The "Sea to Hume Dam" program: Restoring Fish Passage along the Murray River

Jim Barrett[1] and Martin Mallen-Cooper[2]

[1] Murray-Darling Basin Authority, GPO Box 1801, Canberra City, ACT, 2601, Australia.
Email: jim.barrett@mdba.gov.au

[2] Fishway Consulting Services. 8 Tudor Place, St Ives, NSW, 2075, Australia.
Email: mallencooper@optusnet.com.au

Summary

Surveys of fish diversity on the Murray, one of Australia's major rivers, show that native fish species and numbers have declined dramatically since European settlement. It is now a regulated river supporting Australia's most productive agricultural areas. Barriers, including weirs and barrages, now obstruct the passage of fish along the Murray and contribute to the decline in distribution and abundance suffered by many fish species.

As part of a broader program to restore health to the pre-existing biodiversity of the Murray, the Murray-Darling Basin Authority (formerly known as the Murray-Darling Basin Commission) is restoring fish passage along the Murray River from the sea to Hume Dam. This represents a distance of 2 225 kilometres.

Beginning in 2001, the Sea to Hume Dam program has involved the design, construction, testing and evaluation of fishways at 12 weirs and five barrages along the main stem of the Murray. It has involved, through an adaptive management process, considerable effort from many people from diverse backgrounds and expertise, and the commitment and cooperation of a number of government agencies from different jurisdictions.

While the program is due for completion in 2010, results to date are highly encouraging and show that fish passage has been restored to an estimated 20 fish species, including smaller fish, from Chowilla in South Australia, to Mildura, between Mildura and Yarrawonga, and between the sea and Lock 2.

Introduction

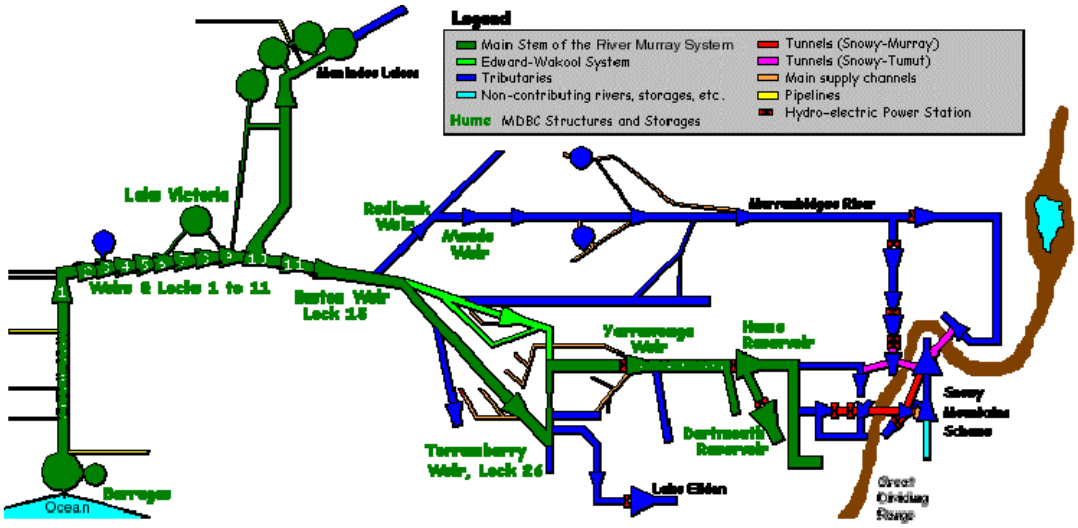
The Murray River system

The Murray River is an ancient river of considerable importance to Australia. It begins in the Australian Alps and winds across the inland plains defining a significant portion of the border between New South Wales and Victoria. It then turns south into South Australia for about 500 kilometres then enters the sea beyond Lake Alexandrina.

The Murray River is part of the Murray-Darling Basin (MDB) which is one of the largest catchments in the world. It covers approximately one-seventh of Australia and encompasses five jurisdictions; New South Wales, Victoria, Queensland, South Australia and the Australian Capital Territory.

The MDB is located within the semi-arid and arid climatic zones of Australia. The area receives low average rainfall and 98 per cent of the catchment contributed only a small amount or no run-off.

