation pressure from fish at these sites. A number of studies have shown dramatic behavioural responses of invertebrates to predation threat by fish (Wooster & Sih, 1995; Diehl *et al.*, 2000). Responses by certain algal-grazing taxa may have more profound effects on community dynamics than the effects of fish on the densities of the same taxa (McIntosh & Townsend, 1996). In the current study on the Witte River, it is likely that both density and behaviour of certain grazing invertebrates are responsible for the dramatically reduced algal biomass at bass-invaded sites compared to non-invaded sites (Figure 9). A similar trophic cascade appears to be operating on the Ratels River (Figure 10) whereby very high abundances of indigenous fish suppress algal grazing invertebrates leading to a high standing crop of algae in summer months. In adjacent fishless reaches (upstream) and bass invaded

reaches (downstream) predation pressure on invertebrates is low and algal standing crop is reduced.

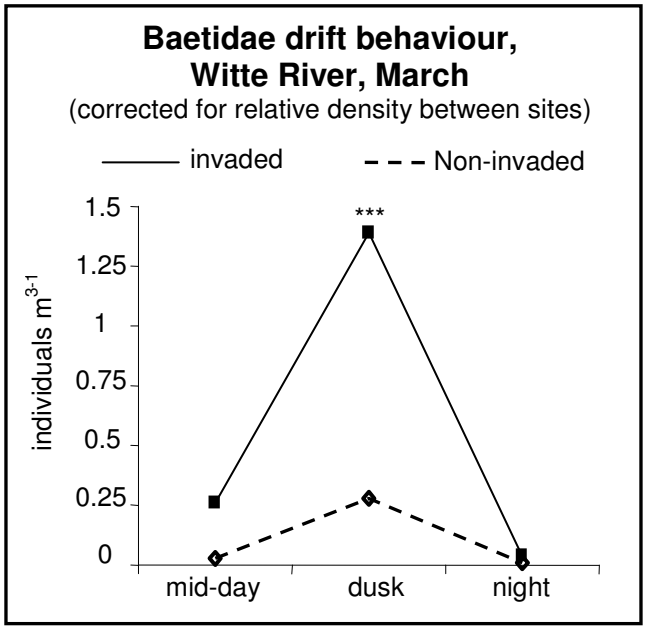

Figure 8: Comparison between the invertebrate drift intensity in the indigenous fish and invaded zones of the Witte River.

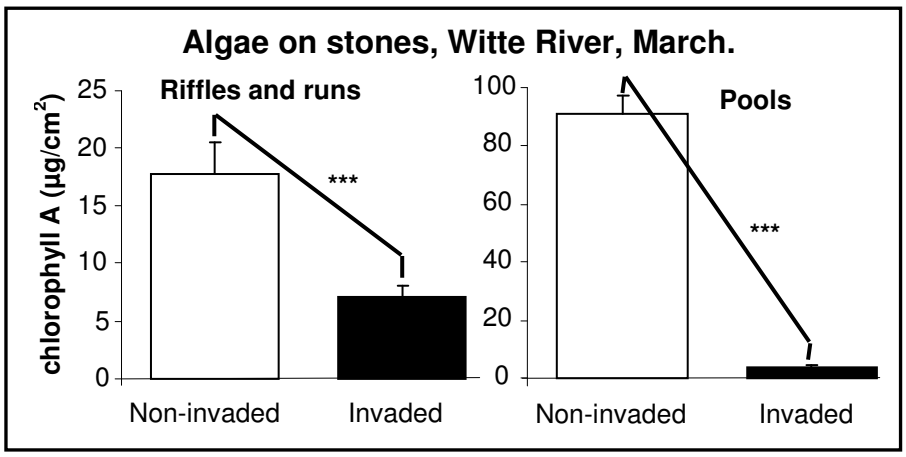

Figure 9: Comparison between the algal abundance on stones in the indigenous fish and invaded zones of the Witte River.

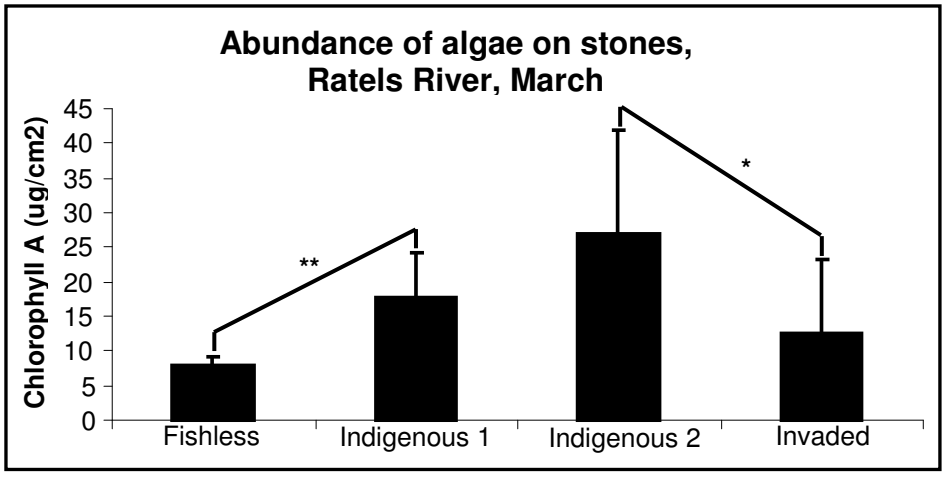

Figure 10: Comparison between the algal abundance on stones in the indigenous fish and invaded zones of the Ratels River.

Numbers of adult trichoptera were higher in stream-side light traps in November and March on the Witte River, as would be expected from the higher densities of larval trichoptera in the river (data not shown). This result provides an initial indication that the consequences of invasion by bass may not be restricted to the ecosystem within the river. Impacts of invasion by *M. dolomieu* on other components of the aquatic biota, such as frogs and crabs, require investigation. The invasiveness and impacts of other invasive fish such as trout, bluegill and sharptooth catfish, are not documented in South Africa and require investigation in order to prioritise for appropriate conservation measures.

Conclusions

In the three foothill rivers of the current study, smallmouth bass depleted indigenous fishes and reduced total fish biomass.

There was reduced predation pressure on most aquatic invertebrate prey, particularly on epilithic algae-grazing invertebrates. This reduced predation alters invertebrate community assemblage structure directly and possibly indirectly through changes in the strength of competitive interactions within the community.

Drifting and foraging behaviour of grazing invertebrates is increased at bass-invaded sites possibly due to decreased predation threat in the absence of indigenous fishes.

Algal biomass is greatly reduced at sites invaded by bass probably as a result of increased grazing pressure from Baetidae nymphs and grazing trichoptera larvae.

Seasonal periphyton dynamics of rivers may be lost upon invasion by bass.

Catchment practices and river ecosystem dynamics influence the specific impacts of bass invasion (e.g. algal and chironomid bloom).

Invasion by smallmouth bass alters ecosystem functioning.

Removal of bass is necessary to restore normal ecosystem functions.

Acknowledgments

Centre for Invasion Biology, University of Stellenbosch.

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Cape Nature staff at Cederberg and Limietberg Reserves (Rondegat and Witte Rivers) and managers at Beaverlac campsite (Ratels River)

Personnel at the Freshwater Research Unit, UCT

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PROGRESS WITH THE EIA FOR THE **CAPE** RIVER REHABILITATION PROJECT FOCUSSING ON ALIEN FISH ERADICATION

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CAPE Alien Fish EIA

1. Initiated by CapeNature in early 2000's
2. Aim was to investigate whether alien fishes could be successfully and cost effectively eradicated from priority conservation rivers in the Cape Floristic Region
3. Funding obtained from Table Mountain Fund to quantify the predatory impact of smallmouth bass and identify priority rivers in the CFR for alien fish eradication
4. Funding from World Bank secured in mid 2000's, to take TMF project towards implementation
5. 4 rivers selected by experts to form basis of CAPE project – 3 in Cederberg (Suurvlei, Krom and Rondegat) and 1 in greater Baviaanskloof (Krom)

Consulting stakeholders

1. 4 rivers identified because eradication could achieve tangible benefits for biodiversity without compromising priority angling waters
2. Rationale for project and choosing rivers explained several times to organised angling before EIA
3. Organised angling (CPS, WPBAA) on task team of CAPE Alien Fish EIA

Authority and funder requirements

1. Preferred method is the use of rotenone – triggers World Bank Environmental safeguards
2. Use in rivers and public waters requires "Duty of care" as per NEMA
3. Comprehensive EIA, that meets best international practice, accepted as the way forward
4. EIA awarded to Enviro-Fish Africa, an environmental consultancy based in Grahamstown
5. EFA comprises a team of specialists, covering freshwater fishes, aquatic invertebrates, ecotoxicology and communication with stakeholders

Progress to date

1. All four rivers visited by D. Tweddle (EFA Project Coordinator & fish expert) & S. Lowe (Western Cape aquatic invertebrate expert). All existing and proposed barriers to fish movements examined and habitats to be cleared thoroughly investigated.
2. Project discussed with landowners at intervention sites.
3. Preliminary internal discussion document prepared for the EIA team, covering all aspects of the programme with suggestions for further study and also ideas for habitat restoration work outside the remit of the EIA. This will form the basis of the scoping report.
4. Background Information Document (BID) prepared and distributed to angling groups, landowners, relevant Government Departments and NGOs (WESSA and WWF SA)(see Appendix 1).

5. BID includes request for registration of Interested & Affected Parties (I&APs), accompanying letter requested recipients to forward the document to any parties who might have been overlooked.
6. Advert for process placed in four newspapers distributed in project areas, i.e. Swartlander, Kontrei, Witzenberg Herald and Our Times, requesting I&APs to register.
7. Telephone contacts made with prominent anglers and organisations.
8. Eco-toxicology study in progress at Institute for Water Research.
9. Literature review in progress.

Next steps of EIA

1. Complete literature review and eco-toxicology study.
2. Prepare draft scoping report for circulating to I&APs.
3. Arrange public meetings for each of the intervention sites.
4. Address aspects identified for further action in the site visits, public meetings, and correspondence with I&APs.
5. Develop EIA, based on the findings

Refer Appendix 1 for the Background Information Document for CAPE Alien Fish EIA

THE RIVER HEALTH PROGRAMME OF THE OLIFANTS-DORING AND BERG RIVER CATCHMENTS

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Introduction

The River Health Programme (RHP) is a national programme which was initiated by the Department of Water Affairs and Forestry (DWAF) in partnership with the Department of Environmental Affairs and Tourism (DEAT) and the Water Research Commission (WRC). The main aim of the RHP is to serve as a source of information on overall ecological status of river systems in South Africa. The main objectives are to:

- Measure, assess and report on the ecological state of aquatic ecosystems;
- Detect and report on spatial and temporal trends in the ecological state of aquatic ecosystems;
- Identify and report on emerging problems regarding aquatic ecosystems;
- Ensure that all reports provide scientifically and managerially relevant information for national aquatic ecosystem management.

The following indices are applied to determine the health of the river system

- Index of Habitat Integrity (IHI) - used to assess the impacts of disturbances on river habitats, i.e. river channel and riparian zone
- Geomorphology Index (GI) - is a geomorphological classification which groups similar sites by channel type classification. It is based on 2 components: channel condition and channel stability
- Riparian Vegetation Index (RVI) – determines the status of riparian vegetation within river segments based on the qualitative assessment of a number of criteria in the riparian zone
- Fish Index (FAII) – categorises the fish community according to an intolerance rating
- South African Scoring System (SASS) – a rapid method which uses macroinvertebrates to assess water quality

The overall ecological status of a river reach is expressed as the EcoStatus, which provides an integrated value of all the ecological indices assessed for that particular reach. The ecological importance and sensitivity rating (EIS) provides an indication of the level of protection that a river should receive. The River Health Categories are given as Natural (N) (blue), Good (G) (green), Fair (F) (orange) and Poor (P) (red).

