RIPRAP
RIVER AND RIPARIAN LANDS MANAGEMENT NEWSLETTER

RIVER AND RIPARIAN habitat for fish

In Australia, fishing is the only high participation recreation that is entirely reliant on the extractive use of natural resources. The recreational sector of the Australian fishing industry includes more than four million people who fish at least once a year, with fish catch rates estimated at up to 54 000 tonnes annually. The Australian population is located predominantly in coastal regions, particularly around estuaries. So, too, is the majority of the recreational fishing effort. As a result, the Australian fishing industry is highly reliant on river systems, their catchments and estuaries. That's simply because the maintenance of sustainable yields of fish is highly dependent on river and riparian systems for good quality water and access to the critical habitats that our fish, and those species on which they depend, require to breed and thrive.

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Land & Water AUSTRALIA
research • development • innovation

EDITION 19, 2001

CONtents

This publication is managed by Land & Water Australia, GPO Box 2182, Canberra ACT 2601

Land & Water Australia's mission is to provide national leadership in utilising R&D to improve the long-term productive capacity, sustainable use, management and conservation of Australia's land, water and vegetation resources. The Corporation will establish directed, integrated and focused programs where there is clear justification for additional public funding to expand or enhance the contribution of R&D to sustainable management of natural resources.

Land & Water Australia's Home Page is: www.lwa.gov.au

Edition 19, May 2001
RipRap is published throughout the year. Contributions and comments are welcomed and should be addressed to the Editor.

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Designed by: Angel Ink
Printed by: Goanna Print

ISSN 1324-6941

RIPArian lands:

WHERE LAND AND WATER MEET

From the Editor

This edition of *RipRap* is special, as it is the first time we have worked with a community-based organisation to address a particular river and riparian management issue. RecFish Australia recently became members of the National Rivers Consortium, and we have 'pooled' our talents to produce an edition of *RipRap* that focuses on river and riparian habitat for fish. As a result, this edition of *RipRap* will be sent to 1500 members of RecFish Australia, and we hope that as a consequence, we will get some new subscribers to our mailing list. This edition is a large one, and it reflects the involvement of a number of different organisations in protecting and managing our fishery resource. RecFish Australia members have contributed many of the It's a Wrap articles, with the Fisheries R&D Corporation, Australian Conservation Foundation, Murray–Darling Basin Commission, Murray-Darling Association and researchers supplying some of the main articles in this edition. I hope you enjoy this edition and that it leads you to promoting better management of our rivers and riparian lands.

RIVER AND RIPARIAN habitat for fish

(continued from page 1)

By Ross Monash

Significant economic benefits from the recreational fishing industry flow into the wider community through jobs in the tourism, tackle, boating, and charter industries. The latest estimate of annual capital and direct and indirect expenditure on recreational fishing is $2.9 billion (McIlgorm & Pepperell, 2000). In addition, the commercial sector of the fishing industry is Australia's fourth most valuable food-based primary industry, extracting about 221 000 tonnes of seafood with a basic, 'on the jetty' (prior to value adding) value of $2.32 billion per annum (FRDC, 1999). This economic benefit is, however, put at risk when we degrade the rivers and riparian environments upon which our fish depend.

What fish need from rivers

For fish to thrive in our river systems they require good quality, disease-free water containing ample dissolved oxygen, food, shade from the sun, and shelter from strong currents and predators such as other fish and birds. They also require unimpeded access to appropriate spawning grounds.

River habitats

River habitat for fish comprises the physical and biological varieties present in river and stream systems. Rivers contain various structural forms that, by their presence or absence, can dictate the degree of biodiversity to be found. Among these are pools, riffles, rapids, woody debris and human-made dams and weirs.

Pools are the slower moving and often deeper sections of rivers and creeks. Many fishers are aware that it is the pools that frequently contain the highest concentration of fish. The deeper sections of rivers and streams provided by pools ensure fish have shelter from predators such as birds, while supplying high numbers of easily found aquatic and terrestrial invertebrates. Fish will often be found feeding on these morsels where the fast moving water from a riffle or feeder stream enter the slower moving water of a pool. Pools are also important to the ecology of rivers and streams with highly variable flows, as they provide a constant source of water during low seasonal flows.

When sediments enter a river, they are carried along with the faster moving water of the riffles and deposited in the pools. When excessive amounts of sediments enter rivers through the erosion of soils on adjacent land and streambank erosion, it is the pools which suffer first, often filling with sediment. Once the pools are filled with sediments, many fish are displaced. Those fish that don't leave the area are more susceptible to predation and find it more difficult to locate the invertebrates upon which many of them feed. The fish that do move away have to compete with other fish that already occupy areas suitable for colonisation.

Snags provide wide diversity of habitat for fish. Tumut River, NSW. Photo by Chris Gippel.

The role of snags and Large Woody Debris in providing fish habitat

Large woody debris (LWD) has been removed from our river systems for many years and for a variety of reasons, but mainly to allow passage for boats in the early days of river transport and to promote a 'better' flow to prevent flooding. The first of these reasons is, in most cases, no longer applicable as river transport has largely been replaced with road and rail transport. The second reason has been found to be untrue, and there is now an effort to reintroduce LWD into areas from which it has previously been removed. The latest research is indicating that the presence of LWD in our river systems provides far more benefits to aquatic ecosystems than its absence.

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LWD provides fish with hiding places from predators such as birds and larger fish. Submerged LWD with its cracks, hollows and spaces of various sizes, also provides habitat for other invertebrates, microbes and algae — on which many fish feed. Crevices provided by LWD, large rocks and bank overhangs are often used by predatory fish, such as Murray Cod, as a dark, concealed place from which to launch an ambush on their prey.

LWD also affects the geomorphology of the streambed itself. The flow of water over and around LWD is often responsible for the creation of pools which, as previously discussed, are vitally important in sustaining fish populations.

The role of riffles and rapids in providing fish habitat

The rocky bottom associated with rapids and riffles provides good shelter against predation for eggs and young fish. The nature of the rocky bottom also provides fish with sheltered areas of slower moving water. This allows fish to rest and move in short, energetic bursts as they migrate upstream along long stretches containing high velocity water in which they could not swim. Riffles and rapids also improve aeration of the water by increasing the amount of water exposed to the air.

Barriers to migration

Since European settlement of Australia, we have tried to ensure that water, our scarcest and most precious resource, is available for a variety of human uses all year round. Thousands of weirs and dams have been constructed to provide a constant supply of water. These structures effectively do what they have been designed for but, in doing so, have deprived fish of their natural migratory patterns into and along our river systems.

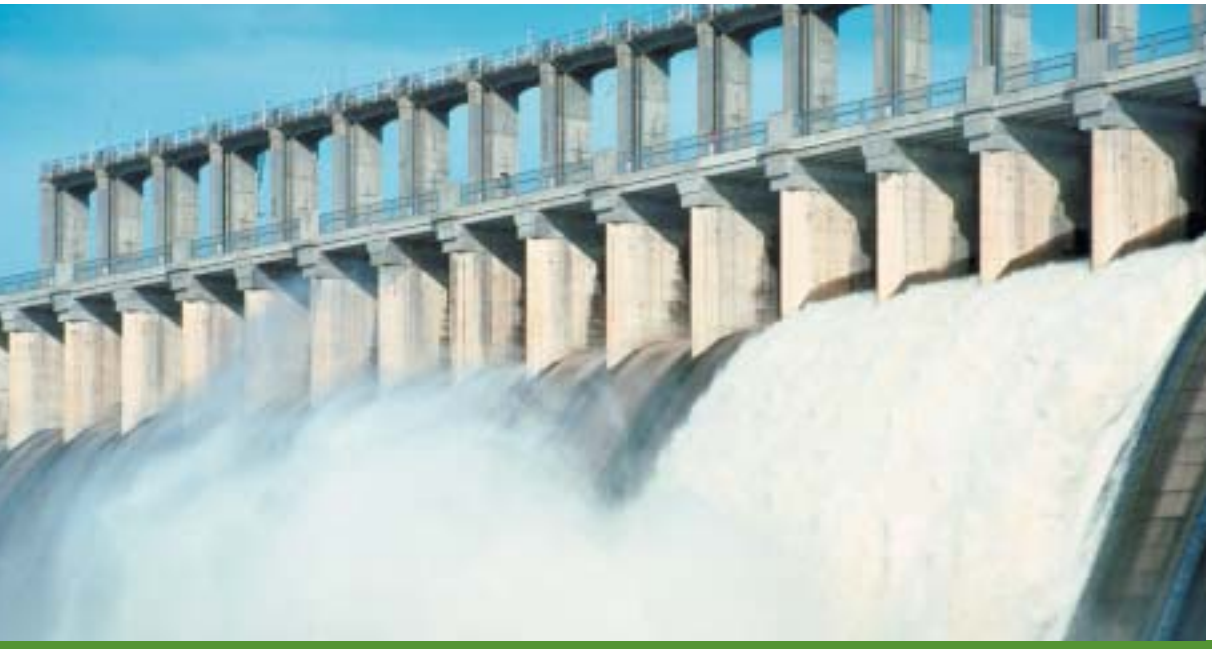
In many instances, problems associated with dams and weirs have been overcome with the installation of fishways or fish ladders. There are various types of fishways for different applications but the use of one fishway can often open up many kilometres of river for re-colonisation by species such as Australian bass which, as adults, live in freshwater but must return to salt water to breed (see Stuart Blanch's article on page 8).

The role of riparian vegetation in providing habitat for fish

Riparian vegetation is vegetation located alongside waterways and it participates in the provision of quality habitat for fish in a number of important ways.

Shade and shelter

Often the most visible role riparian vegetation plays in providing fish habitat is the provision of shade. By providing shade and shelter to the water, riparian vegetation reduces the effects of extreme seasonal temperature variations. Healthy riparian vegetation generally keeps the water



Weirs and dams form barriers to fish migration. Hume Dam. Photo MDBC.

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Stretch of river with intaact riparian vegetation. Photo MDBC.

cooler in summer and warmer in winter when compared to temperature outside the riparian zone. A number of fish species use seasonal changes in water temperature (often in association with rises in river level) as a cue for spawning. If water temperatures don't mirror natural regimes, these cues may not be present and this may effect the crucial timing of spawning.

Reducing pesticides and sediments

Pesticides entering waterways can kill aquatic plants by directly poisoning them. Sediments can have the same effect, simply by covering up the aquatic plants. Pesticides, when sprayed on agricultural lands, can drift in the air for considerable distances. When these pesticides drift onto the water they can have considerable impact on aquatic invertebrates and the fish themselves. Riparian vegetation acts as a physical barrier to airborne pesticide drift, reducing the amount of pesticides entering waterways. Riparian vegetation also acts as a physical barrier to sediments entering waterways from adjacent lands where the soil has been exposed and eroded. It does this by trapping the sediments in the root systems and, to a lesser extent, the leaf litter.

Reducing streambank erosion

Sections of rivers and streams that do not contain riparian vegetation are more susceptible to streambank erosion than areas that do. Once sediments enter the waterway from these poorly vegetated sections, they add to erosion by increasing the erosive capacity of the moving water. As the water propels the soil particles, they crash into the streambank and streambed and remove more soil particles in a snowballing effect. Much of the sediment produced settles downstream where it often adds to the degradation of fisheries habitat.

It has been well documented that riparian vegetation greatly reduces streambank erosion by physically binding the soil against scouring from the water.

Reducing nutrient levels

Nutrients entering our waterways impact on fish in a number of ways, the most visually obvious of which is an increase of algae. Aquatic algae multiply rapidly with an increase in nutrients. This is often called an algal bloom. Algae make the water cloudy and some grow directly on the plants themselves, thereby reducing the amount of light that the submerged aquatic vegetation receives. As we know, plants need light if they

A pool of algae. Photo MDBC.

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are to survive, so lowered light penetration into the water can kill this vegetation. Native and introduced target fish species need these plants to survive, whether they use them for shelter, feed directly on the plants or eat the fish, crustaceans and invertebrates which feed on them.

When the algae themselves die, they decompose in the water, along with the plants they have killed. The plant and algae decomposition process uses the oxygen dissolved in the water, thereby reducing oxygen available to the fish and, in some instances, resulting in fish kills. By absorbing nutrients through the root systems, riparian vegetation plays an active role in reducing the amount of nutrients that enter our waterways. Further benefits can be gained by fencing off riparian zones as stock are prevented from entering the water and directly adding nutrients to the water through their faeces.

Summary

The Australian fishing industry is a huge industry that extracts hundreds of thousands of tonnes of fish annually. The industry also provides significant economic and social benefits to the nation. Currently, among the most prevalent threats to the sustainability of this industry are the problems associated with inappropriate land use management that are degrading our rivers on a national scale. Through sensible management of our land and water resources, our river and riparian fish habitats can be improved and expanded, allowing future generations the fishing resources we currently enjoy.

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THE FUTURE of fishing

RECFISH AUSTRALIA

There have always been rivalries and tensions between the recreational and commercial sectors of the Australian fishing industry about the allocation of finite fisheries resources. During the period of this rivalry, now fortunately well on the decline, there has emerged an overall threat to the sustainability fishing for both sectors.

Our river systems, their catchments and estuaries — the key habitats for sustaining our fishing industries — are becoming increasingly degraded. Poor land use and management practices are impacting adversely and substantially on our marine resources. The loss of terrestrial habitat is the major reason that Australia has the worst mammal extinction rate in the world and while the focus has remained on these visible creatures and their habitats, the insidious destruction of fisheries habitat has continued virtually unabated.

Through Natural Heritage Trust funding, recreational fishers have been able to identify problem areas and commence on-ground works to restore and rehabilitate fisheries' habitats nationwide. But this alone is not enough — there need to be fundamental reforms concerning land use management and its effect on fisheries habitat if our fisheries are to be sustainable.

The peak national recreational fishing sector representative body, Recfish Australia, its commercial equivalent, the Australian Seafood Industry Council, and the indigenous sector of the Australian fishing industry are all currently working together to devise a sustainability assessment process on a national level.

If the Australian fishing industry is to be a sustainable — and it must be; that is the only way ahead — fulfilling its economic, social and environmental responsibilities and potential, the land managers need to respect the rights of other users of our waterways, and catch up to the fishing industry on addressing sustainability issues.

Graham Pike
Vice President, Recfish Australia

Photo Graham Pike

RIVER QUALITY and our fisheries

Recent massive floods in far northern NSW have forced the closure of at least three major river systems. This "blackwater" has resulted in massive disruptions for fishers, destroying fish stocks in huge volumes. The incidence is a stark reminder of the importance of river and waterway health for indigenous, recreational and commercial fisheries.

Effective ecosystem management means a great deal more than restrictions on fishing effort. It means all stakeholders, especially land based polluters, must be brought to account and where necessary change their management practices. There have been numerous reports into the effect on fisheries of land management practices inlcuding a recent national statement on acid sulphate soils.

The seafood industry has advised government it is time to move beyond the reporting phase and into real reforms. The Australian Seafood Industry Council (ASIC) has made detailed submissions on the Federal Government discussion paper: "Managing Natural Resouces in Rural Australia for a Sustainable Future". ASIC wants to see a continuation of the work started under the Natural Heritage Trust. The submission explained the rapid progress by indigenous, recreational and commercial fishers in helping to devise a common sustainability assessment process across all Australian governments — federal, state and territory.

ASIC has drawn particular attention to the 'Fremantle Declaration' by the International Coalition of Fisheries Associations (ICFA). This declaration affirms that land-based management practices can have major downstream consequences for fish habitats and water quality. The Fremantle Declaration calls for global action — including Australia to overcome:

~ increased salinity in soils and groundwater which can enter coastal and marine environments,
~ nutrient, pesticide and residue-laden run-off entering marine environments and producing anoxic zones and harmful, toxic algal blooms,
~ deforestation leading to silting and salinisation of coastal environments,
~ activities leading to the destruction of wetlands and nursery habitats for fish and shellfish,
~ inadequately managed coastal zone development, including ill-considered urbanisation, and therefore
~ reductions in accessible, productive and sustainable fishing grounds.

The blackwater tragedy in northern NSW is a symptom of a much wider malaise. Through a united effort, indigenous, recreational and commercial fishers will continue to drive reforms to land management in order to protect fragile river ecosystems which are currently under their greatest threat ever.

Russ Neal
CEO, Australian Seafood Industry Council

Habitat requirements of Murray Cod (*Maccullochella peelii*)

The Murray Cod is Australia's largest freshwater fish species reaching a size of up to 1.8 metres, weighing up to 113 kilograms, this size and the palatable flesh of this species make it a popular target fish for recreational fishers.

Preferred habitat: Varies from small, clear, rocky streams to large slow flowing rivers which provide shelter such as deep holes, rocks, fallen timber, overhanging vegetation or clay banks. Territorial species that aggressively defend their specific holes or areas.

Diet: Larvae feed on zooplankton, bloodworms, aquatic insects, shrimps; juvenile fish and fish larvae — all of which become abundant when highly productive floodplains are inundated. A top order predator, Murray Cod eat vertebrate and invertebrate fauna, including: most fish species found in its range, cormorants, grebes, tortoises, water dragons, snakes, mice, frogs, mussels yabbies, shrimp, and crayfish.

