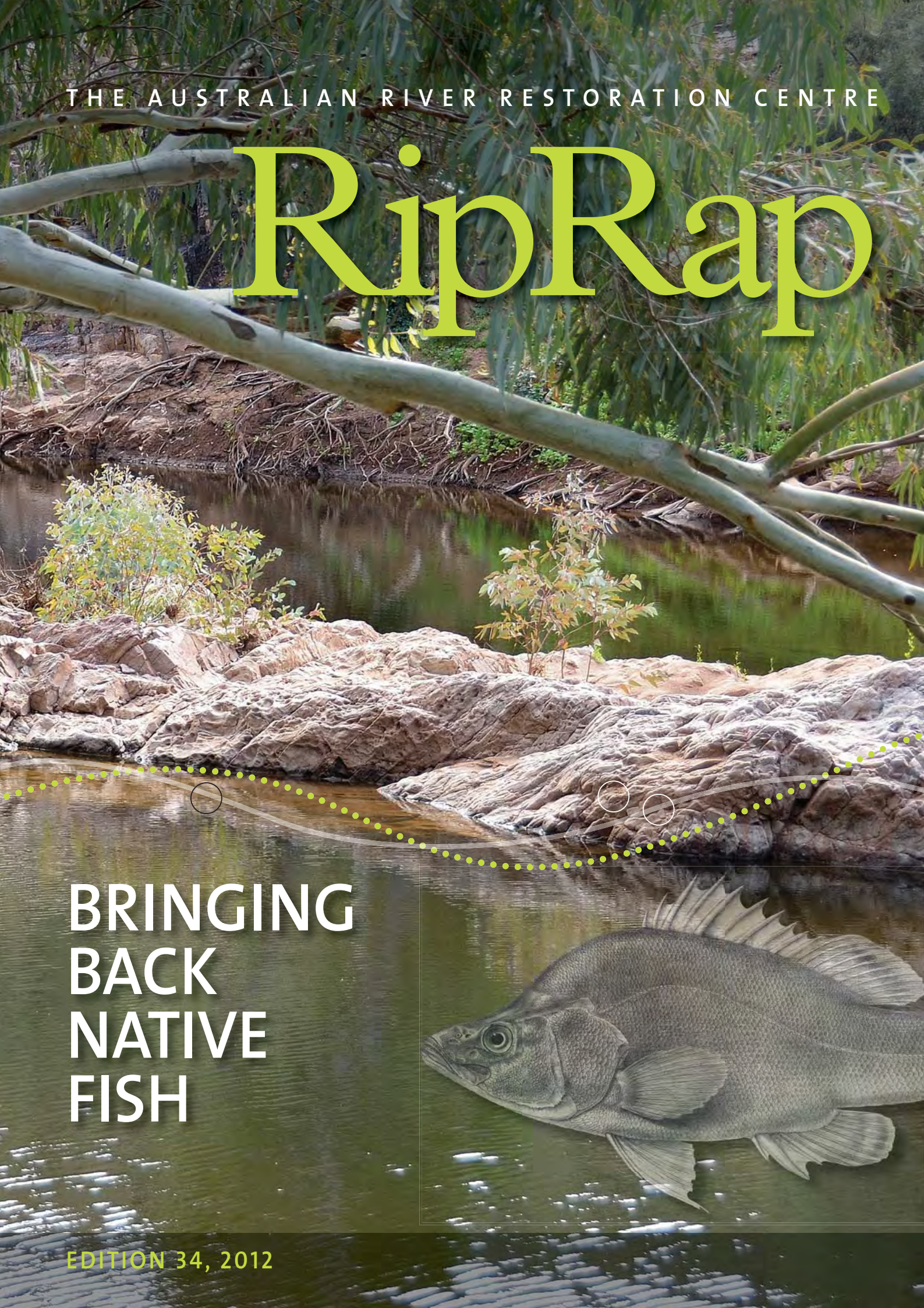
THE AUSTRALIAN RIVER RESTORATION CENTRE

# RipRap



# BRINGING BACK NATIVE FISH

EDITION 34, 2012

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The Australian River Restoration Centre

PHOTO ANDREW TATNELL

# Editorial

It is great to be back editing *RipRap* and sharing knowledge throughout the river and waterway community I love to be a part of. Thank you especially to the Murray–Darling Basin Authority Native Fish Program for sponsoring this 'bringing back native fish' edition. The articles we have brought together cover work across Australia, and I have been impressed with the scope of activity and depth of knowledge amongst river managers, fisherfolk and researchers on 'all things fishy'.

I hope you like our new look, and once you have enjoyed reading the articles, I encourage you to take the time to fill in our online *RipRap* survey. If we are to continue producing *RipRap* we have to demonstrate to potential sponsors that our magazine is read and valued, and the only way I can do this is to hear from you! I would also like to thank Kylie Nicholls and Allison Mortlock who have worked with me to edit, design and produce this great magazine.


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The Australian River Restoration Centre
A: PO Box 881, Dickson ACT 2602
T: (02) 6247 7997
E: <enquiries@arrc.com.au>
W: <australianriverrestorationcentre.com.au>

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Contributions and comments are welcomed and should be addressed to the Editor:
Dr Siwan Lovett
E: <enquiries@arrc.com.au>

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# Smart partnerships bring back native fish

**JOHN KOEHN** HIGHLIGHTS THE BENEFITS OF HEALTHY NATIVE FISH POPULATIONS AND URGES RIVER REHABILITATION EFFORTS TO CONTINUE.

Freshwater fish are a major component of Australia's river life, with significant biodiversity, ecological, cultural, social and economic values. The benefits of healthy native fish populations extend well beyond the river banks and into towns and communities. Rivers are products of their catchments and can be influenced by everything which occurs in and around them, especially upstream. We have massively cleared and developed our river catchments and floodplains, changing the run-off and increasing sediment inputs. In the rivers themselves, we have dammed and extracted water, destroyed and removed habitats, drained wetlands, constructed barriers, altered water quality and introduced new species. No wonder many of our rivers and fish communities are in poor health. While much public attention has been given to introduced species such as carp, many other threats impact native fishes.

The decline in river health has been accompanied by a widespread decline in native fish. As Australia is the driest inhabited continent, we have a low number of fish species —only about 260, with many of these being specialised and unique. The Murray–Darling Basin (MDB) has only 46 native species, compared with more than 3000 in the Amazon Basin. In the MDB, fish populations are now estimated to be at about 10 per cent of levels before European settlement, with 56 per cent of the Basin's species listed as threatened. There is a clear need to rectify this serious situation— **it's time to bring back native fish**.

## Promoting river health

Fish rarely feature alongside the 'cute and cuddlies' as icon species in conservation literature, even though they are often under far greater threat. Living in the water, they are forgotten. Despite this, the community strongly identify with fish. In some ways their hidden nature adds to their mystery and intrigue. Iconic species such as Murray Cod capture public attention and are powerful messengers for river health. Many Australians also connect with rivers and fish through recreational fishing, a hugely popular activity, with almost 20 per cent of the population participating annually. Fishers are an important stakeholder group which support actions to help fish populations and river health.

As we have been shown during the past decade, we live in a land of 'droughts and flooding rains'. One key to healthy fish populations is adequate river flows and the occurrence of flooding. The pressures

THE GOULBURN RIVER © MDBA; PHOTOGRAPHER ARTHUR MOSTEAD.

FISH IMAGES ON FRONT COVER (GOLDEN PERCH) AND ABOVE (MURRAY COD) FROM THE TRUE TALES OF THE TROUT COD PROJECT. REPRODUCED WITH PERMISSION FROM THE STATE LIBRARY OF VICTORIA.


PHOTO ROGER CHARLTON.

surrounding water use have been highlighted during the recent drought and current water debates provide an important opportunity to achieve a balance between use for agriculture and the environment. Provision of environmental flows is an important rehabilitation measure for fish populations—even more important when we consider the possible implications of climate change. **Healthy flows lead to healthy rivers and healthy communities.**

## Native fish strategy

Traditionally, management actions for fish either concentrated on fishery regulations or individual threatened species recovery plans. More recently, there has been a move towards addressing multiple species or communities, protecting ecosystem processes and remediating threats. The Native Fish Strategy (NFS) for the MDB provides a coordinated approach to address threats and takes a whole-of-fish community approach. The NFS emphasises the long time frames which are often needed for rehabilitation, having a 50 year outlook. Its aim is to restore fish populations to 60 per cent of what they were pre-European settlement, in partnership with a wide range of stakeholders.

Rehabilitation must be planned and coordinated. There is a need for partnerships: between agencies, stakeholders, scientists, managers and the community. These projects cannot be carried out by any of these groups on their own over the long term. We need to be smart with our rehabilitation expenditure. For this we need knowledge of native fish and their ecosystems. Existing historical, cultural and scientific knowledge must be made available in a readily accessible form. We need to carry out research to provide and test new knowledge and solve management problems. Credible, applied science is required to ensure we can maximise the benefits achieved for the investments made. Appropriate monitoring is essential to demonstrate outcomes.

## Promising future

Are we making progress? Yes, we are! This issue of *RipRap* provides many brilliant examples of the progress we are making across Australia. Projects such as demonstration reaches show how works can be planned and completed using a range of management methods. Investment in the world class Sea to Hume Dam fishway program is a restoration project with clearly identified, tangible outcomes for native fishes. Along with the many smaller habitat projects, all these works are contributing to help native fish.

We need to ensure we make links across the landscape and include riparian and floodplain zones, as well as land use, hydrology and geomorphology. Fish rehabilitation must be incorporated into waterway and catchment management to ensure our resource use is sustainable.

There is still a need to promote awareness and understanding of fish and secure further support at community, agency and political levels. The many good news stories in this edition of *RipRap* will assist with achieving this. Let us continue the good work, recruit others to this cause and all be champions of bringing back native fish!

**FOR FURTHER INFORMATION**
John Koehn—john.koehn@dse.vic.gov.au

# Fish finding a new way from the sea to Hume Dam

**JIM BARRETT** AND **MARTIN MALLEN COOPER** EXPLAIN THE SUCCESS OF AN AMBITIOUS PROJECT WHICH HAS SIGNIFICANTLY IMPROVED NATIVE FISH MOVEMENT AND MIGRATION ALONG THE MURRAY RIVER.

PHOTO JIM BARRETT.

As part of an ambitious plan to rehabilitate native fish populations, fish passage is being restored along the Murray River from the sea upstream to Hume Dam—a distance of 2300 kilometres. The program, started in 2001, is a multi-state process involving engineers and fish biologists in the design, construction, testing and evaluation of fishways at 13 weirs and five barrages along the main stem of the river.

Monitoring results demonstrate the project is a success with millions of native fish already using the four completed fishways. The program has proved so successful its designs are now being adopted in areas outside the Basin and internationally, including the Mekong River in Vietnam.

## Barriers restrict fish movement

All freshwater fish need to move along streams for feeding, spawning, to seek shelter and refuge, for dispersal of young fish, to counter downstream displacement in high flows, and to recolonise after droughts. Widespread construction of a range of barriers has severely restricted the passage of native fish through the Murray–Darling Basin (MDB). It is estimated about 80 per cent of natural flows are diverted from the Murray–Darling system due to an extensive network of water infrastructure, including weirs, dams, regulators, pumps, pipes and irrigation canals which regulate natural flows. An estimated 10,000 dams and weirs are currently installed on main channels throughout the Basin. Additionally, significant numbers regulate lateral flows onto floodplains, tributaries and irrigation channels.

These structures interfere with the natural migratory patterns of native fish, while at the same time creating ideal environments for alien species such as carp. In the MDBA's Native Fish Strategy barriers to fish passage are identified as one of eight key threats to native fish populations.

## Sea to Hume Dam project

The Murray River is an extensive river system with a large fish population. Fish migrate in spring and summer creating migration 'pulses', particularly in the lower reaches, with fish movements tapering off in early autumn.

PHOTO IAN TOWERS.

The award-winning Sea to Hume Dam project is the first program to allow fish passage for the majority of species in a migrating fish community, rather than being focused on just one or two species of economic or social significance.

It is also one of the longest fish passage river restoration projects in the world. This is achievable because of the low gradient of the river, which means all the weirs from the Barrages to Lock 15 inclusive, are less than 5 metres high, with most less than 3.5 metres.

A range of engineering and design challenges needed to be addressed in the project:

- the weirs were old structures built between 1922 to 1937,
- the fishway entrance design needed to enable a wide range of fish to use it—from a 40 millimetre long gudgeon to a 1 metre long Murray Cod,
- the river can flood in any season during construction,
- the hydraulics of the fishways had to be designed for future environmental flow where headwater could be raised or lowered.

## Adaptive management

The physical structures dominate the project and, with a 100 year design life, will be the legacy. Another key component of the program is the adaptive management framework which comprised:

- biological assessment to quantify fish passage (including species and size) of the new fishways as they were being built,
- biological assessment to determine the ecology of migration,
- experimental research to address new findings on migration,
- changing the fishway designs mid-project to incorporate the experiment findings,
- ongoing re-assessment of the new designs.

The assessment turned up species not previously considered migratory and smaller than expected. The fishway design changed mid-project from a single fishway design trying to pass small and large fish, to dual fishways, where these functions were separated and fish had a choice of fishway.

PHOTO JIM BARRETT.

### NORTHERN MURRAY–DARLING BASIN FISHWAY PROGRAM

The success of the Sea to Hume Dam fishway program has prompted further work on fish barriers throughout the MDB. Other than the River Murray system, there are nearly 4000 registered fish barriers in the remainder of the MDB. Many of these are low level weirs (less than 3 metres), requiring simple fishways or fish passage solutions.

The team from the MDBA Native Fish Program have identified 12 high-priority sites and developed concept designs and investment costs to fix the top five barriers to fish passage. These weirs were chosen because the river reaches where the weirs are located have high ecological value with known native fish populations, as well as good quality fish habitat and long river reaches which could be reinstated for migration. Fishway designs have been developed to suit the fish assemblage and semi-arid ecology of the northern Basin. From these designs cost estimates have been developed to assess the potential of future fish passage projects.

Four fishways in the program have been completed, and monitoring shows millions of native fish are using them, as many as 10,000 per day. The fish diversity is high (13 species) and fish sizes have ranged from 31 millimetres to 1040 millimetres in length.

The uncompleted fishways are located at Lock 2 (Waikerie), Lock 4 (Bookpurnong), Lock 11 (Mildura) and Lock 15 (Euston), and these are expected to be completed in 2012. Fishways have also been built at Stevens Weir and the Edward River Offtake at the largest anabranch of the Murray River, as well as along the lower Darling River at Burtundy and Weir 32.

The Sea to Hume Dam fishway program is an example of successful cooperation and the value of using adaptive management to provide feedback and improvement.

**FOR FURTHER INFORMATION**
Jim Barrett—jimb@grapevine.com.au
Martin Mallen Cooper—mallencooper@optusnet.com.au

# Heavy traffic on fish highway



The Flinders River Cone Fishway.

**TIM MARSDEN, DARREN JENNINGS** AND A QUEENSLAND FISHERIES TEAM HAVE BEEN BUSY BUILDING NEW FISHWAYS WHICH ARE PROVING POPULAR WITH MIGRATING NATIVE FISH.

Three new fishways have been built in Queensland in an effort to improve the migration of native fish upstream. In a collaborative project with the Fitzroy Basin Association and funded through the Australian Government's Caring for Our Country program, the new fishways have been built at Byfield National Park near Yeppoon.

## Fishway success

Recent monitoring of the fishways has confirmed their success with recordings of more than 2000 fish successfully moving through one of the fishways in 8 hours.

Several different species were recorded during the sampling period including Rainbow Fish, Empire Gudgeons, Bullrouts and Eels. In a surprising discovery, Freshwater Mullet, a fish not previously seen north of the Burnett region was also recorded.

Tim Marsden (right) and Darren Jennings inspect the fish trap at Byfield National Park. Both photos courtesy of Tim Marsden.

Byfield National Park is a unique place in terms of fish habitat, being a transition zone between tropical and temperate fish communities. This project highlights the importance of fishways and how they are used by a range of native fish species and other animals.

Different fish species, such as juvenile Freshwater Mullet and Barramundi migrate from marine environments into freshwater habitats to grow and feed, before migrating back to the sea to breed. Fishways play a critical role in facilitating this process.

According to the team from Queensland Fisheries, the key to building a successful fishway is thinking like a fish. Although it is not easy to do, it helps to work out how to construct fishways which suit the fish, the habitat and the seasonal river flows.

## International fish aid

Recently, the Queensland Fisheries fishway building team travelled to Laos where they have been building fishways to enable previously stranded fish from migrating to spawning habitat. These fishways are critical to rebuilding fish populations in Laos which have been negatively impacted through dam and weir building.

Although challenges such as remote locations, logistics and short seasonal climate windows to accomplish the work make building fishways difficult, the team is committed to continuing their work with ongoing projects in Queensland, New South Wales and Victoria.

**FOR FURTHER INFORMATION**

Tim Marsden — timothy.marsden@daff.qld.gov.au

# RIVER CHANGES MAKE BETTER ROADS FOR FISH

**MARTIN PRENDERGAST**
FROM NSW STATE WATER

EXPLAINS THE EFFORTS UNDERWAY TO LESSEN THE IMPACT OF IN-STREAM STRUCTURES ON RIVER FLOW AND NATIVE FISH PASSAGE.

One of the most important features of the Australian environment is its river systems, particularly the Murray–Darling. Rainfall over Australia is variable resulting in significant fluctuations in river flow. Rivers are a source of essential water and food and the location of these systems and their flows was a significant influence on the movements of Aboriginal people and European settlement. Early written records demonstrate the influence of water sources:

> "If however the country is poor, the river is rich in the most excellent fish, procurable in the utmost abundance."
> (From the Journal of John Oxley (1820): 6 May 1817, Lachlan River)

And:

> "We were sitting on the bank of the river … and we noticed a couple of fairly large cod swimming upstream through a narrow channel near a sand bank. We watched for a while and presently two more fish passed the same spot, also travelling upstream. We stayed watching for over an hour and there was an almost continual procession of four or five pound cod passing the same spot. We could only come to one conclusion and that is that the fish were making a general migration up stream."
> (*National Advocate*, 13 January 1925)

Flow variability limited where people settled. As a result more reliable sources of water were achieved by the construction of weirs. The modification of river systems to compensate for natural variability had impacts on the surrounding environment. Early records indicate there were concerns over the impacts dam and weir structures would have on aquatic ecosystems:

> More and more dams will be erected, until there will be many hundreds of such throughout the length and breadth of the land. Without the provision of fish-passes there is a grave danger of fish fauna being cut up into isolated colonies…
> (NSW Department of Fisheries, 1913)

The State Water Corporation (SWC) controls 20 major dams and 228 weirs across New South Wales. These structures alter river flow characteristics and create barriers in the river system impacting on the natural movement and function of native fish species. SWC is working on ways to reduce the impacts in-stream structures have on native populations through two programs, the Cold Water Pollution (CWP) mitigation strategy and the Fish Passage strategy.

The CWP mitigation strategy involves the implementation of a temperature monitoring program and sourcing release water from storage locations in line with incoming water temperatures. The selective release of water at desired temperatures is currently possible at some SWC sites, while others are being retro-fitted with additional infrastructure to allow this to occur.

The Fish Passage strategy aims to open up more than 2700 kilometres of river length allowing the free movement of native fish species. Free movement of fish includes the movement of fauna upstream past SWC structures via fish ladders and the safe movement of fish, particularly juveniles, downstream past the same structures. This free passage for fish will allow re-colonisation of areas and an unregulated gene flow through fish populations.

SWC is continuing to implement programs and works in its management areas which aim to improve river health and ecosystems.

The Island Creek fishway, Lachlan catchment, aims to encourage the free passage of fish through dam and weir structures. Photo courtesy of the author.

**FOR FURTHER INFORMATION**

Martin Prendergast — martin.prendergast@statewater.com.au

www.dpi.nsw.gov.au/fisheries/habitat/rehabilitating/weir-removal
www.dpi.nsw.gov.au/fisheries/habitat/rehabilitating/fishways

# ARRC is creating a new buzz with Curate Bee

BY **SANDRA D'SOUZA** AND **SIWAN LOVETT**

Content drives the Internet, and users are looking for information that solves a problem, answers a question, shares experiences, and provides access to knowledge they would not otherwise find.

The Australian River Restoration Centre (ARRC) has joined forces with Curate Bee to market their online content so it reaches more people.

Content marketing means creating and sharing valuable 'free' content to attract people to your organisation. The type of content you share is closely related to what you do; for example, in the case of the ARRC we will be curating information from organisations such as CSIRO Water for a Healthy Country Flagship, Murray–Darling Basin Authority, National Water Commission and Commonwealth Environmental Water, as the work of these organisations directly relates to the work we do in river restoration.