Olifants/Doring Monitoring Status

Impacts

Flow is severely modified in the Lower Olifants River as a result of 2 large instream dams (Clanwilliam and Bulshoek). A large number of instream and off-channel farm dams in the Kouebokkeveld have severely modified flows in the Houdenbek and Winkelhaak rivers. Many of the Olifants/Doring rivers suffer from habitat loss due to farming disturbances in the

riparian zone. A variety of invasive alien plants occur throughout the Water Management Area (WMA) These alien plants modify the river channel, and reduce habitat integrity and baseflows in rivers. Alien fish occur mostly in the mainstream of the Olifants and Doring rivers and many of the tributaries. Of the 40 sites in the Olifants/Doring catchments, 5% were natural, 45% were good, 45% were fair and 5% were in a poor condition.

Management Actions

- Encourage efficient water-use throughout the WMA
- No further instream dams should be built in the Olifants and Doring Rivers
- Investigate environmental flow release options for all existing instream dams
- Discourage groundwater abstraction within the riparian zone
- Use environmentally acceptable farming practices and maintain a buffer area along river banks
- Clear alien vegetation from riparian buffer areas and the surrounding catchment.
- Investigate the eradication of invasive alien fish from priority areas

Berg Monitoring Status

Impacts

Habitat integrity and water quality in the Berg River deteriorate downstream as a result of alien vegetation encroachment, the interbasin transfer of water and river modification. Urban and agricultural development affects the water quality at Franschoek. River health is reduced in the tributaries as a result of alien vegetation infestation and agricultural development. Water quality and habitat integrity in the Berg River and lower reaches of these tributaries are reduced due to urban development.

Diversion weirs in the Klein Berg and Vier-en-Twintig rivers have altered the flow patterns. Alien fish are widespread and have led to the disappearance of indigenous fish because of predation and competition. Water quality and habitat integrity near Tulbagh are poor. Flow releases are made from the bottom of Misverstand Dam and reduce water quality. Of the 25 sites in the Berg river catchment, 12% were natural, 16 were good, 44% were fair and 28% were in a poor condition.

Management Actions

- Clear alien vegetation
- Re-introduce indigenous riparian vegetation to act as buffer
- Construction of weirs to prevent migration of alien fish upstream.
- Improve monitoring and management of runoff and wastewater discharges
- Improve farming practices
- Eradicate alien fishes from priority waters in consultation with key stakeholders
- Stock dams with indigenous fish from the river system

Breede Monitoring Status

A comprehensive study of the Breede catchment is currently being undertaken.

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GAUTENG REPORT

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INTRODUCTION:

The impact resulting from urban, industrial and mining development is on the increase in the province which in turn could have an detrimental impact on the already degraded aquatic ecosystems in the province. Fortunately with the implementation of the River Health Programme and the strict application of the National Environmental Management Act by GDACE, awareness among the general public, developers, consultants and local authorities has increased considerably. More affective management of the wetlands and rivers at local and provincial government level is being implemented by means of stricter enforcement of the relevant acts and by-laws in terms of the protection of the aquatic environment.

Although no major changes in the current ecological status of the rivers were detected over the last year, some ecological indicators have indicated slight improvement of the ecological state of the Suikerbosrand River downstream of the confluence with the Blesbokspruit. This can be attributed to the fact that the stricter management and control of water quality in the upper catchments has been put in place over the last 5 years. This is still far from satisfactory since poor management, or lack of management of water treatment plants in Gauteng is still a major concern. Sewage spills are common in all the rivers in the province not only as result of poor maintenance, but also as result of uncontrollable vandalism, removal of manhole covers and the obstruction of pipes by means of rock-fills. The substantial rainfall this summer has also contributed greatly to the problem.

WHAT IS HAPPENING IN GAUTENG?

The Upper-Vaal catchment:

All water draining from southern Johannesburg , Florida, Benoni, flows via three river systems, Klip River, Blesbokspruit and the Suikerbosrand River into the Vaal. These rivers are generally in a poor ecological state except that of the upper Suikerbosrand River which does not source in the urban and industrial environment. This has a potential negative effect on the well-being and ultimate survival of the yellowfish species which occur in the Upper-Vaal system.
Illegal abstraction, inundation and pollution in the rivers have modified the hydrological regime and the water quality over the last 100 years and the effect thereof has had a severe impact on the yellowfish populations, especially in the smaller rivers which also serve as spawning grounds for both these species.
Currently the ecological reserve determination study is underway which will in short determine the ecological category for the rivers which in turn will then set clear ecological goals taking the needs of the yellowfish into consideration (habitat and food requirements). Using this information management actions will be formulated and implemented at all levels of government to achieve the goals and objectives in terms of maintaining the ecological conditions as determined by the ecological reserve determination study.

The Kip River catchment has been identified by the City of Johannesburg as a priority aquatic ecosystem and the R 85 million Mayoral Legacy Project was launched with the objective of

rehabilitating the urban wetlands and streams in and around the greater Soweto and Florida. This project is currently underway and is planned to be finished in time for the 2010 World Cup.

Along with this programme an initiative has been launched to rehabilitate the greater Klip River wetlands downstream of the N1 highway crossing. This will be a major project which will involve different national departments and will be very costly. The end result will however have a major positive impact on the downstream Klip River as well as the Vaal River.

A Government Task Team (GTT) has been established to investigate and formulate guidelines for the management of Western, Central and Eastern water basins. The water in these underground reservoirs is highly polluted as result of the gold mining in the Witwatersrand area and will have a detrimental affect on the rivers if not managed in the future. The potential surfacing of acid mine water once the mines close is a major threat to the entire Vaal system if not managed effectively. The main gaol of the GTT is to facilitate mine closures and to manage the polluted water in the future to prevent surfacing of the water.

An initiative by the mines on the Wonderfonteinspruit to clean up the stream has been launched by one of the mines and this project is underway.

No licence has yet been issued by DWAF for Anglo-Coal to proceed with the opencast mining of low-grade coal in the Suikerbosrand River floodplains. This application is not supported by GDACE but the final decision is till with DWAF and DME. The approval of the application for the establishment of this pit inside of the floodplain will have a major impact on the ecological functioning of the Suikerbosrand River and eventually could cause the total collapse of the yellowfish population in the Suikerbosrand River. The river currently provides some of the only spawning habitat for yellowfish in Gauteng, and the development of the pit inside of the floodplain will obstruct the passage to the spawning habitat.

The Crocodile-west/Marico Catchment:

As far as the Crocodile-west/Marico catchment (the northern drainage, Crocodile, Jukskei, Hennops, Pienaars and Apies Rivers) is concerned, the Ecological reserve determination process is also currently underway of which the outcome will pave the way for sound ecological management.

DWAF has also initiated the Hartebeespoort Dam remediation project which is also currently underway. This is a cooperative project involving all stakeholders, DWAF, NW-DACE, GDACE, SANBI-WFW, Johannesburg Metro and NGO's and the private sector. The main objective is to address and manage the cause of the pollution flowing into the dam and at the same time cleaning up the dam itself. This major project is currently underway and the removal of unwanted fish (carp and catfish) is currently being done.

The Upper Olifants Catchment:

The Elands River is still escaping the potential threats of urban development and is generally in fine ecological state. However plans to develop low-cost housing projects in the catchment of one of the upper triturates near Cullinan is of concern and is closely monitored.
Acid mine drainage from the eastern highveld opencast coal mines has eventually drained into the pristine Wilge River resulting in serious fish kills along the entire length of the river and into

Loskop Dam. No response was received from DME to whom the mines are responsible. This pollution may cause the complete wipe-out of the small and large-scale yellofish population in and above Loskop Dam.

Apart from the above and the immense pressure for development, things are looking good in the province and there is a positive attitude towards the protection and bettering of the aquatic ecosystems. This will favour the future existence of all five yellowfish species in the rivers in Gauteng.

RIVER HEALTH IN LIMPOPO PROVINCE

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River Health Surveys have been done in all the perennial rivers in the Limpopo Province and the following table indicates when the surveys were done, what indices were used and which reports resulted from the surveys.

ATTACHMENT	YEARS SURVEYED	INDICES USED	TRAINING	TECHNICAL REPORT	SORR
Phalala	1997 DWAF	FAII, SASS4	Received	No	No
	2005	FRAI, SASS5, RVI, GI, IHI. Ecostatus, EIS	Given	Yes	Not planned
Sand	1997	FAII, SASS4, RVI	Received	In Prep by DWAF.	Yes
	2001	FAII, SASS5,	Given	Yes	No
Olifants and Tributaries.	1998 DWAF	FAII, SASS4, RVI	Received	In Prep by DWAF.	Yes
	1999 DWAF	FAII, SASS4, RVI	Given	In Prep by DWAF.	Yes
	2003	FAII, SASS5,	Given	Yes	Not planned
Luvuvhu	1999	FAII, SASS4, RVI, GI	Given	Yes	Yes
	2003	FAII, SASS5,	Given	Yes	Not planned
Letaba	2000	FAII, SASS5, RVI, GI, HI.	Given	Yes	Yes
	2003	FAII, SASS5,	Given	Yes	Not planned
	2007	FRAI, SASS5, MIRAI, RVI, GI, IHI. Ecostatus, EIS	Given	Yes	Not planned

ATTACHMENT	YEARS SURVEYED	INDICES USED	TRAINING	TECHNICAL REPORT	SORR
Mogol	**2002 & 2006**	**FAII, SASS5, RVI, GI, IHI. Ecostatus, EIS**	**Given**	Yes	**Yes**
Crocodile and Marico.	**2004 - 2005**	**FRAI, SASS5, RVI, GI, IHI. Ecostatus, EIS**	**Given and Received**	**Yes**	**Yes**
Nwanedi	**2006 - 2007**	**FRAI, SASS5, MIRAI, RVI, GI, IHI. Ecostatus, EIS**	**Given**	**Yes**	**Planned**

The Matlabas and Mokgalakwena rivers will be surveyed and reported on during 2008.

Mr. P. Fouche and Dr. W. Vlok are currently conducting a survey on the Shingwedzi River.

The Sand and Njelele rivers will be surveyed later, which will then have covered all the major river systems in the Province.

