MURRAY-DARLING BASIN

MINISTERIAL COUNCIL

Native Fish Strategy for the Murray-Darling Basin 2003–2013

SIX GOVERNMENTS WORKING IN PARTNERSHIP WITH THE COMMUNITY

MAY 2003

Integrated catchment management in the Murray-Darling Basin

A process through which people can develop a vision, agree on shared values and behaviours, make informed decisions and act together to manage the natural resources of their catchment; their decisions on the use of land, water and other environmental resources are made by considering the effect of that use on all those resources and on all people within the catchment.

Our values

We agree to work together, and ensure that our behaviour reflects the following values.

Courage

- We will take a visionary approach, provide leadership and be prepared to make difficult decisions.

Inclusiveness

- We will build relationships based on trust and sharing, considering the needs of future generations, and working together in a true partnership.
- We will engage all partners, including Indigenous communities, and ensure that partners have the capacity to be fully engaged.

Commitment

- We will act with passion and decisiveness, taking the long-term view and aiming for stability in decision-making.
- We will take a Basin perspective and a non-partisan approach to Basin management.

Respect and honesty

- We will respect different views, respect each other and acknowledge the reality of each other's situation.
- We will act with integrity, openness and honesty, be fair and credible, and share knowledge and information.
- We will use resources equitably and respect the environment.

Flexibility

- We will accept reform where it is needed, be willing to change, and continuously improve our actions through a learning approach.

Practicability

- We will choose practicable, long-term outcomes and select viable solutions to achieve these outcomes.

Mutual obligation

- We will share responsibility and accountability, and act responsibly, with fairness and justice.
- We will support each other through necessary change.

Our principles

We agree, in a spirit of partnership, to use the following principles to guide our actions.

Integration

- We will manage catchments holistically; that is, decisions on the use of land, water and other environmental resources are made by considering the effect of that use on all those resources and on all people within the catchment.

Accountability

- We will assign responsibilities and accountabilities.
- We will manage resources wisely, being accountable and reporting to our partners.

Transparency

- We will clarify the outcomes sought.
- We will be open about how to achieve outcomes and what is expected from each partner.

Effectiveness

- We will act to achieve agreed outcomes.
- We will learn from our successes and failures and continuously improve our actions.

Efficiency

- We will maximise the benefits and minimise the costs of actions.

Full accounting

- We will take account of the full range of costs and benefits, including economic, environmental, social and off-site costs and benefits.

Informed decision-making

- We will make decisions at the most appropriate scale.
- We will make decisions on the best available information, and continuously improve knowledge.
- We will support the involvement of Indigenous people in decision-making, understanding the value of this involvement, and respecting the living knowledge of Indigenous people.

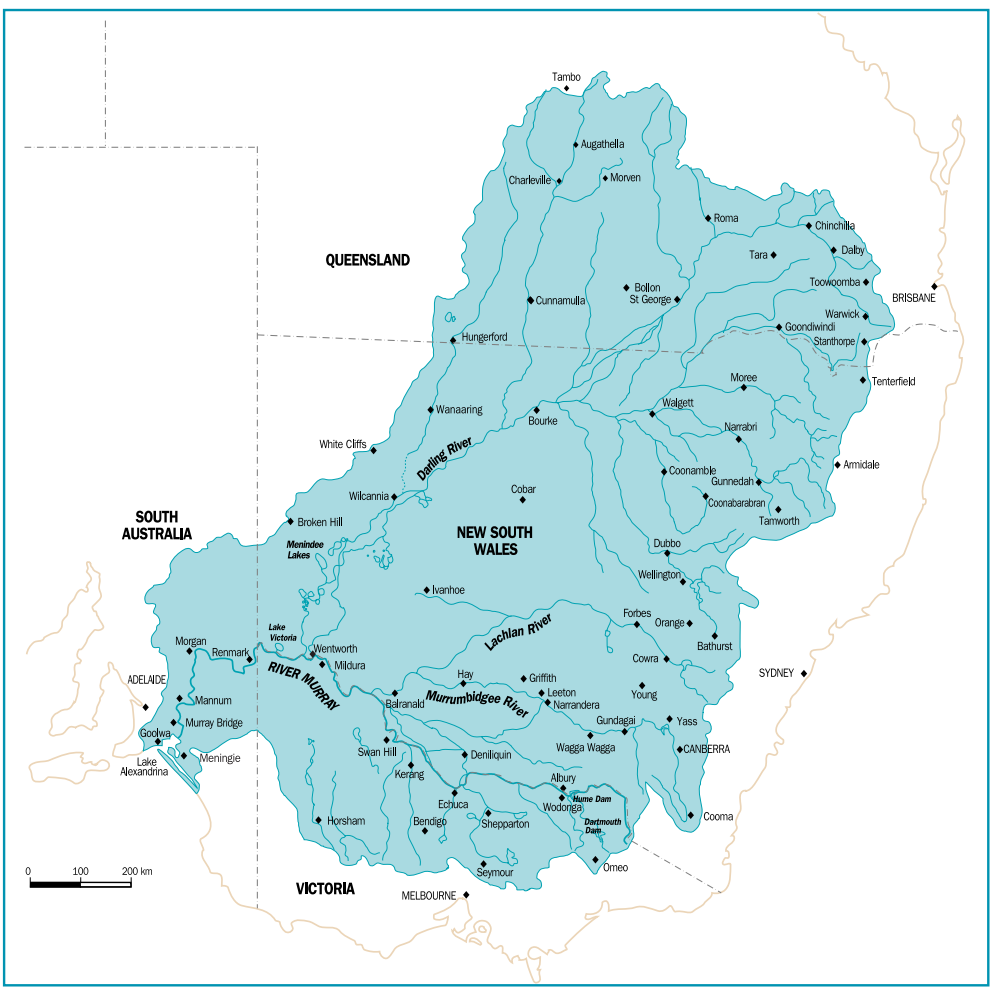
Learning approach

- We will learn from our failures and successes.
- We will learn from each other.

Native Fish Strategy for the Murray-Darling Basin 2003–2013

The overall goal of this Strategy is to rehabilitate native fish communities in the Murray-Darling Basin back to 60 per cent of their estimated pre-European settlement levels after 50 years of implementation.

MAY 2003



The Murray-Darling Basin

The Murray-Darling Basin covers more than a million square kilometres, one-seventh of Australia. It is one of the largest catchments in the world (the river system flows some 2500 kilometres from its headwaters to the sea) and one of the driest. Nearly two million people depend on the Basin's resources and the value of its agricultural produce exceeds $10 billion each year.

The unique plants and animals of the Basin have evolved to survive long periods of drought and to capitalise on sudden floods. Different animals and plants have different river flow needs. Some need periods of flooding in order to breed and others need low flows and still water. For example, spring floods join the rivers to billabongs and wetlands when native fish like Murray cod are breeding. The teeming invertebrate life that the floods stimulate in the billabongs is likely to provide the newly hatched river fish with ample food. The health of the Basin rivers' fish populations is a primary indicator of the health of the Basin's rivers.

The Murray-Darling Basin *Initiative*

The Murray-Darling Basin *Initiative* is a cooperative arrangement between government and community, through the governments of New South Wales, Victoria, South Australia, Queensland, the Australian Capital Territory and the Commonwealth, and a Community Advisory Committee.

The *Initiative* seeks to achieve within the Basin the internationally agreed goals of ecologically sustainable development:

> *Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.*

The *Initiative* seeks to respond to issues that:

- require joint government action or common action by two or more parties; or
- require action by an individual State or Territory but which could have implications for integrated resource management across the Basin.

Partners to the *Initiative* commit to working together for the benefit of the Basin, knowing that cooperation will achieve much more than action by any individual jurisdiction, and that only a true partnership between governments and the community can achieve the changes required for a secure future.

The main focus of the *Initiative* has been the shared water resources of the Basin. However, partners acknowledge that protecting these shared resources requires a whole-of-catchment approach, one that takes account of the relationships between natural systems, including land, water and other environmental resources. Any decision on the use and management of natural resources also affects economic and social values of regional communities. Therefore, *Initiative* partners are committed to strengthening Integrated Catchment Management and the partnership between governments and the community over the next decade.

Lagoon near Condomine – Qld

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Foreword

This Native Fish Strategy seeks to increase native fish population back to 60 per cent of their estimated pre-European settlement levels over a 50-year period. There is sufficient confidence this can be done through key actions ranging from restoring fish passage to environmental flows and rehabilitation of river reaches. The strategy provides direction for investment in on-ground management activities and associated research.

Over the past 100 years, populations of native fish species in Murray-Darling Basin have suffered serious declines in both distribution and abundance.

Many factors have contributed to the deterioration of fish habitat and native fish populations. These include significant changes to water flow, thermal pollution and the introduction of alien fish species. Experts estimate present levels of native fish communities in the Basin to be 10 per cent of the pre-European settlement level which is not sustainable in the long-term.

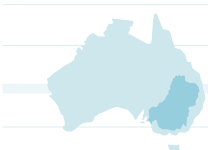
Implementation of the Strategy will involve government agencies, regional catchment organisations and a wide range of community groups. Together we can take into account the values our Basin communities hold for native fish and the riverine environment, and refine our actions as our knowledge of trends and responses in fish populations gets better.

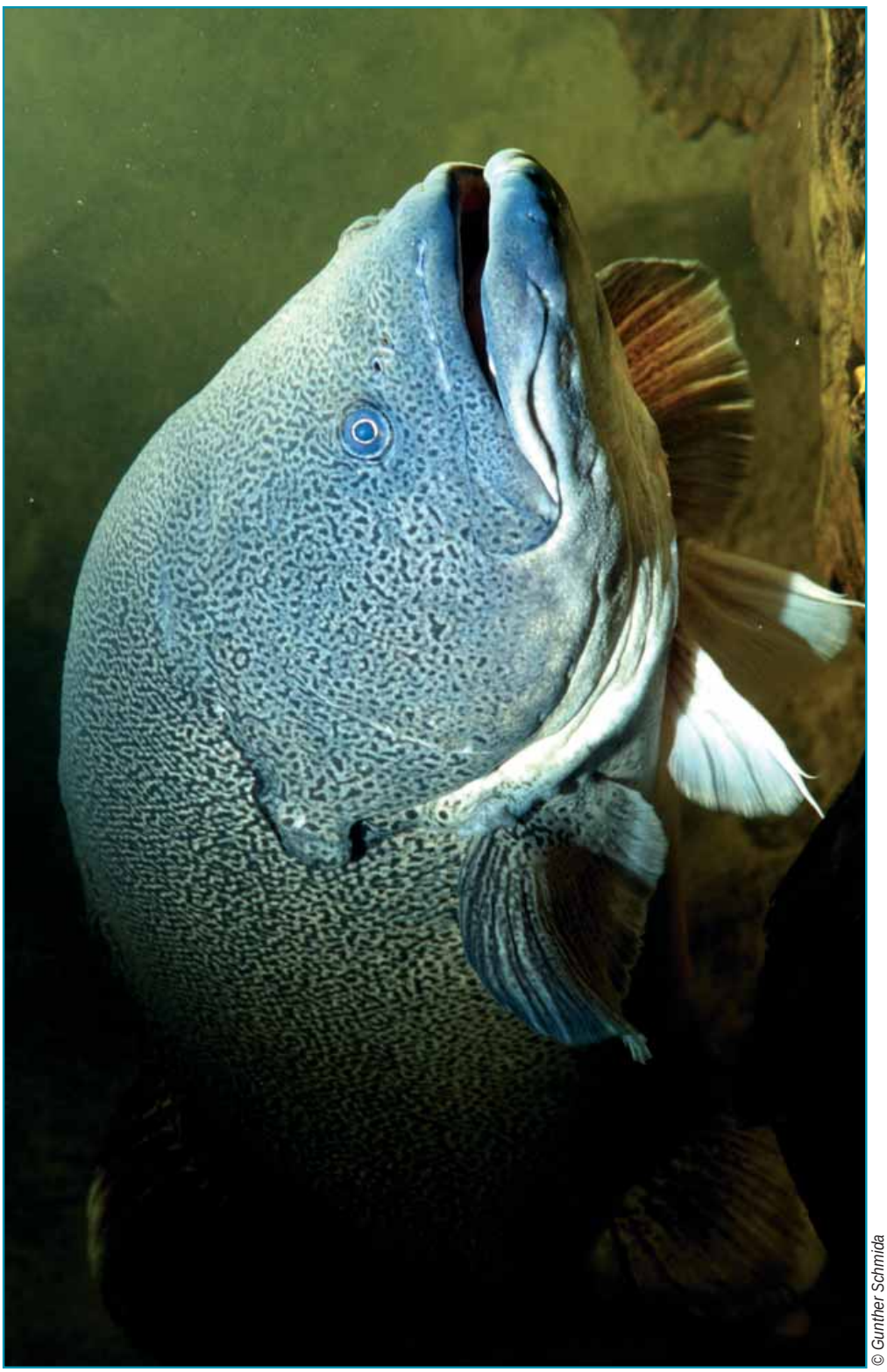
This Strategy has been developed and improved through extensive consultation with agencies, interest groups and individuals, particularly in regional areas. Various Government organisations, through their representatives on the Murray-Darling Basin Commission's technical groups, have contributed valuable perspectives.

This document outlines the goal and objectives of the Native Fish Strategy, together with information on priority actions, responsibilities and targets. I commend it to you.

IAN SINCLAIR AC

President

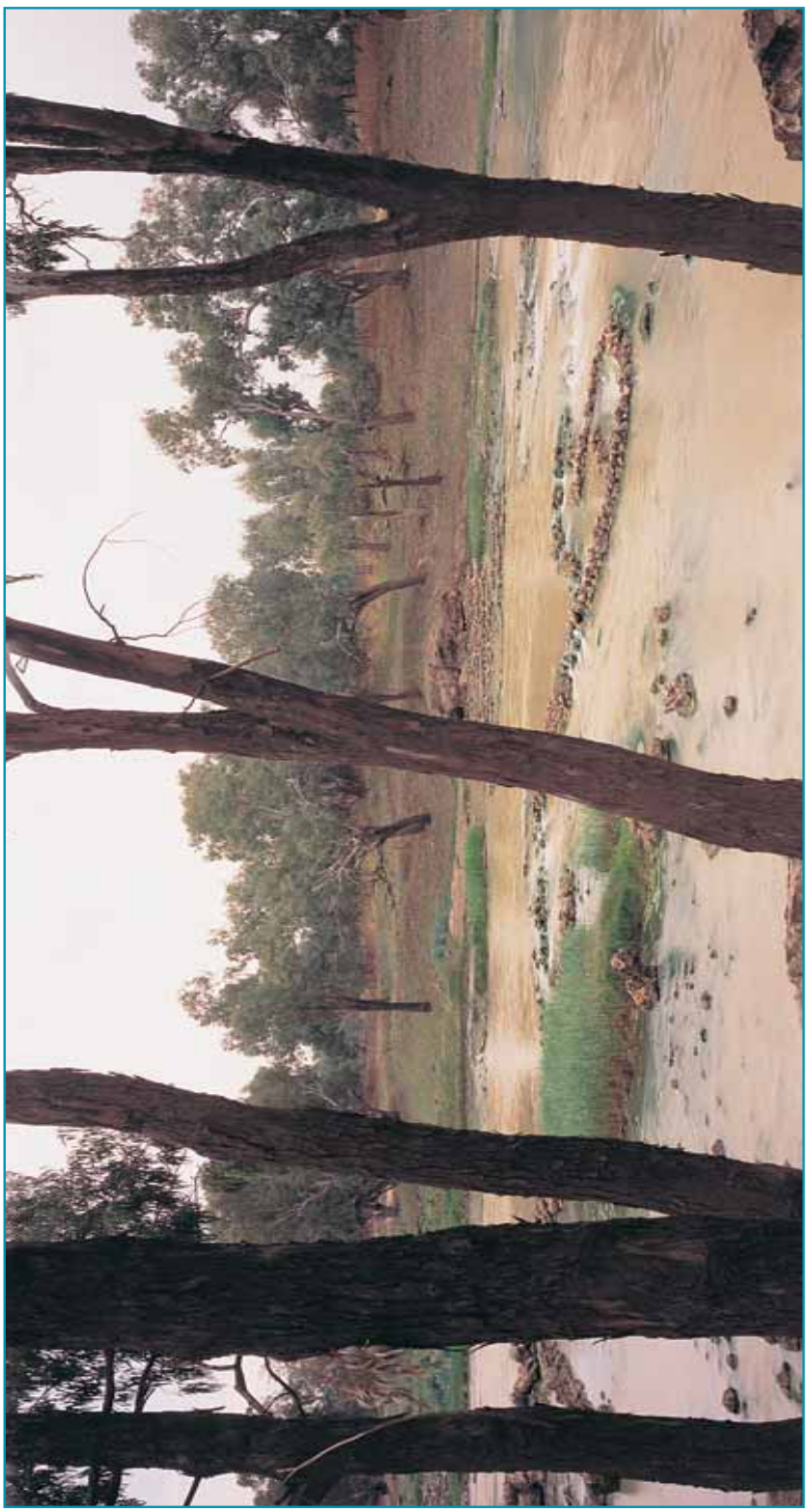




© Gunther Schmida

The Murray cod, an icon species of the Murray-Darling Basin

Contents



Native fish have been valued in the Murray-Darling Basin for generations – Indigenous fish traps, Macquarie River, New South Wales

Strategy summary

This Strategy provides a response to the key threats to native fish populations in the Murray-Darling Basin. These range from flow regulation, habitat degradation, lowered water quality, man-made barriers to fish movement, the introduction of alien fish species, fisheries exploitation, the spread of diseases and translocation and stocking of fish. Native fish populations in the Basin's rivers have declined under these threats with experts estimating that current levels are about 10 per cent compared to pre-European settlement.

The vision of this Strategy is to ensure that the Basin sustains viable fish populations and communities throughout its rivers. The goal of this Strategy is to rehabilitate native fish communities in the Basin back to 60 per cent of their estimated pre-European settlement levels after 50 years of implementation.

In the absence of targets that underpin accountability arrangements, the best expert advice recommends the following as examples of indications of the level of implementation needed by 2013:

- an overall increase of aquatic structural habitat values of 20 per cent; and
- functional processes and river floodplain links re-established for 80 per cent of remaining wetland habitats through improved flow management.

