THE STATE OF YELLOWFISHES IN SOUTH AFRICA 2007

Louis Wolhuter and Dean Impson
(Editors)

TT 302/07

Water Research Commission

THE STATE OF YELLOWFISHES IN SOUTH AFRICA 2007

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Report to the
Water Research Commission

by

The Yellowfish Working Group

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Status of yellowfish populations in South African waters

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YELLOWFISH WORKING GROUP

Mission statement

To promote the long-term conservation of yellowfish as a flagship group within their natural habitats through sustainable utilisation practices, and as a means to create an awareness of conservation with the relevant decision makers.

FOREWORD

Living things, together with their environment, make up what ecologists call an ecosystem. The most fundamental property of an ecosystem is that it is interactive – *any* change in *any* component of the system gives rise to changes that subsequently affect the entire system. Humans have proved to be an exceptionally successful species; more so than any other. But, in common with all organisms, we have certain requirements of life which we must obtain from the environment and to a considerable extent those requirements have had a very detrimental effect on the environment. Like all other organisms, we are not self-sufficient and in order to remain vigorous and healthy we need a full and rich environment.

There are many ways to determine whether an ecosystem is in good health and functioning correctly. One of these is to select a specific organism which, if it is prospering in a particular environment, indicates to us that not only are its requirements being met, but also the needs of the other inhabitants of that ecosystem. An organism that meets these criteria is commonly referred to as a "flagship species".

Yellowfishes are African fishes – nine species occur from the Zambezi River southwards; a tenth is confined to the upper Zambezi and Okavango systems. Four of these species are endemic to the RSA. In this publication we are focusing on the nine species that occur in the Republic and its neighbouring countries. First, we assess and report on the state of the yellowfishes in our rivers in this year, 2007. This will establish a benchmark whereby, in future, the success or failure of any action taken (or not taken) may be judged. Second, we look at the social and economic benefits of yellowfishes and some of the controversies that surround these issues.

Louis E. Wolhuter
Randburg
March 2007

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YWG YELLOWFISH WORKING GROUP

FOSAF

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INTRODUCTION

Bill Mincher

The Yellowfish Working Group (YWG) was conceived at *Trout '94*, a conference organised and hosted by the Federation of Southern African Fly Fishers (FOSAF). The YWG is a dynamic organisation consisting of anglers, conservation officials, members of government, academics and industry representatives who are passionate about the conservation of our indigenous yellowfishes. FOSAF, a registered Public Benefit Organisation, provides the secretariat and the basic funding and has raised additional funds necessary for various projects. The YWG is managed by an executive drawn from its 350 odd members. It holds an annual conference at various venues around the country and publishes the conference proceedings. Members are also kept up to date by means of regular newsletters on the internet. It is appropriate for the YWG to cap a decade of achievement by issuing this report on the status of yellowfish populations in South Africa in 2007. This publication will be followed by a detailed scientific status report as well as a motivational poster on pollution in our rivers.

South Africa is a relatively dry country with an irregular rainfall pattern. In order to move water to regions where it is most needed, it has been necessary to build many storage dams and transfer water from one drainage basin to another. This has had a severe impact on riverine ecology and on yellowfish populations in particular by modifying their habitat and restricting spawning migrations.

In April 2005 the Biodiversity Institute in Pretoria published its National Spatial Biodiversity Assessment Report which revealed that a frightening 82 percent of our rivers are "threatened". Of our 259 estuaries many are in a bad state and only 14 percent are protected. Globally, the greatest contributor to the extinction of species is the loss of habitat; South Africa is no exception and needs to face this challenge with great commitment and skill.

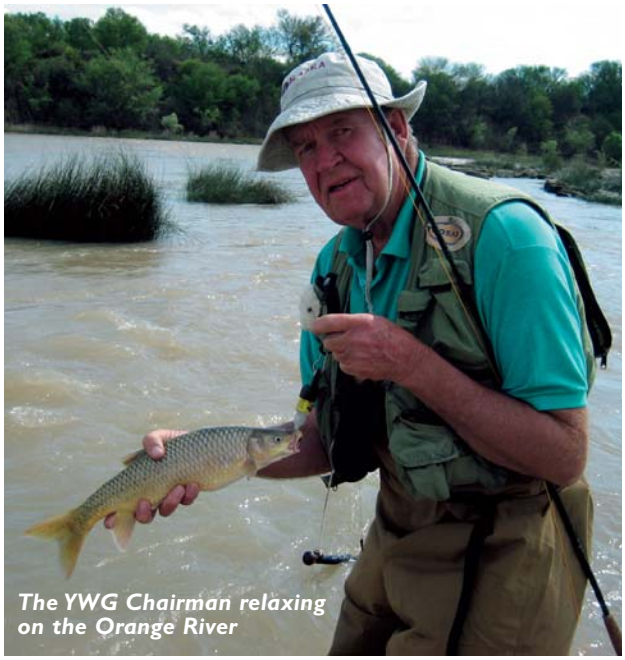
Unless the Water Act is enforced more rigidly to curtail pollution, it is of token value only

The climatic changes accompanying global warming will doubtless have an even greater adverse effect on our biodiversity and meagre water supplies. Our only hope may be that the world is finally, albeit painfully slowly, awakening to the fact that only prompt and concerted international action to reduce the emission of greenhouse gases can slow down or turn around the perilous journey we're on.

The Human Development plan for 2006, was launched in November of that year as part of the United Nations Development Programme. Our President attended this gathering where governments from around the world were urged to treat the shortfall or lack of access to water and

YWG conference delegates – Muden KZN 2000

sanitation as one of the greatest emergencies. Whereas these matters have been on the national agenda for many years, South Africa has now also committed itself internationally. Nonetheless, pollution of our rivers continues on an unparalleled scale, particularly along the Vaal River. Sewage treatment plants have not kept pace with rapid urbanisation and population growth and, coupled with a lack of maintenance and poor skills, this has resulted in unprecedented fish kills and threats to human health. Other provinces are experiencing exactly the same problems. Considering that yellowfish take 5 to 7 years to reach sexual maturity and the rate at which pollution is increasing, we simply do not have the time to allow matters to perpetuate. The situation is critical and calls for speedy and decisive action from the highest echelons of government.



The YWG Chairman relaxing on the Orange River

We have an excellent Water Act but unless it is enforced more rigidly to curtail pollution, it is of token value only. If lack of enforcement is due to a lack of capacity then it can and should be rectified forthwith by the authorities. In mitigation, it should be pointed out that the Department of Water Affairs and Forestry (DWAF) has instituted two excellent programmes: the Working for Water initiative to eradicate alien invasive plants from our watercourses and the River Health Programme (RHP) to monitor water quality and river health.

The YWG has had considerable success in popularising the highly desirable angling qualities of yellowfishes among anglers and riparian owners. Both groups now have a vested interest in protecting yellowfish, their habitat and water quality. Riparian owners across the country are encouraged to join and establish yellowfish conservation and management associations – this can only have a beneficial effect on yellowfish conservation.

The YWG originated a comprehensive research programme on yellowfish genetics and, owing to generous funding from AngloGold Ashanti and the National Research Foundation, is seeing the gratifying results of that research. Other important research projects are funded largely by the Water Research Commission and the results, together with those derived from research projects planned for the future, should provide the scientific basis necessary to develop sound management strategies.

Of the nine species popularly referred to as yellowfish, four are classified in the World Conservation Union (IUCN) Red Data List as "Threatened". Several of the others are not in a healthy state. The purpose of this report is to bring the plight of these indigenous fishes of ours to the attention of an audience comprising government officials, academics, teachers, leaders of industry, anglers and those attending secondary and tertiary teaching institutions.

This situation simply cannot be allowed to deteriorate any further – most of the damage done has resulted from the type of economic development in which there has been little if any concern for the environment. It is gratifying to see, therefore, that across the community there is a growing awareness of and awakening to the importance of good environmental practices. It is my fervent wish that this report will give you a better understanding of the status of the yellowfishes – our "Living Gold" – and that we may walk side by side in our efforts to conserve them and their beautiful environment for future generations.

Copies of this report as well as the scientific one which will follow it are obtainable from orders@wrc.org.za. For further details look up the Water Research Commission website: www.wrc.org. za.

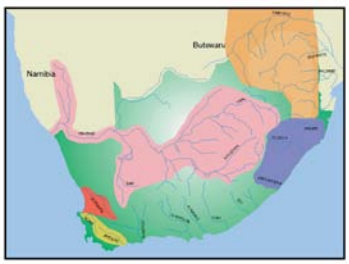
Bill Mincher is Vice President of FOSAF, a founder member and chairman of the YWG.

AFRICAN YELLOWFISH

Labeobarbus and *Barbus*

P H Skelton

African "yellowfish" or *Labeobarbus* species are striking creatures well known and valued for their beauty and as a food source ever since humans first fished in African freshwaters. The archaeological record, including rock art, historical middens and hieroglyphics from ancient Egypt is all evidence of this long-standing relationship.



Yellowfishes are endemic to Africa and constitute a lineage of about 80 large cyprinid fish species with some well defined traits and characteristics. They occur in all the larger rivers in sub-Saharan Africa, including the Nile, Niger, Congo and Zambezi as well as in the Great Rift and other lakes of East Africa. They extend south as far as KwaZulu-Natal in the east and the Orange and Clanwilliam Olifants in the west. A few species have been transported to rivers beyond their natural range – the Orange-Vaal smallmouth yellowfish, in particular, now inhabits coastal drainage basins from the Great Kei to the Gourits.

The most outstanding feature of the African yellowfish lineage is the very high number (about 150) of cell chromosomes – a fact only recently discovered. Most cyprinid fishes have around 50 chromosomes (the normal or diploid state) in each cell. Some species feature around 100 chromosomes (a tetraploid or four-fold condition), and a few, including yellowfishes, have 150, a hexaploid or six-fold condition.

Striking creatures well known and valued for their beauty and as a food source

The physical features of yellowfishes include their relatively large size (i.e. adults grow beyond 150 mm standard length [SL]), with the larger species attaining a length of about a metre and as much as 20 to 30 kg in mass. Yellowfish are strong bodied and generally spindle shaped but a few are stout with relatively deep bodies. Their fins are short-based (with relatively few rays); the dorsal fin has a simple (not serrated) but usually bony and spiny anterior ray. In some species the anterior dorsal rays are extended. In adults the anal fin also has longer anterior rays giving it a characteristic trapezoidal shape. They show little sexual dimorphism (females are plumper in breeding condition); both sexes in many species tending to turn deep brazen gold or yellow when breeding, and they develop small pimple-like nuptial tubercles on the head. The scales are strong and well developed with numerous parallel striations, and a lateral line runs from head to tail. The mouth is mostly sub-terminal with variable lips. When the fish is adapted to grubbing between pebbles and cobbles the lips are large and fleshy (called rubberlips). Where it has to scrape food from rocks and other hard surfaces, the lips are thin, straight, and keratinized (also known as "varicorhinus" or razor-lipped mouth). As with all cyprinids there are no jaw teeth, but they have three rows of strong pharyngeal teeth that vary in form from heavy, rounded (molariform) crushing teeth to slender and hooked. Hooked and pointed pharyngeal teeth are suited to raking soft food from the mouth to the intestine (cyprinids do not have a stomach); heavy rounded teeth crush hard foods such

Early San record of Yellowfish

Image by: Mclean, Rory (RARI)

as molluscs or hard seeds. The digestive tract is longer than the length of the fish, sometimes as much as three or four times that length. They are mostly generalized feeders, taking whatever food is available at the time, feeding in quiet or running waters, from the surface, the midwater column or off the bottom. The few specialized predatory species, characteristically, have larger terminal mouth forms.

Typically yellowfish are large river or lake dwellers, and move into smaller rivers and tributaries to breed. Strong swimmers, they thrive in flowing habitats, in pools below cascades and rapids, even in thundering gorges – and in places are known appropriately as "gorgefish". Yellowfish generally breed in flowing water over rocky or gravel substrates following the onset of the rainy season. Ripe adults congregate downstream of suitable spawning sites until ready to spawn. This occurs when groups of ripe male fishes move into the site and are then joined by individual females who are immediately attended closely and pressured by the males, the ova being released and fertilized over the gravel or rocky bed. Breeding activity may extend over several days, and after spawning the adults return downstream. The eggs hatch and the larvae and young fish move downstream into nursery areas where they form cohort schools in the shallows.

Subsistence fisherman

The evolutionary and phylogenetic relationships of yellowfishes are not well known. The lineage is widespread in Africa and has been present in the rivers and lakes of the continent for a long period of time. The fossil record is poor and the earliest records come from the Middle Miocene of East Africa. A better indicator of the age of the lineage may be an estimate of the time of last connection between now independent river systems where related species occur. For example, the presence of related yellowfish in the Clanwilliam Olifants and the upper Vaal-Orange is part of the evidence indicating these systems were once connected, and geologists estimate the last linkage was during the early Miocene some 20 million years ago.

The evolutionary drivers for yellowfish species may be inferred by considering the nature of the species in a system when more than one species is present. One example comes from a species flock in Lake Tana, the source of the Blue Nile in the Ethiopian Highlands. The 15 or so yellowfish (*Labeobarbus*) species in the lake diverge in terms of head morphology, feeding structures and body shape, as well as in breeding (spawning) times and places. Some species run up the affluent rivers to spawn whereas others remain in the lake and spawn along the shores. *Labeobarbus intermedius* is considered the generalised riverine species probably little changed from the ancestral form from which this flock has evolved, and is common and widespread in the Nile and other rivers of north-east Africa.

This situation is very similar to the differences in biology and ecology as described for the Orange-Vaal smallmouth (*L. aeneus*) and the Orange-Vaal largemouth yellowfish (*L. kimberleyensis*). The smallmouth yellowfish is a more generalized form with variable characteristics in terms of mouth form and body shape. The largemouth yellowfish is essentially a predator with a far more consistent body and mouth form. The two species breed at slightly different stages in the annual hydrographic cycle, the smallmouth earlier in the rainy season, the largemouth later.

In Southern Africa there are two groups of yellowfish, here simply described as largescale and smallscale forms. At present the relationship between these groups is uncertain because largescale and smallscale forms also exist elsewhere in Africa. The two largescale yellowfish species are *L. marequensis* from the Lowveld rivers and *L. codringtonii* from the Upper Zambezi, Okavango and Kunene. The smallscale group is endemic to the Orange-Vaal and surrounding rivers. Evolutionary and phylogenetic relationships between the species are still being established but the current concept is that the Orange-Vaal basin was once more extensive than it is today and was where the common ancestor existed. The

surrounding rivers gradually captured parts of the Orange-Vaal drainage and with each capture some of the common ancestral population was separated and eventually speciated (evolved in isolation) from that ancestor. Within the Orange-Vaal itself components of the population were partially or completely isolated through habitat preference and feeding biology. These components also diverged over time to the point of not interbreeding and therefore speciated into the largemouth and smallmouth species. The recent genetic analysis of these fishes indicates that they are extremely closely related and that there has either been introgression, or incomplete separation. At this stage we can only speculate but it may well be due to environmental pressures that have built up in the Orange-Vaal system. The construction of dams and weirs, the extensive abstraction of water, and further habitat destruction through pollution and other interventions, have so affected the riverine environment that the two species can no longer function independently and have therefore resorted to interbreeding and have hybridized.

Whitefish, Sawfin and Papermouth are not True Yellowfishes

There are several other large (reaching longer than 150 mm Standard Length [SL]) barbine cyprinids in southern Africa, but these are not yellowfish. None of these other species have 150 chromosomes, and they differ in several essential morphological features. The Berg-Breede whitefish (witvis) and Clanwilliam sawfin both have about 100 chromosomes and are therefore tetraploid species. Their dorsal fin spine is serrated, their scales have radial striations and their head shape is different, the snout is generally more tubular and pointed. These two species seem to be more closely related to some of the smaller redfin minnows than to yellowfish. The papermouth from the Limpopo, also with a serrated dorsal fin spine and radial striated scales, is a "diploid" species with 50 chromosomes, related to other African barbs and not closely to the yellowfish lineage.

Paul Skelton is the Managing Director of SAIAB, a professor of Rhodes University and a freshwater fish systematist with broad experience in southern Africa. He is the Regional Co-ordinator for the IUCN Species Survival Commission Freshwater Fish Specialist Group.

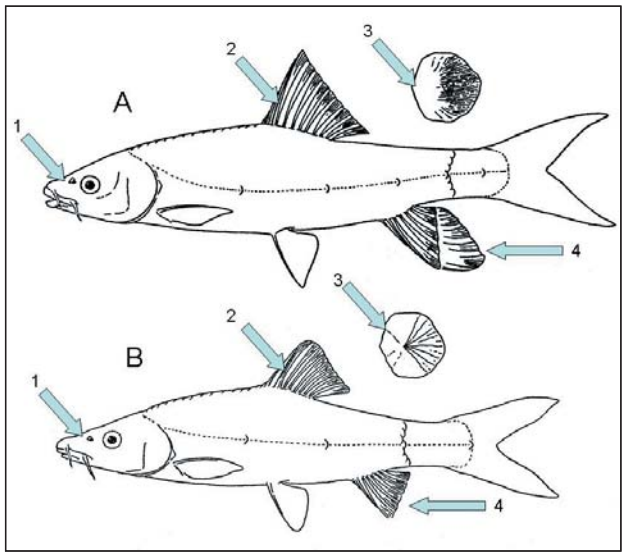


Figure 1. Some differences between yellowfish (A, *Labeobarbus* spp.) and other large barbine cyprinids (B) such as the Berg-Breede whitefish, *Barbus andrewi*. 1. Head shape including snout, longer in B. 2. Form of the dorsal fin ray, simple and spinous in A, serrated in B. 3. Striations on the scales, parallel in A, radiate in B. 4. Shape of anal fin in adult fishes, extended in A, not extended in B.

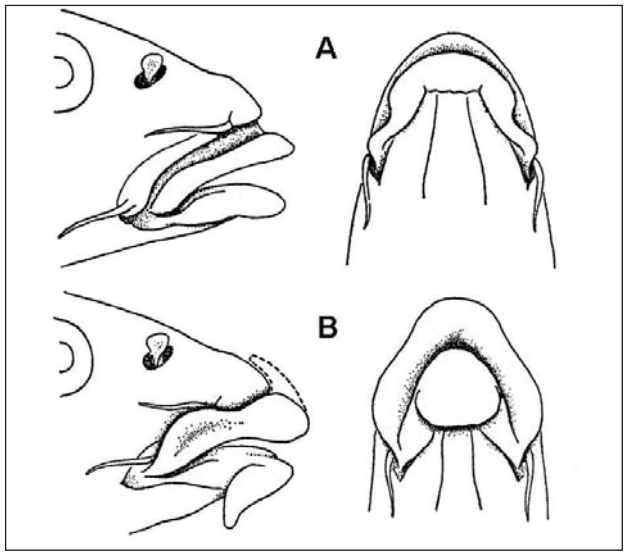


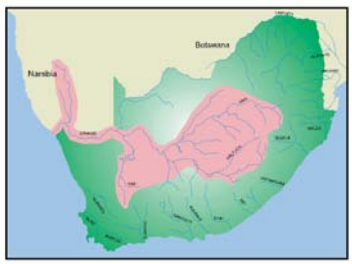
Figure 2. Two mouthforms in a yellowfish species, *Labeobarbus capensis*. A. Normal mouth and lips. B. Rubberlips. (Figure from K H Barnard, 1943).

ORANGE-VAAL SMALLMOUTH YELLOWFISH

Labeobarbus aeneus STATUS: LEAST CONCERN Pierre de Villiers

Introduction

The Orange-Vaal River system is one of the few in South Africa that is truly international. The source of the Orange is in Lesotho and of the Vaal on the Mpumalanga highveld whereas their tributaries extend into most provinces in South Africa as well as into Botswana and Namibia. The Orange River eventually flows into the Atlantic Ocean at Oranjemund. The river drains hugely diverse terrestrial habitat types ranging from grassland, mountains and karoo to deserts. This results in diverse riverine habitats that include clear mountain streams, turbid waters of the middle Orange River and the nutrient-rich discoloured water of the lower reaches of both rivers. Several instream dams have changed the natural flow found in the upper reaches to regulated flow in the middle and lower reaches. This river system is home to South Africa's best-known and favourite yellowfish, the Orange-Vaal smallmouth yellowfish, *Labeobarbus aeneus*.



Biology and Ecology

The smallmouth yellowfish is a hardy and adaptable species that is widespread across its natural distribution range. It has the ability to inhabit smaller streams owing to its smaller size. It attains a mass of 9 kg and is an opportunistic feeder, eating a variety of food types from plant material to aquatic insects, crabs, shrimps and small fish. The smallmouth yellow is a slow-growing species with a low egg to mass ration (fecundity); it only becomes sexually active at a fork length of 30 cm when it is almost seven years old. During the spawning season the skin of the male is covered in sensory papillae which give it a rough feel when touched. Females also show this but to a lesser extent (always wet your hands before handling fish as dry hands remove the critical mucous layer that protects the skin and scales). When water temperatures exceed 19°C in spring, small shoals of fish migrate to shallow rocky areas to spawn and may continue to do so intermittently from October to February. The long spawning season is an adaptation to a flood-driven river and ensures that yellowfish will be able to lay eggs whenever favourable conditions occur. The eggs are relatively large and have a double "shell" which allows the fish to spawn in rough rapids and riffles. The fast water is highly oxygenated and a highly productive zone for algae, diatoms and aquatic insect larvae and nymphs. The juvenile fish have silver bellies and a characteristic olive-green back with black spots. They gather in small groups or shoals in favourable habitat.


Smallmouth yellows are our most abundant yellowfish

Status

The smallmouth yellowfish is listed as "Not Threatened", as it is still widespread across the Orange-Vaal River system and

is abundant in most suitable habitats. However, recent fish kills in the middle Vaal River and some tributaries are cause for concern, as they have the potential to cause substantial damage to valuable recreational fisheries.

Threats

Water pollution in the form of effluent from municipal sewerage plants, agriculture and mine-water return flows pose perhaps the most serious threat to yellowfishes in the middle Vaal River and several of its tributaries. Whereas most of the ingredients of the effluent are not directly toxic to fish, the enriched water facilitates algal blooms that reduce dissolved oxygen concentrations to lethal levels. Additionally, bacteria that break down organic wastes produce by-products such as ammonia and nitrites. At elevated levels these nitrogenous wastes are highly toxic to fish and even sub-lethal concentrations can seriously damage their gills.

Over-abstraction of water from tributaries during the dry winter months results in stretches of river being laid dry, killing fish and their food. In-stream dams such as the Vaal Dam are barriers to fish migration and also regulate river flow, modifying high and low flood-driven flows for much of the year.

Illegal netting takes place mainly in the middle Vaal River and lower Orange River, usually near informal settlements. However, some landowners or entrepreneurs, trying to make extra money from selling fish, are also implicated. Law enforcement operations in which the South African Police Services is actively involved are underway.

Several alien fish species are now common in parts of the Orange and Vaal Rivers. The predatory largemouth bass flourishes in several dams on tributaries of the Vaal River and in the Barrage below Vaal Dam. Carp are widespread and common in the system and compete with yellowfish for food as well as eating yellowfish eggs at spawning time. The recent explosion of grass carp in dams of the middle Vaal River is seen as a potentially serious threat as this prolific species grows to more than 20 kg and is an obvious competitor for food.

Angling is one of the most popular forms of recreation in South Africa. Moreover, many subsistence fishers depend on fish to provide them and their families with a valuable source of protein. Smallmouth yellowfish are a target for both parties who need to be informed of its conservation status. The two groups also need to be managed effectively. Presently, each province straddling the Orange-Vaal catchment area has different policies regarding the capture of yellowfish which complicates law enforcement and angler awareness. The effect of wading through spawning beds (especially by fly fishers) may also be a threat to survival of yellowfish in heavily fished areas. Most provinces have legislation that prohibits people from interfering with spawning fish.

Smallmouth yellowfish spawning in the Vaal River; note river depth and flow

Conservation and Utilisation

Conservancies are terrestrial protected areas that are managed by Conservation Departments in some provinces. For those conservancies that include rivers, it offers an informal river protection facility. Bear in mind that conservancies can only be meaningful if participating land-owners are made aware of river and fish issues and are guided in the implementation of relevant measures.

The Orange-Vaal River Yellowfish Conservation and Management Association (OVRYCMA) is an association of 700 interested and affected people that support yellowfish conservation. This association was established on the Vaal River in 1996. The aims are simple and include three basic

conservation concepts: developing a managed conservation area, releasing captured yellowfish and educating and building capacity in people.

Catch and release of yellowfish species is being actively and successfully promoted in the Orange-Vaal River system with the emphasis being on the "re-use" of a unique resource. Several other education and awareness programmes are implemented by OVRYC-MA through magazines, newspapers and TV.