The State of River Health using the standard river health classification is as follows per catchment:

Letaba River

River	Ecoregion	FISH	INVERTEBRATES
		FRAI	**MIRAI**
Letsitele	3.01	C/D	C/D
Letaba	9.02	C	B/C
Letaba	3.01 and 4.02	D	B/C
Letaba	3.03A	C	C
Letaba	3.03B	D	C

Lephalala River

River	Ecoregion	FISH	INVERTEBRATES
		FRAI	MIRAI
Lephalala	Upper 6.01	D	C
Lephalala	Waterberg 6.01	D	B
Lephalala	Limpopo 1.02	D	B
Blockland	6.01	C/D	C
Daggakraal	6.01	D	B/C

Mokolo River

River	Eoregion	FISH	INVERTEBRATES
		FRAI	MIRAI
Sand	7.02 and 7.03	C/D	C/D
Sterkstroom	6.01	C/D	C/D
Upper Mokolo	6.02	B/C	B/C
Middle Mokolo	6.01	C/D	C
Rietspruit	6.01	C/D	C/D
Lower Mokolo	1.02 and 1.03	D	D

Levhuvhu River

River Reach	Ecoregion	FISH	INVERTEBRATES
		FAII	SASS4
Sterkstroom	2.01	E	C
Lat & Luv	5.04	C	C
Dzindi	2.01	E	B
Dzin & Luv	5.04	E	B
Mutsh	2.01C	E	A
Mbwedi	2.01	F	D
Mutale	2.01		A
Tchiombedi	5.04	E	B
Mutale	1.02		B

Olifants River

River	Ecoregion	FISH	INVERTEBRATES
Olifants	8	D	C
Olifants	9	D	C
Olifants	10	D	C/D
Olifants	3	D	B/C
Mohlapitse	9	C	A
Blyde	3	C	B
Selati and Makhutswi	10	C	A
Selati	3	C	D

Crocodile/Marico Rivers

River Reach	Ecoregion	FISH	INVERTS
		FAII	SASS5
Sundays and Sand rivers	7	B/C	C
Vingerkraal se Loop and Tooyspruit	8	C	C
Platrivier and Buffelspruit	8	D	C
Crocodile River	8	D	D
Crocodile River	7	D	D
Crocodile River	1	C	D
Marico River	1	D	C

Problems facing our fish

- 54 indigenous Limpopo Province species, and 13 alien species on record.
- 3 red data (Bbre, Oper, Smer).
- 10 species provincially threatened (4 eels) Blin, Cswi, Cthe, Hvit, Lcon, Lpol.
- Lack of water (resource demand). NWA Reserve indicators.
- Fragmentation of populations due to dams and weirs.
- Habitat destruction. (eg riparian, sand mining)
- Alien invasive species.
- Water quality.
- Illegal netting with shade net in pools.

The Future

- Documenting the decline in the state of our rivers?
- Limited staff. The position of the "RHP provincial champion" is by no means certain.
- Return period for follow up monitoring totally unacceptable.
- DWAF must accept responsibility for SoRR and reserve monitoring in terms of NWA responsibilities.
- Mitigatory monitoring must be undertaken.
- Government must respond to issues raised in reports.
- Provincial DWAF must start addressing their structure and budget to address environmental issues including monitoring.
- Currently very limited institutional memory IRO skills in the province.
- Training of DWAF personnel is needed.
- Out-sourcing should be considered.

Final Conclusions

- Our knowledge base on the status of our fish populations is substantial.
- Fish have proven themselves to be highly resilient, although most sensitive species are threatened.
- Fish are proving themselves to be a highly valuable taxonomic group for promoting the sustainable management of our aquatic ecosystems.
- Government must just implement legislation.

KWAZULU- NATAL REPORT

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Introduction

KwaZulu-Natal is a water-rich province relative to the remaining provinces in South Africa. It is also one of the more densely populated provinces where increasing demands are being made daily on limited water resources. More than 50 % of the province has already been transformed by human developments. Much of this development has taken place around wetlands creating increased stress on already sensitive ecosystems.

Status of the Habitat

Dr Nick Rivers-Moore, Dr Peter Goodman and Mr. Mncedi Nkosi of Ezemvelo KZN Wildlife's Biodiversity Conservation and Planning Department have recently completed an assessment of the freshwater assets of KwaZulu-Natal for systematic conservation planning. The systematic conservation plan for aquatic ecosystems undertook an initial inventory of the dimensions and broad characteristics of the aquatic resources within KwaZulu-Natal. Seventy-nine main stem rivers, which flow into the sea, were identified. At a map scales of 1:500,000 a total river length of 18,392 km was identified of which only 7.82 % fell within protected areas. Of the 79 rivers, 9 of greater than 100 km in length were free flowing (un-impounded from source to sea). Freshwater lakes and pans which are rare in KZN are of two broad types, those associated with flood plains, and coastal lakes, which are not connected to the sea. The current state of these aquatic resources was indexed by the degree of transformation in the catchments, as well as an estimate of the number impoundments weighted by the amount of water impounded. A broad classification of aquatic ecosystems for conservation planning was developed using bio-geography at the upper level, and empirical sampling correlated with physical determinants at the lower level. It was concluded that in comparison to terrestrial systems, the lack of appropriate freshwater biodiversity information is still a constraint to the development of aquatic conservation plans (Rivers-Moore *et al.*, 2007)

Six broad bio-geographic aquatic regions were identified in the aquatic conservation plan using sub catchments as the basic planning units. The conservation target has broadly been set as 20 % for each category of river system.

Threats

The greatest threat to all species is habitat change followed by alien and invasive species. The national demand for water is increasing at approximately 2 % per annum with many of the important catchments like the Mgeni River already oversubscribed in terms of the natural supply. New alarming threats are the impact of global warming with the predictions that precipitation in the eastern part of the country is expected to increase but also become less regular and more aggressive in nature. The western half of the country is expected to become much drier limiting crop production and grazing and further advancing the effects of desertification. The average air temperature in the Western Cape has already increased by 1 C over the past fifty years which is significantly higher than a global average of 0.6%. Parts of the artic circle have already increased by 2-4 C with impending disastrous ecological results.

Eskom is planning to increase the power generating capacity of the Drakensberg Pumped Storage Scheme as a means to alleviate its current power shedding programme. Water is gravitated from Sterkfontein Dam, on the OFS side of the escarpment, into Kilburn Dam on the KZN side of the border as a means of generating HEP. Increasing the power generating capacity of this facility would result in Kilburn Dam overflowing directly into the Thukela System. Kilburn dam currently holds large numbers of Orange-Vaal species, including Smallmouth yellowfish, Mudfish, Barbel (sharp tooth catfish) and potentially also Largemouth yellowfish. In addition to these translocated indigenous species there are also populations of exotic carp, bass and bluegill. Eskom has now committed itself to a full EIA process based on the concerns of EKZNW. We believe that the fish assemblages of the upper Thukela River be assessed by a team of independent researchers prior to any water overflowing from Kilburn Dam. Database records submitted by Mike Coke have concluded that several Orange-Vaal fish species have already escaped into a stream which ultimately joins with the upper Thukela River. It is now speculated that these fish have escaped via a drain valve in Kilburn Dam which is periodically tested by local DWAF officials.

Pollution remains a major threat in our rivers. The dreaded "Duzi Guts" affected half of this year's contestant of the popular Duzi Canoe race. Isolated cases of typhoid and cholera have also been reported from communities bordering this river system.

Establishment of Conservancies

To the best of my knowledge there have been no conservancies formed around yellowfish fishing in KwaZulu Natal although fly fishing for this species at certain lodges and resorts remains a popular attraction. The Natal Fly Fishers Club now offers fly fishing for KZN yellowfish on the Mkomazi River for its members.

Stockings

Ezemvelo KZN Wildlife does not encourage the stocking of yellowfish species. Any fish stocked beyond its natural range is alien and potentially invasive. The establishment of commercial hatcheries rearing indigenous species increases the risk of transferring indigenous species into regions where they did not previously occur. This poses a great threat to our existing biodiversity.

Genetic Considerations

According to Professor Paulette Bloomer of Pretoria University the genetic work being carried out on the KZN Yellowfish *(Labeobarbus natalensis)* is progressing very well. EKZNW staff dedicated two field trips in 2007 for the specific collection of yellowfish genetic material. One trip was carried out down the South Coast where samples were collected from the Mtamvuna, Umzimkulu and Umzimkhulwana Rivers. The Mtamvuna River represents the southern distribution of this species. The other trip was conducted up the north coast where samples were mainly collected from the Thukela River, Buffalo and Mkuze Rivers. Samples collected from these field trips filled in important sampling gaps from earlier collections. Early results suggest that there are at least five broad genetic groups of KZN Yellowfish (*Labeobarbus natalensis)* in the province.

Education and awareness

EKZNW supports the moratorium placed on the movement of yellowfish.

Legislation

EKZNW is currently reviewing its KZN Biodiversity Bill in preparation for public comment. A team of lawyers has been employed to assist EKZNW with this mammoth task. It is hoped that the KZN Biodiversity Bill will soon replace Ordinance 15/74 which has become antiquated in terms of current conservation requirements. Provincial legislation can be as strict as or stricter than national legislation. To this end EKZNW has reviewed its list of Alien Invasive Species (AIS) and Threatened or Protected Species (TOPS) in collaboration with NEMBA. It is hoped that due cognizance is also given to the protection and conservation of commonly occurring indigenous species like the KZN Yellowfish (*L. natalensis).* This flagship species should at least be protected by a bag limit to secure its sustainability as an angling and subsistence species.

Monitoring

No specific monitoring programmes have been dedicated to KZN Yellowfish.

Research

Professor Paulette Bloomer of the University of Pretoria is currently carrying out research on the genetics of KZN Yellowfish.

Value of Yellowfish resource to anglers and subsistence fishers

Yellowfish remains a popular angling fish in KZN.

Literature

Concluding Remarks

The production of KwaZulu-Natal systematic conservation plan for aquatic ecosystems will hopefully provide further guidance towards future development in KZN. Approximately 50 % of KwaZulu-Natal's landscape has already been transformed by man induced habitat change. Increasing the HEP capacity of the Drakensberg Pumped Storage Scheme poses a potential threat to the ecological integrity of the Thukela River due to the escape of alien Orange-Vaal fish species. Professor Paulette Bloomer of the University of Pretoria has determined that there is considerable genetic differentiation between geographically isolated populations of the KZN Yellowfish *L. natalensis*. She has to date identified five main sub-populations.

References

Rivers-Moore, N., Goodman, P., Nkosi.M (2007). An Assessment of the Freshwater Assets of KwaZulu-Natal for systematic conservation planning. Ezemvelo KZN Wildlife, P.O.Box 13053, Cascades, 3202, South Africa.

FREE STATE REPORT

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Yellowfish conservation awareness is dealt with by forums within the Division Environmental Community Based Projects and Capacity Building of the Department Tourism, Environmental and Economic Affairs. This is because no aquatic scientist has been appointed to replace Pierre de Villiers. Conservation signage comprising boards are erected at entrance gates of riparian landowners where the fishermen can take note of the conservation issue.
Sticker signs are placed on the back of the forum member's vehicles to make the broader public aware of yellowfish conservation wherever they travel, even to attend the conference at Jonkershoek

Yellowfish Conservation as Project.
Riparian landowners on the Vaal and Orange river systems are approached to join as yellowfish conservancies. More than 60% of Vaal riparian owners have joined.

The Clarens Bio-region Conservancy, which consists of three rural, one urban, and one township portion use trained rangers to patrol the mountains, streams and the Axle River for environmental management.

Telemetry Study
Koedoesdraai conservancy in Bothaville district, on the Wag 'n Bietjie Ekoplaas hosts the project. Linda Nel is a student doing the study on a fulltime base. She catches fish, tags them and follows their habits with a radio-transmitting device. The first part of the study has been completed and the battery life of the transmitters has expired. A Bell's Yellowfish Experience is being launched between the 17-20 April to try and retrieve some of these transmitters.

Capacity Building
Honorary Nature Conservators are being trained and used throughout the Free State, especially in the Northern and Eastern regions. They are trained according to the Free State Ordinance and other laws to be environmental officers to assist the Department in law enforcement and awareness actions.

Provincial Fish Hatchery
The hatchery is situated just below the Gariep Dam alongside the Oranje River. It is partly operational due to budget and personnel constraints. A well-established Environmental Education Centre is visited by 500 visitors a month. This is increasing as the word spreads of its existence. The fish cycle is shown with mounted exhibits which is based on the sharp tooth catfish rather than the yellowfish. The mounted yellowfish which was the property of FOSAF has been taken away by them. This is a pity because we could demonstrate what a struggle this fish had to attain such a large size. Live exhibits exist in the aquariums. One is a large tank where the fish can be watched through the windows. This is hands-on education together with well-informed posters of the spawning and breeding processes.

