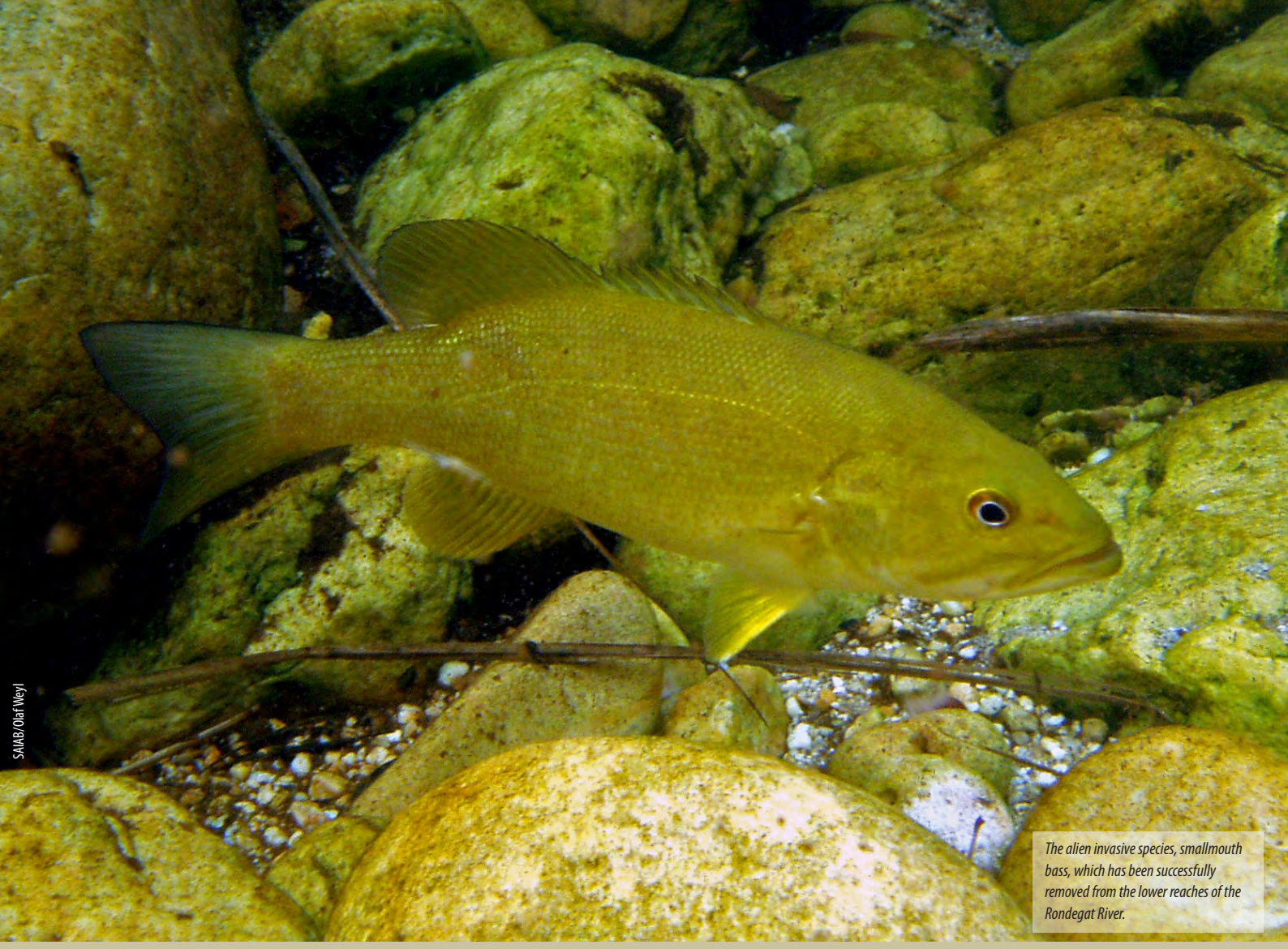


SAIAB/Olaf Weyl

The alien invasive species, smallmouth bass, which has been successfully removed from the lower reaches of the Rondegat River.

ERADICATING INVASIVE ALIEN FISH – It can be done, project shows

Scientists are cautiously optimistic that a unique pilot project aimed at removing the centuries-old invasive alien fish problem in one of the Western Cape's most critical rivers has been a success. Extensive monitoring and surveying formed a key part of the project. Lani van Vuuren reports.

When the Western Cape introduced the first foreign fish to its waters for sport almost two centuries ago, the devastating consequences this would have on indigenous fish populations was little understood. Today, while invasive alien species such as bass and trout still play an important role in generating tourism income, these predatory fish, along with habitat destruction and pollution, have all but wiped out several native fish communities in Cape rivers. Fish in the rivers of the Fynbos biome, which is home to 27 fish taxa (of which 24 are endemic, i.e. found nowhere else) are particularly threatened, with 16 species now either critically endangered or endangered.