Reproduction: Spawn when water temperatures reach 20°C in spring or early summer. Eggs are deposited on the bottom and onto solid objects such as logs, rocks and clay banks. Spawning can take place in water 30 centimetres deep. Sexual maturity reached at about 5 years, can live to sixty.

Threats: Habitat degradation is a major cause of decline in the population of Murray Cod. Other threats include: competition with and predation by introduced fish particularly Redfin Perch, siltation, desnagging, and pollution. Heavy fishing has also been identified as a major threat. In recent years fisheries managers have introduced daily bag limits of two, which will help alleviate pressure and allow stocks to recover, provided its habitat is rehabilitated and maintained.

Source: ACT Native fish information sheets
http://nativefish.www.act.gov.au/fishinfo/fishinfo6.htm


Photo MDBC

FREEING-UP OUR RIVERS for native fish

By Stuart Blanch

Many of our wonderful freshwater fish species migrate over long distances, with spawning runs of tens or hundreds of kilometres. This creates a dilemma for fishers, landholders, river managers and conservationists interested in improving native fish stocks, as most of our rivers have become littered with weirs, barrages, dams, roadways and levees.

Over 4000 weirs and 30 big dams clutter the degraded rivers of the Murray–Darling Basin. Murray cod, yellow belly and silver perch are just a few of the species which have their migrations obstructed, or even completely blocked by these barriers. In east-coast streams, around three quarters of fish species need to migrate between the estuary and brackish or freshwaters to complete their life cycle.

It is commonplace to see large schools of fish below a weir as they try to swim upstream. For example, fish biologists have monitored entire schools of threatened silver perch being wiped out below weirs. With so many hungry fish they can eat out the local food sources quickly, and then rapidly succumb to diseases in their weakened state. Pelicans, cormorants and anglers are experts at fishing below weirs and can also take a heavy toll.

Weirs have played a leading role in the demise of native fish species of the River Murray and its tributaries, with a third listed as threatened with extinction in Victoria and New South Wales (see, for example, www.fsc.nsw.gov.au).

So what can be done to help reduce the impacts of weirs? There are hundreds, if not thousands of weirs Australia wide that serve little or no use which can, and should be removed. In New South Wales alone, 88 weirs have been earmarked by a panel of government and community members for potential removal. Victoria has recently commenced a redundant weir program, and Queensland is soon to commence a review of instream structures.

Many weirs are relics of bygone eras and unwanted by their current owners — if they are indeed owned at all! A local angling club south of Sydney successfully lobbied against an old obsolete weir several years ago and won. Bass now swim through a 3 metre wide gap cut in the old cement weir to spawn — and, importantly, it only cost a few thousand dollars to make the alteration.

For the many weirs which can't be removed but which significantly obstruct fish movement, each should have a fishway. At around $50 000 to $100 000 per vertical metre height (and becoming cheaper) they are a viable option. Governments are increasingly requiring irrigators, who are often the prime beneficiaries of a weir, to pay a fair share of the costs of reducing its impacts.

Leaving weirs and coastal floodgates open is simple and cheap. Everyone wins as they can be closed when necessary but allow fish to pass through when open. Scores of floodgates on coastal creeks along the NSW north coast are being opened under joint agreement by landholders, fishers, floodplain managers and government.

Delivering environmental flows can also allow fish to move past a weir. 'Drown out' flows are increasingly being delivered by river managers and have the added benefit of helping rehabilitate the whole aquatic ecosystem — waterplants, invertebrates and many small fish which are too small to swim through a fishway use the flow to access upstream and downstream reaches.

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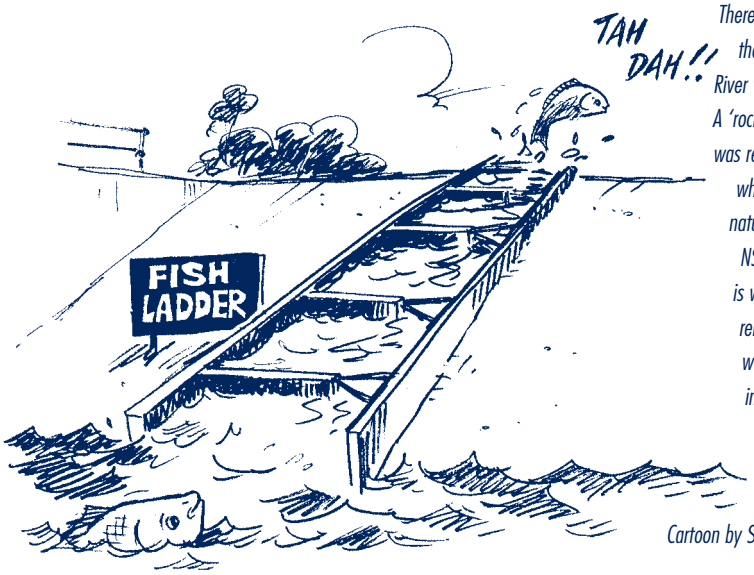
A large weir without a fishway on the River Murray, South Australia.



Theresa Park weir on the Upper Nepean River west of Sydney. A 'rock-ramp' fishway was recently attached which resembles a natural stream. The NSW Government is working towards removing nine old weirs in this river, including the one pictured above.

Cartoon by Simon Kneebone

What can you do to help?

What can you or your angling club do to reduce weir impacts? Survey your local area for structures that block fish movement and urge the owners to adopt one of the above approaches. You can also lobby fish and river management government departments to fix the problem.

The proceedings from the first national conference on weirs, *The Way Forward on Weirs*, hosted last August in Sydney by the Inland Rivers Network, will be available from June. It contains inspiring stories and reports from people and organisations involved in removing old weirs and seeking to protect fish through better management. Contact the Inland Rivers Network Coordinator on tel: 02 9241 6267 or email: coordinator@irnnsw.org.au for a copy (the book costs $45 and the CD costs $25).

Australian Conservation Foundation
INC. ARBN 007 498 482

FISHERIES ACTION PROGRAM
A program of the Natural Heritage Trust

The Australian Conservation Foundation lobbies for the rehabilitation of rivers and removal of unnecessary weirs in the degraded rivers of the Murray–Darling Basin. We are keen to work with anglers to save our threatened fish. Contact us on tel: 02 9247 8564.

Habitat requirements of Macquarie Perch (*Macquaria australasica*)

Classified as 'endangered' in the ACT and 'threatened' under Commonwealth legislation.

Preferred habitat: Currently restricted to cooler, clear mountain streams. Bottom to mid water dweller in slow moving rivers with deep holes that are well shaded and provide shallow riffles for feeding and spawning. Prefers water temperatures between 9 and 26°C.

Diet: Larval stage feeds on zooplankton. Adult Macquarie Perch are primarily insectivorous, feeding mainly on bugs, beetles, caddisfly larvae and dragonfly larvae. Adult Macquarie Perch will also eat shrimp, molluscs, crayfish and small fish.

Reproduction: Increased water temperature associated with rising water levels in November/December provide a cue to swim upstream and commence spawning. Demersal (sinking) eggs are layed in shallow water flowing over beds of boulders, cobbles, or gravel. Eggs are deposited just above a stream riffle or near the downstream edge of a pool and settle immediately downstream among the protection provided by the riverbed.

Threats: Siltation is a threat to the successful reproduction of Macquarie Perch, as silt deposited on newly hatched eggs will kill them. Flooding of habitats and blockage of migration by dams and weirs have also led population decline. Other threats include, competition and predation by introduced species, susceptibility to the EHN virus carried by the introduced Trout and Redfin, and over fishing (fully protected in ACT and NSW).

Source: ACT Native fish information sheets
http://nativefish.www.act.gov.au/fishinfo/fishinfo6.htm

Photo MDBC.

COASTAL FISHERIES and agriculture: working together

By Alex Wells

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It is no secret that the coastal floodplains along the east coast of Australia are now subject to substantial urban development pressures while also supporting valuable agricultural production such as sugar cane and dairy farming. The estuaries that form these floodplains are also an important source of recreation for millions of Australians, while at the same time being the engine room for much of our inshore fisheries production.

In 1994, in recognition of the floodplains importance to fisheries production, the Fisheries R&D Corporation (FRDC) developed a partnership with Land & Water Australia (L&WA), the Sugar R&D Corporation (SRDC), the Dairy R&D Corporation, state/local governments, landholders and the fishing industry, to improve floodplain research and management. The aim of the partnership was to ensure that Commonwealth funded R&D activities across a broad range of disciplines, were consistent with the practical needs of those managing floodplain ecosystems, as well as in preventing research duplication. The Clarence River catchment in northern NSW was selected as the case study catchment to try this partnership approach because it contained a comprehensive range of primary production activities and also a community and County Council who were interested in improving their land and water management outcomes.

Floodgates have been built in many estuaries within northern NSW and Queensland over the last 80 years for the purposes of agricultural development, and this has had a substantial impact on the adjacent aquatic environment. The current focus of the partnership between the FRDC, L&WA and SRDC is in improving the fisheries habitat value of the areas affected by floodgates, while at the same time maximising the productivity of sugar and or grazing enterprises.

The NSW Fisheries research team on the FRDC Project *Coastal floodplain management in eastern Australia: barriers to fish and invertebrate recruitment in acid sulphate soil catchments* are working closely with the NSW Agriculture scientists undertaking L&WA/SRDC project *Hydrologic Effects of Floodgate Management on Coastal Floodplain Agriculture*. Both the NSW Fisheries and the NSW Agriculture teams are working side by side on the same sites, to develop an understanding of the relationships between fish passage/water exchange and soil hydrology/sugar cane/pasture growth. The role of riparian vegetation will also be included in the analysis. These results will then be incorporated into a well defined set of floodgate management guidelines to be implemented by state/local government's and landholders.

One crucial part of the partnership approach to research funding, is in ensuring that research activities are co-ordinated locally as well as nationally. To achieve this, both projects are overseen by a steering committee based out of the Clarence County Council which includes representatives from the key landholder groups. This committee also oversees a host of other research activities that are relevant to the management of the catchment and this ensures research is not duplicated and is incorporated into management when complete. To further assist with the transfer of knowledge from the project teams to the community and management agencies, a forum will be held on 22 and 23 June 2001 where some initial results will be presented and an opportunity for open discussion presented.

***Left**: The main floodgate on the Yarrahappini wetland. Mid-May 2001 will see the gates opened on a trial basis with the aim of restoring the area to a more 'natural' state and improving the fisheries habitat of the area. Photo Matt Barwick.*
***Right**: This area of the Yarrahappini wetland, near Kempsey, was once natural saltmarsh and mangrove habitat, but has been affected by drainage practices to the point where mangroves find it difficult to survive. Photo Matt Barwick.*

WORKSHOP: Wise use of wetlands in northern Australia: grazing management in wetlands and riparian habitats

2–4 October 2001, Northern Territory University, Darwin

The workshop will include presented papers and discussion sessions on the following topics: sustainable grazing management practices, environmental threats, management problems, practical solutions, future research priorities and methods of technology transfer. There will be a one-day field trip to observe and discuss pastoral practices in wetlands of the Darwin region.

This workshop is the second in the Wise Use of Wetlands in Northern Australia series hosted by the Centre for Tropical Wetland Management at NTU.

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The Douglas River. Photo Judy Faulks.

Habitat requirements of Barramundi (*Lates calcarifer*)

Barramundi's great fighting nature make the species a highly prized target for recreational fishers, but Barramundi are also a high quality table fish, as highlighted by the commercial harvesting and farming of Barramundi.

Preferred habitats: Barramundi can be found in the seawaters, estuaries, tidal creeks, inland tidal areas, rivers and billabongs of northern Australia. Within the river systems Barramundi seek out deep waters overgrown with branches or fallen trees in the water, rocky outcrops, inflows from small creeks, and in billabong patches of lily pads or similar vegetation that provide cover. Research suggests that each river system may have its own unique Barramundi population.

Reproduction: Barramundi larvae emerge from their eggs in bays and river mouths. With the high spring tides juvenile barramundi move to mangroves and wetlands, which offer food and shelter. In the second half of the wet season they swim upstream into streams and billabongs. As barramundi approach male maturity they swim back to tidal areas during wet season floods to spawn. Once they have spawned they remain in tidal waters. At about seven years of age the males change sex to females.

Diet: Larvae feed on zooplankton. Adults feed on prawns, bonyfish, benthic crustations, and invertebrates.

Threats: Obstruction to movement from salt to fresh water, over fishing.

Source: Fisheries Western Australia, http://www.wa.gov.au/westfish/rec/broc/ord/index.html

Allan, R., 1990, *Australian Fish and How to Catch Them*, Weldon Publishing, Sydney

Photo Ross Monash.

A BASIN WIDE PLAN for native fish

By Jim Barrett

In the past 50 years, the number and distribution of native fish in the Murray–Darling Basin has declined significantly. This decline reflects the poor state of the river system and the impacts of human use. Many factors contribute to this deterioration, including the construction and operation of dams and weirs, changes to river flows, pollution and water use patterns.

In the last five years, there has been a growing awareness in the community about the state of our native fish. This public and political concern has led to the establishment of the Native Fish Management Strategy (NFMS) by the Murray–Darling Basin Commission. The NFMS aims to improve management of the riverine environment to better meet the requirements of native fish and to restore fish populations in balance with other legitimate demands on water resources. It provides a framework for community involvement, interstate coordination of management actions and policies, as well as research, monitoring and reporting of management activity in the Basin.

The vision of the strategy is to restore viable, sustainable, native fish species and communities throughout the Murray–Darling Basin. The strategy will focus on 12 key objectives that incorporate the threats to the restoration of viable native fish populations:

- Aquatic habitats
- Floodplain and wetland habitats
- Water quality
- Flow regulation
- Fish passage
- Threatened species, communities and conservation zones
- Non-threatened native fish species
- Exotic fish
- Diseases and parasites
- Fishing mortality
- Translocations and stockings
- Aquaculture

What sets this Strategy apart from some other well intentioned, but sometimes ineffective strategies, is that it doesn't just focus on fish. The NFMS acknowledges the need to view fish management in terms of the "bigger picture" of river restoration and integrated catchment management. It also recognises that long-term management and research are necessary so that we can better understand all of the activities in our rivers and catchments across the Basin. In other words, the environment needs to meet certain standards in order for native fish to survive and prosper.

The fluctuating nature of the Australian landscape, and especially its aquatic systems, is based on long time frames incorporating events such as floods and droughts, which trigger the growth of not just fish but the entire aquatic food chain. These factors must be understood and including in planning. The NFMS also focuses on the need for a system of reserves/zones in the Basin to protect fish. Some specific recommendations include:

- investigating 'buyback' options for floodplains as important river conservation areas,
- identifying and instigating river conservation management zones,
- identifying and protecting areas of high conservation values, and
- designating and protecting areas that are currently free of exotic species from future invasion.

Approved in July 2000 by the Murray–Darling Basin Ministerial Council, the NFMS will rely heavily on community participation. This will include the establishment of a Community Stakeholder Group to coordinate information and education activities, as well as provide a network and representation for catchment groups, special interest groups and educational institutions. It will also include representation from the recreational fishing sector to ensure its involvement in the broader issues of flows, input to water infrastructures, environmental impact processes and recovery plan implementation, as well as the adoption of genetic protocols by fishing groups.

The NFMS places great emphasis on riparian zone management: one specific goal is to protect important areas and attributes of riparian habitat and, where necessary, reinstate riparian vegetation and complexes for the provision of fish habitat diversity. Specific tasks to be undertaken include:

- the development of a Basin-wide riparian vegetation protection and replanting scheme,
- the provision of information on the location and status of all riparian zones of the Basin's rivers and streams in relation to protection or rehabilitation requirements, and

MURRAY-DARLING BASIN COMMISSION

A BASIN WIDE PLAN for native fish

~ the development of an inventory of riparian zone plants, their life histories, methods of propagation, ecological advantages and areas in which they should be planted.

In the early stages of implementing the Strategy, the Murray–Darling Basin Commission is concentrating on the provision of adequate fish passage. It has established a Fish Passage Reference Group that will combine the disciplines of hydrology, hydraulics and biology to ensure that appropriate fishway designs are used with consistency across the Basin. The Commission is also finalising a database to provide critical location and other technical details for the 4000 or so dams, weirs, culverts and other structures that impede the migration of native fish within the Basin.

The Murray–Darling Basin Commission recently announced the allocation of $10 million over the next five years to build fish ladders on all of its locks and weirs on the Murray River. Along with improvements at existing structures such as Yarrawonga and Torrumbarry, the program will result in effective fish passage from Lake Hume to the sea. Concurrently, a Basin-wide program for fish passage is being progressed under the umbrella of the NFMS and will include the construction of priority barriers for passage in Queensland, New South Wales and Victoria, automation of the barrages in South Australia, and the examination of other structures at sites such as Lake Victoria and the Chowilla anabranch.

Current projects funded by the Commission that will contribute to the implementation of the NFMS include:

~ a pilot study into resnagging a section of the Murray between Yarrawonga and Tocumwal,
~ an investigation into fish passage through navigation locks,
~ an investigation into fish-friendly regulator design,
~ the feasibility of fish passage through the barrages in South Australia, and
~ a risk assessment of the impacts of pest species in the riverine environment in the Murray–Darling.