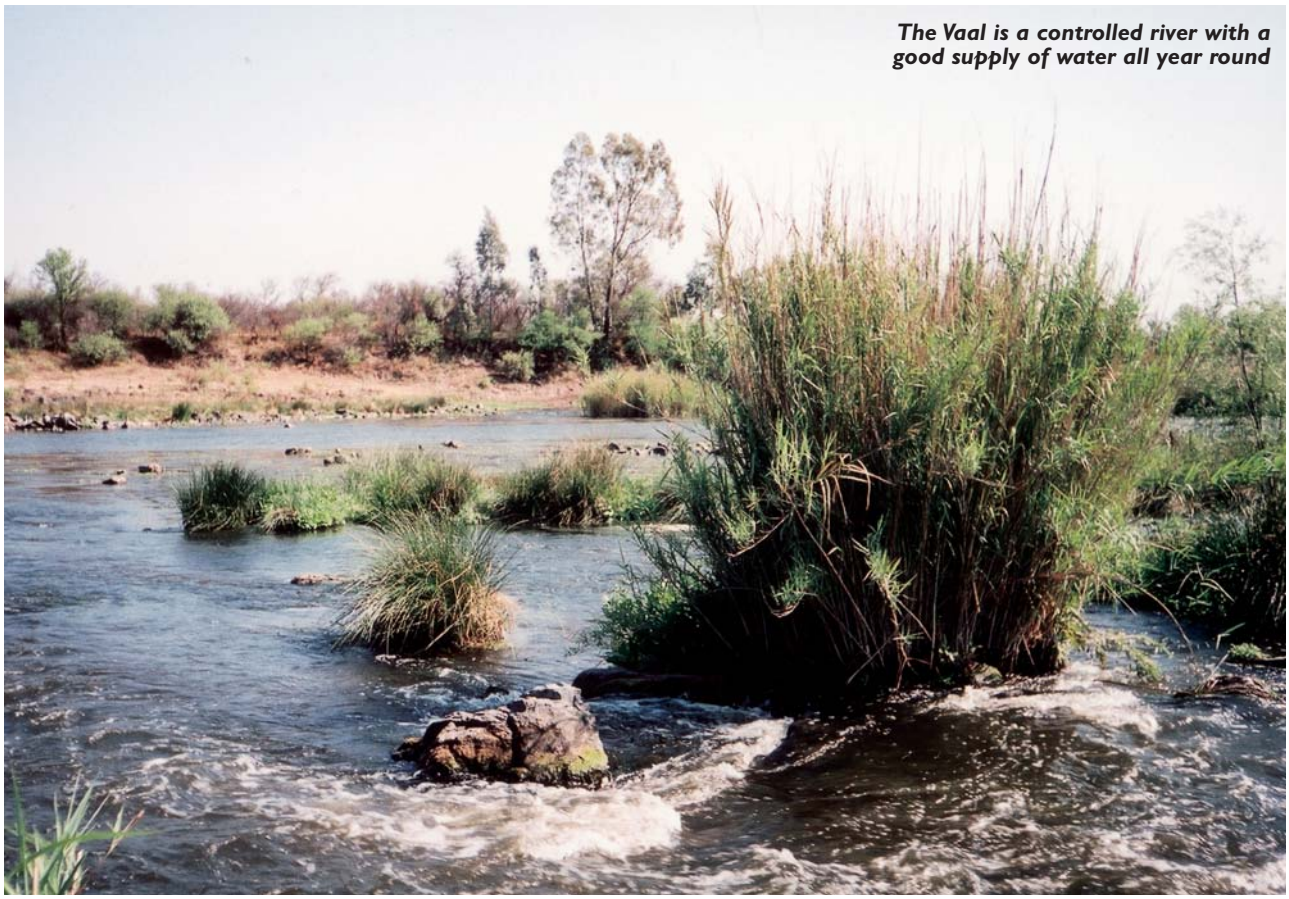
Catch and release of yellowfish species is being actively and successfully promoted

There is a considerable body of national and provincial legislation that enables authorities to respond to illegal activities on rivers such as pollution, netting, interfering with spawning fish, stocking of alien species and so on. Legislation incorporated in provincial nature conservation ordinances also permits the effective management of smallmouth yellowfish and their habitat by means of regulations governing minimum size, bag limits, spawning season, spawning areas and so on. A major concern, however, is the current lack of capacity in nature conservation at provincial and national level to manage rivers and freshwater fish effectively.

The national River Health Programme (RHP) is used as the primary tool to monitor fish communities across South Africa. Free State, Mpumalanga and Gauteng provinces have active and successful RHPs, but other provinces do not. Yellowfishes are generally used as an indicator species on the Orange and Vaal Rivers to give managers an idea of the ecological state of the river. Large numbers of smallmouth and largemouth yellows in good health indicate ecologically healthy rivers.

Research is critical for managers to develop an understanding of the species and how they interact with their environment. This allows them to make informed decisions with regards to water flow releases, pollution standards and fisheries management protocols. Several important and sizeable research programmes are currently underway on yellowfishes in the Orange-Vaal River. These involve research on migration (Telemetry Project), conservation genetics as well as a socio-economic study on the value of the resource.

Smallmouth yellowfish are highly prized gamefish and their proximity to the Gauteng heartland is the keystone of the yellowfish fly-fishing industry in South Africa. The angling



The Vaal is a controlled river with a good supply of water all year round

tourism industry centred on the Vaal River has been valued at a massive R1.2 billion per annum which includes direct costs (fishing equipment) and indirect costs (transport, accommodation and food). All forms of angling have targeted this species with great success and organised angling has been very supportive of measures to improve conservation of the two yellowfishes – competitive fishing for either species has been discontinued.

Subsistence fishers catch smallmouth yellowfish readily on natural baits such as worms, crabs and minnows. Unfortunately they often focus on spawning fish as these are easy to catch. It is essential to develop a programme to teach these anglers to target the more abundant alien carp and sharptooth catfish (barbel) instead.

Subsistence and commercial fisheries using trawl/seine nets and gill nets to target carp, catfish and moggel (*Labeo umbratus*) have operated for many years in certain designated dams in the Vaal and Orange Rivers. The policy has now been changed and only trawl/seine nets may be used unless circumstances preclude their use, in which case a temporary permit may be issued to place gill nets in specific habitats where carp, moggel and catfish are most prevalent.

The Free State Department of Tourism, Environmental and Economic Affairs provides smallmouth yellowfish for stocking farm dams as an alternative to alien fishes. The Gariep Dam State Fish Hatchery is using subsistence anglers to catch smallmouth yellowfish which are then kept in dams at the hatchery. These fish are then supplied to land owners in the Orange River catchment to stock dams. This is preferable to culturing yellowfish which can result in unwanted hybrids as well as fish with genetic material less than ideal for release into natural systems. This protocol flows from concepts developed at previous conferences of the Yellowfish Working Group (YWG) which emphasise that the provision of yellowfish should not be left up to the private sector as there is no control of these institutions. Neither should yellowfish be allowed to be transported into or within any province without a permit from the relevant conservation authority.

Pierre de Villiers is now the Estuarine Co-ordinator of the Cape Action for People and the Environment. He is a founder member of the YWG.

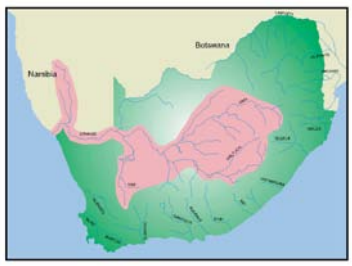
Katse Dam supplies water to Gauteng. Such schemes can also transfer fish which become aliens

ORANGE-VAAL LARGEMOUTH YELLOWFISH

Labeobarbus kimberleyensis STATUS: NEAR THREATENED Pierre de Villiers

Introduction

The Orange-Vaal River system is the largest in South Africa. The Vaal originates on the grassy plains of the Mpumalanga highveld whereas the Orange springs high up in the sub-alpine Lesotho mountain land. The two rivers meet near Douglas in Northern Cape from where the Orange wends its way to the Atlantic Ocean at Oranjemund. This river system harbours what is perhaps South Africa's finest freshwater gamefish, the Orange-Vaal largemouth yellowfish, *Labeobarbus kimberleyensis*.



Largemouth yellowfish are sensitive to changes in water quantity and quality, habitat destruction and utilisation pressure and for this reason are often used by river health authorities as a sensitive indicator species. What this means is that the presence and condition of these fish play a vital role in allowing river managers to gauge the success or failure of management interventions or programmes such as river rehabilitation and catch-and-release regulations. Moreover, the largemouth yellowfish is a classic angling species that provides an angler with a superb fight, once hooked. The initial run is unsurpassable as a freshwater angling experience. The catch-and-release ethic for this premier gamefish is now firmly established among fly and artlure fishermen, and is a great boost to its conservation.

This is arguably our premier freshwater gamefish in South Africa

Biology and Ecology

The largemouth yellowfish is South Africa's largest *Labeobarbus* species and attains an impressive 22 kg in mass. Not surprisingly, it is partial to large rivers like the Orange and Vaal, extending down to the estuary at Oranjemund and well into the larger tributaries. It favours large pools and adapts well to weirs and dams as these provide excellent habitat and an abundance of food.

It is a top predator, preying on smaller fish, crabs, frogs and insects. In common with other yellowfishes, the large-

The Richtersveld is as yet unspoilt

mouth is a slow grower with a low egg to body mass ratio (fecundity). It only becomes sexually active at a fork length of 45 cm when it is approximately 8 years old. The eggs, like those of the smallmouth yellowfish, are relatively large and have a double "shell" to survive spawning in rough rapids and riffles. Whereas spawning requirements of this species are known the exact spawning times and places still need to be identified. Indeed, to date, very few spawning fish have been observed which makes the natural breeding cycle a bit of a mystery. On the other hand, largemouth yellowfish have been spawned and reared successfully and consistently at the Gariep State Hatchery in Free State province.

Status

Although there is no scientific evidence suggesting that the Orange-Vaal largemouth yellowfish is increasing in numbers, its conservation status has been changed recently from "Vulnerable" to "Near Threatened". This change was motivated by anglers' catches which have shown that largemouth are more widespread and abundant across their distribution range than previously recognised. Down-listing does not mean that a "free-for-all" approach to managing largemouth yellowfish should now ensue. This is arguably our premier freshwater gamefish in South Africa, and being a top predator it is never as plentiful as its cousin, the smallmouth yellowfish. For this reason the Yellowfish Working Group (YWG) has recommended that largemouth yellowfish should be protected by a "no-take" policy. This will hopefully be legalised in the near future.

Threats

Largemouth yellowfish face essentially the same threats as smallmouth yellowfish as they occupy the same rivers and share similar habitats. These threats have already been covered in a preceding chapter and only those aspects of specific relevance to largemouth will be discussed below.

Over-abstraction of water during the dry winter months often results in natural over-wintering pools being sucked dry. In certain places, such as highly degraded rivers, the building of dams and weirs has been somewhat beneficial to large-

Sewage spills on the Vaal River are a serious problem

mouth inasmuch as they created huge "pools" that support large numbers of fish. With the onset of flooding in early summer, the fish can then migrate from these sanctuaries to upstream spawning sites. On the negative side, dams and weirs act as serious barriers to fish migration, fragmenting populations and inhibiting normal genetic exchange.

Inadequate fisheries management is a problem because of inconsistencies in provincial fisheries regulations and policies – in some provinces, notably Free State, largemouth must be released when caught whereas in other provinces there is a catch limit of 10 fish.

Angling for this premier species has always been popular with trophy hunters who target specimens over 10 kg for the awesome sport they provide. Unfortunately, not all big fish are released, which is a tragedy as the bigger fish tend to be those females that are the most productive breeders – egg quantity is directly related to fish size. Wading through potential spawning habitat during spawning time is a contentious matter the effects of which still need to be determined. This can only be done when scientists have determined when and where largemouth spawn so that anglers can adapt their tactics to minimize their impact on the fish.

Conservation and Utilisation

The Orange-Vaal River Yellowfish Conservation and Management Association (OVRYCMA) is an association of interested and affected people who want to conserve the valuable yellowfish resource of this river system more effectively. The association was established in 1996 to conserve that stretch of the middle Vaal River, between the Vaal and Bloemhof Dams. The aims are simple and include three basic conservation concepts: developing a managed conservation area, releasing captured yellowfish and educating and building capacity in people.

The Association has been very successful – it has a membership of over 700 landowners, anglers and conservationists who hold regular meetings during the year. The most intensively fished area for yellowfishes lies within Association land which testifies to the healthy yellowfish stocks there. A further plus has been the increase in the average size of yellowfish caught thanks to an actively promoted and enforced catch-and-release policy.

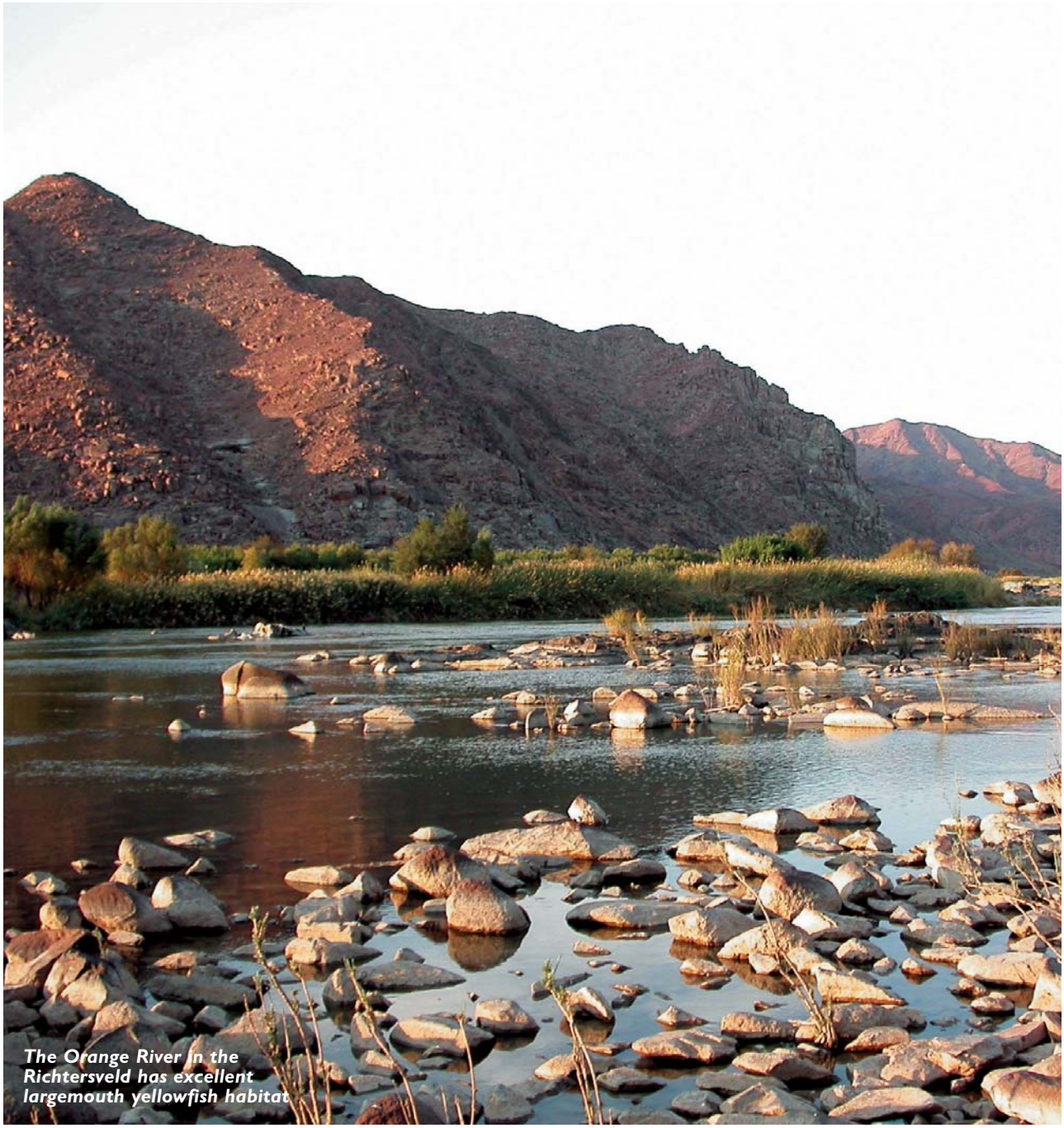
Legislative matters dealing with conservation as well as the national River Health Programme have been dealt with in the chapter on smallmouth yellowfish and need not be repeated here.

The largemouth yellowfish is not a well-studied species and it is essential that in future we have a much better understanding of its biology and ecology. Fortunately, several exciting research projects are underway which address aspects of its biology. A number of largemouth and smallmouth yellowfish have been tagged and released in OVRYCMA territory and researchers are currently monitoring their movements by sophisticated telemetric methods. Another important scientific study seeks to compare genetic and morphological characteristics of largemouth and smallmouth yellowfish throughout their natural distribution range. On a different tack, a socio-economic study is being undertaken in order to make OVRYCMA stakeholders aware of the value of the yellowfish resource in their domain.

Largemouth yellowfish are a highly valued angling species. Although, the main angling pressure within the Orange-Vaal system is on the smallmouth yellowfish, anglers increasingly want to catch the larger and more challenging largemouth. Capture techniques for largemouth yellowfish are continually being improved with new flies and lures appearing almost every month. Skilful bait anglers, on the other hand, have always had great success in taking largemouth on crabs and fish baits. It is gratifying, therefore, that organised angling has become so supportive of planned and implemented measures

Catch-and-release is an essential management tool for the threatened largemouth yellowfish

A happy angler with his quarry



The Orange River in the Richtersveld has excellent largemouth yellowfish habitat

to conserve these two premier angling fishes.

Subsistence fishers tend to target the more abundant smallmouth yellowfish and sharptooth catfish but as they mostly use worms, crabs, fish baits and the like, it is not rare for them to catch largemouth. These fish are not released as they represent a good meal for a family. Ideally, all anglers should be taught to identify largemouth yellowfish and educated about the need to release them once caught.

The Free State Department of Tourism, Environmental and Economic Affairs has provided yellowfish juveniles as an alternative to alien fish species to stock dams. Largemouth yellowfish that were introduced into Sterkfontein Dam in 1994 have prospered to the extent that fish over 4 kg are now being caught. Hatcheries should be discouraged as a means to conserve this species – effective river management is for obvious reasons the preferred method.

Pierre de Villiers is now the Estuarine Co-ordinator of the Cape Action for People and the Environment. He is a founder member of the YWG.

CLANWILLIAM YELLOWFISH

Labeobarbus capensis STATUS: VULNERABLE Dean Impson

Introduction

The Clanwilliam yellowfish, *Labeobarbus capensis*, is Western Cape's premier freshwater gamefish and our second largest yellowfish, attaining 11 kg in weight. This magnificently proportioned and intelligent fish is endemic to the Olifants-Doring River System It is closely related to the Orange-Vaal smallmouth yellowfish, which is not surprising, considering that millions of years ago the Orange and Olifants Rivers shared the same mouth.

Few anglers nowadays have the pleasure of outwitting and landing this powerful fish as alien species have decimated the population and only a small number of adult Clanwilliam yellowfish are still present in the Olifants and Doring Rivers and their first-order tributaries.

Biology and Ecology

Clanwilliam yellowfish are omnivores, feeding on crabs, frogs, small fish, aquatic insects, algae and soft aquatic plants. Young fish feed primarily on small aquatic invertebrates. In contrast to the whitefish, *Barbus andrewi*, adult Clanwilliam yellowfish are quite at home in small streams. I often encounter fish over 1 kg in mass while snorkeling in small shallow streams especially where the pool is deepest and has an abundance of cover. However, in some small streams such as the Ratels, Clanwilliam yellows are often stunted and rarely exceed 500 g because of the high numbers of indigenous fish present and the intense competition for food.

In the bigger rivers, adult fish are mostly found in deeper pools that have cover nearby in the form of rocky beds, water lilies and palmiet (*Prionium serratum*, a spiky bankside rush). Clanwilliam yellowfish are long-lived and fish between 8 and 10 kg (usually females) are normally more than 20 years old. In late spring (October-November), when water temperatures exceed 19°C, schools of adult fish enter shallow riffles and glides to spawn. Spawning starts at first light when a gravid female leaves cover to join several ripe-running males on the

Clanwilliam yellowfish habitat

spawning bed. Fertilized eggs are released near the bottom and drop into the interstices of the cobbles and pebbles. Larval fish hatch after 2 to 4 days and drift downstream with the current into backwater areas. These shallow warm areas are ideal nurseries as they are rich in food and away from adult fish. When they reach a length of about 4 cm the juveniles move back into shallow riffles in the main stem. They grow slowly at first reaching 5 to 7 cm at the end of the first year.

"Countless millions up to 20 lb in weight"

Status

The population and distribution range of the Clanwilliam yellowfish have declined drastically over the last 50 years and it is now listed as "Vulnerable". Before 1960, it was still widespread and relatively abundant and the Clanwilliam Hotel actively marketed angling for this species in the nearby Olifants River as a tourist attraction. It was not unusual then for anglers to catch 5 to 10 fish a day on bait, lures or fly, with fish over 5kg a common occurrence. Nowadays, however, this beautiful fish is virtually restricted to the upper Olifants River above Keerom and to some tributaries inaccessible to bass. Small numbers of adults are still found throughout the Doring River; their numbers replenished by fish over 20 cm (a "bass-proof" size) migrating into the main stem from tributaries.

Irrigation in the Western Cape impacts on rivers

Threats

The major threats to Clanwilliam yellowfish are invasive alien fishes and degradation of habitat. The alien fish that have had the most severe impact are the predatory smallmouth bass and to a lesser extent the less common largemouth bass and bluegill sunfish. One must appreciate that Clanwilliam yellowfish and the other indigenous fish in the Olifants-Doring system evolved in an environment that lacked a specialized fish predator like smallmouth bass. When the Cape Department of Inland Fisheries unwisely introduced these alien predators into this ecosystem in the 1930s, the indigenous fishes literally became "cannon fodder" for the bass. In a few years, the small redfins disappeared and as bass numbers grew, fewer and fewer Clanwilliam yellowfish and sawfin juveniles were able to survive to adulthood.

Other invasive alien fishes in the Olifants-Doring River System include carp, Mozambique tilapia and sharptooth catfish (all recently and illegally introduced by anglers!), as well as banded tilapia, rainbow and brown trout.

The Olifants River valley is one of South Africa's largest citrus producing areas whereas the cooler, wetter upland areas are renowned for their pears and apples. Typically, these are "water hungry" forms of agriculture with the major irrigation demand occurring in summer when rivers in this winter rainfall area are at their lowest. Dams that have been built to store surplus winter water hamper spawning migrations of Clanwilliam yellowfish and sawfin and benefit alien fishes, whereas unacceptable farming practices have led to the wholesale destruction of the riverine habitat and the introduction of fertilizers and pesticides to the detriment of all wildlife.

Conservation and Utilisation

The Clanwilliam Yellowfish Hatchery was built in 1976 by the then Cape Department of Nature and Environmental Conservation in a belated attempt to conserve the indigenous fishes of the Olifants-Doring River System. For various reasons the hatchery was not a long term success and it ceased operating in 1996. Prior to closure, several thousand young fish were produced and stocked into farm dams within the system as well as into several tributary streams. The latter action was highly controversial, as yellowfish were stocked into certain river areas where they had never occurred previously. As an example, Clanwilliam yellowfish now thrive above waterfalls in the Twee River, a tributary of the Doring, and are a major threat to the Twee River redfin, South Africa's most threatened freshwater fish. These days, CapeNature

personnel source fish for stocking dams from nearby streams. For obvious reasons, rivers are no longer stocked.

No conservancies have been established specifically for Clanwilliam yellowfish. However, indigenous fishes will benefit from the recent formation of the Greater Cederberg Biodiversity Corridor, a major internationally funded conservation initiative to better conserve this unique area. Likewise, the creation of conservancies to protect rivers and their catchments such as the Ratels River Conservancy and the Matjies River Conservancy should contribute to the conservation of indigenous species.

A Catchment Management Agency (CMA) for the Olifants-Doring Water Management Area was established in 2005 and should greatly improve river management once it becomes fully operational. The CMA will be guided by the *Olifants-Doring State of River Report*, published recently under the auspices of the national River Health Programme (RHP).

There are not yet enough Clanwilliam yellowfish and sawfin to support a recreational fishery-type management authority as on the middle Vaal River. The Ratels River Conservancy is keen to establish a priority yellowfish zone, by removing alien fishes from the catchment and stocking Clanwilliam yellowfish and sawfin. The Ratels River is perhaps the closest destination in the Olifants-Doring system for Cape Town anglers, and there is growing eagerness amongst conservation-minded anglers to achieve this goal. The recent establishment of the Western Cape Yellowfish Working Group is an encouraging sign. Increasingly, anglers here are turning towards the more challenging and harder-fighting yellowfish as their preferred target species, and are actively working with CapeNature to get suitable dams stocked.

Clanwilliam yellowfish are protected as an endangered species in terms of the Western Cape Nature Conservation Ordinance of 1974. This makes it an offence to kill them in public waters (rivers and public dams). CapeNature regularly monitors the rivers of the Western Cape as part of its commitment to the RHP. Several fish surveys of the Olifants-Doring River System have been undertaken in the last decade by staff from CapeNature, the University of Cape Town and the South African Institute of Aquatic Biodiversity. Thanks to these efforts we have a very good idea of where our best yellowfish stocks are and how to protect them. Capacity to do this remains a problem due to insufficient aquatic staff at all levels. The biology and ecology as well as the breeding and captive culture requirements of Clanwilliam yellowfish are reasonably well known thanks to several research studies.

When Clanwilliam yellowfish were abundant (up to the 1950s) they provided excellent sport for anglers, and being excellent eating were a popular source of protein for farmers and their employees. As an example of what the fishing was like in those days, consider this advertisement for the Hotel Clanwilliam in 1948 which read: "Countless millions up to 20 lb in weight.... The Olifants teems with yellowfish...." In 1947, an angler named Brooks described several visits to the Olifants in autumn which: "...provided the sport of my life – never less than seven yellowfish each day from 3 lb to 5 lb, and on one occasion 19".