Once established in a river system, invasive alien fish are almost impossible to eradicate because of the complexities and cost involved, explains CapeNature Scientist: Freshwater Fishes, Dean Impson. Mechanical removal through electric fishing or netting, for example, is one method of controlling these fish, but this is highly labour intensive and rarely achieves complete eradication. How then to improve the status of South Africa's highly threatened indigenous fish and associated aquatic organisms?

"It is possible to eradicate fishes from stretches of rivers (usually upstream reaches), provided there are barriers such as weirs or dams and waterfalls that prevent re-invasion from downstream sources," notes Impson. "In the same way fish can be removed from farm dams, provided that water entering the dam is not from a 'contaminated' source, which allows for re-invasion. There

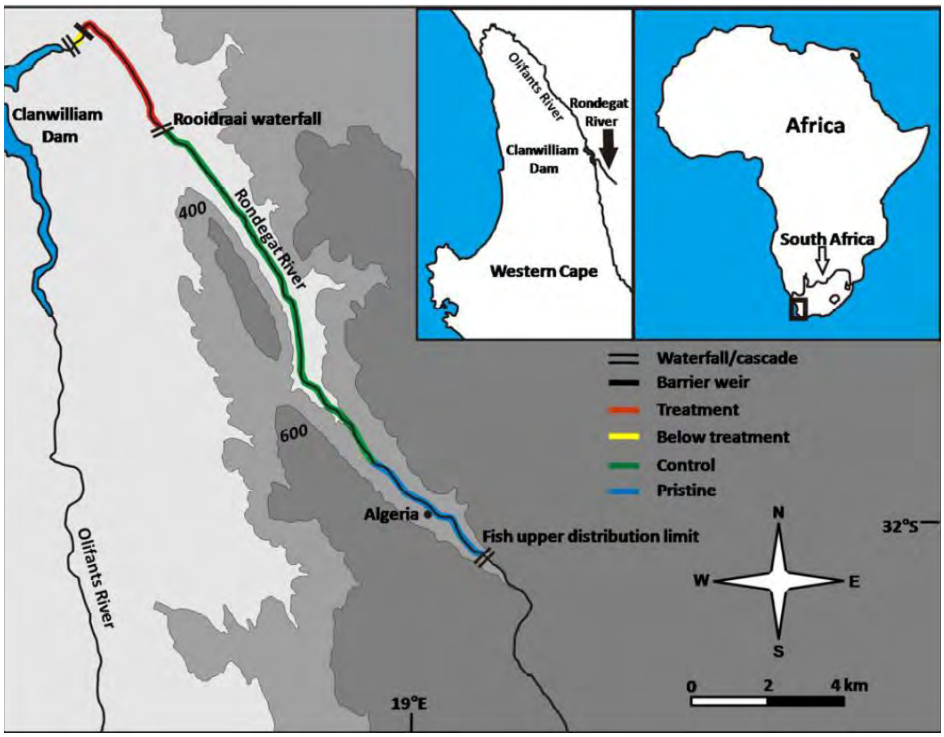
are many successful projects of both types from across the world, with piscicides (fish killing chemicals) most commonly used to achieve this."

Almost a decade of investigations into alternative removal methods has led to the launch of a joint project between the Western Cape government and civil society organisations. The project, which involves the use of the piscicide rotenone, is being implemented by CapeNature. Several priority streams have been identified where alien invasive fish could be targeted for permanent removal, the first being the small Rondegat River, which rises in the Cederberg Wilderness before entering privately-owned farmland and flowing into the Clanwilliam Dam.

Rotenone has already been used successfully to eradicate invasive alien fish from reservoirs and streams in the US, Britain, Norway and New Zealand. Prior to the start of the South African project, a comprehensive environmental impact assessment was carried out, and the project was approved by all the relevant authorities. Independent biological monitoring both before and after treatment formed a key aspect of the project.

The project did attract much attention, both from the public and from angling bodies, as rotenone not only kills fish, but also non-target fauna, such as aquatic invertebrates. "The effect on aquatic invertebrates is dosage and species dependent, with certain groups, such as mayflies, being more sensitive even at low rotenone concentrations (e.g. 50-100 ppb)," explains Impson.

As he points out, however, any attempt to eradicate invasive alien species and re-establish indigenous species has trade-offs that have to be considered in terms of how the aquatic ecosystem should function and what its ecological value should be. "For example, do you want to leave part of your near pristine, priority river full of alien smallmouth bass, with few or any indigenous fish species, and hence have a compromised in-stream biota, or do you want to eradicate the bass, allow the treated stretch of the river to recover and provide a home to thousands of endemic fishes?"