By synthesising the information from these organisations and sharing it via various social media platforms (Twitter, Facebook, LinkedIn), the ARRC will become more valuable to people, as the hard work of finding the links, drawing out key articles and organising the information so it is easily accessible, is already done. This enables further sharing of content through other people's social media and personal networks. In this way knowledge is widely shared and the ARRC continues to grow.

The trust, credibility, and authority content marketing creates, reduces the resistance some people feel about using web-based products. Increased communication for organisations fosters brand awareness, with social media providing a relatively inexpensive platform for organisations to implement marketing campaigns.

ARRC is excited about the changes that will be coming through from our content marketing approach. We intend to run workshops on social media and content marketing so stay in touch via the ARRC blog—www.arrc.com.au to find out when an event is on near you.

The ARRC is on Facebook and Twitter follow us @AustRiverRestor

**FOR FURTHER INFORMATION**
Sandra D'Souza—sandra@curatebee.com
Siwan Lovett—siwan@webone.com.au
http://www.curatebee.com

CURATE BEE

PHOTOS: HONEYCOMB, EMMANUEL BOUTET. PADDLER, THOMAS AND DIANNE JONES.

# New homes reserved for Macquarie Perch

**MARK LINTERMANS** AND **BEN BROADHURST** EXPLAIN THE RESULTS OF AN INNOVATIVE TRIAL ON THE POTENTIAL USE OF CONSTRUCTED HABITAT FOR MACQUARIE PERCH.

Above: Aerial view of some of the 7 kilometres of rock reef habitat. Photo courtesy of ACTEW Corporation.

A new trial shows constructed rock reefs could provide important habitat for Macquarie Perch under threat from changed reservoir and waterway conditions.

The establishment of constructed habitat at the Cotter Reservoir in the Australian Capital Territory (ACT) showed the Macquarie Perch used each of the habitats trialled, but rock reef was the preferred type. The study is the first of its type in Australia and one of few worldwide, it will have significant implications for future reservoir construction where threatened native fish will be impacted.

## Water enlargement threatens fish

To ensure Canberra's long-term water security the Cotter Reservoir (on the Cotter River) is being enlarged from 4 to 78 gigalitres (GL). The enlargement poses a number of threats to native fish species which inhabit the reservoir and inflowing waters. A range of projects have been carried out to identify these threats and provide management options. The main concern is the reduction in critical refuge habitat for adults of the endangered Macquarie Perch population which lives in the reservoir and river upstream. This population is the only self-sustaining population of Macquarie Perch in the ACT, and one of only a handful left in Australia.

**FOR FURTHER INFORMATION**
Mark Lintermans — mark.lintermans@canberra.edu.au
Ben Broadhurst — ben.broadhurst@canberra.edu.au
*Caring for Maccas* — http://www.youtube.com/watch?v=V3GxTclo-Ds

Cotter Reservoir has not been actively used for domestic water supply since the late 1960s and consequently the stable water level has resulted in the establishment of significant stands of emergent aquatic plants such as *Phragmites*, *Typha* and *Juncus* spp. A previous study identified these vegetation stands as important daytime refuge habitat which Macquarie Perch use to avoid predation by cormorants. The emergent aquatic plants are estimated to occupy about 30 per cent of shoreline around the perimeter of the Cotter Reservoir. It was thought the fluctuating water levels associated with the operation of the new enlarged reservoir would prohibit re-establishment of these plant stands and leave adult Macquarie Perch vulnerable to cormorant predation. As a result, alternative habitat was required in the enlarged Cotter Reservoir.

## Constructed habitat study

ACTEW Corporation funded a project through the Institute for Applied Ecology at the University of Canberra to determine if Macquarie Perch would use constructed habitat, and if so, did they show a preference for a specific type of constructed home. The habitats trialled were plastic pipe reef, plastic pipe reef with cormorant exclusion grills and rock reef.

To replicate future reservoir conditions, water levels were reduced by 2 metres to exclude the use of aquatic plants stands during the trial. Remote radio-telemetry and underwater video was used to assess and characterise the use of each habitat type by adult Macquarie Perch for one month each season.

## Results show success

Both methods showed Macquarie Perch used each of the constructed habitats trialled. Remote radio-telemetry of radio-tagged individuals did not show a clear preference for a constructed habitat type, but rock reefs were preferred in two out of three seasons. Review of the underwater video footage showed rock reef was the preferred habitat type of adult Macquarie Perch. The video also revealed juvenile and sub-adult Macquarie Perch preferred rock reef over the two pipe reef types.

Radio-tagged Macquarie Perch were manually tracked each season to study the scale of their movements and depth use. This information is critical in determining the location, size and spacing for the large-scale establishment of constructed habitats.

Along with the scientific approach, the project also featured Richard Snashell documenting the project in a video titled *Caring for Maccas*. The video is available on YouTube and details a range of projects concerning the enlarged Cotter Reservoir and Macquarie Perch.

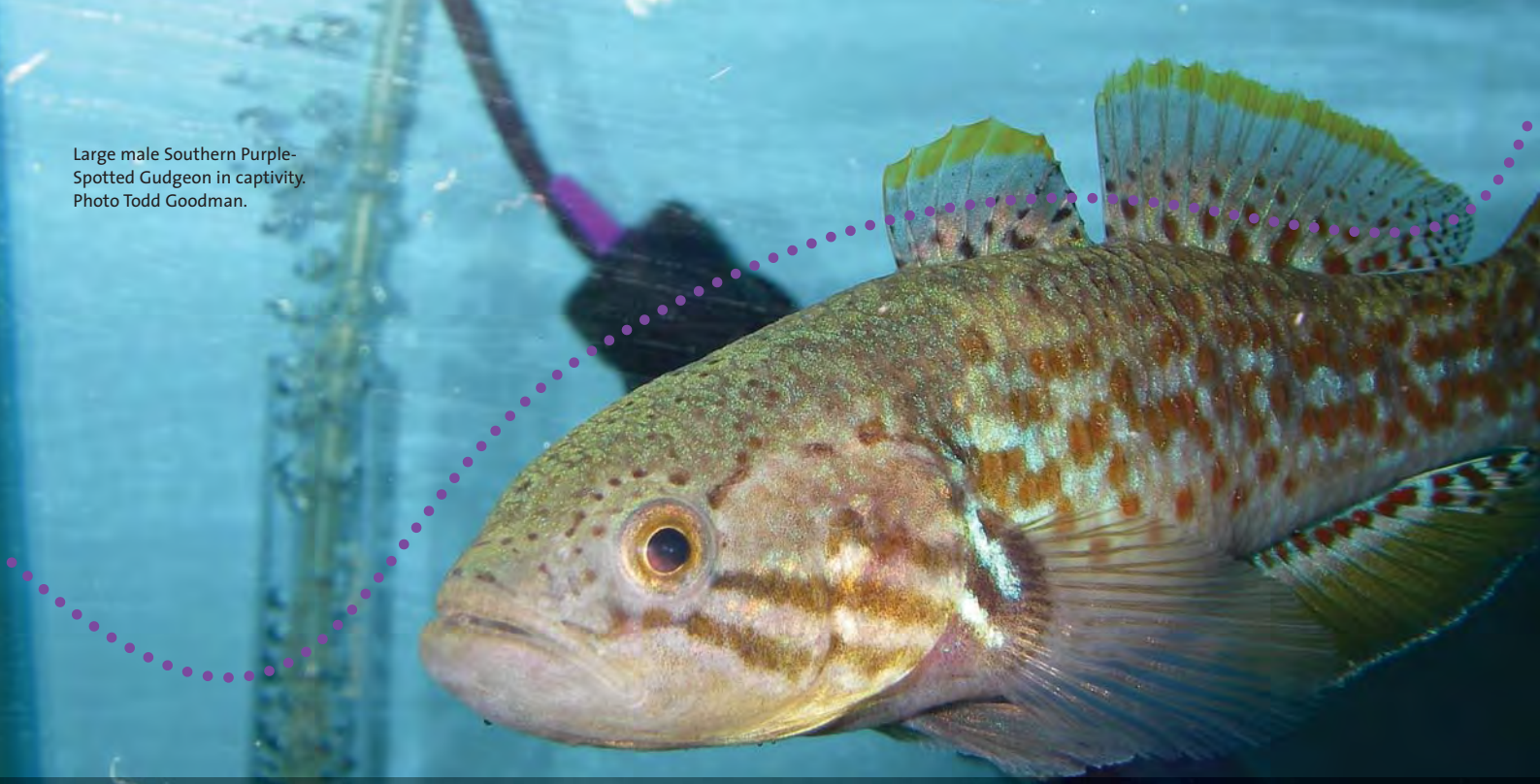
## Construction underway

Based on the trial results, large-scale establishment of constructed rock reef habitat is underway in the Cotter Reservoir with 6 kilometres installed. A long-term monitoring program has been started which will assess the Macquarie Perch population and predator abundance before, during and after filling of the enlarged reservoir. Monitoring program data will guide management to ensure the Macquarie Perch population is sustained.

PHOTO COURTESY OF THE AUTHORS.

Location of fish habitat (image on the previous page) within the Cotter Reservoir construction site. Photo courtesy of ACTEW Corporation.

MACQUARIE PERCH. PHOTO BENJAMINT444 (WIKIMEDIA COMMONS).



Large male Southern Purple-Spotted Gudgeon in captivity. Photo Todd Goodman.

# GUDGEON HITS A PURPLE PATCH

RESEARCHERS **ADAM WATT**, **NICK WHITEROD**, **CHRIS BICE** AND **MICHAEL HAMMER** EXPLAIN THE SUCCESSFUL REINTRODUCTION OF THE SOUTHERN PURPLE-SPOTTED GUDGEON NATIVE FISH SPECIES INTO SITES IN SOUTH AUSTRALIA AND THE ONGOING EFFORTS TO ENSURE ITS SURVIVAL.

## Distribution of the Southern Purple-Spotted Gudgeon

The Southern Purple-Spotted Gudgeon (*Mogurnda adspersa*) was once widespread and common in the lower River Murray in South Australia. Following a rapid decline in distribution and abundance, this species was declared regionally extinct in South Australia in the early 1990s, with the last verified record sampled in 1973 near Blanchetown (South Australian Museum specimen). The species was rediscovered in the Lower Murray in South Australia in late 2002, at Jury Swamp between Blanchetown and Wellington.

## Drought action plan development

Drought, river regulation and over-abstraction resulted in record low inflows during the period 2001–09, with Lake Alexandrina experiencing the lowest water levels in recorded history. Low water levels were accompanied by significant reductions in submerged aquatic vegetation cover, disconnection of habitats and increased salinity, exposing several threatened native small-bodied fish populations to extreme risk of local extinction.

As a result, the South Australian Department of Environment and Natural Resources (DENR) initiated the rescue to recovery 'Drought Action Plan (DAP) for South Australian Murray–Darling Basin threatened freshwater fish populations'. This project aimed to provide guidelines for the management and conservation of five species of small- and medium-bodied freshwater fish of national or state conservation significance in the South Australian Murray–Darling Basin (MDB). The Southern Purple-Spotted Gudgeon was one of the species targeted under the DAP.

**FOR FURTHER INFORMATION**
Adam Watt — adam.watt@sa.gov.au
Nick Whiterod — nick.whiterod@aquasave.com.au
Chris Bice — chris.bice@sa.gov.au
Michael Hammer — michael.hammer@aquasave.com.au

## Securing the Jury Swamp population

The population of Southern Purple-Spotted Gudgeon at Jury Swamp has been under significant threat since its rediscovery. In 2007, monitoring indicated conditions in Jury Swamp had deteriorated, with reduced water levels leading to the loss of critical habitat. Urgent action was necessary to ensure the short-term viability of the population. Management involved capture of the remaining individual fish and subsequent captive maintenance including:

- Fish were collected in 2005 and January 2007, with the next phase of rescues taking place in April 2007 following habitat drying and disease outbreak. In total, 56 fish survived the rescues and were held in captivity.
- Two hatcheries were established and have produced juveniles to back up broodstock and have been released into a surrogate refuge site. Fish released to this site have shown strong survival and wild recruitment.
- Two school programs have been established and these hold fish as backup and rear fish for release.
- The last Southern Purple-Spotted Gudgeon sampled from Jury Swamp was in spring 2009.

Monitoring of the Southern Purple-Spotted Gudgeon population and habitat conditions at Jury Swamp is ongoing and it is hoped the release of captive bred fish to enhance existing populations will happen soon.

## Reintroduction success

Drought conditions across the MDB have lessened and in 2010–11, broad-scale rainfall and significant inflows resulted in increased water levels to most catchments and sites where threatened fish species had previously been at risk. These conditions created potential for the reintroduction of the Southern Purple-Spotted Gudgeon into its former wild habitat.

A reintroduction framework was developed by the DAP to maximise the chances of successful reintroduction of the threatened fish into the Lower Lakes.

Conditions in Jury Swamp from 2010–12 remained unsuitable for the reintroduction of the Southern Purple-Spotted Gudgeon; therefore another reintroduction site was needed. In an innovative move it was decided to reintroduce the fish to the lower Finniss River, where the species has been historically abundant.

The first round of threatened native fish reintroductions were undertaken in November 2011, with about 200 Southern Purple-Spotted Gudgeon being released into the lower Finniss River. Reintroduced fish were 'calcein stained' before release to ensure they could be differentiated from any potential wild stock.

During follow-up monitoring in March 2012, three marked Southern Purple-Spotted Gudgeon were re-captured, all displaying good health. This represents the first record of the species in the lower Finniss River in more than 40 years and highlights the success of the reintroduction project.

A second round of reintroductions was carried out at the same site in the Lower Finniss River with about 400 Southern Purple-Spotted Gudgeon released in late March 2012.

Additional reintroductions and assessments will be carried out during the next 12 months in the lower Finniss River and reintroductions will occur at Jury Swamp as soon as environmental conditions improve.

A recaptured Gudgeon six months following reintroduction, the first record of the native fish in the lower Finniss River in South Australia in more than 40 years. Photo courtesy of the authors.

ACKNOWLEDGEMENTS

The success of this work has resulted from extensive collaboration between the Department of Environment and Natural Resources, Department for Water, Murray–Darling Basin Authority, Native Fish Australia (SA), South Australian Murray–Darling Basin Natural Resources Management Board and Flinders University.

Jury Swamp in dry and wet conditions. Photos Michael Hammer.

# More tales to tell

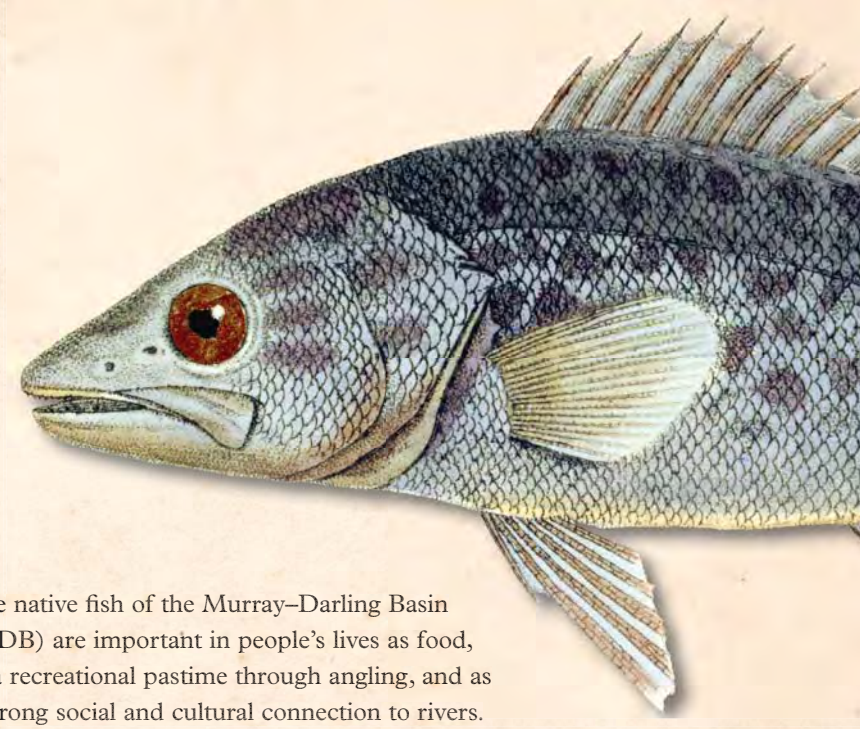
To keep in touch with all the latest True Tales products, events and information, join the Australian River Restoration Centre blog.

The blog comes out every few weeks and is packed full of information relating to river science, native fish, people and different ways of thinking about the work we do.

The blog is free and all you need to do it go to the ARRC website and click on subscribe!

**www.arrc.com.au**


# True TALES from a LOST WORLD



**WILL TRUEMAN** IS THE AUTHOR AND STORYTELLER OF THE TRUE TALES OF THE TROUT COD PROJECT AND EXPLAINS HOW THIS PROJECT HIGHLIGHTS THE STRONG SOCIAL AND CULTURAL CONNECTIONS MANY PEOPLE HAVE TO THE NATIVE FISH AND RIVERS OF THE MURRAY–DARLING BASIN.

The native fish of the Murray–Darling Basin (MDB) are important in people's lives as food, as a recreational pastime through angling, and as a strong social and cultural connection to rivers.

I discovered native fish in my childhood, mostly through family stories of past days when they had been common in north-east Victoria. By the 1960s my 'patch' in Victoria had changed, and native fish had largely been replaced by Redfin Perch, trout, and later European Carp. I then discovered the Seven Creeks (Victoria) which at the time contained healthy populations of native fish whose habitat had been spared from the invasion and impacts of exotic fish. Waterfall barriers prevented upstream access by Redfin Perch and carp and, although it had been regularly stocked with trout, the lack of suitable spawning habitat prevented the establishment of salmonids. The Seven Creeks later came into prominence as containing the last population of Trout Cod in Victoria, an enigmatic fish whose existence was only officially acknowledged as recently as 1972.


BOOKLETS ARE AVAILABLE FOR THE CENTRAL MURRAY, GOULBURN, LACHLAN, MITTA MITTA, MURRUMBIDGEE, OVENS, RIVERINA AND UPPER MURRAY CATCHMENTS. IN ADDITION THERE IS AN ANALYSIS AND HISTORICAL INFORMATION ON NATIVE FISH OF THE MURRAY–DARLING BASIN. FOR BOOKLETS, VIDEOS AND THE FULL DOCUMENT VISIT THE ARRC WEBSITE <http://arrc.com.au/mdb/troutcod>


## Gathering historical records

The Trout Cod intrigued me, as the fish was the subject of arguments about whether it had been a 'lowlands' species of the inland plains, or an 'uplands' species of the foothills and mountains. In 2006, I started a project to investigate what historical records and knowledge was available about Trout Cod. The project resulted in the production of a comprehensive historical record of larger native fish in the MDB and their original environments from the Macquarie catchment southwards. It has now been published as *True Tales of the Trout Cod*, with nine river and fish history booklets focusing on different areas of the MDB, a website and 19 'conversations' with me shared through YouTube.

While I collected a lot of information, and answered the original question about the distribution of the Trout Cod, I also made some other discoveries. The first is the inherent generosity of rural Australians who helped me by sharing their memories and photographs to construct the history. At the project's completion I had interviewed nearly 140 people from 20 to 95 years, and collected 400 photographs as far back as 1862. The people I interviewed were saddened by the changes they had seen to the rivers and native fish. It is the connection to the land which makes rural Australians the key players in our endeavours to repair the environment and achieve the aims of the Native Fish Strategy.

> *It makes me so sad to see what's happening down there, it makes me cry. These days, as I drift back through the years and think about my fishing in the Murrumbidgee, I can only say it may not have been heaven, but it was next door.* (Noel Denson, Tumut, 2008)

My second discovery was how much the riverine environments of the Basin have changed in less than two centuries. I read the original writings of the first Europeans to record the pristine environments in each catchment. The descriptions were Kakadu-like:

> *Swans, in the hot months, abounded on the river; for they came in from the dry lagoons to the water … Ducks of all kinds, teal and native companions (a great large crane), geese and swans abounded in flocks … Along the river you would see the great high-piled stick nests of the swans, so built on branches that they could rise or fall with the river.* (Lawrence Struilby, Mitta Mitta, 1842)

*…These days, as I drift back through the years and think about my fishing in the Murrumbidgee, I can only say it may not have been heaven, but it was next door.*

(Noel Denson, Tumut, 2008)

IMAGES THROUGHOUT THIS ARTICLE APPEAR IN THE *TRUE TALES* BOOKLETS AND ARE CREDITED SPECIFICALLY IN EACH DOCUMENT. GO TO THE ARRC WEBSITE BELOW TO ACCESS THESE BOOKLETS.

