

Rotenone as a tool for restoring indigenous fishes and inland waters

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Introduction

Word and terms such as 'piscicides', 'rotenone' and 'alien fish eradication' are being increasingly used in the Western Cape as part of CapeNature's quest to help conserve its endemic and highly threatened freshwater fishes. Unfortunately, predatory alien fishes such as smallmouth bass and rainbow trout are key reasons for the localised extinctions of smaller indigenous fishes in fynbos rivers. Alien fishes can be highly successful when introduced into new environments. Anecdotal reports by Sydney Hey in 1926 and recent research by D Woodford at the University of Cape Town and S Lowe at the South African Institute of Aquatic Biodiversity have proven how serious these invasive alien predators can be. Invasive alien fishes not only eliminate or greatly reduce numbers of indigenous fishes in fynbos rivers; they cause changes in the structure and dynamics of aquatic invertebrate communities. Worldwide, invasive alien fishes have significantly contributed to the decline of most, if not all, indigenous fishes through competition, predation and hybridisation and often are the greatest danger to their conservation.

The Western Cape has many examples of otherwise pristine rivers that are occupied by alien bass, trout, bluegill sunfish and sharptooth catfish. It is clear that if the alien fish can be completely removed from certain river areas that are not priorities for recreational angling, then indigenous fishes can make a full recovery to the ecological benefit of the river. Conservation authorities need a total eradication, achieved through cost effective methods. Leaving 20-30 or fewer fishes of an invasive alien species behind is a waste of time; in one good breeding season the unwanted fish species quickly rebuilds its numbers and eventually has the same negative ecological effect as prior to the control action. International studies repeatedly show that the most cost-effective option to achieve a complete eradication is by using piscicides, notably rotenone. However, international studies with piscicides also show that co-operation and support of key stakeholder organisations (such as angling clubs) are key ingredients to the success of a piscicide operation.

To allow anglers in the Western Cape to understand and appreciate how piscicides can make a valuable contribution to the conservation of inland waters and associated fisheries, one can turn to studies in the USA and Spain. The studies in the USA involve the use of piscicides, notably rotenone, to help save indigenous species and subspecies of trouts. The Spanish study involves the use of Rotenone to remove alien carp from an ecologically important lake in southern Spain to allow the recovery of the ecosystem, including a highly threatened duck species.

Saving American trouts

The current status of indigenous trouts of the Western United States show that seven of the 13 species are threatened with extinction (Table 1). The decline of these indigenous trouts has been caused by numerous factors, most importantly by alien trouts that compete