Sadly, this unique and valuable indigenous resource was not appreciated at the time. Today, stakeholders interested in yellowfish conservation in the Olifants-Doring catchments will have to work very hard to turn the clock back even just a little. An ambitious project aimed at removing alien fish (mainly bass) from priority streams in the system has been started and, with hard work and official approval, these rivers may be restored to their former glory in 2008. Excitingly, the Western Cape Bass Anglers Association and the Cape Piscatorial Society support this important project.

Mike Dohlhoff with a good Clanwilliam yellowfish

Dean Impson is a freshwater fish scientist at CapeNature and is passionate about conserving Western Cape's threatened indigenous fishes. He enjoys fly fishing, especially for yellowfish.

BERG-BREEDE WHITEFISH

Barbus andrewi

STATUS: ENDANGERED

Dean Impson

Introduction

The Berg-Breede whitefish (*Barbus andrewi*), or witvis as it is more commonly known locally, is a powerfully built bronze fish, ideally suited to life in the larger rivers of the Berg and Breede River catchments of Western Cape Province. The whitefish is not a true yellowfish (*Labeobarbus genus*) because of significant morphological and genetic differences. The whitefish, like its sister species the Clanwilliam sawfin, has a serrated primary dorsal fin ray and is a tetraploid cyprinid, in contrast to the *Labeobarbus* genera which are hexaploid. However, to the layman, whitefish resemble yellowfishes and they occur in very similar habitat, hence their inclusion in this report for awareness and management purposes.

Whitefish are attractive large cyprinids growing to at least 4 kg. They are omnivorous, feeding on aquatic insects, crabs, detritus and algae. Adult whitefish prefer big deep pools with an abundance of cover in the form of palmiet stands and submerged rocks. Breeding occurs in late spring when water temperature reaches 20°C. Schools of spawning adults gather over cobble beds in moderate flowing water that is about 1 m deep. The newly hatched fry congregate in shallow backwaters of pools, often next to marginal vegetation. Here food is plentiful and cover from predators is close by. Once juvenile fish are about 4 cm long they move into shallow faster-flowing riffles. Juveniles grow slowly initially, reaching 5 to 7 cm after a year.

Status

The Berg-Breede whitefish is listed as endangered and its populations and distribution range have decreased drastically

Rainbow trout have severely affected whitefish in several Western Cape rivers

in both river systems over the last 50 years. Historically, B. *andrewi* occured as two separate populations in the Berg and Breede rivers respectively. The Berg River population is now regarded as extinct as no fish have been caught in the river since 1996. This is a conservation and angling tragedy that has developed in little over 70 years, the length of a human lifetime, in which a once abundant and widespread yellowfish species has gone extinct. The Breede population can be divided into two sub-populations; one in Brandvlei Dam near Worcester, characterized by large numbers of whitefish, and a riverine one in the Breede, Hex and Riviersonderend Rivers which has small numbers of adult fish. The latter sub-population is probably still on the decline due to the many alien smallmouth and largemouth bass in these rivers. Whitefish in the Breede River catchment are also likely to become extinct within the next 30 years, if no corrective action is taken.

In little over 70 years a once abundant and widespread yellowfish species has gone extinct

Threats

The major threats to whitefish are invasive alien fishes and habitat degradation. The alien fish that have had the most severe impact on whitefish are predators such as the smallmouth and largemouth bass and rainbow trout. These aliens now dominate wherever whitefish used to be found – in the headwaters, rainbow trout eat the fry and fingerlings whereas the basses, which occupy the middle and lower reaches of rivers, prey on juveniles up to 20 cm long. Other invasive alien fishes in the Berg and Breede catchments; such as carp, bluegill sunfish, Mozambique tilapia and sharptooth catfish are also a substantial problem as they compete with whitefish for food resources.

Attractive Hex River, last sanctuary for the Berg-Breede River whitefish

Whitefish rivers are generally characterized by intensive agriculture along their banks as Western Cape hosts the nation's biggest wine-grape and deciduous-fruit industries. These industries are "water hungry", with major irrigation demand in summer when the rivers are at their lowest flows. Dams that have been built to store surplus winter water hamper spawning migrations of whitefish and benefit alien fishes. The agricultural industries also use large quantities of fertilizers and pesticides, further impacting on habitat quality, as orchards and vineyards have been planted too close to rivers.

A further threat has been the attitude of anglers and land-owners towards whitefish and the complacency of the authorities towards a species known to be in trouble. Only recently have anglers become interested in catching whitefish, and it was only in the 1980s when whitefish were nearly extinct in the Berg River that the then Cape Department of Nature and Environmental Conservation started a breeding programme at Jonkershoek. Until that time the hatchery had focused its attentions on breeding alien fishes – trout, largemouth bass, Mozambique tilapia and others – an unacceptable use of funds dedicated for conservation purposes. Unfortunately, the whitefish-breeding programme used the more abundant and possible genetically different stock in the Breede River.

Conservation and Utilisation

No conservancies have been established specifically for whitefish as there are too few left to support recreational fishery-type conservancies as on the middle Vaal River. The most attractive locations for future conservancies are the Hex River near Worcester and the Klein Berg River near Tulbagh.

To help conserve whitefish, CapeNature has stocked specimens in about 10 dams in the Berg and Breede catchments since 1980. Whitefish breed well in dams that have appropriate gravel and rock beds for spawning areas. Farmers and fly fishers from the Cape Piscatorial Society (CPS) are

also increasingly interested in introducing this powerful and challenging angling fish into their dams. Dams have to be free of alien fishes before permits for stocking will be issued.

"Founder" whitefish stocks with suitable genetic diversity are now being established by CapeNature scientists in selected dams in the Berg and Breede catchments. These dams will serve as "nurseries" for future stocking requirements.

There is growing awareness about the value of whitefish and the need to conserve them. Several popular articles have been written in angling magazines and regular discussions are held with angling organisations to sensitise anglers about whitefish. In fact, CapeNature has not marketed whitefish as much as it could, because of the irregular availability of stocks for respondents interested in acquiring them! Hopefully nursery dams will be successful and allow for a steady supply of whitefish to stock dams and rehabilitated rivers.

Whitefish habitat destroyed by sand quarrying and water abstraction

Berg-Breede whitefish are protected as an endangered species in terms of the Western Cape Nature Conservation Ordinance of 1974. This listing makes it an offence to kill this species in public waters (rivers and public dams).

CapeNature regularly monitors the rivers of the Western Cape as part of its commitment to our national River Health Programme. A detailed survey of the Berg River was completed in 2004 during which no whitefish were caught. A detailed survey of the Breede catchment is scheduled for 2007.

There is a dire lack of research information on whitefish. An urgent biological and ecological study needs to be undertaken to understand better why this species is so threatened and what we can do to assist its recovery.

When whitefish were abundant (up to the 1950s) they provided excellent sport for anglers and fly fishers targeting trout were frequently broken up by large specimens. Coloured communities at Paarl, next to the Berg River, particularly enjoyed eating whitefish and caught large quantities

Alien acacia trees invading the river

when the fish were gathering for spawning or when the river was very low and shallow in late summer. These days one can only imagine what the Berg River looked like in that era. Fortunately we have a picture, thanks to a description in Piscator, Journal of the CPS, of the middle Berg River near Paarl in 1934: *"Clean stony runs alternated with basins of large water-worn stones and long deep pools, fringed with palmiet rushes and overhanging trees and bush, silt beds being confined to the backwater. The bed was in splendid condition and the dire effect of soil erosion had not begun to appear. There was a large population of indigenous fishes. Shoals of witvis up to about 4 lb in weight, and rooivlerk (redfin) minnows amounted to thousands of individuals. The Cape kurper lurked under all favorable stones or swam boldly in the open water, and the little galaxias haunted the marginal weedy areas."* In the words of another early observer: *"The Berg River has an excessively large population of indigenous fish"*.

Whitefish are under severe pressure from humans and alien fishes

Sadly, this unique and valuable indigenous resource was not appreciated at the time. While Harrison was reflecting on the huge numbers of indigenous fish in the Berg River, the Groot Drakenstein Angling Society was devising ways to remove them! In the 1930s they recommended to the then Jonkerhoek Division of the Cape Department of Inland Fisheries, that smallmouth bass should be introduced into the river to get rid of the "witvis pest" so that rainbow trout (introduced about 30 years earlier) would have less competition for food!

How the clock turns! Today, the future of the Berg-Breede whitefish is primarily in the hands of caring anglers and land owners. Moreover, CapeNature, the Department of Water Affairs and Forestry, and the Department of Agriculture share the responsibility to ensure that whitefish and the habitat necessary for their survival are managed sensibly and in a sustainable manner. Although their numbers are slowly increasing, it is essential that future whitefish stocks are not confined to dams – they are a riverine species and it is essential that areas that hold whitefish should be treated as sanctuaries and be given special care.

Dean Impson is a freshwater fish scientist at CapeNature and is passionate about conserving Western Cape's threatened indigenous fishes. He enjoys fly fishing, especially for yellowfish.

Whitefish co-exist in nature with the colourful Breede River redfins

CLANWILLIAM SAWFIN

Barbus serra STATUS: ENDANGERED Bruce Paxton

Introduction

The Clanwilliam sawfin (*Barbus serra*) is endemic to the Olifants-Doring River system in the Western Cape where it occurs in large shoals, often in the company of Clanwilliam yellowfish. By yellowfish standards it is relatively small, particularly in the tributaries where its growth may be retarded by low temperatures and limited living space. Adult fish in the tributary populations reach little more than 300 mm in length, whereas adults in the main stem can grow up to 450 mm and weigh 1.5 kg. Individuals larger than this are rare.

Like the witvis or whitefish to which it is closely related, the sawfin is tetraploid rather than hexaploid and therefore not a true 'yellowfish'. Nevertheless, because it is one of South Africa's larger barbine cyprinids, sharing many behavioural and morphological characteristics with this group, it has been included in this report. It too has a serrated primary dorsal fin ray like the witvis – hence the specific name '*serra*' – but where the witvis is a silvery bronze, adult sawfin are a deep olive-green. Perhaps its most unusual feature is a prominent, elongated snout which lends it a very equine appearance. This long tapering snout together with its darker colouration makes sawfin easy to pick out in a mixed school of fish.

Until quite recently little was known about the behaviour and ecology of this species. Upstaged by the larger and more charismatic Clanwilliam yellowfish, the sawfin has received a relatively low profile on scientific and conservation agendas. However, what it may lack in size and charisma this unusual fish more than makes up for in originality and interest.

Biology and Ecology

Like other yellowfish, sawfin are supremely adapted to life in rivers. Indeed, the daily and seasonal rhythm of their lives is defined by flowing water. They are found in a wide variety of aquatic habitats from fast shallow runs to deep pools, depending on free movement between these habitats for feeding, breeding or resting.


The Cederberg's Rondegat Riverhas been earmarked for alien fish removal

Sawfin are omnivorous and, in addition to typical drift-feeding behaviour, they will also use their elongated snout to grub in the riverbed, grabbing mouthfuls of sediment which they then sift

through their mouths for invertebrates and algae. An unusual sight in sandy-river reaches where sawfin are common are numerous pock marks visible where shoals of sawfin have been feeding in this manner.

Spring is a critical time for sawfin. From August, increasing day lengths and temperatures trigger the development of gonads in mature males and females. By September and October, shoals of sawfin begin migrating upstream in search of suitable spawning beds. Once temperatures reach around 19°C these shoals of up to a hundred or more fish gather in fast-flowing water where the females release eggs fertilized by the attendant males over clean gravel and cobble beds. The eggs settle in the interstices of the pebbles and cobbles where, bathed in the oxygen-rich waters of this specialised habitat, they will hatch out within 2 to 3 days. The newly hatched larval fish remain in the riverbed for up to 10 days while feeding on their yolk sac.s After this period they swim out of the cobbles of the riverbed and are immediately washed downstream into shallow slackwaters along the river margins. In these warm productive areas they begin feeding on micro-invertebrates and grow into young fish. They then begin a gradual downstream migration and will select bedrock reaches where they are able to avoid predation and winter flows by taking cover under ledges and large boulders. Once they mature, (males at around 150 mm and females at around 250 mm) they will join the spring migration of the adults.

Flow alteration and alien invasion have been catastrophic for this species

Smallmouth bass have devastated Western Cape yellowfishes

Status

The Clanwilliam sawfin is listed by the World Conservation Union (IUCN) as "Endangered". Recent surveys have confirmed that numbers throughout the catchment are dangerously low and populations are few. Sawfin appear to have disappeared altogether from the main stem of the Olifants River within the last 30 to 40 years – we know from surveys at the time that they were last abundant here in the 1960s. Perhaps one of the most disturbing findings to emerge is that there are no young recruits in the Doring River main stem, nor for a considerable distance upstream of tributary confluences. Viable breeding populations of sawfin now occur only in the upper Olifants River and the uppermost reaches of tributaries of both the Olifants and the Doring rivers. Even here, the numbers of tributaries that harbour sawfin are few and opportunities for genetic exchange between these tributary populations are limited because of predatory bass which have taken the place of sawfin.

Threats

Largemouth and smallmouth bass were introduced by anglers during the 1930s and 40s and, finding a ready source of food in the indigenous fry, they quickly spread throughout the rivers gradually replacing indigenous populations wherever habitat conditions proved suitable and their movements weren't restricted by natural barriers. Both bass species are now widespread throughout the catchment, except in the uppermost reaches of some tributaries, where as already noted, the last recruiting populations of sawfin have found refuge.

There is a temptation to lay all the blame for the demise of the sawfin on predation and competition from alien fish species. However, a factor that has played a major role in reducing sawfin numbers directly through habitat degradation, as well as indirectly through promoting invasion by alien fish species, has been water abstraction and flow alteration.

In the Olifants River, the Bulshoek Weir and Clanwilliam Dam, built in 1917 and 1935 respectively, have blocked spawning migrations as well as drowning and degrading critical spawning habitats both upstream and downstream of the dam walls. These dams, together with run-of-river abstraction, have combined to produce conditions in the mainstem Olifants that have enabled alien species to invade areas that otherwise would have been marginal for them.

In the Doring River, the situation is no more encouraging. The most serious threats to the survival of fish populations

here are prolonged and more extreme dry seasons, partly as a consequence of the drought conditions prevailing in the Western Cape at present, but also because of extensive water abstraction in the Koue Bokkeveld, one of the most important catchments contributing water to the Doring River. Under these conditions, smallmouth and largemouth bass and bluegill sunfish populations have proliferated in the mainstem and are now the dominant fish species here.

Whatever the relative contributions of flow alteration and alien invasion may have been to the decline of sawfin numbers, there is little doubt that in combination they have been catastrophic for this species. It is quite possible that populations in the mainstem of the Doring River will go the way of the Olifants River populations if no corrective action is taken.

Endangered sawfin being released

Conservation and Utilisation

Although there are committed conservancies dedicated to broader tourism and biodiversity objectives in the Olifants-Doring River catchment, there are no conservancies targeting indigenous freshwater fish specifically. In general, there is limited awareness or appreciation of freshwater ecosystems amongst management authorities or landowners in the area, possibly because these are less visible components of the landscape and because numbers of fish have declined so dramatically in the past few decades. There is therefore a need for increasing awareness around the management and protection of freshwater ecosystems as a whole, particularly in a system that sustains such a unique assemblage of fish species.

In 2004, CapeNature launched the Greater Cederberg Biodiversity Corridor (GCBC). This initiative recognises the need for maintaining connectivity between protected areas, and has been instrumental in greatly increasing land-owner awareness of conservation in the last three years. Other initiatives by CapeNature targeting freshwater fish more directly include the proposed rehabilitation of selected rivers by eradicating bass using piscicides and reintroducing indigenous fish species to the cleared reaches. CapeNature, has also identified critical areas for freshwater fish conservation in Western Cape, and several rivers containing large sawfin populations have been included. These projects have the potential to reclaim important river reaches for sawfin, but can only be effective in selected tributaries if certain conditions are met. Addressing management and conservation issues at a catchment-wide level therefore should not be neglected.

In this regard, the importance of tributary refugia cannot be over-emphasised. Because of their small size and limited runoff, they are particularly vulnerable to disturbance. Unregulated expansion of farming and tourism activities is likely to present the most serious threats both in terms of increasing water demand and pollution. Individual landowners have an important role to play in looking after these systems.

However, having said this, if the future of sawfin populations is to be assured in the long term, it is essential that management and conservation actions target the main stems as well. The pressing social needs in the catchment suggest that these freshwater systems will come under increasing demand to meet the needs of ever-expanding urban and rural populations and it is essential that any water resource development proceeds in a manner that doesn't place additional stress on remaining sawfin populations.

Bruce Paxton is a freshwater ecologist based at the Freshwater Research Unit, University of Cape Town. For the last five years his research interest has focused on the impacts of water abstraction and flow regulation on river fish species.

KWAZULU-NATAL YELLOWFISH

Labeobarbus natalensis STATUS: LEAST CONCERN Rob Karssing

Introduction

The KwaZulu-Natal (KZN) yellowfish, *Labeobarbus natalensis*, locally referred to as scaly, is endemic to this province. It is widely distributed and occurs in all major catchments from the Mtamvuna River on the Eastern Cape border to the Mkuze River in the north. This cyprinid is possibly the most widespread freshwater fish in KZN occurring in nearly all perennial rivers from the coast to altitudes of 1500 m or more along the Drakensberg escarpment. Waterfalls have historically prevented the scaly from accessing the upper reaches of some rivers, notably the Mzimkhulu and Ngwangwane, which both flow for 80 km or more before yellowfish are found in them. Because it is so ubiquitous and abundant the scaly is a popular table fish among subsistence fishers. It is also an excellent gamefish on light tackle.

Biology and Ecology

The KZN yellowfish is an adaptable fish occurring all the way from the headwater streams down to an altitude of about 100 m, just above the estuarine zone. Its preferred habitat is along the middle reaches of rivers that have an abundance of deep pools interspersed with rapids and riffles.

Scalies are omnivorous, feeding on algae, soft aquatic plants, aquatic insects, crabs and other small creatures. They seem to prefer the warmer areas of rivers and often congregate at the inlets of small tributaries where the water is warmer than in the main stem. Typically KZN yellows form loose schools that migrate upstream during spring and early summer to seek out spawning areas. Spawning takes place in fast-flowing riffles over a substrate of gravel and cobbles that is free of algae and silt. Males and females mature at about 10 cm and 15 cm fork lengths respectively. The maximum recorded size is a fish that measured 65 cm with a mass of 4.6 kg.

Status

Recently published World Conservation Union (IUCN) data give the KZN yellowfish a "Least Concern" rating. Most rivers in the province outside of urban areas have good quantities of fish that recruit well. River Health surveys of urban rivers in Durban and Pietermaritzburg, however, show that there are fewer fish in polluted rivers and they also appear to be stunted.

The joy of releasing something special

Threats

The KZN yellowfish is a fairly robust species tolerant of, and in certain instances, capable of taking advantage of man-induced habitat change. The biggest threats it faces are chronic pollution, siltation and physical habitat change.

The uMngeni catchment area, which supplies water to Durban and Pietermaritzburg, is under particular threat due to the rapidly growing demand for water. Urbanization in the lower reaches of the river has lead to an increase in contaminated runoff and faecal pollution. The uMngeni River is also heavily regulated by in-stream dams, resulting in downstream flow reduction and the degradation of downstream water quality, habitat and biotic integrity. Thirty-two rivers were sampled during a River Health Programme (RHP) survey in the Durban Metro area in 2006. Fifteen (47%) of these rivers are known to have had populations of *L. natalensis* in the past. The good news is that 11 of the rivers still supported yellowfish at the time of sampling. Severe pollution may have contributed to the absence of yellowfish in the Palmiet, Lovu, Msimbazi and Msinyati Rivers but it is also possible that because of the relatively few fish left, the survey failed to pick them up. Fish surveys carried out in the Durban Metro area suggest that *L. natalensis* is capable of surviving in a range of river conditions ranging from natural to moderately polluted. Polluted rivers, however, had fewer and more stunted fish. The Msunduze River which flows through Pietermaritzburg had several massive fish kills in 2006 due to an accumulation of biological waste products in the river and the concomitant depletion of dissolved oxygen in the water. *With 70 percent of municipal waste-water treatment plants in KZN rated as being non-compliant we have real reason for concern*.

With 70 percent of municipal waste-water treatment plants in KZN rated as being non-compliant we have real reason for concern

Dam walls restrict fish movement and affect genetic diversity

KZN yellowfish have flourished in some of the larger state-owned dams such as Chelmsford, Wagendrift, Midmar, and Albert Falls. Charles Wright, who pioneered the breeding of *L. natalensis* some thirty years ago, found that silt deposition was the biggest threat to developing ova. Fortunately, the rivers feeding these dams still have excellent spawning and recruitment areas for yellowfish.

Genetic contamination is another threat to KZN yellows, especially in the Thukela River System. In 1991, Mike Coke discovered Orange-Vaal smallmouth yellowfish (*L. aeneus*) as well as Orange-Vaal mudfish (*Labeo capensis*) on the KZN side of the Thukela-Vaal Inter Basin Water Transfer Scheme. There is now a distinct possibility that the two Orange-Vaal species may not only populate the Thukela system but also hybridize with the two endemic species, *Labeobarbus natalensis* and *Labeo rubromaculatus*, the Tugela labeo.

Conservation and Utilisation

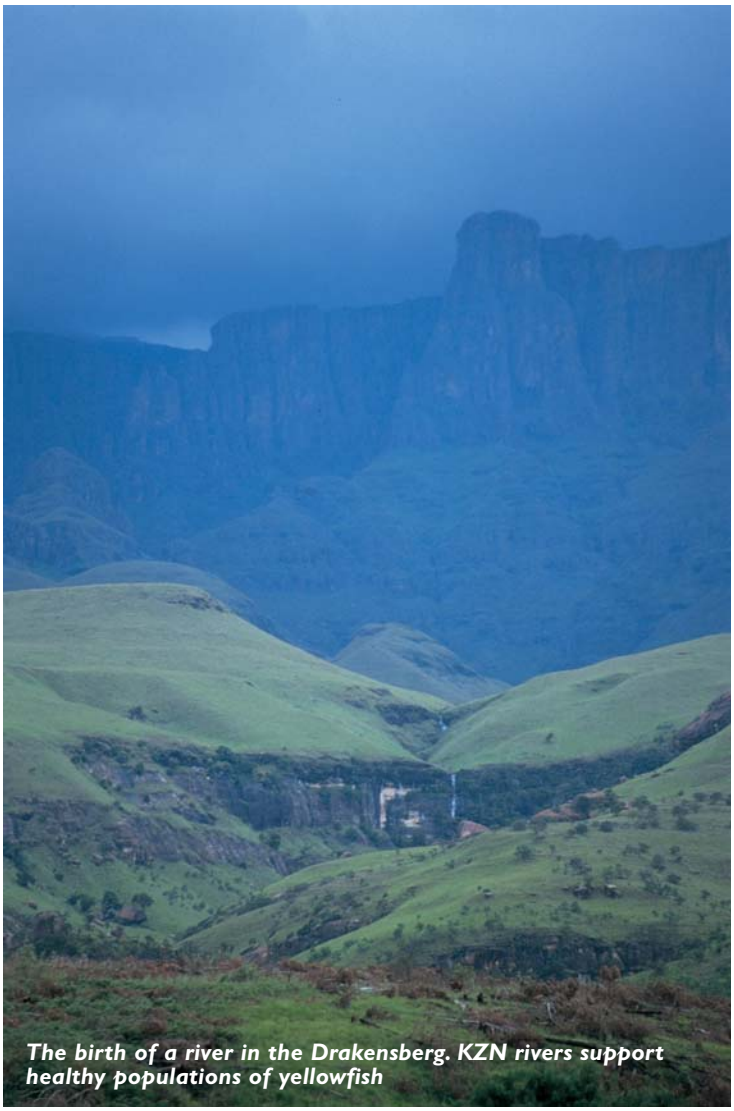
To date, no formal conservancies have been established that highlight yellowfish conservation. The angling potential of yellowfish has, however, been broadly recognized particularly amongst private game reserves and lodges on the Mkomazi River. The demand for fishing is mostly seasonal with hunting still remaining the main attraction. UMngeni Valley Nature Reserve near Howick now offers some excellent yellowfish fishing.

Trial stockings have been carried out at Royal Natal National Park. On 26 October 2006, one hundred and eleven KZN yellowfish were electro-fished in the Thukela River locally and transported a few kilometres to the Rugged Glen Dam. The main aim of the trial, which was carried out under the strict authority of an Ezemvelo KZN Wildlife (EKZNW) permit, is to establish whether yellowfish are a suitable angling fish in small high-altitude dams.

Tissue material of KZN yellows from several rivers across the province has been forwarded to Dr Paulette Bloomer of

the University of Pretoria for DNA analysis.

Legislation to protect ecosystems, enforcement of the "polluter-pays" principle and ensuring that care and sustainable utilisation of yellowfish receives priority will go a long way in protecting this valuable resource for future generations. Provincial regulations will hopefully also protect a more generic range of indigenous fish species, which although not yet threatened, represent a resource that should be conserved for socio-economic reasons. The minimum requirement in this context should at least be a daily bag limit while restricting the capture method to rod and line. EKZNW has recently reconstituted its Fresh Water Fishing Liaison Committee which now serves as a valuable platform for the public participation process. Although yellowfish have become a highly sought-after angling fish, their new-found popularity could, ironically, work against them. There is greater risk that anglers will be tempted to move them to places outside of their natural range. It is well known that a few decades ago KZN yellowfish were translocated to the Save River in Zimbabwe and more recently they have appeared on Swaziland's fish species list as inhabitants of the Nkomati River.



