

Alien species management

Alien infested waters – how to solve an unsolvable problem

While South Africa has realised the negative impact of alien invasive fish on its indigenous freshwater fauna curbing the spread of these resourceful creatures has proven difficult. A recently completed study funded by the Water Research Commission (WRC) sought to find some workable solutions.

Article by Sue Matthews.



Olaf Weyl/SAIAB

The vermiculated sailfin catfish, introduced to South Africa via the pet trade, has invaded two rivers in the Richards Bay area.

The eradication of smallmouth bass from the Rondegat River in the Western Cape's Cederberg has demonstrated that eradicating invasive alien fish can indeed be done (see article in *The Water Wheel*, November/December 2012). But should this approach be applied in other areas, with similar success expected?

A recent WRC research project collated the lessons learned from a number of local case studies and used them to develop a decision support framework for managing alien fish in South Africa.

The first case study – led by Peter Kimberg of Hydrocynus Consulting – assessed the impacts of largemouth bass *Micropterus salmoides* in the Groot Marico catchment. The catchment has been classified a national Freshwater Priority Area, or FEPA, because it contains fish species of special conservation

concern as well as landscape features of special ecological significance, and also because the river's upper reach is the only free-flowing river in the North West Province.

The river rises as springs from a series of dolomitic eyes, discharging into tributaries that flow through deeply incised gorges. The rugged terrain and inaccessible watercourses mean that the fish community has largely been spared the impacts associated with agriculture and other human activities. Nevertheless, one of the 19 indigenous fish species recorded from these upper reaches of the catchment – the endemic Marico barb *Barbus motebensis* – is listed as vulnerable on the IUCN Red List of Threatened Species, largely due to its restricted distributional range and very small area of occupancy.

It is only known from approximately 10 locations in the upper reaches of the Marico and Crocodile rivers, most of which are threatened by water abstraction, seepage from mines or predation by largemouth bass. Two other invasive alien fish species – carp and rainbow trout – have also been recorded in this part of the catchment.

Kimberg and his collaborators sampled 94 sites in the upper catchment during surveys conducted in March and November 2012, using a mix of bank-based visual observation, snorkel transects, backpack electrofishing, seine netting, fyke netting and angling to cater for different habitats and species preferences. They found 14 of the expected 19 indigenous species, as well as largemouth bass and a small number of carp.

In all, 32 largemouth bass were collected at 16 of the 94 sampling sites, primarily in the main stem of the Groot Marico River and the Sterkstroom / Polkadraaispruit tributary. There was also a seemingly isolated population in the Marico eye at the top of Kaaloog se Loop, but otherwise this invader was absent from the tributaries. It had evidently not penetrated into the uppermost reaches of the main stem either.

The Marico barb was found to be the most abundant species, with a total of 2329 fish recorded at 54 sites. Tellingly, it was present in all the tributaries except the Sterkstroom / Polkadraaispruit, and in the main stem occurred only upstream of the invaded zone. This diminutive little fish, generally only three to four centimetres long, shares some habitat preferences with largemouth bass, increasing its exposure to the much larger predator. The numbers of other indigenous fish species did not appear to be affected by the invader's presence.

The second case study – headed up by Dr Darragh Woodford, then a postdoctoral researcher at the South African Institute of Aquatic Biodiversity (SAIAB) – investigated the role of the Orange-Fish-Sundays interbasin transfer scheme in facilitating invasion. Completed during the 1970s, the scheme transfers water via an 83 km long tunnel from the Gariep Dam on the Orange River to the Teebus Spruit, which flows into the Great Brak River, a tributary of the Great Fish River.

After being released from the Grassridge Dam, the water travels more than 200 km downstream before some of it is diverted through the Cookhouse tunnel from the Great Fish River into the Little Fish River, and from there to the

Darlington Dam on the Sundays River. Releases from the dam provide irrigation water for intensive citrus farming in the Sundays River Valley. An offtake at the Korhaansdrift weir diverts water from the river into a network of concrete canals that supply some 300 irrigation ponds.

Previous research has revealed that the interbasin transfer scheme enabled the introduction of five species of fish beyond their natural range – the smallmouth yellowfish, African sharptooth catfish, Orange River mudfish, banded tilapia and Mozambique tilapia. Invasive alien largemouth bass, carp and mosquitofish have been introduced to the catchment via other pathways, the last two being particularly abundant.

The research team sampled the fish entering the irrigation network during seven field trips throughout 2012, and also conducted a winter and summer survey of 30 irrigation ponds. The river goby *Glossogobius callidus* was found to be the most abundant species entering the network, followed by the mosquitofish, the estuarine round herring – native to the tidal reaches of the river but widespread throughout the system since being introduced to Darlington Dam – and Mozambique tilapia. These four species had also established populations in most of the irrigation ponds. Their success can partly be attributed to reproductive strategies that do not require specific habitats for spawning.

