Review of native fish habitat associations and development of guidelines for fish habitat management in the Murray-Darling Basin

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Introduction

The rivers of the Murray-Darling Basin have undergone significant change since the arrival of Europeans. Degradation of in-stream habitat began as early as the 1850s when systematic de-snagging of the lower reaches of the Murray, Darling and Murrumbidgee Rivers commenced to improve passage and aid navigation for paddle steamers. Habitat degradation has continued on various scales to the current day. The construction of large dams and small weirs along most rivers in the Basin, particularly those in the southern Basin, has created barriers to fish passage and contributes to thermal pollution as a result of cold water releases. River regulation has also resulted in changed flooding regimes, shifts in the seasonality of flow, and generally an overall reduction in flow as a result of abstractions for agricultural development. Catchment clearing, erosion and increased salinity are also contributing to a decline in the health and ecological integrity of many rivers in the Murray-Darling Basin.

Native fish have been severely impacted upon by river degradation and in particular loss of habitat, changed flow regimes and barriers to passage. Many native fish are now listed as threatened under State and Commonwealth Threatened Species legislation. The loss of habitat through de-snagging, altered flow and temperature regimes, the loss of riparian vegetation and barriers to passage are considered key processes threatening the survival of native fish and native fish communities in the Murray-Darling Basin. In addition, exotic species compete with native fish for habitat and resources.

Much research has been conducted on the biology and life history of native fish, including the habitat requirements of several key species. For example, it is now known that several species may migrate large distances to spawn, have distinct territories associated with particular habitats and use different habitat types at different life history stages.

As a consequence of recent research, efforts are being made to restore appropriate habitat, such as large woody debris (LWD), reduce impediments to passage through the construction of fishways on key barriers, re-establish connectivity between river and floodplain environments and restore elements of the natural flow regime that trigger key life history stages such as migration and spawning. However, there are still key knowledge gaps in the specific biology and habitat requirements of many native fish species, and there are only limited guiding principles to assist fisheries and waterway managers in habitat management and restoration. While some guidelines for habitat management exist there is no single set of guiding principles for native fish habitat management across the Murray-Darling Basin.

Two recent projects have attempted to address the above knowledge gaps by providing a review of the habitat associations of native fish in the Basin and through the development of guidelines for native fish habitat management and restoration. The outcomes of these two studies provide a useful resource when developing restoration plans. Understanding the specific habitat needs of different species ensures that works can be targeted at restoring the specific habitats required by target species, and the guidelines provide a framework and direction for maximising success of any restoration project.

An additional outcome of the habitat review study was the compilation of a database of habitat associations. The database provides easy access to information on habitat associations of native fish in the Basin, for incorporation in the setting of restoration objectives and development of habitat restoration and management plans.

An overview of each study is provided below and copies of the two reports are provided on the CD accompanying these proceedings.

Native Fish Habitats Requirements study

Objectives

1) Document key ecological, biological and habitat information which allows insight for future research, investigations and best practice management of native fish in the Basin; and

2) Identify the gaps in our current suite of knowledge on the fish habitat requirements in the Basin.

Key tasks

- Undertake a literature review of available information of native fish within the Basin;

- Document and collate the information on each species, setting out comparisons on life history or other requirements to assist the development of management guidelines;

- Clearly document the sources of information: e.g. that which is sourced from published information (using references) and that which is derived from expert opinion;

- Assess information to identify gaps and identify workshop participants who can contribute to gap filling from their experience and expertise;

- Undertake a specialist workshop to assess information brought together, identify gaps and infill gaps using expert opinion;

- Prepare a list of project ideas for future studies; and

- Prepare a report summarising work undertaken.

The fish habitat review involved the collection and compilation of information on fish habitat use from various literature sources and through discussions and a workshop with fish researchers. The review provides a discussion on the types of habitat important for fish and how different life history stages use different habitat, and a compilation of our current state of knowledge on the habitat associations for each life history of each species (**Table 1**).