The birth of a river in the Drakensberg. KZN rivers support healthy populations of yellowfish

For the angler, KZN is endowed with a remarkable array of rivers and dams with plentiful yellowfish and good fishing can be found within 30 km of most cities and towns. Fly fishing for the KZN yellowfish is increasing in popularity although considerable ignorance still exists in terms of locating suitable venues and adopting appropriate angling techniques. For this reason, many freshwater anglers are still content on pursuing the excellent trout and bass fishing available in the province.

It is expected that fly fishing for this species will continue to grow as the cost of trout fishing and vehicular transportation continues to increase. Freshwater fishing is still largely unknown to a large component of KZN anglers who are more eager to pursue the many facets of saltwater fishing.

The KZN Chapter of the Yellowfish Working Group (YWG) has contributed towards the awareness of this species through popular articles written for *The Quill*, a newsletter distributed widely in the Natal Midlands. The chairman of the KZN Chapter, Neil Button, a Protea angler, has also been instrumental in disseminating information on a new website, www.artlure.co.za, providing further incentives for the pursuit of this species on both fly and spin tackle. UMngeni Valley Nature Reserve, which is managed by the Wildlife Environmental Society for South Africa (WESSA), is planning to hold a tagged fish competition soon.

Fly fishers and artlure anglers release most of the fish they capture but bait anglers catch and kill many scalies during the spawning season. A daily bag limit needs to be imposed to restrict this take. Subsistence anglers in rural areas catch large numbers of KZN yellowfish mostly on worms and paste baits. The fish is an important source of protein for them and their families.

Rob Karssing is a chief aquatic research technician employed by Ezemvelo KZN Wildlife. Rob enjoys fly fishing for trout and yellowfish, rock- and surf angling and nature generally.

LOWVELD LARGESCALE YELLOWFISH

Labeobarbus marequensis STATUS: LEAST CONCERN Paul Fouché

Introduction

The Lowveld largescale yellowfish (*Labeobarbus marequensis*) is the most common species in the east-flowing rivers of South Africa. Its range extends from the middle and lower Zambezi through the Limpopo and Inkomati Rivers and as far south as the Phongolo River in northern KwaZulu-Natal. Due to its variable morphology, the species has caused considerable confusion among taxonomists over the last century. The mouth may be terminal or slightly under the snout, and the lip form can vary from soft and bulbous, the so-called "rubber lips", to hard and horny with a cutting edge, the varicorhinus form, which provides a scraping ability when feeding. The fact that the lip form adapts to suit local conditions does not simplify matters. Variability in the species extends to other morphological aspects such as the dorsal fin which is reportedly smaller in the east and becomes progressively higher and larger to the west. The colour of the fish is influenced by water clarity; adults in clear rivers are golden yellow but pale olive in turbid water. Juveniles are silvery with a characteristic dark spot on the caudal peduncle.

The largescale yellowfish has some very distinctive characteristics: as its name implies, it has significantly larger scales than other yellowfish species, the body is deep, and the pelvic fin originates behind the origin of the dorsal fin. Tubercles develop on the snout, side of head and on anal fin rays in males and females during the breeding season. During this time, it is one of our most attractive yellowfishes.

Nutrients from agricultural fertilisers stimulate algal growth in inland waters

Biology and Ecology

Labeobarbus marequensis is omnivorous, feeding primarily on benthic filamentous algae and, to a lesser extent, on aquatic insects, crabs and small fish.

The largescale is essentially a riverine species but it can adapt to standing water. It favours fast water, and has been referred to as "gorge fish" on account of its penchant for strong currents below waterfalls. Although it prefers rivers with a rocky substrate, it will also inhabit sandy -bottomed rivers and rarely swampy environments. It does not occur in rivers that are devoid of fast water such as those reaches of the Limpopo and Inkomati Rivers east of the Lebombo mountains. The largescale prefers water with high oxygen levels but it is tolerant of a wide range of temperatures - it even occurs as high up as the Jukskei River near Johannesburg.

Rivers inhabited by largescale yellowfish in South Africa are heavily exploited for irrigation-intensive agriculture

Preliminary results of an ongoing survey in the Sabie and Luvuvhu rivers indicate that habitat preference seems to be size related - fish below 18 cm are common in fast shallow water, whereas larger fish are rarely found there. The larger fish seem to prefer deeper water, which makes it difficult to sample them owing to the presence of crocodiles!

Excessive water abstraction impacts negatively on stream flow and habitat

Largescale yellowfish breed only in fast water and at the appropriate time adults congregate in shallow riffles lined with gravel or cobbles to spawn. It is interesting that while males mature at the very small size of 7 cm, females only mature when they reach a length of 28 cm. Studies of gonadal development show that breeding occurs from October to April, which coincides with, and is dependent on, the rainy season.

Status

Although *L. marequensis* is not listed as vulnerable or threatened this is no reason for complacency - recent studies on the Luvuvhu River suggest that larger specimens have diminished in number, perhaps due to overexploitation by subsistence fishermen. Historical data show that above an altitude of 600 m the Luvuvhu holds few fish that exceed 23 cm in length.

In South Africa, the population is seemingly homogeneous across its range, probably due to inter-connection within the vast Limpopo River catchment. One would expect differences in the Nkomati catchment but as yet there is no clear evidence to support this.

Fragmentation of river systems by large dams may in due course lead to new isolated sub-populations. In the Great Letaba River, specifically, largescale yellowfish seem to be plentiful and are still found where historical data suggest they should be. The river is however highly fragmented and this can have a long-term impact on the genetics of the species.

Threats

The rivers inhabited by *L. marequensis* in South Africa are heavily exploited for irrigation-intensive commercial agriculture on the one hand, and on the other, traditional game and stock ranches bordering them are being gobbled up and converted into fashionable "eco-farms" and golf estates. All of these endeavours consume vast quantities of water. Moreover, the boom in platinum mining in the Olifants River catchment is placing enormous pressure on water resources that are already stretched to the limit.

Rivers inhabited by largescale yellows flow for long distances through densely populated rural areas where subsistence farming is the norm. It is common practice in these areas for ploughed fields to extend into the riparian zones – often right up to the river bank. Although this type of agriculture does not demand the same quantity of water as a commercial farm, it contributes an enormous load of

sediment to the water courses. During the 2000 floods, many of the pools were silted up or became significantly shallower as a result of the amount of sediment dumped into them. In breeding sites, sand and silt smothered the coarser gravel to such an extent that the interstices between the pebbles, in which the eggs develop, were filled in. This situation still persists in many areas as there have been no proper scouring flows since.

The necessity to procreate has made *L marequensis* vulnerable on two fronts - on the one hand environmental changes that lead to the loss of suitable water, particularly those sites that are essential for the fish to spawn; on the other, over-exploitation by subsistence fishers who often target the large numbers of fish that gather to spawn.

Mark Yelland with an excellent largescale yellowfish

In all watercourses, weirs and dams disrupt the flow regime to a greater or lesser extent by affecting the size and seasonality of floods. Inasmuch as these two factors are important cues for triggering the breeding response in largescale yellowfish, the negative effect of weirs and dams can be substantial.

At this stage, alien fish are not yet considered a major threat to largescale yellowfish, although trout and bass are viewed as a growing problem in the upper reaches of the Great Letaba River.

Conservation and Utilisation

Labeobarbus marequensis can attain a maximum total length of 47 cm and a mass of 6 kg which qualifies it as a large yellowfish species – the South African angling record is 5.75 kg. It is also a food source for humans and in the Luvuvhu River it constitutes as much as 10 percent of the total mass of fish caught by local subsistence fishers.

Although no conservancies have been established for largescale yellowfish, the species and its habitat stands to benefit from the dramatic increase in private conservation areas in Limpopo and Mpumalanga Provinces. This can only happen, however, if the owners and developers of these areas are made aware of the value of the species as a resource as well as the threats that it faces.

Although there are no official records of stocking of largescale yellowfish, environmental agencies in the relevant provinces are actively promoting it as an alternative angling species to bass, carp and trout. Draft regulations in respect of bag and size limits are currently under review.

Although a reasonable amount of research information is available on *L. marequensis*, more knowledge of the specific habitat preferences and diet of the various size classes would go a long way towards improving our knowledge of the species and developing a conservation management plan. Research on the genetic make-up of the species has been proposed but no such work is currently in progress.

Paul Fouché teaches Freshwater Biology at the University of Venda and specializes in the feeding biology and habitat requirement of indigenous fish and river health.

Xikundu fish ladder allows fish to move over the dam wall and spawn in the upper reaches of the Luvuvhu River

BUSHVELD SMALLSCALE YELLOWFISH

Labeobarbus polylepis STATUS: LEAST CONCERN Francois Roux

Introduction

The Bushveld smallscale yellowfish, *Labeobarbus polylepis*, is a large species restricted to the southern tributaries of the Limpopo, Nkomati and Phongholo River systems. It is a temperate zone fish that does not occur below altitudes of 600 meters and prefers perennial rivers with riffles, runs and deep pools. Although it is a strong swimmer, clearly adapted to living in fast-flowing waters, it readily inhabits dams.

Labeobarbus polylepis is a true yellowfish as it has a hexaploid karyotype of around 150 chromosomes and parallel-striated scales. The mouth is sub-terminal and has variable lips with two pairs of barbels. Males and females develop small white tubercles on the head, upper body scales and the anal- and dorsal-fin rays during spawning time. The juveniles are silvery with dark spots on the body, whereas adults are dark olive green above and bronze on the sides. The Bushveld smallscale is an omnivore, feeding on filamentous algae during autumn and winter and benthic invertebrates during the rest of the year. They reach a maximum total length (TL) of approximately 59 cm and a mass of 6.8 kg. Breeding occurs during spring and summer, with females maturing at 30 cm length and males at around 17 cm.

Several areas within the natural distribution range of *L. polylepis* have been separated from each other for very long periods by natural physiographical barriers such as waterfalls. The populations that were isolated in these areas are now morphologically distinct. The construction of several large dams such as Nooitgedacht, Vygeboom and Blyderivierspoort in the latter half of the 20th century has isolated and fragmented these populations even further. *Labeobarbus polylepis* is considered an important indicator species to determine management guidelines for river health.

The long-term conservation of this species will depend on effective ecosystem management

Biology and Ecology

Recent studies by the author show that smallscale yellowfish are highly selective and specialised in terms of their breeding requirements. First, the spawning site has to fulfill very special

Commercial and alien forests reduce water flow and availability for aquatic life

requirements in respect of suitable stream velocity, depth, substrate composition and layout (structure) of the spawning beds. Second, spawning only commences when the specific environmental cues involving daylight length, water temperature and constant low flow satisfy the requirements of the adult fishes.

Spawning activity peaks in early summer, usually October and November, but sporadic breeding by small groups of adults may continue until February. Pre-spawning commences when large concentrations of males and females migrate upstream to the spawning beds in response to water temperatures rising above 18°C and daylight length exceeding 12 hours.

Healthy rivers will support healthy yellowfish populations

Spawning takes place when the water temperature reaches 21°C, but ceases when it either drops below 20.8°C or rises above 23°C. The spawning area is divided into three sections: the spawning beds, male resting areas and nursery areas. Females ready to spawn move upstream from the deeper pools, and swim through the shoal of awaiting males. At this stage, as few as seven to as many as thirteen males follow the female in close attendance on to the spawning bed. When they reach the upstream end of the bed, a wild splashing commences and the mass of eggs and milt being released actually causes a conspicuous discolouration of the water. The fertilized eggs sink and lodge in the interstices of the cobbles and pebbles of the spawning bed.

The eggs of *L. polylepis* are relatively small with a mean diameter of 1.5 mm and a large periviteline space, which shields the developing embryo from turbulence in the riffles when and where the eggs are released. The eggs are slightly adhesive and denser than water ensuring that they sink and attach to the spawning medium. During water hardening, which lasts about 30 minutes, the eggs swell to about 3 mm diameter and lose their adhesiveness. At a water temperature of 21°C hatching commences after 96 hours and continues for another 48 hours. The very small larvae swim rapidly to the surface and are carried to downstream nursery areas. Larval distribution is dictated by both current speed and water depth.

Nursery areas lie alongside pools and are extensive warm, shallow backwaters with a substrate of silt and detritus. They have an average depth of 25 cm, a very slow flow and are rich in plankton that allows the juveniles to grow rapidly. Fry migrate out of nursery areas when they reach a length of 2 cm and move into shallow riffles that have a substrate of bedrock and gravel. Juveniles collected in these riffles ranged from 2.5-cm-long fry to fingerlings just over 10 cm in length. The move to a different habitat type could imply a change of diet or a switch to larger sized food organisms associated with fast water.

Status of Species and Habitat

As for most yellowfish species in southern Africa, the natural distribution range of *L. polylepis* is shrinking. The fish are, however, still widely distributed and relatively abundant across the upper catchments of the Limpopo, Inkomati and Phongholo drainage basins. The World Conservation Organisation gives them a rating of "Least Concern".

In general, the overall status of the habitat of the rivers within the distribution area of the Bushveld smallscale is fair to good, except for the upper Olifants and the southern Gauteng rivers which are poor and polluted as a result of urban, mining and industrial development.

Threats

The geomorphology, hydrology and functioning of rivers worldwide have been increasingly modified by a range of human activities that influence the structure and dynamics of biological communities in those rivers.

The habitat requirements for the Bushveld smallscale yellowfish to breed successfully are extremely demanding and

this may explain why it has disappeared from many impacted rivers in its range. The numerous dams and weirs strung out along rivers and streams severely impede its spawning runs and water released from these dams rarely provides the environmental cues that are a prerequisite for successful reproduction.

Poor farming practices have changed the characteristics of many streams from a typical riffle-pool configuration to wide, shallow, muddy tracts. This has resulted in the loss of suitable spawning sites as the fine silt and mud deposited in the interstices of the pebbles and cobbles, asphyxiates the eggs and embryos. In the absence of flood-velocity flows, the coarse substrate is not scoured which results in a loss of the physical integrity of the river channel.

Horst Filter with a huge smallscale yellowfish

The introduction of alien fishes such as trout in the headwaters of many catchments is a cause for concern. In order to create suitable holding water for trout, many weirs and dams are built across the water-courses. This disrupts the natural equilibrium established over tens of thousands of years and poses a substantial threat to the smallscale yellowfish and other indigenous creatures in the river.

A massive fish kill at an illegal obstruction in the Spekboom River was investigated recently. This obstruction was erected in the river during the summer when adult fishes were upstream on their spawning beds. When the fish tried to return downstream after the spawn they were trapped behind the obstruction. The fish could not escape to warmer water downstream when temperatures fell during winter and most of them died.

Recent genetic studies confirmed that there are significant differences among four populations of *L. polylepis* in different parts of their three native river systems. The highest genetic diversity is present in the Spekboom population and some alleles suggested that there may be hybridisation with translocated Orange-Vaal smallmouth yellowfish (*L. aeneus*). This probably occurred when both species were kept at the Lydenburg fish hatchery in the 1960s but also through direct introduction of *L. aeneus* into rivers in the Limpopo catchment.

Conservation and Utilisation

To date, only the Elands River Yellowfish Conservation Area (ERYCA), established in 2004, has been set up in *L. polylepis* territory. This area covers the Elands River from the town of Waterval Boven to its confluence with the Crocodile River. The goal is to promote the Bushveld smallscale yellowfish as a flagship species for the Elands River and the conservation of the aquatic habitat. According to Gordon O'Brien, Chairperson of the conservancy, their efforts are leading to a steady growth in the *L. polylepis* population in the Elands. Conservation authorities in seeking to conserve Bushveld smallscale yellowfish should focus on:

- Habitat conservation
- Controlling the transfer and stocking of alien fish within the natural range of *L. polylepis*
- Placing a moratorium on the transfer of yellowfish
- Incorporating fishways in dam and weir designs
- Controlling all aquaculture facilities strictly to prevent hybridisation
- Prosecuting illegal gill netting activities
- Monitoring and research

Conclusion

The long-term conservation of this species will depend on effective ecosystem management practices and the role of flagship species to create public awareness of the dire need to conserve our freshwater resources. However, in order to achieve these goals, knowledge underpinned by basic research is imperative. As Prof Paul Skelton said: "Sound basic knowledge is irreplaceable when it comes to making decisions on the environment."

Francois Roux is an aquatic ecologist with the Mpumalanga Parks Board.

[The author has recently completed an intensive study on the reproduction of *L. polylepis*. THE EDITOR]

BUSHVELD PAPERMOUTH

Barbus rapax STATUS: LEAST CONCERN Johan Engelbrecht

Introduction

The Bushveld papermouth, *Barbus rapax*, is found primarily in the large Limpopo River system, generally at altitudes above 600 m. It was previously synonymised with *B. mattozi*, a species described from the Cunene River, Angola. However, the two species are distinct in their morphology and colour patterns and are now recognised as two separate species, hence the recent name change.

Biology and Ecology

The Bushveld papermouth is a silvery fish with orange fins and the snout is distinctively concave. The mouth is terminal, large and protractile. It attains a length of approximately 40 cm and a maximum reported age of 9 years. The SA angling record is 1.3 kg, although most fish caught by anglers are between 250 g and 500 g in size. Unlike true yellowfishes (*Labeobarbus*), the papermouth has radially striated scales, a serrated dorsal spine and the origin of its ventral fins lies forward of the origin of its dorsal fin.

The papermouth seems to be more prolific in large dams than in rivers. This observation is also supported by population estimates for Loskop Dam which indicate that it was one of the most common species in the dam during these surveys. In rivers, they will usually be found in wide and deep pools that have reeds and weed beds.

This fish is an active predator that initially feeds on small

Modifying riverbeds without written permission from the appropriate authorities is illegal

planktonic crustaceans and insects and as it grows switches increasingly to small fishes. It has also been recorded to feed on water-lily seeds (*Nymphaea* species). Its short gut length (approximately equal to standard length) is indicative of its predatory feeding habits and it is easily caught on flies resembling small fishes and on small spinners. Predators of papermouth include piscivorous birds, otters, large catfish, tiger fish and adult papermouth.

Papermouth yellowfish were once plentiful in Pretoria environs

The Bushveld papermouth migrates upstream to spawn with the onset of the first summer floods. Although numerous ripe-running individuals were seen in riffle areas with a cobble and gravel substrate just upstream of Loskop Dam during such a period, no spawning was observed and it may be that they are not dependant on riffle areas for spawning. Individuals mature after 3 years.

Status

According to the recent World Conservation Union (IUCN) assessment of the conservation status of aquatic species in southern Africa, the Bushveld papermouth is listed as "Not Threatened". This is based on the fact that it is still widespread and locally common in some dams within the Limpopo River system. The following five sub-populations were identified within the system:

The taxonomic and genetic status of this species and its sub-populations needs urgent attention

Olifants River above Arabie Dam including the Elands, Wilge and Moses Rivers

Fish in this sub-population are still very abundant in several dams in the area, but recent surveys suggest that their numbers in Loskop and Arabie Dams may be dwindling due to the poor and deteriorating quality of water coming from the Olifants and Wilge rivers. Water abstraction and flow modification impact significantly on the riverine habitat of this group whereas the many in-stream dams are fragmenting and genetically isolating them from other sub-populations downstream.

Blyde River

This sub-population is moderately abundant and stable in Swadini Dam and is most likely also present in larger pools in the Blyde River below the dam. There may still be some genetic interchange between these two populations but the one below the dam is completely isolated from the Limpopo River sub-populations mentioned below.

Upper Limpopo including the Sand, Mokolo, Marico and Crocodile Rivers

This sub-population is still plentiful in some dams in the region but may be impacted on by water abstraction, flow modification and poor and deteriorating water quality. Again, the large number of dams on the watercourses is fragmenting and genetically isolating this sub-population from others downstream.

Shingwedzi River in the Kruger National Park

This stable and moderately abundant sub-population inhabits Kanniedood Dam and some larger pools in the Shingwedzi River. In-stream dam barriers may have isolated it completely from other sub-populations.

Limpopo tributaries in south-eastern Zimbabwe

Unknown

Papermouth appear intermittently in the lower Olifants River near Phalaborwa, usually after floods. It is thought that this is largely due to migration which, historically, may have been necessary for genetic exchange among the sub-populations mentioned above. Some other interesting historical distribution records include the Dwars River (a tributary of

Severe algal growths due to low flow and high nutrients

the Steelpoort) and the upper Olifants River near Witbank. Isolated records of papermouth have also been reported from the Nata River, the upper Zambezi and parts of central-east Zimbabwe. However, the status of these populations needs to be determined.

Conservation and Utilisation

The taxonomic and genetic status of this species and its sub-populations needs urgent attention. The genetic diversity in the fragmented sub-populations may be an important consideration in the long-term conservation of the species. Fish ladders at weirs and dams and frequent translocations within sub-populations may be essential tools to maintain and ensure genetic exchange.

Bushveld papermouth are often caught by anglers using small artificial lures, flies and worm baits. Decades ago it was a common catch in Hartbeespoort Dam and other nearby dams on the Crocodile River system. Due to their relatively small size, anglers were often disappointed in catching them when larger Mozambique tilapia or other species were being sought. Accordingly, papermouth were regarded by many anglers as a nuisance species. Nowadays, its relative scarcity in dams near Johannesburg and Pretoria has made it a prized quarry for anglers wanting to catch all nine yellowfishes on fly. Records in the literature show that substantial numbers are harvested by subsistence fishermen in Zimbabwe. Research on the taxonomic status, life history requirements and genetics of *Barbus rapax* is urgently required in addition to fish surveys to determine the current distribution and population status of this once widespread and common species.

Industrial and agricultural pollution is a blight on the recreational waters of Hartbeespoort Dam

Johan Engelbrecht is an aquatic ecologist with the Mpumalanga Parks Board.

MANAGING ALIEN YELLOWFISHES

Ernst Swartz

What is an Alien Yellowfish?

Any species of fish can be regarded as alien if it has been moved (translocated) outside its natural range and has established itself in its new environment. It is, therefore, important for us to understand the historical distribution of our fishes, before they were moved by man. Yellowfish have been translocated to other river systems where they can cause much environmental damage. They can, however, also cause similar damage if they are moved to parts of their native river system from which, for one reason or another, they were excluded previously.

For example, the Clanwilliam yellowfish, which is endemic to the Olifants River system, was moved above the barrier formed by the waterfalls in the Twee River tributary. They have now established themselves above the falls and should be considered as aliens here because they never occurred naturally. Their presence in the upper Twee now possibly threatens the survival of the Twee River redfin and a unique population of Cape galaxias as well.

Never move any yellowfish outside its natural range

Where are there Alien Yellowfishes in South Africa?

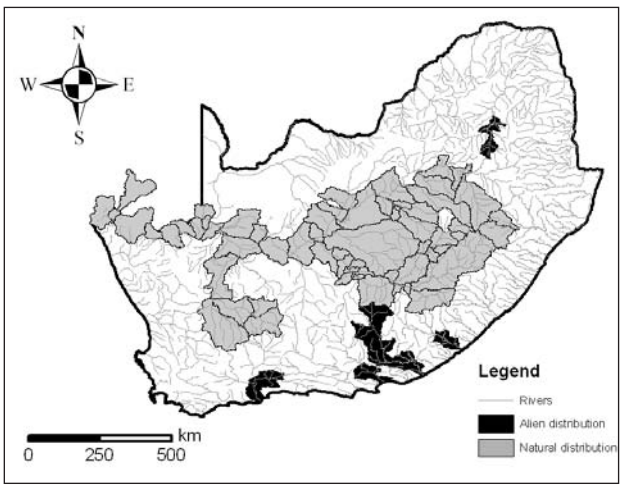
There are several places in the country where yellowfishes have been moved outside their natural range. Some translocations into dams and rivers have not been recorded and we know very little about the impacts that these aliens have on the indigenous populations of fishes and aquatic invertebrates, plants, and food-webs. The translocations that have occurred between different river systems are better understood and documented than the translocations within river systems. The following yellowfish species are known to have alien populations in South Africa:

Smallmouth yellowfish

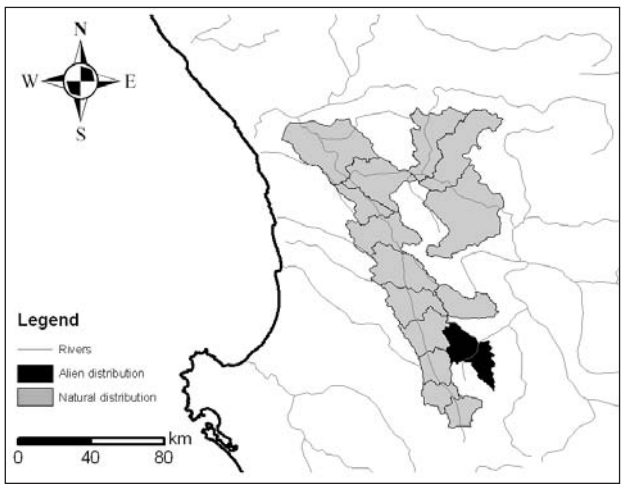
The smallmouth yellowfish has been translocated more often and has established more alien populations than any of the other yellowfishes. It has been a favourite species to move for fishing purposes because it is well known and is adaptable and hardy. Unfortunately, these qualities have also made it a very successful invasive alien species. As a result of deliberate introductions and inter-basin water transfer schemes large populations have become established in rivers such as the Kei and Sundays in Eastern Cape and the Gourits in Western Cape provinces. They have also been moved into the Olifants catchment of the Limpopo River system and occur in dams at the headwaters of the Thukela River in KwaZulu-Natal. They pose a major threat of hybridising with the natural populations of smallscale yellowfish in the Limpopo drainage basin and the KwaZulu-Natal yellowfish in the Thukela system. See Figure 1.