This Strategy has been developed and will be implemented within the context of the Murray-Darling Basin Commission's Integrated Catchment Management Policy. This policy reflects a commitment by the community and governments to do all that needs to be done to manage and use the resources of the Basin in an ecologically sustainable manner. A substantial reallocation of funding will be needed by governments and the community to implement this Strategy.

This partnership approach depends on the commitment of individual landholders, Indigenous communities, Landcare groups, catchment management organisations, waterway managers, urban and rural community groups, local, State and Australian Government agencies, as well as the Murray-Darling Basin Commission.

The Strategy will address its goal and targets through strategic actions designed to achieve 13 objectives directed at improving the status of native fish populations in the Basin. These objectives are to:

1. repair and protect key components of aquatic and riparian habitats;
2. rehabilitate and protect the natural functioning of wetlands and floodplain habitats;
3. improve key aspects of water quality that affect native fish;
4. modify flow regulation practices;
5. provide adequate passage for native fish;
6. devise and implement recovery plans for threatened native fish species;
7. create and implement management plans for other native fish species and communities;
8. control and manage alien fish species;
9. protect native fish from threats of disease and parasites;
10. manage fisheries in a sustainable manner;
11. protect native fish from the adverse effects of translocation and stocking;
12. ensure native fish populations are not threatened from aquaculture; and
13. ensure community and partner ownership and support for native fish management.

These 13 objectives will be achieved by implementing six driving actions that include management, research and investigation, and community engagement interventions:

- rehabilitating fish habitat – helping to achieve objectives 1–8;
- protecting fish habitat – helping to achieve objectives 1–8;
- managing riverine structures – helping to achieve objectives 4–8;
- controlling alien fish species – helping to achieve objectives 6–9;
- protecting threatened native fish species – helping to achieve objectives 6 and 10; and
- managing fish translocation and stocking – helping to achieve objectives 9–12.

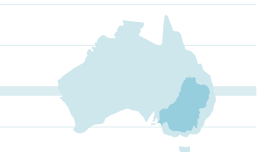
All of the driving actions include a community engagement component designed to achieve objective 13.

The establishment of effective fish passages through major barriers and the implementation of engineering and operational solutions to thermal pollution are the core actions for managing riverine structures. Alien fish species will be managed through integrated pest management approaches that use a combination

of actions to reduce populations and stop the spread of alien fish species. The Strategy urges immediate investment in the development and implementation of species' recovery plans for threatened or endangered native fish species. The establishment of Habitat Management Areas will help such recovery plans. A consistent, coordinated and firm Basin-wide approach is needed for managing fish translocation and stocking.

The implementation of the driving actions will not see an immediate return on investment. While the rehabilitation of fish habitat and the management of riverine structures should result in changes within the next 10 to 15 years to native fish communities, the other driving actions are likely to take considerably longer before benefits become obvious. However, if this investment is delayed it will prove more costly to rehabilitate the Basin's native fish communities in the future.

A key feature of the driving actions, especially for rehabilitation of fish habitat, will be the establishment of Riverine Management Zones that reflect the ecological functioning of the Basin's rivers as well as management capabilities. Management plans will be developed for each Zone and will be prioritised for investment according to both their feasibility and importance. Plans will be integrated with other planning processes.



Within Riverine Management Zones there may be demonstration reaches, varying from a few kilometres in length to larger sections of about 100 kilometres. The demonstration reaches will integrate all land and water programs to form comprehensive rehabilitation exercises on important and visible river reaches. The key purpose of a demonstration reach is to show the community the cumulative benefits of using a number of actions for rehabilitating native fish populations and communities. Riverine Management Zones may also include Habitat Management Areas that aim to protect remnant areas of healthy fish habitat. The Habitat Management Areas can range from those with limited human access to multiple-use areas, such as those which allow sustainable recreational angling.

Experts have agreed that the actions such as habitat restoration and improved environmental flows detailed in the Strategy must be acted upon in an integrated way, if they are to be effective. If undertaken singly, the capacity of these interventions to recover the native fish populations of the Basin beyond 25 per cent of their pre-European level is questionable. The targeting of investment in the actions of developing a system of Habitat Management Areas and managing other alien fish species will also ensure a greater level of success with this approach.

This Strategy will be monitored against accountability indicators in conjunction with the *Sustainable Rivers Audit* process. Its progress will be reviewed annually, with major external reviews of the Strategy conducted in the fifth and tenth year of its operation. In 2013, development of the *2013–23 Native Fish Strategy* will ensure Basin-wide approaches to native fish management into the foreseeable future.

The successful implementation of this Strategy relies on knowledge generation and exchange. This will be achieved by research and investigation to fill gaps in our knowledge and understanding about fish and river ecology, and through a comprehensive communication strategy that focuses on partner consultation and engagement.

An agreed, fully funded *Native Fish Strategy* will provide benefits beyond just those for native fish:

- There are obvious and significant economic advantages to the recreational fishing and tourism industries through having healthy fish populations and healthy rivers;
- Healthy fish populations would signal a return of cultural values and the notion of community 'connectedness' to the River;
- Indigenous people across the Basin have always had a strong spiritual and physical connection to the environment, and healthy fish populations and river systems will ensure the continuation of this connection;
- The holistic and integrated approach promoted in the Strategy will lead to enhanced biodiversity conservation generally, and highlight the contribution of improved native fish populations to river ecosystems;
- The aesthetic value of an improved, functioning river system cannot be overstated – for example, carp-free wetlands and intact riparian vegetation;
- Improved river health will enhance all recreational activities, particularly for those Australians who live in the vicinity of the Basin's rivers and wetlands.

All available evidence indicates that on a Basin-wide scale, native fish populations and communities are not in good shape. However, we are not starting from scratch—there have been some success stories to date. There are a number of examples where the sort of 'interventions' mentioned in the Strategy have led to increased native fish populations. For example:

- Resnagging has been conducted at 14 sites on the River Murray with the addition of over 300 large river red gum snags. The resnagging was conducted on a scientific basis which allowed the testing of different snag pile locations and configurations. Structured monitoring has been undertaken which shows that a range of native fish species use the new snags, in the same proportions as would have been expected in natural snag piles. The snags were favoured by native species such as Murray cod, trout cod and golden perch, but were not heavily used by carp. Different locations were more successful than others, indicating designs to maximise environmental benefit. Similarly, different locations were used by different species. A cost benefit analysis of resnagging was also conducted.
- Torrumbarry was the first fishway built in Australia that was directly based on experiments on the swimming ability of native fish. In 1990 it was the highest fishway at the time, at 6.5 metres. It opened up 350 km of river, to Yarrawonga Weir upstream. From the moment it was opened, native fish used it; in the first two years the fishway passed over 20 000 native fish from seven species. Above the weir, numbers of silver perch increased and juvenile golden perch were seen for the first time in decades. Tagged golden perch moved all the way to Yarrawonga Weir and also entered the Goulburn River. Short-headed lampreys, a very uncommon native species, used the fishway—these fish migrate from the sea and have swum over 1600 km to reach Torrumbarry.
- Before Googong Dam was constructed on the Queanbeyan River in 1978, there was a small population of the threatened Macquarie perch in the river. After the dam was built, a fish monitoring program revealed that Macquarie perch were present in the reservoir, but were not breeding. It is believed that the filling of the reservoir flooded all available Macquarie perch spawning sites, and the population was unable to access the spawning habitats in the river above the reservoir because of a natural barrier posed by a waterfall. Fifty-seven adult Macquarie perch were netted from the reservoir and transported upstream, past the waterfall, and released at two sites on the Queanbeyan River. There is now a thriving population of Macquarie perch, with regular breeding occurring.
- In the lower Murray, there are several local areas where anglers have reported increased catch rates for the larger species (such as Murray cod), while at the same time carp populations seem to be in decline.

© John McKenzie

Resnagging site below Yarrawonga Weir

© AM Photography/Arthur Mostead

Wetland near Forbes NSW, infested with blue green algae growth

© AM Photography/Suzie Mostead

Tourism can be impacted by poor river health

The health of populations and communities of native fish species in the Murray-Darling Basin is an indicator of the overall health of the Basin and its rivers. If there is a decline in the native fish communities, this provides a 'canary in the coal-mine' warning that the natural ecological functioning of the rivers is at risk.

The ecological needs of the Basin's plant and animal communities for seasonal changes in water flows, run counter to the needs of agricultural systems for reliable and predictable water supplies. Over the past century, river regulation to provide water on demand through dams, weirs and diversions has changed the natural flooding and drying cycles of the river systems. This has affected the health of river habitats and native fish populations. Across the Basin, changed river flows continue to exacerbate the problems of salinity, alien fish species and blue-green algal blooms as well as declining native fish populations.

The current state of fish habitats varies widely along the Basin's rivers. Many habitats, such as billabongs, wetlands and riverbanks, are now degraded. River snags (logs, branches, fallen trees) important for native fish breeding and other behaviour have been removed. Murray-Darling Basin fish are generally 'warm water' species and the release of cold water from dams affects spawning, growth and survival. Some native species rely on flooding for successful breeding and others have evolved to exploit the high food availability of the floodplains during flooding. Changing the flow of water through dams, weirs and other structures interferes with these survival behaviours and has benefited carp and other alien species.

Many native fish need to move widely through the river systems of the Basin. Man-made barriers and restricted flooding stops such movement. The adults of some species (e.g. golden perch) can migrate over thousands of kilometres. Large numbers of some juvenile fish (e.g. silver perch) also move upstream. Other fish (e.g. short-headed lamprey, congolli/tupong) need to spend some time in salt water to complete their lifecycle. Dams and altered flow rates restrict the movement of fish larvae, affecting survival and distribution of native fish species in the Basin.

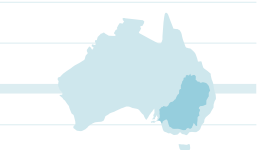
The eight key threats to native fish management in the Basin are summarised in **Table 1**.

The most effective means of rehabilitating the Basin's native fish populations will be through an integrated management approach and remediation of the threats that are impacting on them.

Table 1: Key threats to native fish management in the Basin

Threat	Threatening process
Flow regulation	Loss of water to other uses, critical low flows, loss of flow variation, loss of flow seasonality, loss of low to medium floods, permanent flooding and high water, increased periods of no flow
Habitat degradation	Damage to riparian zones, removal of in-stream habitats, sedimentation
Lowered water quality	Increased nutrients, turbidity, sedimentation, salinity, artificial changes in water temperature, pesticides, and other contaminants
Barriers	Impediments to fish passage resulting from the construction and operation of dams, weirs, levees, culverts, etc., and non-physical barriers such as increased velocities, reduced habitats, water quality and thermal pollution (changes in water temperature)
Alien species	Competition with and/or predation by carp, gambusia, oriental weatherloach, redfin perch and trout
Exploitation	Recreational and commercial fishing pressure on depleted stocks, illegal fishing
Diseases	Outbreak and spread of EHNV (Epizootic Haematopoietic Necrosis Virus) and other viruses, diseases and parasites
Translocation and stocking	The loss of genetic integrity and fitness caused by inappropriate translocation and stocking of native species

Trout cod are critically endangered. The natural range of this species is now restricted to about 120 kilometres of the River Murray, immediately downstream of Lake Mulwala on the NSW–Victoria border.



Status of native fish populations

Native fish populations are currently estimated to be about 10 per cent of their pre-European settlement levels. This estimate has been based on scientific research, fishing records, Indigenous history and anecdotal evidence (see Developing the aspirational goal of the *Native Fish Strategy* on page 12) and takes into account the naturally variable nature of fish populations (see **Figure 1**).

That the status of native fish populations in the Murray-Darling Basin is poor can be demonstrated by many indicators, including:

- localised extinction of some native fish species (for example, trout cod, Murray cod and Macquarie perch have become locally extinct in the Mitta Mitta River for 100 kilometres downstream of Dartmouth Dam);
- threats to other species: 8 of the 35 native fish species in the Basin are nationally 'threatened' (as listed by the Australian Society of Fish Biology) and at least two are 'critically endangered'; 16 species are listed as threatened under State jurisdictions (see **Table 2**);
- rapid decline in the conservation status of 'flagship' species such as silver perch, freshwater catfish and Murray cod across the Basin;
- presence of 11 alien species of fish that now make up a quarter of the Basin's total fish species (carp, gambusia, oriental weatherloach, roach, tench, goldfish, redfin perch, brown trout, brook char, rainbow trout, Atlantic salmon). Carp now make up an estimated 60 to 90 per cent of the total fish biomass at many sites, with densities as high as one carp per square metre of river surface area;
- presence of two native fish species that are not native to the Basin rivers (broad-finned galaxias, spotted galaxias);
- loss of most commercial fisheries (see **Figure 1**); and
- observed declines in recreational angling success—native fish species make up just 4.4 per cent of the total catch in the River Murray region.

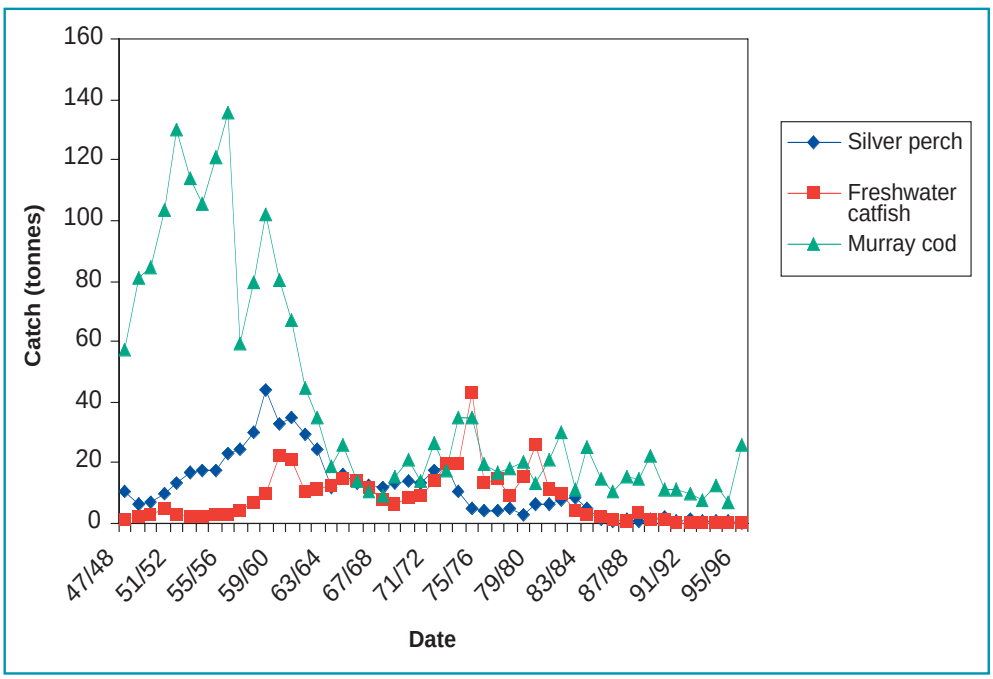
The magnitude of the decline of native fish populations has been most significant in the past 100 years, with the greatest declines in the past 50 years. For example, following the construction of the Dartmouth Dam in 1980, trout cod, Macquarie perch and Murray cod were lost from the Mitta Mitta River. This was at least partly due to the cold water releases that inhibited spawning and favoured the cold water alien brown trout.

Although native fish populations are very low Basin-wide, some anglers are reporting improved catches in some river reaches. Fish numbers are certainly highly variable, both over time as well as among reaches, valleys and rivers due to factors such as environmental conditions and recruitment success. Good numbers of fish in some reaches can be a reflection of successful local stocking programs. While reports of improved adult fish populations for some species in some areas are encouraging, this does not necessarily mean that the overall fish community is healthy. There may not be suitable conditions for fish spawning or larval survival, spawning sites might be absent or degraded, fish may be unable to access them because of barriers such as weirs or levee banks or the environmental cues to stimulate spawning may be absent. In addition, the presence of certain large angling species such as Murray cod or golden perch doesn't necessarily indicate that the entire fish community is doing well. Many of the smaller fish species such as gudgeons, galaxiids and hardyheads are declining at alarming rates, but this would not be reflected by recreational catches.

Trout cod

Figure 1: Declines in catch of Murray cod, silver perch and freshwater catfish in NSW between 1947 and 1996

Note that while the figure shows a long-term decline in fish catch, there is a great deal of variability in catch from year to year.



(Source: Reid D.D., Harris J.H. & Chapman D.J. (1997), 'NSW inland commercial fishery data analysis', *Fisheries Research and Development Corporation Project No. 94/027 Report*)

Eight of the thirty-five native fish species in the Basin are nationally threatened, with three listed as 'endangered' under the Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC).