Threats to indigenous fish species
The diverting of river systems for man's needs is a big threat. This is because of silting of the habitat, habitat destruction or total loss of habitat. This is often just to erect a building or to

utilize the bank for some or other purpose. Golf estates on the banks of rivers and streams pose a threat, not only because of damage to banks, but because they use lots of water for irrigation and all sorts of chemicals and fertilizer is mixed in irrigation water. Sand mining is also a major threat because it stirs the substrate and muddy water is released back into the system which causes mortalities amongst the small aquatic organisms which in turn affect the fish species.

Industries that are irresponsible cause oil spills which land directly into water bodies. This causes massive organism and fish deaths.

Municipal sewage works do not comply with the demand when development takes place and there is no upgrading of these works to take the extra load.

There are blockages and breaks in unmanaged sewer systems in urban areas that lead to raw sewage flowing into water bodies that cause major damage.

BEE companies or government assisted bodies do not always have the skills to do quality work and this leads to spills directly into water bodies.

The Green Scorpions were established according NEMA but they still lack capacity to implement the law. When they do issue directives they lack the time to follow up and the problems continue.

Status of Free State Rivers

Needless to say almost every river or stream is contaminated by raw sewage. It seems that the need for housing is a greater priority than upgrading the necessary service systems. Corporate Governance seems to be the one to blame. This is because they try and assist with little or no money and the result is everything collapses.

NORTHERN CAPE REPORT

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Introduction:

To get a clear picture of the Northern Cape is a logistical nightmare. This is due to its immense size, low population density and the vast distances which have to be traveled.

This report will only cover the area where the Northern Cape Yellowfish Working Group (NCYWG) / 3 Provinces Fly Fishing Club is active. These two associations are inseparable and co-exist as one entity.
Surprisingly many people still think of the area as an arid semi-desert with thorn trees whereas it has large rivers and reservoirs.

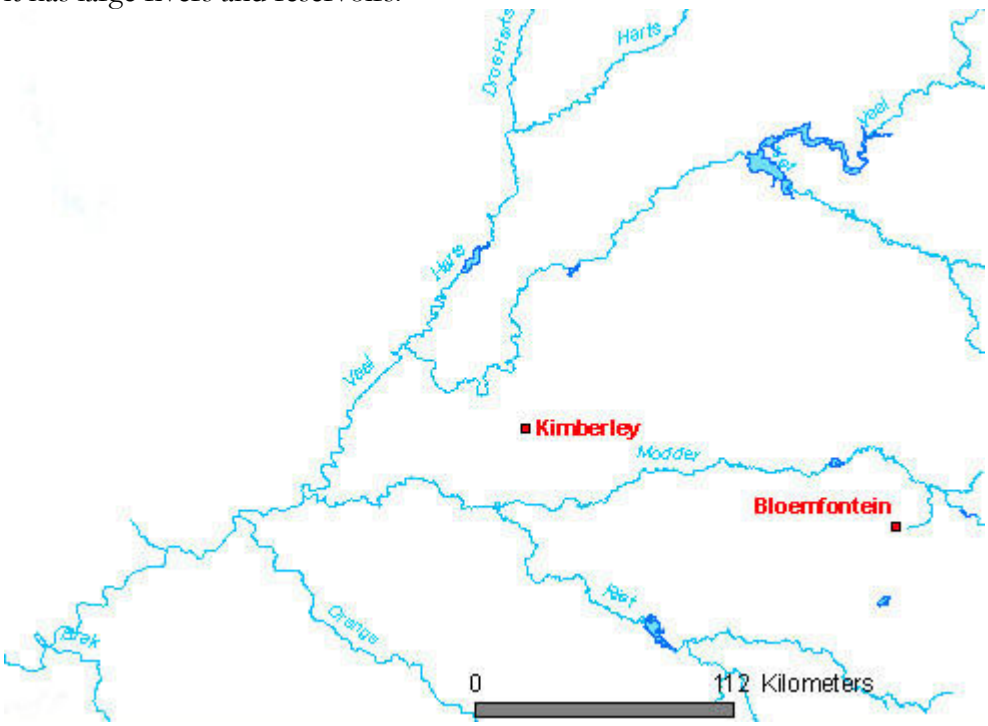

Figure 10: Area of concern to NCYWG

Areas under discussion:

The area has no shortage of rivers, and four main rivers of interest can be named. The Vaal below the Bloemhof Dam flowing past towns like Bloemhof, Christiana, Warrenton, Windsorton to the Orange River junction near Douglas. Then the Orange that flows past towns like Aliwal North, Colesberg and Luckhoff, meeting the Vaal at Douglas, before continuing its journey to the Atlantic. Two smaller rivers, the Harts River and Riet River, also play an important role in the yellowfish story of this area.
The Harts system might be the biggest surprise of them all, holding a real gem, the Taung Reservoir. The Harts rises in the Lichtenburg area and flows past towns like Delareyville, Schweizer-Reneke, Taung and then joins the Vaal near Delportshoop.
The Riet can be divided in two sections: the Modder River, a tributary of the Riet, which has its source in the Witteberge escarpment near Dewetsdorp. From there it flows past Bloemfontein meeting up with the Riet just outside the Free State border with the Northern Cape. The Riet

rises in the Trompsburg area and flows past the town of Koffiefontein and into the Kalkfontein Dam. Below the dam it meets the Modder River and flows westwards joining the Vaal near Douglas.

As can be seen from the above-mentioned typography, areas of the North West Province, Free State and the Eastern Cape have an environmental influence on the Northern Cape waters, and as such cannot be ignored.
The area in which the NCYWG operates at present is large. It stretches east from Bloemhof to the west at Prieska and from the north at Taung to Gariep Dam in the south.
This report will cover these areas, as at the moment there are no other similar organisations to be found in the area.
Dams/ reservoirs in the area include: Gariep, Van Der Kloof, Kalkfontein, Vaalharts, Spitskop and Taung.

Problems faced in the area:
Over the last year some problems have been faced by the NCYWG/ 3Provinces Fly Fishing Club. The area's biggest problem seems to be alluvial mining taking place on the banks of all these river systems.To see the full extent of these problems one can just look at Schmidtsdrift area. This was once known for it's almost chalk-stream like characteristics but these have been almost completely destroyed. Other areas include the Vaalbos Nature Conservation area. Both these areas are to be found on the Vaal River near Delportshoop. Members who have been to these places describe it as a "moon-like" surface, devoid of any plants and full of big craters.
The NCYWG prides itself in having four recognized yellowfish conservation/ protection areas. Right now two of them might be in danger. Lillydale Lodge has long been known to be an exceptionally good area with good populations of largemouth yellowfish (*Labeobarbus kimberleyensis).*
The Lodge and surrounding area have been taken over by SANparks. It is unclear what their intentions regarding development will be. However, the plentiful game in the area leads us to speculate that some game viewing will be included. Concerns have been expressed about the presence of mining equipment that has not yet been removed. Rumour has it also that plans might be made to develop the area for the tourist influx in 2010. A meeting with SANparks is being arranged by the NCYWG to get a clear perspective of the future of yellowfish conservation in the area. The lodge has access to 6 km of water. NCYWG had an active tagging program running in the area, and also held an occasional Bells festival, which might now all be threatened. Any assistance from people having knowledge and contact with SANparks would be appreciated, to ensure the future of this valuable site, as well as helping the NCYWG going on with its tagging and protection of the area and its fish. It also seems that the opposite bank, which was the scene of heavy alluvial mining, is slowly starting to recover naturally, as no steps seems to have been taken to rehabilitate the area by the previous mining company.

The second yellowfish conservation site is to be found situated just below the town of Warrenton. A section of previously mined area (20-30 years ago the river was diverted into a dry river bed while mining continued in the main river. Once finished the river was redirected back into the main section) has caused the Vaal to reach depths of 15 to 20 metres with sudden drop-offs. No need to comment that this area holds excellent populations of smallmouth and especially largemouth yellows.
The Warrenton area seems to be the most problematic at the moment. Reports so far have shown that since 2005 the water clarity in the area has never been over 30 cm. This seems inconsistent with previous years where in winter time the visibility could reach up to almost 3 metres. The possible main culprit for this could be an alluvial mine situated just below the barrage outside the town. This appears to be releasing dirty mining water directly into the river.

Further investigation into these claims should be launched as soon as possible, as this might be disrupting the yellowfish feeding and breeding habits, and actually polluting the river with some types of metals. A contributing factor to the pollution might be the town's sewage system. Reports received show that treated sewage water is flowing into the river directly via a ground trench. One of the pump stations alongside the black settlement is leaking water so badly from one of its connections that it has formed a semi-marsh. It is understood that funds were allocated to the municipality over a year ago to upgrade the sewage system, but as yet nothing has been done. Inspection is needed to monitor the quality of this treated water flowing into the river.
A further problem has arisen in the last few months as one landowner in the conservancy area has allowed alluvial mining prospects to commence. At the moment the section pegs have been placed where the supposed mining will take place, a mere 30 metres from the river. NCYWG has asked for access to the mining permit to check the validity and the conditions which have been specified. It will then be forwarded to nature conservation officials working in other areas who have previous knowledge and experience in this area.
All steps should be taken to protect this 6-10 km stretch of yellowfish conservation area.

The third yellowfish conservation area situated at Nkolo Spa seems to be doing fine at the moment and no complaints have been received. The owners of the lodge are yellowfish conservation orientated, and support the NCYWG drive full heartedly. The lodge is situated near Christiana, but there seem to be troubling developments upstream. A golf course estate and a property development are being established, one at the old Rob Ferreira retirement lodge (Fish Eagle Estates) and the other one on the Free State side at Appiesdeel Lodge, called the Grootrivier Gold Landgoed. Investigation should be carried out on the environmental impact study and the planned sewerage plants for these two estates.
The companies seem to reach new depths with their illegal methods of mining in the area. A miner in the Barkly West area proved this earlier this year. He had devised a floating pontoon boat, with all his mining equipment on it. He was extracting the river gravel via a pipe, sorting it on the boat, and throwing it back into the river once he was finished with it. He also used a tractor standing on the riverbank to supply power to his operation. The NCYWG immediately took steps and reported it to State Departments and OVRYCMA.
After some passing of the buck between different departments and heated debates, the situation was resolved but only with the help of Ramogale Sekwele, the previous conservation official in the area. Alluvial mining seems to be the biggest threat to yellowfish conservation in the Northern Cape area. More stringent steps should be taken when granting permits for mining. This should be followed by continuous checks by Department of Mineral Affairs & Energy, and maybe also by the Department of Environmental Affairs. Steps should be taken to rehabilitate the area once mining has ceased. A meeting is planned between all role players and effected parties in the near future.

In the fourth Yellowfish Conservation area there have also been problems. An article was published a while back about some illegal mining taking place in the Douglas area. John Southey, a well-known and respected yellowfish and art lure angler is active in the area. He reported this activity and also took steps to stop this illegal activity. Another problem in the area seems to be the alien tilapia in this section of the river. This was highlighted during the last two winters when these fish died from exposure in the cold Vaal River. A commercial venture between the University of Stellenbosch and some farmers owning dams alongside the river was established a few years back, to help these farmers earn additional income. With the floods in 2005/2006 the dams broke their earth walls and some of the tilapia escaped into the river. No fish species indigenous to the area was/is being used in this venture. Currently no serious problems are recorded in Douglas area, the fourth conservation site.