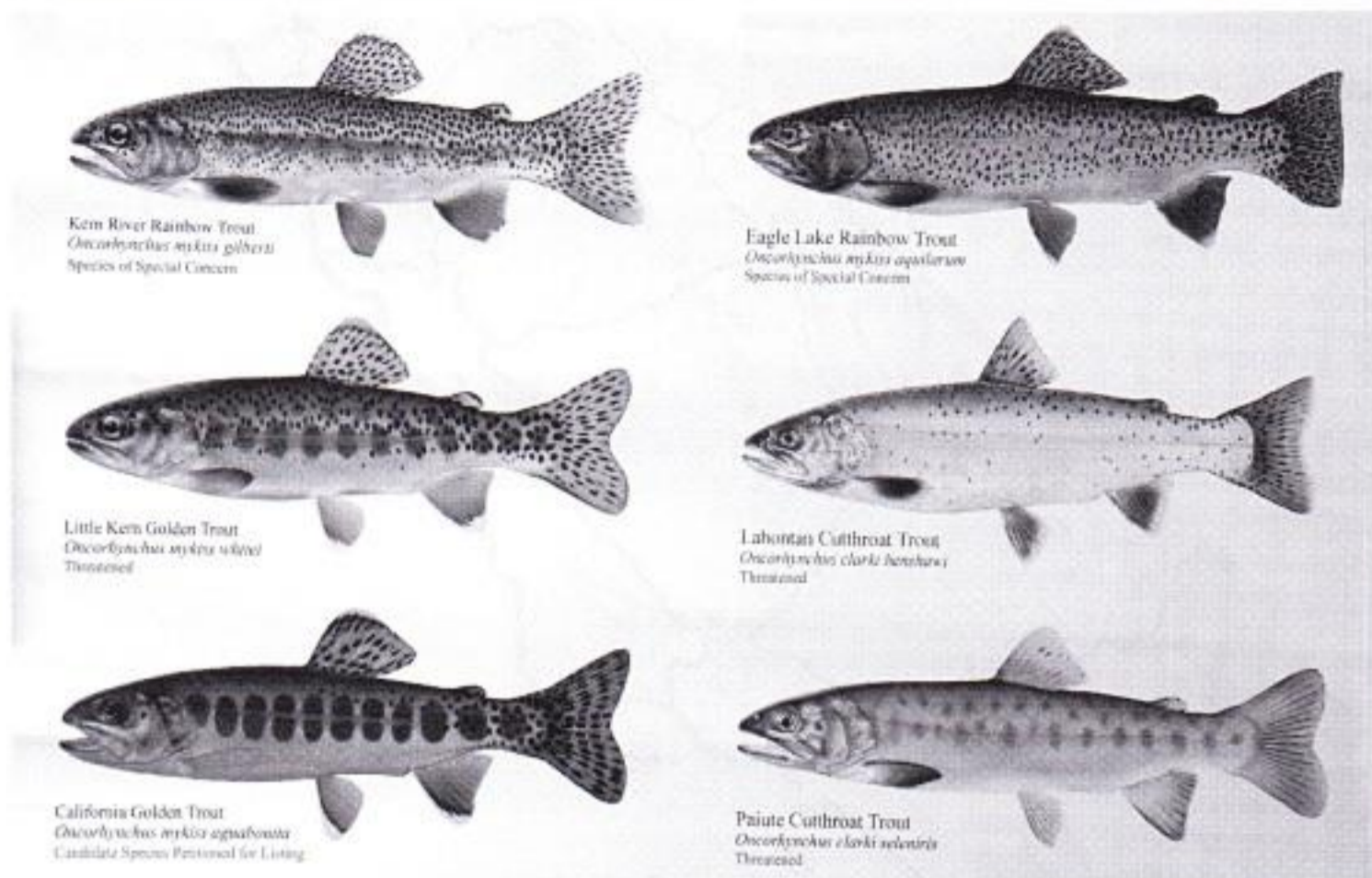


Table 1: Status of indigenous trout species in the Western USA (from Finlayson *et al.* 2005)

SPECIES	CONSERVATION STATUS
Apache trout	Threatened
Bonneville cutthroat trout	Petitioned
Bull trout	Threatened
California golden trout	Petitioned
Colorado cutthroat trout	Petitioned
Gila trout	Endangered
Greenback cutthroat trout	Threatened
Lahontan cutthroat trout	Threatened
Little Kern golden trout	Threatened
Paiute cutthroat trout	Threatened
Rio Grande cutthroat trout	Petitioned
Westslope cutthroat trout	Petitioned
Yellowstone cutthroat trout	Petitioned

with, prey on and hybridise with introduced trouts. It is surprising that so many trout species (a charismatic group of fishes) are threatened in a country where salmonids are highly prized and where there are so many anglers, prominent angling organisations and flyfishers. But that's where the problem lies. Anglers like catching game fish, especially ones they know (eg rainbow trout), hence the continuous pressure to stock and re-stock trout into rivers and lakes across the USA. Although most invading trouts involved are native species within the USA, they are not native to the specific waterbody where they

are competing with indigenous trouts. Heavy stockings are fine if you have only one species of indigenous trout and no genetic variation in the species, but when you have several different species in one large river system and genetically different populations of related species, then you have a conservation nightmare. This is the situation in the Western USA. So the widespread stocking of rainbow, cutthroat and brook trout into areas of Western North America where they are alien has been a conservation disaster. Also a fishing disaster if you, like me, enjoy catching naturally breeding wild races of different fishes on rod and line.