Table 2: Status of native fish in the Basin

Common name	Status and distribution	State and Commonwealth listings
Short-headed lamprey	Lower Murray-Darling Basin	Qld – Extinct in the wild
Pouched lamprey	Lower Murray-Darling Basin, rare	
Short-finned eel	Lower Murray-Darling Basin, rare	
Long-finned eel	Condamine drainage, Qld	
River blackfish	Lower Murray-Darling Basin and cooler regions, declining	SA – Protected (endangered)
Two-spined blackfish	Upland species, southern Murray-Darling Basin	ACT – Vulnerable
Common galaxias	Lower River Murray only	
Climbing galaxias	Recently introduced into Murray-Darling Basin	
Spotted galaxias	Recently introduced into Murray-Darling Basin	
Flat-headed galaxias	Threatened species, lowland and lower Basin	

Table 2 continued: Status of native fish in the Basin

Common name	Status and distribution	State and Commonwealth listings
Mountain galaxias	Upland areas and slopes	
Barred galaxias	Threatened species, upland, lower Murray-Darling Basin	Vic. – Critically endangered, listed under *Flora and Fauna Guarantee Act* Commonwealth – Endangered species listed under *EPBC Act*
Tupong/congolli	Restricted to lower River Murray, declining	
Murray cod species	Fragmented and in low abundance	Vic. – Vulnerable, listed under *Flora and Fauna Guarantee Act* Commonwealth–Vulnerable listed under EPBC Act
Trout cod (bluenose cod)	Threatened species, two known populations, one of which is a translocated population	ACT – Endangered Vic. – Critically endangered, listed under *Flora and Fauna Guarantee Act* NSW – Endangered and a protected species SA – Protected Commonwealth – Endangered species listed under *EPBC Act*
Golden perch	Widespread and common	
Macquarie perch	Threatened species, restricted distribution	ACT – Endangered Vic. – Endangered, listed under *Flora and Fauna Guarantee Act* NSW – Vulnerable and a protected species SA – Protected Commonwealth – Endangered species listed under *EPBC Act*
Estuary perch	Uncommon, lower River Murray only	
Silver perch	Threatened species, declining	ACT – Endangered Vic. – Critically endangered, listed under *Flora and Fauna Guarantee Act* NSW – Vulnerable, protected from commercial catch
Southern pygmy perch	Southern Murray-Darling Basin, threatened	NSW – Vulnerable SA – Protected
Yarra pygmy perch	Highly restricted to lower Murray	SA – Protected Commonwealth – Vulnerable species listed under *EPBC Act*
Australian smelt	Widespread	
Freshwater catfish	Declining, was widespread	Vic. – Vulnerable, listed under *Flora and Fauna Guarantee Act* NSW – Protected from commercial catch SA – Protected
Bony herring	Widespread in mid-reaches	

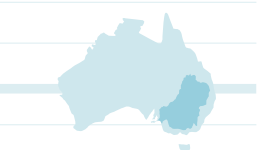


Table 2 continued: Status of native fish in the Basin

Common name	Status and distribution	State and Commonwealth listings
Hyrtl's tandan	Northern Murray-Darling Basin	
Rendahl's tandan	Condamine drainage only	
Southern purple-spotted gudgeon	Threatened species, once widespread	Vic. – Critically endangered, listed under *Flora and Fauna Guarantee Act* SA – Protected NSW – Endangered species
Western carp gudgeon	Widespread	
Midgeley's carp gudgeon Murray-Darling carp gudgeon Lake's carp gudgeon	Taxonomy is complex and unresolved, with several forms and hybrids	
Spangled perch	Common, mid to upper Murray-Darling Basin	
Flat-headed gudgeon	Widespread, common	Vic. – Listed under *Flora and Fauna Guarantee Act*
Dwarf flat-headed gudgeon	Lower Murray-Darling Basin and Murrumbidgee and Murray Rivers	
Murray-Darling rainbowfish	Widespread	Vic. – Listed under *Flora and Fauna Guarantee Act*
Darling River hardyhead	Threatened species, restricted distribution	
Fly-specked hardyhead (southern form)	Widespread, declining	
Murray hardyhead	Threatened species, restricted distribution	Vic. – Endangered, listed under *Flora and Fauna Guarantee Act* NSW – Endangered species Commonwealth – Vulnerable species listed under *EPBC Act*
Olive perchlet	Threatened species, extinct in South Australia	SA – Protected Vic. – listed under *Flora and Fauna Guarantee Act* NSW – Endangered species

NB: The aquatic ecological community in the natural drainage system of the lower River Murray catchment is listed as an endangered community in New South Wales.

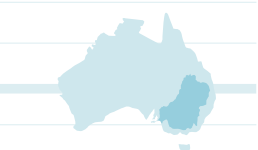
Some anglers are reporting improved catches in some river reaches, which may reflect good environmental conditions or sustained stocking programs.

Strategic response

The improved status of native fish populations in the Murray-Darling Basin will be the key criterion by which the public will judge the success of this Strategy.

If the Basin is to be rehabilitated and ensure viable populations of native fish species in its rivers, urgent action is needed. This action must be coordinated and consistent across State boundaries. It needs to build upon the knowledge gained through past research as well as current and often local efforts being carried out to rehabilitate fish habitats and protect existing viable populations.

In 1991, the Murray-Darling Basin Commission (MDBC) developed and implemented a *Fish Management Plan for the Murray River*. The principles of this original Plan are incorporated into this *Native Fish Strategy* that has been extended to cover the whole Basin. This is one of the first strategies, along with the *Basin Salinity Management Strategy*, to be developed under the MDBC's Integrated Catchment Management Policy Statement. This Strategy builds on research into native fish management carried out over the past decade. However, native fish populations continue to decline, so emphasis needs to be placed on rehabilitation rather than maintaining the status quo, as this will inevitably result in continuing declines and loss of species. As these declines have taken place over many years, so must rehabilitation be undertaken over a similar timeframe: 50 or more years. The level of rehabilitation required to reverse declines will vary with species, communities and areas, and should be assessed over the medium and longer terms.



The overall goal of this Strategy is to rehabilitate native fish communities in the Murray-Darling Basin back to 60 per cent or better of their estimated pre-European settlement levels after 50 years of implementation. This goal includes all fish species across the entire Murray-Darling Basin, and encompasses measures of fish abundance (numbers and biomass) for all fish species (not just the larger, recreationally important ones), as well as fish distribution, and will vary from site to site and year to year (as does the fish community). For example, if after 50 years, Macquarie perch were returned to 60% of their distribution and abundance across the Basin, the *Native Fish Strategy* would have been successful. The goal of 60% does not relate to fish diversity, i.e. if at the end of 50 years of management action there is only 60% of pre-European fish species remaining in the Basin, the goal will not have been met! The goal for fish diversity is implicitly 100%, that is no species should become extinct in the Basin.

Native fish populations are currently estimated to be about 10 per cent of their pre-European settlement levels. Without any intervention this is likely to fall to 5 per cent over the next 40 to 50 years. Experts have agreed that interventions must be undertaken in an integrated way if they are to be effective. If undertaken singly, the capacity of interventions to recover the native fish populations of the Basin beyond 25 per cent of their pre-European level is questionable. If a number of interventions (such as allocation of environmental flows, habitat rehabilitation, abatement of cold water pollution, improved land-use management practices, provision of fish passage, creation of a Habitat Management Area system, and control of alien fish) are implemented in an integrated way, then experts believe the goal of this Strategy is achievable.

It should be noted that actions vary considerably in the timing it takes to establish them. For example, with sufficient funding, abatement of cold water pollution could be achieved within 5 to 10 years, benefiting native fish populations relatively soon. However, the benefits of habitat rehabilitation may take a lot longer to achieve. An Expert Panel has developed a conceptual model for the cumulative impact of interventions on native fish populations (**Figure 2**).

Figure 2 models expert advice regarding the response of native fish communities to strategic rehabilitative interventions. The figure shows that while single interventions, such as environmental flow and habitat restorations will improve fish communities, the most significant positive impact will occur through a combination of interventions which address a range of problems. It is important to note that the figure does not prioritise interventions. Some reaches have very specific problems which must be addressed, such as cold water pollution.

The implementation of this Strategy requires a balanced investment plan that will see financing of some short-term quick return actions, such as providing fish passage and mitigating cold water pollution. This will ensure that existing native fish populations do not decline any further, and will begin to recover for later actions to build upon, particularly habitat restoration and environmental flows.

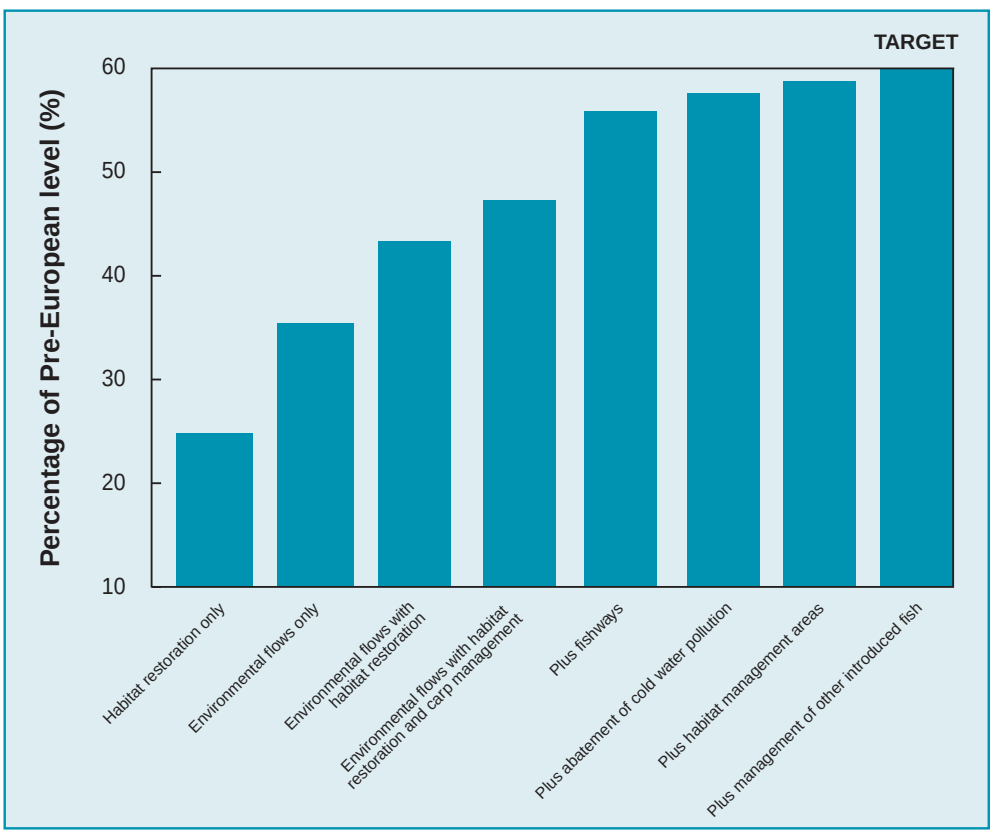
Implementation will necessarily involve all Basin partners: Commonwealth and State agencies, industry, catchment management organisations, Landcare groups, the Indigenous community and the general public. Strategic actions can only be

implemented throughout the Basin by dealing with the threats on a local catchment-by-catchment basis. Catchment management organisations have a central role to play in habitat rehabilitation, and a clear agreement on priorities and the targeting of investment will be needed within their accredited catchment management plans. Within these plans, there will be significant opportunity for local community actions.

State governments and the MDBC are responsible for environmental flow policies and plans, in consultation with community advisory bodies. While not detailed in this Strategy, environmental flow regimes that return rivers to a healthy, working condition are integral to achieving the Strategy's outcomes and the Strategy will work very closely with the MDBC's The Living Murray initiative.

An Expert Panel concluded that in general terms of abundance and diversity, native fish across the whole Basin are currently at a level of about 10% of their status 200 years ago.

Figure 2: Rehabilitation of native fish communities – cumulative impact of all interventions



Developing the aspirational goal of the *Native Fish Strategy*

During 2001/02 the Commission found that insufficient information was available to rank the values of potential river rehabilitation programs in the Basin and to predict their outcomes, in terms of improving native fish populations. What would be the relative environmental benefits of programs on carp control, control of other pest fish, environmental flows, resnagging, abatement of cold water pollution and fishway construction? To help understand the issues better, an Expert Panel was assembled, comprising six people, two eminent in each of the fields of river ecology, fish ecology and macroinvertebrate/vertebrate pest ecology. The Panel used all available data and their combined experience of the Basin's rivers to produce a conceptual model. The model provides estimates of the current status of native fish relative to predictions of the 'natural' situation prevailing about 200 years ago. Given the limited amount of direct data from those times and the need to make retrospective assumptions based on more recent information, the model and estimates must be treated as general guides, rather than being definitive. The types of recent information that the Panel could draw upon to produce the model include:

- the 93% decline between 1940 and 1990 in the numbers of silver perch passing through Euston Weir;
- the fact that 16 of the Basin's 35 native fish species are now listed as threatened;
- the decline in the commercial catch of Murray cod in NSW from approximately 74 tonnes/year in the late 1940s to 9.5 tonnes/year in the early 1990s;
- 80–90% of fish biomass at many sites in the Murray and Murrumbidgee Rivers now consists of alien species.

With the proviso that the model is not exact, the Expert Panel concluded that, in general terms of abundance and diversity, native fish are currently at a level only about 10% of their status 200 years ago, and still declining. This is an assessment of the status of all species across the **whole Basin**. Without appropriate interventions, this level will decline further. Furthermore, in view of the ongoing need for human exploitation of the Basin's rivers for water resources, it would not be possible to return rivers and native fish to their natural condition. At best, with all feasible rehabilitation options, there could be a return to about 60% of natural levels. The rehabilitation level of 60% is seen as an important aspirational goal that is achievable over a 50-year timeframe. It is also indicative of the commitment to a defined outcome from the implementation of this Strategy.

Graphical representation of the model demonstrates two key points: the response to various kinds of rehabilitation is cumulative, and they will take time. It is clear that addressing only a few of the problem areas will produce only modest results. For the 60% goal to be realistic, each of the major contributing problems need to be dealt with concurrently in an integrated way. Widespread responses from native fish populations will not occur overnight, as many of the recovery processes will take time, in some instances even decades.

The Expert Panel therefore strongly recommended that the Commission should use an integrated program, incorporating all the major rehabilitation issues for native fish. While they cautioned that in some cases results would be slow at first, and a very substantial, long-term program is needed, they agreed that fish populations can potentially be restored to much improved conditions.

The vision of this *Native Fish Strategy* is that the Murray-Darling Basin sustains viable fish populations and communities throughout its rivers.

This means rehabilitating aquatic habitats and ecological processes in the Murray-Darling Basin through management actions designed to restore healthy native fish communities.

This Strategy targets the causes as well as the symptoms of declining native fish species, and focuses on long-term rehabilitation rather than restoration. As part of the *Integrated Catchment Management Policy Statement* for the Basin, this Strategy provides a framework for improved management of native fish in the Basin, rather than prescribing specific management practices. The framework outlined in this Strategy will evolve with better knowledge and new research outcomes. Inter-State cooperation and coordination of actions and policies is an essential ingredient of the Strategy's framework. While the Strategy provides a 10-year framework, a sustained commitment needs to be maintained for the next 50 years.

Through a Basin-wide approach to fish management, this Strategy seeks to achieve the following outcomes:

- wild, self-sustaining native fish populations and fish communities rehabilitated to 60 per cent of their estimated pre-European settlement levels after 50 years;
- river rehabilitation actions integrated with other strategies and management initiatives, including environmental flows that restore and protect aquatic habitats;
- consistent and integrated Basin-wide management activities that positively affect native fish populations and communities; and
- ownership of the Strategy by the community and other partners.

This Strategy provides direction for investment in on-ground fish management activities and associated research and investigations.

Strategy objectives

To achieve the Strategy's vision, 13 objectives have been identified, as described below.

1. To repair and protect key components of aquatic and riparian habitats important for sustaining native fish populations

Suitable habitat is essential for the survival of all native fish species. Key components of habitat include home sites, spawning sites, provision of shade, shelter from certain water velocities and predators, and a variety of feeding sites and water depths. A diversity of habitats is needed for a diversity of species and life stages. In-stream and riparian habitats within the Basin have been severely degraded by factors such as river de-snagging, loss of wetland, floodplain and river connectivity, bank erosion and sedimentation.

2. To rehabilitate and protect the natural functioning of wetlands and floodplain habitats for native fish; and revive the links between terrestrial ecosystems, wetlands and rivers

Floodplains and wetlands play a significant role in the ecological functioning of riverine systems. They provide important habitats for fish and other plants and animals, including those on which fish are dependent for food. They are important for carbon-cycling, uptake of excess nutrients and sediment stabilisation. Substantial areas of floodplain have become degraded in the Basin and cut off from the river system.

3. To improve key aspects of water quality that affect native fish

The Basin's native fish are facing a number of water quality problems including changed temperatures, increased salinities, pesticides, heavy metals, sedimentation and turbidity. For example, reduced water temperatures or dissolved oxygen levels can prevent fish spawning, reduce metabolic rates and cause fish kills. Poor water quality is generally associated with poor management practices.

4. To modify flow regulation practices to facilitate native fish rehabilitation

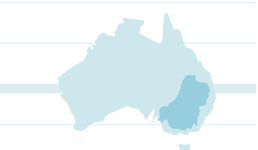
Regulation of river flows through storages and off-stream extraction has vastly changed the natural flows of water in the Basin's rivers, causing widespread degradation. Restoring more natural flows to the Basin's rivers will reduce such degradation and help rehabilitate fish populations. A range of processes is already in place, attempting to address the issues of flows on many rivers. The objectives of this Strategy need to be incorporated into these processes.

5. To provide adequate passage for native fish throughout the Basin

Barriers such as dams, weirs, levees, causeways, culverts and road crossings can stop the natural migration patterns of many native fish species

This Strategy works within the Integrated Catchment Management framework to target the causes as well as the symptoms of declining fish species.

This Strategy has thirteen objectives designed to achieve its vision for a Basin that sustains viable fish populations and communities throughout its rivers.



within the Basin. Such barriers prevent many native fish from completing key components of their lifecycle. State agencies have recognised more than 3600 barriers in the Basin, and only a small number have implemented engineering works or operating procedures to mitigate their impacts on fish movements.

6. To devise and implement recovery plans for threatened native fish species and communities

A number of the Basin's native fish are listed on various national/State lists as being endangered, and there is potential for the extinction of some species in the future. Risk-management strategies and implementation of recovery plans are needed to reverse this trend of endangerment, for both individual species and fish communities. A comprehensive, adequate and representative network of Habitat Management Areas for fish needs to be established.

7. To create and implement management plans for all non-threatened native fish species and communities

Substantial declines have occurred in populations of many native non-threatened species. Such declines may be rapid or masked by other factors. The cost and effort of maintaining healthy populations are far outweighed by the resources necessary to reverse the conservation status of threatened species. Appropriate management arrangements for all fish need to be implemented.

8. To control and manage carp and other alien fish species effectively

The Basin already contains at least 11 alien fish species in the wild, some in pest proportions, and further introductions are inevitable over time. Both the abundance and attributes of some alien fish, including carp, continue to cause damage to habitats and populations of native species. Management actions are needed to minimise the risk of future introductions and seek to tackle the problems of existing introductions.

9. To increase understanding of fish diseases and parasites, and to protect native fish from such threats

Disease outbreaks have potentially devastating effects on native fish populations. However, our knowledge of fish diseases and parasites is far from complete. The potential sources and risks of disease outbreak need to be determined. Attention also needs to be paid to the mechanisms that transfer diseases and parasites across the Basin.

10. To manage fisheries in a sustainable manner

The exploitation of fish by both the recreational and commercial sectors, together with illegal activities, has made substantial impacts on the viability of native fisheries in some regions of the Basin. Fish populations need to be returned to a viable, sustainable status to provide for ecologically sustainable fisheries in the future.

11. To protect the natural species composition, population structure, genetic integrity and diversity of native fish communities from the adverse effects of human interventions into native fish movements and restocking

The composition of native fish populations can be threatened by the liberation of fish from outside their natural range or from hatcheries. While carefully managed stocking can play a significant role in species recovery programs, the impact of fish from hatcheries can have enormous impacts on the genetic viability and evolutionary potential of native fish populations. Appropriate guidelines to minimise such risks are required.