Table 2. Native fish recorded in the Murray-Darling Basin

Family	Scientific name	Common name
Ambassidae	*Ambassis agassizii*	olive perchlet
Anguillidae	*Anguilla australis*	short-finned eel
Anguillidae	*Anguilla reinhardtii*	long-finned eel
Atherinidae	*Craterocephalus amniculus*	Darling River hardyhead
Atherinidae	*Craterocephalus fluviatilis*	Murray hardyhead
Atherinidae	*Craterocephalus stercusmuscarum fulvus*	fly-specked hardyhead (southern form)
Bovichthyidae	*Pseudaphritis urvilli*	tupong/congolli
Clupeidae	*Nematalosa erebi*	bony herring
Eleotridae	*Hypseleotris* sp.	carp gudgeons
Eleotridae	*Mogurnda adspersa*	southern purple-spotted gudgeon
Eleotridae	*Philypnodon grandiceps*	flat-headed gudgeon
Eleotridae	*Philypnodon* sp.1	dwarf flat-headed gudgeon
Gadopsidae	*Gadopsis bispinosus*	two-spined blackfish
Gadopsidae	*Gadopsis marmoratus*	river blackfish
Galaxiidae	*Galaxias brevipinnis*	climbing galaxias
Galaxiidae	*Galaxias fuscus*	barred galaxias
Galaxiidae	*Galaxias maculatus*	common galaxias
Galaxiidae	*Galaxias olidus*	mountain galaxias
Galaxiidae	*Galaxias rostratus*	flat-headed galaxias
Galaxiidae	*Galaxias truttaceous*	spotted galaxias
Geotriidae	*Geotria australis*	pouched lamprey
Melanotaeniidae	*Melanotaenia fluviatilis*	Murray-Darling rainbowfish
Mordaciidae	*Mordacia mordax*	short-headed lamprey
Nannopercidae	*Nannoperca australis*	southern pygmy perch
Nannopercidae	*Nannoperca obscura*	Yarra pygmy perch
Percichthyidae	*Maccullochella macquariensis*	trout cod/bluenose cod
Percichthyidae	*Maccullochella peelii peelii*	Murray cod
Percichthyidae	*Macquaria ambigua*	golden perch
Percichthyidae	*Macquaria australasica*	Macquarie perch
Percichthyidae	*Macquaria colonorum*	estuary perch
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's tandan
Plotosidae	*Tandanus tandanus*	freshwater catfish
Retropinnidae	*Retropinna semoni*	Australian smelt
Terapontidae	*Bidyanus bidyanus*	silver perch
Terapontidae	*Leiopotherapon unicolor*	spangled perch

The compilation includes information on physical habitat requirements but also water quality tolerances and triggers for migration and spawning. Information on the quality or source of reference material used is provided in the form of annotated citations. All of the information provided for each species has also been included in an Excel database that the Murray-Darling Basin Commission will place on its Internet site (**Table 3**).

Table 3. Example of output from native fish habitat database

Species		Spawning	
1.2.1. Trout Cod		Pre-spawning migration	No evidence of migration associated with spawning (35, 36)
		Timing of migration	—
Taxonomy		Migration trigger	—
Family	Percichthyidae	Spawning season	Spring, 2-3 weeks earloer than Murray Cod (45, 78)
Scientific name	*Maccullochella macquariensis*	Spawning trigger	Increasing water temperatures & day length (35, 38, 78)
Other names	Bluenose Cod	Spawning site	Adhesive eggs layed on hard substrates & inside hollow logs (45, 154)
		Post-spawning migration	Not recorded
Conservation status		Parental care	Not recorded
World Conservation Union	Endangered	Other	—
National	Endangered	**Larvae and Juveniles**	
Australian Society of Fish Biology	Critically endangered	Movement	Proportion of lavae drift downstream during spring & early summer (98)
Queensland		Habitat	Found in adult habitat & also amongst small debris & sandy beaches (335)
New South Wales	Endangered	Temperature range	Data deficient
Australian Capital Territory	Endangered	Salinity tolerance (mg/L)	Data deficient
South Australia	Protected	DO tolerance (mg/L)	Data deficient
Victoria	Critically endangered (L)	Other	—
Distribution		**Adults**	
Upland	*	Habitat	Deep water, fast flowing streams with complex woody debris or boulders (36, 78, 144, 225)
Midslope	**	Temperature range	Data deficient
Lowland	*	Salinity tolerance (mg/L)	Data deficient
* Partial association		DO tolerance (mg/L)	Data deficient
** Strong asociation		Other	Territorial with high site fidelity (35, 78)