## Changed environment

As I travelled from catchment to catchment and recalled what they had been once like it was difficult to reconcile the past with the present. Although people will have an interest in True Tales to learn what fish were once present in what streams, it is the information providing comparisons between past and present day environments which are most powerful.

> *For fish and wildlife, the changes to original populations in some cases have been so slow and subtle as to be almost unnoticed, in others sudden and dramatic. There is something of a parallel in what we each experience by looking at our image in a mirror on a day to day basis and then at the photograph of years ago. Each day we appear exactly as we did yesterday, however the photograph shows the accumulated change.* (Jack Rhodes, Corowa, 1999)

The Murray–Darling Basin Authority's *Sustainable Rivers Audit* concluded, based on current native fish populations, many slopes, upland and montane habitats are in very poor condition. My work shows the situation is even worse, as I discovered substantial, diverse populations of native fish in areas not thought to support these fish. This means the Audit probably overestimated the health of many of these waters and they are in even poorer condition than currently recognised.

In my life time I have seen significant progress. Landcare groups are restoring riparian environments, environmental flows are being provided to waterways, snags are being returned to rivers, and barriers to fish migration removed. Trout Cod are making a comeback, with several reproducing populations becoming established from stockings. These are all positive signs.

True Tales is a valuable educational tool to increase awareness of current environmental issues and the need for action. By collating the historical descriptions of the fish and rivers of the MDB, a window into a lost world has been created. We can't change the past; we can only create the future. Achieving the goals of the Native Fish Strategy can only take place through the recognition of river managers, anglers and the community as to what the past was like and how the MDB can be improved in the future.

> *It's no use blaming what happened, in a lot of cases it was sheer ignorance, not knowing a new country. When you look at the rivers and see what's happened, well, they're not the same. I think we need to fix some of the rivers for the natives. One man can't make a difference, but a lot of men can.* (Frank Moore, Mansfield, 2006).

**FOR FURTHER INFORMATION**

http://arrc.com.au/mdb/troutcod

Will Trueman — williamtrueman@bigpond.com

# Communities help native fish to thrive

**JOHN KOEHN** AND **MARK LINTERMANS** HIGHLIGHT THE DECLINE IN NATIVE FISH NUMBERS IN THE MURRAY–DARLING BASIN AND HOW THE NATIVE FISH PROGRAM IS TACKLING THE PROBLEM THROUGH COMMUNITY INVOLVEMENT AND KNOWLEDGE SHARING.

Native fish populations in the Murray–Darling Basin (MDB) are in decline. It is estimated native fish numbers are about 10 per cent of what they were before European settlement. This is not a good record and we need to reverse the decline. With only 46 native fish species naturally occurring in the MDB, they must be managed carefully.

Nine species of native fish are nationally threatened with another 14 species listed under state threatened species legislation. There have been rapid declines in key recreational and commercial 'flagship' species (such as Silver Perch, Freshwater Catfish and Murray Cod) and declines in recreational angling success. Native commercial fisheries have long been closed and there are now 12 alien fish species to manage. Carp dominate fish numbers in many waters.

A range of threats have caused the decline in native fish, including changes to flows, dams and weirs, habitat removal and degradation, poor water quality, barriers to fish movements, alien species, exploitation and diseases.

## Strategy tackles rehabilitation

So how do we approach the significant task of rehabilitating native fish populations? It has been recognised it is important to increase native fish numbers and prevent further declines. It is a large and difficult job with so many species in trouble and so many threats to them, all happening across four states, the Australian Capital Territory (ACT) and, with a Commonwealth oversight.

The Native Fish Strategy (NFS) for the MDB has been developed to tackle this problem. It employs a whole-of–fish-community approach, in contrast to the single-species focus of many fish conservation programs. The NFS is a commitment by all six management jurisdictions to address existing threats, and reflects agreement on the need for urgent, coordinated action across state boundaries.

The NFS aims to rehabilitate native fish populations to 60 per cent of the levels which existed before European settlement. The emphasis is on rehabilitation rather than just maintaining current populations which would inevitably result in continuing declines and loss of species. Given it has taken more than a century to create the problem, the NFS has a 50-year time frame to attempt restoration.

Images: Hollands Creek Demonstration Reach field day. Other Demonstration Reach practitioners from around the MDB visited a project site on a property owned by the President of the HCDR Community Reference Group; Kevin Smith. Photos courtesy of the Hollands Creek Demonstration Reach.

**FOR FURTHER INFORMATION**

Murray–Darling Basin Authority Native Fish Strategy — www.mdba.gov.au

John Koehn — john.koehn@dse.vic.gov.au

Mark Lintermans — mark.lintermans@canberra.edu.au

**MURRAY–DARLING BASIN NATIVE FISH SPECIES**

Australian Smelt
Barred Galaxias
Bony Herring
Carp Gudgeons
Climbing Galaxias
Common Galaxias
Congolli
Darling River Hardyhead
Desert Rainbowfish
Dwarf Flat-headed Gudgeon
Estuary Perch
Flat-headed Galaxias
Flat-headed Gudgeon
Freshwater Catfish
Golden Perch
Hyrtl's Tandan
Lagoon Goby
Long-finned Eel
Macquarie Perch
Mountain Galaxias
Murray Cod
Murray–Darling Rainbowfish
Murray Hardyhead
Northern River Blackfish
Olive Perchlet
Pouched Lamprey
Rendahl's Tandan
Short-finned Eel
Short-headed Lamprey
Silver Perch
Small-mouthed Hardyhead
Southern Purple-spotted Gudgeon
Southern Pygmy Perch
Spangled Perch
Spotted Galaxias
Tamar Goby
Trout Cod
Two-spined Blackfish
Un-specked Hardyhead
Western Blue-spot Goby
Yarra Pygmy Perch

## Community action

Two key areas of the NFS are community and stakeholder involvement and the use of current knowledge. The engagement of communities and stakeholders is being carried out by using dedicated coordinators to work at a range of levels between states, agencies, local government and communities.

The NFS has developed 'demonstration reaches' at river sites where projects can be carried out, with community involvement, using a range of methods to address threats to native fish. The sites are working examples of how real rehabilitation can occur, and provide a focus for undertaking, testing and developing river restoration. (See pages 26–33.)

Links with the community are also strengthened through a Community Stakeholder Taskforce with particular emphasis on the involvement of anglers. A Native Fish Awareness week is held each year to publicise native fish through a range of community events.

Knowledge is king when delivering effective natural resource management. There is a need to gather information from past research and management, and to build on this with new knowledge to provide a scientific basis for future management.

The NFS is supported by a targeted number of priority research projects which include fish movements, biology of invasive species, behaviour and threats to larval fish, fish recruitment in relation to flows, the benefits of resnagging and results from intensive monitoring of fishways.

## Coordinated partnership

The NFS provides an effective partnership model where central coordination by the Murray–Darling Basin Authority, coupled with focused jurisdictional actions, can deliver benefits to all states and the ACT. It disseminates knowledge, integrates research and management and catalyses actions for priority problems which pose threats to native fish.

The NFS has fundamentally changed the way fish are managed in the MDB by taking a whole-of-the-fish community approach which provides coordination across all states, agencies, stakeholders and the community.

Importantly, it focuses on rehabilitation —not just managing the status quo. The NFS provides an approach which is suitable for restoring fish populations in many large river systems.

# Collaboration is the key to better Murray Cod fishing

**MATT BARWICK** FROM THE MURRAY COD FISHERY MANAGEMENT GROUP AND A PASSIONATE ANGLER EXPLAINS THE ALLURE OF ONE OF AUSTRALIA'S MOST ICONIC FISH SPECIES AND WAYS TO INCREASE THEIR NUMBERS IN OUR RIVERS.

A partnership between researchers, anglers, river managers and government representatives has been established to secure the future of the iconic Murray Cod fish for both conservation and recreational fishing. Declines in the population of Murray Cod have led to its listing as a nationally threatened native fish species. The preparation of a National Recovery Plan for Murray Cod highlighted many actions which can be carried out to recover the species, including many relating to the importance of recreational fishery. Recognising the need for collaborative action, researchers, managers, anglers, government representatives and research and development funding bodies have formed the Murray Cod Fishery Management Group (MCFMG) which aims to strengthen Murray Cod fisheries.

**FOR FURTHER INFORMATION**
Murray Cod Fishery Management Group—www.murraycod.org
Matt Barwick—matt.barwick@recfishingresearch.org

## The allure of Murray Cod

There is something special about Murray Cod. They are unparalleled as sport fish but I think the remote, peaceful, timber-filled waters you need to explore to find them also adds to their allure. Murray Cod are also important socially, economically, and culturally. A recent study in Victoria found 44 per cent of inland Victorian recreational fishers target Murray Cod, and their estimated direct expenditure in 2009–10 was $166.7 million. While we do not have similar data for other parts of the Basin yet, the total expenditure would be significant. Current investments in Murray Cod stocking are up to $1.2 million annually in Victoria and New South Wales.

There is no denying the importance of this species or the love affair anglers have with them. Nothing demonstrates this better than the increase in release after capture rates, with studies showing anglers release up to 77 per cent of the Cod they catch, and 85 to 98 per cent of these released Cod survive to be caught again.

Changes to fishing rules, the cessation of commercial fishing, stocking programs, and a shift in anglers attitudes towards custodianship of a great sports fish have played a role in the Murray Cod returning to parts of the Basin, with some fishers reporting "the best fishing ever" during recent years. Issues such as the 2010–11 fish kills due to 'blackwater' events which resulted in the loss of many large fish, however, mean there is still much to be done to ensure the future of the Murray Cod.

## Cod management

Murray Cod can only be properly managed with the most up to date knowledge. Significant research of the Murray Cod's biology, distributions, habitats, movements and breeding in the wild has been carried out during the past 10 years. It is important this new knowledge is made readily available to inform management decisions. The MCFMG's collaborative approach has examined what we know about the Murray Cod and pulled all this information together to develop a detailed assessment of the status of Murray Cod, including species distribution, how many fish there are, how big they are, whether they are spawning, and whether those young fish are surviving. This information is critical to enable a range of management options to be developed, such as setting bag and size limits, for a sustainable Murray Cod fishery.

### ACKNOWLEDGEMENTS

The Murray Cod Fishery Management Group is supported by the Murray–Darling Basin Authority's Native Fish Strategy and the Australian Fisheries Management Forum.

PHOTOS THROUGHOUT THIS ARTICLE COURTESY OF JAMIN FORBES.

Careful handling is the key to survival of Murray Cod.

## Research facts about Murray Cod

Many anglers may find the Murray Cod they are catching are older than they are! A study carried out in 1992 reported the age of a 1.4 metre long, 43 kilogram Murray Cod as being 47 years old. In another study the reported age of a 1.27 metre fish collected from the Murray River in 1996 downstream of Yarrawonga was 49 years old. It is likely there are even older Murray Cod swimming around out there—the largest Murray Cod ever caught was 113.6 kilograms, and has been estimated at between 74 and 114 years old.

Every Murray Cod stocked into Lake Eildon as part of the Million Murray Cod project funded through Victoria's recreational fishing licence have been marked with calcein, a harmless food dye which stains bony body parts, enabling researchers to learn more about the effectiveness of stocking as the fish get older.

Murray Cod were once thought to form pairs and spawn annually, but research carried out by researchers from the New South Wales Department of Primary Industries has shown Cod exhibit polygamy and polyandry (basically they sleep around).

Our understanding of spawning behaviour in Murray Cod has changed dramatically over the years. It was once thought Murray Cod require changes in flow to spawn, and this would prompt mature fish to undertake upstream spawning migrations. It is now known the species can spawn in both high and low flows, and only some of the mature population migrates upstream to spawn. Recent observations have also confirmed Murray Cod can also spawn in dam environments, with nesting Cod observed in Glen Lyon Dam (Queensland) and the southern basin of Blowering Dam (New South Wales). It is not yet known if the spawning were successful.

# Fishers unite to improve river health

**CHRISTOPHER COLLINS** IS THE CHAIR OF THE MURRAY–DARLING BASIN RECREATIONAL FISHING COUNCIL AND IS ENCOURAGING KEEN FISHERS TO PLAY A ROLE IN CARING FOR RIVER HEALTH AND NATIVE FISH COMMUNITIES.

Recreational fishing brings families together.

Recreational fishing groups have united to form the Murray–Darling Basin Recreational Fishing Council (MDBRFC) which aims to ensure rehabilitation efforts focus on native fish. Recreational fishing is the lifeblood of rural communities near the rivers and tributaries which form the Murray–Darling Basin (MDB). Recent research has shown about 430,000 fishers in the MDB spend $1.3 billion each year when fishing in the area, and support around 10,950 jobs throughout the Basin. The importance of fishing to MDB communities extends beyond dollars and cents, bringing families together and providing time to think and relax, along with the odd meal too.

Over the years, recreational fishers have observed a gradual decline in river health and fish communities, particularly during drought when the over-allocation of available water was evident. It was clear a new approach was needed, and the draft Basin Plan was developed.

Rec[reational] fishers were keen to have input into the draft Basin Plan but they were disappointed to find a lack of emphasis on providing for native fish needs. Access to water for the environment is important, but it needs to be delivered the right way and at the right times of year, to be of benefit for native fish. Other management strategies such as fishways on dams, improving fish habitat and allocating water for fish was also felt to be lacking in the draft Basin Plan.

The need to provide a unified voice for recfishers resulted in the formation of the MDBRFC which is an alliance of recreational fishing bodies from five states and territories throughout the Basin. It includes Victorian Recreational Fishing, the Capital Region Fishing Alliance, Native Fish Australia, Freshwater Fishing and Stocking Association of Queensland, NSW Council of Freshwater Anglers Inc., South West Anglers Association Inc. (NSW), Field and Game Federation of Australia, South Australian Recreational Fishing Advisory Council, Australian Fishing Trade Association, and Recfish Australia. Collectively, this Council represents the voice of more than 991,000 recreational fishers.

PHOTOS THROUGHOUT THIS ARTICLE COURTESY OF JAMIN FORBES.

Recfish Australia chair Russell Conway said "We may not see eye to eye on some issues, but we are a united voice in calling for healthier waterways and fish communities in the Murray–Darling Basin. That means more healthier habitat, enhanced fish passage, and obviously, water. It's important to remember that it's not just about volume too; water needs to be high quality, and flows need to be delivered at the right time and in the right way to optimise benefits for fish."

To date, MDBRFC members have attended meetings with Murray–Darling Basin Authority staff and government representatives to call for greater focus on native fish requirements. The MDBRFC has provided feedback on the proposed MDB plan, advising how it can be improved to provide greater benefit for native fish and recfishers. These collaborative efforts have also played a role in allowing recreational fishers to provide input to high level MDB management committees.

Australia Fishing Trade chief executive officer Alan Hansard said "There is a long road still ahead, but results so far really show what Rec fishers can achieve when we come together and cooperate on issues we all feel are important."

**FOR FURTHER INFORMATION**
Fish Habitat Network—
www.fishhabitatnetwork.com.au
Christopher Collins—
christopher@vrfish.com.au

# Return to **RipRap**

## WE NEED YOUR FEEDBACK

*RipRap* was first published in 1993 and from those early days grew to bumper editions of 60 pages (as this one) with 6000 hard copies printed, the last in 2008.

Though it's been some time since that edition, it is clear that *RipRap* was doing something right by connecting people interested in river restoration and management. If *RipRap* is to continue, we needs to demonstrate to potential sponsors that the 'new-look magazine' is read and valued by people working and living along our waterways.

The Australian River Restoration Centre, believes in *RipRap* and the importance of providing ways for people to share science and stories. We encourage you to complete a short survey about this edition. Go to **http://www.surveymonkey.com/s/SLNCVHX** or access the survey through **www.arrc.com.au**

The eight questions include what you liked about this edition, if it was too long or too short, how often you would like to receive it and what other topics you would like to see in future editions.

**We really need to hear from you!**

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# RESNAGGING THE MURRAY RIVER

**JAROD LYON** DETAILS A PROGRAM RESTORING WOOD TO THE MURRAY.

## Background

Trees, branches and logs which have fallen into river channels provide important structural habitat for fish. Historically, such habitat was removed from many rivers for riverboat navigation, water conveyance and infrastructure protection. These rivers include those of the Murray–Darling Basin (MDB) where records indicate several million trees were removed. Investigations into the status of native fish in the Basin have identified tree removal as a significant factor in the dramatic decline of native fish populations.

In recognition of the large amounts of in-stream habitat which have been removed, and to alleviate associated declines in native fish populations, the Murray–Darling Basin Authority (MDBA) started a project in 2003 to restore structural woody habitats (SWH). The project focuses on 194 kilometres of the Murray River between Lake Hume and Lake Mulwala and is designed to assist native fish recovery in this reach. Over 24,000 SWH were removed from this reach between 1976 and 1987, and an investigation in 2004 identified only 5000 SWH remaining. Native fish surveys conducted at the same time identified low abundance of native fish in comparison to neighbouring and less disturbed reaches. As a result, between 2004 and 2009 more than 4500 new 'snags' were reintroduced to this reach of the Murray River—part of the largest project of its kind undertaken in Australia.

## Monitoring

Given the history of widespread desnagging along large areas of the 2500 kilometre Murray River, it is important to provide a robust scientific evaluation of changes in native fish populations following resnagging efforts. Previous studies have provided clear evidence that native fish will use restored in-channel woody habitats. It is unclear however if this type of restoration will result in an increase in population growth (especially for threatened species), enhance distribution or assist recreational fisheries objectives. For example, does the process of in-stream habitat restoration actually increase the number of fish in a river, or does new habitat just act as a 'honey pot', localising already present fish without increasing total numbers. Achieving these criteria are important steps in recovering fish populations in line with the MDBA and Native Fish Strategy objectives. Understanding the contribution of woody habitat restoration to achieving these objectives will enhance future investment in this type of restoration by MDBA and its partner governments.

The data collection program is currently entering its seventh and final year. The data will be used to inform a model which measures change in fish population structure by the completion of the basic population growth formula of '$Population\ Growth_{(t+1)} = Nt + Birth - Deaths + Immigrants - Emigrants$'. This data is being collected using a multi-faceted approach, which includes electrofishing data to measure changes in Catch Per Unit Effort (CPUE) over time, passive tagging to inform mark recapture models (including survivorship),

PHOTO ABOVE © MDBA; PHOTOGRAPHER MICHAEL BELL

yearly trials to determine electrofishing efficiency, a large radio-tracking program to determine immigration and emigration rates and yearly mortality, and a research angler program to determine angler CPUE.

## Key findings

A multi-state Bayesian model is currently being constructed to allow a combined analysis of the various data sets collected (radio-tracking, mark-recapture, electrofishing detection, age structure and research angler). However, early analysis has shown a trend for increasing numbers of key native fish species such as Murray Cod and Golden Perch in the resnagging reach. Radio-tracking has also shown the resnagging reach (between Lake Hume and Lake Mulwala) is a net 'immigrator' of fish (i.e. more radio-tagged have moved into the reach than have moved out of it), with the major 'source' of fish being Lake Mulwala. In addition, densities of two key threatened species, Trout Cod and Silver Perch, have also increased markedly in the resnagging reach. During the last two years of the monitoring program, small numbers of young of year (i.e. one year old) Murray Cod have also been detected in the resnagging reach—an important finding given the first four years of sampling failed to locate these cohorts in the population.

## Management implications

There are several key learnings arising from the progress to date. These include:

- In rivers where bank stabilisation works are becoming increasingly used (thereby significantly reducing natural tree input to the river from eroding banks), the 'artificial' introduction of SWH needs to be incorporated into management plans.
- When undertaking in-stream habitat restoration, it is important detailed mapping is carried out to identify longitudinal 'gaps' in SWH. For example, it is better to target an area of low habitat density which is located between two areas of higher habitat density, to create a continuous area of habitat, and increase the cost-benefit from expensive resnagging works programs.
- Due to the long time frames needed to measure populations changes in long-lived, large bodied native fishes, monitoring programs should be designed and funded over a time frame which is likely to ensure biological responses can be determined.
- When designing programs for the reinstatement of in-stream habitat, take into account other prevailing environmental factors. For example, although the statistical modelling is yet to be completed, observations by field teams working on the project show positive responses of native fishes have been greater further away from the impacts (cold water, high water velocities) of Lake Hume. As this work is expensive, it is prudent to try and make sure the main limiting factor in the fish population is lack of habitat.

"Anyone who has an affinity with freshwater fish, from anglers to stream managers to researchers, understands the importance of habitat. We have got a long way to go to repair the damage of the past, but through projects like this, and also through better catchment management including riparian restoration, the future for our native freshwater fish seems more secure."

PHOTO COURTESY OF THE AUTHOR.