Despite the Basin's rivers experiencing very little discharge, flows within the Basin support approximately 40 per cent of Australia's agricultural production and a population of over two million people (Barrett et al. 2008).



Location of weirs and locks on the Murray River system

Lock 1 at Blanchetown, South Australia. This is the site of the first lock on the Murray, built in 1922 to support navigation for trade. By the time the lock was built, trade along the Murray was in decline. The fishway is fitted into the existing structure with the fishway entrance integrated into the weir and its operation. Photo: John Prentice

Stakeholders and budget

The Sea to Hume Dam program represents the efforts and cooperation of the Federal Government, and the New South Wales, Victorian and South Australian Governments. It involved scientists, fish biologists, engineers, government representatives and Murray River lock staff.

Before construction of fishways, Aboriginal, heritage and environmental representatives were consulted to ensure that cultural and heritage places of significance would not be impacted by the construction or any associated works.

Through cooperation with these and other stakeholders, river management agencies and the broader community, on-ground strategies for the rehabilitation of native fish populations are being achieved for the Murray River through the program.

The Sea to Hume Dam program has also received considerable support from the Murray-Darling Basin Ministerial Council.

It is estimated that once the program is completed in 2010, about A$45 million would have been spent of contributions from the federal and state governments.

Ecosystem and impacts

The character of the Murray River is varied along its considerable length. From the Snowy Mountains, the Riverine Plains, through the Mallee to Lakes Alexandrina and Albert, along with the Coorong, the River passes red gum forests, low woodland and saltbush.

Barmah Forest floodplain vegetation

The Murray River contains a unique native fish community although, compared with other major river systems, the species diversity is very low. Over 50 species of fish have been recorded from the Murray-Darling river system, 11 of which are non-Australian species.

Some of the 50 species are marine species or estuarine species found in the lowest reaches of the system. Another six species are diadromous, spending part of their lives in fresh water and part in the sea. Only 26 species complete their life cycle entirely within the river system (Cadwallader and Lawrence 1990)

Native fish in the Murray-Darling system have evolved in a widely-fluctuating environment in which large, natural changes in population size are to be expected.

However, the native fish of the River and the broader Basin have undergone serious declines in both distribution and abundance since European settlement.

Rainbowfish collected in Lock 8. Photo Martin Mallen-Cooper

The decline has been attributed to a number of causes including: barriers to fish passage; flow regulation; alien fish species; habitat degradation; reduced water quality; disease; exploitation; poorly managed translocation and stocking; and thermal pollution (MDBC 2003).

Barrage and weir construction has contributed to a dramatic decline in native fish populations and aquatic biodiversity. These constructions have meant that native fish migrations for feeding, spawning, refuge and dispersal have been greatly depleted (MDBC 2008).

The urgency of finding an answer to this problem is intensified by the knowledge that at least one-third of the Basin's native fish are listed as threatened; this includes Australia's largest freshwater fish, the Murray Cod (*Maccullochella peelii peelii*). The Sea to Hume Dam program was established to contribute to the rehabilitation of native fish by restoring stream continuity, mitigation pathways and fish population dynamics.

The beginning of the Sea to Hume Dam program

Researchers and managers have long been aware of the need to restore fish passage for the conservation of biodiversity. However, opportunities to make the costly changes required to infrastructure were limited. In 2000, when a need arose to refurbish weirs along 1 110 kilometres of the Murray River to improve Occupational Health & Safety standards, the issue of fish passage on these structures was drawn to the attention of relevant state, territory and federal Ministers.

In 2001, the Murray-Darling Basin Ministerial Council adopted a River Murray structural works program to provide passage for migratory fish from the sea to Hume Dam. This represented a distance of 2 225 kilometres. The tidal barrages at the Murray River mouth were included in the program.

Restoration goals and planning

The Sea to Hume Dam program was established to fund the construction of 14 new fishways from the tidal barrages near the Murray Mouth to Lock/weir 15 at Euston. The process used to design and construct the fishways reflects adaptive management principles so that there is a direct relationship between research findings and its practical application. New research findings are quickly integrated into on-ground works.

The program is underpinned by a number of other factors that have contributed to its success:

- The planning associated with the program takes a “whole-of-ecosystem” approach and aims to provide passage for the majority of the fish community, including 35 freshwater species.