The Murray-Darling Basin Commission has also organised or sponsored regional, community workshops on fish passage, cold water pollution, *tilapia* and carp.

The NFMS is only the first stage in a process that will take many years to bring to fruition. However community involvement is crucial to maintain the will to make this important work happen in the Basin. Good community involvement on issues such as carp control and in other areas of the Murray–Darling Initiative has shown the way. The NFMS provides the framework to make serious and long-overdue improvements for our native fish.

For more information on the NFMS, look at the following website
http://www.mdbc.gov.au/naturalresources/policies_strategies/projectscreens/fishproject.htm

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Habitat requirements of Rainbow Trout (*Oncorhynchus mykiss*)

Rainbow trout is a popular fish targeted by recreational fishers around the globe. It was introduced into Australia in the late 1800s and has been regularly restocked in rivers and lakes ever since.

Preferred habitat: Cool well oxygenated water with good cover and shelter.

Reproduction: In spring, rainbow trout migrate upstream to areas of gravel streambed, eggs and milt are deposited in a depression in the gravel made by the female. Eggs hatch after about five weeks, where they hide in the gravel feeding on their yolk-sacks until they emerge as fry. As they get larger they move downstream into deeper water.

Diet: Insects — both terrestrial and aquatic, crustaceans, molluscs and small fish.

Threats: Low flows prior to juveniles leaving gravel nests, loss of instream habitat, sedimentation.

Source: Inland Fisheries Service Tasmania, *Freshwater Fish Facts Number 27 Rainbow Trout (Oncorhynchus mykiss)* http://www.ifc.tas.gov.au/fact_sheets/rainbow_trout.html

Photo MDBC.

FISH HABITAT management challenges on an intensively developed tropical floodplain

BURDEKIN RIVER NORTH QUEENSLAND

Jim Tait and
Colton Perna

Impact of development on the floodplain

Today, the Burdekin River floodplain is an example of a highly modified floodplain environment. The following set of images (on pages 15, 16 and 17) shows how changed water and land use practices have dramatically altered this floodplain environment. It is important to recognise that the ecological impacts identified in these images often have drivers that operate at a catchment scale.

Stands of riparian trees have been reduced by a number of factors including clearing, weed competition, water logging, fire, increased insect attack and saline groundwater intrusion. The loss of riparian trees, nutrient loading, hydrological changes and a reduction in grazing land use has resulted in an increase in exotic weeds. Dense stands of invasive exotic pasture grasses including para grass *Brachiaria mutica* and guinea grass *Panicum maximum* exclude native sedge and aquatic grass species and reduce the recruitment of riparian tree species.

In some instances, vigorous floating aquatic weeds including hyacinth and salvinia (see left), grown over by exotic pasture grasses form semi-submerged mats dense enough to support a person's weight. The dark, organic loaded anoxic water underlying these features will not sustain diverse fish life and create water quality barriers that restrict their movement. Recent research by CSIRO (Ford et al. in press) has identified that these environments create conditions that promote cyano-bacteria (blue–green algae) blooms.

Within the floodplain, water quality has significantly deteriorated with low dissolved oxygen, high nutrient levels and turbidity affecting the quality of surface waters in Burdekin floodplain habitats. A range of chemical contaminants have also been recorded in surface and groundwater, sediments and biota (DNR 1996).

Changes to flow regimes in order to meet irrigation and aquifer recharge needs, have resulted in ephemeral systems now being more permanent. This has altered the seasonal changes and exchanges between surface and groundwater systems. A range of water management structures such as dams, weirs (photo 1, page 20), salt-water intrusion bunds and culverts (photo 2, page 20) have reduced aquatic habitat connectivity, and limited the capacity of many fish species to move between floodplain and lower catchment estuarine habitats for breeding and other life cycle events.

What about the fish?

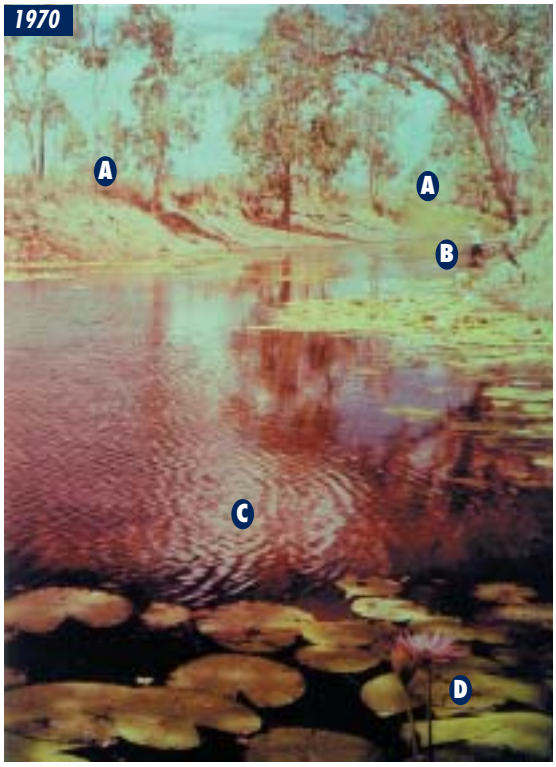
Concerns about the status of the Burdekin's floodplain fish community as a result of these negative ecological impacts, has been growing over the last couple of decades. Local fishers had observed a decrease in catches of popular species such as barramundi and also a general decline in other fish life. Local stocking groups have endeavoured to increase the recruitment of barramundi through stocking but were concerned that such efforts may be in vain if basic habitat requirements were not being met due to the deteriorated ecological condition of floodplain waterways.

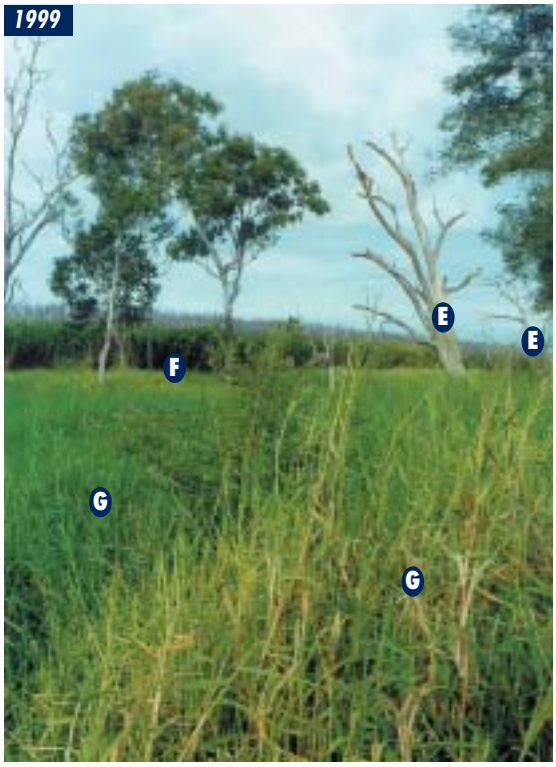
In 1999, a particularly wet year, a large number of fish kills occurred in sugar industry dominated catchments up and down the Queensland east coast, including the Burdekin. This further raised concerns within recreational fishing interests that generic habitat impacts associated with the sugar industry may be to blame (see http://www.sunfish.org.au/Fishkills/Fishkills.htm). Although the industry correctly asserted that fish kills have long been a natural occurrence in floodplain environments, the frequency and extent of events raised the prospect that environmental conditions on agricultural dominated floodplains could be exacerbating the causes.

Responding to community interest, the Burdekin Integrated Floodplain Management Advisory Committee with financial support from the local sugar industry, sought NHT funding under the Fisheries Action Program, to

Payards Lagoon, Burdekin delta
***Top**: The lagoon covered by water hyacinth prior to weed harvesting.*
***Middle**: Weed harvester in operation.*
***Below**: After harvesting and bank raking.*

FISH HABITAT management challenges





Changes in the riparian zone — indicators of catchment scale impact drivers
'Round waterhole' (1970–99) on Sheep Station Creek, a distributary channel on the Burdekin River northern delta.

The letters highlight the different changes that have occurred between 1970 and 1999 in the same site.

A ***Reduced riparian tree recruitment*** *— due to ground layer competition and intense dry season fires associated with dense growth of fire loving (phyrophytic) exotic grasses.*

B ***Loss of recreational fishers*** *— due to gross habitat changes, reduced fish populations and loss of open surface water.*

C ***Deteriorated water quality*** *(low DO_2, high nutrients, high turbidity) — loss of open water surface areas, organic loading from weeds, nutrient rich agricultural run off, flows of irrigation water supplied from turbid upper catchment reservoirs.*

D ***Loss of native macrophytes*** *— due to shading and smothering growth of exotic pasture grasses.*

E ***Death of riparian trees*** *— most likely due to waterlogging (mainly low-lying trees) related to changed channel hydrology, i.e. sustained high water levels due to artificial irrigation / aquifer recharge flows. Tree death also likely to be associated with intense fires and increased insect predation of isolated stands.*

F ***Encroachment of irrigated agriculture*** *— providing a ready source of nutrient rich tailwater and frequent fires related to harvest burnoffs.*

G ***Invasion and growth of exotic pasture grasses*** *— related to removal of riparian grazing, sustained water levels, availability of nutrients and lack of competition with riparian trees.*

fund a research project to establish the status of Burdekin floodplain fish populations and habitat. The Australian Centre for Tropical Freshwater Research (ACTFR), from Townsville's James Cook University was engaged to assess the situation and to help formulate an integrated management strategy to maintain and improve floodplain fish habitats.

Given the extensive modification that has occurred to aquatic habitats on the Burdekin floodplain it could be expected that freshwater fish abundance and community composition would reflect these environmental changes. Results of surveys conducted to date by the ACTFR have confirmed that this is the case. After one full climactic year of sampling, results suggest a very depressed fish species abundance and diversity. Out of up to 40 species historically recorded from freshwater lagoons in the area, or with distributions that fall within the region, only 20 have been recorded (Table 1, page 21), and many of these at low abundances. Only seven native and one feral species have been recorded at more than half of the 11 lagoon sites sampled. This contrasts with historical surveys of Burdekin freshwater lagoons, which found barramundi in abundance and a relatively diverse fish community (Macleay 1883).

Water quality monitoring indicated a very poor dissolved oxygen status for most lagoon sites surveyed, with observed mean values typically less than 2 mg/l. Unstable cycling between anoxia and hypoxia was also evidenced by wide value ranges. Fish sampling data shows that the fish communities are now dominated by low dissolved oxygen tolerant native and feral species, e.g. tarpon, gudgeons and mosquito fish (see Table 1).

Many of the expected fish species not recorded or observed at only low abundances are

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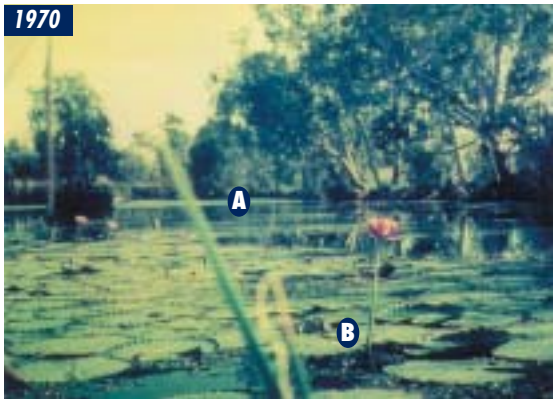
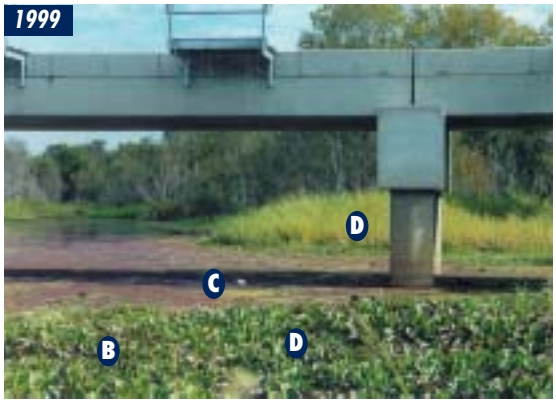
FISH HABITAT management challenges



A ***Changed hydrology*** *— due to irrigation and aquifer recharge flows and construction of earth barrage immediately downstream to prevent inflow of high spring tides.*

B ***Loss of native macrophytes*** *— due to shading and smothering growth of exotic pasture grasses and floating aquatic weeds, higher turbidity levels and loss of spring tide inflows which 'reset' macrophyte community.*



C ***Deteriorated / water quality*** *(low DO_2, high nutrients, high turbidity) — loss of open water surface area, organic loading from weeds, nutrient rich irrigation tailwater flows, input of irrigation water supplied from turbid catchment reservoirs, prevention of spring tide inflow due to construction of earth barrage.*

D ***Invasion and growth of exotic pasture grasses and floating aquatic weeds*** *— related to removal of riparian grazing, sustained water levels, availability of nutrients and prevention of tidal (brackish) inflows.*

Changes in the riparian zone — indicators of catchment scale impact drivers
Rail crossing (1970–99) at Saltwater Creek, a distributary channel on the Burdekin River southern delta.

either low oxygen intolerant, e.g. bony bream, rainbow fish, hardyheads or catadromous (downstream migrating marine breeding), e.g. barramundi, milkfish, silver-biddies, snakehead-gudgeons. Reduced abundances of these groups is thought to be due largely to poor water quality associated with the high biomass of exotic floating weeds.

Of greatest concern, has been the finding that freshwater herring or bony bream *Nematalosa erebi*, have been all but lost from some floodplain drainage systems. Bony bream are considered the food chain drivers of flood-plain environments from the Murray–Darling Basin to the tropical floodplains of the Fly River in Papua New Guinea. In healthy floodplain habitats, bony bream are the boon of a fish biologist existence, large schools capable of filling every mesh of a survey gill net within an hour of being set. However, they are also recognised to be a low oxygen intolerant species and one of the first to show signs of distress when a water body's oxygen levels drop.

Historically, Burdekin wetlands contained an enormous biomass of this species witnessed by annual wet season fish kills in which dead bony bream would cover hectares of surface water area. The highly fecund, constant breeding season, short life span, life cycle of this species has always ensured that sufficient recruits are available to replace high annual mortality levels. The absence of this species from the majority of sites surveyed by the ACTFR now suggest that environmental conditions have become too challenging for even this resilient species.

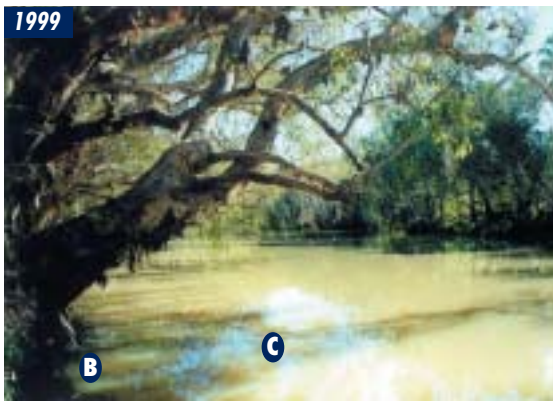
Catadromous species, many of which are also sensitive to poor water quality, are known to face a large number of water infrastructure passage barriers when attempting to access upstream habitat from downstream recruitment areas (see photos 1, 2 and 3, page 20). However, data suggests that stream reaches with poor water quality may also present chemical barriers for these species. The finding that tarpon *Megalops cyprinoides* a catadromous, low dissolved oxygen tolerant native species are still common, indicates that connectivity to estuarine reaches still exists and supports the suggestion that poor water quality may in fact be the primary factor limiting the upstream migration of catadromous species.

Other functional characteristics of species that are missing or only observed at low abundances include: macrophyte feeders (herbivores i.e. striped grunter), macrophyte egg layers (i.e. rainbow fish, hardyheads, blue eyes), visual predators (long tom), detritivores (mullet, milkfish), planktivores (snub-nosed gar, pipefish) and terrestrial invertivores (archer fish). The high turbidity of irrigation water supplied via floodplain distributary channels or entering wetlands as tailwater, would offer a likely cause of impacts to these groups.

With high levels of suspended solids, light penetration is much reduced thus decreasing the effectiveness of visual predators and the biomass of macrophytes within streams (see photo 5, page 20). High turbidity also reduces the growth of filamentous algae, phytoplankton and in turn zooplankton, all of which can affects the nutritional status of detritus.

The apparent loss of archer fish, a terrestrial invertivore from Burdekin floodplain habitats is not as readily explained by high turbidity as the species is known to live in turbid environments. Reduced riparian vegetation cover (and parallel reduction in prey abundance), and low dissolved oxygen sensitivity may also account for its absence. This species has been observed to become locally extinct at other north Queensland lagoon sites (i.e. Ross River pers obs) following the infestation of floating exotic weeds.