KwaZulu-Natal yellowfish

The KwaZulu-Natal yellowfish has been stocked sporadically in various parts of the province by Ezemvelo KZN Wildlife although details of translocations are sketchy. Sub-populations



Orange-Vaal smallmouth yellowfish. Figure 1



Clanwilliam yellowfish. Figure 2

of KZN yellows from different river systems may have been mixed and some populations may be alien within their native river system if they were stocked above natural barriers.

Clanwilliam yellowfish

This species was stocked into several rivers and farm dams in the Olifants River system by the former Cape Nature Conservation Department after the establishment of the Clanwilliam Yellowfish Hatchery in 1977. It is possible that populations of Clanwilliam yellowfish in certain tributaries of the Olifants River system may have been introduced in this way. For example, it is not known if the populations in the upper reaches of the Rondegat River and the Driehoeks-Matjies River have been stocked, are natural, or a mixture of stocked and natural. The only confirmed case of translocation outside their natural range is in the Twee River catchment mentioned earlier. See Figure 2

Clanwilliam Yellowfish have also been translocated, unfortunately

Whitefish

CapeNature staff has stocked whitefish (witvis) into several farm dams in the Berg and Breede River catchments as part of a co-ordinated plan with land owners to conserve this highly threatened species. These stockings have generally utilised whitefish from Brandvlei Dam, which are characterised by low genetic variation. To safeguard the species, it is essential that stockings for conservation purposes use the best genetic stock available.

Other alien yellowfishes

Several stockings of the largemouth and largescale yellowfishes have taken place under the auspices of the Gariep and Lydenburg hatcheries, both controlled by provincial conservation authorities. This took place before the Yellowfish Working Group (YWG) called for a moratorium on the stocking of yellowfish in 2002. Without details of where these fishes were stocked or where they originated we cannot determine whether different sub-populations of each species were mixed or not. To date it does not seem as if any alien populations of other yellowfish species have been established outside their natural distribution ranges.

How Did They Get There?

Yellowfish are moved by humans for various reasons and by various means. They can simply be caught by an angler and moved physically from one water to another. This often occurs when farm dams or neighbourhood ponds are stocked and it is commonly done by people who enjoy fishing and do not realise the potentially harmful consequences of their actions. In the past, several nature conservation authorities have transferred yellowfishes which were reared in their hatcheries or obtained from natural populations to other catchments. This was carried out with total disregard to potential impacts on receiving systems, including genetic mixing of stocks. Thankfully this practice has stopped and all stockings are now done within the natural range of the

Orange-Vaal smallmouth yellowfish were frequently translocated before the importance of genetic integrity and river conservation were recognised

species and with fish derived from sources close by. Inter-basin Water Transfer Schemes (IBTS) between different rivers have been responsible for some of the most damaging translocations of fishes in South Africa. For example, the Orange-Fish tunnel has totally transformed the fish population of the Great Fish River to one that is now dominated by Orange River species that include the smallmouth yellowfish. These Orange River aliens have also been able to colonise the Sundays River system because of the Cookhouse tunnel that links the Great Fish and Sundays River systems. Smallmouth yellowfish have also been able to penetrate the Thukela and Limpopo River systems by way of IBTS. Privately owned hatcheries and aquaculture facilities also pose a threat if they have fish species or genetic stocks that do not occur in the waters of the local catchment area. These hatcheries potentially pose the biggest future threat to yellowfish genetic conservation if they promote their yellowfish stocks across South Africa and supply fishes without permits from receiving provinces.

Impacts of Alien Yellowfishes

The impacts that alien yellowfishes have on aquatic ecosystems are poorly studied and hence not well understood. They probably prey on and compete for food (and maybe breeding grounds) with natural populations of fishes and invertebrates. As fish communities change from being indigenous to alien dominated, they substantially affect the food-web of which they are part, with unpredictable consequences. Studies are urgently needed to substantiate these suspicions.

How to Prevent the Introduction of More Alien Yellowfishes

Yellowfishes are becoming ever more popular angling fishes largely due to the efforts of the YWG, concerned conservationists, scientists and the fly-fishing community. There is, therefore, every possibility that yellowfish species may be translocated, either deliberately or inadvertently, to waters where they do not belong. To prevent this from happening is very simple in theory. In practice, however, it will require a concerted public awareness and education effort on behalf of all stakeholders involved in yellowfish conservation.

The plan would simply be never to move any yellowfish outside its natural range, never to mix different populations that have not been tested genetically, and to stock farm dams only from nearby populations within the same catchment area (not above natural barriers). A management plan for each of the nine "yellowfish" species in South Africa is urgently required which should go hand in hand with educating conservation managers, landowners, fisherman and the general public about the dangers of stocking fish species without permits or without properly considering genetic issues.

Ernst Swartz is an aquatic biologist at the South African Institute for Aquatic Biodiversity and does research on African freshwater fish diversity, genetics and conservation.

Critically endangered Twee River redfin now threatened by translocated Clanwilliam yellowfish

ECOLOGICAL HEALTH OF GAUTENG RIVERS WITH SPECIAL REFERENCE TO YELLOWFISH

Piet Muller

Introduction

Gauteng Province straddles the Continental Watershed or Divide. It is, therefore, not surprising that tributaries of three of South Africa's major rivers originate in the province. They are the Vaal River, whose waters ultimately end up in the Atlantic Ocean, the Crocodile (West) River and the Olifants River. The latter two make the long journey to the Indian Ocean via the Limpopo River. Smallmouth yellowfish (*Labeobarbus aeneus*) and largemouth yellowfish (*L. kimberleyensis*) are native to the streams and rivers in the Vaal catchment, whereas Lowveld largescale yellowfish (*L. marequensis*), Bushveld smallscale yellowfish (*L. polylepis*) and Bushveld papermouth (*Barbus rapax*) inhabit the tributaries of the other two rivers.

Land-use planning is failing to conserve the important wetlands and river corridors

The rivers and wetlands of Gauteng are under siege due to burgeoning development – the bulk of the land has been developed for mining, industrial, residential and agricultural purposes, and few natural areas remain. As a result seven large dams have been constructed in the province to meet the ever increasing demand for water. This, of course, has had the inevitable ecological impact on aquatic systems and on the yellowfishes in particular.

Urban litter always ends up in the river system

Distribution and Status of Yellowfishes in Gauteng Rivers

No formal survey to determine the status and distribution of yellowfish in Gauteng rivers has been undertaken since the early 1980s. Over the last two decades students from tertiary institutions and independent consultants have carried out sporadic surveys, largely as a consequence of the Environmental Impact Assessment process and the Gauteng River Health Programme (RHP). These surveys have shown that those yellowfish species that were present historically may still be found in some of the rivers. Gauteng Nature Conservation is currently planning a comprehensive fish survey of all rivers in the province to commence in 2007.

Upper-Vaal Catchment

Rietspruit-Leeuwspruit system

Both streams originate in the industrialized and urban parts of the West Rand. They flow southward for some distance before the Leeuw joins the Riet on its way to Loch Vaal. The excellent spawning grounds that existed in the upper reaches of both streams have long been obliterated by mining and urban sprawl and all their associated ills.

Although the Rietspruit water improves below the Leeuwspruit confluence, any benefit is immediately nullified by the highly contaminated discharge emanating from the Vanderbijlpark industrial complex. So potent is this dosage being injected into the river that it forms an invisible chemical barrier that blocks any attempt on the part of smallmouth or largemouth yellowfish to reach historical upstream spawning sites. Anglers occasionally take a few yellowfish in the lowermost reaches of the Rietspruit.

The Klip River system

The source of the Klip River is in the general area of Soweto in the west whereas its main tributaries the Elseburgspruit, Natalspruit and Rietspruit rise on the East Rand. All these streams receive high volumes of return-flow water from the

major sewage treatment plants that serve the southern Gauteng region. High levels of phosphates and other chemicals stimulate massive algal blooms that lead not only to a loss of aquatic invertebrate habitat but also, in summer, to oxygen depletion – the greatest cause of fish kills.

Attempts to prevent flooding by diverting the Klip River around the large floodplains and wetlands in its upper reaches led to an increase in stream velocity. As a result the river started scouring its bed as well as its banks and deposited the eroded sediment in the large weir at Henley-On-Klip.

The Blesbokspruit-Suikerbosrant system

The Blesbokspruit has two sources: the western tributary rises near the O R Tambo International Airport and flows south through industrial, mining and urban areas. It has been effectively converted into a succession of dams, canals and weirs. Major fuel spills at the airport, urban surface runoff, return flows from sewage treatment plants and tainted mine water being discharged into the stream are all responsible for the extremely poor water quality and ecological state of this tributary. Not surprisingly, almost all its natural wetlands have been destroyed.

Polluted mine water

The eastern arm has its source in the Bapsfontein area where agricultural activities have ruined the upper wetlands and disrupted its natural flow. Where it flows through the sprawl of formal and informal settlements in the Daveyton area, the stream is now confined to a canal. The combined effects of urbanisation, canalisation, subsistence farming and overgrazing have obliterated what was once a vast wetland. Further downstream the stream has to run the gauntlet of a succession of disused mine tailings dams - a limitless source of acid mine water. As if this were not enough, the Blesbokspruit receives a further dose of treated mine water below the confluence of its two tributaries At this point it enters the Marievale Bird Sanctuary which forms the core of the Blesbokspruit RAMSAR site. Several weirs that were constructed here for mining use in the early 1930s have created extensive artificial wetlands that play a significant role in purifying the water. Quite unexpectedly you can actually still find a few smallmouth as well as largemouth yellowfish at this spot.

The Blesbokspruit joins the Suikerbosrant River south of Heidelberg. Although both species of yellowfish still occur in this stretch they are being decimated by the many illegal gillnets in the river around Ratanda.

The Suikerbosrant River originates in the rural agricultural areas near Delmas and Balfour. Between Balfour Dam and the Blesbokspruit confluence it is still in a good to natural ecological condition with ample spawning grounds for fish. Over the last 7 years, fry of both yellowfish species have been collected in this stretch at RHP survey sites. Although the good quality water in the upper Suikerbosrant River deteriorates rapidly below the Blesbokspruit confluence, some fish still manage to reach the spawning areas extending up to the Balfour Dam. Several gauging weirs and causeways as far down as Three Rivers are major obstacles to migrating fish.

The Vaal River

The stretch of the Vaal River between the Vaal Dam and the Barrage is considered to be the main source of yellowfish that migrate up the tributaries described above. It is, however, under severe threat due to the continuing deterioration of water quality from its entire catchment. Moreover, the Barrage and the Vaal Dam are two major physical barriers that restrict the movement of yellowfish completely and confine them to this reach. Unless the problems of water quality and quantity receive serious and urgent attention, the yellowfish populations in this part of the river and below the Barrage face a grim future.

The Crocodile (West) catchment

Several tributaries of the Crocodile River originate in Gauteng, some within the city limits of Johannesburg and Pretoria. Canalisation and other modifications to the original river channels have altered the hydrological regime and this, coupled with poor quality water being discharged into the rivers, has had a devastating effect on the aquatic biodiversity. Indeed, many sensitive aquatic species have disappeared altogether from these streams.

Nonetheless, the three yellowfish species which occurred naturally in the region are still present in places but not to the same extent as in the past.

Urban, industrial and mining development is not as prevalent as in the Upper-Vaal catchment. Ironically, acid mine water from defunct gold mines on the West Rand is being pumped across the watershed and discharged into the headwaters of the Limpopo River drainage basin.

Property development encroaching on a wetland in Benoni

The Magalies and Skeerpoort Rivers

The Magalies River taps a vast underground dolomite aquifer, gushing forth at Maloney's Eye and continuing from there to its confluence with the Crocodile River in Hartbeespoort Dam. Above Magaliesburg the river is in a near pristine condition but below the town it deteriorates dramatically due to urban pollution and miscellaneous agricultural activities such as piggeries, dairies and chicken farms. Consequently all three yellowfish species occur in good numbers upstream of Magaliesburg but diminish steadily below.

The Skeerpoort River which joins the Magalies not far from Hartbeespoort Dam is fortunately still in a pristine ecological state. All three species occur in the river and spawn in its upper reaches.

The Crocodile River and Bloubankspruit

Both streams commence on the urbanised northern slope of the Witwatersrand near Krugersdorp and meet just above the newly constructed Aloe Ridge Dam some 12 km to the north. Juvenile fish collected here during RHP surveys indicate that self-sustaining populations of *L. marequensis* and *L. polylepis* are still present. Whether *B. rapax* is still around is in doubt as no evidence of it has been found lately. The Aloe Ridge Dam now forms a permanent barrier in the Crocodile River and prevents any migration of yellowfish from Hartbeespoort Dam to the headwaters. The boom in massive housing estates and recreational facilities such as golf courses and polo fields in this region can only impinge negatively on the ecological integrity of these rivers.

The Jukskei River

The Jukskei River and its tributaries, the Little Jukskei, the Modderfonteinspruit, the Braamfonteinspruit and the Sandspruit all originate in built-up areas of Greater Johannesburg. The Jukskei continues past Kyalami and the Diepsloot informal settlement to join the Crocodile River near Lanseria Airport.

Having its catchment completely transformed into an urban area has caused irreparable damage to the physiographical and ecological integrity of the Jukskei River. The highly irregular and erratic stormwater run-off from built-up areas and the large volume of treated water being discharged from the Northern Works Water Treatment Plant have scoured the river to the point where it resembles a storm-water canal with little if any ecological function. Although all three yellowfish species have been recorded in the lower reaches of the river, only a few individuals were collected during RHP surveys, confirming the lamentable condition of the river.

The Hennops River

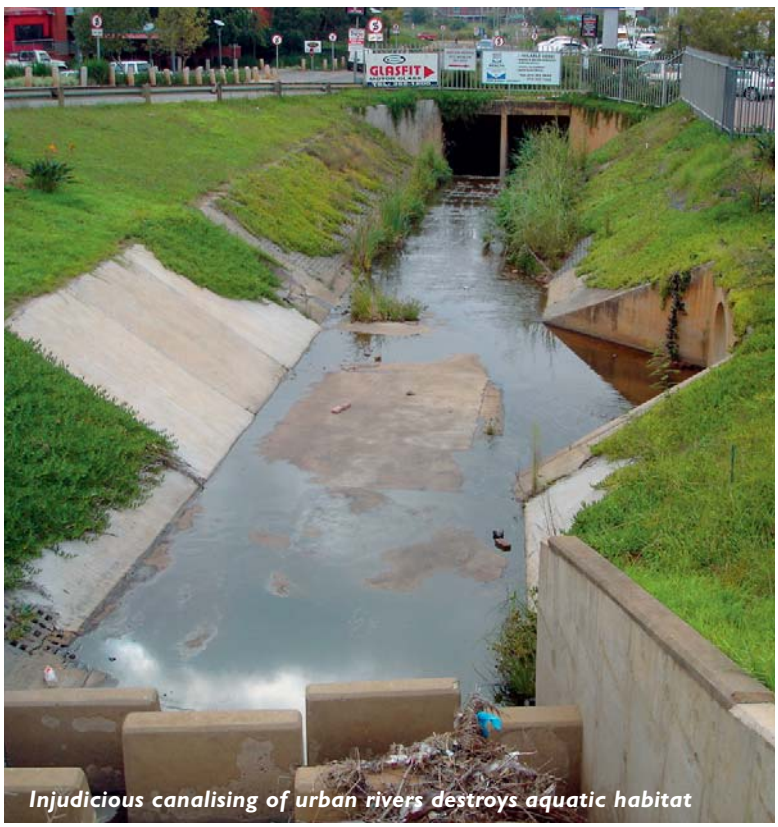
The main tributary of this river rises in the industrial areas of Kempton Park and flows northward through Tembisa and

Rietvlei Dam before entering Centurion Lake. From there, the Hennops continues westward and joins the Crocodile River near Hartbeespoort Dam.

Except for the occasional Bushveld smallscale showing up in Rietvlei Dam, the Hennops no longer holds yellowfish above Centurion Lake. Below the lake, the river is still in a fair ecological state and both *L. marequensis* and *L. polylepis* are reasonably common. *B. rapax*, however, has only been found close to Hartbeespoort Dam. High-density housing developments currently being constructed in the catchment, do not auger well for the future of this river – the portents are that it will suffer a similar fate as the Jukskei.

The Apies-Pienaars River system

Both these rivers have their sources in the greater Pretoria area and accordingly show all the adverse effects of their urban origin. Juveniles of *L. marequensis* and *L. polylepis* were noted in Wonderboom Poort during RHP surveys implying that spawning still takes place in this relatively isolated reach of the river. The Bon Accord Dam, however, prevents any upstream migration of yellowfishes. No papermouth were found in this part of the river.



Injudicious canalising of urban rivers destroys aquatic habitat

Both *L. marequensis* and *L. polylepis* occur in the Pienaars River between Roodeplaat Dam and Mamelodi but the dam prevents them from migrating upstream. Vast housing developments to the east of Pretoria are currently under construction and will doubtless lead to a further degradation of this river.

The upper Olifants catchment

Three tributaries of the Olifants River rise in Gauteng. They are the Elands River, the Wilge River and the Bronkhorstspruit. Fortunately no serious urban development has taken place in their catchments and, on the whole, all are still in a near pristine state. The exception is the stretch of the Bronkhorstspruit between the town of the same name and the Premier Dam. All three yellowfish species are present and they have ample spawning sites.

Summary

We do not have a clear picture of the current status of yellowfishes in Gauteng but it requires no great deductive ability to realise that they are under great threat. Massive development has taken place in the last 10 years and there is grave concern that land-use planning is failing to conserve the important wetlands and river corridors. Our inland waters are vital for future development but they have to be managed in ways that maximizes water quality as well as recreational and tourism opportunities. The province is endowed with five species of yellowfish that are still present in functional numbers in the healthier rivers. The future well-being of these rivers will be reflected by the health of the yellowfishes that inhabit them. Urgent and effective action is required to stop the degradation of our rivers and wetlands, and to set in motion a programme of rehabilitation for the benefit and survival of not only the creatures within the rivers but also those who inhabit the world outside.

Piet Muller is the River Health Programme Champion for Gauteng and does biomonitoring in all the rivers of the province. He is a keen fly fisherman and is very concerned about the negative impact of human activity on rivers.

RIPARIAN LAND-OWNERS – "KEEPERS OF THE RIVER"

Gordon O'Brien

Introduction

The responsibility of managing and conserving our fish populations in South Africa is widely considered by the public to be the sole responsibility of provincial departments of nature conservation as it is part of their mandate of conserving biodiversity. The Department of Water Affairs and Forestry (DWAF) is also an important player as it is the custodian of water resources in South Africa. Yet, conservation authorities and DWAF have limited human resources to undertake these vital tasks, both in terms of finances and the numbers of aquatic scientific and technical personnel available. It is here that the private sector can make a major contribution. Arguably, riparian land-owners (those that have property bordering on rivers as well as dams) should make the biggest contribution, provided that they understand why and how riparian zones, fishes and the ecosystems associated with rivers, wetlands and dams should be conserved.

Yellowfishes are an important aquatic resource in South Africa in that they provide users with tangible economic, social and ecological benefits. Their economic value relates to the direct and indirect monetary value obtained as a result of angling for them as well as their tourism use. Their social value relates to their use as a food source, a source of recreation and in educating users on the structure, function and importance of indigenous aquatic resources. Ecologically, yellowfishes are frequently used as indicators of aquatic ecosystem health, and their popularity and importance in the food-web has made them flagship species for conserving our rivers. A flagship species is a charismatic indigenous species which readily attracts public support.

The riparian zone is critical to the functioning of an ecologically healthy river

Value of the Riparian Zone

The riparian zone of a river is one of the most important components that define the ecological health of a river. Riparian zones consist of tree, shrub and other plant species that are water-loving, and are dependent on the river for their survival. Rivers with undisturbed riparian zones generally

The riparian zone is important for a healthy river

have excellent riverine habitat diversity and water quality. These rivers usually have high numbers of fish and for the nature lover provide a wonderful wildlife corridor with a diversity of terrestrial birds and aquatic creatures.

Riparian zones typically consist of a wet bank and a dry bank (Figure 1). Generally they become more structured and diverse as a river changes from its upper to its middle and lower reaches. Mountain streams are small, steep and fast flowing and have a narrow riparian zone. In the middle reaches, the flow slows as the gradient decreases and the river widens as more tributaries enter it. Here, the river may become braided (multi-channelled) and develop a small flood-plain which will give rise to a wider and more diverse riparian zone. In their lower reaches rivers usually meander across an extensive flood plain and have wide riparian zones.

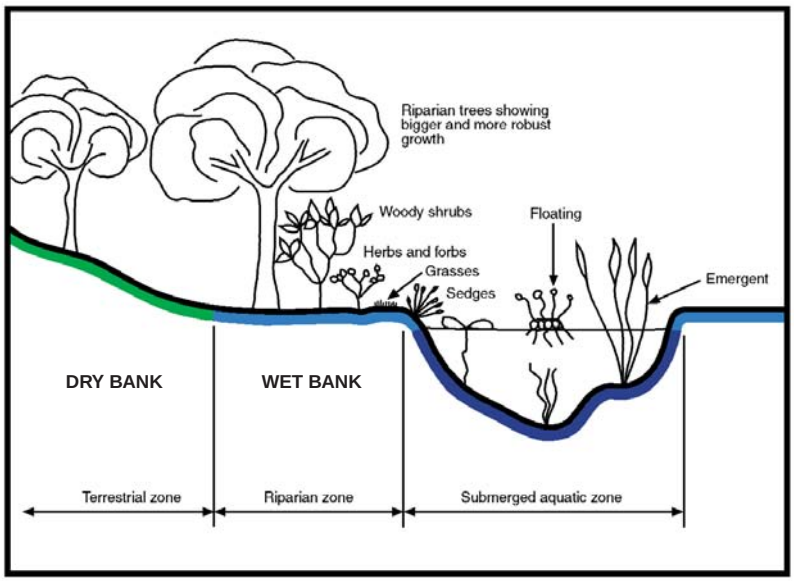


Figure 1: Typical cross section of a river channel

The riparian zone is critical to the functioning of an ecologically healthy river because:

- Riparian plants stabilize river banks and protect the river during floods. These plants are well rooted and flex during high flows, slowing down the flood waters and reducing damage.
- The plants intercept nutrients leached from adjacent farmlands before they enter and pollute the river.
- An intact riparian zone also causes storm water laden with sediment eroded from neighbouring land to drop much of its load before discharging into the river.
- The plants in the wet-bank zone play an important role in the provision of food and shelter for fish - leaves, flowers, branches and terrestrial insects that fall into the river all contribute to the food web.
- Rivers with healthy riparian zones act as vital corridors for migrating wildlife such as kudu, bushbuck, otters, ducks, kingfishers and other wildlife when they seek new food sources or territories.

Threats to Riparian Zones

Unfortunately many river users do not fully appreciate the value of riparian zones and have caused significant damage to most of those in South Africa. The key threats to riparian zones include:

1. The removal of riparian vegetation in order to plant crops and orchards in the moist and fertile soil. Unfortunately these areas lie within the flood plain of the river and are frequently damaged by floodwaters. Some farmers respond to this problem by bulldozing river banks to canalize and speed up river flow which destroys the riparian zone and degrades the habitat for fish and other aquatic organisms.
2. On some rivers, the excessive abstraction of water for agriculture reduces the flow to such an extent that the riparian zones dry out and die. Likewise, during dry periods, weirs on certain rivers inhibit water from flowing over the weir and the entire downstream section suffers a similar fate.
3. In many areas of South Africa, riparian zones are severely infested by invasive alien plants such as gums, wattles and pines. These plants thrive in the moist soils of the riparian zone and in the absence of their natural predators outcompete and replace indigenous vegetation. Many are not adapted to South African riverine conditions and, during flooding, frequently fall into the river damaging the bank or blocking the channel. Their leaves, flowers and branches are not a suitable source of food for local aquatic invertebrates. Alien plants are also water thirsty, consuming vastly more water per day than their indigenous counterparts.

Conservancies as Management Tools for Riparian Land-owners

Currently, two conservation organisations, the Orange-Vaal River Yellowfish Conservation and Management Association (OVRYCMA, established in 1996) and the Elands River Yellowfish Conservation Area (ERYCA, established in 2004)

are operative.

The establishment of this type of initiative requires a strategy and management system that directs and focuses the efforts of the individuals and/or stakeholders undertaking the effort. An outcome that can be measured, must be incorporated into the system (usually the maintenance or improvement in the stability of the yellowfish population and biodiversity), so that the individuals who undertake this conservation effort can monitor the success of their efforts.