On the Orange no serious problems were recorded, except by an angry farmer below the Van Der Kloof Dam. His land borders the so called the floodplain caused by the daily flooding caused by releases from the dam. The fish and especially the yellows move into this rocky floodplain, sometimes spawning. When the water recedes, some fish get caught in this floodplain, and wait until the next day's flows. Locals from the black and coloured community took it upon themselves to use this resource as a commercial venture. They entered his farm illegally and used gaffs to take out the yellowfish caught in this floodplain, to sell in the town for R5 a piece. The problem was reported by NCYWG, and taken up from OVRYCMA side with Free State Conservation. About a week later an official from the department had visited the farmer, and investigated the problem. Unfortunately no feedback was received within a month from the conservation official, and the farmer has put up signs on his farm forbidding entry. He has also used his gun to fire warning shots in the air when he sees any of these perpetrators. This highlights the need for constant feedback between the landowners, anglers and various state departments. In this case the farmer had no positive feedback, and the word spread to neighbouring farmers.

Bloemhof, just below the dam that has the same name, might be seen as the furthest point of interest for the NCYWG. Problems in the area have been reports of pollutants like sewage in, but the biggest problem is the illegal netting below the dam. An Indian business called Essops is selling nets to the local black community. They supply him with the biggest quota of the fish caught, while at the same time taking some fish for themselves. I have seen this first hand while fishing at a site called "Lawaai Hoek", situated about 2 km outside the town, where the local garbage disposal area is. These locals were throwing these nets in prime yellowfish waters and also spawning beds. The problem was reported to OVRYCMA and given to the nature conservation official from the Sandveld/Bloemhof conservation area to investigate. As yet no feedback has been received from these officials, and therefore it assumed that the investigation must still be underway.

Projects, communication and future plans:

As noted previously, the NCYWG prides itself on holding a Bells Yellowfish Festival every year; the preferred sites being Nkolo Spa and Lillydale Lodge. Yellowfish are being tagged and presentations made to show the problems faced by yellowfish conservation and management. The work group will be holding a Bells festival every year, and other festivals are also being held on a regular basis.
The central point of activity for the Northern Cape Chapter seems to be in Kimberley. Monthly evening sessions are held, where ideas are exchanged i.e. fly-tying, methods and conservation and problem reporting. The NCYWG has it own website ncywg.kimvertise.co.za or the 3 Provinces Fly fishing Club website: flyfish.kimvertise.co.za. These websites play a pivotal role informing their members of all news in this large area.
Good news is that a new water quality scientist has been assigned to the Northern Cape area. He is fresh out of university and willing to learn and help the NCYWG. Steps are being taken to build a strong bond between the working group and the scientist, as was the case with his predecessor. DWAF in Kimberley is also very helpful in many instances, and assists regularly with the checking of pathogens. One of the DWAF officials, Abe Abrahams, contributed to the establishment of the work group in 1999.
As noted previously all steps are being taken to protect all four yellowfish conservation sites.
Due to the vast distances involved the members of the NCYWG have learned to do their own work, with little or minimal help from any state department, or any other conservation orientated associations. Members are carrying out all yellowfish conservation with funding out

of their own pockets. Active steps have been started to help the NCYWG and its conservation projects from OVRYCMA (Orange Vaal Yellowfish Conservation Management Association). Feedback on meetings is being exchanged between the two associations. The key to this is Dirk Human who is a member of the NCYWG/3 Provinces Fly Fishing Club and also an OVRYCMA representative. He is also responsible for the FOSAF chapter Free State.
NCYWG is in serious need of professional and scientific help and analysis. This is seen in the need of capturing and processing of scientific data of the ongoing yellowfish tagging project. OVRYCMA has committed itself to try and help with this problem in 2008, building a stronger bond with the workgroup and hopefully making a permanent bond of co-operation between them. The seeds of success are slowly starting to show, and this report being presented at the annual YWG Conference indicates the willingness of both associations to co-operate. The biggest stumbling blocks of time, funds and logistics need to resolved first before any real advances can be made.

Taung Dam Case Study (report submitted to OVRYCMA, NCYWG and FOSAF by D.Human):

- This project lies close to my heart, as most anglers who have fished the dam will testify. The rough terrain means that it can only be reached with a 4x4 vehicle with high clearance and a very experienced driver.
- A brief oversight of the dam reveals a body of water of about 500 ha, averaging a kilometre wide and a length of about 15-18 km. The depth of the dam varies between 7-10 metres, but some places in excess of 30 metres.
- The dam was built during the apartheid era in the black self-governing area of Bophuthatswana, by the then government of South Africa. Completion date is believed to be about 1992.
- The dam was constructed to supply water to the area, and possibly form part of the greater Vaalharts irrigation scheme, but this all fell through due to the re-incorporation of the independent states into present day R.S.A.
- Maintenance of the dam has fallen behind, and it is believed that there are plans to construct overflows alongside both sides of the dam once the dam drops to below 60 percent capacity.
- The area is unique and beautiful, with semi-arid shrub and bush growing in this kloof.
- The area falls under DWAF, but it is still owned by the tribe, as this is tribal ground.
- In view of the above-mentioned factors, and being situated in a very remote area, this has ensured that the fishery is kept in a splendid condition. All steps should therefore be taken to preserve it in its current state.
- There are no facilities in the immediate area. Troops of baboons are plentiful and good numbers of leopards are rumoured to be present. One just has to look at the cliffs and hills and many small caves to believe this.
- There is a community staying about 5-10 km from the dam, and there have been many reports of theft from unattended fishing vehicles.
- Above mentioned points make a trip to this dam a logistical and safety hazard, as cell phone reception is as best times almost nonexistent on large parts of the dam.
- Luckily the dam is protected by the local fly fishing club, 3 Provinces Fly Fishing Club/NCYWG. With the help of the Taung Municipality a protective area has been earmarked. No outboard engines bigger than 5 horsepower are allowed on the dam, and a strict catch and release programme for yellowfish is being implemented.
- Two species of yelowfish are to be found in the dam, smallmouth (*L.aeneus*) and largemouth (*L.kimberleyensis*).

- The dam has interesting geographical and manmade boundaries. The difference in height between the Wentzel Dam near Schweizer-Reneke in the Hartsriver and the inflow at Taung Dam is 800 metres. This means there are waterfalls in a river that only flows sporadically in the rainy season. This stops any migration up the river.
- Due to no slipways being built there is no other outflow from the dam, except for the "windows" located on top of the dam, which were in use with the 1000 mm floods in the 2006 season. There is also a small opening in the base of the dam wall which keeps the concrete cool.
- This has lead to an almost closed system for the last 15 years.
- Anglers started catching "weird" looking yellowfish for the last 3 to 5years.
- It has become famous as "middelbekke" (middlemouths)
- Two distinctive characteristics of these "middelbekke" are the positioning of their eyes and the form of their mouths. The eyes are placed higher on the skull, and the mouths are bigger and a somewhat harder structure with the incisors (lips) coming together further behind the nostrils compared with what is common in smallmouths.
- The so-called "middelbek" has been caught on small nymph patterns through to bulky streamer type flies. This shows an adaptation to a variety of different types and size of food.
- Normal small and largemouth yellowfish are also being caught in the dam.
- The "middelbek" is by no means a smaller breed, as fish in access of 2 kg are being caught in the dam.
- There are two bodies of opinion on the theory of the evolution of the "middelbek". One group sees this as a hybrid, between the two species, as they were forced to spawn together on the scarce mining gravel found in certain parts of the dam. This was left many years ago when alluvial diamonds were being prospected for along the river. A local fisherman/club member has been fishing the dam for a decade now, and has told me that spawning can start late August to early September in the dam, due to the strong winds blowing at that time. It should also be taken into account that the area is always warmer than in the Highveld (3-8 C warmer), and it seems possible that the shallows could warm up quicker.
- The second group sees the "middelbek" as an adaptation towards its surroundings/environment. The dam does not have much insect life compared with the Vaal. It seems the dam lends itself more to a more predation/ piscivorous lifestyle as there is an abundance of smaller fish. There is also plenty of rock & tree structure and very clear water with 2-3 metre visibility at times. It is believed that part of the smallmouth population has adapted to this type of lifestyle, and are breeding because small "middelbekke" (300-500g) are also being caught.
- It should be noted that fishing on this dam is difficult at best of times, and a guide is a prerequisite, and even then the fishing can be heartbreak and neck break.
- Request has been made from the NCYWG for a genetic analysis of these species to confirm the origins of these fish.
- Since joining the NCYWG and also being part of the YWG, I took matters into my own hands and started a DNA study.
- I would firstly wish to thank Pierre De Villiers for pulling the strings with the university to do the analysis. I would also like to thank Linda Nel for providing me with the veils, and giving me the necessary instructions on how to collect the DNA samples. Also to Carel from the university, who will be doing the tests. I would like to further thank NCYWG/ 3Prov. Flyfishing Club for trusting me and letting me do the test. Also thanking Dawie Ras and MJ van Rensburg (Mr.Taung) for the information and guidance.

- I had gone to the dam to collect samples in August 2007, but with the bad weather we managed to get only one "middelbek". The DNA sample was collected, and the necessary photos were taken.
- Unfortunately the angler (non-club member) who took the photo has been in a disagreement with another angler and it seems that he is holding back the photos. MJ Van Rensburg has contacted the angler a few times to get the photos from him, and promises were made, but as yet the angler has not delivered. Speaking to the geneticist, Carel, he made it clear to me that he would need as many samples as possible (5-10) to make an accurate assessment.
- I have contacted the club and all other persons that I do know who fish the dam to participate in this study.
- I truly believe this to be one of the last true examples of "yellowfish heaven". Everything should be done to protect it from becoming the next Sterkfontein, and to understand this dam and its fish. A more ecological friendly approach should be taken towards its fishing. Bass are also to be found in the dam, and the anglers are taking steps to remove the species. Support for the idea that all recreational fishing on this dam should take place under the auspice of the NCYWG/3Prov. Club should be strongly encouraged because they have protected this dam for the last 10 years.
- A serious plea goes out to any organization to help with the DNA study and to help conserve this dam.
- Steps are also being taken to place some yellowfish conservation boards with the help from two local anglers/NCYWG members as has been done near Bothaville and Elgro Lodge near Potchefstroom.

Conclusion:

All steps should be taken to preserve the yellowfish in this area including the Lower Orange/ Sak systems. These systems are less polluted and have lower angling pressure. Studies show that the population of largemouth yellowish *(L.kimberleyensis)* is higher in the Douglas/ Christiana/Luckhoff area and the lower Orange (Richtersveld area) than in any other area. Logistical problems could be overcome with the help of financial backing and willing anglers, scientists and conservationists. All necessary steps should be taken in studying and preserving this area before it is too late.

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CHARACTERISATION OF THE SOCIAL AND ECONOMIC VALUE OF THE YELLOWFISH DEPENDENT USE AND ASSOCIATED CONSERVATION OF THE YELLOWFISHES IN THE VAAL RIVER

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Abstract

The aim of this study has been to characterise the social and economic benefits and implications associated with the use of the Vaal River by the yellowfish dependent angling activities and yellowfish related conservation initiatives in the Vaal River, South Africa. To achieve the aim of the study the following objectives have been proposed:

1. Characterise the social value that stakeholders obtain as a result of the angling and related conservation of the yellowfishes from the Vaal River.
2. Characterise the economic value that stakeholders obtain as a result of the angling and related conservation of the yellowfishes from the Vaal River.

Conclusion:

In an attempt to establish the total estimated social and economic value of the use and related conservation of yellowfish in the Vaal River the study team was brought into contact with various stakeholders of the management, conservation and use of yellowfish in the Vaal River. Without fail the stakeholders were exceptionally courteous and helpful and attempted as far as possible to facilitate the study. In total 91 questionnaires were comprehensively completed by anglers, 23 equipment retail store representatives were interviewed 17 accommodation sector representatives were interviewed, and numerous interviews were carried out with professional guides, conservationists, specialist consultants and academic researchers as well as with various magazine editors, Vaal River ecosystem managers and municipality representatives. The total economic and social value relating to the use and associated conservation of yellowfish in the Vaal River is exceptionally high. The total estimated value of the fly-fishing industry that actively targets only these species is just under R200million per season. The total social value of the use and associated conservation of yellowfish in the Vaal River occurs in the form of yellowfish acting as an indicator species, yellowfish being an important source of protein to local communities, yellowfish have a recreational value in that they are an actively targeted angling species (specifically to the fly-fishing and artificial lure groups of anglers), yellowfish use and conservation has the potential to add value to riparian property, has eco-tourism values, promotes social cohesion, stewardship and community engagement, and yellowfish use and conservation has the potential to improve the quality of life of many South Africans.