Map of the Rondegat River indicating the four areas: treatment (red) and below treatment (yellow) areas in the invaded zone and the control (green) and pristine (blue) areas in the non-invaded zone.

"One must accept that rotenone use may have some adverse or unexpected impact – that is why each rotenone project in public water must have a sound biological monitoring base so that we can get a very good idea of how the ecosystem responds to the treatment. If treatments are bad for their intended purpose (i.e. ecosystem recovery), they should not be undertaken," maintains Impson.

It is acknowledged that the piscicide can be deadly if placed in untrained hands. For this reason, CapeNature invited international piscicide use experts Dr Brian Finlayson (recently retired California Fish and Game) and Dr Jarle Steinkjer (Norwegian Department of Nature Management) to assist with the supervision of the treatment and train its treatment team in the safe and effective use of rotenone. CapeNature is now preparing a rotenone use policy, which could guide its future use in South Africa. Preparation and implementation of the Rondegat project was guided by the manual, *Rotenone Use in Fisheries Management* prepared under the auspices of the American Fisheries Society.

SURVEYS AND MONITORING

The invasion of the Rondegat River by smallmouth bass (*Micropterus dolomieu*) has resulted in the local extinction of several native fish species in the lower reaches of the river. Rehabilitation

The lower Rondegat River, which was treated with rotenone to eradicate the invasive alien smallmouth bass.

Courtesy CapeNature

was focused on this particular 4 km-stretch, now dominated by small-mouth bass.

To monitor the project, independent surveys covering the fish, invertebrate and amphibian populations were carried out both before and after chemical treatment of the river. The surveys, funded by the Water Research Commission (WRC) and led by the South African Institute for Aquatic Biodiversity (SAIAB), were conducted over a two-year period from May 2010 to May 2012. Individual seasonal surveys were undertaken over three to five days, and were generally divided between a fish survey team and an invertebrate team.

According to WRC Research Manager, Bonani Madikizela, the project forms part of a key thrust of the Commission which is focused on reducing threats to indigenous species, thereby restoring ecosystem functions and processes, hopefully leading to improved biodiversity. "South Africa has the third-richest biodiversity in the world. This heritage is worth protecting for current and future generations."

Right: *An underwater screen shot of the Rondegat River. Underwater video was one of the tools used to survey the river both before and after treatment.*

Below: *Clanwilliam yellowfish has been re-established in the lower reaches of the Rondegat River following eradication of invasive alien species.*

SAIAB/Darragh Woodford

The fish team was led by Dr Olaf Weyl (SAIAB) and Bruce Ellender (Rhodes University), assisted by two MSc and nine Honours students who gained valuable experience during the rotenone application. Dr Darragh Woodford of SAIAB/Centre for Invasion Biology (CIB), Terence Bellingan (Rhodes University) and Jeanne Gouws (CapeNature) made up the invertebrate team. Insect identification services were also provided by Dr Ferdy de Moor and Helen Barber-James of the

SAIAB/OlafWeyl

Albany Museum, while Prof Jenny Day of the University of Cape Town provided support in the planning and design of the monitoring programme. Dr Michael Cunningham led the specialist amphibian study.

To ensure that all species present in the river were detected, the project teams used a combination of electrofishing, mask-and-snorkel surveys and underwater video analysis in all zones of the river. In the case of the frog study, aural encounter searches were also employed, with the bioassessment method SASS5 and species level assessments being used to survey invertebrates. Food-web effects were also measured by assessing algal production on stone surfaces.

While the Rondegat River supports five species of indigenous fish, the surveys (both current and past) confirmed that alien fish dominated the lower reaches of the river. "Fifteen years of population monitoring on the Rondegat River has shown that the alien bass severely depleted the native fish community, with at least three and possibly as many as six species driven to local extinction in the invaded zone," explains Dr Weyl, Principal Scientist with SAIAB. "The only species capable of co-occurring with smallmouth bass was the Clanwilliam yellowfish (*Labeobarbus capensis*), but only those individuals that are too large to be eaten actually survived in the lower reaches of the river, and survey evidence suggested that no successful juvenile recruitment had occurred there for decades as a result of the smallmouth bass."

"Juvenile yellowfish were recorded in the first pool of the treatment area just three days after the operation, and two months later both yellowfish and redfin minnow (*Barbus callidus*) were recorded (the latter for the first time in probably 70 years)."

Prior to rotenone operations, a fish rescue operation was conducted by CapeNature and volunteers, which removed significant proportions of the yellowfish and bass populations from the stream. The remaining fish were all apparently killed by the rotenone operations, and no live bass were found during the fish surveys conducted following treatment. Juvenile yellowfish were recorded in the first pool of the treatment area just three days after the operation, and two months later both yellowfish and redfin minnow (*Barbus callidus)* were recorded (the latter for the first time in probably 70 years) as far as 200 m downstream of the bass barrier, indicating recolonisation of the treatment area by native fish was underway. This indicates that the re-establishment of the 4 km of treated river should not only be successful but fairly rapid.