12. To ensure native fish populations are not threatened from aquaculture

Apart from releases of alien fish, natural populations of native fish are threatened by the potential release of genetically restricted material from native fish aquaculture operations using limited brood stock. The release of such material has potential to reduce the genetic fitness and hence viability of fish populations.

13. To ensure community and partner ownership and support for and understanding of the *Native Fish Strategy*

As fish are hidden under water, the general community understanding of issues relating to native fish is often less than that for more visible and identifiable terrestrial animals. There is a clear need for the community to be made more aware, participate in programs, and provide local expertise and skills in relation to native fish, their status, importance and threats to them. Indigenous people in particular, have a great deal of knowledge and understanding of the landscape and the environment which will be invaluable for furthering our understanding of native fish communities.

Guiding principles

This Strategy applies the following principles:

- a holistic approach is necessary for river management and rehabilitation;
- a precautionary approach is to be applied where knowledge or understanding is limited;
- biodiversity conservation is central to ecologically sustainable development;
- conservation is best undertaken within a species natural habitat;
- the existing natural assets in the Basin's waterways must be protected;
- conservation depends on knowledge and understanding of species, populations and ecosystems; and
- it is more cost-effective to conserve existing wild fish populations and aquatic communities now, than to rehabilitate them later.

Policy context

The MDBC has developed a standard for the development of all natural resource management strategies within the Basin under its Integrated Catchment Management (ICM) Policy. The ICM Policy is a commitment by governments and the community of the Murray-Darling Basin to do all that needs to be done to manage and use the resources of the Basin in a way that is ecologically sustainable.

The ICM Policy is based on setting targets for catchment health and building the capacities of governments and the Basin community to achieve these targets. The approach will take another 10 years to build. It will require substantial government, community and industry leadership and commitment, and will significantly test the capacities of everyone to manage the natural resource base for the benefit of present and future generations. The areas for target-setting under the ICM Policy are water quality, water sharing, riverine ecosystem health and terrestrial biodiversity.

This Strategy will be closely linked with the ICM Policy as well as the MDBC's *Sustainable Rivers Audit* (SRA) and The Living Murray initiative. The SRA is intended to provide information on the health of the Basin's rivers to inform target-setting for riverine ecosystem health. The health of the Basin's native fish populations will form part of the SRA. The Living Murray initiative has the goal of creating a healthy working River Murray system which will benefit native fish populations.

The *Sustainable Rivers Audit* (SRA) is being developed to monitor the environmental health of the Basin's rivers and provide more information to resource managers and the community on the location and extent of degradation. The SRA is seen as a logical extension of the Cap on Diversions and a means of providing a stronger scientific base for debate in relation to ecological, environmental and social considerations associated with water management in the Basin. The SRA will regularly measure and report on river health, with those reports being independently audited. The health of fish populations will be used as one of the outcome-based indicators of river health, with measures of current fish populations compared to a baseline reference condition to give a general assessment of fish health. Over time, the SRA reports will reflect the impact of management initiatives (such as the *Native Fish Strategy*) on the direction and rate of change in the health of fish populations.

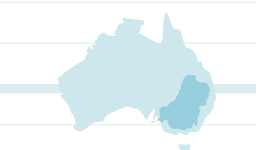
As many actions will be undertaken through other initiatives, it is important that effective links are developed and maintained with such initiatives to ensure appropriate priorities are selected.

The implementation of this Strategy will also influence the progress and outcomes of other projects being conducted within the Basin. After consultation with relevant MDBC technical groups, this Strategy also incorporates relevant existing government policies and programs (for example, *National Management Strategy for Carp Control 2000–2005*).

Strategic management can only be undertaken after assessment of available options and the careful formulation of plans.

Through The Living Murray initiative, the Murray-Darling Basin Ministerial Council is looking at the best ways to restore the health of the River Murray system. The Council's strong desire is to manage the resources of the River Murray system to improve its environment and maintain the social and economic benefits of water use. The return of some water to the River Murray is thought to be necessary to create a healthy working river—one that assures us of continued prosperity, clean water and a flourishing environment.

Responding to declining native fish populations in the Murray-Darling Basin is not the responsibility of any one State or agency. The responsibility for rehabilitation belongs to all.



The Living Murray initiative includes:

- a comprehensive study of the costs and benefits to the environment and the community of returning various amounts of water to the environment. This work includes scientific analysis of the ecological benefits of recovering water as well as an assessment of the social and economic impacts;
- a $150 million program of structural and operational measures, including modifications to dams, weirs and locks, to make the best use of the water currently available to the environment; and
- a community engagement process aimed at ensuring that the full range of community values, issues and aspirations are considered in the decision-making process.

The Living Murray initiative is being developed in close association with the *Native Fish Strategy*, as activities to achieve a healthy working river will also contribute to the Strategy's objectives. For example, native fish will benefit from actions being considered under The Living Murray initiative such as increased environmental flows, the construction of fishways, restoration of habitat and carp control.

Implementation of the Strategy

The *Native Fish Strategy* is a work-in-progress, and will address the following actions through a costed investment plan.

The investment plan has been formulated to guide activities over the first decade of the 50-year rehabilitation program, across the whole Basin. It provides direction for investment in on-ground management activities and associated research. Achieving the Strategy's objectives requires the development of strong linkages with other aquatic initiatives and programs, and the initiation of a series of high-profile on-ground works to showcase the results of integrated rehabilitation efforts. While it will be the responsibility of all key stakeholders to contribute to the implementation of the investment plan, the jurisdictions will have the major role, and will provide a significant share of the resources.

The investment plan will be guided by the ICM Policy principles related to investment:

- the economic, environmental and social benefits of the investment must be greater than the costs;
- government investment will be used to stimulate private investment, and to prevent unacceptable levels of resource degradation;
- alternative investments will be considered and evaluated;
- joint-venture partnerships with the community will be the preferred government investment approach; and
- on-ground investment will be supported by strong institutional arrangements, knowledge, sound planning and adequate monitoring, evaluation and reporting systems.

Implementing the driving actions of this Strategy will require a targeted and sustained effort across governments, catchment management organisations and communities. It is imperative to define the actions and associated responsibilities required within each catchment. This will need to be done in collaboration with government agencies and catchment groups in those catchments.

The prime responsibility for managing rivers falls to State governments. Many of the in-stream interventions needed to improve conditions for fish in rivers will require funding from the States. This will also be the case for any interventions on State-owned land. However, the Commonwealth through its funding programs may supplement State funds for these actions. Where interventions are required on private land, such as stream banks, States may use a number of mechanisms to encourage changes to the way land managers use and manage their land and water resources. These mechanisms range from financial incentives through to regulation.

In the case of the Murray and lower Darling, the MDBC has specific responsibilities (e.g. management and operation of structures for water supply, etc.). In this sense, the Commission can provide direct resources (human and financial) to achieve resource management outcomes, as well as recommending policies to be adopted for the wise management of those rivers by all relevant jurisdictions.

It is recommended that a new inter-State management and science committee be established by the MDBC, to draw all partners and managers together to achieve the Strategy's investment plan.

A partner representative group has been formed from catchment organisations and special interest groups. Implementation of partner actions will occur through incorporation of fish management actions into local and regional plans, operation and maintenance of river rehabilitation works and assistance in monitoring, education, research and reporting.

Priorities for each year of activity will be determined in consultation with the jurisdictions, as represented through the inter-State management and science committee and the MDBC. The determination of priority actions for fish and fish habitat management will allow the jurisdictions to make a relative assessment of priorities according to their own trade-off processes, in the context of the Basin-wide framework provided by this Strategy. Reporting of progress towards targets will be the annual responsibility of the inter-State management and science committee.

Targets

The use of targets is a way to measure progress towards achieving the Strategy outcomes. Partners to the Murray-Darling Basin *Initiative* use targets to ensure their own accountability for implementing the Strategy and to give the community confidence that the outcomes of the Strategy will be achieved. Targets will guarantee that all partners can agree on how healthy the native fish populations should be, how to measure trends in native population status and knowing the full costs associated with achieving this. Targets ensure the Strategy remains on track in reaching its long-term objectives for 50 years and beyond.

Targets are not the outcomes sought by the Strategy; they are merely a way to bring accountability to achieving outcomes. Targets need to be audited to ensure actions are progressively achieving the environmental, economic and social outcomes of this Strategy. Targets will be reviewed throughout the life of the Strategy to assess their success and current relative priority. This review process will be conducted in the context of the relative risk of undertaking or not undertaking actions, and within a framework of adaptive management. The achievement and assessment of these targets must be underpinned by adequate monitoring and evaluation, knowledge and properly set objectives.

The targets for this Strategy will be formulated so they are consistent with the *Sustainable Rivers Audit* (SRA), the *Integrated Catchment Management Policy Statement*, and The Living Murray initiative. Targets for river health and fish populations will

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Electrofishing below the gulf regulator, Barmah Forest

be coordinated with monitoring, which will be undertaken for the SRA.

The wide-ranging scope and complexity of the *Native Fish Strategy* means that targets must be set on a range of scales, including whole-of-Basin, major catchments, within jurisdiction, river process zones or on a priority-setting basis. For some objectives, each jurisdiction will need to develop their own set of targets that are compatible and consistent with the Strategy.

In the absence of targets that underpin accountability arrangements, the best expert advice recommends the following as indications of the level of implementation needed by 2013:

- aquatic structural habitat values increased by 20 per cent;
- functional processes and river floodplain links re-established for 80 per cent of remaining wetland habitats through improved flow management;
- water quality that meets 90 per cent of all biological requirements;
- elements of the natural flow regime and connectivity important to sustain fish populations reinstated;
- 50 per cent of migratory pathways and 50 per cent of habitat for all native species currently affected by structural barriers reinstated;
- population declines stabilised in all threatened species and communities;
- no additions to threatened or declining fish conservation listings by Commonwealth or State government agencies, professional bodies or non-government organisations;
- the distribution and abundance of all exotic species reduced by 30 per cent;
- no introductions or outbreaks of damaging native fish diseases or parasites;
- native fish populations that are able to support a selective harvest of 10 per cent without negative impacts on them;
- threats to native fish populations by the translocation or stocking of native or alien species minimised by active management;
- 90 per cent of identified key partners actively engaged in the *Native Fish Strategy*; and
- 50 per cent of the general community aware and supportive of the *Native Fish Strategy*.

These are indications of what is required to meet the objectives of this Strategy, but they have not yet been assessed in terms of their possible economic and social impacts. Any final targets will need to take account of these impacts and the trade-offs required for them to be acceptable.

The overall goal of this Strategy is to rehabilitate native fish communities in the Murray-Darling Basin to 60 per cent of their estimated pre-European settlement levels after 50 years of implementation.

Achieving this goal will require:

1. the distribution of native fish across the Basin to expand toward their estimated pre-European settlement status; and
2. the abundance of established native fish populations to return towards their estimated pre-European settlement status.

The development of targets for accountability purposes in this Strategy will be the basis on which we can estimate and audit changes in distribution and abundance on a regular basis.

It is important to note that while some actions have more immediate impacts (5 to 10 years), others will require a long lead time (50 to 60 years) before their impacts will be reflected in the native fish population distribution and abundance.

Over the next 10 years, the Strategy will measure progress toward achieving the overall goal, by measuring indicators of changes in fish population, distribution and abundance. For example, by 2013 the trout cod population in the River Murray may have expanded by 50 kilometres downstream as well as 50 kilometres upstream into Lake Mulwala and both the Murray and Ovens Rivers. Three additional self-sustaining populations could be established through a concerted, scientifically designed stocking regime.

Roles and responsibilities

Implementation of the *Native Fish Strategy* requires a partnership between governments and the wider Basin community. Important roles in the implementation of the Strategy will be held by individual landholders, Indigenous communities, Landcare groups, catchment management organisations, waterway managers, urban and rural community groups, local, State and Australian Government agencies and the MDBC.

Governments are responsible for establishing policies and institutional arrangements, and for providing technical and financial support. State and local governments have direct responsibility for the management of land and water resources. Through the Basin-wide structure of the MDBC, the rehabilitation of fish populations is to be

sought on a whole river-system basis. The Commonwealth and State governments will implement agreed action through their specific programs, and report against the achievement of agreed targets.

Community and individual roles

Individuals and communities, including Indigenous communities, are the foundation of integrated catchment management. They have an important role in native fish management. Ways in which individuals and communities can assist in the rehabilitation of native fish populations in the river system include:

- helping to develop and implement local action plans to solve specific local river fish habitat problems;
- supporting the implementation of national and State initiatives for their area;
- becoming aware of key threatening processes relating to fish populations, and reducing them in accordance with catchment plans by such actions as: (1) ensuring land management practices conform with best possible techniques; (2) revegetating eroded stream banks and floodplains to stabilise soil and nutrient movement and to provide a filter for overland flows; and (3) restoring natural wetland, floodplain and river connectivity where practical;
- assuming ownership and involvement in the management of native fish populations; and
- playing a major role in increasing education and awareness.

The recreational and commercial fishing industries, as major beneficiaries, must play a major role in rehabilitating fish populations and can help by participating in developing management plans and regulations as well as removing alien fish species.

Non-government organisation roles

Catchment management organisations (established under State statute), river management committees, environment groups, research groups, commercial and recreational fishing organisations, fish stocking groups, farming groups, Landcare groups, conservation groups and other non-government organisations all undertake actions that have the potential to support the implementation of the Strategy.

Their on-ground activities in land and water management, in line with catchment management strategies, will help to protect the rivers and fish habitat. Their involvement should be encouraged through a variety of links at various levels of government and through various agencies. Cooperative Research Centres, universities and government research centres all play major roles in undertaking research and informing river management activities.

Local government roles

Local governments control most land use planning. For example, recreational management and usage zones, links between water quality and land management and effluent disposal are all important river management actions that can impact on native fish populations and their environments. The participation and commitment of local governments (including water authorities and boards) and their agencies, occurs through local action and regional management plans that can also incorporate local biodiversity strategies. Local governments can also play a key role in raising community awareness and participating in relevant educational activities.

State government roles

The State governments will contribute to rehabilitating fish populations in the Murray-Darling Basin by:

- managing recreational, commercial and Indigenous fishing and fish habitats in an ecologically sustainable manner;
- establishing and maintaining existing controls over fishing, aquaculture and many catchment practices;
- developing and implementing relevant legislation, policies, guidelines and codes of practice;
- providing resources and funding for relevant projects;
- participating in and providing resources and technical advice to catchment management organisations that are developing strategies;
- providing extension services to the community on ways of improving waterway management activities, to enhance fish populations;
- participating in the development of national and regional fish management;
- protecting species or communities listed under State threatened species legislation;
- taking the requirements of native fish into account as part of water resource management and exploitation;
- undertaking research, monitoring and stock assessment;

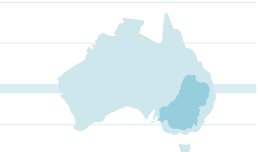
The implementation of this Strategy requires a coordinated partnership approach between governments at all levels and the Basin communities.

- implementing weir policies, wetland policies, floodplain and catchment management plans, and water reform strategies;
- ensuring environment protection and pollution control;
- controlling aquaculture development; and
- undertaking agricultural, forestry and other natural resource management.

MDBC roles

The MDBC provides direction, policy and strategic advice, and plays a coordinating role in the holistic management of rivers and their fish habitats. It plays a crucial role in ensuring consistency across State boundaries in the implementation of this Strategy. The MDBC plays a role in information exchange and public awareness activities. Actions by the Commission that aim to rehabilitate fish populations in the Basin include:

- funding knowledge generation projects in the Basin;
- developing policies and strategies and providing policy advice about significant natural resource management issues in riverine environments;
- on-ground actions, including general water management/operational activities, fishway construction, and support and advice to partner governments on fish-related projects; and
- ensuring effective cooperation between departments and adequate involvement and ownership of issues.



The MDBC also has a direct role in river management through its responsibility for the operation and management of the River Murray and Lower Darling. The MDBC is therefore responsible for the operation of structures, the allocation of environment flows and arrangements for fish passages on these rivers.

Australian Government roles

The Australian Government contributes to the rehabilitation of fish populations in the Murray-Darling Basin by:

- providing national policy leadership through inter-governmental forums, such as the Council of Australian Governments (COAG), aimed at improved planning and management of land and water;
- providing funding support to joint venture programs such as the Natural Heritage Trust;
- providing impetus for whole-catchment approaches to water and land resource management, through projects and related structural measures implemented jointly with the community, local and State governments and with assistance through the Natural Heritage Trust and the *National Action Plan for Salinity and Water Quality*;
- facilitating and encouraging research and development activities which will enhance sustainable use, productivity and conservation of Australia's land, water and related vegetation resources, particularly through organisations such as the CSIRO, Land & Water Australia and Cooperative Research Centres;
- protection of species or communities listed under Commonwealth legislation;
- the *National Strategy for the Conservation of Australia's Biodiversity* and the *Environment Protection and Biodiversity Conservation Act*;
- the promotion of ecologically sustainable use and the *National Strategy for Ecologically Sustainable Development*;
- promotion of the *National Water Quality Management Strategy*;
- applying national principles for the provision of water for ecosystems; and
- promoting COAG water reforms.

Driving actions have been developed in accordance with the principles of the Integrated Catchment Management Policy. They give momentum to improved management of native fish in the Basin, leaving specific management actions to the responsible and knowledgeable bodies, within a proposed monitoring, reporting and auditing framework. The following six driving actions seek to achieve the 13 objectives of this Strategy through management, research and investigation, and community engagement interventions:

- rehabilitating fish habitat – helping to achieve objectives 1–8;
- protecting fish habitat – helping to achieve objectives 1–8;
- managing riverine structures – helping to achieve objectives 4–8;
- controlling alien fish species – helping to achieve objectives 6–9;
- protecting threatened native fish species – helping to achieve objectives 6 and 10; and
- managing fish translocation and stocking – helping to achieve objectives 9–12.

All driving actions meet objective 13, ensuring that there is community and partner ownership and support for native fish management.