- The program is also based on the long-term involvement and funding of the federal, New South Wales, Victoria and South Australian governments – ensuring cooperation and commitment across geographical boundaries.

- Fishway design criteria for the Sea to Hume Dam program are determined by a Fish Passage Task Force comprising scientists and engineers. Reporting to this Task Force is a team of freshwater fish scientists from New South Wales, Victoria and South Australia established to assess fishway implementation and any other benefits from improved fish passage.

The tri-state team of scientists established to assess fishway performance and associated benefits were guided by four assessment criteria to gauge fishway design effectiveness. These were:

1. To assess whether the fishways were optimally designed, located and operated.
2. To quantify any reduction in accumulations of fish downstream of barriers.
3. To assess the performance in enabling fish passage of a wide size range and species community.
4. To demonstrate any positive changes in abundance and diversity of native fish in the Murray River post fishway construction.

Project implementation

The process of design and development of the fishways has linked knowledge in biodiversity, hydraulics and engineering. The existing weirs were old and the new fishways needed to be designed to enable a wide range of fish. Additionally, the fishways needed to allow for flooding in any season and the hydraulics of the fishways needed to be designed to respond to future environmental flow manipulations.

Implementation of the Sea to Hume Dam program has resulted in the design, construction and establishment of 10 new fishways that allow passage for the majority of the migratory fish community, not just those species valued for commercial purposes.

Fishway construction at Lock 7 in 2004. Photo: John Prentice

On-ground implementation has been teamed with research and monitoring and any findings are integrated back into the program. For example, research found that small fish species, such as Carp gudgeon, Murray rainbowfish and Unspecked hardyhead, once believed not to be migratory had, instead, been trapped from migratory behaviour by barriers. In response, duel fishways have been developed incorporating a system that resembles a 'fish elevator' that can readily transport fish from one level to the other.

Progress to date

The Sea to Hume Dam program has resulted in a highly successful restorative program. A large number, high diversity and a wide size range of fish - from 40 millimetres to 1 000 millimetres long-are passing through the fishways.

The passage of smaller-sized fish is particularly important in terms of progress in this field as small-bodied species and immature large-bodied fish also need to migrate upstream to complete various stages of their life cycle.

The on-going monitoring is beginning to demonstrate a change in riverine fish communities as a result of the fishways that now allow for migration of fish species. Other benefits are likely to be observed over time through continuation of monitoring and research following the implementation of fishways.

Further research is required to support the development of more efficient fishway designs at a lower cost and to help gain a greater understanding of native fish populations.

Aerial view of Lock 7. Photo: John Prentice

Monitoring and research links

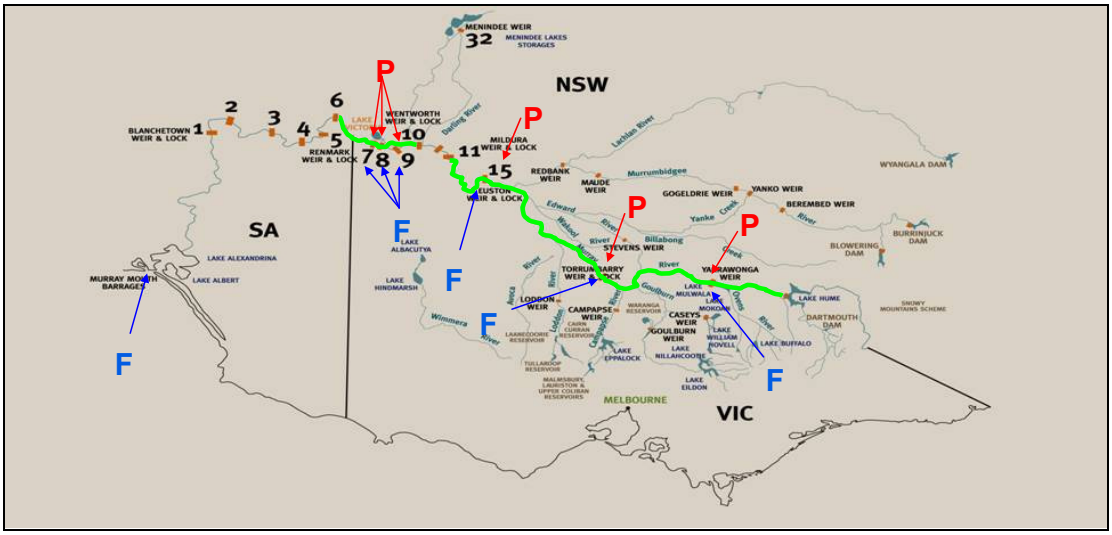
Monitoring and research are integral to the Sea to Hume Dam program. Knowledge generated through research findings associated with the program is constantly introduced back into the program through the adaptive management process.