**FOR FURTHER INFORMATION**

Jarod Lyon — jarod.lyon@dse.vic.gov.au

Hear Jarod on Radio National's Bush Telegraph talking about the need for wood in rivers, as well as the differences between Trout Cod and Murray Cod — http://abc.net.au/rural/telegraph/content/2012/s3547526.htm

# Show us how it's done

TEAMS FROM ACROSS THE MURRAY–DARLING BASIN EXPLAIN THE RESULTS FROM SEVEN DEMONSTRATION REACHES WHICH AIM TO IMPROVE RIVER HEALTH AND NATIVE FISH POPULATIONS, AS WELL AS RAISING COMMUNITY AWARENESS.


Electrofishing on Blackrock Gorge near Scottsdale. Photo Mark Jekabsons, Upper Murrumbidgee Demonstration Reach.

Preliminary results from seven demonstration reaches throughout the Murray–Darling Basin (MDB) highlight a range of successful outcomes including increased native fish numbers, riparian revegetation, improved water flow and fish passage and weed removal. The demonstration reaches were established as part of the MDBA's Native Fish Strategy. The goal of the strategy is to rehabilitate native fish communities in the MDB back to 60 per cent of their estimated pre-European settlement levels. Native fish populations in the MDB have declined due to a range of threats including flow regulation, habitat degradation, lowered water quality, man-made barriers to fish movement and the introduction of alien fish species.

One of the key objectives of the strategy was to establish a range of large-scale river demonstration sites to increase community awareness of ways to improve native fish numbers, and provide practical examples of river rehabilitation. The sites include:

- **Brewarrina to Bourke** Demonstration Reach project along the Barwon–Darling River, New South Wales
- **Dewfish** Demonstration Reach incorporating parts of Myall Creek, Oakey Creek and the Condamine River, Queensland
- **Katfish** Demonstration Reach Project on the Katarapko/Eckert Creek anabranch system between Berri and Loxton along the River Murray, South Australia
- **Namoi** Demonstration Reach along the Namoi River between Gunnedah and Narrabri, New South Wales
- **Ovens** Demonstration Reach on the Ovens River near Wangaratta, Victoria
- **Upper Murrumbidgee** Demonstration Reach along the Upper Murrumbidgee River between Bredbo, New South Wales and Casuarina Sands, Australian Capital Territory
- **Hollands Creek** Demonstration Reach along the Hollands Creek near Tatong, Victoria.

# BREWARRINA TO BOURKE
## DEMONSTRATION REACH

The Brewarrina to Bourke Demonstration Reach was established for the rehabilitation and protection of aquatic habitat and native fish populations along the Barwon–Darling River. Various on-ground works and community awareness activities have been carried out along a 207 kilometre stretch of river extending from the Brewarrina Weir to the Bourke Weir.

The project demonstrates a range of best practise management methods to alleviate the pressures affecting native fish species, including improved fish passage at Brewarrina and Bourke weirs, riparian zone management and reinstating in-stream habitat.

Some of the main project outcomes include the construction of a reverse rock-ramp fishway at Brewarrina Weir, reinstatement of over 400 structural woody habitats (snags) across 11 sites, and significant community engagement, including eight carp musters involving hundreds of participants and removing several hundred kilograms of carp from the river.

Stream bank works include weed control covering 100 kilometres of riverbank, planting of more than 8500 local provenance trees, remediation of eroding gullies and the provision of riparian fencing and alternative livestock watering points.

*continued overleaf*

**FOR FURTHER INFORMATION**

Sam Davis — sam.davis@dpi.nsw.gov.au

David Cordina — david.cordina@dpi.nsw.gov.au.

http://www.fishhabitatnetwork.com.au/demonstration-reaches/

# DEWFISH

## DEMONSTRATION REACH

BREWARRINA TO BOURKE CONTINUED

Preliminary results from fish monitoring have indicated native fish are beginning to respond favourably to the interventions within the demonstration reach and in particular, are using reinstated structural woody habitat at the resnagging sites.

An important part of the project has been the involvement of a variety of stakeholders including landholders, local government, communities, schools and other state government organisations to implement on-ground works and community awareness activities. Those managing the demonstration reach believe that through education and involvement, the community will be able to better manage the health of the riverine environment and native fish populations beyond the project timeframe.

### ACKNOWLEDGEMENTS

The project is a collaborative agreement between the Western Catchment Management Authority and the Conservation Action Unit of NSW Department of Primary Industries, with additional funding from the Murray–Darling Basin Authority, NSW Environmental Trust, NSW Recreational Fishing Trusts and State Water Corporation.

Photos throughout these pages supplied courtesy of the demonstration reaches.

The Dewfish Demonstration Reach stretches for more than 110 kilometres and has fast become the flagship project for the Condamine River Rescue program led by natural resource management group Condamine Alliance. Strong community and industry partnerships have also attracted additional funding which has helped to achieve the project's aims.

One of the major project outcomes has been an upgrade to the Loudoun Weir fishway which has improved fish passage by up to 150 kilometres and resulted in the return of three native fish species not seen in the catchment for up to 15 years, including Moonfish in Myall Creek. Other project results include:

- increased numbers of Golden Perch, Bony Bream and Eel-tailed Catfish have also been recorded in high intervention areas,
- installation of snags, logjams and lunkers at five sections,
- revegetation of riparian areas with more than 5000 native trees and plants,
- off-stream watering points erected on five sections of Oakey Creek,
- removal of more than 800 kilograms of pest fish,
- extensive biodiversity surveys of Myall Creek, Loudoun Weir Pool and Oakey Creek.

**"This project is the best thing that has ever happened to Oakey Creek…there is no way we could have recovered this area without the help of Condamine Alliance."**

Noal Kuhl (pictured), Oakey Freshwater Fish Stocking Association

**FOR FURTHER INFORMATION**

Carl Mitchell — carl.mitchell@condaminealliance.com.au
www.condaminealliance.com.au

# KATFISH
## DEMONSTRATION REACH

Community awareness has also been vital with the project joining forces with local schools to develop riparian educational programs, involving local fish stockers in creel surveys to monitor native fish populations and educating fellow anglers about the dangers of translocating pest fish.

The Reach Steering Committee is made up of a range of community representatives from local and state government, the Condamine Alliance, Murray–Darling Basin Authority and local schools.

Above: Installing snags at Bowenville Reserve as part of the Dewfish Demonstration Reach near Condamine in Queensland.
Below: The Loudoun Weir fishway.

The Katfish Demonstration Reach project covers an area of nearly 9000 hectares and traverses over 38 kilometres of River Murray frontage. The site is a South Australian River Murray priority floodplain.

One of the major threats to river health in the area is the lack of environmental flows. To halt the widespread ecological decline currently being experienced, the project plans to implement a range of water and fish passage management options to achieve an adaptive hydrological system. Manipulating the site's hydrology will lessen the impact of future droughts and climate change.

The hydrological adaptive system will be created by:

- increased flows and fish passage through 56 kilometres of waterway,
- flooding at low flows of more than 1000 hectares of floodplain,
- temporary partial drying and variable pool levels along 20 kilometres of waterway and associated wetlands.

*continued overleaf*

Above: Katarapko Creek is a slow flowing creek, with a diverse in-stream habitat including small and large bodied fish. Dominant species include Golden Perch, Bony Herring, Un-specked Hardyhead and carp. The Katfish Demonstration Reach project is aiming to improve water flows and fish passage in the Katarapko Creek.

Right: The Katarapko stone weir is a major barrier to Katarapko Creek, and is proposed to be modified to increase fish and flow passage as part of the Katfish Demonstration Reach.

**FOR FURTHER INFORMATION**
Michael Harper — michael.harper@sa.gov.au
www.katfish.org.au

# NAMOI
## DEMONSTRATION REACH

KATFISH CONTINUED

Funding has been secured through the Murray Futures Riverine Recovery Project to implement part of the project plan which includes:

- replacing six major in-stream barriers to improve water flow management and fish passage through the Katarapko and Eckert creeks,
- developing an integrated hydrological plan,
- further monitoring,
- securing the current Murray Hardyhead native fish population at the Berri Saline Water Disposal Basin,
- restoring the Katarapko Island Saline Water Disposal Basin.

"Katfish Reach has been a very rewarding project, bringing together the community and government to conserving and improving our natural environment."
Kevin Smith, Chairperson,
Katfish Reach Steering Committee

As part of the Katfish project, the hydrology of the Berri Saline Disposal Basin will be managed to secure the current native fish population of Murray Hardyhead. Photo Michael Hammer.

The Namoi Demonstration Reach was established in 2007 as part of the Namoi Aquatic Habitat Initiative, which recognised native fish populations and river health had significantly declined in the Namoi catchment. Since the project started, a range of on-ground activities has been completed including:

- reintroducing 300 snags at priority sites,
- replanting 5700 aquatic plants at priority sites,
- planting of more than 9000 native trees and shrubs,
- completing 33.5 kilometres of woody weed management,
- completing 33.5 kilometres of riparian fencing,
- installing 20 off-stream watering points,
- constructing eight in-stream and gully erosion protection works.

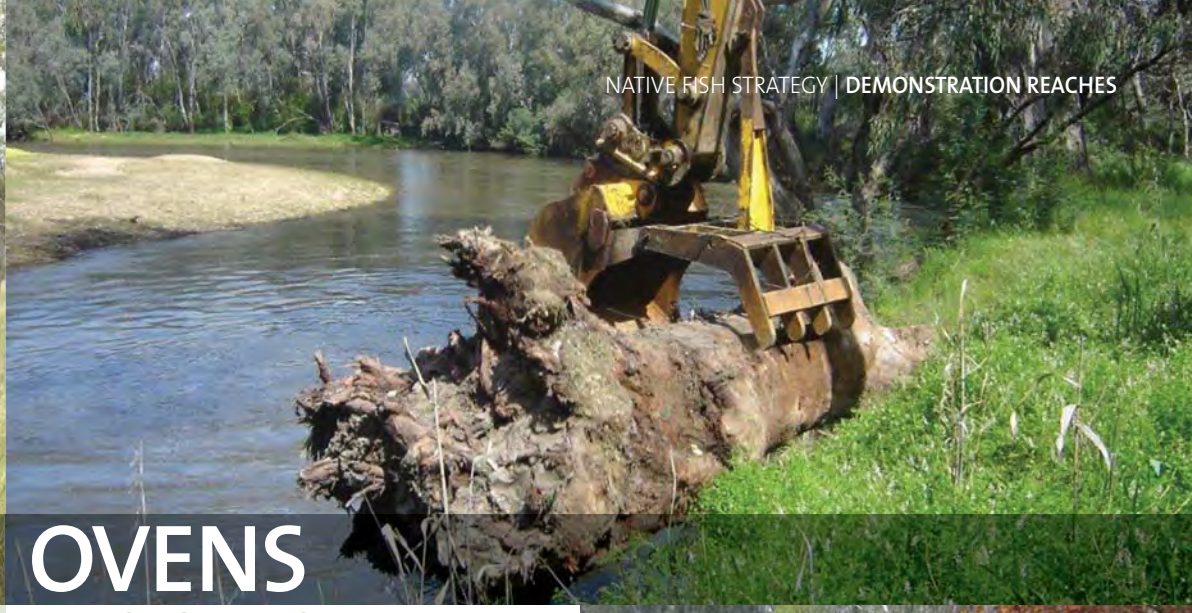
The Namoi Demonstration Reach has achieved significant community ownership of the river. Strong partnerships have been forged with more than 25 stakeholder groups, including federal, state and local government, community groups, local landholders, businesses and schools. Community engagement has involved workshops with recreational fishers, Aboriginal communities, and landholders, through to environmental education days and carp muster events.

The change in community attitude towards the demonstration reach and the benefits to native fish has also been encouraging. Local community members and landholders who have lived on the river all their life are now showing an interest in the innovative solutions to aquatic and riparian health issues, including resnagging activities.

Local fishers are also benefiting from the resnagging works, with anecdotal evidence and observations indicating Murray Cod and Golden Perch are occupying the newly created habitats in the Namoi River.

"Having the river fenced off makes life that much easier. We can control stock access and will have a more reliable water supply. We are also controlling the willows and planting native trees along the river, so it's a win-win situation. Not only do we benefit but it's good for the health of the river and the fish."
Tim Tapscott, East Bresrow, Boggabri, New South Wales

**FOR FURTHER INFORMATION**
Milly Hobson — milly.hobson@dpi.nsw.gov.au



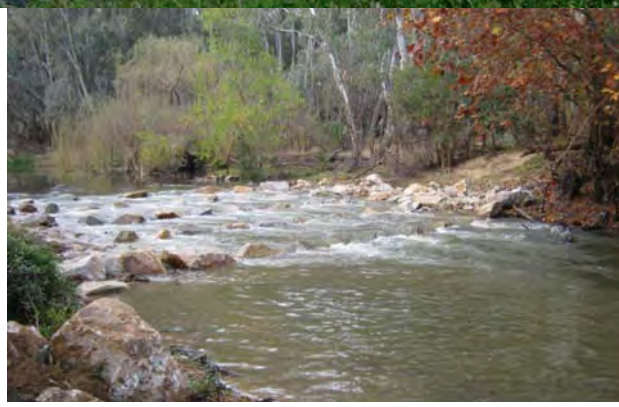
# OVENS
## DEMONSTRATION REACH

**Acknowledgements**
Funding for the Namoi Demonstration Reach has been provided by Namoi Catchment Management Authority, Murray–Darling Basin Authority and the NSW Department of Primary Industries. Inkind support has also been provided by local industry, councils, fishing clubs, community groups and individual landholders.

The Ovens River Demonstration Reach project started in 2007 to highlight the benefits of using a combination of river health management actions to increase fish numbers. The Ovens River was chosen due to high environmental values downstream of Wangaratta and the known presence of several endangered native species including Murray Cod, Trout Cod and Macquarie Perch.

So far, the project has targeted the Ovens River directly upstream of Wangaratta using a range of management interventions including woody weed removal, stock exclusion, increased snag loading and riparian revegetation. The reach was chosen for its easy access for all river users to observe the projects' activities and increase community awareness.

Community engagement for the project has been strong, with individual landholders whose properties adjoin the Demonstration Reach area targeted to improve their riparian management practices. Incentives such as fencing materials, weed control and supplying off-stream watering points for stock after river frontages have been fenced off, have been offered.



Demonstration stalls have been well attended at the Wangaratta Fishing and Camping Show, and Native Fish Week, which were aimed at creating greater community awareness about river rehabilitation. Local carp removal demonstrations have improved the community's awareness about exotic fish species. School groups have also been educated about the importance of the Ovens Demonstration Reach as a refuge for endangered native species.

Severe bushfires and flood which resulted in above average river heights have posed challenges to the project. Despite this, many successes have been achieved including:

- reintroduction of more than 150 hardwood snags to improve stream habitat,
- removal of 11 kilometres of willow and woody weeds,
- establishment of 5 kilometres of riparian fencing and revegetation works,
- construction of the Wangaratta Fish Ladder to allow fish species to access the upper reaches of the Ovens River past an artificial weir.

**FOR FURTHER INFORMATION**
Anthony Wilson —
anthony.wilson@necma.vic.gov.au

# UPPER MURRUMBIDGEE

## DEMONSTRATION REACH

Established in 2009, the Upper Murrumbidgee Demonstration Reach is the youngest of the seven reaches in the MDB. The Upper Murrumbidgee River has a history of aquatic and riparian habitat loss due to land use practices. In many areas of the catchment this has led to a highly degraded river and a significantly altered native fish community.

Despite this degradation, the Upper Murrumbidgee River is valued as a significant riverine ecosystem containing critical habitats for several threatened species, including Trout Cod, Murray Cod and Macquarie Perch.

On-going works are focused on woody weed control, managing stock access to the river, restoring native vegetation along the banks and in-stream, engaging communities, encouraging adoption of best management practices, improving fish passage and recreating geomorphic complexity.

Currently, the Tharwa Fish Habitat project is a focus for activities. Large sections of the Upper Murrumbidgee Reach area suffer from sedimentation and establishment of 'sand slugs', which smother critical habitat and breeding areas for native fish, and inhibit the migration needed to better quality habitat up and downstream for the completion of life cycles. The project aims to recreate in-stream habitat, including engineered log jams, and improve fish passage.

Community engagement of key stakeholders is an ongoing activity and strong relationships have been formed with local fishing groups, schools, landholders and community groups.

Annual fish monitoring is now being carried out and has recently detected a range expansion of Murray Cod and natural recruitment of the endangered Trout Cod.


### ACKNOWLEDGEMENTS

The reach is a collaborative partnership between the ACT Government, Murrumbidgee Catchment Management Authority, NSW Department of Primary Industries, local communities and the Murray–Darling Basin Authority's Native Fish Strategy.


Trout Cod and Murray Cod are frequently caught in Kambah Pool on the Murrumbidgee, ACT. Photo Mark Jekabsons.

Inset: Willow control workshop. Below: ACT Australia New Guinea Fishes Association community sampling under scientific research permit. Both photos Charlie Carruthers.


**FOR FURTHER INFORMATION**

Lisa Evans — lisa.evans@act.gov.au

Felicity Collins — felicity.collins@cma.nsw.gov.au

http://www.upperbidgeereach.org.au/

# HOLLANDS CREEK

## DEMONSTRATION REACH

The Hollands Creek Demonstration Reach (HCDR) is focused on protecting and expanding suitable habitat for Macquarie Perch populations which are currently restricted to a few remaining streams in the catchment.

The program, which has been in place for more than three years, has implemented a range of on-ground works including fencing, revegetation, pest plant control, habitat creation, monitoring and community activities.

To determine the project's success, ongoing monitoring of stream conditions and fish populations is being carried out. Surveys monitor the fish community, macroinvertebrates and water quality at each site. Recent results include:

- an increase in the Macquarie Perch population and geographic distribution,
- altered in-stream habitat as a result of flooding,
- improved connectivity between four sites enabling Macquarie Perch to access habitat previously unavailable to them,
- the presence of the Two-Spined Blackfish in the reach, and survey results revealing even higher numbers of these fish, along with the highest abundances recorded for River Blackfish since the project began,
- the decline in numbers of some alien fish, including Gambusia and Redfin Perch,
- the increase in Brown Trout abundance,
- the decline of small native fishes.

Ongoing community involvement will continue, including an extension of the Talking Fish project (see pages 38–39) as well as fostering greater school student and community involvement through regular field days and visits to the reach.

### ACKNOWLEDGMENTS

Murray–Darling Basin Authority's Native Fish Strategy Team.

TOP PANEL PHOTOS
Left: Annual surveys in HCDR involve both backpack electrofishing and fyke netting; Dr Scott Raymond of the Arthur Rylah Institute, Victorian Department of Sustainability and Environment, with a captured, tagged Macquarie Perch.

Right: Demonstration Reach practitioners from around the MDB visited a project site on a property owned by the President of the HCDR Community Reference Group; Kevin Smith. Kevin (left) is shown discussing HCDR actions with Kevin Graham, from the Dewfish Demonstration Reach.

FRAMED PHOTOS
Top right: At the start of the project, a range of threats to the Hollands Creek was identified; fencing to reduce stock access to the creek is progressing and now only a very few landholders still allow stock access.

Above right: Kevin Smith records his stories from generations of his family on the Hollands Creek, as part of the recent MDBA Native Fish Strategy Talking Fish project.


Right: HCDR project signage.

Below: Taungurung elder Uncle Larry Walsh's storytelling session at the HCDR field day.

**FOR FURTHER INFORMATION**

Fern Hames—
fern.hames@dse.vic.gov.au
www.gbcma.vic.gov.au/hollandscreek

Work at Coonancoocabil Lagoon will facilitate the ongoing development and refinement of the decision support tool. Photo Anthea Brecknall.

# Commissioning water for fish

*Optimising environmental protocols to benefit native fish populations* was a collaborative project funded by the National Water Commission under the Raising National Water Standards program and undertaken by the Murray–Darling Freshwater Research Centre (MDFRC), a multi-disciplinary research organisation based in Wodonga, Victoria, in partnership with the Arthur Rylah Institute for Environmental Research.

Delivered in late 2011, it is one of only a few studies which have investigated the fine-scale relationships between the application of environmental water, wetland habitat characteristics and the fish community. The project aimed to provide critical information to water managers on how to make best use of environmental water to sustain native fish populations.