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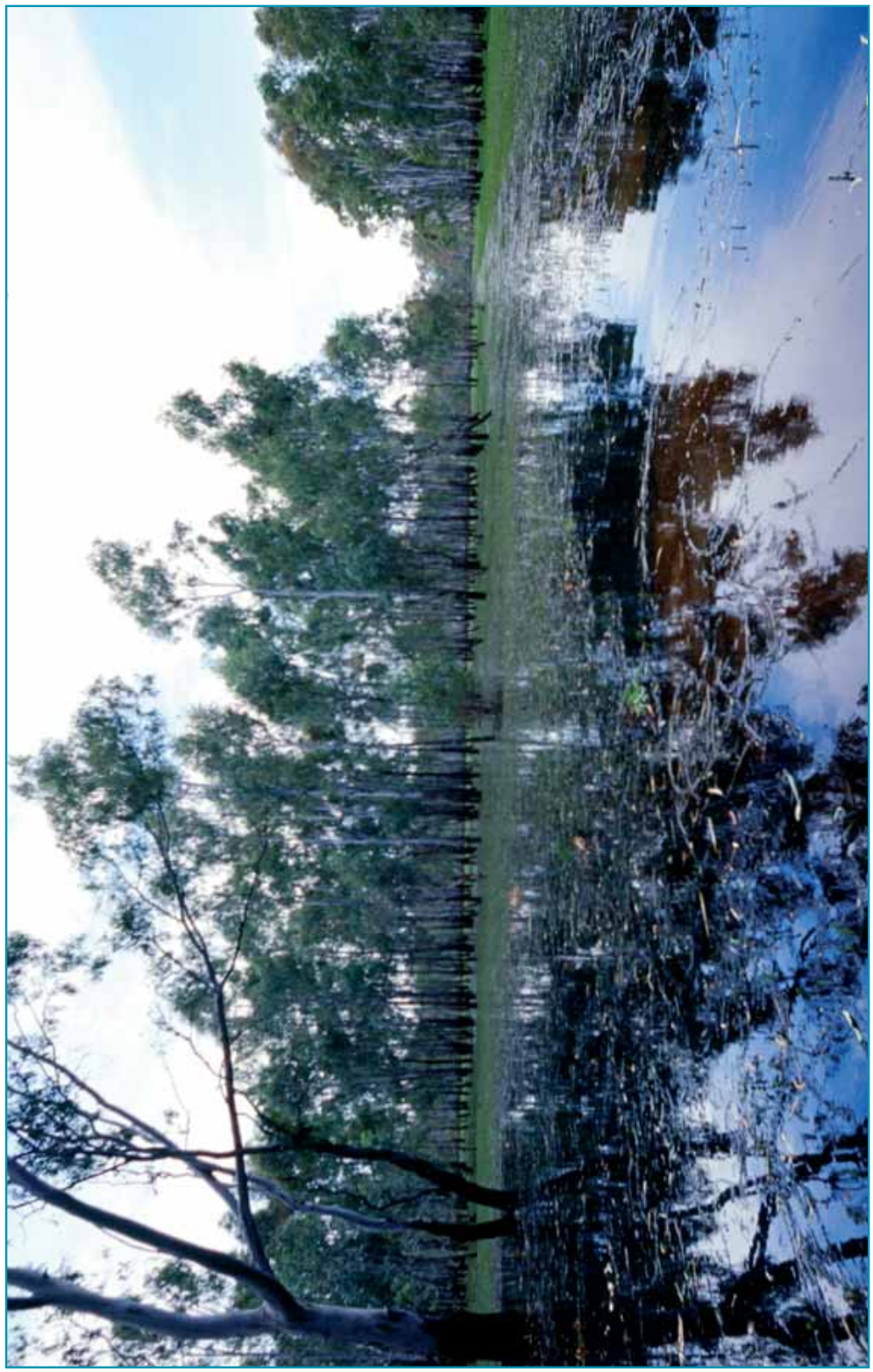
Flat-headed gudgeon



Barmah-Millewa Forest, Wetlands

1. Rehabilitating fish habitat

Habitat degradation has been identified as a major cause of loss of diversity and decline in populations of freshwater fish in Australia. There is now an urgent need for a long-term comprehensive river rehabilitation effort to be undertaken to repair this degradation. Specifically, rehabilitation must be undertaken to provide acceptable habitats and functioning ecosystem processes for fish populations.

Physical habitat for fish includes flow conditions, in-stream structures (snags, undercut banks, root masses), substratum (silt, sand, pebble, boulders), aquatic vegetation, wetlands and the floodplain during periods of flooding. A high diversity of habitats provides the required environments for a range of fish species to complete their different lifecycle stages.

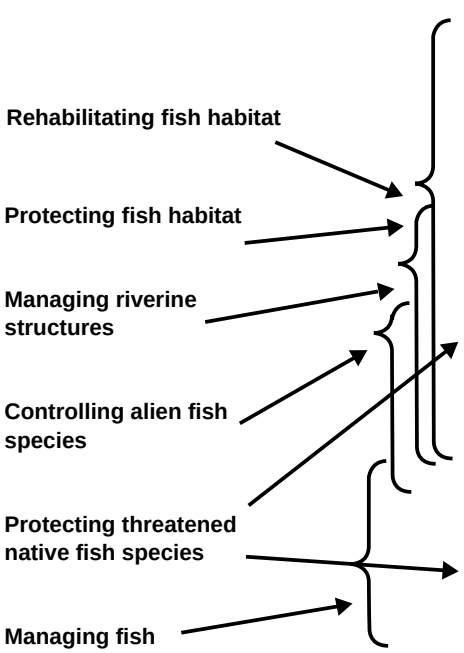
Water quality is also important for the sustainability of native fish populations. Changes in temperatures, increased salinities, pesticides, heavy metals, eutrophication and turbidity, all have major implications for the health of the native fish populations in the Basin.

Poor river water quality can directly interrupt the lifecycle of native fish species (e.g. changed temperature inhibiting spawning) or have indirect effects (e.g. increased salinity decreases fish egg viability).

Regulated flow procedures now cause segments of the Basin to experience:

- severe reductions in available water due to damming, storage or extraction;
- sustained unseasonal flows in rivers, which in some cases have reversed the normal seasonal pattern;
- periods of unnaturally constant flow;
- reduction in occurrence or loss of small to medium sized floods (this is also evident in unregulated rivers due to off-allocation water extractions);
- reduction in occurrence of flood events and substantial reduction in size, rate of rise and duration of remaining flood events;
- reduction in occurrence or loss of low flows due to unseasonal irrigation releases;
- the conversion of open-flowing riverine environments to a sequence of pools because of the construction of weirs; and
- parts of wetlands and floodplains continually saturated (waterlogging) rather than experiencing a wetting and drying period.

Six driving actions seek to achieve this Strategy's thirteen objectives through management, research and investigation, and community engagement interventions.



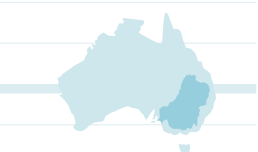
Objectives

1. Repair and protect key components of aquatic and riparian habitats
2. Rehabilitate the natural functioning of wetlands and floodplain habitats
3. Improve key aspects of water quality that affect native fish
4. Modify flow regulation practices
5. Provide adequate passage for native fish
6. Devise and implement recovery plans for threatened native fish species
7. Create and implement management plans for other native fish species and communities
8. Control and manage alien fish species
9. Protect native fish from threats of disease and parasites
10. Manage fisheries in a sustainable manner
11. Protect native fish from the adverse effects of translocation and stocking
12. Ensure native fish populations benefit from aquaculture
13. Ensure community and partner ownership and support for native fish management

These conditions affect water quality and change the flow-related triggers for fish movement, recolonisation and spawning. Flows necessary for fish breeding, recruitment and occupancy have been reduced, and habitat diversity has been lost. It has been shown that native fish species diversity and abundance has decreased along the River Murray as a result of flow regulation.

An environmental flow is any managed change in a river flow pattern intended to maintain or improve river health. Environmental flows help ensure moderate floods across floodplains to stimulate native fish breeding, an increase in the diversity of fish habitat and maintenance of water quality.

Rehabilitating habitat in the Basin will be a critical step in the return to sustainability of our native fish populations. Further research and investigation are needed, but this should not delay the commencement of rehabilitation activities. Habitat rehabilitation includes actions such as resnagging, the rehabilitation or protection of riparian margins, rehabilitation of floodplain wetlands, restoration of connectivity between rivers, floodplains and wetlands and the reduction of catchment-wide erosion and associated sedimentation. The provision of environmental flows that mimic natural flows is also important for fish habitat rehabilitation.



In providing environmental flows it is important to look at ways in which benefits can be maximised by ensuring that any environmental flow:

- is timed to occur in the right season to trigger breeding of native fish species;
- occurs often enough and lasts long enough to allow breeding to succeed;
- is large enough to link the river to its floodplains, wetlands, billabongs, anabranches and/or the sea; and
- provides varying water levels to provide wetland and river banks with wet-and-dry cycles which reflect natural conditions.

Actions

Management

1.1 Establish a system of distinct Riverine Management Zones with accompanying management plans

Although rivers need to be managed as an overall unit, they are often too large to effectively do so at a practical level. Each river should have a management plan that indicates why and how the river is going to be managed. However, the river needs to be split into smaller management units to achieve river management outcomes practically. This is most easily achieved by establishing a system of distinct Riverine Management Zones (RMZs). The plan for each RMZ becomes a subset of the overall river plan. The RMZ plans should detail the actions required to restore native fish population, and include and revise where necessary, existing operational procedures. Logically (at least initially), these may largely be based on existing operational zones (e.g. Dartmouth Dam to Lake Hume). There are ecological and geomorphic processes operating both within and across these management zones that also need to be incorporated into management planning. These processes influence the distribution, abundance and structure of fish populations. Often these processes are too large to manage in their entirety. They need to be determined and then incorporated into the RMZ plans. The process of establishing and prioritising RMZs needs to be further developed as one of the first steps in implementing this Strategy.

The process of establishing RMZs and developing plans will identify specific issues which need to be addressed in that zone, priority actions for investment and actions that may apply across more than one RMZ. Identification of these actions will also determine the scope of the action and the responsible authority (e.g. water agency, MDBC, Catchment Management Authority/Board). This may necessitate links/partnerships between different agencies to ensure an integrated approach.

1.2 Prioritise RMZs for action according to ecological function and management capability, consistent with other Basin initiatives

Priorities for action need to be set both between and within each RMZ. This can only be achieved after a determination of the priority of threats in each RMZ. The importance of these threats at both the RMZ and whole-of-river/neighbouring RMZ scale will be necessary. Such priorities will then be the keys for targeting investment.

Criteria for prioritising RMZs for action need to consider: the importance of the river reach, the degree of degradation, downstream effects and benefits, expected response times, connections to other waterways, sequence and timing of restoration actions, and cost benefit analysis. The same criteria need to be applied when prioritising actions within RMZs, although the

weightings of each criterion may alter. Key threats and key ecological issues need to be considered and an assessment made as to whether such threats may be being managed or affected by some larger scale process.

Management plans that focus on rehabilitation of native fish populations will be developed for priority RMZs. These plans will form part of an overall river plan and will prescribe integrated approaches to rehabilitating fish habitat, with the MDBC acting as an overall coordinating body and broker of information. Two important actions from RMZ management planning may be the establishment of Habitat Management Areas and demonstration reaches.

1.3 Establish demonstration reaches

Demonstration reaches will integrate land and water programs within comprehensive rehabilitation exercises on substantial (important and visible) river reaches. This could include provision of environmental flows and greater resnagging along these reaches to provide a growing habitat from which native fish can recolonise their surrounding environment. It will also include rehabilitation or protection of riparian margins and the rehabilitation of floodplain wetlands.

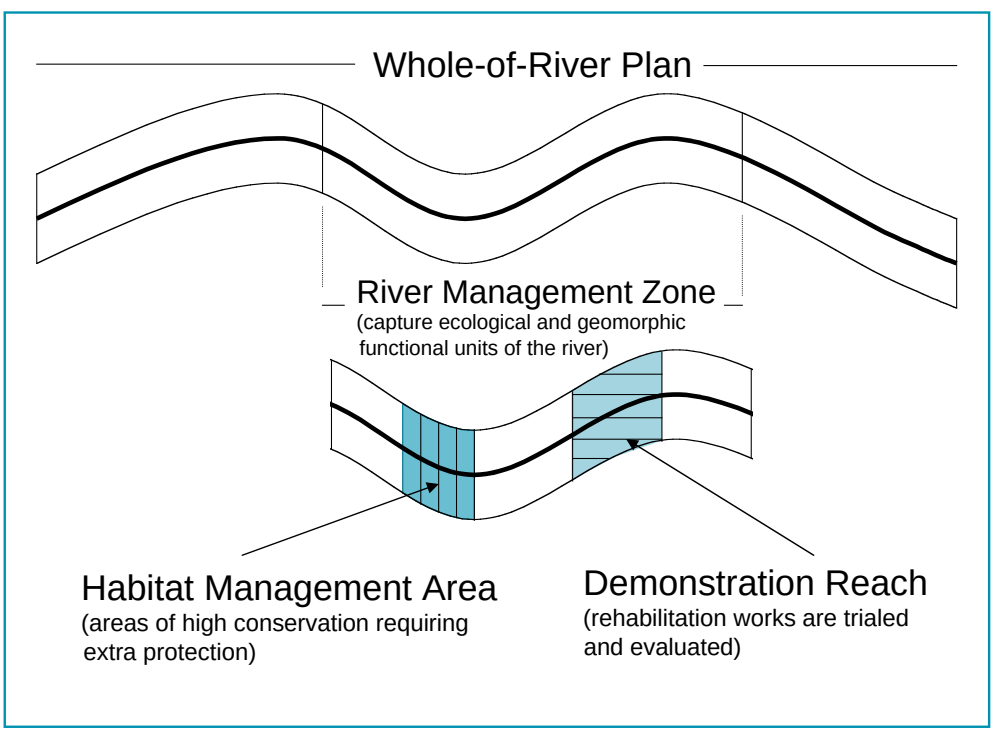
Demonstration reach: a river reach established for the purpose of demonstrating to the community the cumulative benefits of applying a number of interventions (e.g. provision of fish passage, resnagging, alien species management) for rehabilitation of native fish habitat and populations.
Refer to **Figure 3**.

Research and investigation

1.4 Provide information on the location and status of key native fish habitats in the Basin's rivers, streams, wetlands and floodplain channel

The information required for the establishment of demonstration reaches is exhaustive and is fundamental to the success of any rehabilitation actions. Biological and ecological information is essential, and effort should be made to acquire the data from the chosen site, as opposed to reliance on the literature, which may relate strongly to the site from which those data were collected. Similarly, data should be as current as possible given the expansion of threatening processes. The value of historical data, whether scientific, Indigenous or anecdotal, should not be forgotten as a valuable source of information relating to dynamics of fish populations, 'natural' river form and flow regimes and human impacts.

Figure 3: Schematic diagram of the River Management Zone concept

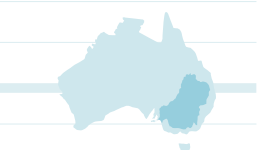


1.5 Develop and review best management practices and options for rehabilitating, managing and protecting priority fish habitats along significant reaches of rivers within each State

This will require knowledge of the habitat requirements of native fish, including knowledge of environmental flows.

1.6 Identify effective measurement techniques for determining the responses of native fish populations to comprehensive rehabilitation of substantial reaches of the rivers (demonstration reaches)

The measurement techniques and indicators used will be determined by the restoration action which is undertaken and the objective which has been set. Objectives need to be set which are suitable, measurable, attainable, reliable and targeted, and which can provide feedback under an adaptive management framework. Measurement of results can only occur through a scientific design and necessitates the allocation of appropriate resources for monitoring. Examples of measurement techniques may include fish collections to determine changes in distribution, abundance or recruitment.



Community engagement

1.7 Support involvement of catchment and community groups in local rehabilitation programs

The management actions described above are not 'quick-fix' options and require considerable capital outlay and government leadership. They are reliant to a large extent on strong catchment-based and community-supported programs at the local level.

It will be important to use visible demonstration reaches to engage community confidence and support, ownership and involvement as they witness the benefits of rehabilitation works.

1.8 Involve the community in adaptive management of native fish habitats

Involving the community in management and monitoring of native fish habitats, and in the setting of environmental flows, is important. Monitoring of progress in habitat rehabilitation will provide feedback for regional adaptive management of river reaches.

Costs and benefits

Considerable investments in fish habitat rehabilitation have been established through various State/Territory and Commonwealth programs. Increases in funding need to be carefully directed if there are to be immediate and direct benefits for native fish populations. Rehabilitating environmental flows and fish habitats in demonstration reaches are the best strategies for providing long-term return on investment. They are critical steps for returning sustainability to our native fish populations. Scientific advice suggests that the combined benefits of habitat rehabilitation and environmental flow allocations could see native fish communities returning to levels approaching 60 per cent of what they were estimated to be at pre-European settlement. However, priorities for investments in rehabilitating very degraded areas need to be balanced against the need to protect healthy riverine habitats.

Targeted use of environmental flows can yield short-term results that also support other actions, including those designed to manage carp and protect threatened native fish species or communities.

Accountability indicator

- Major rehabilitation demonstration reaches implemented in relevant Riverine Management Zones

There is an urgent need for long-term comprehensive river rehabilitation to provide acceptable habitats for native fish populations.

The establishment of distinctive Riverine Management Zones with accompanying management plans will practically assist this Strategy to achieve its objectives.

Demonstration reaches need to be established to showcase to the community the comprehensive river rehabilitation actions along substantial and visible river reaches.

2. Protecting fish habitat

Some areas in the Murray-Darling Basin are still in relatively good condition and support healthy aquatic ecosystems, including viable fish populations. These specific areas which are in good condition should be managed carefully so that the requirements of native fish species, including all of their lifecycle needs, are met. It is acknowledged throughout the world that it is significantly easier and more cost effective to carefully manage healthy habitats rather than rehabilitate them when their condition has deteriorated.

Proposed 'Habitat Management Areas' are areas that would require additional management attention or recognition to ensure that their condition is maintained or enhanced. A system of Habitat Management Areas that encompasses

a 'multiple-use management' framework would be particularly relevant to the Basin. 'Multiple-use management' in Habitat Management Areas would not normally exclude popular recreational pursuits such as fishing and camping, which are important to many local communities along the Basin's inland waterways. State fisheries and catchment management legislation already contain provisions for closed seasons, closed areas and protection of critical habitats. A system of Habitat Management Areas may simply formalise and coordinate the protective measures already in place, and identify areas where additional measures will enhance and secure the viability of native fish and freshwater ecosystems.