FISH HABITAT management challenges



***Changes in the riparian zone — indicators of catchment** scale impact drivers Lagoon on East (images above) and West (images below) Barratta Creeks (1968–99), distributary creek systems on the Burdekin River floodplain.*

A ***Loss of native macrophytes*** *— due to sustained higher turbidity.*

B ***Changed hydrology*** *— sustained high water levels associated with irrigation channel overflow, tailwater inputs and regional groundwater rise.*

C ***Deteriorated / water quality*** *(high nutrients, high turbidity) — system receives turbid, nutrient rich irrigation tailwater from BRIA located upstream. Water clarity previously clear 'blackwater' during no-flow dry season periods.*

Management challenges

There are several major challenges in confronting the fish habitat impacts on the lower Burdekin floodplain. These challenges help define pragmatic management goals, and the appropriate actions that may deliver them. They include:

- **The catchment-based nature of processes impacting fish habitats**. These require catchment-based solutions. Unless the scale of impact drivers are recognised there is often little point in addressing habitat impacts identified at a site which may represent nothing more than symptoms of processes operating at a larger catchment scale.
- **Integrated problems need integrated solutions**. Many of the impacts occurring to floodplain fish habitats have their origins in a multiplicity of causal factors. For example, the benefits gained by removing weed infestations will be short lived where the hydrological, land use and nutrient drivers contributing to the weed infestations are ignored.
- **Management endpoints need to be defined and achievable goals identified**. The lower Burdekin floodplain is a highly modified environment. It is neither feasible nor, in some cases, desirable to attempt to manage the aquatic habitats back to a pre-settlement state, given the level of intensive development surrounding floodplain wetlands. Identifying management actions that contribute toward creating a healthy ecosystem, within the constraints provided by an irrigated monoculture dominated landscape, provide a pragmatic focus for goal setting.
- **Changing on-farm management practices**. On a floodplain intensively dominated by agriculture and freehold tenure, it is not surprising that many of the impact drivers, and hence, solutions lie with on-farm practices. Three key areas for on-farm initiatives lie with (1) water (irrigation, tailwater and run off) management, (2) nutrient/fertiliser application management and (3) habitat management. One of the key challenges is getting primary producers to recognise that their on-farm actions can impact on floodplain aquatic environments and ultimately fish habitat integrity and fisheries productivity. This is particularly the case for ephemeral and small freshwater wetlands, which seem far removed from the coastal estuarine habitats most associate as 'fish habitat'. Fortunately many primary producers are keen recreational fishers and notwithstanding economic constraints, the desire to improve the fish habitat status of the district and the fishing potential is a powerful motivator for change. Some of the changes that could be made on-farm to improve river and riparian habitat for fish are shown in the following boxes.

On-farm management practices to improve floodplain fish habitat values

Water management: seeking more efficient irrigation methods (i.e. overhead or trickle versus furrow) or practices (i.e. timing, pulses, furrow length and shape) that contribute to greater water use efficiency and less accessions to groundwater or tailwater flows leaving the paddock. Where tailwater volumes are significant, tailwater recycling basins offer both economic and environmental benefits. Up to 20% of new BRIA farms now include tailwater recycling basins as part of their on-farm water management infrastructure.

Nutrient management: Historically nutrients have been seen as one of the crop growth variables that producers can have most control over. When profit margins are good, the tendency with fertiliser application rates has always been to err on the side of surplus. Assessment of paddock nutrient status, marrying of application rates to soil type and nutrient status, precision application, fertigation, use of split stool application (and other burial methods) and reduction in surface application practices, all offer prospects for reducing off-farm nutrient exports in the lower Burdekin. These types of activities are being promoted through industry best practice initiatives including BSES and CANEGROWERS supported farmer cell groups.

Habitat management: The retention of on-farm habitat in the lower Burdekin region is perceived in some sectors of the producer community as being tantamount (with some justification) to an open invitation to crop pests including wallabies, rats and cane beetles. However, the increasing recognition of the extent of regional habitat loss and the associated loss of amenity (including fishing and swimming spots), that has accompanied changes perceived to occur since *"when we were kids"* has led to increased interest in on-farm habitat management.

Initiatives that are being implemented include revegetation of riparian corridors, controlled grazing and fire regime management in habitat remnants. The retention of habitat is also being promoted as part of property and water management plans developed for new cane assignments or water licences. A full time revegetation officer employed by a joint CANEGROWERS and Landcare sponsored NHT project, is gradually working toward the implementation of a district revegetation strategy that includes a goal of 50 000 trees planted on farms.

Management of habitat connectivity/fish passage

Given that a third of the potential freshwater fish community species on the lower Burdekin are migratory, the facilitation of fish passage between estuarine and floodplain habitats is essential for the maintenance of fish community integrity. Stocking of key top order predators such as barramundi is often promoted as a means of replacing reduced natural recruitment, including that due to the effects of fish passage barriers. However, this approach does not address the needs of a host of other lower profile species i.e. snake-head gudgeons, giant herring, jungle perch, mangrove jack, mullet, milkfish, silver-biddies, empire gudgeons, all which may have important roles in terms of community predator-prey relationships and overall productivity.

In the near coastal environment, saltwater intrusion bunds across supra-tidal channels create seasonally eutrophic ponded pasture 'wetlands' (see photos 3 and 4, page 20) that can act as death traps for juvenile fish recruitment. These environments replace more ephemeral and higher productivity fish nursery swamps that previously occupied the coastal plain post wet season. Management options for these features may be selective removal and reinstatement where possible of the pre-existing hydrology.

Department of Natural Resources are currently investigating the potential to improve fish passage around major structures, i.e. weirs on the Burdekin and Haughton River channels. Primarily this involves assessments of species present above and below passage impasses and the scope for the construction of passage facilitating structures such as vertical slot fish ladders or cheaper rock ramps. The North Burdekin Water Board is also trialling the wet season removal of drop board structures from channel culverts as a means of encouraging increased post flood upstream recruitment of both predator and prey species.

Less obvious structures such as high velocity generating narrow pipe culverts also remain widely distributed across the floodplain affecting movement of small fish species and larval recruits. Queensland Department of Primary Industries fisheries guidelines for the design of 'fish friendly' culverts and road crossings are now available.

Floodplain aquatic weed management strategies

Addressing the hydrological and nutrient drivers of aquatic weed infestations provides a viable long term strategy for their control, however existing weed infestations also need to be managed if riparian, fish habitat and water quality are to improve in the shorter term. An integrated approach requires a mixture of physical, chemical and biological control approaches. Control efforts need to be aware of the recruitment potential posed by upstream sources and seek to exploit opportunities posed by wet season floods which expel an enormous biomass of floating aquatic weeds, sometimes destroying bridges and other infrastructure in the process.

Collaborative aquatic weed control strategies supported by the local Burdekin Shire, Department of Natural Resources and the Water Boards are being promoted as part of the Burdekin Shire Pest Management Strategy. A mixture of approaches involving chemical (herbicide spraying), biological (the release of water hyacinth bio-control weevils) and physical methods (including the use of back-hoe operated 'weed rakes' and an 'aquatic weed harvester' have all been used or trialled.

Fish community response to weed removal

Although costly to operate, the aquatic weed harvester delivers the most immediate results and has benefits in that weed biomass is being removed from the water body. The ACTFR took the opportunity to treat the first trialling of an aquatic weed harvester within a Burdekin deepwater lagoon as a large-scale experiment. Monitoring of water quality and fish assemblage changes pre and post the use of the harvester have provided some encouraging results. Local fish species have been found to be highly resilient. It would appear that given appropriate habitat requirements they will quickly recruit back into the system. Over a seven-month period after the weed harvesting, sampling showed a large change in fish community structure in the lagoon. Catches became dominated by native species and there was an apparent concomitant decrease in the abundance of the exotic mosquito fish. Most encouraging was the reappearance of freshwater bony bream in post weed harvesting samples. Water quality has also shown a sharp increase and maintenance at above average levels.

One man's weed

One of the challenges encountered in the formulation of aquatic weed management strategies are the production benefits ascribed to some. A relatively recently invading deepwater ponded pasture species *Hymenachne*, poses threats to wetlands and fish habitat values but is valued by coastal plain beef producers as a pasture species. Industry lobbying to retain the right to utilise it as a pasture species, undermines attempts to have it listed for eradication from the district.

The lining of irrigation supply channels by para grass infestation is also viewed as positive by some Water Board members due to its perceived role in encouraging the settlement of suspended solids thereby reducing turbidity and increasing the capacity for aquifers recharge. The shading and growth inhibiting affect of water hyacinth on native submerged macrophytes is also appreciated by irrigators who see its benefits in terms of preventing the blocking of pump intakes by submerged aquatic plants. An alternative method for avoiding the blockage of pump intakes is to acquire old steel mesh cane tram bins to place around pump intakes.

Ultimately multiple value perspectives on management issues negates a 'one size fits all' approach to solving problems. For aquatic weed infestations this translates into a need to identify where investment in control programs will provide fish habitat and other benefits and where the status quo of the modified environment has sufficient inertia or justification as to not merit management effort. One of the prohibitive aspects of weed management is that it needs to be ongoing if gains made by periodic concerted efforts are to be maintained. Few agencies are prepared to accept such responsibilities.

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FISH HABITAT management challenges

To successfully implement environmental management strategies on an agriculture dominated floodplain where there are a range of values and competing demands for natural resource management, requires an inclusive approach in which all stakeholders feel involved and informed. In the lower Burdekin, the BIFMAC (Burdekin Integrated Floodplain Management Advisory Committee) an advisory committee to the lower Burdekin Landcare association is providing such a forum. The BIFMAC is made up of multiple representatives from community, industry, and government bodies, and one of its main accomplishments has been the development of a 'Community based natural resource management strategy for the lower Burdekin-Bowen floodplain sub-region of the Burdekin Dry Tropics' (BIFMAC 1999). This regional strategy provides a framework for identifying and addressing priority NRM issues, two of which were water management and fish habitat.

During the formulation of the regional strategy, one tool used to get the community focussed on environmental changes in the region was to seek historical photographs of wetland sites within the district and compare these with contemporary images from the same sites. Several of these images compiled from the author's family's personal slide collection are illustrated in this article. The increased recognition of issues by industry and community stakeholders that followed the compilation of these 'before and after' images certainly supported the maxim that 'a picture paints a thousand words' and 'beats writing reports'!

***Photo 1**: Drop board flow culvert blockage at ouflow of deepwater lagoon. These types of structures limit the capacity of many species to move between habitat reaches.*

***Photo 2**: Weir on Haughton River. Design elements intended to act as flow energy baffles actually facilitate upstream fish passge around this weir under certain flow conditions.*

***Photo 3**: Saltwater intrusion bund wall on lower Kalamia, Burdekin Delta facilitation agricultural expansion to the margin of the delta soils.*

***Photo 4**: Freshwater ponded pasture developed using earth bunds to exclude tides from previously mangove wetland areas.*

***Photo 5**: High turbidity in Payard's Lagoon, resulting from pumping of water from turbid Burdekin Falls Dam.*

Benefits of an ICM approach

Although much of the discussion within this article has focussed on the status and dynamics of fish habitat within the floodplain, the importance of the biophysical linkages and framework provided by the total catchment should not be undervalued. The linkages of some issues to upper catchment processes and the generally integrated nature of fish habitat problems and solutions, underlies the strength of Integrated Catchment Management (ICM) approaches to fish habitat management. Important for the implementation of ICM is the identification of catchment and sub-catchment boundaries, including within the floodplain. These identify communities of common interest and provide a geographic framework for action priority setting, related to the intrinsic values and status of a particular drainage unit.

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FISH HABITAT management challenges

Table 1. Freshwater fish of the lower Burdekin floodplain

Name	Genus and species	Trophic niche	Catadromous (estuarine – coastal migration)	Recorded in current survey (No. sites)	Possible reasons contributing to absence, low abundance or presence at low numbers of sites
1. Tarpon	*Megalops cyprinoides*	Piscavore	Yes	Yes (10)	Abundant suited to habitat. Low DO_2 tolerant
2. Long-finned eel	*Anguilla reinhardtii*	Aquatic – macroinvertivore, piscavore	Yes	Yes (4)	Still abundant but not easily captured by gill nets
3. South Pacific eel	*Anguilla obscura*	Aquatic – macroinvertivore	Yes	No	Naturally low abundance
4. Bony bream	*Nematalosa erebi*	Detritivore / planktivore	No	Yes (3)	Low DO_2 sensitive
5. Salmon catfish	*Arius graeffei*	Macrophagic omnivore	No (a)	No	Mouth brooder with low DO_2 sensitive recruitment
6. Rendahl's tandan	*Porochilus rendahli*	Aquatic – macroinvertivore	No	Yes (8)	Abundant suited to habitat
7. Butter jew	*Neosilurus ater*	Aquatic – macroinvertivore	No	Yes (8)	Abundant suited to habitat
8. Hyrd's tandan	*Neosilurus hyrthi*	Aquatic – macroinvertivore	No	Yes (8)	Abundant suited to habitat
9. Eel tailed catfish	*Tandanus tandanus*	Aquatic – macroinvertivore	No	No	Prefers running clear water
10. Snub-nosed gar	*Arrhamphus sclerolepis*	Herbivore / planktivore	No	No	Turbidity reducing plankton density
11. Long tom	*Strongylura kreffti*	Piscavore	No	No	Visual predator affected by high turbidity
12. Fly-speckled hardyhead	*Craterocephalus stercusmuscarum*	Aquatic – macroinvertivore / herbiviore	No	Yes (5)	Low DO_2 sensitive. Submerged macrophyte egg layer
13. Pacific blue-eye	*Pseudomugil signifer*	Aquatic – macroinvertivore	No (a)	Yes (1)	Low DO_2 sensitive. Submerged macrophyte egg layer
14. Eastern rainbow fish	*Melaanotaenia splendida*	Aquatic – macroinvertivore / herbiviore	No	Yes (3)	Low DO_2 sensitive. Submerged macrophyte egg layer
15. Bullrout	*Notesthes robusta*	Piscavore	No (a)	No	Prefers clear running water
16. Barramundi	*Lates calcarifer*	Piscavore	Yes	Yes (3)	Estuarine access dependent
17. Agassiz's glassfish	*Ambassis agassizii*	Macroinvertivore	No	Yes (8)	Low oxygen intolerant, requires macrophyte cover
18.	*Ambassis agrammus*	Macroinvertivore	No	No	Low oxygen intolerant, requires macrophyte cover
19. Spangled perch	*Leiopotherapon unicolour*	Piscavore / macroinvertivore	No	Yes (5)	Habitat loss, low oxygen intolerant
20. Black striped grunter	*Amniataba perchoides*	Herbivore	No	No	Reduced abundance of submerged macrophytes associated with sustained turbidity
21. Sooty grunter	*Hephaestus fuliginosus*	Macrophagic omnivore	No	No	More river channel orientated species never abundant on floodplain
22. Jungle perch	*Kuhlia rupestris*	Piscavore / macroinvertivore	Yes	No	Low DO_2 sensitive, estuarine access dependent
23. Mouth almighty	*Glossamia aprion*	Piscavore	No	Yes (4)	Estuarine access dependent
24. Mangrove jack	*Lutjanus argentimaculatus*	Piscavore	Yes	No	Estuarine access dependent
25. Silver batfish	*Monodactylus argenteus*	Aquatic – macroinvertivore	Yes	No	Estuarine access dependent
26. Archer fish	*Toxotes chatareus*	Terrestrial – invertivore	No (a)	No	Reduced input of terrestrial invertebrates associated with riparian habitat loss
27. Scat	*Scatophagus argus*	Detritivore / aquatic – macroinvertivore	Yes	No	Estuarine access dependent
28. Bully mullet	*Mugil cephalus*	Detritivore / planktivore	Yes	No	Estuarine access dependent
29. Milkfish	*Chanos chanos*	Detritivore / aquatic – macroinvertivore	Yes	No	Estuarine access dependent
30. Silver biddy	*Gerres filamentosus*	Macroinvertivore	Yes	No	Estuarine access dependent
31. Empire gudgeon	*Hypseleotris compressa*	Aquatic – macroinvertivore	Yes (b)	Yes (10)	Abundant suited to habitat. Low DO_2 tolerant
32. 'Boof headed' gudgeon	*Hypseleotris sp (~galii afin)*	Aquatic – macroinvertivore	No	Yes (6)	Abundant suited to habitat. Low DO_2 tolerant
33. Purple spotted gudgeon	*Mogurnda adspersa*	Aquatic – macroinvertivore / piscavore	No	Yes (4)	Suited to habitat, low catch numbers may reflect sampling more than distribution
34. Snakehead gudgeon	*Ophieleotris aporos*	Piscavore / macroinvertivore	Yes	Yes (2)	Estuarine access dependent
35. Sleepy cod	*Oxyeleotris lineolatus*	Piscavore / macroinvertivore	No	Yes (3)	Suited to habitat. Low catches may reflect sampling more than distribution
36. Big-headed gudgeon	*Philypnodon grandiceps*	Aquatic – macroinvertivore / piscavore	No	No	Generally a locally rare species that may not be readily sampled by methods used
37. Flathead goby	*Glossogobius giurus*	Piscavore / macroinvertivore	No (a)	No	May not be readily sampled by methods used
38. Pipefish	*Parasyngnathus sp*	Planktivore	Yes	No	Turbidity reducing plankton density
39. Mosquito fish	*Gambusia affinis*	Aquatic – macroinvertivore	No	Yes (10)	Exotic: Abundant suited to habitat. Low DO, tolerant
40. Gurami	*Trichogaster trichopterus*	Herbivore	No	Yes (4)	Exotic: Well suited to habitat, air breather, bubble nest breeder
41. River whaler	*Carchafinus leveas*	Piscavore	Yes	No	Chemical (water quality) and physical barriers and well as lack of schooling food fish
42. River sawfish	*Pristis pristis*	Piscavore	Yes	No	Naturally rare. Chemical and physical barriers and well as lack of schooling food fish

(a) No, but has estuarine affinity (b) Yes, only to brackish areas – can also breed in landlocked freshwater

Monday 27 to Wednesday 29 August 2001 Hilton Hotel Brisbane, Queensland

THE CONFERENCE

The conference will explore the theme '*The Value of Healthy Streams*'.