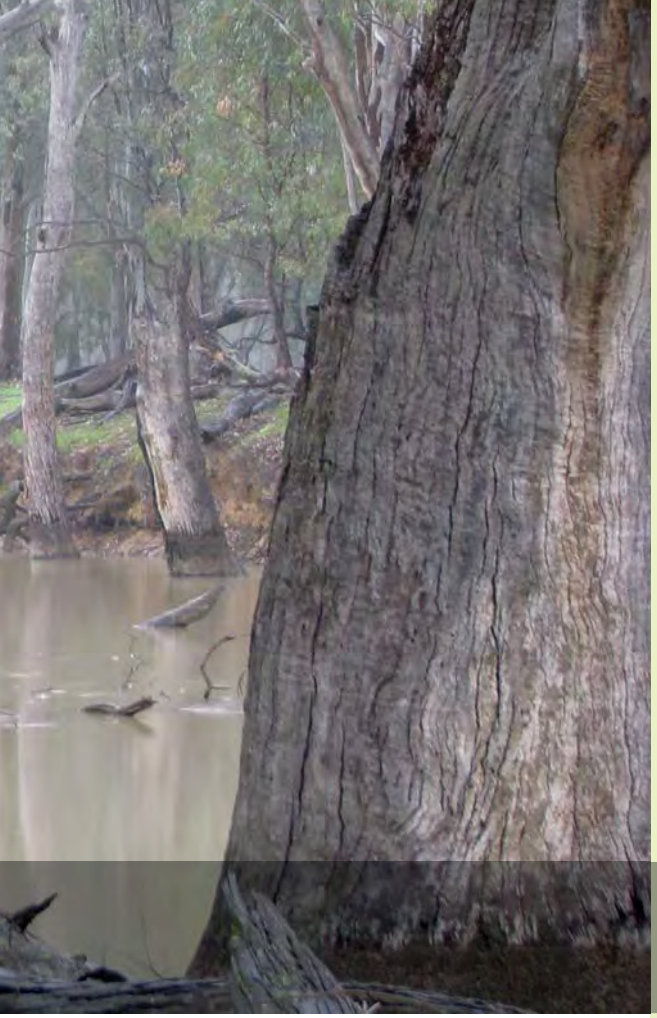
The National Water Initiative calls for best available science which allows for informed judgement on the trade-offs between competing outcomes for water systems, and the need for knowledge which demonstrates ecological outcomes from environmental flow management. The knowledge, information and tools generated through this project assist water managers in achieving this goal.

A number of key findings resulted from the field-based research. The research team found wetlands are productive hotspots in floodplain riverine landscapes—this is the first time the importance of floodplain wetlands to the overall productivity of fish populations has been quantified in Australia. It was determined the method of delivery of environmental water is critical to boosting fish numbers in wetlands and delivery through natural flow or regulators provides greater fish recruitment than delivery methods which limit fish passage into the wetland, such as pumping. The timing of water delivery is important—short-term fish recruitment can be maximised if water delivery coincides with fish spawning seasons. Appropriate water sourcing from rivers or large permanent creeks will benefit short-term fish abundance rather than depauperate sources such as irrigation channels.

**FOR FURTHER INFORMATION**

National Water Commission—http://nwc.gov.au/

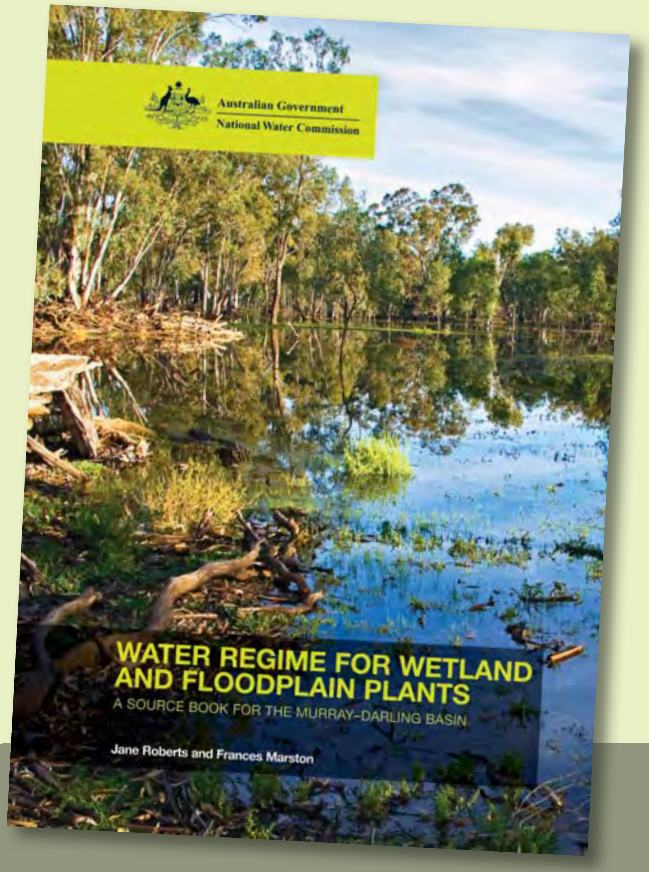
Murray–Darling Freshwater Research Centre_http://www.mdfrc.org.au/



These findings were translated into recommendations of relevance to water managers and cover such issues as identification of wetland prioritisation, the focus of conservation outcomes and specific comment on the water regimes required for native fish abundance. The research team comment strongly on the contribution strategically optimised monitoring can make to the adaptive management process and the importance of long-term data to inform research and management over time. The collaborative approach and appropriate integrated institutional arrangements are also crucial to achieving sustainable outcomes.

Further information on the project and the resulting tools and products can be located as follows:

- the report *Watering floodplain wetlands in the Murray–Darling Basin for native fish* can be found on the National Water Commission website,
- access to the Fish-in-Wetlands Decision Support Tool and information on the demonstration wetland, Coonancoocabil Lagoon, can be located on the MDFRC website.




# PLANTS IN DAMP PLACES

*Water regime for wetland and floodplain plants: a source book for the Murray–Darling Basin*, by Jane Roberts and Frances Marston

This updated volume, authored by Dr Jane Roberts and Mrs Frances Marston and published by the National Water Commission, captures the wealth of research knowledge generated over the past decade about effective vegetation management as part of the ecology of our inland wetland and floodplain systems. Nineteen species were selected for their ecological importance and relevance to flows and flow management of Basin wetlands, floodplains and rivers. For each species, details are provided on the water regime, what is known about its ecological dependency on flow and the effect of this on growth, survival and capacity to reproduce.

The book is an invaluable resource for everyone involved in wetlands and floodplain management in the Murray–Darling Basin.

**FOR FURTHER INFORMATION**
http://nwc.gov.au/publications/topic/environment/water-regime-for-wetland-and-floodplain-plants

# A longer look at riparian restoration

**PAUL REICH** AND **SAM LAKE** EXPLAIN THE RESULTS OF A PROJECT UNDER WAY IN THE MURRAY–DARLING BASIN TO ASSESS THE RESPONSE OF RIPARIAN AREAS TO LIVESTOCK REMOVAL AND REVEGETATION.

Positive responses to a range of riparian management efforts have been recorded in a project underway in the lower Murray–Darling Basin (MDB).

Riparian zones support a range of important ecological functions, many of which are beneficial for native fish. Healthy riparian zones are a major source of the organic matter which drives stream food webs and also supply woody structure which provides fish with shelter, feeding and spawning habitat. Intact riparian zones also filter nutrients and reduce water temperature through shading, improving water quality for aquatic biota.

Restoring degraded riparian zones is a major focus of waterway natural resource management across Australia, costing millions of dollars annually. Despite the significant outlay, the ecological effectiveness of riparian management is often based on limited evidence. As a result there is little understanding of how streams and their riparian zones respond to management efforts and what indicators are best measured to document change.

PHOTOS THROUGHOUT COURTESY OF THE AUTHORS.
EARTH TEXTURE BITTBOX.

## LONG-TERM RIPARIAN STUDY

Since 2004, a project has been underway in the southern MDB to evaluate the ecological responses to restoration of River Red Gum-dominated riparian zones along five streams.

The main project objectives are to document the response of degraded lowland streams and their riparian zones to livestock removal and replanting and to assess a range of in-stream and land indicators. The project results will be used for the implementation and monitoring of riparian restoration works across the MDB.

Study sites along five lowland tributary streams in the southern MDB have been fenced off to exclude livestock and replanted with native vegetation. Each site comprises 1 kilometre of stream length, and restoration works have been carried out on both sides of the stream to a minimum width of 20 metres from the stream channel.

## INFORMATION COLLECTION

Data was collected from each site one year before any management activity and have since been re-measured. Measurements have also been collected from similar sites located about 4–5 kilometres upstream where management practices were left unchanged. These locations provide a control for comparison with the trial sites.

**FOR FURTHER INFORMATION**

Sam Lake — sam.lake@monash.edu
Paul Reich — paul.reich@dse.vic.gov.au
www.riparian.net.au

The project is assessing the ecological response to riparian management including livestock exclusion and replanting at a range of sites in the southern Murray–Darling Basin. The aerial photo above was taken at one of the trial sites along Faithfuls Creek in the Goulburn–Broken region, Victoria.

Indicators were chosen to represent a range of timeframes over which responses were expected to occur including short- (1–3 years), medium- (3–8 years) and long-term (more than 10 years). The timeframes were determined through conceptual modelling and outlined the predicted timing, direction and magnitude of each response to livestock exclusion and replanting. The variables included:

- land use, hydrology,
- geomorphology, soil properties and nutrients,
- vegetation—land and aquatic plants,
- leaf litter and coarse wood,
- water quality,
- fish, aquatic macroinvertebrates and birds.

## POSITIVE RESTORATION RESULTS

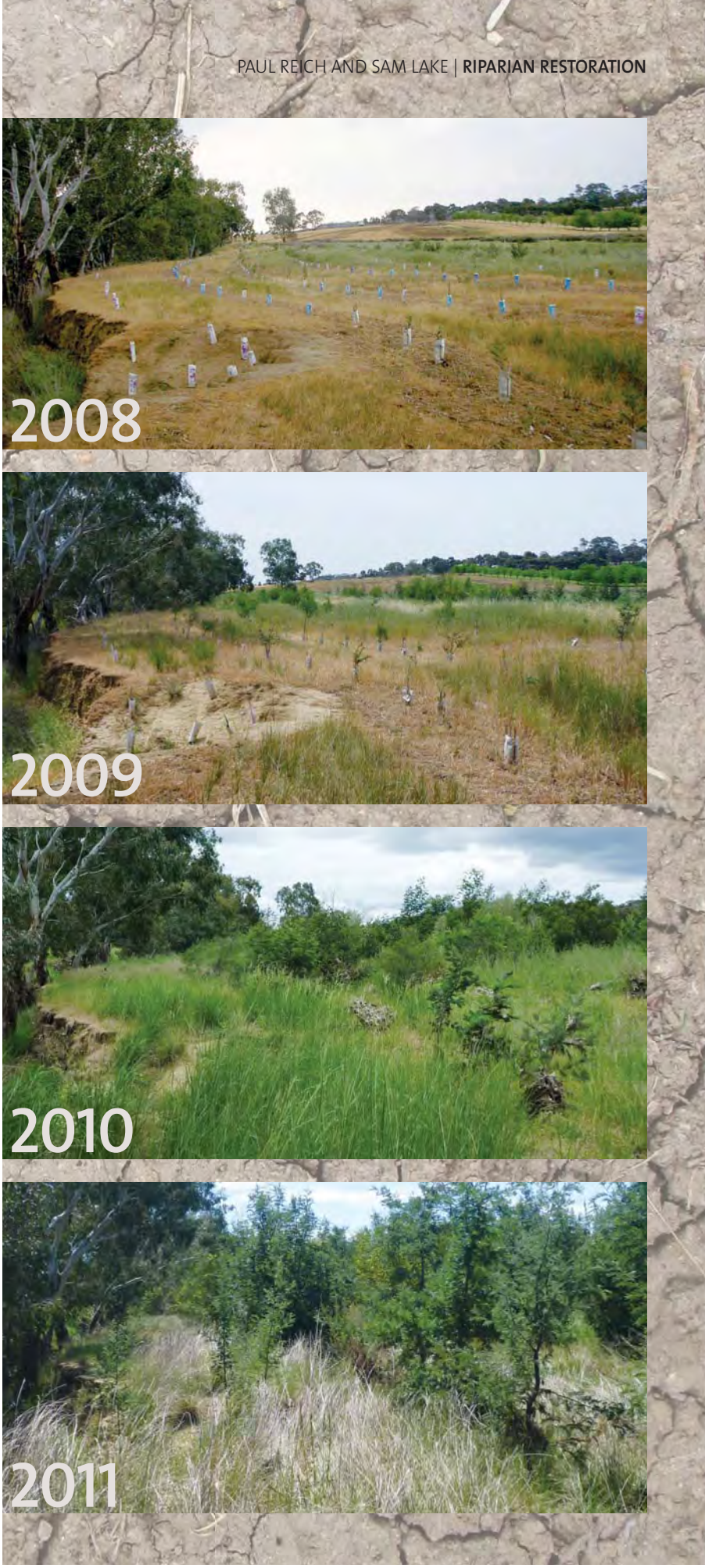
Despite a severe drought affecting all sites between 1997 and 2010, there has been a positive response to restoration activities. There have been reductions in bare ground and increases in plant and litter cover at trial sites, compared with the controls. Successful recruitment of River Red Gum seedlings has also occurred at some sites.

Most of the ground, however, comprises exotic species. An examination of the soil seed bank at several sites showed exotic weeds dominated and most native plant seeds were rare or absent.

Insufficient time has passed to evaluate whether aquatic responses will occur as the aquatic plants, fish and macroinvertebrates all declined in response to drought. Although the results indicate livestock exclusion increases the ability of some birds and plants to persist through drought.

Data collected to benchmark pre-restoration conditions across all sites have revealed some clear relationships between riparian condition and key response variables. For example, riparian canopy closure of more than 50 per cent was required before leaf litter consistently accumulated in the stream. Work has since shown this litter forms the main resource at the base of aquatic food webs in these systems.

The results indicate riparian restoration is a long-term venture and requires commitment by management agencies. Natural disturbances such as floods and droughts will impact on the expected environmental response.




The project results show riparian vegetation will respond to livestock removal and replanting. This series of photos were taken between 2008 and 2011 at Joyces Creek in the Loddon region, Victoria, and demonstrate the improvement in riparian areas.

# Talking fish preserves river memories


**SCOTT NICHOLS**, FROM THE DEPARTMENT OF PRIMARY INDUSTRIES IN NEW SOUTH WALES, EXPLAINS HOW THE PERSONAL EXPERIENCES AND MEMORIES FROM THE TALKING FISH PROJECT CAN HELP IMPROVE THE HEALTH OF THE MURRAY–DARLING BASIN.

Have a think back to the first time you fished. Who taught you? Where did you go? What did you catch? What was the river like?

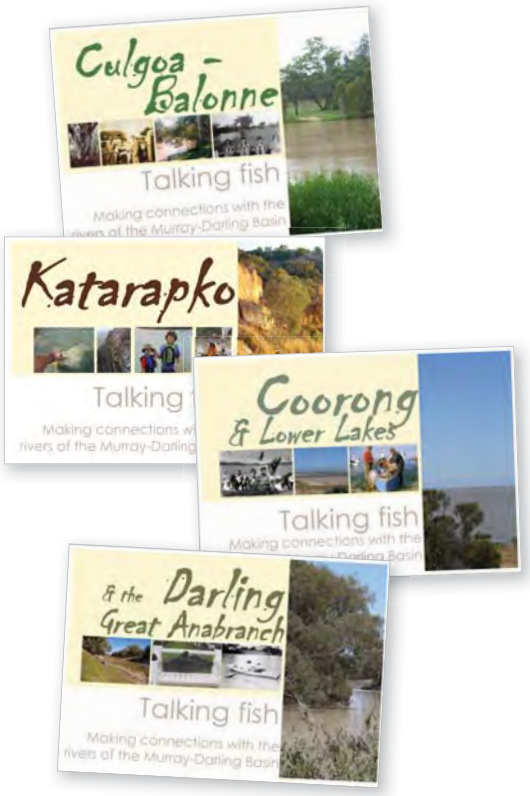
Now think about today. Do you still fish? What do you catch? What changes have you seen? Why do you think that is?

Fishing is an experience—not just related to the fish, but to the surrounding environment, the weather and the company. Chances are when you think back you can see the trees, hear the birds, smell the water, and feel the fish tugging on the end of the line. You'll also probably remember who was with you.

The observations you make as you wait for a bite are incredibly valuable. The type of bait, the cast direction, the fish you were targeting, the water colour and vegetation type help to build a picture of what the river was like at the time. This information, built up over years, becomes an encyclopaedia for the waterway you fished and help determine what has changed and, potentially, what needs to be done to fix it.

The Talking Fish project arose from an increasing realisation among researchers and river managers of the unique relationship different groups of people, including fishers, Indigenous communities and landholders, have with the rivers of the Murray–Darling Basin (MDB). By accessing people's stories about their experiences of a river, its fish, and how both have changed, our collective river knowledge has been expanded, and this is helping to shape future management decisions. The shared stories are also giving people a sense of what the rivers and their fish were once like—and could be again—with ongoing rehabilitation efforts.

The Talking Fish project visited a range of areas across the MDB. Where possible, people were interviewed from a range of backgrounds to ensure many voices were heard.




**FOR FURTHER INFORMATION**

Talking Fish project booklets—
http://www.nativefishweek.com.au/talking-fish.html
Scott Nichols—scott.nichols@dpi.nsw.gov.au

## Shared river stories

Some stories were typical fishing yarns, others lamented the demise of certain species, or the arrival of others. In the Murray we heard from the Green brothers who grew up on the outskirts of Corowa with their house backing onto a lagoon. They recalled a famous Murray Cod which they swear pulled their 26 stone (165.1 kilogram) uncle into the river, and no one could ever land it. Their dad used to say it had:

> "Eyes like dray wheels. Beard of spinners, gravel rash on his belly and sunburn on his back."

At Lightning Ridge Roy and June Barker were interviewed who grew up on the Brewarrina Mission on the Barwon River. They recalled seeing their friends underwater 7–8 feet away and catching turtles by sight. They also spoke of how they used to catch a small fish which they called *Mulgu* and looked like a little Murray Cod. *Mulgu* was caught by twirling a forked stick into the waterplants and dragging it out onto the river edge to eat.

In South Australia, we spoke to Tracy Bye of Loxton who told us about the strong connection she and her family have with the river and Katarapko Creek. Tracy's husband proposed to her there and, when her father passed away, they took the kids down to the river to tell them.

Memories of carp arriving were vivid for many people, for example Dennis Lean of Yarrawonga, said their numbers were so great, they were shovelled out of the river with pitchforks. Carp were also seen as the main reason for the decline in Catfish numbers. Clayton Sharpe of Mildura recounted stories of his family speaking of their abundance:

> "Before my time there were heaps of Catfish apparently. My uncles and my father talk about them being in pest proportions … It's hard to believe that in one generation it can change."

It was not only Catfish which were noted to have declined—there was a real sense fish used to be more plentiful, as Adrian Brown, ranger with ACT Parks, recalled:

> "… at the right time the Silver Perch would be just roaring up the river … They'd end up with piles and piles of Silver Perch ... Now you go there, you won't get one."

SCOTT NICHOLS | **TALKING FISH**

> "The water being beautifully transparent, the bottom was visible at great depths, showing large fishes in shoals, floating like birds in mid-air."

People's recollections showed the river they knew, and the one they know now, is a changed system. Their accounts of today's rivers differ markedly from the historical accounts of the first explorers and of early newspaper records from across the Basin. The excerpt (above) from Thomas Mitchell's diary in 1835 on the Darling is repeated in many rivers of the Basin.

A disregard for native species and their habitat was also like this article in relation to desnagging in South Australia in 1930:

> "Between Lock 4 and Loxton … about 50 large snags were removed … cod and large crayfish dropped out of holes in the logs—which … had been on the river's bottom for half a century or more."

PHOTOS THROUGHOUT THIS ARTICLE PROVIDED COURTESY OF THE AUTHOR.

## Conserving native fish

The Talking Fish project aims to show what people experience now in the Basin is not what it was once like. For young people, or people who have only lived in the Basin for a short time, carp have always been there, so have willows, dams, weirs and irrigation.

The project is valuable because it documents a time before carp, before willows and before large scale irrigation, and there are still people who remember what the rivers were like without them.

*continued overleaf*

By tapping into this knowledge Talking Fish demonstrates how the rivers have changed, with personal accounts and stories to motivate people to look after native fish numbers and habitat.

For example, most of the fishers spoken to now practice catch and release, rather than keeping all their catch. The reasons behind this are varied, but Jason Simpson from Narrabri on the Namoi said if he caught the fish and took it home, he couldn't catch it again. Goulburn River's Donny Richter used to catch as many fish as he could so he would get bragging rights at the local pub, but now teaches his grandson the 'proper' way to fish, so they can be caught again.

Perhaps the best explanation about people's connection with the rivers of the Murray–Darling Basin was summed up by Paakintji woman Jenny Whyman:

> "We can't live without that river and the Nguku [water] in the river."

All material collected as part of the project (photos, transcripts, audio and the booklets) are archived at the Mitchell Library in Sydney and the Aboriginal and Torres Strait Islander Digital Archives at the University of Technology, Sydney, New South Wales, which are both nationally accessible.