Tagged Carp release. Through the PIT system, a tagged fish can be tracked along the Murray River for its lifetime providing ecological data for fishway design, river and habitat management, environmental flows, and optimising weir operation to enhance fish passage. Photo: Invasive Animals CRC

For example, a lock manager observed that concentrations of carp were occurring at fishways. From this observation a new approach to carp management was developed to take the place of the labour intensive and less humane trapping method. The ‘William’s carp separation cage’ was trialled and found to be a highly effective way to separate and capture carp whilst avoiding capture of native fish.

The program is supported by the monitoring of fishway operations through passive integrated transponder (PIT) tags and readers, and a database to store, analyse and disseminate the information.

It is intended that PIT tag reader systems will be installed and maintained at all fishways between the sea and Hume Dam. To date, PIT systems have been installed at Lock 7 to 10, Lock 15, 26 and at Yarrawonga Weir. The system monitors fishways for any of the 20 000 fish that are PIT tagged in the River.



Map describing the location of Sea to Hume Dam program Fishways (F) and PIT tag reader systems (P)

Lessons learned

Fishways have been used on the Murray River since the 1930s. These early designs were imported from northern hemisphere prototypes that worked well with the powerful upstream swimming abilities of the Northern Hemisphere salmon. It was soon observed that in the Australian context, these fishways provided passage only for larger native fish.

In the 1980s, greater knowledge was gained through observation and experimentation about the swimming abilities and behaviour of native fish in fishways. This knowledge was applied to the MDBC funded fishway constructed at Torrumbarry Weir in 1990.

Through the adaptive management process new findings are constantly emerging from the program and employed practically. In so doing, the Sea to Hume Dam program not only supports the implementation of fishways along the Murray but also adds to vital ecological understandings associated with native fish and habitat of the Murray River.

Further reading

Barrett, J., Baumgartner, L. J., Boys, C., Mallen-Cooper, M., Stuart, I. G. and Zampatti, B.P. (2008) 'The Need for Fish Passage in the Murray-Darling Basin', in *The Sea to Hume Dam: Restoring Fish Passage in the Murray River*, ed. J. Barrett, pp. 1-10, Murray-Darling Basin Commission, Canberra, ACT.

Cadwallader, P. and Lawrence, B. 1990, 'Fish', in *The Murray*, eds. N. Mackay and D. Eastburn, Murray-Darling Basin Commission, Canberra, ACT.

Mallen-Cooper, M. (1999) 'Developing Fishways for Nonsalmonid Fishes: a Case Study from the Murray River in Australia', in *Innovations in Fish Passage Technology*, ed. M. Odeh, pp. 173-195, American Fisheries Society, Bethesda, Maryland.

Mallen-Cooper, M. (2000) 'Taking the Mystery out of Migration in Fish Movement and Migration', in *Australian Society for Fish Biology Workshop Proceedings*, eds. D.A. Hancock, D.C. Smith and J.D. Koehn, pp. 101-111.

Murray-Darling Basin Commission (2003) *Native Fish Strategy for the Murray-Darling Basin 2003-2013*, Murray-Darling Basin Commission, Canberra.

Murray-Darling Basin Commission (2008) *The Sea to Hume Dam: Restoring Fish Passage in the Murray River*, Murray-Darling Basin Commission, Canberra, ACT.

O'Connor, J. P., O'Mahony D. J. and O'Mahony J. M. (2005). 'Movements of *Macquaria ambigua* in the Murray River, south-eastern Australia' in *Journal of Fish Biology*, vol. 66, pp. 392-403.

Contact information

For further information contact the Murray-Darling Basin Authority on telephone (02) 6279 0100, or if telephoning from outside Australia: + 61 2 6279 0100, or visit the website at http://www.mdba.gov.au.