Although the use and conservation of yellowfish in the Vaal River has proven social and economic values a threat to these activities occur in that there no or currently inadequate management approaches and resources available to implement any management plans for this industry. The stakeholders of this industry are concerned that this is not a sustainable industry and that signs of a looming population crash exist in the form of widespread fish kills in the Vaal River. Should the yellowfish populations in the Vaal River be removed so too would this R200million a year industry and its associated social benefits.

THE ORANGE-VAAL RIVER YELLOWFISH CONSERVATION AND MANAGEMENT ASSOCIATION

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Introduction

The Orange-Vaal River system is South Africa's largest and has its origins in Lesotho (Orange River) and the Mpumalanga highlands (Vaal River). It has tributaries in most provinces in South Africa as well as in Botswana and Namabia, and eventually flows into the Atlantic Ocean at Oranjemund. This stately river is home to perhaps South Africa's best gamefish, the Orange-Vaal Largemouth yellowfish (*Labeobarbus kimberleyensis)* and the Oranage-Vaal Smallmouth yellowfish (*L. aeneus).*

Both species are sensitive to changes in water quantity and quality, habitat destruction and utilization pressure and are often used by authorities responsible for implementing the River Health Programme as a sensitive indicator species. These species play a vital role in allowing river managers to gauge the success or failure of any management interventions or programmes (e.g. river rehabilitation, catch and release, ecological reserve).

Largemouth Yellowfish (*Labeobarbus kimberleyensis*)

The Largemouth yellowfish is a sensitive indicator species that has been declared a near threatened species (IUCN). It is also a Protected Species in South Africa (NEM:BA). It has a slow growth rate and low fecundity. It is a top predator that inhabits large rivers and is very sensitive to pollution and habitat destruction. Largemouth yellowfish spawn over gravel beds during the warmer summer months.

Smallmouth Yellowfish (*Labeobarbus aeneus*)

The Smallmouth yellowfish is also a sensitive indicator species but is not listed as vulnerable yet. While it also exhibits a slow growth rate and low fecundity it is more of a generalist that inhabits both large and small rivers. The Smallmouth yellowfish is sensitive to pollution and habitat destruction and has similar spawning requirements as the Largemouth yellowfish. Both species are documented to be serial spawners.

Threats (lack of management)

The lack of management of the various sources of polluted effluent is a critical issue that threatens all aquatic biota. Excessive abstraction of the available water resources and the altered flow regimes to facilitate year round water usage has a serious impact on the aquatic habitat and the associated aquatic biota. The lack of effective fisheries management results in inconsistent legislation in the different provinces. Illegal netting and the uncontrolled stocking of invasive alien fish species is proving to be an issue that needs to be continuously managed. The capture of spawning fish or interference with spawning fish is an issue that needs to be monitored and managed.

Orange Vaal River Yellowfish Conservation and Management Association
The Orange Vaal River Yellowfish Conservation and Management Association was initiated in Bothaville (Free State) in 1996. It is a cooperative association of people interested in the conservation of yellowfish and the rivers in which they live. It was established to assist government with the conservation and management of indigenous fish species. One of the major marketing tools used was to market the wise utilization of indigenous fish species. This would increase the value of the species as well as create critical social and economic benefits for people in rural areas.

Conservation areas and members
It was noted that landowner support is critical to the success of this initiative. The principle of managed access to the resource was implemented. A chairperson was elected and an associated management committee was established (driven process). Four managerial meetings take place annually. Formal records are kept in the form of minutes. Ad hoc meetings to address emergencies can be arranged if necessary. Membership forms were designed and are now disseminated to new applicants. A constitution was developed upon which management decisions are based.

A total 769 members including anglers and interested people form an integral part of this Association. Over 700 kilometres are listed as conservation area (mainly Vaal River between Bloemhof Dam and the Barrage). The initial massive success has slowed down as active personnel and critical funding is lacking and new areas require additional travel/costs. The first managerial meeting of 2008 aimed at identifying critical interventions in each of the managerial units. Specific actions were listed for each area.

Funding and fund raising was identified as a major constraint. This will be a focus point for the next 12 months.

The Association has had a significant impact on the increased compliance actions and monitoring taking place in the area. Aerial inspections in association with ground follow up operations have been successfully completed. Several successful arrests have been made by provincial compliance staff. The Association has focused on a philosophy of capacity building and co-operative governance with regards to the issues faced by the local authorities. The effective management of sewerage plants has become a critical issue in the Vaal River in particular.

Discussions have taken place as to the use of a newsletter and/ or a web page as a method of disseminating information. Both will probably need to be used as some landowners do not possess the required IT equipment.

Catch and release, awareness and education
A great deal of energy, time and commitment from critical people and agencies went into designing and driving the implementation of the catch-and-release principle. It does provide an example of how a sound principle has caught on within angling circles. Articles have been published in flyfishing magazines describing the process.

Good communication and the creation of yellowfish conservation awareness is critical. Several articles were published in local newspapers and interviews took place on local radio stations. Articles in magazines and on TV are important to maintain the momentum of any successful conservation initiative. Several yellowfish conservation information boards have been erected at strategic places along the river (bridges).

It is vital to identify a simple but critical intervention that can be marketed to maximum effect.

Legislation

The various sets of applicable legislation were noted. NEM:BA (Protected Species Management Plan) was discussed in relation to the development of a management plan for the Largemouth yellowfish. This would result in consistent legislation in all provinces. The NEM:BA legislation on Protected Species came into effect as of the 01 February 2008. This implies that an angler will need a permit to target Largemouth yellowfish. The permit will probably be issued by a Provincial Conservation Authority. This has not been clarified yet. The South African Freshwater Bank Angling Federation has removed both Smallmouth and Largemouth yellowfish from competition angling. The presence of either of these species in an angler's keep-net will result in his/her disqualification. This is a great example of how the anglers themselves can work with the conservation authorities and implement critical conservation interventions while National and Provincial legislation is still being finalized. The species cannot wait for this process.

It was noted that the DWAF (Ecological Reserve) legislation if implemented in such a way that it took the habitat requirements of these fish species into consideration, would be an effective way of ensuring habitat management. The Association has been registered as an interested and affected party in this process. Association members have been actively participating in this critical process.

Provincial Ordinances vary but it was noted that most address some form of fisheries conservation. The lack of personnel to implement the legislation was also a problem. Inter and intra-Provincial communication between officials in Conservation Departments and DWAF is an important issue that needs to be supported.

Monitoring

The only fish monitoring that is taking place in the Orange Vaal River system is associated with the River Health Programme operating in the various Provinces. This includes the Free State, Eastern Cape, North West, Gauteng and Mpumalanga. This programme will be initiated in the Northern Cape soon (DWAF).

Research

Initial funding for the genetic study on the two yellowfish was sourced and secured by the Association. AngloGold Ashanti provided these funds and further follow up funds which were co-ordinated by the researchers, the YWG/FOSAF and the funders themselves. A final report was produced early in 2008.

A radio telemetry study sponsored by the WRC was motivated for and secured by members of the OVRYCMA, YWG and University of Johannesburg. The programme was initiated in the Vaal River in the river reach adjacent to "Wag-n-bietjie" Lodge. Preliminary results were presented at the YWG Conference 2007. The anglers have supported further work in this field.

FlyCastaway has sponsored further studies. This is an important achievement for conservation. The users of a resource are now supporting research on that resource.

Members of the OVRYCMA in association with University of Johannesburg motivated for and secured funding for a social and economic study funded by the WRC. This programme has been initiated in the initial OVRYCMA conservation area. The aim is to assess the social and economic value of the yellowfish angling industry that has been created by the initiative. There will be focus on flyfishing, lodges and the tackle industry amongst other things.

A proposal aimed at sourcing funds for an assessment of the distribution of grass carp in the Orange Vaal River system has been submitted to the WRC. This invasive alien fish species is fast spreading in the entire catchment. Its impact needs to be assessed.

Literature

It was noted that The Yellowfish Working Group Technical reports will address this. It was also noted that there is a need for additional research to support conservation decisions, especially regarding the threatened yellowfish species.

Concluding remarks

The use of a Yellowfish Conservation Association is a very effective way to introduce conservation principles into a wide area. However it was noted that the principles upon which it is based must be based on good science. While an Association can assist government it must not be seen as replacing government and it must be understood that Governmental support is critical. There must be effective funding as the lack of funds can be restrictive. There needs to be continual adaptive management and commitment from the management committee.

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- B2 Marketing

AN UPDATE OF THE YELLOWFISH TELEMETRY RESEARCH IN THE VAAL RIVER

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South Africans have enjoyed fishing for the two "premier" yellowfish species in the Orange and Vaal River systems for the last 40 years at least. Recent research has shown that the angling activity for these species is not new. Within the last 10 years there has been an exceptional increase in the angling activities for these fishes, predominantly in the fly-fishing sector. Signs that the fisheries in these systems (Orange and Vaal rivers) were being negatively impacted due to the excessive use or pollution of these systems was raised by anglers and thereafter researched by an aquatic ecologist in the 1970's. Following the findings of the yellowfish biology study carried out by Muller in 1973, for the first time managers of the Orange River and Vaal River ecosystems were warned that if the existing increasing trend in the excessive use of these systems was continued, that in the future South Africans could be faced with the possibility that we may lose one of both of these species all together. In 1973 this argument seemed unlikely, but today we are forced to acknowledge that a real threat to the continued survival of the Orange Vaal River Largemouth and Smallmouth yellowfishes exists. Within the last few years widescale fish kills have occurred in the Vaal River, supposedly due to a lack in adequate management of sewage treatment works associated with Gauteng. Mining and other industrial activities have been blamed form polluting the Vaal River ecosystem, specifically in the area between the Vaal River barrage and the Erina Spar Bridge. Demands for water by the agriculture sector along the lower Vaal River has resulted in ecologically vital flow regimes not being met in the middle and lower Vaal River reaches. And finally, with the national electricity shortage a new threat in the form of water pollution from poorly managed new coal mines in the upper Vaal River catchment has reared its proverbial, ugly head

In view of all of these negative, potentially ecologically devastating activities, very little has been done to address the continually decreasing state of the Vaal River and the yellowfish within the river. Aquatic ecologists from what is now called the Centre for Aquatic Research (Zoology Department of the University of Johannesburg) have developed a research study. This study, a radio telemetry fish behavioural determination study is being carried out in the Middle Vaal River at, "Wag 'n Bietjie Ekoplaas", by Linda Nel (principle researcher from FlyCastaway and the University of Johannesburg), Gordon O'Brien (Project manager and researcher from the University of Johannesburg), Andre Hoffman (project facilitator from Wag 'n Bietjie Ekoplaas and the Orange Vaal River Yellowfish Conservation and Management Association (OVRYCMA)) and Pierre De Villiers (project coordinator and conservationist from the OVRYCMA). The study was initiated in 2006 and has reached its first milestone in 2008. To date 24 individual yellowfish have been individually captured, fitted with radio telemetry tags, released and monitored in the Vaal River during at least two full seasons.