**ACKNOWLEDGEMENTS**

The Talking Fish project would like to acknowledge the interviewees and contributors, including Dr Jodi Frawley, Hamish Sewel, Professor Heather Goodall, Dr Liz Baker and Dr Zafer Sarac, state project partners, Native Fish Strategy Coordinators and the Murray–Darling Basin Authority for funding and supervision.

# Early Aborigines active managers of native fish

**WILL TRUEMAN** EXPLAINS THE IMPORTANCE OF NATIVE FISH IN THE LIVES OF ABORIGINAL PEOPLE AND HOW THEY ACTIVELY MANAGED EARLY FISH POPULATIONS TO ENSURE SUSTAINABILITY.

Like the native fish of the Murray–Darling Basin (MDB), most of the Aboriginal knowledge of the fisheries of the past and how they were managed has vanished, but early records indicate they were active managers of native fish populations. Native fish played a prominent role in the lives and spirituality of Aborigines from the lowlands upstream into the mountains.

Contemporary management practices for native fish in the MDB include species identification and study, harvest management to ensure sustainability, habitat repair and maintenance, and population enhancement through stocking. Historical evidence collected during the True Tales of the Trout Cod project indicates comparable activities were carried out by Aborigines.

The Aboriginal nations of the MDB recognised the differences between fish species on a level equivalent to scientists, through the allocation of specific names. There is also evidence they assigned distinctive names to indicate fish life stages. From limited historical sources, a vocabulary of names for the larger fish species of the southern half of the Basin is presented in the table below and includes words from 14 languages. It is clear Aboriginal people from several nations recognised Murray Cod and Trout Cod as distinctive species, which the scientific community only agreed on in 1972.

| Common name | Species name | Aboriginal names |
|---|---|---|
| Murray Cod | *Maccullochella peelii* | *Ponkoo, Ponde, Barnta, Googoobul, Kurrumerruck, Pandyil, Burnanga* |
| Trout Cod | *Maccullochella macquariensis* | *Yaturr, Ngumel, Bangami, Inme* or *Inna* |
| Golden Perch | *Macquaria ambigua ambigua* | *Colubco, Tarkee, Birnett, Pollungunder, Kaakaalain* or *Kookalin, Kongoopna, Kupe* |
| Silver Perch | *Bidyanus bidyanus* | *Toorroo, Teheeree, Kooberry, Bagguck, Karpa, Buruitjall, Bipe* |
| Macquarie Perch | *Macquaria australasica* | probably *Wanambiyu*, possibly *Nooraderri* or *Gubir* |
| Catfish | *Tandanus tandanus* | *Pomery, Pulyee, Kenaru, Dundong, Wanyakayi, Pirra-wil, Wannhak* |
| Blackfish | *Gadopsis marmoratus/ bispinosus* | *Paltk, Mekunang, Wuggar* |

Aboriginal people fishing and camping on Merri Creek. Tinted lithograph by Charles Troedel, 1864 from *Souvenir Views of Melbourne and Victorian Scenery*, Melbourne, 1865.

## Spiritual connection

The writings of early explorers make reference to Aboriginal laws prohibiting the eating or taking of certain native fish at specific times or conditions. Aboriginal people operated a system of totems assigned at birth which spiritually connected individuals to specific fauna. Individuals 'baptised' with a totem could not eat it and had to ensure the resource was managed sustainably. Historical accounts indicate some of these totems existed with native fish. Aboriginal people established fish and fauna reserves, for example at the Abercrombie River, the Monaro and near Wagga Wagga, New South Wales. Temporary closures were also placed to ensure fishery sustainability at Lakes Cargellico and Cowal, New South Wales, as well as local closures.

Poet Mary Gilmore penned several pieces recalling the days of her youth and the existence of a network of giant fish traps across New South Wales, where huge gatherings of Aborigines took place. She described the gatherings as 'intertribal conferences', at which tribal boundaries were negotiated and where plans and regulations were set for the management of environmental resources including fish. The giant traps, covering up to half a kilometre of river, were an aquaculture system prepared 12 months in advance to sustain the gatherings and locations were rotated to keep the tribes happy. Known venues of these gatherings were Brewarrina (the only one where the stone traps remain intact), near Bringagee on the lower Murrumbidgee, the upper Murray (believed to be near Tintaldra) the Lachlan River and on the upper Murrumbidgee River.

## Active fish management

Early writers including Thomas Mitchell, Charles Sturt and Gilmore recorded Aboriginal people constructing wooden in-stream structures for trapping fish. Gilmore also reported wooden structures being placed in the river to provide habitat, spawning sites and to partition off lagoons and streams for management. In the Riverina small dams were constructed from wooden balks, stone and mud to create permanent ponds which supplied both water and fish. Eggs and juvenile fish were moved from perennial streams to stock the ponds.

The Yorta Yorta people near Barmah placed a number of wooden structures in the Murray River to improve habitat and trap fish. One account suggests they artificially fertilised the eggs of cod and placed them in suitable structures in the Murray River. The first European to fertilise cod eggs was Harold Dannevig on the Murrumbidgee River near Wagga Wagga in 1905.

Early settlers recorded how Aboriginal people carried out earthworks from the headwaters of the coastal Wannon River catchment to the Wimmera River to allow passage of migrating eels over the Great Dividing Range. Their work was successful as the Wimmera catchment was recorded at the time as being the only catchment in the MDB to carry significant eel numbers.

The records indicate the importance of Aboriginal people's management of native fish and acknowledgement needs to be given to Aboriginal fishery sites and to the spiritual importance of native fish to the Australian landscape. The near complete loss of some Aboriginal groups, particularly from the uplands, shifts the burden of guardianship for native fish to the wider community.

**FOR FURTHER INFORMATION**

www.australianriverrestorationcentre.com.au/mdb/troutcod/

Will Trueman — williamtrueman@bigpond.com

FISH (SILVER PERCH) IS FROM THE TRUE TALES OF THE TROUT COD PROJECT. REPRODUCED WITH PERMISSION FROM THE STATE LIBRARY OF VICTORIA.

# Murray Cod ~ creator of the river

IMAGE FROM FRONT COVER OF THE MDBA REPORT.

Aboriginal people have had a close association with the Murray and Darling Rivers for tens of thousands of years and the Murray Cod was, and continues to be, an important and central part of this relationship. The traditional, historic and contemporary associations and significance of the iconic Murray Cod for Aboriginal people across the Murray–Darling Basin (MDB) has been poorly documented to date.

In 2007, an Murray–Darling Basin Authority (MDBA) research project was carried out to record the oral history and contemporary significance of Murray Cod for a number of Aboriginal communities. The project adopted a broad approach to identifying cultural significance. It was considered that cultural significance involved any of the following elements: social, spiritual/religious, historic and inter-generational, utilitarian, environmental, and aesthetic. As the project progressed it was apparent different Aboriginal groups across the MDB viewed the Murray Cod in distinct ways and at varying levels of significance.

**FOR FURTHER INFORMATION**

This article was taken from an excerpt of a report by Alan Ginns from Gondwana Consulting for the MDBA.

## Murray Cod creation story

The Lower Murray area, in Ngarrindjeri Country, is the stronghold of the Murray Cod's cultural significance. The creation stories and traditional cultural associations of the Murray Cod have also been better documented for this area compared with other parts of the Basin.

Dominating most of these works is the creation of the Murray River by *Ponde*, or *Pondi*, a giant ancestral Murray Cod. Several regional and sub-regional variations of this creation story occur. The two most frequent and thoroughly attributed accounts are presented here.

The first of these Murray River creation stories involves *Ponde*, the Murray Cod, and the ancestral hero *Ngurunderi*, with the essential elements as follows:

> a huge Murray cod [*Ponde*] … chased by a great hunter [*Ngurunderi*], thrashed along the channel, forming the bends, reaches and billabongs of the river. When the great fish was speared at Lake Alexandrina, the hunter threw pieces of the cod back into the water, naming them for the fish they would become; Golden Perch, Bony Bream, Silver Perch and so on. When he finished he threw the remainder back and said, 'You keep on being ponde'. (Wahlquist 2005, p. 40)

Some versions include the mythic ancestor *Nepeli*, *Ngurunderi's* brother-in-law, assisting in the final capture and killing of the cod.

The other more widely recognised account gives less emphasis to the pursuit, with the ancestral Murray Cod (spelt *Pondi* in these versions) emerging 'at the source of the Murray' after 'a great earth shock or earth tremor', to create the Murray River from a small stream 'by digging with its head, making the river deep and swinging its powerful tail, causing all the bends in the river'. In this version the totemic human ancestors are only involved when the giant mythic fish reaches Lake Alexandrina where they catch, kill and cut-up the fish to create all the fish of the river, lakes and sea. Both these creation stories identify the Murray Cod as the creator of the Murray River.

Accounts of the Murray River's creation were included in Aboriginal dreamtime stories published in the 1960s and 1970s which gave the *Ponde* creation story a wider profile and recognition in the general community. This story has now become, for the non-Aboriginal community, entrenched as the principal creation story for the Murray River.

## Creation stories vary in regions

There is also evidence of other creation beings figuring prominently in Aboriginal peoples' mythology around the Murray–Darling junction and the Central Murray. The 'winding of a very large serpent', acting under direction from the ancestral hero *Norallie* (believed to be a regional variation of *Ngurunderi*), is described as creating the Murray River in some accounts around the Murray–Darling junction.

In the Upper Murray at Echuca (in Yorta Yorta and Bangerang Country) the ancestor figure *Baiame* becomes more prominent in Aboriginal stories. This includes accounts of the Murray River's creation, which *Baiame's* 'old lubra' and 'giant snake' created. The Murray Cod also starts to appear in other traditional beliefs in this part of the Basin.

There is also a creation story from this area in which an ancestral Murray Cod, called *Otchout*, creates the Murray while being pursued by the mythic hunter *Totyerguil*. This account explains the origin of the Murray Cod's dorsal spines, which are *Totyerguil's* spears, as well as several traditional fishing implements. *Baiame* is also the dominant ancestral figure across the Murrumbidgee–Lachlan area (in Wiradjuri Country) and the North-east Rivers (in Kamilaroi/Gamilaroi Country) with the Murray Cod ancestor playing a minor role (according to available information).

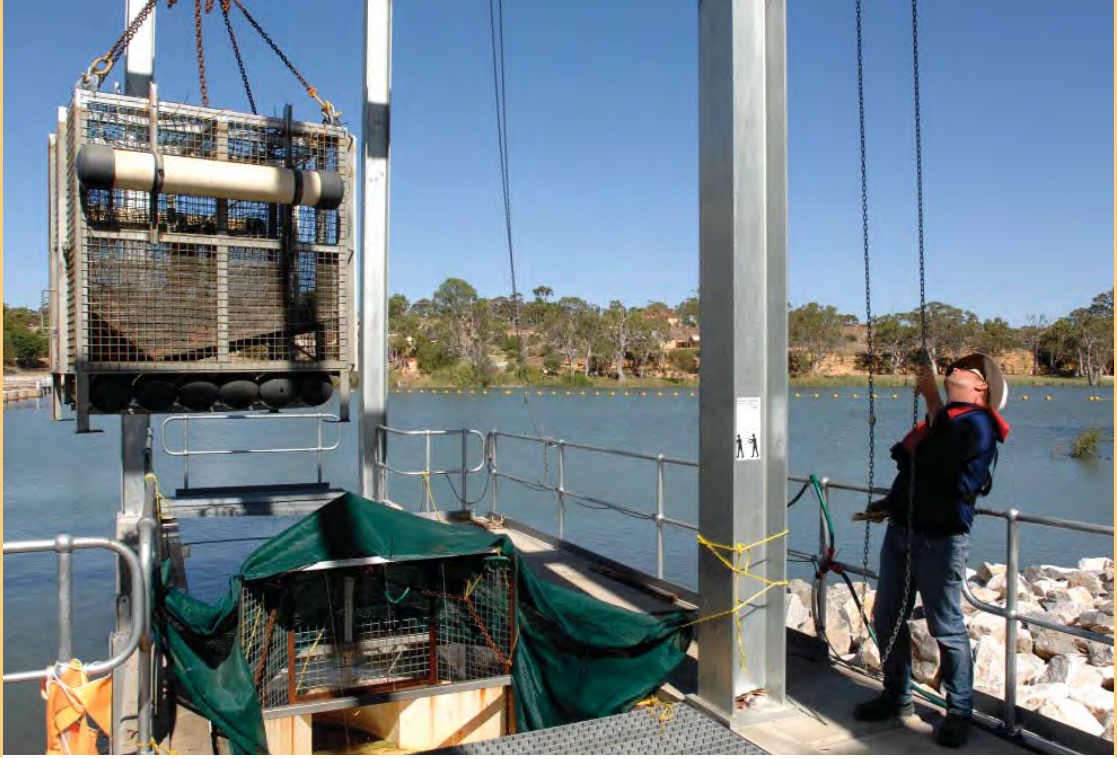
## Darling River boundary

The Darling River has been suggested as the boundary and meeting place between the traditional Aboriginal cultures of central and eastern Australia. This diversity and meeting of differing cultures may provide one explanation for the rapid relegation of the Murray Cod as a central element in Aboriginal peoples' creation stories and the decline in its cultural prominence upstream on the Darling River.

Generally, the Murray Cod appears to be a part of, but not central to, traditional beliefs along the Darling River, particularly on the Upper Darling where *Baiame* again becomes prominent, including being responsible for the River's creation in most of the available records. From the fewer and more fragmented accounts available for the Basin's far north, it appears the Murray Cod was not a central creation figure or traditionally significant being in this area.

> When he finished he threw the remainder back and said, 'You keep on being ponde'.

# Clever cage keeps carp out





**ANTHONY CONALLIN** AND **IVOR STUART** EXPLAIN THE RESULTS OF A TRIAL INVESTIGATING THE SUCCESS OF A NEW SEPARATION CAGE FOR CONTROLLING CARP POPULATIONS.

A special cage which effectively separates migrating carp from native fish could help to reduce carp numbers across the Murray–Darling Basin (MDB).

The number of carp in the MDB have significantly increased since the 2010–11 and 2011–12 floods. NSW Department of Primary Industries Fisheries monitoring has shown a 1000 per cent increase in the abundance of carp in the Central Murray region in 2011, and increases as high as 4000 per cent in other areas of the Basin.

A return to more regular flooding (natural and environmental) in the future is likely to lead to an increased dominance of carp throughout the MDB.

## New carp cage design

Carp are highly migratory and will benefit from the fishways being constructed across the MDB to facilitate the passage of native fish. Historically, control of carp dispersing through fishways was limited to manual trapping and sorting the carp out from native fish. This method was costly, time consuming and posed undue stress on native fish.

More recently, Alan Williams, a weir keeper at Torrumbarry Weir on the Murray River, designed a cage which separates carp automatically by exploiting their unique jumping behaviour. The cage prototype was trialled in the fishway at Torrumbarry and found to separate 88 per cent of migrating carp from native fish. Importantly, few native fish (less than 0.01 per cent) separated with the carp.

## Commercial trial

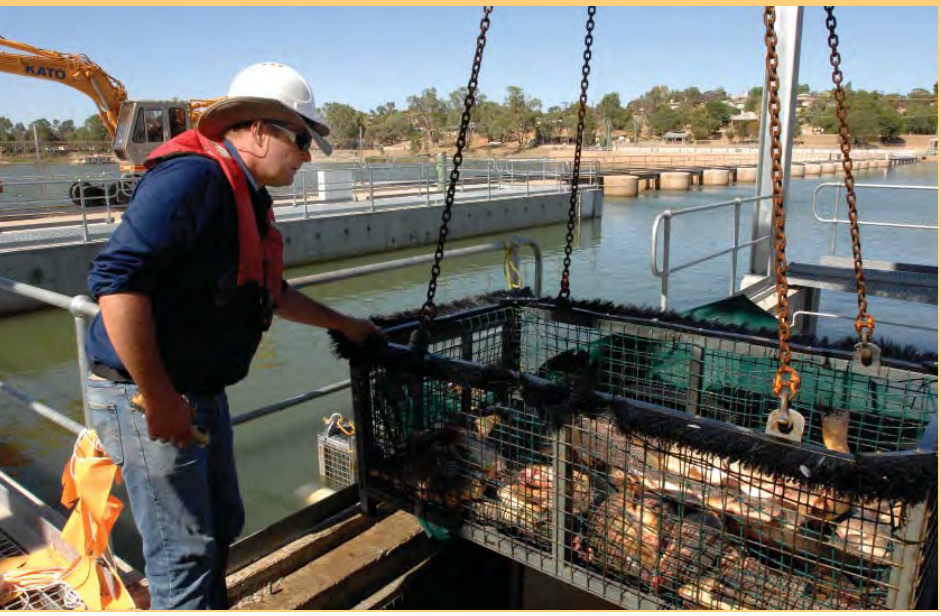
In 2007, the Williams' separation cage was commercially trialled at Lock 1, Blanchetown, South Australia. To date, the cage has separated 250 tonnes of carp, 120 tonnes from August to December 2011.

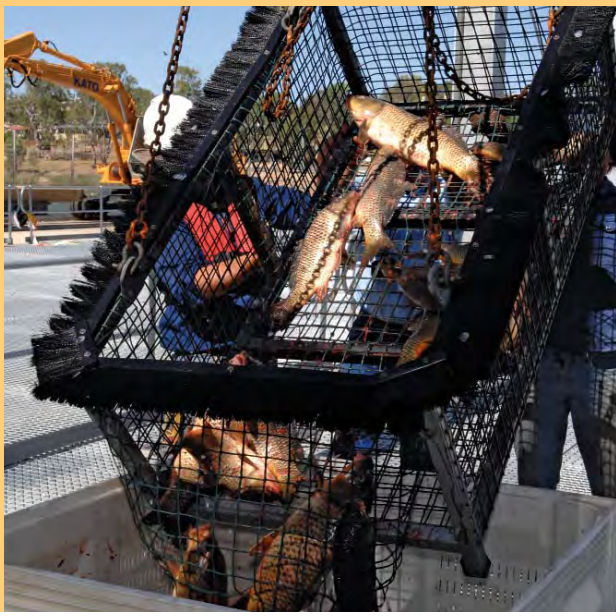
The cage can remove up to 5 tonnes of carp in a single day. Improvements to the cage and harvesting system have maximised the separation of carp and improved the passage of native fish. Harvested carp have been used as crayfish bait and converted into garden fertiliser and soil conditioners.

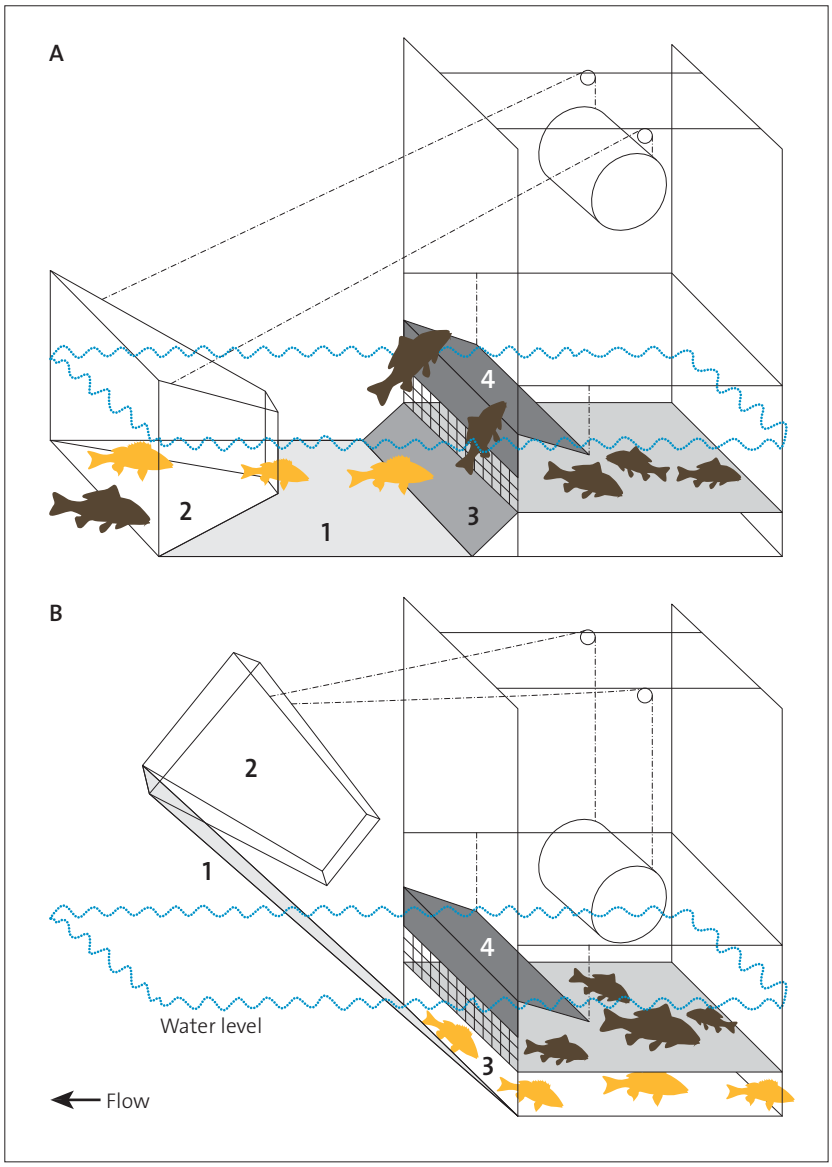
### Key findings

- The Williams' cage has proven effective at automatically separating large biomasses of migrating carp from native fish in fishways.
- Native fish by-catch within the Williams' cage is minimal and the technology has been tailored to maximise constant passage of native fish species.
- Carp migration is predictable and primarily related to water temperature and spawning status.
- Cages are most effective removing spawning carp migrations from August to December.