The conference speaker will be Professor James Salzman, of the Washington College of Law, American University. He has published articles in legal, scientific and popular journals as well as co-authored the leading text book on international environmental law.

The conference theme will be explored through oral and poster presentations in four technical streams:

- Ecosystem services: Keynote presenter is **Dr Steve Cork** of CSIRO;
- Hydrological connectivity: Keynote presenter is **Don Blackmore** of the Murray–Darling Basin Commission;
- Bio-physical Integration: Keynote presenter is **Associate Professor Martin Thoms** of University of Canberra; and
- Tools and techniques: what are the latest developments in science that will assist us to better plan and manage our stream systems in a cost effective way?

REGISTRATION FEES

	REGULAR	DISCOUNTED*
Full (3 days)	$480	$340
Daily (Monday or Tuesday)	$150	$115
Daily (Wednesday to Friday)	$220	$220
Conference and Symposium	$935	$570

All registrations received after **Monday 6 August** will attract a **$50 late fee**. Fees are payable at time of registration.

** Discounted registration fees apply to full-time students and members of volunteer-based organisations (such as Landcare and WaterWatch).*

SOCIAL PROGRAM

Happy Hour: 6.30pm, Sunday 26 for delegates to pre-register and catch up with friends over a drink and finger food. The cost is included in the full registration fee with extra tickets $30 each.

Conference Dinner: 7.30pm, Monday 27 at the Hilton Hotel, including wine, food and entertainment. The dinner is not included in the registration fee. Cost is $85 per person.

River*prize*: 6.00pm, Wednesday 29 at the Brisbane City Hall to witness the awarding of prizes for outstanding international and national river management achievement. This function is free.

River*feast*: 7.30pm, Wednesday 29, the famous "dinner on the bridge" with food, drinks and roving street theatre. The dinner is not included in the registration fee. Cost is $120 per person.

OPTIONAL TOURS

North Queensland Rivers Tour: 8.00am, Cairns, Saturday 25 and returning to Brisbane on Sunday afternoon, $250.

Whitsunday Rivers Tour: 8.00am, Mackay, Saturday 25 and returning to Brisbane on Sunday afternoon, $230.

Post-Conference Day Tours: 8.00am, Brisbane CBD, Thursday 30. Four tours are on offer, each costing $45 per person (including lunch and teas).

REGISTER NOW

Delegates are urged to register as soon as possible because the number of registrations available is limited due to venue constraints. There will also be constraints on accommodation and air travel that week due to Brisbane hosting the 2001 Goodwill Games and the River*festival*.

Register either **on-line** (via www.catchment.crc.org.au) or by **fax** or **mail** (contact the Convenor for a registration form, see details below).

ASSOCIATED EVENTS

River*symposium* (29–31 August, Hilton Hotel) visit www.riverfestival.com.au for details.

Third Australian Fishways Technical Workshop (30–31 August, Maroochydore) visit www.monash.edu.au/oce/fishways for details.

ACCOMMODATION

A limited number of rooms have been tentatively reserved at several hotels in the Brisbane CBD for delegates. The price for these rooms ranges from $74 to $235 per night, which is significantly below the "at market" rates expected during that week.

FURTHER DETAILS

For further information on the conference program, travel, tours and accommodation:

Visit the conference web site at www.catchment.crc.org.au/streamconference

or contact the Conference Convenor, John Amprimo:

Email: streamconference@dnr.qld.gov.au
Tel: (07) 3224 7668
Fax: (07) 3224 8359

For further information on how to register for the conference, tours and other events contact the Conference Registrar, Rachel Taylor:

Email: conference@riverfestival.com.au
Tel: (07) 3846 7444
Fax: (07) 3846 7660
Mail: PO Box 5696, West End QLD 4101

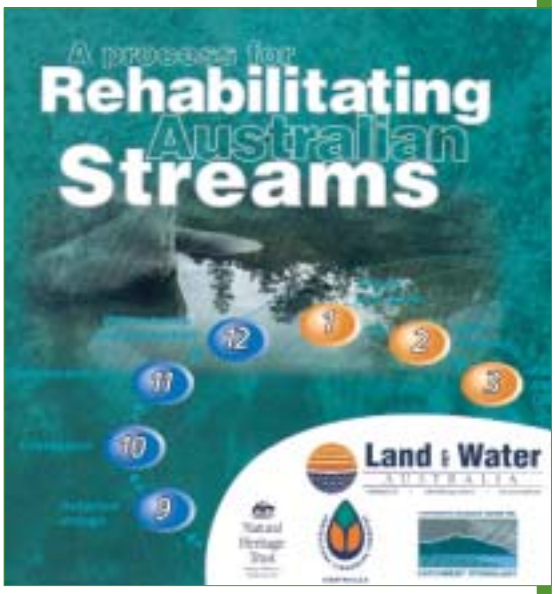
THE BIGGEST RIVER EVENT IN AUSTRALIA SINCE THE CRETACEOUS!

NEW RELEASE

Land & Water Australia and Agriculture Fisheries Forestry Australia have teamed up to produce an exciting new CD ROM to assist groups and individuals undertake 'A process for Rehabilitating Australian Streams'.

This CD is an interactive version of *A Rehabilitation Manual for Australian Streams* by Ian Rutherfurd, Katheryn Jerie and Nick Marsh. It brings to life this important manual through the use of videos, audio, animation, virtual reality and real life case studies. It has been developed to assist anyone involved in stream rehabiliation and provides a dynamic and innovative way of working through the planning, implementation and evaluation processes that are important to follow when undertaking stream rehabilitation activities.

The CD is easy to use, enjoyable and fun. You can work through it on your own or with a group, so why not get a copy!



For your free copy contact:

Rivers Program Officer
Land & Water Australia
Tel: 02 6257 3379
Fax: 02 6257 3420
Email: public@lwa.gov.au

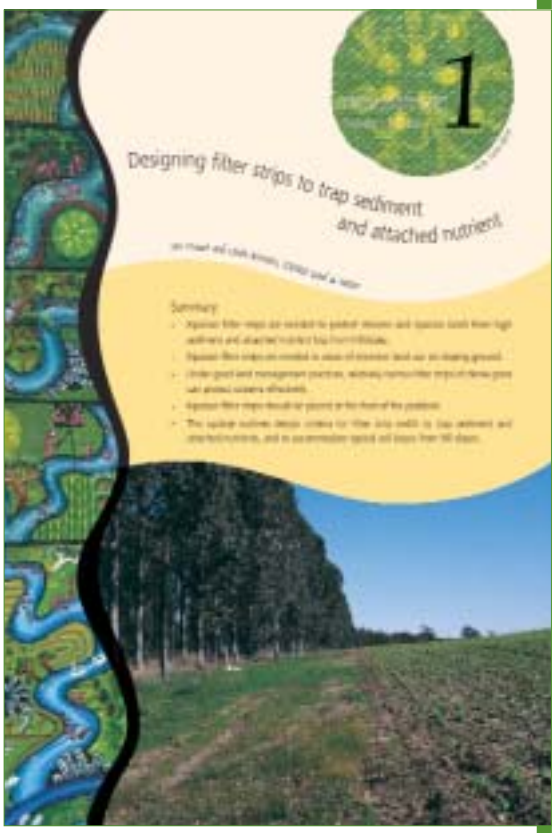
or

Kirsten Willcox, Rivercare Manager
Agriculture Fisheries Forestry – Australia
Tel: 02 6272 3932
Fax: 02 6272 6448
Email: kirsten.willcox@affa.gov.au

NEW PUBLICATION!

Designing filter strips to trap sediment and attached nutrient

So that we can keep you informed of the latest research findings, we have begun a new series of *Riparian Land Management Technical Guideline Updates*. These Updates build on Volumes One and Two of the *Riparian Land Management Technical Guidelines* by keeping you up to date on further research and development work in river and riparian management. The first of these Updates, by Ian Prosser and Linda Karssies (CSIRO Land & Water), focuses on how we can use riparian filter strips to protect streams and riparian lands from high sediment and attached nutrient loss from hillslopes. These Updates are designed for catchment managers and others working with landholders to better manage river and riparian environments, so a degree of technical knowledge is assumed.



The Updates are FREE and are available from:

Land & Water Australia
Tel: 02 6257 3379
Fax: 02 6257 3420
Email: public@lwa.gov.au

Please allow a minimum of 2 weeks for delivery.

THE NATIONAL CARP TASK FORCE — Driving the carp agenda

By Adrian Wells

Carp downunder

It surprises many people to know that carp have been in Australia since the 1850s. It also surprises people to learn that carp were deliberately introduced in the early to mid-1900s to address some specific problems in dams and irrigation channels. However, it wasn't until their illegal importation during the 1960s and their escape into the Murray River in floodwaters, that carp became a real nuisance. The release of the 'Boolara' strain in the 1960s led to a rapid expansion of carp, especially in the Murray–Darling Basin. Over the last 30 years, carp has become Australia's most abundant, yet most despised large freshwater fish. In some parts of the Murray–Darling Basin, carp make up 90 per cent of the fish.

Community driven

In recent years, moves to better understand carp and improve their management have been very much driven by the community. During the 1990s, the community's view of carp as a nuisance fish and environmental pest increased dramatically. A number of forums and workshops were held in regional centres around the Murray–Darling Basin, the most significant outcome being the formation of the National Carp Task Force.

A full-colour poster on carp in Australia developed by the Murray Darling Association and the National Carp Task Force, was offically launched by Warren Truss, the Federal Minister for the Department of Agriculture, Fisheries and Forestry. The poster was launched at the same event as the release of the National Carp Management Strategy.

The Task Force was established by the Murray–Darling Association, a local government and community-based organisation with membership of 90 councils in four states.

Since 1996, the National Carp Task Force has provided a strong and active focus for local government and community participation in the management and control of carp. The Task Force has membership of local government, the community, government agencies, commercial and recreational fishers, and scientists from six states and the ACT.

The Task Force seeks a coordinated approach to carp management and control through research, education, information and commercial opportunities. It has been keen to encourage the exploitation of carp for commercial uses, encourage community initiatives designed to reduce the impact of carp on Australian waterways, and increase community awareness of the carp problem.

A natural resource management approach

An underlying principle of the National Carp Task Force was that carp had to be managed as part of an overall integrated catchment and natural resource management process, not simply as a fisheries issue. In the past four years, the National Carp Task Force has prepared and distributed a range of quality education and awareness materials on carp; supported the development of business plans to commercially fish and process carp; supported a range of research projects; helped community groups wishing to remove carp from wetlands; and contributed to the development of a national approach to managing carp.

All of this activity has been regularly reported to the community through a regular national newsletter *Cyprinus*; community carp forums and workshops, conferences, publications and the media. The group has developed a database on community carp observations and to deliver carp information.

Photo by Adrian Wells.

Carp control group

An early initiative of the Task Force was to get the Murray–Darling Basin Ministerial Council to accept a greater role in carp management. This decision, and further lobbying by the Task Force, led to the formation of the Carp Control Coordination Group to provide national leadership and coordination to develop management and control initiatives. The Carp Control Group developed a national carp management strategy and a strategic research plan and promoted effective liaison among all groups involved in carp control.

The Group worked in partnership with the National Carp Task Force and was able to use the Task Force's expertise and community network to assist in the implementation of carp management and control at a regional level. The Task Force contributed to the draft plans, widely promoted the draft and helped community groups develop responses.

Much more than carp

One of the outcomes of all of this activity was a growing awareness by the community of not only carp, but also the state of native fish, the need to improve opportunities for native fish habitat, and the relationship between fish and river habitat and land and water management. This has contributed to the development of a Native Fish Management Strategy by the Murray–Darling Basin Commission (see Jim Barrett's article on page 12) as well as various state initiatives to improve native fish habitats. The carp issue is also helping raise awareness in the community about the potential of several other exotic fish species and the need to manage them through community/government partnerships.

While the ultimate goal of the National Carp Task Force is the eradication of carp, members understand that this is a very long-term goal. At the moment, eradication is not possible, in the longer term, control is likely to be achieved through a combination of commercial exploitation, biological manipulation, and restoring riverine environments. Since the establishment of the Carp Task Force and the Carp Control Group, there has been a shift of emphasis in the community from talking about 'eradication' of carp to focussing on the 'management' of carp.

The future

In some ways, the work of the National Carp Task Force is complete. In other ways, the work has just started. Having a set of nice national management documents and education material does not guarantee on-ground results. It is important to ensure that action is undertaken and that the national carp strategy is imple-

More information

Information on carp is available from the following organisations:

National Carp Task Force: Tel: 02 6021 3655 (for general information, posters, brochures, etc)

National Carp Task Force Carp Location Database: http://www.recfishoz.com/NCTF/

NSW Fisheries: Tel: 02 9566 7802 for information or visit www.fisheries.nsw.gov.au

Murray–Darling Basin Commission: Tel: 02 6279 0141 for free copies of the following documents:

- National Management Strategy for Carp Control
- Future Directions for Research into Carp
- Ranking Areas for Action: A Guide for Carp Management Groups

Bureau of Rural Sciences website: http://www.affa.gov/docs/rural_science/agrifood/pests/carpfact.htm

AFFA Shopfront: Tel: 02 6272 5550 for copies of the Bureau of Rural Sciences book Managing the Impacts of Carp

Queensland Department of Primary Industries Call Centre: Tel 13 25 23

Queensland Fisheries Service webpage: www.dpi.qld.gov.au/fishweb/

THE NATIONAL CARP TASK FORCE

Carp are probably victims more than the actual villains.

Photo by David Rodgers, NSW Fisheries

mented. The community wants to be kept informed on achievements and wants the opportunity to be involved in management and research activities. The Task Force will continue to work to achieve its goals. It is currently investigating the potential of a shared mobile carp processing unit and is refocussing itself as a community-based group interested in the management of all exotic pest fish in the Murray–Darling Basin.

A major impetus to get a national carp management strategy came from the community and the National Carp Task Force. An underlying principle of this national strategy is that it will only be achieved through the committed involvement of the community at the catchment or sub-catchment scale. This will require the identification of what is the real problem, developing objectives, involving all stakeholders, integrating with other natural resource management plans, and recognising that management will be involve a range of techniques.

Villain or victim?

The spread and abundance of carp have probably been assisted by the degraded riverine environments in many parts of Australia. Rehabilitating Australia's river systems and regenerating native fish populations require a range of actions of which carp management is just one. Carp are probably victims more than the actual villains. Thus, carp management alone will not lead to improved rivers, the recovery of threatened species, better water quality, or less bank erosion. It needs to be set within a broader context of aquatic habitat rehabilitation.

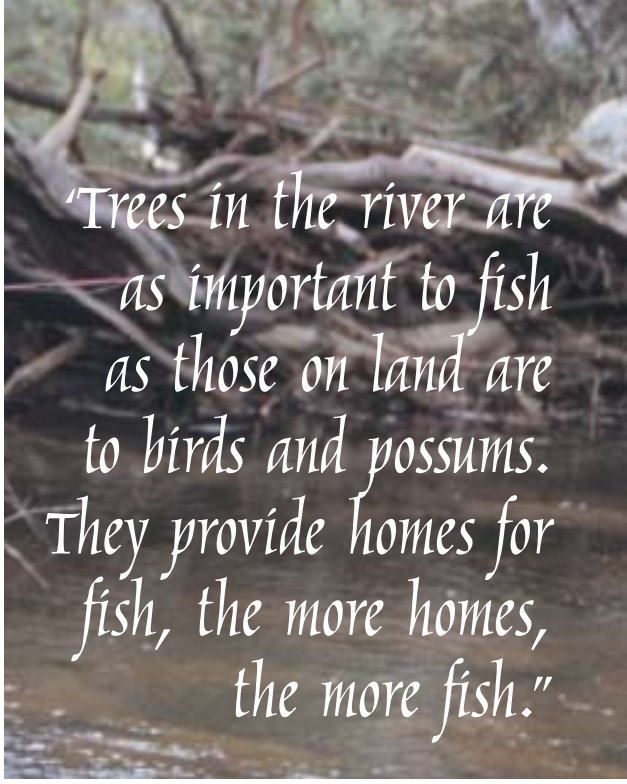
The National Carp Task Force and the Carp Control Coordination Group believe that carp must be managed through a natural resource approach, not just a fisheries approach. The national strategy also emphasises carp requiring vertebrate pest management rather than simply fisheries management.