The yellowfish telemetry study aims to characterise the habitual behaviour of mature yellowfish individuals, across changing seasons and environmental conditions to obtain some idea of what the consequences of these changing environmental conditions are to the biology of these species. This information will be used to establish a yellowfish conservation plan for the Vaal River that has the potential to change the way in which this nationally important aquatic ecosystem is used and conserved.

As is to be expected from this type of study more new questions have seemed to be raised than answers obtained. We have learned that during some parts of the season individuals may remain in relatively small areas (very small for Smallmouth - +/- 500m and up to 3km for Largemouth) and move continually over large distances during elevated flow conditions. Some individuals seemed to show some signs of territorial behaviour and moved back to precisely the same location as they were captured. Both species appear to have a very good idea of their surrounding areas and during stable climatic periods adopt daily habitual patterns. We are still not convinced that we have determined the time, frequency and location that Largemouth spawn and we have not determined what environmental conditions are required to act as a cue to initiate the spawning of these fishes.

The principle researcher is writing up the findings of this study (due at the end of 2008) which will be published by the Water Research Commission. Following the completion of this phase the research team feels that we are in a position to build on this information and solve some important yellowfish biology questions. The focus of the study will be changed to address the breeding and feeding biology of the two yellowfishes in greater detail. This involves a change in the study area from the Vaal River at Wag 'n Bietjie Ekoplaas to the Vaal River in the vicinity of Scandinavia Drift (Elgro Lodge). This study area has been selected due to the following benefits:

1. The study area is surrounded by elevated ridges and hills that serve as ideal look-out points that will facilitate the tracking of approximately 30 km of the study area from the ground. This will drastically improve the monitoring potential of the study area.
2. Habitat diversity is great in this reach and the population of Orange-Vaal Largemouth Yellowfish is stable, but the abundance is considered to be lower in this reach compared with the previous study area. In addition specimens from the Elgro reach are very large with individuals in excess of 9 kg being angled from this reach during the 2006 season.
3. The infrastructure of Elgro Lodge that has been offered in support of this study will benefit the researchers during the monitoring surveys. In addition to infrastructure, Elgro Lodge has offered human resource support and this will enable the research team to increase the frequency of monitoring surveys and increase the amount data collected.
4. One of the new objectives of this study is to characterise the breeding biology of the Orange-Vaal Largemouth Yellowfish. Within the new study area a large, clean empty (of fish) dam has been offered to the study team to facilitate the study. Additional Largemouth specimens will be relocated from the adjoining Vaal River (500m away) and monitored in this dam. These fishes will be used in an artificial spawning experiment in October of 2008 and 2009.
5. A range of new, complementary research tasks, in the form of yellowfish biology studies will be carried out in this study are and the data will be available for consideration during the telemetry study. These tasks include:

    a. An assessment of the risk of the catch and release practices in the Vaal River by fly-fishermen, by Nico Smit and his team form the University of Johannesburg, Centre for Aquatic Research.
    b. An assessment of the selection of spawning areas and the effects of flows on the spawning of the Orange-Vaal Largemouth and Smallmouth yellowfishes. Bruce Paxton from Rivers of Life CC will undertake this.

c. An assessment of the breeding biology of the Orange-Vaal Largemouth and Smallmouth yellowfishes from selected locations in the Vaal and Orange rivers. This study will be undertaken by Gordon O'Brien (Rivers of Life) in collaboration with the Pretoria Zoo and the Zebra Research Aquaria.

In conclusion the findings of the preliminary telemetry study will be published by the Water Research Commission before the end of 2008 and at the 2009 YWG conference a paper presenting the findings will be presented.

PHYSIOLOGICAL RESPONSE OF LARGEMOUTH AND SMALLMOUTH YELLOWFISH TO ANGLING: IMPACT OF ANGLING DURATION, FISH SIZE, BODY CONDITION AND TEMPERATURE

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Freshwater angling has become an important recreational activity around the globe, generating substantial income for regional and national economy. The practice of "catch–and-release" (C&R) angling is growing as a proportion of total fishing and is widely promoted by angling fraternities. It is considered to be a popular conservation strategy and fisheries management tool. The ultimate success of C&R angling depends on ensuring high release survival rates by minimising handling, injury and mortality of caught individual fish. Currently no species specific information exists for the effect of C&R on the survival of any of the South African freshwater game fishes. It is thus hypothesised that increased angling duration, exposure to air and incorrect handling will negatively impact on the survival of South African premier game fishes. The aim of this study will thus be to use two yellowfish species (*Labeobarbus kimberleyensis & Labeobarbus aeneus*) as case study to determine the potential risk posed to the fish populations in the Vaal River, due to stress induced by current C&R practices. This will be achieved by analysing the angling methodologies and stress induced by individual fish caught by anglers during organised angling tournaments during 2008. In order to achieve the above various species specific data need to be collected. The methodology that will be followed includes drawing blood from the caudal vein of each specimen for later determination of cortisol, lactate and blood glucose levels. The blood will be drawn using 21 or 22 gauge needles and heparinised syringes. Haematocrit will also be determined by centrifuging blood in heparinised capillary tubes. Following tournaments, at the same location, a day or two is required per event to collect an additional 20 yellowfish specimens *in situ*. Specimens of all sizes will be collected using standard angling techniques. These specimens will be used to establish controls for the study and additional information related to the breeding biology and growth of the fish will be determined. This will be done by removing gonads, scales and otoliths. Gonadal histology will be used in conjunction with the gonado somatic index (GSI) to confirm gonadal phenotype and to determine the state of sexual development (Grier 1981). Age determination will take place using both scales and otoliths. These findings will facilitate the development of an age-weight growth relationship of fishes in these systems and in the formation of an appropriate fisheries management plan for these two yellowfish species. The expected outcome of this study will be to develop a sustainable, non-destructive, conservation friendly C&R methodology for premier game fish in S.A. This methodology will target the C&R angling community & provide ecosystem managers with the tools to confidently manage C&R in ecosystems where these fishes occur.

CASE STUDY: THE EFFECTS OF ANGLING ON LACTATE ON THE TIGERFISH, *HYDROCYNUS VITTATUS* FROM THE OKAVANGO DELTA, BOTSWANA

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Abstract

Sport fishing is an important recreational activity for people around the globe, generating substantial income for both regional and national economies. While some anglers keep a portion of the fish captured, many fish are captured and immediately released. Catch-and-release (C&R) fishing is thus growing as a proportion of total fishing and has become a popular conservation strategy and fisheries management tool. The ultimate success of C&R angling depends on ensuring high release survival rates. Despite the importance of this premise, research on this topic is only available for a few popular North American species with no information available on the C&R angling effects for any of Africa's freshwater game fish. The aim of this study was thus to determine the physiological effect of angling on tigerfish (*Hydrocynus vittatus*), through testing blood lactate levels as bioindicator for physiological stress. Data was collected during August 2006 in the Okavango Delta, Botswana. Thirty fish were captured using standard recreational angling gear. For each fish caught the landing time and handling time were recorded. Caught fish were immediately anesthetised in a 0.5% concentration of clove oil. Blood was drawn from the caudal vein of anethetised fish, where after the fish were weighed, measured and transferred to fresh aerated water for recovery and then released. Five fish were kept in large 10 000 l ponds to serve as controls. Blood lactate levels of all fish were immediately measured with a Lactate Pro Portable Lactate analyser and that of the control fish 72 hours after capture. Of the 30 fish captured, 17 were landed between 30 seconds and 1 minute, 9 between 1-2 minutes, 2 between 2-3 minutes and 2 between 3-4minutes. The average lactate levels of these were 4.6 mM/l, 5.2 mM/l, 7.2 mM/l and 5.1 mM/l respectively. These were all significantly higher ($P < 0.005$) than resting lactate levels of the five control fish (average = 1.9 mM/l). These results confirm that blood lactate can be used as bioindicator for physiological stress in tigerfish and that significantly higher levels are already present in fish played for as little as 30 seconds.

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ASPECTS PERTAINING TO THE GENETIC AND MORPHOLOGICAL DIFFERENCES BETWEEN FIVE POPULATIONS OF THE BUSHVELD SMALLSCALE YELLOWFISH, *LABEOBARBUS POLYLEPIS* IN SOUTH AFRICA

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Within South Africa, many isolated populations of the Bushveld smallscale yellowfish (*Labeobarbus polylepis,* Boulenger, 1907) exist, specifically within the upper reaches (above 600 m) of rivers in the Limpopo, Inkomati and Phongolo catchments, South Africa. Due to the preference that this species has for upper reaches of rivers, no fewer than at least eleven isolated populations of *L. polylepis* occur. Although very little of the biology and ecology of *L. polylepis* is known, some morphological and genetic variation between isolated populations have been observed in the past. From as early as 1969, consistent morphological differences between populations of *L. polylepis* have been observed. This morphological difference relate primarily to the occurrence of a single population that exhibit a high percentage of individuals with the rubber-lip formation, a rare occurrence in *L. polylepis*. Following this initial account of morphological differences between *L. polylepis* populations, similar observations have been made. No formal assessment of the possible morphological differences between communities has been undertaken. More recently, with the development of methods to characterise genetic variation within and between populations, consistent differences between three *L. polylepis* communities occurring in the Phongolo, Komati and Spekboom rivers were discovered. Unfortunately, some of the genetic variation observed between *L. polylepis* populations from the Phongolo, Komati and Spekboom rivers were attributed to genetic contamination of specifically the Spekboom River population due to potential hybridisation of *L. polylepis* with *L. aeneus* in this system. These findings suggested that although the possibility of genetic differences between isolated populations exists, there is still insufficient data to warrant a change in the currently adopted management and conservation strategies for this species towards conserving isolated populations that may be unique and where the survival of these populations is threatened.

Findings from an assessment about the state of the identified populations of *L. polylepis*, recently released, are extremely concerning since at least five of the eleven populations are believed to be rare, threatened or declining in numbers. Seven communities are considered to be negatively affected, mainly by: hybridisation with other *Labeobarbus spp.*, water quality and quantity, river connectivity, river habitat destruction, competition with alien fishes, and excessive harvesting usually during spawning activity. One population of *L. polylepis* that originally occurred in the Letaba River is now considered to be extinct. Within South Africa, national legislation makes provision for the conservation of biological diversity between and within species (NEM:BA, Act 10 of 2004). Although the possibility of ongoing differentiation between isolated populations of *L. polylepis* exists, no specific management or conservation plans have, as yet, been implemented to conserve any unique population that may be facing some kind of threat.

This study which has been carried out and is expected to be completed in 2008 aims to characterise the occurrence of morphological and genetic differences between five isolated populations of *L. polylepis*.

THE STATUS OF ALIEN YELLOWFISH AND LARGE BARBS IN SOUTHERN AFRICA

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Alien fish – the main culprit

Despite serious habitat destruction caused by bulldozing, excessive water extraction, pollution and the building of dams, it is doubtful whether any fish species in the Cape Floristic Region would be red-listed as Critically Endangered or Endangered under IUCN criteria (www.iucnredlist.org) if it were not for alien fishes. Alien invasive species are one of the greatest threats to the ecological and economic well-being of the planet (Matthews, Brand, 2004). For freshwater fish, alien invasive fish species are regarded as the most serious threat globally (Cowx, 2002). Defining which species are alien should be kept simple. Any fish that occurs outside its natural range should be classified as an alien fish regardless of where that natural range may be. For example, the Clanwilliam yellowfish that have been introduced into the Twee catchment above their natural range, but within its native river system, is as alien to the Twee catchment as rainbow trout from North America. There are important differences between "African aliens" and "foreign aliens" in the South African context. These differences are summarised in the Table below and suggest "African aliens" can be more dangerous than "foreign aliens" in certain cases.