**FOR FURTHER INFORMATION**
Anthony Conallin — anthony.conallin@cma.nsw.gov.au
Ivor Stuart — ivor.stuart@gmail.com








The Williams' cage showing A) the operating position to catch and separate jumping carp (brown fish) and non-jumping Australian native fish (gold fish), and B) the raised position, showing: 1 false lifting floor, 2 cone-trap, 3 native fish exit gate, and 4 non-return slide. For clarity the mesh covering is excluded. Source: Stuart, I.G., Williams, A., McKenzie, J. & Holt, T. (2006). *The Williams' cage: a key tool for carp management in Murray–Darling Basin fishways*. Freshwater Ecology, Arthur Rylah Institute for Environmental Research, Heidelberg Victoria.

## Future research

The commercial trial at Lock 1 represents the only ongoing and successful best practice carp control initiative in the MDB. The trials have demonstrated the need for detailed planning and collaboration between key stakeholders to ensure its success. Stakeholders were required to work together on various issues including cage design and construction, cage operation and maintenance, carp collection and disposal, animal ethics and fisheries permits, and occupational health and safety obligations.

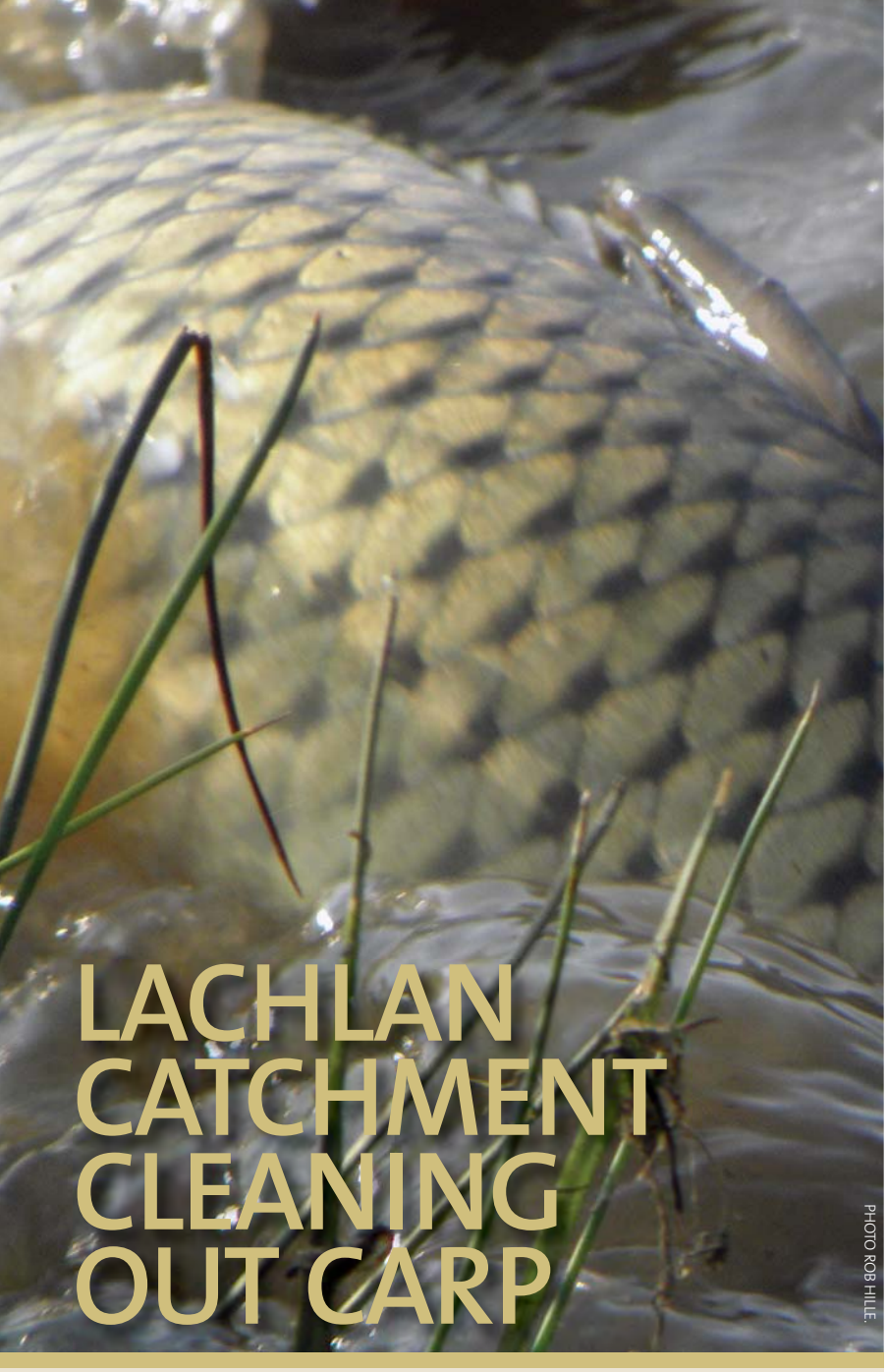
Although automated to release native fish, the Williams' cages are not 'set and forget', the devices require ongoing maintenance for successful operation.

The success of the Williams' cage trials suggests it could help to limit carp dispersal and reduce carp numbers in rivers, but it is unlikely to control carp numbers on its own as those carp which do not jump (most do) are released with native fish.

The cage design is flexible allowing it to be installed at other fishways in the MDB and trials are underway at wetland regulators. Future research will investigate the impact the Williams' cage is having on the wider carp population.

### ACKNOWLEDGEMENTS

The Lock 1 trial was a collaborative project between researchers, commercial fisherman, state government agencies, the Murray–Darling Basin Authority and South Australian Water.



# LACHLAN CATCHMENT CLEANING OUT CARP

PHOTO ROB HILLE.

**WAYNE FULTON** AND **MARTIN ASMUS** EXPLAIN THE RESULTS OF A COLLABORATIVE PROJECT IN THE LOWER LACHLAN CATCHMENT TO TRIAL AND SHOWCASE CARP CONTROL TECHNOLOGIES.

**FOR FURTHER INFORMATION**
Wayne Fulton — wayne.fulton@invasiveanimals.com
Martin Asmus — martin.asmus@dpi.nsw.gov.au

A range of innovative carp control methods have been tested in the Lachlan River in an effort to reduce numbers of the invasive fish and improve aquatic health and habitat for native fish species.

The lower Lachlan River, including its tributaries and floodplain wetlands, is recognised as a Priority High Conservation Value Aquatic Ecosystem in New South Wales. Key threats to this vulnerable area include invasive species such as carp, and the impact of river regulation on fish passage and the habitat of vulnerable species.

## Collaborative project

Between March 2009 and June 2011, Invasive Animals Cooperative Research Centre technologies and other carp control tools were tested in the Lachlan Demonstration Reach by researchers from the NSW Department of Primary Industries and the Victorian Department of Sustainability and Environment.

Innovative and newly developed techniques being trialled included:

- trap designs such as Williams' carp separation cages to harvest carp migrating within the river channel,
- pheromone traps in the lake versus flowing water environments,
- the Judas Carp approach to identify over-wintering aggregations to maximise the commercial harvest and removal of carp from Lake Cargelligo,
- otolith (earbone) micro-chemical analysis and investigation of nursery 'hot spots' for carp recruitment.

## Varied results

### Williams' carp separation cages

Cages were installed on two fishways in the Lachlan catchment. Catch rates for both cages were low, with operational issues arising from variable flows, debris, a possible lack of migrating carp and the remote nature of the locations. Installation and management of cages at un-manned weirs remains a difficult task for resource managers.

### Pheromone trials

Pheromone lure fish implanted with slow release osmotic pumps were used in three separate trials at Lake Cargelligo and the Lachlan River in autumn 2010 and 2011. Each trial compared:

- traps containing female pheromone lure fish,
- traps containing male pheromone lure fish,
- control traps without any lure fish.

In all trials there were no significant differences among the three treatment levels in catch rates, sex-ratios or length-frequency distributions of the harvested carp. The use of implanted pheromone lure fish did not enhance trapping catches and the hormone implant method used was not effective. Using pheromones as attractants may still have potential to increase trapping catches, but other simpler pheromone induction methods such as hypophysation or hormone injections may be more viable options.

### Judas Carp

Twelve adult male carp were fitted with radio transmitters and tracked for more than a year in the Lake Cargelligo system. Some site fidelity was apparent, but no aggregation of Judas fish was observed during winter. In contrast, a substantial spawning aggregation was observed in spring and it was learnt these aggregations form and disperse in as few as two to three days. If commercial fishers are to benefit from using Judas Carp, they must be ready to act quickly in the mid-September period.

### Otolith (earbone) chemistry

Post-larval carp were collected during 2007, 2008 and 2010 from four spawning locations; Great Cumbung Swamp (GCS), Lake Cargelligo, Lake Brewster and Curlew Water. Young-of-year Carp (YOY) and water samples were also collected along main channel sites.

Analysis of YOY fish otoliths was used to discriminate between populations or stocks of fish. The results showed Lake Cargelligo was the most important nursery source in 2008 while the Oxley and GCS region contributed most YOY recruits in 2010. These contributions were strongly influenced by river flows and water management during the project duration. Fish from the upper catchment originated from local sources, and there was little mixing of recruits between the upper and lower catchment.

The results of this study demonstrate water and earbone analysis can provide valuable information for identifying and estimating the contributions of key locations for recruitment of invasive fishes in large lowland rivers.

### CarpSim modelling

Using the CarpSim framework a meta population model was developed to mimic the geographic arrangement, biological connections and 'unfished' stock-structure of the pest population of common carp in the Lachlan River catchment. The model was fitted to recent observations of carp populations and the likely harvest from four carp-control tools: Williams' carp separation cages, wetland carp separation cages, pheromone traps, commercial fishing and recreational fishing.

The modelling also simulated the potential effects of several proposed biological control options such as the introduction of the koi herpesvirus which is contagious to carp and gene technology which biases offspring ratios towards males.

The results showed the proposed levels of carp control using trapping and controlled draw-down could reduce the average biomass by around 50 per cent. While significant, this level of control may not be sufficient to reduce carp populations below thresholds for ecological damage.

A koi herpesvirus bio-control program has potential to reduce carp numbers to target levels if mortality rates exceed 30 per cent and large scale outbreaks occur in at least 40 per cent of years. The results also showed a synergistic bio-control program using koi herpesvirus, followed by the gene distortion technology could potentially reduce carp numbers by more than 90 per cent in the long term.

**Acknowledgements**

The River Revival: Lachlan River Carp Cleanup project was funded by the Invasive Animals Cooperative Research Centre, the Lachlan Catchment Management Authority and the NSW Department of Environment, Climate Change and Water.


Electrofishing demonstration at Lachlan Carp project launch. Photo courtesy of Wayne Fulton.

Fisheries researcher Taylor Hunt returns a large Murray Cod to the water after maturity testing. Photos throughout courtesy of the author.

# A numbers game for Murray Cod

RESEARCHER **PAUL BROWN** EXPLAINS THE KEY ROLE RECREATIONAL FISHERS HAVE PLAYED IN A PROJECT AIMED AT ENSURING THE RECENT INCREASE IN MURRAY COD NUMBERS CONTINUES.

Angler surveys are helping researchers to better understand if current management strategies will ensure the sustainability of Murray Cod. Recreational fishers have provided vital information to help researchers understand the impact of harvest, catch and post-release survival rates on Murray Cod fish populations in the Murray–Darling Basin (MDB). The results indicate Murray Cod can be protected from overfishing if overall mortality rates can be kept below 20 per cent.

## Conserving Murray Cod stocks

The Murray Cod sits at the top of the food chain and plays an ecologically important, but complicated role in the MDB river system. Its status as an Australian icon, a favoured target of recreational fishers, and a protected species, further raises the stakes for conservation efforts. While population numbers have started to bounce back following a long-term decline, researchers from the Victorian Department of Primary Industries felt a new in-depth fishery analysis was needed to ensure ongoing conservation efforts are based on robust data.

There were concerns among both anglers and researchers about the size structure of the population, with many fish below the size limit but far fewer above it. Stocks are currently protected by a minimum size limit, with fishers required to release fish below 60 centimetres in length. Researchers wanted to determine whether the size limit did correlate well with sexual maturity. The aim was to ensure individual Murray Cod stand a good chance of reproducing at least once, before being caught and kept.

About 1400 anglers provided information about their fishing activity as part of a roving creel survey which ran for two years and sampled along 1700 kilometres of the MDB river system, including the Murray River from Yarrawonga downstream to the South Australian border, and on the lower Goulburn, Ovens and Loddon Rivers.

**ACKNOWLEDGEMENT**

The project was funded by the Fisheries Research and Development Corporation.

## Angler survey results

The survey found about 6500 Murray Cod were kept from the study area from a total catch of about 98,000 fish—this amounts to a release rate of about 93 per cent and is explained by the prevalence of fish which are less than the minimum size limit. In contrast, the voluntary release rate for fish larger than 60 centimetres, was found to drop to between 14 per cent and 32 per cent.

The study also examined what happens to the fish once released. With the help of the Donald Angling Club in northwest Victoria, released fish were observed for seven days and scored for injury and death. Since Murray Cod are notoriously aggressive, the fish were held in individual enclosures dangled by ropes into the river. The post-release mortality rate was estimated at 2 per cent. The rate may seem low, but has important implications for conservation, as thousands of Murray Cod are being caught, and in some areas the number of fish dying following release can be equal to the number legally kept.

The findings are now being incorporated into models which simulate the impact of different management strategies. For example, simulations have found increasing the minimum size limit would improve the sustainability of the population and result in reduced harvests, but not catch rates. Conservation also stands to benefit from further reducing post-release mortality.

The results indicate while there is no harm in occasionally keeping a Murray Cod, the fishery will benefit from higher adoption of best practice methods for releasing fish. Ongoing work is needed to educate anglers as the uptake of best practice methods was found to be low, despite being well publicised.

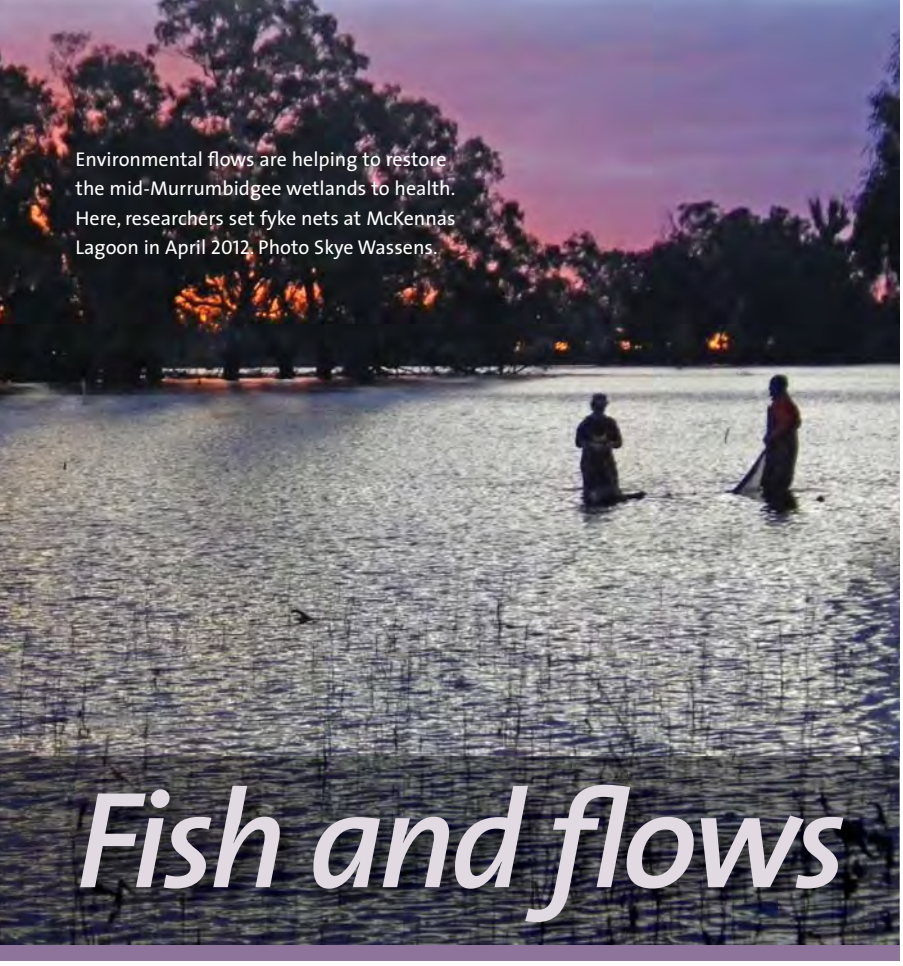
**FOR FURTHER INFORMATION**

Sustainability of recreational fisheries for Murray Cod in the Murray–Darling Basin Report—www.frdc.com.au/documentlibrary/finalreports/2006-053-DLD.pdf

Victorian Department of Primary Industries Fisheries researcher Paul Brown demonstrates how Murray Cod stocked into reservoirs such as Lake Eildon make great sustainable fisheries for recreational anglers.

### SURVEY FINDINGS

- The top three successful baits used to catch Murray Cod were cheese (24 per cent), shrimp (18 per cent) and bardi grubs (12 per cent).
- Between two and 12 Murray Cod were caught per hectare, with 0.14 kept per hectare and an overall release rate of about 90 per cent.
- Anglers also removed almost 60 tonnes of carp, an invasive pest species, from approximately 1500 kilometres of stream surveyed during the 18-month study.
- Catch of threatened species, such as Trout Cod and Silver Perch, was relatively high; for example, more than 12,000 fish in 350 kilometres of the Murray River downstream of Yarrawonga Weir.
- Anglers fishing with two rods had significantly higher harvest rates than those using a single rod. However, using three to five rods achieved similar keep rates to single-rod users.
- Bait fishing was consistently the most popular method for 52 to 97 per cent of anglers across the reaches studied.



Environmental flows are helping to restore the mid-Murrumbidgee wetlands to health. Here, researchers set fyke nets at McKennas Lagoon in April 2012. Photo Skye Wassens.

# Fish and flows

RESEARCHERS **JOHN CONALLIN** AND **SKYE WASSENS** HIGHLIGHT THE RESULTS OF THEIR PROJECTS AIMED AT ASSESSING THE ONGOING BENEFITS OF ENVIRONMENTAL WATER FLOWS.

Two projects in the Murray–Darling Basin (MDB) are underway to provide efficient and effective environmental flows to improve native fish communities and catchment health. Funded through Commonwealth Environmental Water (CEW), the programs aim to better manage environmental flows to rivers and wetlands.

## EDWARD–WAKOOL FISH AND FLOW PROGRAM

The Murray Catchment Management Authority (CMA), New South Wales Department of Primary Industries and the CEW have been working on a partnership 'fish and flows' program since August 2010, in the Edward–Wakool system. The main objective of this program is to measure the responses of large-bodied fish to targeted environmental flow releases.

**FOR FURTHER INFORMATION ON EDWARD–WAKOOL PROGRAM**
John Conallin — john.conallin@cma.nsw.gov.au
www.murray.cma.nsw.gov.au
Type 'Edward-Wakool video' in your browser

The Edward–Wakool system is located in the south west Riverina, New South Wales. The system is a large anabranch system of the Murray River main channel which begins at Picnic Point, and travels northwest through a series of River Red Gum forests before discharging back into the Murray River downstream of Kyalite. The system is large and varied with more than 1000 kilometres of rivers and small creeks.

It is highly regulated, featuring a significant range of flow management infrastructure, irrigation channel offtakes and outfalls, and includes a diverse range of resources and stakeholders. This system historically had abundant areas of fish habitat and diverse fish communities which supported both commercial and recreational fisheries.