The use of Habitat Management Areas for recreational or commercial pursuits should be appropriate to the individual site and follow a hierarchical structure such as that adopted by the International Union for the Conservation of Nature (IUCN). IUCN sites are categorised and range from areas of almost complete public exclusion to those that afford a 'sustainable flow of natural products and services to meet community needs' (IUCN 1994). Though strongly dependent on size, resource use may also vary within a management area, so that in some areas certain activities may be excluded while in others there may be multiple-use of resources.

A Habitat Management Area might be a habitat which supports a unique fish community, or a habitat in pristine condition which supports a healthy community. It might be a location where existing management practices have already contributed to the enhanced values of the area. There are many examples of similar management systems already within the Basin. Many water supply catchments are important habitats and operate under different management regimes to ensure that the catchments and the water they produce remain in good condition. The Barmah Forest and Gunbower Forest are special places and are listed as wetlands of international importance under the 'Convention on Wetlands of International Importance' (Ramsar Convention). There are also a number of rivers in Victoria which have been recognised under the Heritage Rivers classification.

A network of Habitat Management Areas throughout the Basin will certainly help protect the habitat which supports native fish listed as threatened or endangered. However, substantial declines have also occurred in many native fish populations not currently listed as threatened and the designation of Habitat Management Areas will help protect the habitat of all the Basin's native fish.

Valuable remnant fish habitats and populations will be particularly targeted by the Habitat Management Areas. Such a system will yield

Pilby Creek wetland
– an example of community group involvement in rehabilitation activities

Pilby Creek wetland, near Lock 6 on the River Murray near Renmark in South Australia, is an old billabong of about 17 hectares. Carp moved into the Pilby Creek from nearby rivers during floods and were thought to decrease the aquatic vegetation and water quality of the wetland. This contributed to a decline in native bird and fish species. There was concern in the local community about loss of aesthetic values, poor water quality and reduced opportunities for duck shooting.

In 1989, the Murray-Darling Association and the Renmark Berri Branch of the South Australian Field and Game Association initiated a project of restoration. The project aimed to improve the ecological quality of the wetland through restoring the natural wetting and drying cycle, getting rid of carp and preventing their return, and restoring the aquatic vegetation.

It became a cooperative effort with the involvement of the Murray-Darling Association, SA Field and Game Association, the Riverland Fishermen's Association, the then Department of Environment, Heritage and Aboriginal Affairs, and SA Water.

Since 1993, a team involving several stakeholder groups has drained and refilled the wetland several times to remove carp. They also installed screens to prevent the recolonisation of carp. The reduction of carp over the years has resulted in a vast improvement in water quality and some significant changes to the flora and fauna of the wetland, including the return of some bird, insect and plant species not seen since the invasion of carp.

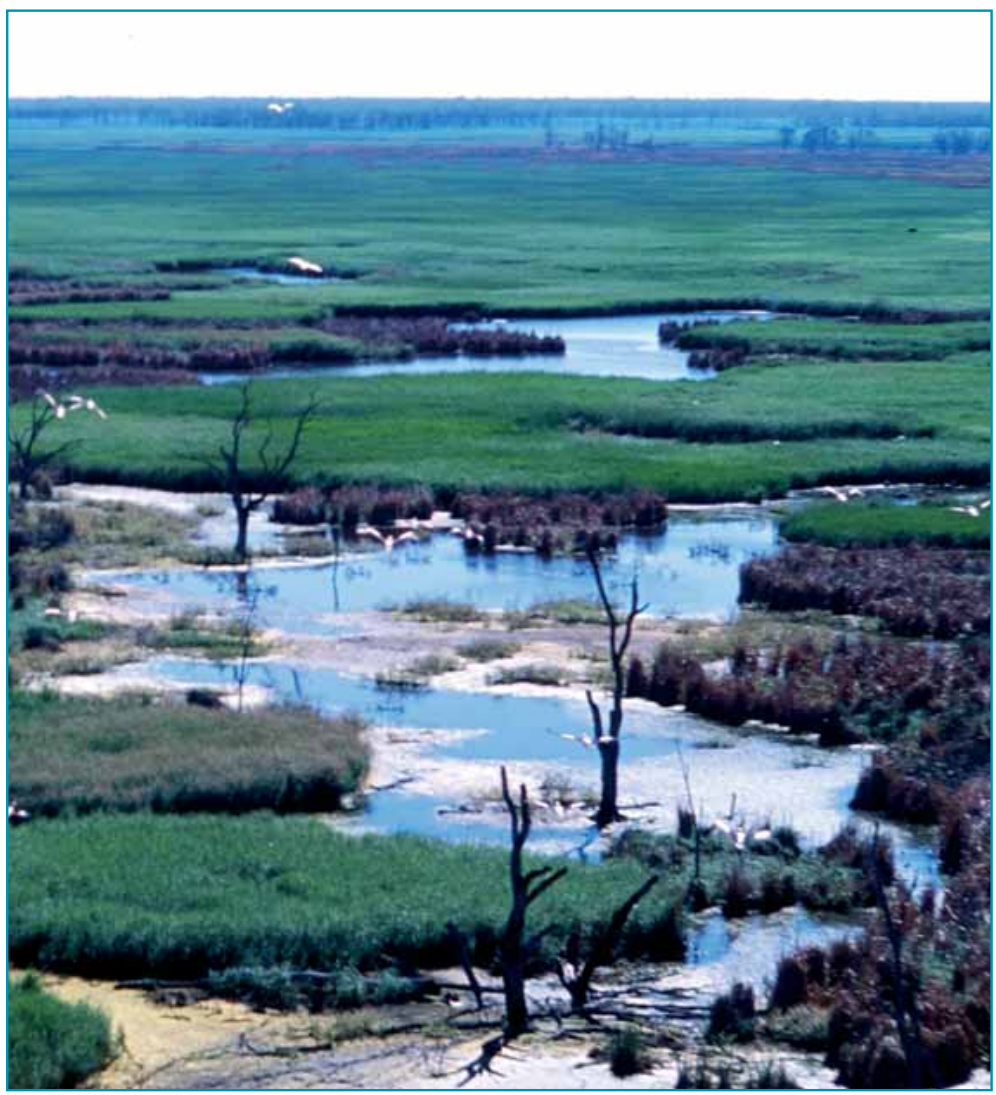
With the management of carp, the focus in Pilby Creek is now on establishing more natural filling and drying cycles to encourage and enhance the breeding of native fish. This work is being coordinated by a community-based group under the auspices of SA Parks and Wildlife.

Multiple-use management in Habitat Management Areas would not normally exclude popular recreational pursuits such as fishing and camping, which are important to many local communities along the Basin's inland waterways.

significant benefits for biodiversity conservation, including some native fish communities, as well as contributing to the overall health of the Basin's rivers and floodplains.

Developing a system of Habitat Management Areas will mean that threatening processes such as the impacts of reduced water quality can be more closely managed in these areas. The rehabilitation of viable populations of threatened native fish species is also more likely under such a system. The establishment of a system of Habitat Management Areas in the Murray-Darling Basin would add to Australia's current commitment to biodiversity conservation, which includes a network of terrestrial and marine protected areas.

A system of Habitat Management Areas for fish cannot succeed without broad community support and assistance. The local community adjacent to a Habitat Management Area can play a vital role in identifying the area and establishing its values, designing suitable management objectives, assisting with on-ground works, and ensuring that messages about the importance of the area are understood and embraced by the wider community. The *Native Fish Strategy* makes a commitment to active partnership between local communities and management agencies in the establishment and ongoing operation of Habitat Management Areas.



Macquarie Marshes – central west New South Wales

Comparing demonstration reaches and Habitat Management Areas

A core function of a demonstration reach is to create public awareness and ownership and to promote knowledge transfer to convey the benefits of rehabilitating native fish populations. Demonstration reaches are temporary, but lasting at least 10 years. In contrast, a Habitat Management Area is a more permanent area, protected by legislative power with a focus on conserving habitat and fish populations over the long-term through integrated management plans. In some instances, where a new 'type' of habitat is proposed for conservation, the demonstration area may become eligible for declaration as a Habitat Management Area after the given period of rehabilitation and if the community and legislative framework are supportive.

Actions

Management

2.1 Develop a framework of principles and guidelines for the establishment of Habitat Management Areas throughout the Basin

Habitat Management Areas are areas of high conservation value requiring extra care. A framework is needed to establish Habitat Management Areas which will guide not only the process of selection of sites, but also the design of each specific management area. Implicit in this process will be negotiation with the local community as Habitat Management Areas can only be successful through community involvement and support.

2.2 Examine the due process for implementing the Habitat Management Area concept

Once suitable Habitat Management Areas have been selected and the framework for implementation determined, the due process for establishment of each area will need to be undertaken. The process will need to be relevant to the jurisdiction in which it lies for the purposes of establishment, conservation, management and enforcement.

Most jurisdictions have existing management strategies that are similar to the proposed Habitat Management Areas and these processes could assist in implementing the management areas. Heritage Rivers in Victoria, the Murrumbidgee River Corridor in the Australian Capital Territory and Fish Habitat Areas in Queensland are examples of similar management strategies that already exist. Processes will need to be negotiated where sites encompass more than one jurisdictional boundary, such as many areas of the River Murray that flow along the NSW–Victorian border.

2.3 Establish a series of scientific reference sites that provide a representative system of recognised habitat types

A series of scientific reference sites is needed to provide baseline data and information about the species to be restored and the associated riverine ecosystem, as well as provide for an integrated monitoring system. These areas may coincide with other Habitat Management Areas or demonstration reaches in some circumstances. Criteria for selecting these areas should include:

- biological integrity;
- completeness of ecological processes;
- areas of substantial previous research/knowledge; and
- ability to provide baseline data.

2.4 Implement environmental flow strategies where needed

River flows through Habitat Management Areas and reference sites need to mimic natural flows as closely as possible. For example, during dry periods it may be important to protect low flows downstream of impoundments to conserve fish refuges. Environmental flow strategies will need to be coordinated through existing jurisdictional processes, such as *Water Resource Plans* (Queensland), *Water Sharing Plans* (New South Wales), *South Australian River Murray Environmental Flows Strategy* (South Australia), *Environmental Flow Guidelines* (Australian Capital Territory) and *Streamflow Management Plans* (Victoria).

Research and investigation

2.5 Investigate the benefits of a system of Habitat Management Areas to protect and enhance fish habitats and populations

Research is needed to identify those habitats that represent a healthy environment for native fish species. Such habitats will need to be conserved through a system of Habitat Management Areas or through the implementation of local catchment management plans. Once these Habitat Management Areas are instituted, a scientifically based and adequately resourced monitoring regime should be undertaken so the benefits can be meaningfully demonstrated. Investigation is also required to establish the most effective mechanism that encompasses the

Habitat Management Areas can only be successful through community involvement and support.

‘wise-use’ or ‘multiple-use’ philosophy for instituting a system of Habitat Management Areas.

Community engagement

2.6 Consult relevant communities about establishing Habitat Management Areas and scientific reference sites

The establishment of Habitat Management Areas and reference sites throughout the Basin’s rivers will need to be negotiated through community involvement and support. The maintenance of such areas in a sustainable condition will also depend on the plans and actions of local communities, including Indigenous communities, catchment organisations and landholders.

Costs and benefits

In conjunction with enhanced environmental flows, habitat rehabilitation and control of alien fish species, the establishment of a system of Habitat Management Areas is an important strategic intervention for conserving threatened species and maintaining populations of non-threatened native fish. The establishment of Habitat Management Areas and reference sites may require buy-back options for important conservation areas.

In the short-term, new Habitat Management Areas may be warranted in an effort to secure important habitat for threatened species or communities, or remaining important populations. In the medium and longer terms, Habitat Management Areas provide:

- havens or refuges for threatened species or communities;
- protection for important habitats or populations; and
- fish stocks for recolonising rehabilitated habitat areas.

Burrendong Dam on the Macquarie River, central west New South Wales

Accountability indicator

- A system of representative Habitat Management Areas for fish implemented Basin-wide.

3. Managing riverine structures

Native fish species move along rivers for breeding, recruitment, attaining critical habitat, protection from threats, recolonisation and/or the establishment of new territories. Artificial in-stream barriers such as dams, weirs, flood barriers, stream gauging weirs, causeways, culverts and road crossings can affect fish movements. Other barriers to natural fish movement include poor water quality and temperature, siltation, habitat loss, reduced flow and alienation from other waterways, floodplains or wetlands by levee banks, flow regulators etc.

An expert group of ecologists and engineers assist the MDBC to plan at a broad strategic level as well as at specific sites. This group helps to ensure that the most effective fishway designs are used at particular sites under a Basin-wide fish passage program for priority structures. In the case of some obsolete weirs, removal is the most effective form of restoring fish passage, especially where the diminished economic returns are clearly outweighed by the environmental advantages of removing the structure.

Water releases from dams and other structures can also affect fish populations. Temperature changes can cause 'thermal pollution', where water temperatures do not meet the critical temperatures required for sustainable growth and maintenance of native fish populations. For example, water tends to stratify in storages, with warm water occurring in the surface layers and very cold water occurring in the bottom layers. Low-level outlets from storages release this very cold water into the rivers below, with large volumes released during summer when natural water temperatures are high. Such sudden temperature changes can cause large-scale disruption to fish migration and can interrupt spawning and kill eggs, larvae and possibly juvenile fish.

During autumn, the cessation of seasonal irrigation flows coincides with the onset of cold, frosty weather. If releases are small or absent, violent daily swings in water temperature can occur in the shallower water. This has caused widespread fish-kills below dams at moderate altitudes. Another impact of thermal pollution is to provide alien fish species with ideal habitats for hundreds of kilometres below major storages. In the southern parts of the Basin (south of the Lachlan River), in particular, thermal pollution is a far greater problem than in the northern parts and needs to be considered a priority.

The MDBC is investigating the thermal effects associated with the Hume Dam. In considering the effects, the compounding problem of multiple impacts on the River Murray downstream of Hume Dam will need to be considered. These include:

- altered flow seasonality from high flows in winter and early spring, to having high flows in late spring, summer, and early autumn;
- reduction in flood frequency and duration;
- altered riparian vegetation;
- alienated floodplain and wetlands and significantly altered floodplain ecosystem with agriculture replacing the floodplain red gum forest;
- loss of shallow backwaters below large impoundments;
- the significant de-snagging action happening up until about 20 years ago; and
- the thermal effects of the Hume Dam.

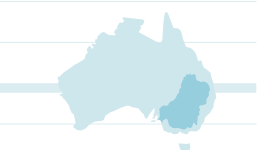
Another issue related to riverine structures is that about 80 per cent of the flow in the Basin's rivers is diverted. Native fish are unable to maintain their position in the riverine systems as there are no mechanisms associated with these diversions to prevent fish from leaving the rivers. An estimated two-thirds of the native fish are lost from the Basin's rivers onto farmland and farm dams.

Farm dams

The most practical place for a farm dam is often on a waterway. However, these dams have a greater ecological impact than those situated off waterways. It can be very difficult to ensure that stream flows are maintained, particularly during summer, and this can significantly affect fish migrations and spawning. High water temperatures and lowered oxygen levels that occur during periods of low flow can kill many native fish. Low stream flows can also have serious effects on macroinvertebrate populations. Other environmental concerns include:

Very cold water released from the bottom layers of deep dams during summer can prevent spawning, slow growth and even kill fish.

Riverine structures such as dams and weirs form barriers to natural fish movements along the river and affect fish habitats by altering flow and temperature.



- the role of dams in acting as barriers to fish migrations and to the localised movement of fish;
- increases in silt entering the waterway from the construction of dams; and
- flushes that freshen streams, which can affect deeper pools that provide a sanctuary for fish and other aquatic life during dry periods.

Developers need to be discouraged from building dams on waterways as these have high environmental values. Dams should only be constructed on a waterway if there are no suitable off-waterway sites. They must be built to ensure that downstream users are not adversely affected and that the ecological needs of the waterway are maintained, including:

- the aquatic, riparian, floodplain and wetland ecosystems;
- water quality;
- the flow of water within the waterway; and
- the condition of the land that forms the waterway or its surrounds.

Licences are required to construct, alter, operate, remove or abandon dam works on a waterway and to construct a dam off a waterway if the dam is likely to be hazardous to life, property or to the environment.

(Source: *DRAFT Victorian Farm Dams Review Committee Report*, December 2000)

Actions

Management

3.1 Implement the Murray-Darling Basin fish passage program

A high priority and immediate action is to implement the Murray-Darling Basin fish passage program to:

- agree on shared criteria for prioritising fishways;
- complete the database of existing fish barriers;
- design whole-catchment fish migration strategies;
- establish Basin-wide priorities for fish passage works;
- pursue technological advances in fish passage; and
- commit to monitoring the use of fishways by both native and alien species.

Such a program aims to rehabilitate all ineffective fishways (e.g. at Boggabilla in NSW, Loddon in Victoria and Lake Mulwala in NSW) and construct and monitor new fishways in priority areas. It also reviews, and when necessary, revises operating procedures on Basin structures to optimise fish passage—for example, reinstating procedures for increasing periods of open river. In some cases, barriers to fish passage will be removed where they are no longer useful.

3.2 Provide fish passage on the River Murray from Lake Hume to the sea

As a priority over the next five years (2003–08), provision of fish passage from Lake Hume to the sea is being implemented. This includes providing appropriate fishways at the barrages near the mouth of the Murray, and assessing the success of structural changes. Other MDBC structures connected to the River Murray, such as Mildura Weir and Lake Victoria, will also receive fish ladders so as to be in harmony with the River Murray fish passage program.

3.3 Implement fish passage on 18 priority barriers (not associated with the River Murray)

The MDBC has identified 18 barriers of priority importance for fish passage (see **Table 3**), and will work to coordinate a Basin-wide passage program with its State partners. An expert group of ecologists and engineers has used a number of criteria to prioritise remedial works for the thousands of instream barriers to fish migration present within the Basin. Criteria include the quality and extent of habitat available, the fish species present and their requirements, and the economic and social costs of any works.

3.4 Develop built-in thermal mitigation measures for all future water infrastructure or management decisions in relation to rivers currently unaffected by thermal pollution

The past problems of thermal pollution must be avoided in currently unaffected rivers. Outlet structures and procedures should ensure that EPA water quality requirements and the biological requirements for all native species can be met by all releases.

3.5 Pursue improved operational approaches to dam management where thermal pollution is already a problem

Approaches allowing gains to be achieved without unduly compromising irrigation supplies, flood control or water quality standards

are a priority. This may include modification to rates of change of releases, releases from different levels in the water column or altered timing of releases.