Integrated approaches are also evident in the increasing involvement of the community as a whole, in properly understanding what is the problem and what is a symptom of a problem, and in developing the required solutions. Hopefully, the community will harness its energies to that end.

COD LOVE SNAGS

By John Koehn

The removal of snags from our rivers has been widespread. Most de-snagging has been conducted with very little concern for environmental effects and often with little scientific basis for its intended purpose. The consequence of this has been an enormous loss of fish habitat. Steps need to be taken now to protect remaining snags in rivers; to protect and enhance existing bank vegetation so that they can provide snags in the future; and in some areas, put snags back into the river.



Why are snags so important?

Intensive study has recently been undertaken on the habitat preferences of Murray cod using radiotagged fish. Key findings on the preferred habitats of Murray cod include:

~ A distinct preference for large wood debris as habitat.
~ 80% of fish being found within 1 metre of wood.
~ 97% of fish have had some form of wood debris within the 12 x 12 metre surrounding grid.
~ Cod show a preference for larger wood debris piles — 74% of preferred habitat grids had more than 50% wood cover.
~ Submerged bank vegetation was widely utilised as shelter during high flows.
~ Murray cod appear to use objects such as wood debris to shelter from water velocities.

A similar study was conducted on the endangered Trout cod showed an even stronger preference for snags and wood debris, with 96% being located at snags. Again, there was a preference for wood piles rather than single logs, and they utilised wood debris habitats that are further from the river bank with faster surface velocities and deeper water. Traditionally, these have often been the first snags to be removed or realigned to provide for boat passage.

Smaller wood debris and associated organic debris also plays an important role in the ecosystems of rivers and stream and should not be divorced form the management of Large Woody Debris (LWD). On its own, smaller wood debris provides habitats for smaller fish species and for the juveniles of larger species. Often wood debris and other smaller debris becomes trapped around LWD and this retention process enhances the breakdown of organic matter creating invertebrate colonies. It also increases the shelter provided by the original LWD.

Study of young-of-the-year Murray cod also shows the importance of wood debris as habitat with 94% of captures being made at sites with wood debris. These findings highlight the fact that wood debris is important as a habitat source for both adult and young Murray cod.

The use of 'homes' and homing as a behaviour has received some attention in the study of terrestrial animals, with repeated nesting sites in some bird species for example. To date, there has been little study and, as a result, almost no understanding of the importance of such sites for freshwater fish. Recent studies of Murray cod has indicated that such homing patterns do exist, with individual fish returning to the same 'home' sites (LWD sites) after return spawning migrations of up to 240 kilometres. The strong site fidelity of Murray cod, and even more so by Trout cod, indicates the importance of LWD as long lasting sites which have constant and repeated use by individual fish. Hence the loss of such sites can be a major a problem especially for such localised species.

For further information

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BOTTOM LINE OF THIS RESEARCH — COD LOVE SNAGS

If you would like more information about the importance of snags contact Land & Water Australia for a free copy of Riparian Management Fact Sheet 7 — Managing Snags in Rivers. You can also check out Edition 16 of RipRap on Large Woody Debris that is on the website at www.rivers.gov.au in the publications area.

THE IMPACT OF LANDUSE on fish communities: research findings from the UK

Learning from overseas experience is always valuable, and this article from the UK shows us how many of the problems we are facing in Australia are shared with those working overseas.

By Rupert Quinlan

There is little evidence of research into the effect that some land-uses have upon instream fish communities, although there is increasing recognition and discussion of the importance of riparian vegetation. Two small streams in the New Forest (Hampshire) were studied in the summer (European) of last year to attempt to investigate this importance. Of the two streams chosen, one runs through open areas which are intensively grazed, the other runs through semi-natural woodland. The fish species found in the reaches of the open lawns of the Oberwater (below right) were at odds with those normally associated with headwater streams. The Oberwater's fish community contained brown trout *Salmo trutta* (in wooded reaches only), minnow *Phoxinus phoxinus*, bullhead *Cottus gobio*, stone loach *Barbatulus barbatulus*, brook lamprey *Lampetra planeri*, eel *Anguilla anguilla*, Roach *Rutilis rutilis*, rudd *Scardinius erythrophthalmus*, dace *Leuciscus leuciscus*, chub *Leuciscus cephalus*, perch *Perca fluviatillis*, bream *Pagrus aurata* and stickleback *Gasterosteus aculeatus*. The majority of these species are generally associated with lowland rivers and streams. No brown trout were caught in the open reaches of the Oberwater during this research.

The wooded Highland Water (below left) supported fewer fish species, and these were more typical of those expected in headwater streams. It also supported a higher fish biomass by area than the Oberwater. It appeared to contain a more spatially-structured (hence established) fish community containing *S. trutta*, *A. anguilla*, *L. planeri* and *C. gobio*.

It was found that the removal of bankside vegetation, primarily trees, has led to elevated water temperatures and weed growth in the Oberwater. Some instream temperatures were well beyond the recognised limits for growth in brown trout (19°C), and were close to the lethal limit of 25°C. It was concluded that these factors had led to the absence of brown trout in the open reaches of the Oberwater during the summer months. Similar studies in France and the Pacific-northwest of the United States have found that in instances of elevated temperatures such as these, *S. trutta* is outcompeted by other species such as chub, often leading to a complete exclusion. The increased presence of weed in open reaches also favours these replacement species, through the provision of habitat and spawning opportunities, and the sedimentation of salmonid spawning gravels.

As a pointer to forms of mitigation, the wooded reaches on the Oberwater did contain brown trout juveniles, but in reduced numbers when compared to the lesser-disturbed Highland Water. Additionally, there is evidence to suggest that certain tree species are more favourable for truly productive instream communities; both through the provision of effective habitat in the form of debris (which is particularly important for adult brown trout), and also in the form of leaf litter that contains and releases a proportionally higher input of nutrients than other tree species. This leaf litter provides a vital source of nutrition for instream invertebrates, and ultimately species such as *S. trutta*. These inputs are notably absent on large sections of the Oberwater.

Left: *The Highland Water, New Forest, Hampshire.*
Right: *The Oberwater, New Forest, Hampshire.*

THE IMPACT OF LANDUSE

This study questions previous suppositions held by some management agencies (and government agencies), who subscribe to the need of increasing light levels entering headwater streams; recommendations made by governmental agencies on the two streams discussed. It also points to the importance of a patchwork of riparian vegetation, where complete cover is not possible, to encourage reduced instream temperatures, reduce weed growth, and encourage invertebrate communities through litter inputs. Furthermore, it seeks to explain the absence of certain fish species in some rivers and streams during summer months.

For further information

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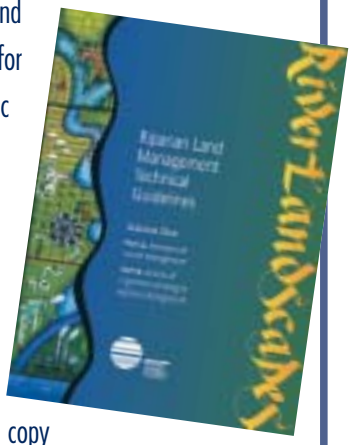
WWW.Headwaterstreams.Com

Work similar to that undertaken by Rupert has been done in New Zealand and Australia, with the second phase of the Riparian Lands R&D Program further examining the relationship between riparian vegetation, temperature and river health. If you would like to learn more about the importance of riparian vegetation and stream temperature for fish and other aquatic species, the *Riparian Land Management Technical Guidelines: Volumes One and Two* cover this subject in some detail. You can get a copy of the Guidelines from the AFFA Shopfront by calling 1800 020 157. If you would like to know more about the work we will be investing in Phase Two of the Riparian Lands R&D Program, visit our website at www.rivers.gov.au and check out the 'Activities' part of the site.



A NEW BOOK

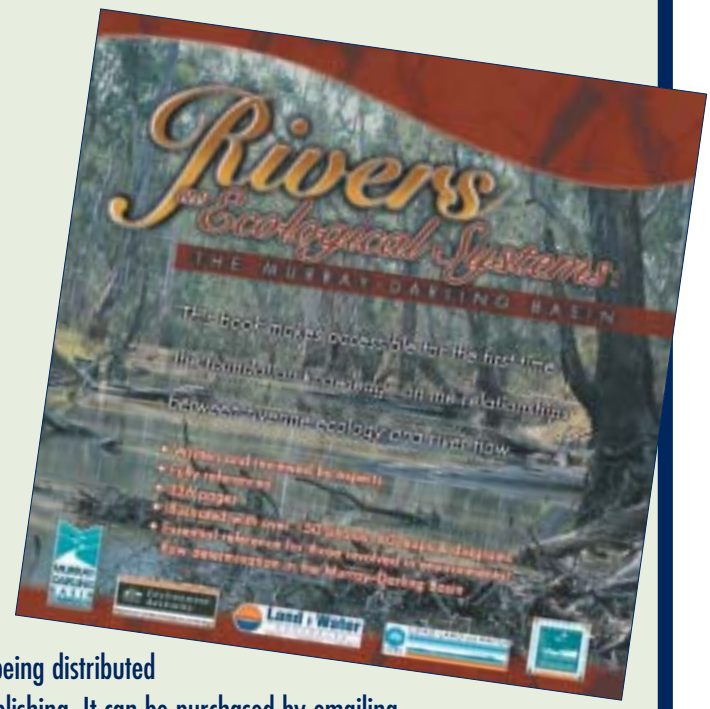
Rivers as Ecological Systems — The Murray–Darling Basin

Edited by Dr Bill Young from CSIRO Land and Water, the book is a compendium of information about how river flow regimes influence riverine ecology. The 320 page book is, therefore, a key source of information to assist in determining environmental flows.

The book is in two parts. The first explains how the rivers of the Basin function, and describes the linkages between rivers and their catchments and floodplains. It also explains how sediment and nutrients transport in rivers affect habitat condition and food web structure. The first part of the book concludes with two short case studies demonstrating the application of these concepts. The second part provides more detailed information on climate and river hydrology, and on the plants and animals of the rivers and floodplains of the Basin. Details of life cycles, habitats and specific water requirements of key plants and animals are included.

The book is a full colour production with dozens of high quality maps, diagrams and photographs. It is fully-referenced and contains a detailed index. The book is authored by several scientists from CSIRO Land and Water and the Cooperative Research Centre for Freshwater Ecology, and has been peer-reviewed.

The book is a product of the Environmental Flows Decision Support Program — a collaboration between the Murray–Darling Basin Commission, Environment Australia, and Land & Water Australia.



The book is being distributed by CSIRO Publishing. It can be purchased by emailing sales@publish.csiro.au or by phoning 1800 645 051 or 03 9662 7666

WISE WATER WAYS 2001

Following on from the success of the previous three Water Ways Workshops, The North East Catchment Management Authority, ID&A, LaTrobe University, Department of Natural Resources and Environment and The Centre will again be running this important workshop in October 2001.

This program has already proved invaluable to 150 field staff involved in Natural Resource Management from landholders to managers in the Murray-Darling Basin Commission. An exciting program has been compiled covering stream management topics such as Hydrology, Water quality, Ecology, Riparian vegetation, Geomorphology and Rehabilitation techniques.

Participants will undertake 'hands on' assignments which constitute a minor 'Stream Management Course' and will receive a qualification from the 'Diploma of Natural Resources Management'.

The workshop runs from 21–25 October 2001 and is limited to 60 participants to maximise the 'hands on' aspect of the workshop. It will be at the Beechworth Campus of LaTrobe University.

Further details
Lachlan Campbell at The Centre on 03 5721 0200

WORKSHOP

PUBLICATIONS SALE

Land & Water Australia has drastically reduced prices to clear remaining stock of many titles including some riparian and river publications. To find out about these publications go to the Land & Water Australia website www.lwa.gov.au

Land & Water Australia's saleable publications are available from the Agriculture, Fisheries and Forestry – Australia Shopfront, freecall 1800 020 157, or fax your order to the Shopfront on 02 6272 5771.

Free items are available from Land & Water Australia: contact email: public@lwa.gov.au or telephone 02 6257 3379, or fax 02 6257 3420, or write to Publications at GPO Box 2182, Canberra ACT 2601.

Publications with a price 'FREE @ CIU' are available free-of-charge from Environment Australia's Community Information Unit — call toll free 1800 803 772.

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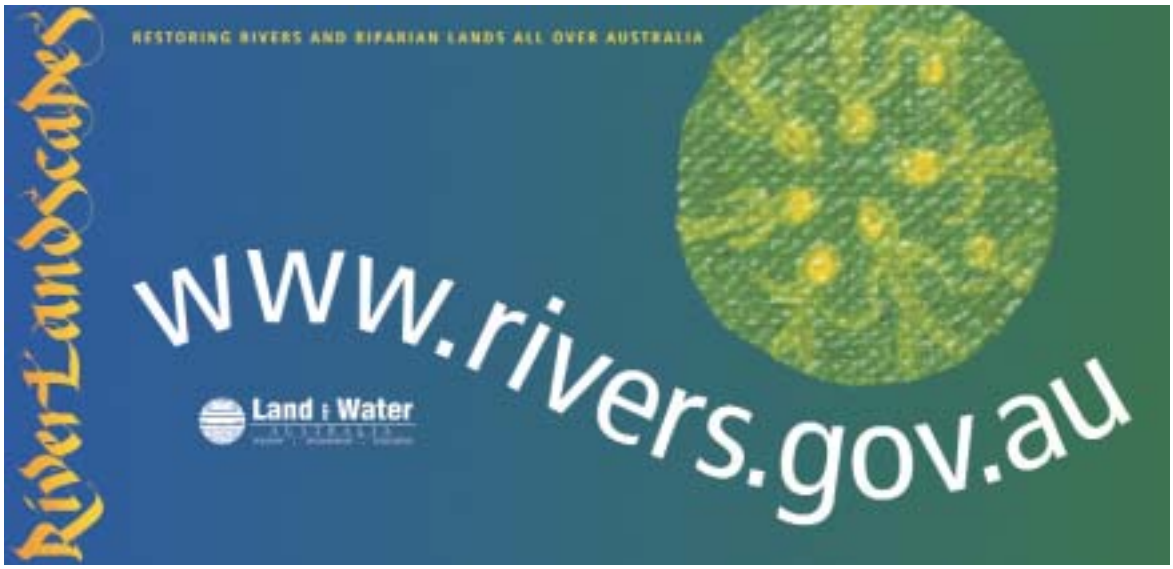
Remember to check our website www.rivers.gov.au as we are constantly updating and upgrading our information, links and publications!!



Australian Capital Territory

by Louise Gallagher

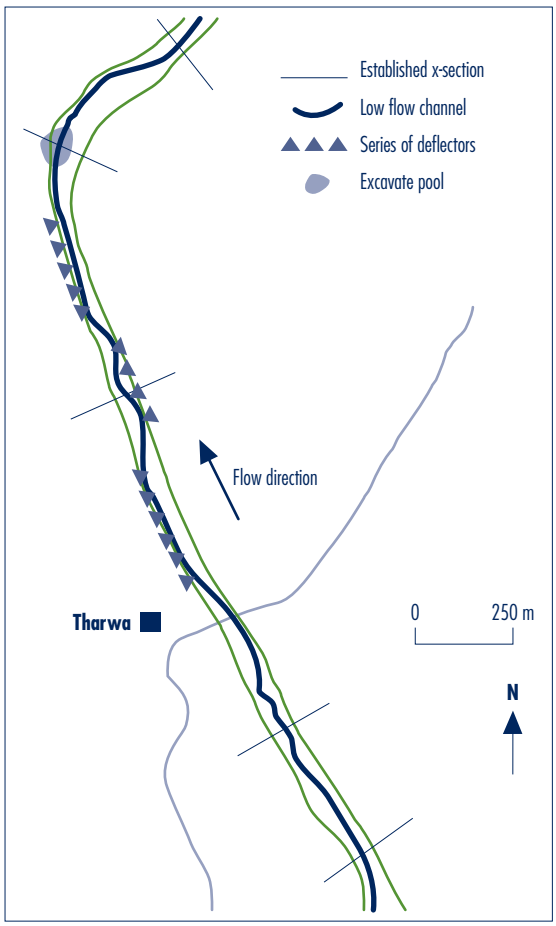
Rehabilitation of fish habitats in the Murrumbidgee River, ACT

The Murray Darling 2001 FISHREHAB component of the Natural Heritage Trust (NHT) program provided funds to rehabilitate fish habitats in a section of the Murrumbidgee River in the ACT. The project is managed by Environment ACT. Its specific objectives are:

- to rehabilitate degraded fish habitats (particularly pools) in a section of the Murrumbidgee River between Tharwa and Point Hut Crossing,
- to provide enhanced habitat for fish and invertebrate species through the provision of structural diversity in the form of snags, and
- to provide connectivity between high quality fish habitats upstream and downstream of the degraded river section.

A section of the Murrumbidgee River between Tharwa and Point Hut Crossing has been severely impacted by habitat degradation, mainly the accumulation of sand. Habitat quality has been declining since the mid-1800s when poor land management practices and three large floods resulted in extensive erosion and accumulation of sand in the river. There is little habitat diversity remaining, as the river has changed from a narrow, self-scouring channel to a wide depositional system. Sand has filled the majority of holes with a consequent loss of the former pool/riffle sequence. During summer and autumn the river in some sections near Tharwa is only 10–20 centimetres deep, making it too shallow for native fish passage.