The success of such conservation initiatives is primarily dependent on the involvement of riparian owners, who are generally aware of activities on neighbouring rivers and dams and who often utilise or conserve the yellowfish resource or its associated aquatic ecosystem. As "Keepers of the River", riparian owners increasingly play a critical role in the conservation of yellowfish populations in South Africa. Those that are members of active and effective river-focused conservancies are making the biggest contributions. Some key actions that riparian land-owners can take to enhance the conservation of our rivers are:

An intact riparian zone will help intercept sediments eroded from neighbouring land

- Promote awareness and understanding of the structure and functioning of riparian zones and how this contributes to a healthy aquatic ecosystem.
- Develop knowledge and understanding of the biology, environmental requirements and population dynamics of yellowfish populations in rivers under their control.
- Implement the sustainable use of yellowfish by encouraging the conservation-friendly practice of catch and release. Promote the concept of "take only pictures, leave only footprints" among anglers.
- Implement management plans focused on conserving threatened populations of yellowfish as well as the aquatic ecosystem in which they live.
- Promote the collective effort of aquatic conservation by all relevant custodians and stakeholders. Establish or join riverine conservancies.
- Be on the lookout for threats to rivers and yellowfish, such as water pollution, bulldozing of rivers, illegal stockings of fish, and report this immediately to your nearest nature conservation or DWAF office.
- Monitor excessive angling for yellowfish, but remember that it is legal for local communities to utilise yellowfishes in rivers (except the threatened Western Cape species) provided that catch restrictions are met. Never allow members of the public to net (whether gill nets, seine nets or cast nets) or to spear fish as this is illegal.
- Protect important yellowfish spawning areas by demarcating these and educate anglers about not wading through these areas from October to January. Fish that are on spawning beds should be left undisturbed.
- Eradicate invasive alien vegetation such as wattles, bluegums, pines, water hyacinth and parrot's feather on riparian properties. Terrestrial invasive plants, in particular, should not be permitted within 50 m of the bank of a river or dam.
- There is a lot of support and documentation available on how to establish formal conservation areas in South Africa, and a project is currently underway to determine their economic and social benefits. Riparian land-owners should also read this chapter in conjunction with other chapters in this report, notably those on conservancies and the various yellowfish species.

Informed and aware riparian land-owners are vital ingredients in our quest to enhance conservation of our yellowfish heritage. Our natural resources are increasingly under pressure and it is essential that we work together with conservation and water authorities to protect our valuable rivers for future generations.

Gordon O'Brien is an aquatic ecologist at the Zoology Department of the University of Johannesburg. He is co-founder of the Elands River Yellowfish Conservation Area.

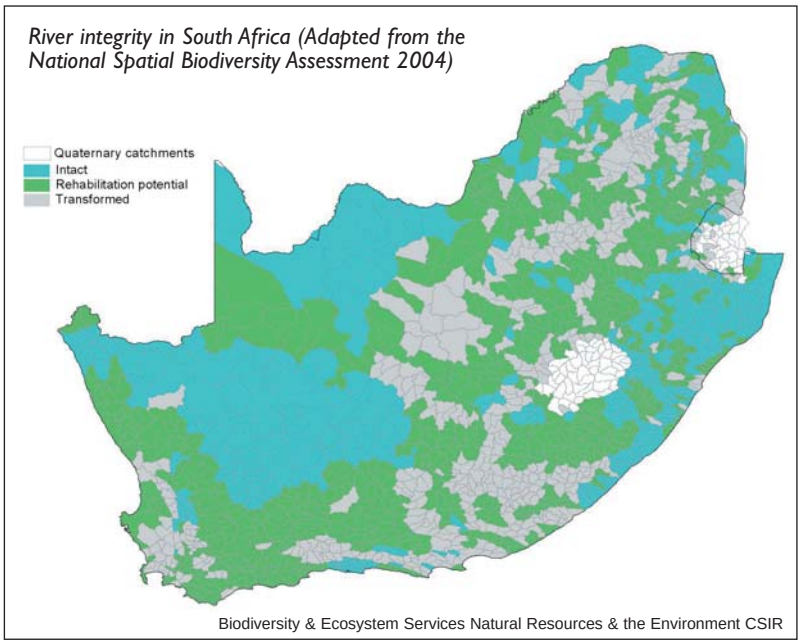
CONSERVANCIES AND YELLOWFISH MANAGEMENT ASSOCIATIONS: TOOLS FOR RIVER MANAGEMENT AND CONSERVATION

Peter Mills

Introduction

Conservation implies the management of natural resources in a way that allows them to be utilised without becoming depleted. Conservation, therefore, covers a continuum of management options that range from complete protection of biodiversity to the use of flagship species that could be used for commercial or sporting purposes. If flagship species are conserved, it means that their habitat will also be conserved and, by implication, all other species dependant on that habitat. The map below shows the status of rivers in South Africa in 2000 – what is alarming is that most of the rivers are either transformed or degraded and require rehabilitation. Degraded or transformed rivers are not ideal environments for yellowfish to thrive. To rehabilitate transformed rivers, all stakeholders, including private landowners, need to work together and commit substantial resources to rehabilitation.

River integrity in South Africa (Adapted from the National Spatial Biodiversity Assessment 2004)



Conservancies

Conservancies have existed in South Africa since the 1960s. They were developed as a conservation tool to encourage landowners to actively manage wildlife on their properties. Most of our wildlife, including freshwater fish, occurs on private land. Obviously, the involvement of private landowners is essential for effective conservation.

A conservancy can be defined as a voluntary association of land users and/or landowners who wish to manage their natural resources co-operatively and in a sustainable and environmentally friendly manner without necessarily changing the land use of their properties. The association must be registered with a local conservation authority.

Most provincial conservation departments run a conservancy programme with varying degrees of success. If such a programme exists in your province, affiliate with it because you will gain valuable guidelines with regard to the establishment and management of your conservancy. However, there is nothing stopping you from starting and running your own conservancy if your local conservation authority has a weak support programme or is too thin on the ground to be of any assistance. There are a number of individuals that you can consult as well as privately run national and provincial conservation associations that will gladly give you advice. The addresses of some of these associations are given at the end of this article – consult the websites to find the appropriate contact person.

Successful conservancies are often run by one or more individuals that are passionate about the project and who normally end up driving the process. Once you have decided to start a conservancy follow these steps:

- Define your objectives and the reason for wanting to start a conservancy along your particular stretch of river.
- Develop clear objectives that will help you sell the programme to your neighbours who may not have given the matter much thought at this stage.
- Hold a public meeting, preferably with a representative from your local conservation department whose presence may lend further credibility to your idea. The first meeting is an opportune time to elect a committee that will take the process further.
- Also, start a register of people who will become the

foundation of your membership.

- It will be the responsibility of the committee to canvas and register members and to draw up a constitution that can also be used to sell the conservancy to prospective members. The constitution should address issues such as conditions of membership, meetings and, more importantly, mechanisms for providing better management and security of the area. These are great incentives for potential members. A pro-forma constitution may be downloaded from the websites given below.
- Membership fees are not compulsory but they do help pay for administration. In a fully functional conservancy, funds could be generated by membership fees and/or commercial activities such as fishing and lodging. Once you have reached this point it is time to register your conservancy with the local conservation authority.

Managing the Natural Resources of your Conservancy

As a conservancy you will doubtlessly have a business plan but, to manage your wildlife resources effectively, you will need a blueprint outlining how you intend doing this on your stretch of river. Such a management plan can be quite technical, so it may be advisable to contact your local conservation department to help you in drawing it up. This kind of service is normally provided without charge.

There are many projects that a conservancy can undertake but for a river conservancy they are relatively simple. On your stretch of river you should focus on protecting riparian habitat and spawning beds, controlling fishing, and creating recreational opportunities for visitors. Keep your objectives simple, attainable and measurable. Time, available budget and resources will determine how much you are actually able to do. For example, an objective may be to eradicate alien vegetation on the river banks within your conservancy. You then need to develop a strategy of clearing alien trees using special techniques, herbicides and manpower. As a measure of success you can define how much you wish to clear within a prescribed period at the end of which you can evaluate whether you met your objectives.

Yellowfish Conservation Management Associations

Here, riparian landowners unite to manage and control valuable yellowfish populations in the waters that flow through their properties. The Orange-Vaal River Yellowfish Conservation and Management Association (OVRYCMA) is a good example of this approach. In this model, riparian owners on both sides of the river are encouraged to join the association with the express purpose of conserving the yellowfish in the system. The whole process is co-ordinated by the Free State Department of Tourism, Environmental and Economic Affairs. Membership is voluntary and free but members who register undertake to reach the following objectives:

The involvement of private landowners is essential for effective conservation

- Conserve yellowfish, especially the largemouth yellowfish.
- Organise information days and clinics to promote good river management.
- Encourage and enforce the practice of catch and release of yellowfish and to have this principle applied throughout the Vaal River system.
- To promote sustainable tourism and to ensure that the conservation of yellowfish is secured despite the increased numbers of anglers on the river.

Protea Resorts have joined in the yellowfish conservation initiative

Whereas the overall aim is to develop yellowfish conservation associations along the entire length of the Orange Vaal River system, an initiative like this needs to divide the region up into "bite-size" chunks. The initial chunk was between the Barrage and Bloemhof Dam on the Vaal River. So far, some 300 km of river frontage is being managed in this way. Members are committed to the objectives and communicate

by farm visits or newsletters. There is no formal contract with provincial governments.

This has proven to be a very effective method of getting people together and organising a conservation network for a particular river. This type of association can be developed for any river in South Africa, and indeed Africa. There must be a person (champion) and a small committee to drive the process. It does take a substantial amount of energy and networking but the results are worth the effort. OVRYCMA has been the leading force in developing the yellowfish conservation initiative at grassroots level in South Africa. This has created a huge amount of awareness within the ranks of landowners, anglers and government departments. In addition, OVRYCMA has given rise to an extremely valuable angling industry that is worth millions of rand annually. This in itself will result in the fish and their habitat being conserved for socio-economic reasons in this developing country of ours.

Conservancies offer sustainable angling. Peter Mills, YWG and FOSAF executive

The Elands River Yellowfish Conservancy Area (ERYCA) workshop at Waterval Onder

Funding is always an issue and there are no specific guidelines on how to access these funds. A conservancy needs to prove that it is effective before it approaches the authorities for funds. Management of these associations will not be without its share of human politics – a clear aim and objectives as well as a philosophy that "Yellowfish conservation must benefit" will keep the unit going during troubled times. It is advisable to get your local conservation officials and water managers involved and remember, a good scientific basis is imperative to make sound decisions.

The Elands River Yellowfish Conservation Area (ERYCA) is a conservancy that has been established specifically to conserve the Bushveld smallscale yellowfish (*Labeobarbus polylepis*). This stretch of the Elands River, isolated by two waterfalls, contains a unique population of these fish and it is also one of the last remaining refuges for the critically endangered Inkomati rock-catlet (*Chiloglanis bifurcus*). This conservancy is trying to establish a relationship between landowners, guesthouses, resorts, academic institutions and the local conservation authority in order to conserve this stretch of the river. The conservancy also has an educational objective that aims to make landowners and the general public more aware of the importance of rivers and why they should be conserved.

Specific Guidelines for Yellowfish Conservation

- Act as a lobby and report water contamination resulting from poor land use, inadequate sewage treatment and bad mining practices.
- Actively discourage the use of keep nets among anglers because yellowfish kept in these are unlikely to survive.
- Encourage anglers to fish with barbless hooks only.
- Promote catch and release of all yellowfish despite provincial legislation which may allow the angler to keep some fish.
- Encourage subsistence fishers to target only alien and other species.
- Conserve spawning beds by not allowing wading in these areas during spawning periods.

Useful Contacts

- www. conservancies.org www.nacsa.org.za
- Orange-Vaal River Yellowfish Conservation and Management Association: Pierre de Villiers, estuaries@cncjnk.wcape.gov.za
- Elands River Yellowfish Conservation Area: George McAllister, aloes-inn@huxnet.co.za

Peter is the environment manager for the Cradle of Humankind and Dinokeng. He has over twenty years of conservation experience and is an avid fly fisher.

THE INFLUENCE OF WATER QUALITY ON AQUATIC BIODIVERSITY WITH PARTICULAR REFERENCE TO THE FISH KILLS IN THE MIDDLE VAAL RIVER

Steve Mitchell

Introduction

We all need water. Water is used in everything that we use or consume in our daily lives in the home, in the workplace and elsewhere. It is, in fact, the basis of wealth creation. South Africa is largely a semi-arid country. Recent estimates from the World Wide Fund for Nature (WWF) put water availability at about 800 to 900 m^3 per person per year for everything including our food production. This may sound like a lot until you realise that, for instance, a kilogram of wheat takes about 1 m^3 of water to grow. It is estimated from current projections based on the changing demographics of South Africa that water availability will decrease to less than 500 m^3 per person per year by 2025.

Our quality of life depends on there being sufficient available water of good quality

Our quality of life depends on there being sufficient available water of good quality and one important step in ensuring that this is the case is to look after what we have. We draw water from the environment and when we return it to the environment we need to make sure that it is treated to a standard that we can use again. In short, our water will go further if we look after it. The National Water Act (1998) (NWA) provides the blueprint for this.

Classification of Rivers

In terms of the NWA each significant water resource must be classified and then managed according to its classification. In terms of this classification a pristine river is considered "A" class and a hard-working and moderately degraded river would be considered a "D" class. The classification system deems that rivers in classes "E" and "F" (the highly degraded) must be rehabilitated to at least a "D". In terms of the balance between ecological benefits (goods and services) and economic use, an A-class river would be managed to maximise ecological benefits whereas a D-class river would be managed for economic (usually consumptive) activities. It is intended that D-class rivers will be used to the maximum. As I explain below, this puts a considerable responsibility on the managers of water quality.

Water Pollution – Causes and Effects

There is a direct relationship between using the water from a river and the effect of that use on the river. This is outlined diagrammatically in Figure 1. Important parameters that are likely to be altered from the natural state when a river is used are the flow regime and water quality. Impoundments, for instance, enable the floods to be stored for release in the dry season. This is important for ensuring an uninterrupted supply of water for urban, industrial and agricultural activities, but these same floods drive many of the processes in the

Frequent fish kills on the Vaal River due to polluted water

ecosystem. When these are removed, the ecosystem does not receive the cues which, for instance, initiate breeding in fish. The quality of the return flows is also very important. Ecosystems are resilient and do have a capacity to treat wastes. However, this process will cause changes in the ecosystem, and when this capacity is exceeded the magnitude of these changes will become much greater.

The discharge of plant nutrients, mainly nitrogen and phosphorous from sewage works and agriculture, into an ecosystem shows this principle clearly. An increase in the nitrogen levels in a water body will stimulate growth in a wide variety of plants, but an increase in phosphorous will stimulate blooms of blue-green algae which give bad tastes and odours to water and, under certain circumstances, will generate toxins which are difficult to remove.

The results of poor maintenance of sewage systems

As can be seen from Figure 1, two effects are apparent when the nutrient load of a water body is increased. There is an increase in biomass and there is a decrease in the biodiversity occurring in the system. Two other changes occur which are less apparent because they are not gradual changes but are event driven. These are that the ability of the system to cope with events such as minor accidents is decreased and so the risk of major system disruptions is increased. Pollution by toxic material from industrial or agricultural discharge has a similar effect to nutrient enrichment as shown in Figure 1 except that the biomass will not increase. Instead, the biomass will tend to follow the biodiversity curve.

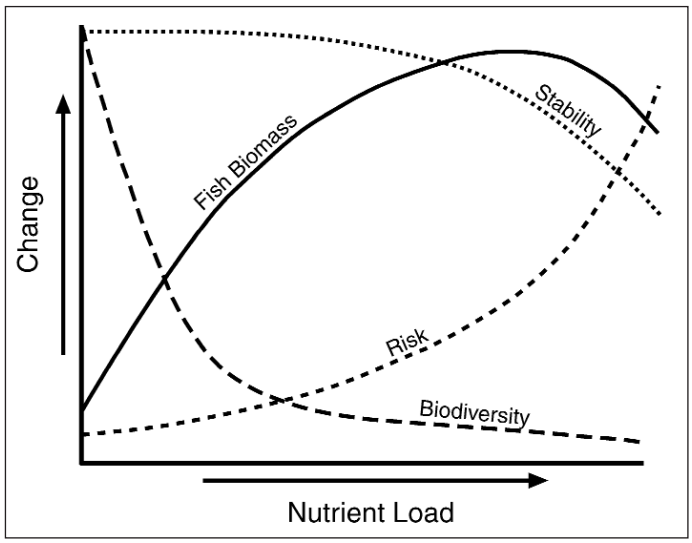


Figure 1: Diagrammatic representation of the response of an ecosystem to increased nutrient load.

A system which is managed as an A class will carry less biomass, but will have a relatively higher ability to survive pollution incidents. On the other hand, a hard-working river that is being managed as a D-class resource is near its limit, and relatively minor incidents are likely to have a greater impact. There is, thus, less latitude for error in the quality of discharged effluents in the case of a D-class system.

In catchments that are heavily populated the main cause of pollution is likely to be from urban and industrial sources. Effluent strength is measured in South Africa as Chemical Oxygen Demand (COD), and this is a measure of how much oxygen is required to mineralise the impurities in the effluent. The strengths of effluent from various sources differ, and this is a consideration in the design of treatment plants. When considering the COD values given below, bear in mind that oxygen saturation in freshwater at the altitude and ambient temperature of the middle Vaal is in the order of 8 milligrams per litre (mg/ℓ). Untreated domestic sewage in South Africa has a COD of 600 to 800 mg/ℓ, but it is normally over 700. This is higher than in the USA (~300 mg/ℓ) as we use less water. Effluent discharged from a properly functioning activated sludge treatment plant has a COD of 35 to 50 mg/ℓ which the environment can handle through dilution and natural turbulence.

Dairy and abattoir wastes, on the other hand, are much stronger. The levy paid to local authorities is based on the strength of the waste water discharged to the sewer, so industries generally have balancing tanks on site in which the waste streams are blended. As a result, the waste discharged to the sewers is an average from the entire plant. The strength of the final effluent discharged to the sewers may be in the region of 10 000 to 20 000 mg/ℓ. Particular care should be taken to keep these high strength effluents out of the environment as both blood and milk are

readily biodegradable - even more so than domestic sewage, so any dissolved oxygen available in the environmental water is mopped up very rapidly by the biodegradation process. Unlike better-watered regions of the world, South Africa does not have the volumes of water required to dilute wastes like this to levels where they will not cause damage.

As we can see, classifying a river as a hard-working river has a number of implications beyond simply the decision to support increased economic activity. This decision will mean more effluent being discharged into the environment. These rivers serve areas of high population density and this means that water is likely to be abstracted and returned more than once. This puts additional burden on those in the effluent treatment industry to ensure that effluent discharged to the environment is properly treated. Improperly treated effluent will damage the river with the more severe incidents leading to fish kills.

Water pollution also impacts on human health

Water Pollution and Human Health

As serious as fish kills are in themselves, they are also indicators of other problems, and paramount amongst these is the threat to human health. The high ingress of storm water into the sewers during the heavy rains early in 2006 flushed out the treatment plants and caused serious fish kills in parts of the Vaal. Various reports in the media during subsequent days told of outbreaks of gastro-enteritis in towns downstream of the fish-kill incidents. These two incidents were not linked in the press, but sewage not only has a high oxygen demand but also carries a high pathogen content. It is this pathogen content which is the danger to people.

The cholera and salmonella (typhoid) outbreaks that South Africa has experienced over the last few years show the danger of inadequate treatment of effluent discharged into the environment. *Escherichia coli* are bacteria that commonly cause gastro-enteritis when they are present in high numbers. They are ubiquitous in sewage, and provide us with a widely used indicator of contamination. *E. coli* occur in raw sewage at concentrations of roughly 10^6 to 10^7/100 ml. Treated water is discharged with an average *E. coli* count of approximately 10^3/100 ml and it is then diluted further in the receiving water. In the current guidelines of the Department of Water Affairs and Forestry (DWAF), the quality of water used for recreation should ideally contain 0 to 30 *E. coli*/100 ml, with concentrations of over 2 000 *E. coli* /100 ml being considered high risk for recreation use. Drinking water should not contain more than 5 *E. coli*/100 ml.

The two factors or components most important in safeguarding the environment from the dangers of contamination by untreated effluents are the condition of municipal infrastructure and the competence of the people operating and maintaining this infrastructure. If infrastructure is not well maintained then it costs more to get it back up to standard. This is recognised by DWAF together with the Department of Provincial and Local Government, and these two departments are working to ensure that local authorities are both properly trained to operate their infrastructure as well as being able to maintain it in a functional state. The importance of good operation and maintenance of infrastructure is all the more important when the number of people relying on the resource is taken into consideration.


Efficient water treatment should be a national priority

Acknowledgements

I wish to thank Dr Sebastian Jooste and Dr Gerhard Offringa for assistance given in the preparation of this document.

Steve Mitchell is an ecologist with the Water Research Commission. He is a keen angler, fly fishing being the preferred way to fish.

LEGISLATION PERTAINING TO THE MANAGEMENT OF YELLOWFISHES AND THE PROTECTION OF THEIR HABITAT

Morné Viljoen

Introduction

The Constitution guarantees us the right to an environment that is not harmful to our health or well-being and to have the environment protected for the benefit of present and future generations. This is to be accomplished through reasonable legislative and other measures that prevent pollution and ecological degradation and promote conservation. There are a variety of laws that govern the use of our yellowfishes and the conservation and management of their habitat. The key laws are the National Water Act of 1998, The National Environmental Management: Biodiversity Act of 2004, and the various provincial Nature Conservation Ordinances. This chapter highlights the key provisions of these acts that are of relevance to the sustainable use of yellowfishes and their habitat.

National Water Act

The key issues focussed on in this act are the amount of water taken from rivers for human use and pollution of inland waters.

Water Pollution

Water pollution is an enormous threat to aquatic life and particularly so to the yellowfish species as it poisons and depletes water of oxygen. It is defined in the National Water Act as:

Polluting water resources is a criminal offence

"the direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it -

(a) less fit for any beneficial purpose for which it may reasonably be expected to be used;

(b) harmful or potentially harmful -

Illegal gill nets recovered and being incinerated, Kosi Bay

(aa) to the welfare, health or safety of human beings;
(bb) to any aquatic or non-aquatic organisms;
(cc) to the resource quality; or
(dd) to property."

Resource quality is defined as -
"the quality of all the aspects of a water resource including -
(a) the quantity, pattern, timing, water level and assurance of in-stream flow;
(b) the water quality, including the physical, chemical and biological characteristics of the water;
(c) the character and condition of the in-stream and riparian habitat; and
(d) the characteristics, condition and distribution of the aquatic biota."


Sewage spills are a huge human health risk

This definition of water pollution extends beyond the normal interpretation as it also includes the introduction of invasive alien fish.

In terms of the National Water Act, the owner or occupier of land on which a situation exists which may cause water pollution must take all reasonable measures to prevent any pollution from occurring, continuing or recurring. Should any pollution occur, the person who is responsible for the incident, or who owns or was in control of the substance involved, must undertake the following reasonable measures:

- cease or control the process causing the pollution;
- contain or prevent the movement of the pollution and eliminate the source thereof;
- remedy and minimise the effects of the pollution; and
- report the incident to the Department of Water Affairs and Forestry ("DWAF").

Should the responsible person not take reasonable measures, DWAF may order him/her to take steps to remedy the effects of the pollution, failing which the said department may undertake these measures itself and recover the costs from the responsible person.

Polluting water resources is a criminal offence and a contravener will be liable, upon the first conviction, to a fine or imprisonment for up to five years or to both and in the case of a second or subsequent conviction, to a fine or imprisonment for a period not exceeding ten years or both. Should a contravention have resulted in another person suffering harm or loss then the contravener may also be ordered to compensate such person for his/her loss.

Should a company or its employees be guilty of water pollution then, under the National Environmental Management Act 107 of 1998, unless the directors have taken all reasonable steps to prevent the offence, they will be held personally guilty. Former directors of a company can still be held personally liable for offences committed during their tenure.

In addition to the National Water Act and the National Environmental Management Act, each province has provincial legislation prohibiting water pollution.

Over-abstraction

In addition to its many adverse effects, over-abstraction intensifies the effects of pollution. Therefore, a user may only abstract the amount of water authorised by DWAF or the relevant Catchment Management Agency. However, before any water can be allocated for abstraction, the water "Reserve" must be determined. "Reserve" is defined as the quantity and quality of water required to satisfy basic human needs and to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource. *Only if a water resource contains surplus water after the amount of water required by the reserve has been subtracted from the total amount of water available, may water be allocated for abstraction.*

National Environmental Management: Biodiversity Act

Invasive alien fishes adapt quickly to a new environment and compete with indigenous species for the same food sources and habitat. The stocking of waters with alien fishes or with indigenous fishes (even yellowfish) in waters where they *do not occur naturally* can cause irreparable harm to the native species and is illegal.

The objectives of the National Environmental Management: Biodiversity Act include the management and conservation of biological diversity and the components of such biodiversity within the Republic. This act applies to all alien fish species and prohibits the breeding, propagating, having in possession, conveying, translocating, trading in, receiving, giving, acquiring, disposing or practising catch and release with these species, unless a permit is obtained to do so. As an example: you may not catch and release any alien fish such as carp or the basses without a valid permit issued by the appropriate conservation authority. To do so is a criminal offence and punishable with a fine of up to R 200 000 or with imprisonment for up to five years, or both. Government is in the process of drafting regulations in terms of this act for the control of invasive species as well as regulations to protect endangered indigenous fish species.

Water pollution is a criminal offence. Offenders should be prosecuted

Provincial Legislation

Provincial environmental legislation states that one may not release a fish into a water resource except when practising "catch and release" or unless one has been authorised by the provincial government to do so. Contravention of this legislation is a criminal offence which is punishable, depending on which province the crime was committed in, with a fine of up to R250 000 or to imprisonment of up to 15 years or to both. Remember that the introduction of invasive fishes also falls within the definition of water pollution and one may be fined or imprisoned for up to five years!

Some of the provincial legislation dates back to the 1970s and its bag limits are totally inappropriate today. Clanwilliam yellowfish, Clanwilliam sawfin, Berg-Breede whitefish and large-mouth yellowfish are all listed as endangered by IUCN and you should not fail to release any of these species if you catch them, even though provincial regulations may allow you to keep some. In fact, it would not be amiss to release all yellowfishes that you catch. The following bag limits are applied in the respective provinces.