### Monitoring results

The monitoring of environmental flows is part of a larger adaptive management process that the Murray CMA has initiated in the Edward–Wakool system. This ensures the monitoring results are constantly being used to refine and adapt flow delivery within the system to meet objectives.

To assess how large bodied fish respond to flow, an acoustic tagging program was launched. This has involved the tagging of over 100 adult fish of four fish species, the Murray Cod, Golden Perch, Silver Perch and carp. Fish movement can be tracked by listening stations (established over entire system) so when a tagged fish passes, its unique number is recorded, and its movement tracked over the system.

The program was set up in 2010 when the drought was still occurring, but has since experienced both natural flooding events, and environmental flow releases. In the initial natural high flow event, all fish species immediately responded to increased flows by moving into newly inundated habitat, with some fish moving more than 100 kilometres in a day.

Different fish species responded differently with Murray Cod and carp showing similar movement patterns, with shorter upstream movements than Golden Perch and Silver Perch.

In the first year's sampling, the results showed most of the tagged fish returned to the initial tagging pool which suggests maintaining refuge habitat is an important requirement for long-term survival of fish in the system.

### The future

The information collected so far has already helped decision making for the program's future. Research in the coming year will document fish responses (including spawning and recruitment) to different environmental water applications. This will help guide best water delivery practises (when and where to use it for which species), assess third party impacts from different flow scenarios, inform stakeholders, and provide justification for use of water for environmental purposes.

## MONITORING IN THE MID-MURRUMBIDGEE WETLANDS

Following a positive result to environmental watering in 2011, scientists are optimistic that with the ongoing delivery of environmental flows, the mid-Murrumbidgee wetlands can be restored to health. These wetlands are a series of ox-bow lagoons and meander cut-offs associated with the Murrumbidgee River between Wagga Wagga and Hay in south western New South Wales. The nationally important wetlands have been severely impacted by river regulation which, combined with the impacts of the millennium drought, left them cut off from the river, with many sites not receiving water for more than a decade.

### Environmental survey

A team of researchers monitored the response of wetland fauna (fish, frogs and tadpoles, waterbirds and freshwater turtles) and flora to the delivery of environmental water in June and December 2011, as well as the natural flood event in March 2012. The study was commissioned and funded by CEW with additional kind contributions from NSW Office of Environment and Heritage (OEH).

In 2010 widespread rain across the Murrumbidgee catchment resulted in natural overbank flooding which reconnected the wetlands. In June 2011 the NSW OEH managed the delivery of 160 gigalitres. A further 98 gigalitres of NSW environmental water was released in December 2011. These flows were delivered to aid in the long-term recovery of the mid-Murrumbidgee wetlands.

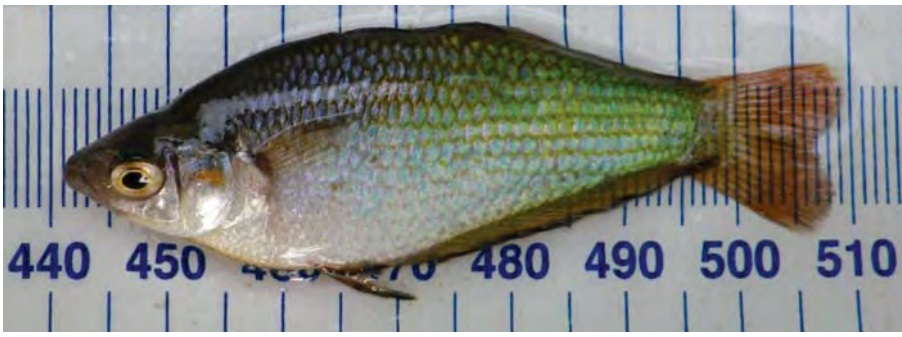
Six native and five introduced fish species were recorded during the study. Native fish communities changed over time, with small natural and managed top-up flows in spring and summer helping more native fish species to move into the wetlands. In August 2011 the two most common native fish species, Carp Gudgeon and Australian Smelt dominated wetland fish communities. In the October and December 2011 surveys small numbers of Un-specked Hardyheads, Murray–Darling Rainbowfish and Bony Bream were recorded. Juveniles of these species were detected in February 2012. Adult and juvenile Golden Perch were also collected in April 2012 after major natural flooding in the Murrumbidgee River.

One of the interesting trends was the dominance of native species, with native species out numbering exotic species by more than three to one throughout spring and summer. Carp become dominant only after the natural flood event in March 2012.

The mid-Murrumbidgee wetlands are still in a recovery phase. It is expected wetland refuges will start to dry out from the middle of 2013. Providing environmental flows to connect these wetland refuges with the main channel to the Murrumbidgee River in future years could help fish move back to the river, rather than becoming stranded in the wetlands as they dry out.

The study also identified key wetlands which historically retained water over a longer time and could help re-establish healthy populations of native fish and freshwater turtle in the region in future years.

Murray–Darling Rainbowfish, collected in the mid-Murrumbidgee wetlands in December 2011. Photo Skye Wassens.




**FOR FURTHER INFORMATION ON MID-MURRUMBIDGEE WETLANDS PROGRAM**

Skye Wassens — swassens@csu.edu.au
Jennifer Spencer — jennifer.spencer@environment.nsw.gov.au
www.environment.gov.au/ewater/publications/ecosystem-response-monitoring-murrumbidgee-2.html

Delicate Blue-eye. Photo Neil Armstrong.

# A tropical protection project

**MARK KENNARD** AND **AMY KIMBER** EXPLAIN THE RESULTS OF A PROJECT AIMED AT IDENTIFYING FRESHWATER PRIORITY AREAS FOR CONSERVATION IN NORTHERN AUSTRALIA.

Innovative research is underway in northern Australia to assess and better protect the area's unique and highly valued freshwater ecosystems. Australia's tropical rivers flow through the world's largest area of good condition savanna, with almost all of its 56 major rivers flowing freely to the sea. The region contains one of the most biologically diverse and healthy freshwater aquatic ecosystems in the world. These rivers sustain more than half of Australia's freshwater fish species, three quarters of the freshwater turtles, and they are of great importance for more than 90 species of migratory birds. They not only provide clean water, food and recreational opportunities, but have important cultural and ecological values.

The continuing discovery of new fish species suggests the real amount of unique biodiversity present in northern Australia's rivers and wetlands is significantly underestimated. The ecological health of these freshwater habitats is, however, declining due to a range of threats including feral animals, weeds, overgrazing, catchment clearing and fire. Increased development and climate change pose new challenges.

## Research initiative

The Tropical Rivers and Coastal Knowledge (TRaCK) research consortium was formed in 2007 to address fundamental knowledge gaps about how tropical rivers work and their value. TRaCK has brought together more than 80 of Australia's best tropical river and coastal scientists from different disciplines and institutions. As part of this program of research, a project was recently completed to identify freshwater conservation priorities across northern Australia. This involved characterising and mapping aquatic ecosystems throughout the region, developing predictive models of biodiversity patterns (for example, fish, turtles and waterbirds species distributions), and applying several spatial prioritisation frameworks. As it is not feasible to protect all areas, the goal of this research was to identify areas which can be targeted for efficient conservation management.

## Inadequate protection

The project team evaluated the extent to which freshwater biodiversity is represented in existing protected areas in northern Australia. Protected areas are defined as an area of land or sea dedicated to protecting and maintaining biodiversity and natural and cultural resources. The current reserve system includes 178 reserves in northern Australia, covering 115,963 square kilometres (about 9 per cent of the region).

The project found many elements of freshwater biodiversity and aquatic ecosystem types are poorly represented in protected areas, highlighting the potential inadequacy of existing protection measures. For example, up to 80 per cent of all fish, turtles and waterbirds have less than 5 per cent of their total distributions contained within these areas in northern Australia, and protected areas may already be at risk from current and future threats including invasive species and climate change.

Protected areas are not the only mechanism for conservation. Mixed protection and conservation management schemes, where reserves go hand in hand with community efforts, may also be needed to achieve conservation goals. The challenge is to identify how the existing reserve system could be built upon to represent a higher proportion of the region's freshwater biodiversity and provide the best value for investment.

## Evaluating potential conservation areas

The TRaCK research team applied several approaches to evaluate and prioritise areas with significant freshwater biodiversity values. Highly diverse and distinctive areas were identified using simple maps of species richness and endemism. The team also applied a more systematic approach to spatial prioritisation using Marxan software, a tool widely used for conservation planning. The aim was to efficiently represent the full range of biodiversity, within the least amount of land area, to complement areas already protected. Biodiversity distribution, longitudinal and lateral connectivity requirements, and levels of human disturbance were also considered.

This study was the first in the world to use this type of approach in freshwater ecosystems across such a broad region, and involving so many biodiversity features. The researchers identified two different types of freshwater priority areas which would complement the current reserve system and represent all the species.

The approaches applied in this study are a tool to help in the decision making process in identifying conservation priority areas. Incorporating scientific knowledge and stakeholder needs is the next step in implementing a realistic conservation plan.

### ACKNOWLEDGEMENTS

The project was funded through TRaCK's research program by the Department of Sustainability, Environment, Water, Population and Communities, and the National Water Commission.

**FOR FURTHER INFORMATION**

Amy Kimber — amy.kimber@cdu.edu.au
Mark Kennard — m.kennard@griffith.edu.au
www.track.org.au/research/project/509

Freshwater turtle.
Photo Brad Pusey.

Floodplain wetland.
Photo Mark Kennard.

# Climate change with a freshwater twist

RESEARCHERS **PETER DAVIES** AND **PAUL CLOSE** HIGHLIGHT TWO PROJECTS BEING CARRIED OUT TO HELP PROTECT FRESHWATER FISH SPECIES IN SOUTH-WESTERN AUSTRALIA.

Research is underway as part of the National Climate Change and Adaptation Research Facility, and co-funded by the National Water Commission are currently underway to test the resilience of native freshwater fish in south-western Australia to climate change. The freshwater fish species in this region face a variety of challenges. Existing climate change has impacted on the region's hydrology through drying and warming, and future changes are likely to place further stress on the availability and continuity of freshwater habitats. The longevity of ephemeral habitats, which are important for several of the regions endemic fish such as the Salamander Fish and Black Striped Minnow could also be affected.

Groundwater plays a significant role in maintaining aquatic habitats in the region, however, increasing demands on groundwater resources threaten native fish species by reducing groundwater outflows, causing the loss of summer habitat as well as increases in salinity. Increased frequency of extreme events, as predicted by climate change modelling, could also exceed the thermal tolerance of native fish, representing a significant and escalating risk.

**FOR FURTHER INFORMATION**
Paul Close — paul.close@uwa.edu.au

Many of the catchments in the region have naturally elevated salinity, although historical clearing of native vegetation has also caused widespread secondary salinisation. There are examples of local extermination of native fish populations, contraction of sensitive species into remaining fresher habitats, and upstream colonisation by estuarine species in response to clearing induced salinisation. Climate change is predicted to increase the extent and severity of these effects on freshwater fish.

## Projects assess climate change

The future resilience of native freshwater fish in south-western Australia will be partly determined by their capacity to adapt to new environmental conditions. Two projects will assess the resilience of fish to altered conditions and, where this is not possible, what river restoration practices would need to be prioritised to ensure the construction of suitable environmental conditions.

The first project will develop and test a risk assessment and decision framework for climate change adaptation capable of promoting resilience and biodiversity in groundwater dependent ecosystems. The plan is for this framework to have broad applicability and eventually be adapted for use Australia-wide. As part of this project, functional biotic traits of freshwater fish such as salinity tolerances and life history requirements for surface water, which indicate vulnerability and response to changes in groundwater levels, will be explored.

## Providing refuge habitats

The second project aims to evaluate a range of novel methods for managing refuges to see whether they could be used as part of a climate change adaptation strategy for freshwater fish. This project will establish direct links between habitat refuge qualities and their ability to support biodiversity. Four methods of enhancing refuge function or creating new refuges will be evaluated including:

- provision of cooler water for fish (for spawning and dispersal),
- provision of refuges from higher temperatures and extreme temperatures,
- provision of refuges from extensive or prolonged wetland drying,
- identification of barriers to dispersal between refuges and other areas of stream channels by fish.

These projects are designed to have direct management implications for the protection of freshwater fish in southwestern Australia. This area is recognised as a global biodiversity hotspot; one of 24 worldwide and the only one on the Australian continent.

Balstons Pygmy Perch, endemic to south-western Australia and restricted in distribution, is threatened by habitat alteration, salinity and climate change. Photo Geraldine Janicke.

ACKNOWLEDGEMENTS

These projects are part of the National Climate Change and Adaption Research Facility and are being carried out by the University of Western Australia. Partner organisations include Murdoch University, the Western Australian Department of Water and the Commonwealth Department of Climate Change and Energy Efficiency.

Previous page: Shading by intact riparian vegetation helps reduce water temperatures to provide refuge for aquatic fauna under a warming and drying climate. Photo Paul Close.

Left: Paul Close and David Tunbridge electrofishing to determine environmental water requirements for the Denmark River. Photo Craig Carter.

# Water levels—the golden key

**SCOTT HARDIE** FROM THE TASMANIAN DEPARTMENT OF PRIMARY INDUSTRIES, PARKS, WATER AND ENVIRONMENT

HIGHLIGHTS THE IMPORTANCE OF WATER LEVELS ON NATIVE FISH BREEDING AND HABITAT IN TASMANIA.

The native fish fauna of Tasmania is dominated by small-sized fishes that belong to the family Galaxiidae, with 16 galaxiid fishes occurring in the state. The Tasmanian Central Plateau (TCP) is home to several thousand lakes and lagoons, and is also a hot-spot for freshwater fish biodiversity with seven endemic galaxiid species occurring in the area.

Most of these lake-dwelling galaxiids only occur in a few waterbodies where they are susceptible to habitat alterations from water resource use associated with hydro-electric power generation and agricultural water demands. Galaxiid populations in this area have also suffered decades of predation and competition from introduced trout.

Climate change models also predict reduced rainfall in central Tasmania during the next century, adding further constraints on water availability. For these reasons, all seven endemic species of the TCP are listed under state or Commonwealth threatened species legislation.

Above: Adult Golden Galaxias. Photos throughout courtesy of the author.

**FOR FURTHER INFORMATION**
Scott Hardie—scott.hardie@dpipwe.tas.gov.au

## Detailed native fish study

During the past 12 years studies have been undertaken on the biology, ecology and hydrological needs of one species of these endemic fishes, the Golden Galaxias (*Galaxias auratus)*, in the Clyde River catchment. This species is endemic to the inter-connected Lake Crescent and Lake Sorell, which lie in the south-east of the TCP at 800 metres above sea level (ASL). Although the Golden Galaxias is considered threatened, it has been an ideal species to study because its populations are currently reasonably abundant.

The research has involved:

- sampling all its life stages over eight breeding seasons in a wide range of water levels,
- using GIS-based methods to map spawning habitat in the lakes,
- documenting its life cycle,
- studying relationships between water levels and breeding, recruitment and population dynamics.

## Project results

The results show the main threat to the Golden Galaxias is altered water level regimes, and associated impacts on breeding and habitat condition in Lakes Crescent and Sorell. Three hydrological conditions are critical for breeding, and the long-term viability of Golden Galaxias in these lakes.

1. Water level controls the availability of spawning habitats (rocky shores and aquatic vegetation in fringing wetlands). This is particularly the case in Lake Crescent where water levels below 802.2 metres ASL dewater most of the spawning habitat in the lake. Low water levels also negatively impact on the quality of spawning habitats in the lakes due to increased sedimentation, and cause a general deterioration in water quality and habitat conditions.
2. Seasonal (winter–spring) rises in water levels provide stimuli for Golden Galaxias to spawn and inundate spawning habitats.
3. In Lake Crescent the magnitude of seasonal water level rises during breeding seasons affects larval abundance and subsequent recruitment.

Knowledge of how water levels influence Golden Galaxias populations was also used to carry out water level manipulations in 2007 and 2009 to assist breeding of the species following several years of drought. The trials showed appropriately timed releases of water from Lake Sorell to Lake Crescent provide a powerful tool for managing Golden Galaxias populations and the Sorell–Crescent ecosystem.

This work on Golden Galaxias has provided valuable information which is helping lake managers secure its populations. I feel confident the Golden Galaxias will continue to be an important part of the ecosystems of Lakes Crescent and Sorell in the future.

Left, dewatered rocky shore; below, juvenile Golden Galaxias.

Southern Pygmy Perch.

# COMMUNITY EFFORTS SAVE A SMALL NATIVE FISH

**LORI GOULD** AND **LUKE PEARCE** EXPLAIN THE RESULTS OF A COLLABORATIVE EFFORT TO SECURE THE FUTURE OF THE THREATENED SOUTHERN PYGMY PERCH NATIVE FISH.

The successful reintroduction of the Southern Pygmy Perch at a new home along the Pudman Creek in New South Wales has strengthened efforts to increase the spread and survival of this threatened native fish. The Southern Pygmy Perch, is a small, attractive native fish once found in most areas of the Murray and lower Murrumbidgee catchments in New South Wales. During the past 25 years they have disappeared from most of their natural range in response to habitat degradation, particularly the loss of aquatic vegetation and associated macroinvertebrates.

Only three populations are known to exist in New South Wales, one of which was recently discovered in a tributary to the Lachlan River north of Yass. During the height of the drought, this creek ceased to flow and many of the pools containing Pygmy Perch were becoming low and drying out. In a bid to save this isolated population, some of the fish were taken to the Narrandera Fisheries Centre, New South Wales, with the aim of returning them to the creek once the drought had passed. Obviously happy in their new home, the fish bred, and concurrent surveys at their original home on the creek indicated fish numbers were still high. As a result it was decided an alternative site could be used for the release of the Pygmy Perch and their progeny, to further distribute and protect the species.

**FOR FURTHER INFORMATION**
Lori Gould — lgould@act.greeningaustralia.org.au
Luke Pearce — luke.pearce@dpi.nsw.gov.au

## New home for native fish

The Pudman Creek, located in an adjacent catchment in the Upper Lachlan, was identified as suitable due to its unusually high abundance and diversity of water plants (one of the main habitat requirements for the Perch), and a characteristic missing from many of our river and creek systems. In addition, there are no introduced fish species in the creek which is a rarity in the Lachlan catchment. Landholders along the Pudman Creek had long decided there were no fish in the creek except for a few trout which died out in the drought. After being told there were good populations of small native fish they agreed to work with the project, but were not interested because the fish were too small to catch.

Since then, and through the implementation of a partnership project titled 'Pygmy Perch in the Pudman', landholders along the creek have learnt to appreciate the small fish and are enthusiastic about protecting their special fish. The project is part of the Boorowa River Recovery—a large scale riparian rehabilitation program which rehabilitated 80 kilometres (654 hectares) of riparian zone within the Boorowa catchment. Approximately 20 kilometres of streams in the Pudman Creek catchment have been rehabilitated (fenced and revegetated using locally native species), with a focus on linking riparian remnant vegetation and reducing sedimentation.

## Monitoring results

A community fish survey using electrofishing and bait traps was carried out in 2010 with NSW Department of Primary Industries Fisheries and members of the Boorowa Landcare Group, and 12 Pygmy Perch were found in the creek, along with other native fish such as the Flathead Gudgeon. Surveys in 2012 showed the Pygmy Perch are surviving well in their new home, but surveys in locations downstream did not show evidence of them spreading. Riparian habitat along the Pudman Creek is fragmented and revegetation is likely to take many years to reach maturity and ecological complexity. This is why working with landholders to protect existing riparian remnants is a priority.

## Future work

Further monitoring of fish populations is planned for the next few years to provide a better picture of native fish populations, and the survival and spread of the Pygmy Perch. The community are central to this work and have shown significant enthusiasm to protect their creek not only for the fish but for biodiversity, water quality and the whole ecosystem. The Boorowa River Recovery program work will continue with the recent announcement of funding from the Australian Government's Biodiversity Fund Rivers of Carbon project. Rivers of Carbon is being managed by the Australian River Restoration Centre in partnership with Greening Australia.

PHOTOS COURTESY OF THE AUTHORS.

Electrofishing

**Acknowledgements**

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# The Australian River Restoration Centre

The Australian River Restoration Centre's mission is to:

> Support, facilitate and provide opportunities for Australians to work together to protect, maintain, restore and celebrate our riverine environments.

We do this by providing a range of free and commercial services, with all proceeds going back into the ARRC to continually improve, update and invest in the best knowledge, resources and opportunities for sharing information provide across Australia. We also have strong international links to the European and Asian River Restoration Centres, as well as with organisations doing similar work in Canada and North America. Come and join the ARRC community by visiting the website, subscribing to our blog, sharing your knowledge and letting others know about our work.

**www.arrc.com.au**

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# RipRap

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