Sediment addition is a major threatening process to fish, particularly species which lay adhesive eggs on the substrate, such as Macquarie Perch. In such situations, sediment can either smother the spawning beds rendering them unsuitable, or smother the eggs themselves. The reduction in depth and occurrence of pools has also removed potential refuges for fish from high summer water temperatures. Increased sediment loads have probably also affected benthic (bottom-dwelling) invertebrate communities, the primary food source of native fish species.



The sand impacted area as viewed downstream from Tharwa Bridge.

***Figure 1**: Diagram showing planned rehabilitation works in the Murrumbidgee River, ACT.*

Most of the eucalypt trees have been removed from along the river's edge, depriving fish of shady areas and a natural source of large woody debris, needed to provide habitat diversity.

Rehabilitation of the river has two components, (1) the construction of a series of 'deflectors' (rock groynes anchored to the riverbank) along the banks of the river downstream of Tharwa Bridge, and (2) the creation of a habitat pool incorporating woody debris.

(1) A series of 15 deflectors, spaced approximately 50 metres apart will be established along the river. These will constrict the flow of the river to scour away the accumulated sand, providing deeper holes in the river for the area's endangered fish Macquarie Perch and Trout Cod and the locally rare Murray River Crayfish. The works will promote movement and recolonisation of fish by enabling them to move between the higher quality habitats upstream and downstream of the sand-impacted area.

(2) A 20 x 5 metre habitat hole will be established in the project area and logs placed in the pool to increase habitat diversity. The pool is designed to recreate a major fish habitat in an area where deep pools no longer exist.

Rehabilitation works in the area first began in 1998 when Environment ACT, with funding from the Natural Heritage Trust's Fisheries Action Program, constructed two trial deflectors in the river, successfully producing one-metre deep scour holes. Recent fish surveys have recorded Trout Cod using these scour holes. Trout Cod had not previously been recorded in this section of the river. Construction of the 15 deflectors and the habitat hole should be completed by April 2001. Increased river depth, along with increased fish diversity and abundance, are expected as early as 12 months after the deflectors and habitat hole are completed.

The rehabilitation works are consistent with the management strategy outlined in the Recovery Plans for the threatened Macquarie Perch, Murray River Crayfish and Trout Cod. Other fish species such as Murray Cod and Golden Perch are also expected to benefit. Importantly, the changes to the river will be monitored using depth and variability of depth as indicators of success of the deflectors. Fish surveys will be conducted annually to assess changes in fish species and abundance.

***Top**: Annual monitoring of fish species and abundance will indicate success of the rehabilitation works.*
***Above**: Construction of one of the trial deflectors.*
***Left**: One of the trial deflectors constructed in 1998 which was successful in producing 1 metre deep scour holes.*

For more information

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Commonwealth

What the Commonwealth is doing to help protect and preserve our fish resources for recreational and economic enjoyment

The Commonwealth Government, through Natural Heritage Trust programs administered by the Department of Agriculture Fisheries and Forestry is helping address the issues facing Australia's fish resources. These programs seek to protect the values of these natural resources for all Australians, including those of a recreational nature.

Fisheries Action Program

The Fisheries Action Program is helping to rebuild Australia's fisheries to more productive and sustainable levels through:

- restoring and protecting fish habitat,
- encouraging community participation in activities to improve fisheries ecosystems,
- controlling aquatic pests,
- ensuring that fishing by commercial and recreational fishers is sustainable and responsible,
- raising awareness, and
- promoting related research to encourage integrated approaches to fisheries resource use and habitat conservation.

Some projects funded under the program are:

The Barwon River Fish Habitat Restoration (Vic)

A consequence of detrimental land use practices over the years has seen the Barwon River catchment become degraded. Undertaken by the Barwon River Care Group, this project attempts to address this problem and help improve the freshwater environment and, in particular, restore habitat of fish in the Barwon River catchment. The project targets private property and conducts works along the adjoining Barwon River and its tributaries. Activities include weed eradication, stock removal, fencing and tree planting within the riparian zone. The project utilises resources from both the private sector and the community. The Geelong and District Angling Clubs Association Inc have direct involvement and participate in project activities. Outcomes of the project are fish habitat restoration and protection, greater community awareness and involvement in activities that improve fisheries ecosystems, and the creation of healthy and sustainable recreational fisheries in the Barwon River.

Conservation and Restoring Riparian Habitats for Mary River Cod (Qld)

This project aims to ensure the conservation and recovery of Mary River Cod and its habitats through protection, restoration, expansion and linking of identified priority areas and sites. The Mary River Cod is an endangered species. Undertaken by the World Wide fund for Nature, the project will initially document existing information on habitat rehabilitation programs. This will be achieved by collating information on riparian rehabilitation sites done by Landcare and the Department of Natural Resources (DNR), and developing information and fact sheets through DNR Rivernotes. The next stage is to develop a plan of action for the rehabilitation of in-stream and riparian habitats. To facilitate this process relevant stakeholder groups and landholders will be identified and consulted to ensure the protection of key cod habitat. A management action plan will be developed to enable the re-stocking of Mary River Cod. This will be facilitated through consultation with the Cod Recovery Team and the development of a plan for the restocking at proposed sites. Establishment trials and site monitoring will also be conducted.

Monitoring Impact of Carp on Riparian Vegetation (Vic)

The proponent of this project, the Bairnsdale and District Business and Tourism Association, aims to monitor the impacts of carp in the wetland and shallow areas of the Gippsland Lakes. The study

AUSTRALIA

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Helping Communities Helping Australia

investigates the relationship between ecosystem disturbance and carp in waterbodies. The first stage is a collaborative hands-on wetland rehabilitation project. During the first year, community groups were brought together and the project team trained in monitoring, mapping and restoration methods. The project team includes community groups, educational and research institutions and investigates causes for the decline in the reed beds of the Gippsland Lakes. A series of controlled trials around damaged reed beds was conducted to discover whether they can be rehabilitated through the exclusion of carp. The project maps and measures the distribution of reeds and salinity. Sampling of macro invertebrates, fish eggs and larvae is conducted to determine the importance of reed beds as a fishery habitat. The project reports to the National Carp Task Force and liaises with other similar Australian projects. The project establishes a database for all community members, local authorities, industry and educational bodies to input information concerning carp and perceived impacts. Reed beds and vegetation are mapped using a GPS and GIS. The project produces a newsletter to distribute to provide information on its activities and outcomes that include the development of understanding of the impacts of carp on native vegetation.

Restoration of the ACT Section of the Murrumbidgee River (ACT)

Through this project, the ACT Parks and Conservation Service aims to improve the ACT section of the Murrumbidgee River for the benefit of native fish, terrestrial wildlife and recreational use. The ACT section of the Murrumbidgee River has been subject to development pressures and other modifications since the mid 1800s. Six of the 12 native fish species are now locally extinct or have severely reduced distributions. The introduced willow has further compromised the viability of the system. The project will attempt to improve the river system by replanting or seeding selected sections of the river to stabilise banks and to provide shelter and foraging sites for aquatic vertebrates and invertebrates. To monitor these works a record of each section of the river selected for improvement will be compiled before works commence and then evaluated to monitor changes. The project will also prepare sections of the river and some of the higher order streams for revegetation. The value of actively resnagging sections of the river will also be investigated. Water quality within the river will be monitored by community groups under the guidance of the Waterwatch Coordinator. Finally, the project will link in with other community groups whose activities focus on other sections of the Murrumbidgee River in the ACT. The project intends to improve and restore the riparian vegetation along 14 kilometres of bank, plant 125 hectares of native species for watertable control, contribute to improved utilisation for 400 hectares of land. Control and management of weeds will be conducted over an area of 400 hectares. This will result in improved habitat and water quality along a 14 kilometre section of the Murrumbidgee River within the ACT. Funding for this project was first received in December 1997. The project is due to be completed early this year.

Further information on any of these projects

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Fish Rehabilitation Program

The Fish Rehabilitation Program is a component of the Murray Darling 2001 program and aims to initiate targeted activities to expedite the return of water to the environment and regenerate native fish populations, including the appropriate management of European Carp at a national level. Projects are sought annually through advertisement in major papers.

Further information

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FISHERIES ACTION PROGRAM
A program of the Natural Heritage Trust

The National Rivercare Program

The National Rivercare Program focuses on addressing issues such as erosion or build up of river banks and beds, maintenance or improvement of water quality by preventing pollution, improvements in the management of discharges or controlling stock access to rivers, re-establishing riparian vegetation, strategic planning, public awareness-raising and/or demonstrations in improved river management practices. Although activities funded under the program are often not specifically targeted towards fish habitat management, the very nature of river rehabilitation and management means that fish habitat improvement is often an added bonus of many of the river works funded by the program. The program recognises that fish habitat is an important component of river management through funding projects which assist Rivercare groups in understanding and improving fish habitat in conjunction with their general river works. These include:

Freshwater Fisheries Extension Officer for Community Rivercare Projects (Tas)

Undertaken by the Inland Fisheries Commission, the project aims to provide assistance to community groups involved in Rivercare projects. This assistance may be in the form of:

- ~ advice on sustaining freshwater fish communities and habitats and to direct Rivercare groups to appropriate expertise where necessary,
- ~ ensuring Rivercare projects are conducted to maintain or enhance freshwater fisheries,
- ~ establishing, promoting and facilitating an active and participative relationship between Rivercare community groups and the freshwater angling club network in Tasmania,
- ~ undertaking small scale monitoring projects, and
- ~ providing advice on rare and threatened invertebrates and fish so that work is conducted with a minimum of short term impact and with long term beneficial outcomes.

Prioritising Stream Rehabilitation Works to Protect and Restore Fish Habitat (Qld)

This project uses standardised fish habitat surveys and State of the Rivers information to identify key stresses on freshwater fish resources in the Pumicestone and Mooloolah catchments. A structured ecological freshwater fish resources audit willl be produced to prioritise cost-effective regional stream rehabilitation works. Linkage to the Pumicestone Region Environment database will enable management groups to measure and evaluate system responses to such works in a regional context. Field demonstration and other reporting activities will be used as a driving medium for reduction of the impacts of catchment degradation on stream resources. This project is managed by the Pumicestone Region Catchment Coordination Association.

Restoration of River Blackfish Habitat: A Demonstration Tool for Community Rivercare Groups (Tas)

The University of Tasmania intends this project to establish demonstration sites for the use of Rivercare groups, to observe the correct placement and appropriate methods to secure woody debris to enhance the habitat available for River Blackfish. The demonstration sites in the Liffey River and Quamby Brook will serve to initiate similar projects within their own Rivercare planning, therefore maximising the ecological and environmental benefits of their own works.

Further information

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New South Wales and Victoria

by David Crook

Using radiotracking and GIS to assess fish habitat requirements in a lowland river

In common with many lowland rivers around the world, most lowland rivers in the Murray–Darling Basin (MDB) are degraded and have fish communities that are depleted, both in terms of abundance and diversity (Harris & Gerke 1997). The loss of suitable habitats within rivers is widely believed to be a factor contributing to the decline of native fish in the MDB. Over the past century, several million snags (fallen trees) have been removed from MDB rivers in attempts to improve navigability and water conveyance, resulting in the loss of vast amounts of potential fish habitat (Treadwell et al. 1999). Similarly, sedimentation of rivers resulting from erosion in degraded catchments has caused the infilling of deep pool habitats that provide refuge for fish. Habitat restoration programs, including snag reintroduction, have been underway for several years in the MDB. However, there is still relatively little detailed information regarding the habitat requirements of fish to guide these programs (see Koehn & O'Connor 1990).

This study used radiotracking techniques in combination with Geographic Information Systems (GIS) to examine patterns of habitat use by golden perch and carp in the Broken River in north-east Victoria. A low-gradient tributary of the Goulburn River, the Broken River flows through the south-eastern region of the Murray–Darling Basin. The study reach was 450 metres long, 12–30 metres wide and up to 3.5 metres deep. Seven carp and eight golden perch were collected by rod and line during a period of low summer flows. Radio-transmitters were attached to the fish and their movements within the study reach were tracked for ten days and nights. The habitats available to fish within the reach were then mapped at 1 metre transects. The fish location and habitat data were entered into a GIS program (Arcview™) and spatial analyses were conducted to examine relationships between the fish locations and the measured habitat variables.

The results of the study showed that golden perch were almost entirely restricted to deep pool habitats during the day (see figure below). At night, golden perch still restricted most of their activity to pools, although their preference for deep habitats was much reduced. The large-scale distributions of golden perch were not positively correlated with wood debris, although there was a positive relationship between golden perch and wood debris at small scales during the day. Carp, in general, showed much lower associations with particular habitat variables, probably due to their more mobile feeding habits. The results of the study clearly demonstrate the importance of deep pool habitats for golden perch in the Broken River. This river is badly affected by sedimentation due to erosion within the catchment, resulting in large "sand slugs" that swamp complex fish habitat and reduce habitat depth. The findings of this study suggest that to prevent the loss of habitat for large native fish in rivers similar to the Broken River, restoration efforts should concentrate upon the preservation of deep, pool habitats.

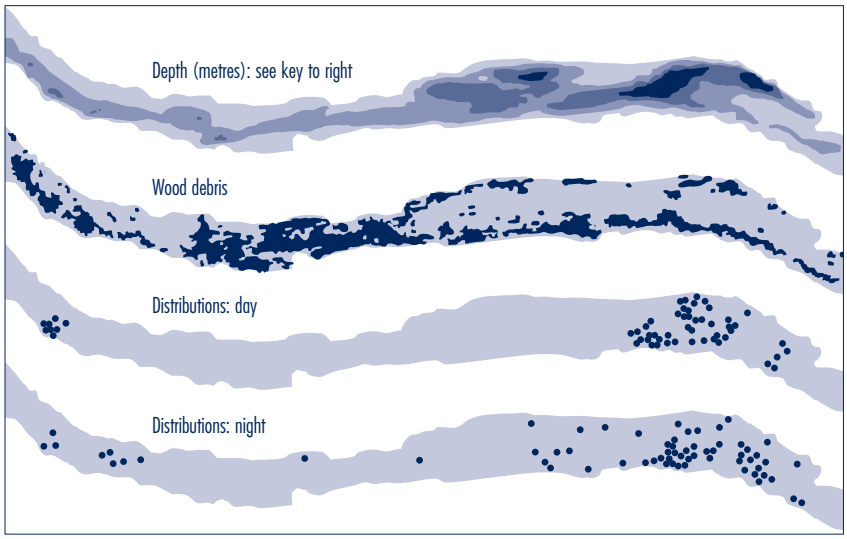

***Figure 1**: GIS maps showing the distributions of radio-tracked golden perch in relation to the spatial arrangement of habitat depth and woody debris.*

This work is beng undertaken in New South Wales and Victoria.

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References

Harris, J.H. & Gerhke, P.C., 1997, (Eds), *Fish and Rivers in Stress: The NSW Rivers Survey*. NSW Fisheries Conservation Office and CRC for Freshwater Ecology, Cronulla, NSW.

Koehn, J.D. & O'Connor, W.G., 1990, *Biological information for the management of native freshwater fish in Victoria.* Department of Conservation and Environment, Victoria.

Treadwell, S., Koehn, J. & Bunn, S., 1999, 'Large woody debris and other aquatic habitat', in *Riparian Land Management Technical Guidelines. Volume One: Principles of Sound Management* (eds S. Lovett & P. Price) pp. 79–97. Land and Water Resources Research and Development Corporation, Canberra.

The impact of spillways on barramundi in the Mary River wetlands

The Mary River wetlands, located about 150 kilometres east of Darwin, are of great worth, both from a conservation perspective supporting an exceptionally rich and diverse flora and fauna, and from the economic wealth generated through grazing, tourism and fishing. For example, a recent survey by Department of Primary Industry and Fisheries (DPIF) 'Fishcount' found that 21% of all the hours fished by tourists in the Northern Territory were spent in the Mary River.

Over the last 50 years, there have been substantial changes to the environment of the Mary River and the adjacent coastal wetlands. A combination of natural events and large populations of feral buffalo have caused the breaching of the remnant coastal dunes known as *chernier* ridges which have historically prevented saltwater from intruding onto the wetlands. The channels between the previous fresh and saltwater areas are being continually expanded by the daily tidal cycle during the dry season, and from large volumes of freshwater flowing off the floodplains during the wet season. To date over 240 square kilometres of freshwater wetland has been destroyed by the intrusion of salt water.

To prevent damage to the wetlands, earthen barrages (bund walls) have been placed across creeks leading to affected areas. The walls act as barriers to prevent tidal saline waters penetrating into the wetlands, thus allowing the affected wetlands to recover. At present, about 65 bund walls have been constructed along the coastal and inland expanse of the Mary River wetlands. Although they are effective in preventing saline intrusion, the walls can impede the annual migration of many fish such as barramundi and tarpon, both as mature adults from the freshwater areas to the sea and as fingerlings or juveniles, from the sea into the relatively protected habitats of the wetlands.