Towards the end of 2012, the research team also conducted surveys in three major tributaries of the Sundays River that flow through the Addo Elephant National Park – the Uie, Wit and Coerney rivers, home to the endangered Eastern

Cape redfin *Pseudobarbus afer* and other conservation-worthy indigenous fish. The preceding wet winter had broken a six-year drought in the catchment, when most of these tributaries had dried up and fish were confined to isolated pools. The drought had the effect of eradicating the invasive African sharptooth catfish *Clarias gariepinus* from the Coerney River, because the water hole in which it was recorded was fished to depletion and then evaporated.

It had been presumed that a causeway on the lower Coerney River would prevent catfish in the Sundays River from moving upstream and back into the national park, but the survey showed that this unwelcome guest had somehow returned. Further investigation revealed that the irrigation network has sluices that allow sections of the canal system to be emptied for maintenance purposes, and one of these discharges water into a pool in the Coerney River, several kilometres upstream of the causeway barrier.

“What we tried to do in this project is ensure that if an authority engages in management they can use the framework to do what’s feasible, but will also be able to plan against using unrealistic amounts of resources to attempt to solve an unsolvable problem.”



Left: Darragh Woodford and assistants sampling fish in the Sundays River catchment.

Right: Darragh Woodford displays an African sharptooth catfish caught in the Sundays River catchment, where an irrigation scheme has allowed the species to invade the Addo Elephant National Park.

A similar scenario has occurred in the Richards Bay area, where the vermiculated sailfin catfish *Pterygoplichthys disjunctivus* was able to spread via the local water transfer infrastructure. The species is native to the Amazon basin, but has become invasive in various other parts of the world. It was presumably imported to South Africa through the pet trade, probably under the guise of a more innocuous look-alike species, but was evidently released by an aquarium owner or allowed to escape from a garden pond, because in 2000 it was reported from a lake near the town of Empangeni.

In 2004 two juvenile specimens were collected from the Mhlathuze River, downstream of the lake, and in 2007 an adult specimen was collected from the adjacent Nseleni River. The two rivers are in separate quaternary catchments but are linked by a pipeline allowing water to be pumped the few kilometres from the Mhlathuze River into Lake Nsezi, which flows into the Nseleni River.

A research team led by Dr Olaf Weyl conducted three surveys on the Nseleni River over a two-year period from 2010 and collected 346 specimens, both juvenile and adult, indicating a well-established and self-sustaining population. Apart from its potential impact on other riverine biota through its algal grazing, the catfish is known to destabilise the banks of rivers and canals as the males excavate burrows for females to lay and guard their eggs. The resulting erosion and siltation has knock-on effects for other species, as well as economic impacts through damage to infrastructure.

The species was included in the Alien and Invasive Species Regulations published in 2014, listed as category 1b in protected areas, indicating that it must be controlled, and category 3 elsewhere, restricting activities that might facilitate its spread to areas where it does not already occur.

In terms of the regulations, management authorities of protected areas, as well as organs of state in all spheres of government, will have to submit Invasive Species Monitoring, Control and Eradication Plans by mid 2016. But how will they decide where to focus their efforts, or select species to be targeted for eradication, rather than only control? Furthermore, the regulations only deal with species that are foreign to South Africa, but indigenous species that have spread through human activities to areas beyond their natural range – known as extralimital species – may also warrant attention.

To assist management authorities in their deliberations, the research team developed a decision support framework to prioritise areas for alien fish eradication efforts by adapting a 'summary of options' flow diagram in the IUCN Global Invasive Species Programme toolkit.

"What we're trying to do through the framework is to say 'where do you really need to manage alien fish'; and there are lots of areas that don't require intervention anymore because they've been settled for a long time, and the impacts have already happened," says Dr Weyl, principal scientist at SAIAB.

"Most important is to try to prevent alien fish getting into the last refuges of our native fishes. Headwater streams are number one priorities, and the last defence at the moment is to stop fish being introduced over waterfalls or into areas where they don't already occur."

The decision support framework asks the following questions in sequence:

1. Is the population established?

The research team recommend using the 'unified framework for biological invasions', developed by Blackburn et al. (2011), to assess the invasion status of an alien species in a given area. The population is considered established if there is evidence of successful reproduction at the site. Management of established populations that are not invasive should focus on preventing further spread and mitigating any negative impacts on indigenous, naturally occurring species.