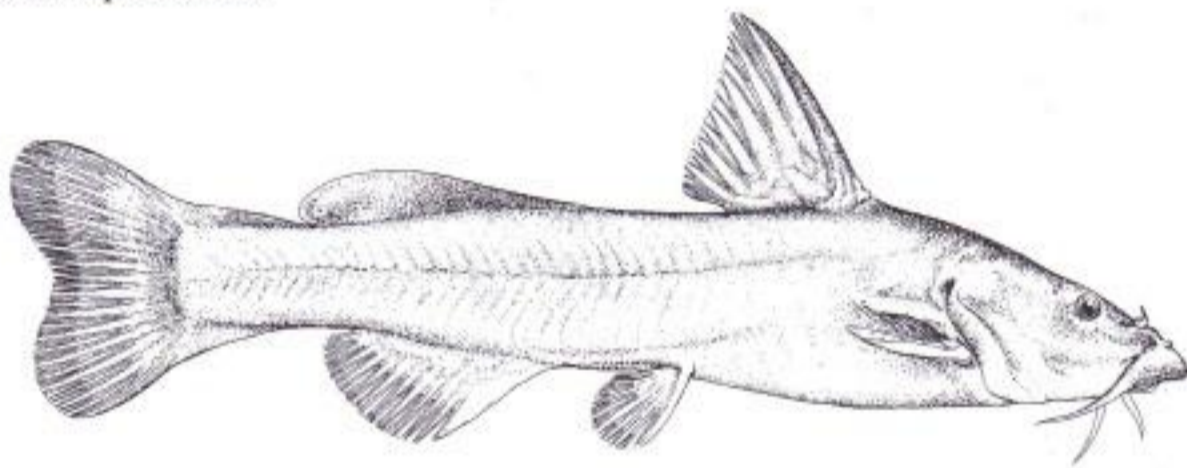
Saving America's unparalleled salmonid heritage has become a conservation priority and substantial resources have been allocated at national and state level to achieve this vital goal. Organisations like Trout Unlimited have also been established with the mission to 'conserve, protect and restore North America's coldwater fisheries and their watersheds' with the 'conservation of native trout and salmon being a Trout Unlimited priority'. One of the key strategies used to conserve indigenous trouts is to eradicate alien invasive trouts from certain areas, so as to allow indigenous trout species to recover as genetically pure populations. Piscicides (notably rotenone) are the most commonly used tools to restore populations of indigenous salmonids with a minimum impact on non-target wildlife. Trout Unlimited has stated that "Piscicides are the dominant tool in restoration projects to control or remove non-native species existing in native salmonid habitat". Although procedures vary, dependent on on-site considerations and the species targeted for removal, the general approach is to chemically treat a section of river that is isolated by downstream barriers (either natural or artificial) and then restock the treated section with indigenous trouts sourced from nearby rivers or appropriate hatcheries. Conservation of the following trout species have benefited from successful piscicide operations: brook trout (in eastern USA), California golden trout, Gila trout, Lahontan cutthroat trout, Bonneville cutthroat trout, Westslope cutthroat trout, Yellowstone cutthroat trout, Apache trout, and Paiute cutthroat trout.

Other techniques used include electro-fishing and gill-netting; these are more control-type methodologies as they rarely achieve a total eradication. Repeated electrofishing was found to be cost-prohibitive and impose unacceptable levels of stress on non-target organisms as well as having unintended environmental consequences. Brook trout and other alien trouts have been eradicated under limited conditions by extremely intensive gill netting (10 000 net nights in one example!) from small high altitude lakes in the USA and Canada. Anglers often state to me that they can through angling pressure achieve a complete removal of unwanted fishes. However, there are no successful examples of this; although obviously through intensive angling pressure, numbers of fishes can be greatly reduced. In California, angling pressure was counter-productive to removing alien trout from a stream where both indigenous and alien trout were present; much greater impacts to the indigenous fish occurred, and the effort had to be abandoned.

The use of piscicides in the USA is a highly regulated practice and permits from several agencies and a risk assessment are required prior to treatment of rivers and lakes. Piscicides are regulated by the USA Environmental Protection Agency under the authority of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and have been intensively evaluated for environmental and human safety. Trout Unlimited has concluded that "the risks to human health and the environment from piscicide use can be reduced to a level of



The Clanwilliam rock catfish (above and below) that Cape Nature says will benefit if the Krom River is poisoned.



A Driehoeks sawfin which, the author says, is being threatened by developments that Cape Nature is doing nothing to counter.

insignificance when piscicides are applied in appropriate situations according to USA Environmental Protection Agency label directions". The USA Environmental Protection Agency in 2007 re-approved rotenone for use as a piscicide.

Saving Spanish impoundments

Laguna de Zonar is a lake in the Cordoba region of southern Spain that, prior to an invasion by alien carp, was characterised by a rich waterfowl community. The lake had clear water and large weed beds and was an important over-wintering habitat for 5 000 waterfowl, including the Endangered white headed duck. The lake is a proclaimed nature reserve and RAMSAR site. Carp were illegally introduced to the lake in 1985 and became over-populated, causing the lake to become turbid with the loss of weed beds. The deeper waters of the lake had become increasingly anoxic. Loss of weed beds, poor water quality and carp predation pressure resulted in major losses of aquatic insect diversity. Densities of several waterfowl species also plummeted, including that of the white-headed duck while numbers of piscivorous birds such as cormorants and herons increased substantially.