3.6 Design and construct structures suitable for mitigating thermal pollution on all storages where they are required

One of several structural options is the installation of variable level outlets which allow water to be released from any level from the water storage. The level with the appropriate temperature for local native fish communities can then be chosen.

3.7 Review of all jurisdictional legislation and policies dealing with thermal pollution

This involves identifying institutional and licensing arrangements and resourcing that will increase the effectiveness of these policies and legislation. It is important to focus more attention on thermal pollution and pursue a more coordinated approach. This can be achieved by listing thermal pollution as a threatening process under all relevant legislation.

3.8 Ensure the National Guidelines for fish-friendly crossings are taken up by road and rail authorities and private landholders

It is important to recognise that many of the barriers to fish movements are roads, culverts and rail tracks that cut across waterways. It is important that actions documented in the National Guidelines for fish-friendly crossings are promoted to and adopted by local governments to reduce the blockage of fish passage.

3.9 Develop a Basin-wide program which supports the removal of weirs and other barriers to fish passage

Many barriers to fish passage are no longer required by their original owners and a program to remove obsolete structures should be formulated.

Table 3: Priority barriers in the Murray-Darling Basin needing new fishways or modifications to existing fishways (listed in priority order)

NB: The Lake Hume to River Murray mouth fishways program being implemented by the MDBC covers fishways within South Australia.

Barrier name	River	State
Steven's Weir	Edwards River	NSW
Menindee Lakes Main Weir	Darling River	NSW
Caseys Weir	Broken River	Vic.
Boomi Weir	Macintyre River	Qld
Cunnamulla Weir	Warrego River	Qld
Gogelderie Weir	Murrumbidgee River	NSW
Redbank Weir	Murrumbidgee River	NSW
Kerang Weir	Loddon River	Vic.
Brewarrina Weir	Barwon River	NSW
Gowangardie Weir	Broken River	Vic.
Gulf Regulator	Smith Creek–Barmah Lakes	Vic.
Loudoun Weir	Condamine River	Qld
Mullaroo control structure	Lindsay River–Mullaroo Ck	Vic.
Tea Garden Creek Weir	Ovens River	Vic.
Bourke Weir	Darling River	NSW
Walgett Weir	Barwon River	NSW
Neil Turner Weir	Maranoa River	Qld
Eulo Weir	Paroo River	Qld

Research and investigation

3.10 Develop and monitor cost-effective fish passage technology suitable to native fish migration in the Basin's rivers

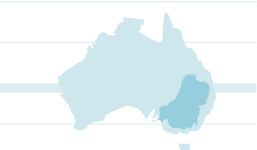
This includes building experimental fishways for various structures and assessing their performance using the most effective fish counting and monitoring techniques available.

3.11 Improve knowledge on the effects of barriers on downstream movements of juvenile and adult populations of fish

3.12 Investigate the removal of unwanted alien species, especially carp, at every fishway

Developmental work is already underway to pursue methods to either physically or electronically separate unwanted (usually carp) and wanted (i.e. native) fish species as they pass through fishways. This work should be supported by further research, including humane and efficient methods of disposal.

3.13 Document the scale, distribution and severity of thermal pollution



Such information is important so that appropriate mitigation measures or structures can be designed. This is a priority for guiding future actions.

3.14 Undertake scientifically-based pilot studies to demonstrate the benefits of mitigating thermal pollution, and to monitor the recovery of native fish

Management actions for mitigating thermal pollution need to be preceded by a risk management analysis of the social, economic and environmental costs and benefits.

Community engagement

3.15 Liaise with partners, including the community, about the Basin-wide fish passage program

While the MDBC manages and operates most of the River Murray structures, State or other partners own other Basin structures. It is important that the MDBC plays an overall coordinating role in implementing a Basin-wide fish passage program. This will include consulting with the general community, including Indigenous communities, about the problems of regulated structures and solutions that benefit fish populations. This includes the notion that restocking of areas with fish is not a long-term solution. Strategies for overcoming the problems of fish passage and thermal pollution need to form part of established and proposed initiatives directed at integrated catchment management, natural resource management and river rehabilitation.

3.16 Set up an inter-agency working group that also includes community and scientific representatives for coordinating responses to thermal pollution

Costs and benefits

The MDB Ministerial Council has already committed $25 million over the next five years to provide fish passage from Lake Hume to the sea. The estimated cost of the other 18 priority fishways (see **Table 3**) is about $15 million. Fish counters, important for monitoring the effectiveness of fishways, can range in cost from $25 000 to $100 000 each, depending on their accuracy and the size of fish they can detect. The costs and benefits of mitigating thermal pollution need further and immediate investigation. However, it appears to be a clearly definable, tangible, cost-effective intervention that can be completed for the major storages in the Basin within ten years, through a combination of engineering and operating changes.

The abatement of cold water pollution and the provision of fish passage are important complementary actions. Investing in this intervention will have long-term benefits for the whole Basin, and is an ideal early target that at the very least will help stop further degradation until other strategies take effect.

Accountability indicators

- Effective fishways implemented to assist fish migration and movements.
- Improved flow management for fish habitat diversity, fish lifecycle movements, and reduction of thermal pollution.

4. Controlling alien fish species

The Basin already contains at least 11 alien fish species in the wild, some in pest proportions, and further introductions are inevitable over time. Both the abundance and attributes of some alien fish continue to cause damage to habitats and populations of native species. Most attention has been given to carp and trout because they are the largest and visibly most abundant, but there are many other species that can have impacts through predation, competition and disease. The risk of further introductions into the Basin—especially from aquariums and nearby rivers outside the Basin—also needs to be considered. Precautionary approaches, to minimise the risk of future introductions, and pest management principles, to address existing introductions, should be applied across the Basin.

Redfin perch carry disease to native fish

Redfin perch were first introduced to Victoria in 1868 and are now widely distributed throughout the temperate portion of the Murray-Darling Basin. They are absent from the colder headwaters and the hotter reaches of the upper part of the Basin. Their distribution is largely explained by their temperature tolerance—they can survive in water temperatures up to about 31 ºC. They are a predatory species with adults eating crustaceans and small fish, including western carp gudgeon.

Redfin perch are the main host for a virus, EHNV. This virus, unique to Australia, was first isolated in 1985 on redfin perch. It is characterised by sudden high mortalities of fish displaying breakdown of renal tissue, liver, spleen and pancreas. The virus also affects trout species, which can act as vectors to spread the disease. Experimental work has demonstrated that a number of native fish species (including Macquarie perch, silver perch and mountain galaxias) are extremely susceptible to the disease. Once EHNV has been recorded in a water body it is considered impossible to eradicate.

After their establishment in the ACT in 1983, redfin perch rapidly increased in numbers in the urban lakes. By 1989 they formed 58 per cent of the total catch in Lake Burley Griffin. Their numbers in Lake Burley Griffin, Lake Ginninderra and Googong Reservoir all declined dramatically after the outbreak of EHNV in these water bodies in the early to mid-1990s. Redfin now comprise around 10 to 15 per cent of the catch in Lake Burley Griffin.

Carp prefer slower running waters and river pools, and are most prevalent in the more highly regulated rivers of the Basin, such as the River Murray and Murrumbidgee River. Experts have rated them the near perfect 'invader', as they are a highly adaptable and tolerant species.

Carp are fast-breeding and can achieve large population numbers in a relatively short period of time, recording densities of up to one fish per square metre of water surface area.

In some river reaches of the Murray-Darling Basin it is estimated carp now represent more

The Basin contains at least eleven alien fish species that may affect native fish populations through predation, competition, disease or degradation of habitat.

© John Baker

Vertical slot fishway

than 90 per cent of the total fish biomass, and across the Basin the estimate is that carp constitute 80 per cent of the biomass.

Carp are now the dominant fish of the Murray-Darling Basin. If this continues they will out-compete more and more native fish and other riverine species. Carp are also partly responsible for the increasing turbidity of the water within the Basin, and their feeding habits uproot aquatic vegetation.

Carp control

The MDBC has published the *National Management Strategy for Carp Control 2000–2005*. It aims 'to provide direction, and focus for the coordinated national approach to the control of carp'. Its goals are to:

- prevent the spread of carp;
- reduce the impacts of carp to acceptable levels;
- promote environmentally and socially acceptable application of carp eradication and control programs;
- improve community understanding of the impacts of carp and the management strategies to counteract those impacts; and
- promote the cost-efficient use of public resources in carp eradication and control programs.

The focus of all management of alien fish species should be on reducing the impacts of such fish on native species, rather than on complete eradication of numbers. The best approach to reducing such impacts is an integrated one that combines a range of techniques. For example, with carp, appropriate techniques could include rehabilitating the wetting and drying cycles for floodplain wetlands, commercial exploitation, and the installation of screens and fish traps to prevent adult fish migrations. There is unlikely to be one 'silver bullet' that can solve any single alien species problem. Control of alien species needs to be part of an overall river rehabilitation process.

Control of tilapia
(Oreochromis mossambicus) in the northern part of the Murray-Darling Basin

Tilapia is an alien species now found in some catchments of south-east Queensland. Without proper management there is a risk of its introduction into the Murray-Darling Basin. They are a hardy fish species that can tolerate a wider range of water quality conditions, including salinity, both high acidity and alkaline water, and low levels of dissolved oxygen. This makes tilapia a difficult species to control with the range of techniques currently available. Like carp, there is little sound information about the

© Ivor Stuart

Processing carp on the River Murray

damage they cause. They could be a symptom of degraded water rather than the cause. However, remnant native fish populations are likely to be further stressed by the presence of tilapia as a competitor for space and food.

Actions

Management

4.1 Support the implementation of the goals and strategies of the National Management Strategy for Carp Control, including the development of regional carp management plans

The MDBC has produced a document titled *Ranking Areas for Action: A Guide for Carp Management Groups*. The first section describes a method for identifying and prioritising areas for carp management, while the second outlines a four-step process to help develop and implement an effective carp management plan for such areas. This Strategy supports the ongoing implementation of this guide by regional groups. In prioritising areas for action, it will be important to:

- determine management units for aquatic systems and assess and rank their conservation and water quality status;
- assess and rank the threat of carp in each of the units; and
- assess the likelihood that an effective program to manage carp damage can be implemented.

Ultimately, other factors such as urgency for action, ease of implementation and level of cooperation, may mean that lower-ranked areas are treated in preference to higher-ranked areas. Nevertheless, the method is a systematic and transparent process that involves partners at each step. The aim is to provide a structured process to assist decision-making. It can be modified to suit the particular needs of the management group. It is usually necessary to implement management across a wide area and work to boundaries, such as weirs, waterfalls and other boundaries to carp movement.

It is essential that regional carp management plans are integrated with other local management plans, such as Integrated Catchment Management (ICM) plans, to ensure that the carp management plan is consistent with the objectives of these other plans and initiatives. In such plans, an integrated package of carp control techniques needs to be considered. Progress towards meeting objectives needs to be systematically monitored and evaluated, and results reported to the relevant local authority.

4.2 Ensure a consistent legal status and approach to all alien species management across the Basin

There is a need to resolve the numerous inconsistencies in both legislation and policy, between and within States, in such areas as import, sale, release, use as live bait and enforcement.

4.3 Develop a rapid response system for new alien species in the Basin

The development of a rapid identification and response system is needed to ensure that a standard plan is put into place as soon as there is a report of a new alien species occurring within or near the Basin—this process will ensure that the likelihood of successfully eradicating a newly introduced species is maximised. A rapid response system would also include contingency plans and outbreak control strategies for any anticipated alien species.

4.4 Encourage an integrated pest management approach to the control of alien fish species in the Basin

Successful alien species management involves using a combination of techniques (such as biological control, chemical control, commercial fishing, environmental manipulation and environmental rehabilitation) with a focus on reducing impacts, not numbers. These techniques need to be effectively integrated with other river rehabilitation measures.

Research and investigation

4.5 Identify regions, recruitment areas and dispersal patterns for all alien fish species

Successful recruitment and colonisation by alien species allow for future spread and risk to native fish populations. The identification of key population and recruitment areas for targeted management actions is important for control of alien species. Similarly, patterns and mechanisms of dispersal need to be addressed to restrict future spread. Whilst many of these attributes are already known, they need documentation or investigation.

4.6 Identify areas that are currently free of alien species so that they can be protected from future invasions

The spread of alien species which are already present in Australia, represent a threat to fish populations they may invade. Areas which are free of these alien species, but susceptible to invasion need to be identified and protected. In some cases, the identification will require surveys, but in most cases, mapping of existing distributions may be all that is needed.

This Strategy urges an integrated pest management approach to the control of alien fish species where a combination of techniques is used to reduce their impacts.

4.7 Identify any potential new alien species and assess the likely ecological impacts of such species

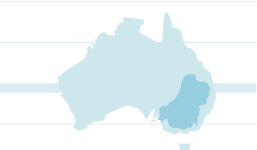
New alien fish species are almost inevitable and there is a need to be ready and proactive towards preventing their invasion and successful colonisation. Identification of potential threats and the risks posed can be determined by undertaking an Ecological Risk Assessment of potential new alien species that may become established in the Basin.

4.8 Carry out priority research projects to fill gaps in knowledge about carp and other alien species

The MDBC has produced a document titled *Future Directions for Research Into Carp*, which was approved by three Ministerial Councils. This document outlines a number of knowledge gaps that need to be filled about:

- carp biology and ecology;
- distribution and stock structure of carp;
- the impact of carp;
- the control of carp;
- commercial use of carp;
- environmental rehabilitation of degraded areas;
- social issues related to the control of carp;
- the need for decision support system/s;
- evaluation and monitoring procedures; and
- the impacts of carp control on native species.

Gaps in the knowledge of other alien species such as gambusia, oriental weatherloach and redfin perch should also be identified and appropriate research carried out.



4.9 Investigate the value, potential risks and application of biotechnology to control alien fish species

The use of biotechnology to control alien fish species has long-term potential. The 'daughterless' fish technology, developed by CSIRO Marine Research, involves controlling an enzyme in the fish, so that they only produce male eggs. If populations of such fish are built up in ponds and then released into sections of the Basin's rivers, over successive generations their populations could decrease and progressively fewer female fish would be available for reproduction. Due to the long-term, multi-dimensional and community sensitive nature of this work, a Business Plan has been prepared to reflect a strategic approach to develop, manage and evaluate the project. However, such technology is just one tool in a whole suite needed to control alien fish species.

Community engagement

4.10 Encourage and build on the actions already being undertaken by communities for controlling alien fish species

A number of community organisations in South Australia have installed carp exclusion grids in floodplain wetlands with dramatic impact. Aquatic vegetation has begun to return, water quality has improved and the overall health of these wetlands is on the mend. In the northern parts of the Murray-Darling Basin, community groups are also acting to reduce local alien fish populations.

Control of alien fish species in Queensland

A Strategy for controlling alien fish was released in 2001 by the Queensland Fisheries Service in consultation with a community consultative committee. The Strategy recognises that broad-scale eradication of 'exotic pest fish species' is not possible, so it prioritises activities directed at controlling the spread of alien species. The Strategy is based on the principles of integrated pest management within an adaptive management framework. The Strategy aims to:

- prevent the further spread of exotic pest fish species already established in Queensland waters and prevent the establishment of additional species in the wild;
- reduce the impacts of wild populations of exotic pest fishes to acceptable levels and eradicate where possible;
- ensure the environmentally and socially acceptable application of exotic pest fish eradication and control programs;
- establish community understanding of the impacts of exotic pest fishes and management strategies to counteract these impacts;
- ensure that exotic pest fishes management is undertaken in accordance with best practice management and is underpinned by science and evaluation; and
- coordinate State management of exotic pest fishes with national management strategies.

(Source: *Control of Exotic Pest Fishes – An operational strategy for Queensland freshwaters*)

Costs and benefits

If direct carp management is conducted in conjunction with the allocation of suitable environmental flows and habitat rehabilitation, then its impact on helping to rehabilitate native fish populations is likely to be very high. Other strategies listed in this document, such as abatement of cold water pollution and the provision of fish passage, are also important complementary actions.

Carp management can be considered a medium to long-term investment, especially when this is taken to include the 'daughterless' carp technology, which is expected to take at least 7 years to refine and another 20 to 30 years to take effect.

The threats posed by other alien fish species vary, as do the measures required to reduce their impacts. The most important species to consider are redfin perch, the salmonids, gambusia, goldfish and oriental weatherloach. In the short-term, abatement of cold water pollution, habitat restoration and allocation of environmental flows will help to manage the populations of such species, while at the same time advantaging native fish. In the longer term, some specific targeted actions may be needed on a case-by-case basis.

The risk of alien species such as tilapia spreading further throughout the Basin or of new alien fish species being introduced into the Basin also needs to be managed.

Accountability indicators

- Assessment of threats posed by all alien species completed
- Control measures for all alien pest species implemented across the Basin

5. Protecting threatened native fish species

Many native fish species within the Murray-Darling Basin have declined dramatically in distribution and abundance. Declines in the population of fish species often occur suddenly. There is potential for the extinction of some species in the future. Risk management strategies are needed to reverse this trend of endangerment, for both individual species and fish communities as a whole. Recovery planning and urgent implementation of new and existing plans is required for all species and communities under threat in the Murray-Darling Basin. Critical habitat and threatening processes need to be identified and remedial actions implemented. Areas of high conservation value need to be determined and appropriate management developed to maintain this value.

Forecasting of future fish population trends and the implementation of actions to reverse trends towards endangerment are required. While it is important that specific legislative requirements are provided to manage species under threat, it is also important to recognise that appropriate management arrangements for all fish need to be implemented. Further, it is easier and more economical to maintain healthy populations than it is to restore depleted populations.

In the past, commercial fishing of native fish species has been an important activity in the Basin. South Australia is now the only State with an ongoing commercial fishery for native species. Commercial fishers in South Australia, through their monthly catch and effort statistics, provide a valuable and inexpensive view of native species stock assessment and river conditions.

In addition, recreational fishing is still a popular activity throughout the Basin.

It is important that both recreational and commercial fishing for native species is managed effectively, and that such fishing does not threaten the long-term sustainability of native species.

Actions

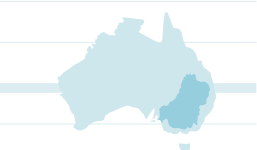
Management

The MDBC will work in harmony with State and Commonwealth partners to coordinate the establishment of Riverine Management Zones (RMZs) and Habitat Management Areas, as stated previously in this Strategy. Such areas will become havens or refuges for threatened native species.