Illegal stocking of sharptooth catfish (barbel) is causing severe ecological problems in the Eastern and Western Cape

Province	Species affected	Catch restrictions	Angling licence required and cost
Western Cape	Clanwilliam yellowfish, Clanwilliam sawfin, Berg-Breede whitefish, smallmouth yellowfish	The first three species in the previous column are all endangered and must be returned unharmed when caught. Smallmouth yellowfish are aliens in this province with no official catch restrictions	S A freshwater angling licence costs R45 per year or R20 for two weeks
Eastern Cape	Largemouth yellowfish, smallmouth yellowfish	No restriction on the number of fish that may be kept, provided that smallmouth yellowfish have a minimum length of 400 mm and largemouth yellowfish a minimum length of 300 mm	No angling licence is required
Northern Cape	Largemouth yellowfish, smallmouth yellowfish	No restriction on the number of fish that may be kept, provided that smallmouth yellowfish have a minimum length of 400 mm and largemouth yellowfish a minimum length of 300 mm	Freshwater angling licence costs R50 per year
North West	Largemouth yellowfish, smallmouth yellowfish, smallscale yellowfish, largescale yellowfish	Old Transvaal Area: 10 fish may be kept, provided they have a minimum length of 300 mm Old Cape Province Area: No restriction on the number of fish that may be kept, provided that smallmouth yellowfish have a minimum length of 400 mm and largemouth yellowfish a minimum length of 300 mm	Freshwater angling licence costs R20 per year
Gauteng	Largemouth yellowfish, smallmouth yellowfish	10 fish may be kept, provided that they have a minimum length of 300 mm	Freshwater angling licence costs R25 per year
Mpumalanga	Largemouth yellowfish, smallmouth yellowfish, papermouth, largescale yellowfish, smallscale yellowfish	6 fish may be kept, provided that they have a minimum length of 300 mm	Freshwater angling licence costs R20 per year
Limpopo	Papermouth, largescale yellowfish, smallscale yellowfish	No bag limits in this province	No angling licence is required
Free State	Largemouth yellowfish, smallmouth yellowfish	10 fish may be kept, provided that they have a minimum length of 450 mm	Freshwater angling licence costs R20 per year
KwaZulu-Natal	KZN scaly, smallscale yellowfish, largescale yellowfish	Daily limit of 10 scalies with a mini-mum length of 200 mm per person. There are no restrictions on other yellowfish species	No angling licence is required

Enforcement

The Department of Environmental Affairs and Tourism, DWAF and the provincial nature conservation departments are all responsible for enforcing the legislation outlined above. However, the National Environmental Management Act provides for private law enforcement and any person may prosecute any breach of any duty pertaining to the protection of the environment in cases where the breach of that duty is an offence.

Please note that in addition to imposing one or more of the penalties mentioned above, the state may now also attach any personal property used in committing an offence.

Morné Viljoen is an attorney who specialises in Environmental and Water Law. He is passionate about protecting our country's aquatic resources and is an avid angler and enjoys all forms of fishing.

WHY IS THE CONSERVATION OF YELLOWFISH GENETIC DIVERSITY IMPORTANT?

Paulette Bloomer

Introduction

Biodiversity encompasses ecosystem, species and genetic diversity. Although genetic diversity is typically placed at the lowest level of this hierarchy, it is not the least important. In fact, all processes taking place at the genetic level will affect the higher levels. Genetic variation within a species naturally varies over time due to a balance between the major processes of mutation, genetic drift and selection. Whereas mutation slowly generates new variation, genetic drift removes variation whereas selection can either remove or maintain mutations. These processes are intricately linked to the biological characteristics of the species such as dispersal ability and reproductive system. Levels of genetic variation will thus differ between species but genetic variation as such is important for the future survival of most species.

The conservation of genetic diversity is analogous to an insurance policy for the species

Loss of species is relatively easy to quantify but loss of genetic variation and the impacts thereof may go unnoticed for many generations. In a sense the conservation of genetic diversity is analogous to an insurance policy for the species. One cannot predict when the policy will become crucial, but theoretical and practical scientific evidence show that genetic diversity allows a species to adapt to changes in its environment. The latter may include physical changes due to climatic fluctuations, or changes in biological attributes such as responses to parasites and pathogens. Genetic variation is also necessary for speciation to take place. We only get a snapshot of a species' status within our lifetimes, but speciation is a continuum and genetic variation records the history of the species and its constituent populations over both ecological (tens to hundreds of years) and evolutionary (thousands of

The collection of biological samples by anglers and officials is appreciated by researchers

years) time scales. The challenge for geneticists is to retrieve this information from the vast pool of genetic material, as not all genes reflect different historical time periods with equal clarity and accuracy. With respect to species history it is of fundamental importance for yellowfish conservation that the patterns of genetic variation and the underlying processes that generated these patterns are understood.

What Do We Know About Yellowfish Genetics?

Despite several genetic investigations over the past two decades, understanding of relationships between and within yellowfishes is still severely lacking. The position of these species within the larger context of the related Barbus species is known. Based on the number of chromosome sets in the cell nucleus (called ploidy level) and specific gene sequences, the large African hexaploid (150 chromosomes) species share a common origin and have been reclassified within the genus *Labeobarbus*. The ages of the species within the genus are contentious, with genetic data suggesting much younger ages than predicted by current understanding of their biogeography. The smallscale and largescale species appear to be distinct but it is uncertain from where their predicted tetraploid (100 chromosomes) ancestor originated. *Barbus andrewi* and *B. serra* are sister species within a group of South-African tetraploids that includes the endemic *Pseudobarbus*. *Barbus rapax* is predicted to have a diploid chromosome number (50 chromosomes) and is related to the South-African tetraploids and African small diploids. Studies of different variants of particular proteins (called allozyme analysis) support a very close relationship between most *Labeobarbus* species, as only a few of the proteins tested are able to detect differences between them. Some populations show consistent differences whereas others suggest the presence of hybrids. This may not be surprising, as hybridization appears to be common among related cyprinids and is one of the suggested natural mechanisms involved in speciation in the family.

Extracting DNA from fish samples which are to be used for genetic analysis

Although more in-depth studies are needed, preliminary allozyme and DNA analyses of the narrowly distributed species have been done and can guide conservation actions. *Barbus andrewi* has low levels of genetic variation and based on a small sample size no significant difference between the Berg and Breede rivers was evident. The best strategies to protect and enhance the variation among the remaining populations should be evaluated. Preliminary allozyme analysis of *B. serra* found differences between the Olifants and Doring catchments and these should be managed as separate conservation units until the underlying historical connection between them is better understood.

Several *Labeobarbus* studies are underway and unravelling the variation between and within the smallscale group will be particularly important. The Clanwilliam yellowfish has been isolated from the other species for some time but variation within this species must be addressed. Preliminary data for the KwaZulu-Natal scaly show differences between two river systems; the study has to be broadened to include the northern parts of the species' range where there is potential geographic overlap with *L. polylepis*. Due to its presence in several river systems, the Bushveld smallscale should be looked at thoroughly and the impact of potential *L. aeneus* transfers within this species' distribution needs urgent attention. The Orange-Vaal yellowfishes is the focus of an ongoing study that includes morphological, allozyme and DNA analyses. Due to the geographic extent of the Orange-Vaal system and the almost complete overlap of the species' ranges, teasing apart their variation is daunting. Preliminary morphological analyses show clear distinction between specimens identified in the field as representing the two species and also found

considerable variation between *L. aeneus* from the upper and lower Orange. Mitochondrial DNA data revealed shared genetic lineages between the two species. This could indicate a very close relationship between the two species, extensive hybridization or two morphs within one species. The latter suggestion was raised by earlier allozyme analysis of two Vaal populations. As mitochondrial DNA is strictly maternally inherited it reflects one part of the species' history and should be evaluated together with nuclear DNA and allozyme results. Nuclear DNA genes will be investigated in the near future. Allozymes show that only individuals from the lower Orange can be clearly distinguished whereas the results from the upper Orange are indicative of a single intermixing population. In agreement with the morphological variation, mitochondrial DNA revealed several very distinct *L. aeneus* lineages from the lower Orange.

A PhD student working on yellowfish samples

Threats to Yellowfish Genetic Diversity

Lack of understanding of relationships between and within species as well as the natural evolutionary and ecological processes underlying this variation is hampering our ability to make sound conservation recommendations for these valuable freshwater fishes. Sound knowledge of natural processes will enable an evaluation of the impacts of human induced habitat changes. Mainstream degradation and instream barriers affecting gene flow can fragment previously connected populations and diminish overall levels of genetic variation. Conversely, inter-basin water transfers and inappropriate stockings can lead to the inadvertent mixing of naturally isolated and adapted units, potentially resulting in hybridization, genetic homogenisation and limiting of adaptive ability.

It is therefore critical to move away from a typological view to a process-orientated approach that aims to understand and conserve the ecological and evolutionary processes that generate diversity. The latter will require comprehensive multi-disciplinary investigations of the ecological genetics and phylogenetics of yellowfishes.

Paulette Bloomer is a lecturer in the Genetics Department at the University of Pretoria.

Using a seine net to collect fish for research

STOCKING YELLOWFISHES FOR CONSERVATION AND RECREATION

Dean Impson

Introduction

The yellowfishes are becoming increasingly popular gamefish with anglers and there is a growing awareness of the existence and angling potential of the nine species across South Africa. Many anglers now prefer to catch them instead of alien trout, bass and carp, and consequently seek out rivers and dams that have good populations of yellowfishes. To satisfy growing demand, more landowners and managers of syndicated waters are choosing to stock dams with these fishes. Whereas this may appear to be a welcome and progressive step by the private sector, it presents substantial challenges to the future conservation of our yellowfishes and rivers.

The YWG does not support the haphazard stocking of yellowfish in farm dams

Why Stock Yellowfishes?

Yellowfishes are stocked for three main reasons:

- Legally for conservation purposes – here the provincial conservation agency stocks rivers and dams with a specific goal in mind. Rivers can be re-stocked if natural stocks suffer major mortalities as a result of disasters such as drought or pollution and the possibility of natural recovery is low. For angling purposes dams on nature reserves may be stocked with local yellowfish species instead of alien fishes as has been done at Royal Natal National Park by Ezemvelo KZN Wildlife. Where wild stocks are highly threatened, sanctuaries may be established such as the one for the Berg-Breede whitefish in the Vrolikheid Nature Reserve. Additionally, private landowners that manage property for conservation purposes usually choose indigenous fishes for stocking dams, and yellowfishes are a popular selection for this purpose.
- Legally for recreational purposes – here, private landowners stock their dams with yellowfishes for angling and consumption under permit from their provincial conservation agency.
- Illegal stockings – this is commonly carried out by members of the public who introduce yellowfish into rivers and dams without a permit.

The Yellowfish Working Group (YWG) recommends that only conservation agencies should be permitted to stock yellowfish into rivers. In addition, it strongly opposes the stocking of yellowfish species outside their natural distribution range. Rivers with yellowfish are regarded as having self-sustaining populations, unless, as in the Breede River, these have been severely impacted by invasive alien fishes. The focus on rivers should be on ensuring excellent habitat and water quality which, in turn, will produce thriving populations of yellowfish.

Smallmouth yellowfish spawning in Sterkfontein Dam over suitable structure

The Correct Way to Stock Yellowfishes

The YWG does not support the haphazard stocking of yellowfish in farm dams. Such stockings should be carefully managed through a permit system regulated by the relevant nature conservation agency. Uncontrolled stocking has the potential to cause major ecological damage across South Africa.

General requirements for stockings for recreational fishing

1. The land-owner must apply to the relevant provincial conservation agency for a permit to stock yellowfish species into a farm dam.
2. The dam or dams must be free of bass, and preferably all other alien fishes.
3. The conservation agency will determine which species of yellowfish are native to the catchment area in which the dam is situated. A permit will then be issued listing the species that may be stocked and where they may be obtained.
4. For genetic purposes, stocked fish (preferably juveniles ranging from 4 to 10 cm) should be caught by conservation agency staff from the nearest stream or river in the same catchment as the farm dam. If possible 50 to 100 fish should be stocked for genetic purposes. It is imperative that fish are not moved from one river system to another for stocking purposes such as from the Thukela to the Mkomazi. The landowner should not catch fish for stocking unless authorized to do so by the conservation agency.

Smallmouth yellowfish have adapted well to stillwaters such as Sterkfontein Dam

5. landowners should pay to have dams stocked. This will include travel costs, labour costs and the cost of individual fish.
6. Where feasible, spawning areas should be created in dams to allow stocks to expand.
7. A record of each stocking must be kept by the provincial conservation agency and it is essential that the co-ordinates of the dam being stocked are taken and retained for future reference purposes.

General requirements for stockings for conservation purposes

1. Dams that are free of alien fish and that have gravel and rock beds in shallow water for spawning purposes are the most suitable to stock.
2. Dams must obviously be within the natural distribution range of the yellowfish being stocked.
3. If dams are on private land, the landowners must be fully informed of the conservation value of their yellowfish stock.
4. Dams should be stocked using genetic conservation principles which requires, among others, a minimum of 50 unrelated fish per species. To achieve this, fish should be caught in several pools of a river, preferably at least 100 m apart.
5. A detailed record of the stocking must be kept (species, size and number of fish stocked, where and how captured, date stocked, landowner details, locality details).

Threats of Illegal or Poorly Managed Stockings

The chapter on alien yellowfishes highlights the dangers of these fishes being stocked outside their natural distribution ranges or of different sub-populations of a yellowfish species being mixed. Yellowfish are omnivores, eating a range of plant and animal materials that extend from the base of the food web (algae, aquatic inverte-brates) to near its apex (other fish). They are generally large, adaptable and prolific and migrate freely within rivers. There is strong evidence that the true yellowfish species will interbreed freely. Consequently, they have the potential to cause major ecological and genetic damage when introduced into new waters. Future stockings of yellowfish, therefore, need to be undertaken with care and should be supervised by knowledgeable staff from provincial conservation agencies. We don't need to establish any new alien yellowfish populations or create any more hybrids. Moreover, no authority issues a record certificate for catching a hybrid fish.

Dean Impson is a freshwater fish scientist at CapeNature and is passionate about conserving Western Cape's threatened indigenous fishes. Dean enjoys fly fishing, especially for yellowfish.

YELLOWFISH ARE AN EXCITING CHALLENGE ON ARTIFICIAL LURES!

Bernard Venter

Introduction

Artificial lure (artlure) angling means catching any fish only on artificial lures. It is often referred to as *extreme* angling because it tests your skills to the limits. But the reward of catching a fish on an artificial lure, an imitation of a natural food on which it would normally prey, is a much greater challenge than catching it on bait. In its widest sense artlure angling could also include fly fishing, as flies too are artificial. However, for purposes of this article, I am focusing on catching yellowfish on artificial lures only, not on flies.

The scaly is one of the most rewarding fish to catch on artlure

Fishing Tackle, Angling Techniques and Habitat

Orange-Vaal largemouth yellowfish

The largemouth yellowfish is undoubtedly the king of the genus. These yellow submarines are the largest of the yellowfishes in Southern Africa and attain a weight of 23 kg. Unfortunately, circumstances, such as water pollution, habitat destruction and the indiscriminate killing of this magnificent fish by certain anglers have caused its numbers to decline markedly in many areas. The largemouth yellowfish inhabits rivers and dams in the Orange-Vaal River System. It is a predator *par excellence* which makes it a sought-after artlure fish species. Larger crankbaits and medium-heavy fishing tackle are usually required to capture these fighters. A medium-weight rod with a matching baitcaster or spinning reel loaded with 6-kg breaking strain (BS) monofilament line is a good bet. Largemouth yellowfish prefer to hunt their prey in deeper pools and weedy bays, but they often enter fast water, particularly in early morning and late afternoon, to hunt smaller fish and crabs. A 7-cm sinking Countdown Rapala is one of my favourite lures in broken

Artlure angling is effective for catching yellowfish

water. The largemouth normally hits a lure at high speed and its first run is very powerful, so avoid light lines. Fishing from a boat in dams and the large, deep pools of rivers is one of the best ways to catch them. Cast or troll crankbaits, such as a deep-diving Shadrap, near rocky reefs, sunken logs, weeded bays and overhanging trees. One of the most beautiful and productive places to catch largemouth is the lower Orange River in the Richtersveld National Park. The South African artlure record for this species is 13.8 kg.

Orange-Vaal smallmouth yellowfish

The smallmouth yellowfish has the same natural range as the largemouth yellowfish, but it has also been translocated to rivers in the Indian Ocean catchment such as the Kei, Great Fish and Gourits. The adaptable and prolific smallmouth is common in many dams in these catchments, where it may attain a weight in excess of 7 kg. Among anglers it is our most popular and frequently caught yellowfish species. The continued abundance of this hardy fish indicates that it can tolerate high angling pressure. The smallmouth yellowfish is undoubtedly one of the toughest fighters in our waters. It feeds freely in riffles and runs but look for the bigger fish in the deeper parts of the river. Smallmouth respond well to smaller crankbaits, spoons or even spinners such as Big O, Fat Raps and in slower waters the Dam Effzett spinners. A medium- to light-action rod with a spinning reel and 4-kg BS monofilament is ideal for smallmouth. The South African artlure record for the species is 4.9 kg.

A good Clanwilliam yellowfish caught on a Rapala

Lowveld largescale yellowfish

The largescale yellowfish is confined to the lower reaches of east-flowing rivers such as the Limpopo, Olifants, Crocodile, Inkomati and Blyde as well as the dams in these rivers. Loskop is my favourite dam for this species. The largescale is one of the more difficult fish species to catch on artlure as it feeds primarily on algae and tiny aquatic invertebrates. Small crankbaits, especially the suspended-type minnows in natural colors, are usually a good choice to tempt a largescale yellow. Use the same tackle as for smallmouth, but go for a 2-kg line. The South African artlure record is 3.8 kg.

Bushveld smallscale yellowfish

The smallscale yellowfish is another native of east-flowing river systems, but it prefers the higher, cooler reaches above 600 m altitude. Some of the best spots for them are the upper parts of the Crocodile, Blyde and Nkomati Rivers in Mpumalanga. In earlier years, good catches were made in Rietvlei Dam near Pretoria but water pollution and alien predators such as smallmouth bass and largemouth bass inevitably led to their demise. Eco-Care Trust restocked Rietvlei with smallscale yellowfish in 1996 and since then there have been sporadic reports of catches. The smallscale yellow is a prime artlure target. It is a predator and readily takes small crankbaits such as Bagleys Big O and Fat Raps or Dam Effzett spinners in slower streams. A small Rapala countdown is a top choice for fast water. Surface lures, such as the Heddon Crazy Crawler and Tiny Zara Spook can be surprisingly effective in early morning or late afternoon. Use the same tackle as for smallmouth yellowfish. The South African artlure record for this species stands at 4.1 kg.

Bushveld papermouth

The papermouth is endemic to the Limpopo River system.

Formerly, many were caught in Roodeplaat, Hartbeespoort, Vaalkop, and Rust de Winter Dams but in recent years their numbers have declined drastically. Reasonable stocks can still be found at Mokolo, Loskop Dam and Molatedi Dams. Despite its small size, the papermouth, is a favourite with artlure anglers because it is an active predator of small fish, generally takes a spinner or small spoon avidly and puts up a spirited fight. Occasionally they lose their aggressiveness and then need to be tempted with a small grub or Curlytail weighted with a splitshot. Light tackle is the obvious choice. The South African record on artlure is 0.96 kg.

KwaZulu-Natal yellowfish

The KZN yellowfish or scaly is one of the most rewarding fish to catch on artlure. It is a clean and hard fighter and takes a well-presented lure eagerly. A No. 1 Dam Effzett spinner (silver, yellow or a touch of orange, depending on the water clarity and brightness of the sunlight) is hard to beat. On the surface try a small 3-cm floating Rapala in natural green colours and a Rapala Shadrap for deeper water. Scalies love lying in eddies on the edge of the main current and behind large rocks. They are loath to take a lure retrieved against the current so your spinner or crankbait must be cast upstream of the fish and brought back slowly past it. Once hooked hold on for the ride of your life because on a weight for weight basis few fish can match a scaly! A light spinning rod and reel filled with 2- to 3-kg BS mono is an excellent choice. The South African artlure record of 2.3 kg was caught in Craigieburn Dam.

Hooked on smallscale yellowfish in the Elands River

Clanwilliam yellowfish

This threatened species is endemic to the Olifants and Doring rivers in Western Cape. The Clanwilliam yellowfish has long been recognised as one of our finest gamefishes but the alien smallmouth bass that were introduced into the Olifants River in the 1930s have decimated the population. Today they are very scarce and it is difficult to find any to catch. Catch and release is mandatory. The Clanwilliam yellow feeds extensively on small fish, crabs, frogs and dragonfly nymphs and is much admired by artlure anglers as it smacks a lure with gusto. Fish over 2 kg readily take crankbaits such as small Broken-back and Fat Rap Rapalas, especially in faster water. Spring and early autumn are very good times as fish are feeding actively and are holding in the riffles. The tackle used for smallmouth yellowfish is perfect for the Clanwilliam yellow. The South African artlure record is 5.9 kg, although much bigger fish have been taken on lure including a recent catch of more than 10 kg.

Berg-Breede whitefish and Clanwilliam sawfin

Both of these smaller yellowfish species are endemic to a few Western Cape Rivers. They are endangered and have to be released when caught. They are difficult to catch on artificial lures because they feed primarily on small aquatic invertebrates. Although they will take small crankbaits and spinners, the best lure is probably a Curlytail. Brandvlei Dam near Worcester is a good choice for whitefish and the Doring River for sawfin. The South African artlure records are 0.850 kg for sawfin and 1.5 kg for whitefish.

Bernard Venter is a State Law Adviser with a passion for conservation of our aquatic ecosystems. He is the founder of the Eko-Care Trust and is a Protea artificial lure angler. He is a regular contributor to Tight Lines *magazine.*

FLY FISHING FOR YELLOWFISHES

Turner Wilkinson

Introduction

Although yellowfish have been caught on fly for more than a hundred years it is only during the last 25 years or so that the sport has become widespread. During the past decade, in particular, fly fishing for yellowfish has mushroomed as a result of many articles in local fly-fishing magazines, clinics and presentations by enthusiastic yellowfish anglers, and a good deal of publicity emanating from the Yellowfish Working Group (YWG).

During the past decade fly fishing for yellowfish has mushroomed

Anyone in doubt about the popularity of yellowfish as a fly-fishing quarry needs only to visit one of the many fly-fishing venues along the Vaal River on a weekend to be convinced of which group of fishes holds top spot in South Africa today.

In the process, fly fishing for the yellowfishes has developed into an extensive business without which many fly shops in various parts of South Africa could not exist.

Locating Yellowfish in Rivers

Where you find yellowfishes in a river is determined by two of their primary needs – food and protection. At times, a third requirement, the need to breed will also concentrate them in specific areas but it is unethical and indeed illegal to disturb spawning fish.

When I hunt yellows, I start by looking for areas that I believe will offer them the necessary protection: this will include stretches that are at least knee-deep so that they can avoid detection, and also riffles and runs where the broken water makes it difficult for predators to see the fish. Any undercut banks and overhanging vegetation close by are further inducements to provide yellowfish with a sense of security. Areas such as these that offer protection primarily, but little or no food, are known as sheltering zones[1]. It is important to know where the sheltering zones are because they give you a good idea where a fish will be heading once hooked.

There is a saying; "find the food and you will find the fish", so my next step is to look for places where food items are being concentrated. The most important clue is provided by so-called scum or bubble lines – current seams tend to concentrate drifting matter in these lines so, in effect, they become feeding lanes. Fortunately, these scum lines are normally easy to see and follow. Food items are normally concentrated at the heads of pools immediately below shallow runs and riffles, and also at the tail-ends of pools. These spots in a river that offer abundant food but not much protection

1 The author uses the term "zone" rather than the conventional "lie" to emphasise a major difference in the feeding habits of yellowfish and trout. In general terms, trout are very territorial and tend to remain in a particular lie of their choice. When yellowfish feed they are prone to roaming around in an area that may vary considerably in size, hence the "zone" terminology. THE EDITOR

Fly fishing in the Vaal River has become very popular

against predators are called feeding zones. Feeding zones are important because you generally find fish in them in late afternoon and early morning when they can move more freely under cover of low light or darkness. When an insect hatch is on, huge amounts of food become available and you may find that fish throw caution to the wind and venture into the feeding zones in large numbers – they will, however, be very skittish and ultra-difficult to catch.

All rivers have places that offer both protection and food such as a deep hole in a shallow riffle; the current assures a steady supply of food whereas the depth provides enhanced security against predators. Not surprisingly these spots are called prime zones – they are obviously also prime targets for fly fishers. Prime lies are the key to a good day on the water as fish tend to be gathered in them much of the time, thereby increasing your chances of success. If you can read the water and identify these lies, you have it made!

Knowing now where the fish are likely to be, let's have a look at the particular preferences of the various species:

Largemouth Yellowfish, Clanwilliam Yellowfish and Sawfin, Largescale Yellowfish, Papermouth and Whitefish

These six species all have a preference for pools, especially the adults. When hunting them you should focus your efforts in pools with structure. Largemouth and Clanwilliam yellowfish are particularly fond of rocky ledges and points and also the drop-offs at the edges of sandbanks. Look for largescale yellows in those parts of a pool with a sandy to light gravel bottom and a water depth ranging from 0.5 m to 1 m. Papermouth, on the other hand, like patrolling the edges of reed beds in search of prey.