Due to the elevated conservation value of the lake, and the severe impact of the carp, various stakeholders decided to take action and remove the carp in 2006. These included the Regional Environmental Agency, the University of Cordoba's Department of Zoology and InterAgro of Sweden. Rotenone was chosen because of its history of success elsewhere. After a careful programme of laboratory and field experimentation, the project team concluded that rotenone could be applied safely with a high probability of success. A further aim of eradicating the carp was to re-establish appropriate numbers of indigenous sand smelt *Atherina boyeri* to the lake. Prior to treatment about 3 000 sand smelt were caught in the lake and kept in holding containers for later re-introduction.

Rotenone was administered in two treatments, six days apart, in 2006 with the first application achieving a complete kill as no carp were recovered after the second application. About 13 000 kg of carp were collected and buried. The project was televised to communicate the reasons for the operation and create greater public awareness.

The operation was a major success with the lake recovering to pre-carp conditions within one year after treatment. There were substantial improvements in water clarity and quality, re-establishment of aquatic weed beds and dramatic recoveries of aquatic invertebrates. The bird community changed, with increased numbers of waterfowl, including that of the threatened white headed duck, while densities of fish predators such as cormorants declined. The eradication of carp hence allowed a delicate ecological balance to be restored.

Saving indigenous fishes in fynbos rivers

The above case histories clearly show how piscicides can be beneficial in eradicating alien fishes and restoring populations of indigenous fishes that culminate in the restoration of biodiversity and eco-system functioning. CapeNature and the Cape Action Plan for People and the Environment (CAPE) want to rehabilitate selected rivers in the fynbos using appropriate fish eradication methods. Rotenone appears to be the most suitable tool, but this needs to be confirmed through a comprehensive risk assessment which includes good public participation.

However, we are not going to start alien fish removal operations in an irresponsible way. Four priority rivers in the Western and Eastern Cape have been identified for alien fish removal through a series of workshops with ichthyologists. These are the Krom, Rondegat and Suurvlei rivers in the Cederberg and the upper Krom River near Jourbertina. We have confirmed with local angling organisations that none of these rivers are priorities for recreational angling. The basses, trouts and bluegill in them are small, since the rivers are small and nutrient poor. We are about to embark on a comprehensive Environmental Impact Assessment (EIA) to ensure that the technique used to control alien fishes can be used highly effectively and in an environmentally responsible way. The EIA involves a social component in which key stakeholders (riparian owners, anglers groups, environmental NGO's) and the public will have the opportunity to provide input.

South Africa must act responsibly against the growing invasion of our waters by invasive alien fishes; otherwise we will start losing valuable components of our indigenous aquatic heritage. Since starting work at CapeNature in 1991, I have seen our most precious river system, the Olifants-Doring, illegally stocked with Moçambique tilapia, carp and sharptooth catfish by uncaring or ill-informed anglers. These fishes are now invasive and causing further damage to the delicate ecology of this unique river system.

Our indigenous fynbos fishes, like the wild trouts of the USA, are beautiful and valuable animals, and it is our responsibility to conserve them. Likewise we must look after the ecological health of our rivers and dams, and ensure that carp and other alien species are not stocked without legal transport permits. Carp, in particular, have the ability to substantially modify aquatic environments to the detriment of water quality and most other species and that is why a growing number of farmers want them removed from their farm dams. Some farm dams with carp are so turbid that the water cannot be used for irrigation as the suspended sediment blocks small irrigation pipes.

There are no doubt anglers who are concerned about the long-term implications of a successful alien fish eradication strategy in one or more of our provinces. If we eradicate alien fishes from the above four rivers, which rivers are next on the horizon? This is where a zoning system becomes critical – identifying zones for each alien fish species that is legally in the province. Within the zones we need to promote and support angling for the species concerned; outside of the zone the species would need to be controlled which would include eradication where appropriate and feasible. CapeNature and angling stakeholders need to engage each other to develop these zones.

It is vital that all stakeholders in freshwater fish and river conservation work closely and productively together to ensure that we achieve a better balance between the needs of recreation and conservation.

References

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