5.1 Prepare and implement species recovery/threat abatement plans for threatened species and communities

Recovery plans should include all fish communities at risk, rather than a single species, and they should include conservation of currently non-threatened native fish species. Any threatening processes should be identified under relevant legislation. The recovery of threatened species requires an ongoing and consistent effort. There are currently a number of management plans in place (e.g. MDBC's recovery plans for silver perch and catfish). However, there needs to be an immediate commitment to implementation of these existing plans, and to the development of recovery plans for other threatened species/communities within the Basin.

Urgent development and implementation of recovery plans is needed for threatened native fish populations and communities.



5.2 Develop management plans with clear objectives for other native fish species

These plans do not necessarily have to be extensive documents, but should outline the key objectives for the management of the particular species. Where native fish are exploited commercially or for recreational uses, fisheries management objectives need to be included in management plans.

Research and investigation

5.3 Produce a template for developing generic recovery plans for each threatened species of native fish or ecological community

5.4 Identify major threatening processes, particularly those affecting multiple native fish species, and create an inventory of critical habitat areas for threatened species and communities

5.5 Support the writing of nominations for listing threatened species, communities and threatening processes under all relevant legislation

5.6 Establish facilities, techniques and procedures for monitoring the abundance, distribution and population structure of all fish species in the Basin

Such monitoring data can then be used to predict the future trends of all fish species using population modelling.

Community engagement

5.7 Raise community awareness about the status of the Basin's native fish

Greater partner awareness will lead to improved support and involvement in actions designed to rehabilitate and protect populations of native fish. In many cases, such actions will be part of overall catchment management plans.

Community and special interest groups are already active in spreading the word about native fish, with groups like the Australian Capital Territory branch of the Australia New Guinea Fishes Association holding displays of native fish at regional visitor centres and producing a poster of the Upper Murrumbidgee Catchment native fish. Native Fish Australia is also active, working with State branches to produce information and displays on native fish, as well as initiating breeding programs for threatened species such as trout cod and Macquarie perch.

Costs and benefits

There needs to be a significant immediate investment to ensure consistent and coordinated efforts in implementing fish recovery plans. An example of short-term investment for habitat restoration is the need to resnag high-priority reaches to support recovery of native fish populations, including threatened species. Havens and refuges for threatened species or communities offer a medium to longer-term investment in rehabilitating fish populations. Fishways are important for threatened fish, especially in the uplands. The costs of implementing such actions are likely to be expensive and time-consuming, and obvious recovery of fish populations is not likely to be observed in the short-term.

Silver Perch Recovery Plan costings

The Silver Perch Recovery Plan includes 51 actions that should be undertaken to restore populations of silver perch. These actions consist of 21 high priority actions, 21 medium priority actions and 9 lower priority actions. As many of the actions recommended form part of other actions that are being undertaken on wider management issues (e.g. environmental flows), not all have been costed. Six major high-priority initiatives to generate new knowledge have been costed at $1.4 million, with a further 24 medium-priority actions costed at an additional $2.9 million.

Accountability indicator

- Recovery programs funded and implemented for all threatened fish populations and communities in the Basin.

6. Managing fish translocation and stocking

The composition and evolution of native fish populations can be threatened by the liberation of fish outside their natural range or from hatcheries. This is true for both native and alien fish species. Appropriate guidelines and codes of practice to minimise this risk are required. However, while some States do have guidelines in place, it is very difficult to verify whether these guidelines are being followed.

Apart from releases of alien fish or restocking of native fish, natural populations of native fish are threatened by the potential release of genetically restricted material from native fish aquaculture operations using limited brood stock. The release of such material has potential to reduce the genetic fitness and hence viability of fish populations. NSW is developing a quality assurance program that aims to produce a comprehensive accreditation scheme for hatcheries.

Aquaculture is a rapidly developing industry throughout the Murray-Darling Basin. Measures to protect native fish from adverse impacts need to keep pace with this development.

Inadvertent translocations of genetically restricted or diseased native fish are possible and could have enormous impacts on native fish populations. There is a need for consistent and appropriate guidelines/codes of practice for the industry across the Basin.

The risk of disease and parasites to native fish populations is another problem that can emerge from fish stocking or aquaculture enterprises. Both exotic and endemic disease outbreaks have potentially devastating effects on native fish populations. Our knowledge of fish diseases and parasites is far from complete. Control of disease outbreaks is extremely difficult. A precautionary approach needs to be applied and the potential sources and risk of disease outbreak determined. Attention also needs to be paid to the mechanisms that transfer diseases and parasites throughout the Basin.

Actions

Management

6.1 Ensure a consistent, coordinated and firm Basin-wide approach to the issue of fish translocation and stocking

All States and Territories have adopted the *National Policy for the Translocation of Live Aquatic Organisms* and are either implementing consistent State-based policies or have adopted the national policy framework. There is a need to monitor and evaluate the implementation of the National Policy, ensuring that any Basin-wide stocking policies, procedures and guidelines are complementary.

6.2 Develop protocols that monitor the efficiency and benefits of conservation stocking programs

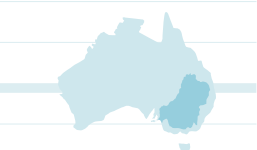
Demonstration reaches that have been rehabilitated may need to be restocked with native fish as a last resort for improving the status of fish populations. The effectiveness of such restocking needs to be carefully assessed.

6.3 Implement a comprehensive scheme for hatchery accreditation across the Basin

NSW is developing a quality assurance program that may be appropriate for other jurisdictions within the Basin. Once the NSW project is completed, the MDBC will consult with other State jurisdictions as a basis for developing a Basin-wide program. This should include quality-control procedures for hatcheries to prevent disease, adverse genetic effects and inadvertent translocations. Guidelines need to be developed as part of an inter-State agreement to regulate the use of non-native species for aquaculture in the Basin.

Macquarie perch

A consistent, coordinated and firm Basin-wide approach is needed to manage fish translocation and stocking.



Research and investigation

6.4 Complete current research designed to improve knowledge about the risks associated with fish stocking, aquaculture and disease

The following research projects are already being undertaken:

- cataloguing the releases of native and other fish by private and public sectors in the Murray-Darling Basin, and investigating the efficiency and benefits of such releases (Cooperative Research Centre for Freshwater Ecology);
- evaluating the population genetics of each species of Murray-Darling native fish in natural wild populations, stocked populations and hatcheries (Arthur Rylah Institute, Victoria); and
- developing a Model Hatchery Quality Assurance Program in NSW to provide a suitable accreditation system for the sale of fingerlings to various markets, including stock enhancement that could be taken up by other States (NSW Fisheries).

6.5 Review the impact of translocation and stocking on all native fish populations

6.6 Investigate all endemic and threatening diseases and parasites of all fish species in the Basin

Community engagement

6.7 Involve the community in any decisions about fish translocation and stocking in the Basin

There is relatively strong support for fish stocking in some parts of the Basin. The community needs to be involved in developing Basin-wide policies, procedures, guidelines and accreditation systems.

6.8 Bring together State agencies, industry and the community to ensure a coordinated and consistent approach across the Basin to fish translocation and stocking

Costs and benefits

The actions under this driving action largely represent second-order interventions that are of lesser importance to the other actions listed in this Strategy, such as restoring environmental flows and native fish habitat. However, for the long-term viability of the Basin's native fish populations, it is still important that they are considered. The actions listed above need to be implemented and resourced by the relevant State agencies, with the MDBC taking a coordinating role.

Accountability indicators

- Rigorous procedures for managing fish translocation and stocking implemented in each jurisdiction
- All native fish hatcheries accredited and following sound production and distribution practices
- Basin-wide risk management procedures implemented for preventing and managing outbreaks of disease or parasites affecting native fish populations

The implementation of the driving actions will not see an immediate return on investment. While the rehabilitation of fish habitat and the management of riverine structures should result in changes within the next 10 to 15 years to native fish communities, the other driving actions are likely to take considerably longer before benefits become obvious. However, if this investment is delayed it will prove more costly to rehabilitate the Basin's native fish communities. It is also important to provide additional knowledge to support the ongoing needs of the Strategy.

© Arthur Mostead

Fish farming on 'Dunoon', Paul and Joan Trevethan have diversified into aquaculture, farming silver perch for table fish, Howlong, NSW.

© Matthew Jones

Crane lifting prototype carp separation cage at Torrumbarry Weir

Trialing carp bait at Bulgari Lagoon, near Narrandera

About 10 per cent of the total budget allocated to implementing this Strategy will be used for monitoring, evaluation and review. This will seek to:

- report annually against accountability indicators in conjunction with the *Sustainable Rivers Audit* processes;
- evaluate at any time the progress in achieving the Strategy's 13 objectives against process and implementation indicators;
- audit cumulative actions every five years against the overall goals of rehabilitating the abundance and distribution of native fish populations to 60 per cent of their estimated pre-European settlement levels; and
- conduct an overall Strategy review after five and ten years.

Evaluation of progress

Process indicators review and assess the Strategy's management structures and implementation procedures through the:

- involvement of relevant MDBC technical committees in an annual review of progress that is undertaken against agreed targets; and
- involvement of the advisory groups in receiving reports, providing policy advice and ensuring integration with related strategies.

Implementation indicators measure the extent to which appropriate managers in government agencies and communities have actually used and understood the information, resources and opportunities for actions, and include:

- workshops to synthesise findings and disseminate outcomes to managers;
- presentation of findings to the wider community; and
- the development and use of existing and new benchmark examples that provide best practice measures of progress and achievement.

Evaluation will ensure the implementation of the Strategy occurs through an adaptive management process, and will ensure that money allocated to the driving actions has been well spent. An evaluation group will be established to review existing work and develop further options for better coordination across the Basin.

Auditing cumulative actions and their impacts on fish populations

Assessment and monitoring are essential to determine the status of native fish populations and provide knowledge for the development and evaluation of indicators. There is a need to:

- collate existing baseline data and new data for the establishment of long-term datasets;
- develop a database/library that can catalogue data/results/outputs from projects;
- develop a Basin-wide fish distribution database;
- undertake oral history projects, similar to *Listening to the Lachlan*, focusing on fish and fish habitats in an attempt to gain a historical perspective not available from other data sources;
- assess ongoing condition of fish populations, which may take a form similar to the NSW Rivers Survey;
- standardise the collection of data so that comparisons can be made both across the Basin and over time;
- collect scientifically valid data and provide scientific interpretation;
- consider the timing and cost effectiveness of data collection (for example, it may be better to collect data only annually rather than seasonally, depending on the reason for collection);
- use data collected by recreational and commercial fishers to assess and monitor fish populations; and
- ensure data and information are shared with all stakeholders.

Strategy review

This will involve using resource condition indicators that demonstrate improvement in the sustainability of native fish populations, including:

- major reviews of progress to be undertaken by external referees after five and ten years (specifically, the Strategy should be externally audited in 2007 and 2012); and
- evaluation of the science, objectives and milestones, to provide a better Strategy.

The central question is: Has the Strategy provided a strategic platform for the rehabilitation of native fish populations in the Basin?

In 2013, it will be important to finalise development of the *2014–24 Native Fish Strategy* to ensure a Basin-wide approach to native fish management into the foreseeable future.

It is imperative that the key skills, resources and capacity to undertake monitoring and associated research are identified, developed and maintained across all partners, including the community.

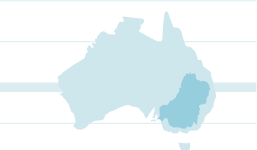
Approximately 10% of the total budget allocated to implementing this Strategy will be used for monitoring, education and review.

Beyond this Strategy

The life of this Strategy extends to 2013. However, native fish management is a long-term challenge that will extend well beyond that date. As this Strategy is implemented, consideration will be given to the most appropriate framework for native fish management beyond 2013. The Commission and Council will ensure that a seamless transition occurs from this Strategy to the subsequent framework.

Knowledge generation and exchange

As fish are hidden under water, the general public awareness and understanding of issues relating to them is often less than for more visible and identifiable terrestrial animals. There is a clear need for the community to be educated about native fish, their status, importance and threats to them. A communication strategy will be developed and implemented for this Strategy, focusing on community awareness, consultation and engagement. The use of demonstration reaches and associated actions can be used to illustrate the value of restorative actions. Prominent and substantial demonstration reaches are useful for integrating all relevant land and water programs into a comprehensive rehabilitation plan that uses the principles of adaptive management. They provide an excellent mechanism for improving public awareness, understanding and support for habitat rehabilitation and the protection of native fish species.



Importance of consulting with partners

In designing and implementing both demonstration reaches and Habitat Management Areas, it is vital to liaise with key partner groups. This is important both as a means of identifying partner issues and concerns and in fostering support for future rehabilitation works and Habitat Management Area proposals. The following partner groups, in no order of importance, should be considered for consultation:

- State governments;
- State agencies (such as fisheries departments, water departments);
- local governments;
- catchment management organisations;
- conservation groups;
- landholders;
- recreational and commercial anglers;
- urban water users;
- Indigenous groups;
- local industry;
- tourism and recreational groups; and
- the scientific community.

There is a lack of biological knowledge for many species. There are also gaps in understanding about fish and river ecology. Lowland river ecology is a relatively new area of study in Australia and there is always the need for new knowledge to ensure better management decisions. This requires an ongoing research program that can provide answers to targeted questions and information for priority knowledge gaps.

Assessment of the success (or failure) of management actions is essential and can only be undertaken by dedicated evaluation. Regular monitoring can provide knowledge on trends and progress towards a target.

This Strategy seeks to:

- engage the community and stakeholders through a comprehensive communication strategy;
- initiate relevant scientific research that will provide new knowledge to support management actions in an adaptive context;
- ensure that the Strategy's actions are monitored and evaluated to measure its success and provide a basis for adaptive management; and
- demonstrate recovery of native fish through comprehensive rehabilitation of the key factors degrading demonstration river reaches.

Glossary

Glossary of acronyms

CAC – Community Advisory Committee

COAG – Council of Australian Governments

CSIRO – Commonwealth Scientific and Industrial Research Organisation

ICM – Integrated Catchment Management

IUCN – International Union for the Conservation of Nature

MDB – Murray-Darling Basin

MDBC – Murray-Darling Basin Commission

RMZs – Regional Management Zones

Conservation definitions

Conservation definitions from the International Union for the Conservation of Nature (also adopted by the Australian Society for Fish Biology, ASFB)

Extinct
A species is Extinct when there is no reasonable doubt that the last individual has died.

Extinct In The Wild
A species is Extinct In The Wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range.

Critically Endangered
A species is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

Endangered
A species is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

Vulnerable
A species is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

Threatened
A species is Threatened when it is close to being listed as Vulnerable.

River Murray – Renmark, South Australia

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Supporting documents

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Report on Community Submissions, Native Fish Strategy Public Comment: 1 July–31 December 2002, Murray-Darling Basin Commission.

If you would like copies of any of the supporting documents, please contact the office of the Murray-Darling Basin Commission on (02) 6279 0100. Alternatively, you can download the supporting documents from www.mdbc.gov.au

Other relevant strategies and plans

The following strategies and plans are closely aligned with the *Native Fish Strategy*. All works and actions undertaken for the *Native Fish Strategy* will therefore consider potential links and collaboration with these strategies and plans, to optimise productivity and maximise outcomes.

Sustainable Rivers Audit, Murray-Darling Basin Commission

The Living Murray initiative, Murray-Darling Basin Commission

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Excerpts taken from submissions to the *Native Fish Strategy* (1 July –31 December, 2002)

'… the comprehensive strategy should lead to significantly improved sustainable returns for recreational angling while at the same time ensuring the recovery of all the presently endangered fish species'. Patrick Washington, VRFish Chairman.

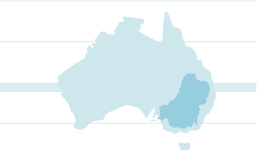
'The draft strategy has enormous potential to bring about healthier native fish populations and healthy rivers'. NSW Irrigators' Council.

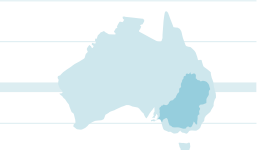
'Enhanced native fish numbers and habitat will improve tourism, recreational and community development opportunities as well as help to link Local Government to good natural resource management outcomes'. Adrian Wells, Murray-Darling Association.

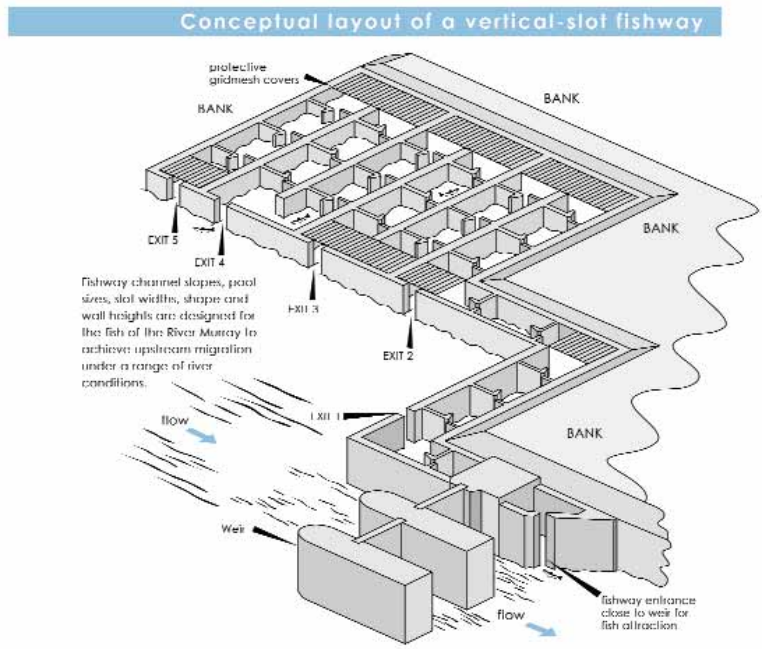
‘We would like to express our total support of the proposed strategy and look forward to being able to be involved in some way to ensure its adoption, implementation and ultimate success’. Warwick District Recreational Fish Stocking Association Inc.

‘Great to see a strategy being formed to help rehabilitate declining native fish numbers ... Please advise me as to what further I can do or we as “Fly Fish Bathurst” can do and we will to the best of our ability’. Ken Smith, Kelso NSW.

‘We would like to congratulate you on both the initiative and the high quality of the current draft document, and to lend our support to this strategy’. World Wide Fund For Nature.







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Vertical-slot fishway under construction at Lock 8, River Murray

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