Smallmouth Yellowfish, Smallscale Yellowfish and KZN Yellowfish

These yellowfishes generally frequent the faster water of riffles and runs, especially during the warmer months or as soon as the water temperature has risen above the 15° C mark. Under these conditions, you will have greater success if you dead-drift your fly through the prime zones. It is essential when fishing faster water to get your fly as close as possible to the bottom where the bulk of the fish's food is found. The bottom layer is also where the current is at its slowest and most comfortable for the fish. Do not think for one moment that these yellowfishes vacate the pools entirely in summer. Indeed, there are always some fish, particularly the bigger ones that prefer to hang back in the deeper water.

During the colder months all yellows move into the pools where they enjoy increased protection from predators and the more stable temperatures of deep water.

How to Catch Yellows on Fly

The tackle and techniques required to catch the different species of yellowfish on fly have been covered extensively in local fly-fishing literature. The best sources are the successive issues of *The Nedbank Guide to Flyfishing in Southern Africa*, the recent FOSAF series entitled *Favoured Flies and Select Techniques of the Experts* and the two fly-fishing magazines *The Complete Fly Fisherman* and *Flyfishing*. With this wealth of information available, I'll only discuss the topic in its broadest sense.

In my opinion, fly fishing for yellowfish in rivers boils down to two tactical approaches: fast-water tactics and slow-water tactics.

Francois Roux, Dean Impson and Pierre de Villiers - 9 yellowfish species on fly in 9 days

The dead-drift method is at the heart of fast water tactics. Here the intent is to drift your fly as naturally as possible in the current so that the fish mistakes it for some hapless small aquatic bug being tumbled along by the current. It is probably the most successful way to target yellows. Cast your fly to a likely spot and watch the strike indicator on your leader to detect any takes. Alternatively, you may choose to use one of the short-line nymphing methods such as the Czech nymphing technique. Here the emphasis is on a thin leader to which you attach one or more heavily weighted flies. Both techniques are successful as long as you address the critical issue of getting your fly right down to the bottom of the river.

Slow-water tactics require that you actively impart movement to the fly. Of course, you first have to cast your fly to where you believe fish will be and then, by varying the retrieve, you can move the fly in such a way as to imitate the movement of a free-swimming creature. Obviously, the technique is meant to imitate naturals who can swim well and who frequent pools and stretches of river with a slow current. It is important, therefore, that that you should get to know the natural organisms you are trying to imitate and how they behave so that you can impart the correct movement to your imitation. For example, damselfly nymphs swim slowly by sculling their tails from side to side. A slow, steady hand-twist retrieve is therefore indicated, as any fast or erratic movement will alert the fish to the fact that it is dealing with a fake.

A Highlands Flyfishing Academy guide giving advice

In dams your primary objective is to locate cruising and/or feeding fish. This is relatively easy in clear-water impoundments such as Sterkfontein Dam near Harrismith. Floating lines with 4- to 5-m leaders tapering to 4X points are key factors for success. Once you have located a fish, cast 30 to 60 cm ahead of it and watch the fly or strike indicator very carefully for the take. Sight-fishing is perhaps the most rewarding form of fly fishing as you can see your quarry which may be a very big fish. It is up to you to use your skills to catch that fish.

Fly-fishing Tackle for Yellows:

When selecting a fly-rod for a specific venue you should consider the following:

- What size fish you may encounter
- What size fly you will cast
- What strength of wind you have to cope with

If you intend catching all nine species and you are restricted to three rods, I would recommend a 2.6-m 4-weight, a 2.7-m 5-weight, and a 2.7-m 8-weight. However, use the following criteria as a guide to select an appropriate rod for your particular needs: for rivers wider than 10 m and for yellows averaging 1 kg or more, I would recommend a 5-to 7- or even 8-weight rod. This will allow you to cast more easily on windy days and subdue bigger fish more readily. If you are consistently targeting fish over 3 kg (usually largemouth yellowfish) go for a 7- or 8-weight. On smaller streams which generally also have smaller fish, a 3- to 4-weight outfit will enable you to cast small flies accurately and gently: prerequisites for having great sport with these gamesters.

In our generally shallow rivers you need look no further than a floating line – I prefer double-taper lines, as long casts are rarely necessary and you can reverse the line when the starting tip wears out. If you favour a weight-forward line, as many anglers do, it will serve you as well. Reels are an essential component of your equipment and they vary enormously in price. Personally I prefer a quality product as opposed to some of the cheaper models on the market. If in doubt, choose one of the middle-of-the-range reels which should serve you well for all freshwater applications. Load it with at least 70 m of Dacron backing. The end of my fly line is attached to a standard 2.7-m store-bought leader tapered to 2X or 3X.

See you on the water soon!

Turner Wilkinson is yellowfish editor for The Complete Fly Fisherman *and a well-known yellowfish guide.*

BAIT FISHING FOR LARGEMOUTH YELLOWFISH

John Southey

In order to be successful at hunting and catching largemouth yellowfish there are three things you must understand. First, you should know how the fish behaves, second, what tools you need to capture it and third, how to use these tools most effectively.

Largemouth Yellowfish Behaviour

Understanding the behaviour of largemouth yellowfish hinges on a knowledge of their habitat and biology.

Let's start by looking at the shape of the fish – it is streamlined and clearly built for acceleration and speed. The mouth is terminal and can extend which tells us largemouth will take mobile prey such as small fish and frogs as well as insects and crustaceans such as dragon fly nymphs, shrimps and crabs – it is decidedly not designed to grub for clinging or crawling aquatic insects among rocks. The eyes are positioned on top of its head which gives binocular vision both forward and above and monocular vision sideways – perfectly adapted to the unique feeding needs of this predator. As in all fishes, the lateral line contains sensory organs that can detect faint sounds and vibrations.

Choose your own style and set out to do battle with this magnificent gamester

If you ever watch a largemouth yellowfish in clear water you may see it reacting to unusual movement much like a cat pouncing on a string being drawn past it.

Habitat

Where do you find largemouth yellowfish? Look for them where you find the prey species described in the preceding section. Based on autopsies I performed back in the distant past I would guess that in summer, when largemouth yellowfish share the top predator spot with sharptooth catfish (barbel), their diet consists of about 10 percent fish and 90 percent other food. In winter the pattern may be reversed and the bulk of their food seems to be fish with a smattering of insects and so on.

So now that you have an idea as to what largemouth eat at different times of the year, where are the places where their favoured foods tend to gather? A deep pool below a riffle or rapid is always a good spot. If there are some big rocks protruding above the surface, so much the better – largemouth yellowfish often swim past such a structure repeatedly and seemingly use it as a reference point. Your choice of baitfish should focus on local species such as mudfish and minnows. (As they are opportunistic predators, largemouth will actually feed on any weak and suffering fish)

The preferred varieties of shrimps and insects favour water grass which typically occurs on sand banks, in eddies and along river banks. There are two types of water grass: one with a long slender leaf that looks like a normal veld grass and the second type that has a fernlike leaf. Where these two grasses occur together is, in my experience, a prime spot for largemouth yellowfish. When you find such a place it is advisable to wait and watch for fish that might be patrolling the edges of the weeds before making your first cast.

Bait fishing is the most popular form of recreational angling

Angling Techniques

Let's now get down to the business of catching largemouth yellowfish on bait.

The head of a pool below a riffle is a good starting point for setting up your rods. Attach a 2/0 silver-coloured hook on a metre-long leader and a sinker on a shorter, weaker line to a three-way swivel at the end of your line in the customary way: About 15 cm above the swivel attach the butt end of a black feather with cotton so that it lies along the main line. The feather acts as a teaser because it has a slight sheen underwater and the curved shape causes it to undulate in the water. Find yourself a crab, the carapace of which is about the size of a 20-cent coin. (If you cannot find a crab, try a cricket.) Place the point of the hook on the belly of the crab, press it through the back and move the crab up the shank of the hook to the eye. Next, impale a soft mealie pip on the hook so that the point barely protrudes. Finally, cover the hook with dough and mould it into a spoon shape.

Position the two rod stands on the bank so that the rear one holds the butt of the rod and the front one supports the middle of the rod. The rod must be held securely so that it cannot be pulled off the stands when a fish grabs the bait. I position the two stands in such a way so that when the rod rests on them it points 45 degrees upstream. Break off a few of the crab's legs and toss them into the stream as chum. Cast your bait into the stream at right angles to the bank and place your rod on the stands, making sure the line is straight and that there is no slack. The current will now swing the bait downstream of the sinker which is anchored to the bottom. The smell of the crab will also be carried downstream along with pieces of the dough which form a chum line. Small fish will find the chum first and follow it upstream to the bait. Their activity in turn should catch the attention of a largemouth yellowfish who will follow them. When the largemouth sees the movement of the black feather it probably thinks that a competitor is trying to steal the bait. This fires up the fish and causes it to charge in and grab the bait at speed. You now have a fight on your hands!

Largemouth yellowfish are beautiful and precious creatures

If you choose to use live bait one of the best is a small mudfish. Fish it on a 50-cm leader below a sliding sinker. I prefer a sharp silver 2/0 hook which I insert through the skin between the tail and the dorsal fin. Other anglers insert the hook under the skin behind the head claiming that this ensures a more natural swim. A fresh-water shrimp is also a potent bait; impale one or more on a small hook below a float and drift them through largemouth territory.

With this information as background you can now choose your own style and set out to do battle with this magnificent gamester.

Angling Ethics

Always use tackle that is appropriate for the size of the fish you are pursuing. Bring a hooked fish to net as quickly as possible as a prolonged fight causes an excess of lactic acid to build up in its muscles which may prove to be fatal even if the fish is released. If you intend releasing the fish always handle it with wet hands to minimise damage to the slimy film on the skin which protects it against fungal and other infections. If you have to photograph your catch, do so very quickly and gently return the fish to the water. It makes good sense to release the larger fish as these are invariably females comprising the prime broodstock of the species. Proposed legislation will make it illegal to keep any largemouth yellowfish in future.

John Southey hails from Douglas in Northern Cape where the Vaal and the Orange Rivers meet and where the biggest largemouth yellowfish are found.

SUBSISTENCE FISHING AND ITS IMPLICATIONS FOR YELLOWFISH MANAGEMENT

Horst Filter

The Oxford Dictionary refers to subsistence as, "Denoting or relating to production at a level sufficient only for one's own use or consumption, without any surplus for trade." Perhaps the only group in South Africa who truly lived according to this definition has been the San who were hunter-gatherers that never over-exploited their natural resources. South Africa's growth over the last 50 years has reached a point where natural resources such as water cannot sustain economic development without becoming severely depleted and degraded. Water resources are being re-directed from areas of abundance, such as Lesotho, to areas of shortage (notably Gauteng) via dams and inter-basin water-transfer schemes in order to sustain economic growth and quality of life. This network of dams, weirs and tunnels has led to fish stocks being cut off in certain areas and no longer able to migrate freely to their traditional spawning sites. As a consequence, large concentrations of fish gather on the remaining breeding and feeding sites, and are usually viewed by the poor and hungry as an easy meal and an inexhaustible resource. Unfortunately, the "subsistence" fisher often becomes "hungry" in more ways than one and unlike the San never thinks of tomorrow and the future.

An aerial view of Lake One, Kosi Bay with fish traps

Our fish stocks in both freshwater and saltwater are finite and need to be nurtured very carefully. It is most amazing how people think a resource is inexhaustible if they do not actually see it being depleted before their eyes. The sardine run on our east coast in winter is a classic example: the shoals are harassed by a multitude of trawlers, seine netters and ski boats, but if you talk to most of these people they all say that the sardines can never be over-fished. The same attitude prevails among subsistence fishers in Kosi Bay. This lake has been fished for the last 150 years or so by the Ngensi people and has been more or less self-sustaining. Certain families have the right to fish using fish kraals – this right is passed down the family making the fishing sustainable up to a point. However, as the population of the local community grows, so does its needs, and this requires more and more fish kraals. Fishers are now also selling their catch. Even if primitive fishing techniques are being used, the fine line between true subsistence fishing and commercial fishing is now being

A subsistence angler using conventional tackle

crossed. I have often talked to people on the lake and been told how many fish are thrown away if they are not sold. If you then ask why so many fish are caught and killed, the answer is always that you can never finish the fish. The worst part of the scenario is that people have started to gill net the lake and are devastating the fish stocks. If you read some of the old saltwater angling books you get a very good idea of the enormous populations of inshore species such as shad (elf), white steenbras, red steenbras and other desirable fishes that frequented our coast 50 or more years ago. Where are they now? They have been almost fished to extinction and mostly by rod and line.

The freshwater scene isn't any better; in fact it is arguably worse. People use a variety of methods to carry out "subsistence" fishing. The traditional rod and line or a hand line is probably the most sustainable way of fishing legally without wiping out fish stocks. This is true if you use one rod or hand line and only keep as much as you need for a day. The problem arises when one person starts using five to ten "hand lines" set up along a river or dam in order to increase his catch and sell it. The same applies when you start using gill nets, seine nets, fish kraals or poison to capture fish. In many of our rivers, yellowfish migrate upstream into shallow rapids to breed only to be confronted by a crowd of people waiting to kill them with hatchets, spears, swords and a variety of sharpened metal objects. Many fish are injured but escape, only to die somewhere else and be wasted. Others use shade cloth to build kraals in the rivers, thereafter they herd the fish in, close up the entrance and scoop out everything with landing nets. In this way they can deplete an entire pool. Elsewhere you may see people on rivers jigging and snagging fish with a rod, heavy line and a big treble hook. All this would be tolerable if people would really only catch and kill for their own use.

The solution to this problem is threefold. First, the authorities must ensure that regulations governing the capture and disposal of yellowfishes are uniform and apply nationally. Equipment for catching fish and catch limits must be policed by the authorities as well as elements from the private sector such as angling clubs and riparian landowners. Second, subsistence fishers should be taught to target widespread and abundant alien fish species such as carp. Third, there must be a concerted attempt, including financial incentives, to establish more fish farms to sustain the growing demand for fish protein. As recreational fishers we can play our part by explaining to people who are fishing illegally what effect their acts are likely to have. We can also ensure that local land owners and nature conservation authorities are informed immediately we encounter gill nets on rivers.

There must be a concerted attempt, including financial incentives, to establish more fish farms

It is high time for people to wake up and realise that we have a huge problem on our hands, one that requires urgent attention and speedy action. It would not be amiss to look back at the San and learn from them the true meaning of subsistence.

Horst Filter farms in southern Mpumalanga, just across the border from Lüneburg, KZN. He is also a fishing guide and an avid birder and amateur botanist.

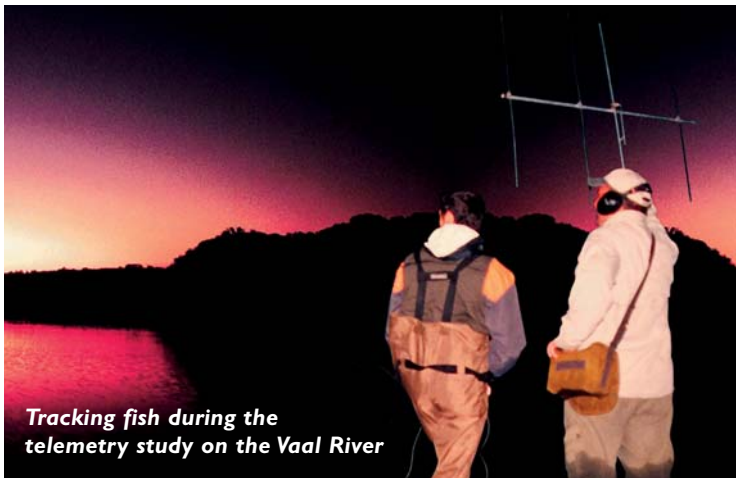
Traditional fish traps near Kosi Bay mouth

RESEARCH AND MONITORING NEEDS AND LITERATURE ON YELLOWFISH

Wynand Vlok

Introduction

If we want to conserve our "Living Gold" successfully, we have to understand what the different yellowfish species need with regard to habitat (where they live), water quality (what is the impact of pollution on the fish?), spawning sites (type of gravel beds) and food during the different stages of development. It is important to remember that the fish spawn in a specific area, the fry will feed in a certain zone and as they grow to fingerling size, they migrate to other parts of the river to utilise preferred food sources.



Tracking fish during the telemetry study on the Vaal River

The complexity of the water environment makes grasping these needs more difficult as they are influenced by what is happening in the catchment of the river we want to protect. This includes all activities that impact on water quality such as effluent treatment and discharge, land-use practices, erosion and siltation; each will affect the system and the fish differently.

The advantage of a well-structured research strategy is that when everything is in place to conserve the yellowfishes, we can work towards an ecologically healthy catchment and river. What do we mean when we say we need a healthy environment? It means that we have to deal with the entire catchment area of the river - its main stem as well as its tributaries. The wetlands right at the top of the system must be functioning and well protected and we have to ensure that enough water is available to sustain the ecosystem from its source to where it enters ithe sea. This quantity of water is known as the "Reserve" as defined in the National Water Act – Act 36 of 1998. (See also p. 54, this publication.)

An extensive survey of the scintific literature has revealed that relatively little scientific information on yellowfishes has been published. There is a substantial amount of "grey literature" – reports and data gathered by conservation bodies and researchers that is not published in either scientific literature or in popular articles, to the detriment of other stakeholders. Over the last 10 years, the awareness of yellowfish has mushroomed due to the many articles that have appeared in all the angling magazines.

The information gathered in the literature search will accompany a scientific publication which is to be issued shortly after this volume. Details on how to obtain it are set out at the end of the introductory chapter. A summary of the

	Scientific
L. aeneus	26
L. kimberleyensis	12
L. polylepis	3
L. marequensis	8
B. mattozi	1
L. natalensis	2
B. andrewi	3
L. capensis	7
B. serra	1
Yellowfish (species not specified)	2
TOTAL	65

Table 1: Summary of popular and scientific papers per species

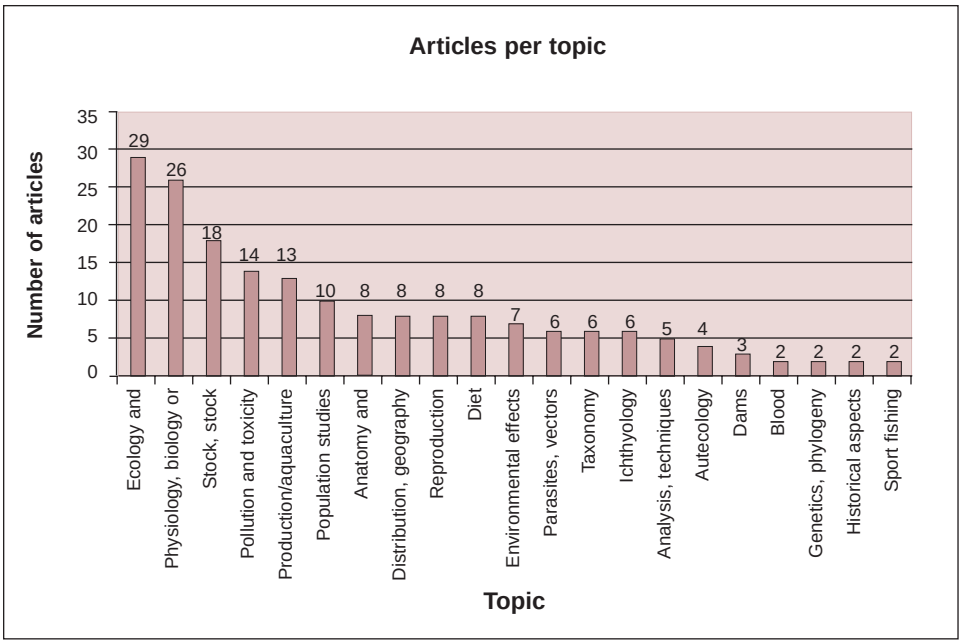


Figure 1: Graphical representation of number of articles published per species.

survey results, of primarily the scientific literature, is presented in Figure 1.

It is important to note that this is definitely not a complete list of the available scientific literature, but it represents most scientific papers written on yellowfishes. Requests to various researchers have not uncovered any further articles and it may be assumed that this list is probably 85 to 90 percent correct. The obvious question is: Where are the gaps? To which areas of yellowfish research do we have to give particular attention? The critical ones are biology (breeding and reproduction,

physiology and sensitivity to pollutants, growth and feeding and habitat requirements), the flow velocity and water depth required at various life stages, water quality, migration, and the role of yellowfishes in the ecosystem. Much information is available, but it is mostly anecdotal and not based on the results of scientific research.

To ensure that the scant resources, essentially manpower and funding, are utilised effectively, a comprehensive strategy that focusses on the aspects listed below is needed.

- First and foremost, the identification of priority research areas.
  - All the research needs must be compiled into a strategic document which will serve as a template to guide research activities. Each priority can be drawn up as a one-page document and distributed through newsletters and web pages to universities and other research organisations. It is important to target a relevant audience to determine its interest in the projects.
- The difficulty involved in obtaining research funds. This is usually channelled through research agencies (such as nature conservation departments) that have access to the large research-funding organisations such as the National Research Foundation, the Water Research Commission and the World Wide Wildlife Fund.
  - Once researchers have indicated their interest in a specific project, they approach the Yellowfish Working Group (YWG) or other appropriate conservation bodies to endorse and support the project. This is important as such endorsement will enhance the researchers' prospects of getting funding from the agencies.
- Using yellowfishes to promote habitat protection.
  - Yellowfishes are a strong marketing tool to promote conservation issues, pollution prevention and education.
  - They are a sought-after angling species among local and international anglers.
  - The benefits for landowners who become involved, as the spin-offs from ecotourism can be significant.
- Awareness and education programmes. Here it is important to heed the following matters:
  - The importance of developing and sending out a strong and unified message.

We have to understand what is happening in the catchment of the river we want to protect

YWG Vice-chairman, Wynand Vlok, collecting yellowfish with an electro-shocker

- A determined effort to ensure that this message is directed to all target audiences.
- The necessity to develop a "road show" to reach selected target audiences. Such a show will have to be adapted to suit specific audiences such as anglers at a competition or school children attending an environmental exhibition.
- A broadly-based research network.
- One of the strongest tools in the research and conserva tion of yellowfish is a strong and extensive network. Through this network, all role players become involved in different activities. Inasmuch as the collective is stronger than the individual, this gives access to a broader knowl edge base, a more comprehensive approach and dealing with issues on the systems level rather than focussed studies on a single component. Such interaction ensures that knowledge is shared and that questions are addressed from a variety of viewpoints. Messages coming from a net work will have a much wider and effective impact, especially when dealing with governmental bodies.
- A functional network comprising a diverse group of individuals already exists in the YWG but it needs to be strengthened.

Another conservation tool currently in use is monitoring. The objectives of the national River Health Programme (RHP) are that every province should have effective monitoring systems that use a variety of indices to gauge the health of rivers and their tributaries. One of the indices used, is the Fish Assemblage Integrity Index (FAII) which uses the sensitivity of fish to various environmental components to judge the amount of impact on the system. Although not focussing specifically on yellowfish, it is a tool that measures the health of the river as a whole and is used as an indicator of potential problem areas related to the management and conservation of all species.

Although not yet fully implemented, the programme is providing valuable information on the environment, potential threats and trends attributable to pollution, as well as habitat loss.

The lack of manpower in most conservation agencies is one of the reasons for the infrequent surveys so far. In what way can the public contribute? By forming conservancies and contracting consultants to carry out regular surveys. Monitoring is an essential part of the management strategy in the conservation of the fish, their habitat and the environment in general.

Wynand Vlok is a wetland and freshwater ecologist based at the University of Limpopo with an interest in the conservation of our freshwater resources and their inhabitants.

Analysing macro invertabrate samples for an RHP study

Recommendations for Yellowfish Conservation

Dean Impson and Pierre de Villiers

Yellowfish Management

1 Catch and release is encouraged for all indigenous yellowfishes except where they are aliens (such as small mouth yellowfish in the Gourits River catchment).

2 Mandatory catch and release for all Berg-Breede white-fish, Clanwilliam sawfin, Clanwilliam yellowfish and Orange-Vaal largemouth yellowfish.

3 Yellowfish for subsistence angling and consumption should be confined to non-endangered species between 30 and 50 cm in length and a daily catch limit of 2 fish per person

4 No capture of fish in rivers with the use of nets.

5 Yellowfish should not be held in keep nets.

6 No yellowfish may be stocked outside their natural distribution range.

7 Yellowfish may only be stocked in dams under permit from provincial conservation agencies, and only within the same catchment in which they were captured.

Habitat Management

1 No development including forestry, agriculture and mining, should be allowed in the riparian zone within a designated distance (50 meters) from the river bank.

2 The riparian zone needs to be kept free of alien plants.

3 Ensure that appropriate environmental flows are released from in-stream dams.

4 Encourage establishment of provincial yellowfish working-group chapters and YCMAs

5 Ensure that water-treatment works are functioning effectively.

6 Use the River Health Programme as a monitoring tool for yellowfish conservation.

7 Any diversion of the flow of a river by landowners should be prohibited.

8 Fishways should be mandatory on all in-stream barriers on rivers holding yellowfish.

Research and Awareness

1 Establish an effective and sustainable research-funding component within the YWG.

2 Identify the key research priorities to ensure more effective conservation of our yellowfishes.

3 Identify and motivate research projects on an annual basis.

4 Ensure that awareness tools such as this report and accompanying posters are created regularly as well as being distributed effectively and widely to all stakeholders.