Extensive collaborative research by the Northern Territory Departments of Primary Industries and Fisheries, Lands Planning and Environment, and Transport and Works has led to the redesign of bund walls to include fish passageways or fishways. The design of fishways in the Mary River wetlands varies considerably and includes low rock spillways, concrete culverts and submerged weirs. Regardless of their design, the aim of these fishways is to allow the passage of fish through, or over the walls while still reducing the intrusion of salt water into the wetlands. However, simply installing a fishway within an existing bund wall is not always sufficient to provide adequate fish passage. Expert opinion is that an understanding of the local fish communities, their migratory patterns, and the effects of the fishways on these fish should be an integral part in any design and installation of fish passageways.

The DPIF, with funding assistance from the Natural Heritage Trust, recently conducted a research project with the aims of answering the above questions. The project was carried out in the Mary River wetlands from November 1998 to June 1999. The research program was split into two sub-programs. The first program aimed to identify the fish and the size of the fish that are found on the coastal wetlands, with

The result of salt water intrusion on a paperbark forest.

This photo shows a bund wall situated on the west of Tommycut Creek.

four locations along the coastal wetlands sampled using a combination of mixed panel gill nets, scoop nets and cast nets.

In total, 4160 fish of 40 different species were caught, ranging in size from 8 to 580 millimetres. The types of fish sampled were found to change over the period of the wet season, with juvenile marine fish dominating the wetland habitats in the early wet season and freshwater species in the latter part of the wet season. The most common fish found in the wetlands were barramundi (*Lates calcarifer*), glassfish (*Ambassis agrammus*), blue eyes (*Pseudomugil tenellus*) and silver scats (*Selenotoca multifasciata*).

The results showed a difference in both the number and species of fish between the locations sampled. Areas that had bund walls were found to contain less fish compared with the areas immediately around a spillway. This result was important, as it reflects the relative availability of food for juvenile barramundi. These fish require food-rich environments to achieve the large growth rates seen in the first year of their lives. The placement of walls, which reduce the diversity and abundance of prey may have a detrimental effect on the survival of juvenile barramundi thus reducing their abundance in those areas.

The second program investigated the effect of a rock spillway on barramundi migration. A two-way trap was constructed over an existing spillway and all fish that were caught were measured, tagged and aged before being released. A total of 1760 barramundi were caught over the wet season either moving to or from the wetland. These fish varied in size from 60 to 690 millimetres, and in age from new recruits (0+) to 3 year old fish.

The results clearly showed that the spillway provided a means for fish to migrate to and from the wetlands, while still preventing the intrusion of salt water. However, some fish were trapped upstream as the water level dropped below the spillway towards the end of the wet season. This problem may be overcome by the use of a new type of spillway being trialed, the submerged weir. Built using a large number of mud-filled bags, this spillway aims to choke the mouths of creeks, thus reducing the amount of tidal water that pushes into the wetlands. The advantage of this type of spillway is that it does not impede the passage of fish.

***Top**: The two-way trap built on an existing rock spillway.*
***Above**: The submerged weir in action.*

The results achieved through this project have implications for all tropical wetlands, providing information both on spillway designs and migratory habit of fish within a tropical wetland ecosystem. It is conceivable that in the future through global warming, a rise in mean sea level will have an impact on the world's coastal wetland habitats. The results of this project will then provide advice and management options for protecting these wetlands for future generations.

For further information

Please refer to the Northern Territory Governments Integrated Catchment Management Plan for the Mary River or contact
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A community approach to fisheries resource conservation

The need to conserve our wetlands in coastal Australia is recognised as being essential for a whole host of ecosystem processes and to provide support for flora and fauna. The use of wetlands by key migratory bird species is now becoming well understood by the community because of the high media profile this issue has gained. Less well known and understood is the role that wetlands play in the support of our fisheries resources. The primary reason for this is that fish are not readily visible and tend to use such habitat as juveniles, whereas we generally encounter them as adults in different habitats such as rivers, estuaries and the ocean. This has made understanding the need for protection of such areas for fisheries reasons more difficult.

In Central Queensland, Capricorn Sunfish, a community based recreational fishing organisation and others are playing a part in developing a better understanding of the relationship between our fish species and wetlands. Of specific interest is the use by barramundi of freshwater and brackish wetland areas adjacent to the Fitzroy River around Rockhampton and other nearby coastal systems. Barramundi is a key species in tropical Australia, supporting major recreational and commercial fishery industries and a growing aquaculture sector. Understanding the relationship between barramundi and their use of wetlands will be a critical requirement for conservation of the species as well as the habitat it depends upon.

Capricorn Sunfish currently has a project funded by the Natural Heritage Trust (NHT) to examine the use of these wetlands by barramundi. This involved determining when barramundi move into these habitats, how long they stay and what are the water flow or climatic conditions that are associated with such movements. Simple sampling techniques have been adopted that allow this type of monitoring to be widely undertaken in this project, and elsewhere by community members with minimal scientific support. Monitoring future movement and growth is undertaken by tagging of fish by local fishing club members affiliated with the Australian National Sportfishing Association Qld (ANSA Qld). This is undertaken through their Suntag program.

Barramundi such as this require access to freshwater or brackish wetlands as part of their life cycle.

But understanding is not enough. As part of a longer term strategy, Capricorn Sunfish is cooperating with the Cooperative Research Centre (CRC-CZ) for Coastal Zone, Estuaries and Waterway Management in knowledge building. The CRC-CZ has developed a project to examine the wider issue of the effects on fisheries resources of changes in freshwater flows to estuaries. This issue is of importance to all areas where water regulation is changing the natural flow patterns of freshwater to the sea. This will be a longer term broad based study that will feed into catchment strategy plans such as that developed by the Fitzroy Basin Association and decision making bodies such as local government, state and federal government agencies.

Action is now required to conserve the remaining habitat and rehabilitate it where possible. To this end Capricorn Sunfish has another NHT funded project to revegetate part of the 12 Mile Creek at Marmor. A particular waterhole on this creek has been identified as a critically important habitat for barramundi. However, the land surrounding that part of the creek was cleared many years ago — including the riparian zone. As a result, the waterhole is gradually degrading through erosion and siltation. Capricorn Sunfish is replanting part of the riparian zone with species native to the area and has undertaken work to halt the erosion and siltation.

Tree planting project for NHT, 12 Mile Creek.

Capricorn Sunfish cannot tackle this issue on its own, but by working with other community groups, catchment strategy groups and decision making agencies there is the opportunity to make a significant contribution to the future of our fisheries resources.

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The Tod River Watercourse Management Project

Funded by the Natural Heritage Trust (NHT) and South Australian Department of Environment and Heritage (DEH), the project will produce a watercourse management report on the Tod River and its tributaries that incorporates:

~ assessments of watercourse condition,
~ landholder and stakeholder consultation outcomes, and
~ watercourse management needs.

The semi arid Tod River catchment is located in the south-eastern of Eyre Peninsula in South Australia, to the north of Port Lincoln. Eyre Peninsula has no perennial flowing streams and the Tod River is the only watercourse on the peninsula that can be relied upon in normal rainfall years to provide some flow of water. The Tod Reservoir was built between 1918 and 1922 in the Toolillee Gully subcatchment of the Tod catchment. When the Tod River Scheme was established, the catchment was predominantly natural vegetation. However, since the 1920s the majority of the land has been cleared for cropping and grazing. This broad acre clearing has had a negative impact on water quality from the Tod Reservoir, as it has become increasingly saline. As with the other areas, this project arose from landholder and agency concerns over declining watercourse condition.

More than 102 kilometres of watercourses were surveyed which included 56 landholders that are responsible for managing 14 272 hectares of properties adjacent to the watercourse. The survey was conducted using a rapid assessment survey that recording riparian data on:

~ landuse (adjacent land use and unrestricted access by stock),
~ riparian vegetation (remnant vegetation and important riparian habitat, lack of native overstorey, exotic trees and weeds),
~ channel characteristics (bed stability, bank stability and erosion heads),
~ capital assets (structures threatened by watercourse process, poorly designed structures having a detrimental impact on watercourse processes), and
~ on-ground riparian management activities.

At the first consultation meeting, landholders were asked to identify watercourse management issues in their subcatchments through informal group discussions on:

~ What do you see as the watercourse management issues in your catchment?
~ What are the conditions of watercourses in your catchment?
~ What is your idea of a watercourse in good condition?
~ What are the barriers to better watercourse management?

At the second meeting, the results of the survey were presented to landholders and through a simple voting process the most significant watercourse management issues were identified. The issues identified were: unrestricted stock access, lack of native vegetation, weeds and bank instability. Of the weeds, dense bridal creeper is having a severe impact on some reaches by smothering the vegetation (photo 1).

A technical workshop was held with technical and strategic representatives from SA Water, DEH and Department of Water Resources, Primary Industries SA and CSIRO to discuss the more complex natural resource management issues facing the management of the catchment, in particular acid sulphate soils and salinity. GIS mapping was been used to present the significant watercourse management issues.

The riparian survey methodology was not designed to determine the cause and symptoms

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***Photo 1**: Bridal creeper infestations smothering riparian vegetation.*

of the complex catchment-scale management issues of acid sulphate soils (photo 2) and salinity (photo 3) which also impact on watercourse condition. However, information from other studies and observations of impacted areas made by the project team, have been incorporated into the report.

In addition to the impacted areas, the catchment has some important areas of diverse native remnant riparian vegetation which require protective management strategies. This is to ensure that the area does not become threatened by degrading processes such as weed invasion (photo 4).

The Tod River report is currently being drafted and aims to be a decision making tool for landholders and key stakeholders with an interest in the management of the Tod River catchment water resources, on a local and catchment scale. It is structured to meet the needs of landholders who have a watercourse running through their property, as well as stakeholder organisations involved in operational (on-ground) and strategic (planning) activities associated with water resource management. For landholders, it can be used to help raise the awareness of the management issues in their part of the catchment as supporting documentation for individuals or community groups seeking funding (e.g. Natural Heritage Trust) for on-ground watercourse rehabilitation works.

***Photo 2 (top)**: Acid sulphate soils are having a detrimental water quality and habitat impact to riparian zones and the broader landscape.*
***Photo 3 (above)**: Vegetation shows signs of stress from dryland salinity problems.*
***Photo 4 (left)**: Remnant riparian vegetation in the Tod River catchment.*

Restoration of fish habitat in rice grass infested estuaries

The Rice Grass Management Team from the Tasmanian Department of Primary Industries, Water and Environment (DPIWE) has demonstrated impressive progress in the control of the exotic saltmarsh plant, rice grass (*Spartina anglica*). Through the effective control of this plant, which inhabits a number of Tasmania's estuaries, fish habitats are being restored, ensuring the maintenance and protection of these valuable and productive ecosystems. The success and strategic management of the program has recently seen the Rice Grass Management Steering Group awarded the Australian Water Association — Tasmanian Environment Merit Award.

Rice grass is a hardy perennial grass, which inhabits bays and estuaries of temperate regions throughout the world and was first introduced into Tasmania in the 1920s. The dense growth and complex rhizome/root network acts as an effective trap for estuarine sediment. Mature infestations form extensive terraces and saltmarsh islands that dramatically alter water flow in estuaries. In some cases, rice grass has choked saltmarsh creeks and drainage channels.

Intertidal mudflat is the habitat most susceptible to rice grass invasion. Colonisation transforms these valuable estuarine fish habitats into dense broad bands of exotic saltmash that many resident and transient fish species cannot utilise. While small mobile species such as hardyheads (Atherinidae) and juvenile mullet (*Aldrichetta forsteri*) are able to enter the marsh, other species including important recreational species such as flathead (*Platycephalus basensis*) and flounder (*Rhombosolea tapirina*) cannot penetrate the marsh due to their morphology. With the continual spread of rice grass these species face the impending danger of losing this intertidal habitat altogether. Native saltmarsh flora are also at risk of displacement such as the beaded glasswort (*Sarcocornia quinqueflora*) and *Juncus Sp.* which, in turn, impacts the biodiversity of invertebrate and wader bird communities.

Growing concern surrounding the impact of rice grass on the biodiversity and integrity of native mudflats, saltmarsh and seagrass communities brought about the formation of the Rice Grass Advisory Group (RGAG) in 1996. In 1998, with funding from the National Heritage Trust, the DPIWE implemented the 'Strategy for the Management of Rice Grass in Tasmania'. Outlined within the strategy are details on management techniques and management objectives for each of the infestations around the state.

Currently approaching the end of the second control season, the management team are reporting excellent success with control efficacy rates averaging 95%. Follow up monitoring work is vitally important and is concentrated on finding and removing the remnant plants from targeted estuaries. Already there are clearly visible signs that the once infested estuaries are returning to their pre-invaded natural states. In some areas local residents have reported that as rice grass infestations are disappearing some species of invertebrates, fish and wader birds are recolonising mudflats. There are also strong signs that native saltmarsh vegetation and intertidal seagrass is returning to areas where rice grass has been eliminated.

Rice grass invading a small creek entering the Little Swanport Estuary.

Estuaries and the various habitats within them are extremely valuable to fish production. Many fish species including recreational and commercial species spend part if not their entire lives within estuaries. The maintenance of these habitats is therefore essential to the sustainable future of these fisheries. The Rice Grass Management Program is making a significant contribution to the restoration of fish habitats in Tasmanian estuaries. These achievements have eventuated through an integrated management approach that incorporates shared management responsibility, scientific research, innovation and effective on-ground action.

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A stream restoration project — a worthwhile venture

About eight years ago, the Latrobe Valley Flyfishers club decided to 'adopt a stream', with the aim being to restore a section of it to its former state, and to initiate environmental improvement of the central Gippsland waterways. This decision came about because of a dissatisfaction with the lack of activity being undertaken to address habitat and stream degradation, and the associated decline in the fishery — not only the native but also the introduced species as well.

The club was fortunate to have in its ranks a very dedicated environmental scientist who saw this as a dream project and immediately volunteered his services and time to get the project off the ground. This member put together a very detailed report on the chosen section of river and this report became 'a proposal for the restoration of the lower Tanjil river'. With this report, the club now had a blueprint for action and a section of stream was chosen on the lower Tanjil to restore. Implementing the report required manpower and money — manpower was at hand with a number of club members who volunteered time for the working bees. In addition, the landholders on both side of the project site contributed machinery and equipment. This manpower in monetary terms ran into many thousands of dollars, as did the use of machinery. Money was the second most important requirement and this was gained mainly through donations from many local businesses and major power companies, some of which donated much of the flora that was needed to revegetate the project site.

The proposal was to clear 300 metres on both banks of the stream of all willows and other weeds and then revegetate both banks with local native trees shrubs and grasses. The revegetation area was also fenced to protect it from stock. The second stage of the project involved the creation of beached chutes to allow stock access at certain points to water, with the third stage being the placement of artificial reeds to promote the propagation of fish stocks.

The project progressed through these stages, with a number of the larger willows retained for stock shelter and bank stabilisation reasons, and others targeted for poisoning. Several months after the poison had done its job, extraction of the trees occurred — this was achieved with brute force — manpower, tractors, bulldozer, excavators and lastly, some very strong 4x4 vehicles all of which were donated. It was then time to burn the willow stacks. At the same time as the burnings were going on, so was the poisoning and removal of regrowth in preparation for the coming spring planting session. The cleared banks were replanted with all native vegetation, and fenced as mentioned before, during the intervals between removal of vegetation and the replanting, beached chutes and artificial reeds were constructed.

The project over its ten year life span has proven to be most successful to the point that all the new vegetation is proving to be a hazard for errant back casts (!). In-stream flora and fauna growth has flourished with the added sunlight, and insect life is thriving in the surrounding vegetation. An additional benefit is that in the project area the removal of the willows from the stream bed has lowered the water level by 6 inches (152 mm). The landholders up and downstream of the project were somewhat ambivalent at the beginning of the project, however, based on the success of the strategies they have now initiated their own projects and have used the expertise of club members to assist.

There is now a proliferation of similar projects throughout the region, with projects on the Rainbow Creek, Lower Tarwin River, and Traralgon Creek just to mention a few. Having achieved all the hard work in the first three years, the bulk of the work now involves ongoing maintenance, some of which involves the thinning of the replanted area as the growth rates and coverage of the vegetation exceeded all expectations.

The above description is a very condensed version of the whole project, and more detailed information can be obtained from the club, as well as copies of the pilot report being available for a small cost. From the point of view of a club project, it has been most successful, but that success only comes from the vision and dedication of our members and the willingness to participate on the behalf of the landholders. The benefits have been many with few headaches along the way, as the saying goes, if you want anything done properly do it yourself. This we have done, and as a club we highly recommend it to other clubs to give it a go.

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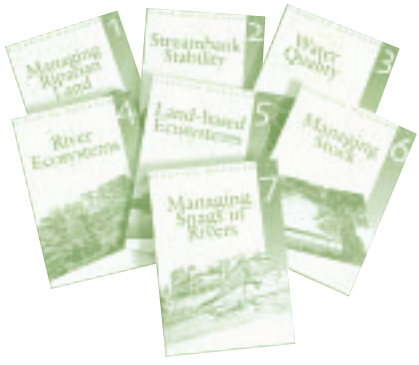

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