Three common species of frog were found to occur in the vicinity of river reach earmarked for rehabilitation, namely the Cape river frog (*Amieta fuscigula*), the clicking stream frog (*Strongylopus grayii*), and the FitzSimons' ghost frog (*Heliphryne depressa*). Post-treatment surveys indicated no

difference in the numbers of adult frogs, and the removal of fish from the treatment area actually resulted in a short-term increase of amphibian densities. However, these populations are expected to be restored to near pre-treatment levels following the re-colonisation of native fish.

Characterising the native insect population proved particularly challenging, as it consisted of many uncommon and incidental species which appeared to naturally occur in very small numbers and at only certain times of the year, explained SAIAB/CIB post-doctoral fellow, Dr Woodford. "The challenge was looking at the number of species 'missing' following the rotenone treatment and assessing how many of these absences actually were the result of the piscicide and not just an artefact of the low detectability of species. This challenge is one of the main reasons why long-term recovery monitoring is necessary to properly understand how rotenone ultimately affected this community."

"The insect team were pleasantly surprised by the speed at which some insect species appeared to recover, and by how many groups of insects were apparently unaffected by rotenone treatment."

The insect team were pleasantly surprised by the speed at which some insect species appeared to recover, and by how many groups of insects were apparently unaffected by rotenone treatment. "Only five out of 29 common species were still missing when we re-visited the river two months after operations," notes Dr Woodford. "In comparison, studies in American streams have shown up to half the insect species recorded pre-treatment can still be missing a year after treatment."

CAUTIOUSLY OPTIMISTIC

While initial concern was expressed over the potential impact of rotenone on other (indigenous) aquatic species, results of the monitoring and surveying of the Rondegat River following the application of the natural chemical indicate that these concerns were unfounded. No significant changes in ecosystem health could be attributed to the rotenone operations, and the fundamental conclusion of the monitoring programme is that the river rehabilitation has been a success, in that all bass appear to have been removed from the treatment area

SAIAB/OlafWeyl

Courtesy CapeNature

Above left and right: *The monitoring team at work in the Rondegat River. Extensive surveys were undertaken both prior and after the treatment of the river with rotenone.*

Below left: *Honours students from the Department of Ichthyology at Rhodes University collected dead fish for further study. They were joined by CapeNature Acting CEO Dr Kas Hamman.*

Below right: *A treatment station administering rotenone. Several observers attended treatment, including personnel from Natural Resource Management Programmes, SANParks, the Department of Water Affairs, and water users.*

SAIAB/OlafWeyl

without significant long-term damage being accrued to other wildlife of the Rondegat River. "We are very confident that that bass will be eradicated using the methods used, and if we can prevent any re-introduction, then the pools and rifles of this lovely small river should have large numbers of indigenous fishes in the treatment area, just as it does above the waterfall that marks the start of the treatment area," notes Impson.

CapeNature will be working with the key landowner in the treatment area to establish a conservation stewardship site that elevates the conservation importance of the treated area. The organisation is also working with angling groups to ensure that bass are not re-introduced into the treatment area, or above it. Signage is also being established at recreation areas along the Rondegat River to highlight its importance to fish conservation and the need to prevent any foreign fish introductions.

Courtesy CapeNature

A further treatment is scheduled for next February to ensure the river is completely free of bass. This is because two treatments, a year apart, seems to be standard operating practice for river treatments using rotenone in the USA and Norway.

According to Dr Weyl, the project has successfully demonstrated that insect communities in a South African stream are relatively robust to the potential negative effects of piscicides. "Given the significant threat posed by alien fish to the survival of endangered freshwater fish species in many places in the country, the positive outcome of removing the alien fish from streams with rotenone is likely to outweigh the short-term negative effects of using the piscicide."

Dr Weyl points out that it is important that such projects to be assessed on a case-by-case basis. "Pre-treatment biodiversity monitoring will always be essential to establish the baseline situation before a decision regarding the use of rotenone can be made."

For instance, the invasive alien fish on a river proposed for rehabilitation may co-exist with highly threatened fish or invertebrates, meaning the use of rotenone to remove alien fish may have negative conservation implications itself. Notes Dr Weyl: "This was clearly not the case on the Rondegat River where monitoring suggests the fish and insects will both benefit from the rotenone operation over time, as a more natural community develops in the previously invaded stream."

It is hoped that long-term monitoring of the Rondegat River will confirm the success of the project, and that this method can be successfully (albeit carefully) replicated to help save what is left of our precious indigenous fish heritage. Natural Resource Management Programmes (previously Work for Water) is funding the Rondegat alien fish eradication project, and have expressed their intention to support further projects of this kind, given the positive results achieved so far. ❑