Threat	**Foreign alien fish**	**African alien fish**
Predation threat	High	High
Competition	High	High
Hybridization potential	Low	High
Parasite threat	High	Moderate/unknown
Translocation history	Advanced	Starting

Artificial breeding and hatcheries are not the answer

Artificial breeding and hatchery operations have been used in the past as a conservation strategy and is still suggested by some as a potential solution for the conservation of threatened species. Internationally it has become apparent, however, that these operations cause more problems than they solve. What follows is a summary of the dangers of hatcheries reported. (see also Swartz, Bloomer, 2003). Escapes from hatcheries certainly contribute to the alien fish problem. There is also the possibility that hatcheries might import alien parasites that can either escape directly from the hatchery or be spread with the translocation of fish from the hatchery. Populations from different historically isolated lineages can inadvertently be mixed in hatcheries and unique evolutionary lineages can be lost through hybridization (Avise *et al.*, 1997; Dowling, Childs, 1992; Leary *et al.*, 1993; Quattro *et al.*, 1996). Artificial selection in a hatchery environment can lead to a loss of adaptive gene complexes (Garcia de Leániz *et al.*, 1989; Waples, Teel, 1990) and general effects of inbreeding in hatcheries leads to an overall loss of genetic diversity (Briscoe *et al.*, 1992; Leary *et al.*, 1993; Quattro, Vrijenhoek, 1989).

Which large cyprinid species has alien populations?

All six yellowfish and all three large barbs in South Africa may have alien populations outside their natural range. *Labeobarbus aeneus* have established outside their natural river system in the Gourits River system (Western Cape Province), several river systems in the Eastern Cape, in the Olifants branch of the Limpopo River system, in Kyle Dam in Zimbabwe and they may also now occur in the Thukela (KwaZulu-Natal). There is the potential that *L. kimberleyensis* could establish in the Great Fish and Thukela River systems from the Orange River system through inter-basin transfer schemes. *Labeobarbus natalensis* have been introduced above natural barriers in their native river systems in KwaZulu-Natal, but outside their natural range. They may also have established an alien population in the upper Save system (Zimbabwe).

Not much is known about the translocation history of *L. polylepis* and *L. marequensis*. Both species were reared in hatcheries and stocked from there. The latter species was even kept in hatcheries in KwaZulu-Natal from where they may have escaped. *Labeobarbus capensis* and *Barbus serra* have been introduced outside their natural range (within their native river system) in Cederberg tributaries of the Olifants River system by CapeNature's predecessor organizations, until as recently as 1998. Even more recently, CapeNature helped a flyfishing business in Jonkershoek establish an alien population of *Barbus andrewi* that could establish in the Eerste River system. *Barbus mattozi* (or *B. rapax* as some are calling the southeastern populations) have been introduced into dams around Bulawayo and the Matopos and may have established an alien population in the Nata River that is part of the Makgadigadi/Okavango system.

There have also been several translocations within the range of the yellowfish and other large cyprinid species that could cause mixing of historically isolated lineages. This is not desirable if we are interested in conserving genetic diversity and integrity to ensure long-term survival of these species. The most disappointing aspect of these translocations is that nature conservation authorities continue to grant permits and sometimes actively assist in the establishment of alien populations of large cyprinids despite the fact that aliens have been recognised as the most serious threat in freshwater fish conservation. For more detailed information about the translocations and the threats they pose, please refer to Swartz (2007 and unpublished chapter).

The green flyfisherman

If one is interested in being a "green flyfisherman" there is no doubt that some thought will have to go into deciding about one's actions. There are the obvious things, such as practising catch and release of indigenous fish, not littering, not disturbing breeding fish, etc. Possibly the most critical aspects of being green, however, involves quite complex decisions one has to make between fishing pleasure and conservation considerations. For example, should we be fishing in conservation areas or promote fishing for threatened species when we know that even catch and release can lead to the death of individuals? Fly fishermen will no doubt come across the debates surrounding alien fishes and their impact on our natural environment. Yellowfishes and other large barbs have not escaped this debate, especially since they are actively being promoted as an alternative to alien species from North America and Europe, whist themselves posing a threat to indigenous fishes in zones where they have become aliens themselves. Our actions with regards to the alien fish problem and our attitude towards the deliberate and accidental movement of fishes will ultimately be the greatest test of whether we are green or not, mainly because it tests the balance between fishing pleasure and conservation principles the most. All of us can agree that riverine habitats should improve from a pollution perspective, for example, but if introductions can bring a fishery closer to home or improve

fishing potential, it might be more difficult to follow conservation principles. The following questions should be asked if one wishes to contribute to environmentally friendly fishing:

- Is the population I am fishing for alien or indigenous?
- Is the population threatened? Should I be fishing for all 9 large cyprinids in South Africa when some of them are threatened species?
- What is my impact on the river?
- How do I catch and release the fish? Should I be catching a releasing at all (alien populations)?
- What message am I sending to other fishermen and the public?
- Can I make a contribution?

The most important principle in the conservation of South African freshwater fishes, however, remains never to translocate fish.

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THREATS FACING THE MAGALIES RIVER AND THE WAY FORWARD

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Location:
The Magalies River has its source in the foothills of the Magalies mountain range. Water bubbles up through limestone deposits and out Maloneys Eye. The Eye actually consists of 9 fountains that provide 1 million cubic litres an hour.

The river course then travels for approx 50 km between the Magalies range to where it flows into Hartebeespoort Dam.

Threats:
Critical water levels
The primary cause is over-extraction of water by agriculture in the Tarlton area (This is where the dolomitic aquifer is located). Illegal centre pivots are lowering the water in the aquifer to critical levels. In 2007, the water level was so critical that DWAF was unable to measure the flow. The government also failed to carry out the research required to identify how much water was available and allowed the existing legal extraction to continue without the correct facts.

As a result the river was only flowing at a trickle within 5 km of the source and then was basically dry for the balance of the way down to Hartebeespoort Dam. A number of areas had a drastic loss of river life including, fish, invertebrates and aquatic plant life. The areas nearer the source, that were fortunate to have some water saw the following effects:

1) Heavy algal build-up that created a terrible smell and covered the rocks in the river
2) Juvenile yellowfish were forced out of the shallower nursery pools and into the larger pools and weirs where they were aggressively predated on by bass. A large portion of the juveniles was lost.
3) Fish were unable to move up the river to spawn

Illegal fishing
The indigenous riparian bush on the initial section of the river from the source of the river runs for approx 3 km. This area is difficult to monitor without sufficient manpower. Illegal fishing with nets in a small stream environment can be catastrophic and we have noticed a definite decline in fish numbers. We have caught people taking fish with nets before, but there must be a lot more illegal fishing that we have missed. My concern was that the larger fish (breeding stock) that were always resident in the larger pools have all but disappeared. It may be that the low water levels have led to them becoming more wary and so they are hiding or that there is not enough oxygen in the water and they are dying (We have not seen evidence of dead fish).

Way forward:
I have been proposing a monitoring system utilizing people from the local community (Similar to the River Ranger project). This would create much needed employment, and guides once trained would be utilized for :

- Tourism activities such as guiding for fly-fishing, birding and the Anglo Boer war history.

- Controlling the illegal fishing, monitoring fish movement (identify whether migration is being affected by any weirs etc) and constantly identifying alien plants that should be removed.
- Stopping potential crimes from burglaries to stock theft by identifying suspicious characters in the area

Major erosion
Overgrazing by goats and cattle has led to the creation of a major erosion gulley near the river source. The larger substrate that has washed out is damming up the river (Also filling up weirs) and the finer silt is destroying spawning grounds by covering the pebble substrate.
We tried to get Government departments involved to resolve the erosion problem but received no support.
Nimag Group sponsored the creation of a temporary erosion wall in 2005 which helped to slow down the progress of the erosion, but once the area behind the wall filled up the eroded soil/rocks runs over the top of the wall.

Way forward:
GDACE, Working for Wetlands and Gauteng Nature Conservation need to allocate staff to create and implement a management plan to stop the erosion and allow the river to recover naturally.
(Since the YWG conference I have had Siya Buthelezi visiting the site and he is working on getting a solution to the problem implemented.)

Alien plant species
Alien invader plant species affect quality and quantity of the river water (Mainly bluegum, Yellow Firethorn, Poplar & Privet). A large portion of the alien trees and plants have been removed on the Nimag property (450 hectares – 2,5 km from Maloneys Eye) by a combination of Nimag sponsored projects and assistance from Working for Water. Unfortunately we have not had as much success in the top stretch, closer to the source of river due to challenging access and insufficient planning by Working for Water. The main threats are Yellow Firethorn which is a horrible plant which is extremely difficult to work with. One of the downsides of removing the Firethorn is that it acts as an extremely safe environment where the fish can hide. We have seen fewer fish since we have removed some areas of the firethorn and increased numbers of birds, which predate on the fish.

Alien fish species
Carp and bass in a small river system are destroying the yellowfish and minnow population. The carp, which were illegally introduced by Magaliesberg locals have bred like crazy and are having the following negative effects:

- Muddying up the water when they feed and the silt then settles on the rocks and aquatic plants in the slow moving areas. This stops the growth of algae on the rocks and plants and you no longer find invertebrates on them. The result is less food for the fish.
- In the search for food the carp suck eggs off the yellowfish spawning areas and destroy thousands of potential juvenile fish.
- The bass prey on the yellowfish juveniles and the impact has been made worse by the low levels of the river that has forced juveniles from the safe shallow nursery areas (bass proof) into the deeper open pools and weirs where there is no protection

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Way Forward:
A strict policy has been implemented where any bass or carp that are caught are disposed of. We are also seeking assistance from GDACE, DWAF or the universities to assist with electro shocking to remove as many alien fish as possible.

Development of housing estates
Over the past year there have been two applications to provincial government to build luxury housing estates. The one estate is on the land where a catchment and the source of the Magalies River are located. On inspection of the property we found that the river had been blocked off and all the water diverted into the concrete dams where the old trout hatchery was. In addition to this a section of the river banks (500 metres from the Eye) had been bulldozed.

This is huge problem as the area cannot sustain the pressure that is already being put on the environment and it seems that landowners are just going ahead without any fear of the local authorities.

The other development (Proposing 240 properties) is approx 2 km downriver, but I am not sure what the current status of their application is.

Way forward:
It will have a terrible impact on this delicate eco-system if these developments are allowed to continue. We are monitoring these developments and will try to assist in keeping them from happening (With support from the authorities and local community).
If the developments are authorized then these developers need to consult with those people who are involved in conserving this environment for input on how to minimize any damage that may be caused.

In addition to these issues addressed above, we could really do with a plan developed with DWAF or GDACE to create a map of areas in Gauteng where the smallscale and largescale yellowfish are situated and then assist land owners with signage to indicate yellowfish conservation areas (as has been done on the Vaal River)

SUNDAY WORKSHOP

FOCUS: CONSERVATION OF WESTERN CAPE YELLOWFISHES

Participants: Bruce Paxton, Ernst Swartz, Pierre de Villiers, Ryan Weaver, Dean Impson, Ramogale Sekwele, Sean Marr, Bill Mincher, Johan Hardy, Bernard Venter, P Ramollo, T Mathebula
Rapporteur and workshop facilitator: Dean Impson

Key Recommendations

1. Develop management recommendations for each priority freshwater fish conservation area.

2. Motivate for the appointment of at least two freshwater fish technicians at CapeNature to assist Dean Impson.

3. Re-activate the provinces Freshwater Anglers Forum and have quarterly meetings

4. Ratels River yellowfish stockings – these should be assessed with due caution. See paper on this subject by Impson (this volume). Participant reaction to a proposal by CapeNature to restock dams cleared of carp with local yellowfishes ranged from negative to positive. If stockings did proceed then the river above Beaverlac waterfall should be carefully monitored, especially in terms of aquatic invertebrates.