2. Is the population invasive?

Characterising a population as invasive requires evidence of further, unaided spread beyond the point of introduction, and of negative environmental impacts at the site or in other areas where the species has been introduced. Containment is the first priority for management of invasive species, after which control strategies can be considered.

3. Does the population have socio-economic value?

Some invasive fish species are valued as a food source, recreational fishery or pest control agent, increasing the risk of non-compliance with eradication efforts. The socio-economic value of the invasive species should be considered on a site-specific basis, and stakeholder engagement conducted to gain support for management action.

4. Is eradication feasible?

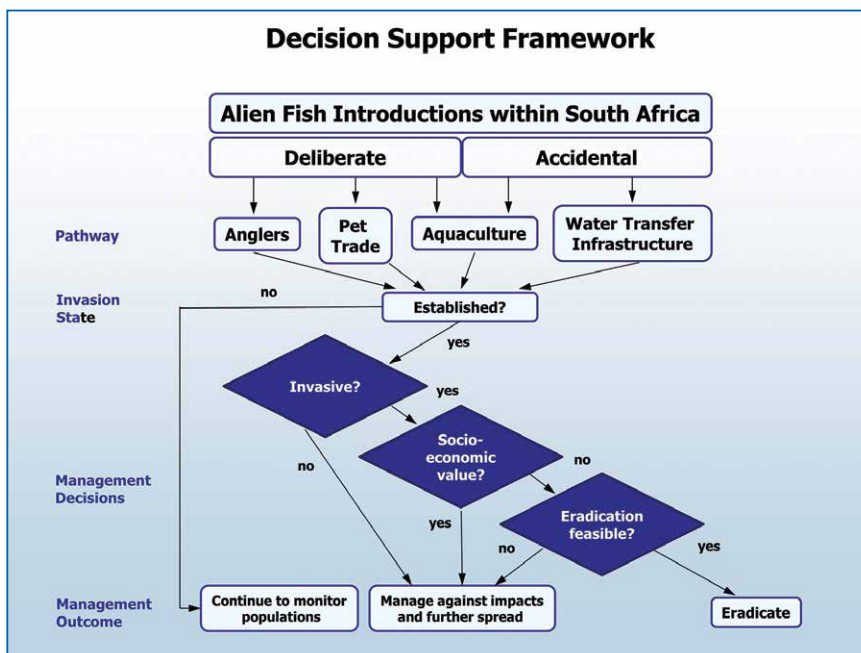
Aspects to be considered when assessing whether eradication efforts are likely to have a successful and sustainable outcome include the size of the target area, the need for barriers to re-invasion, the choice of method, and the availability of resources in terms of funding and skilled human capacity.

Using this framework for the case studies, the research team demonstrated that the small population of largemouth bass in the Marico Eye is an appropriate target for eradication, given its geographic extent and proximity to the sensitive Kaaloog se Loop stream. Piscicides such as rotenone – used so successfully in the Rondegat River – are not an option here because of the conservation value of the indigenous fish community, but the high water clarity makes manual removal by spearfishing quite possible.

In the Sundays River catchment example, alien fish populations within the irrigation network were found to be unmanageable, but the African sharptooth catfish population in the Coerney River could be managed to prevent further spread and mitigate negative impacts. Eradication should not be pursued because the catfish occurs as patchy populations, the presence of endangered Eastern Cape redfin precludes the use of piscicides, and there is no physical barrier in the lower Coerney River to prevent re-invasion. Likewise, eradication of the vermiculated sailfin catfish is not feasible due to the size of the Mhlathuze and Nseleni rivers.

“One really has to guard against misapplying limited resources,” says Dr Weyl. “What we tried to do in this project is ensure that if an authority engages in management they can use the framework to do what’s feasible, but will also be able to plan against using unrealistic amounts of resources to attempt to solve an unsolvable problem.”

“The criteria in the framework can help prevent authorities from spending too much time and effort on things that aren’t worthwhile, so that eradications are focused on situations where they are likely to lead to the desired objective.”



The decision support framework developed by the project team to assist in managing alien freshwater fish species in South Africa.



Tinus van Vuuren, Water Manager of the Lower Sundays River Water User Association, stands over the discharge pipe that allows water from the irrigation network to spill into the Coerney River, creating a point source for fish invasions.



Olaf Weyl at the Marico Eye, identified as a priority for largemouth bass eradication.



A selection of largemouth bass caught in the main stem Groot Marico River.

To obtain a copy of the report, *Understanding the unintended spread and impact of alien and invasive fish species – development of management guidelines for South African inland water* (WRC Report No. 2039/1/14) contact Publications at Tel: (012) 330-0340; Email: orders@wrc.org.za; or Visit: www.wrc.org.za to download a free copy.