Table 3. Example of output from native fish habitat database (continued)

General summary
The Trout Cod is endemic to the south-eastern region of the Basin. The range and abundance of Trout Cod has declined since European settlement. There are only two self sustaining populations remaining in the wild, a remnant population in the Murray River between Yarrawonga and Tocumwal and a translocated population in the upper reaches of Sevens Creek near Euroa in Victoria. There are also a number of stocked populations in Victoria, NSW and the ACT. Historically, Trout Cod inhabited the Murray River from Mannum in South Australia to above Yarrawonga Weir. Natural populations also occurred in the upper Murrumbidgee River and Macquarie River catchments but are now believed to be extinct, although stocking has occurred in these rivers in recent years. Their distribution has probably changed due to translocation into other waters, for example Cataract Dam on the Nepean River. Trout Cod are often found associated with logs or accumulations of woody debris in rapidly flowing streams with rocky or gravel sub

Summary of key threats
The key threats to this species include their restricted distribution and isolation between existing populations and habitat degradation, particularly loss of snag habitat. Fishing pressure may have contributed to declines in populations, but all populations are now protected from fishing. They are endangered throughout their range and are listed as Endangered Nationally (under the *EPBC Act 1999*) and Endangered in both NSW and the ACT (listed under the NSW *Fisheries Management Act 1994* and the ACT *Nature Conservation Act 1980*). They are protected under the South Australian *Fisheries Act 1982* and listed under the Victorian *FFG Act 1988*. They are considered Critically Endangered in Victoria.

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Development of best practice principles, guidelines and practices for native fish habitat management

Objectives

1) Review known information on Murray-Darling fish habitat requirements; and

2) Develop best practice principles, guidelines and practices for fish habitat management.

Key tasks

- Undertake a literature review of available information of native fish within the Basin;

- Use this information to develop best practice principles, guidelines and practices for native fish habitat management to be used by environmental, fisheries and waterway managers;

- Undertake a specialist workshop to assess the proposed management guidelines and identify any knowledge gaps required for future management of native fish habitat;

- Prepare a list of project ideas for future studies; and

- Prepare a report summarising work undertaken.

The habitat management guidelines provide an overview of the processes that contribute to fish habitat degradation and the impact that this has on fish abundance and diversity. Freshwater ecosystems are under pressure from changes as a result of many impacts. There are a number of processes that cause degradation of fish habitat. Many of these are associated with landuse practices and river regulation. These can include land clearing, desnagging, wetland drainage and river works. In addition, the introduction of alien species can adversely influence native fish habitat. Changes brought about by these processes can result in changes to channel morphology, natural flow regimes and may cause bank erosion, eutrophication and sedimentation. Habitat degradation has many negative impacts on native fish species. It may cause changes in the population and community trophic structure, alter inter- and intra-species competition, affect spawning success and cause

local extinction of sensitive species. Changes to physical habitat, pressures from introduced species, poor water quality and river regulation have contributed to a decline in the abundance and diversity of native fish communities throughout the Basin.

There is already a range of guidelines available to waterway managers for managing and restoring habitat. Some of these guidelines are targeted at specific habitat restoration activities or at protecting specific habitats, while others provide general protocols and tools for planning and undertaking general restoration projects.

The guidelines developed for this study draw on these previous guidelines and suggest a process to follow when undertaking specific fish habitat management or restoration projects. They provide general technical advice and links to more detailed technical advice for undertaking specific activities, for example resnagging, where such technical guidelines already exist.

A strong focus of the guidelines is the identification of achievable management or restoration objectives based on a sound understanding of the condition of a particular system and knowledge of the expected response from management intervention. The success of a project can thus be determined based on the development of clear objectives or hypotheses and an appropriate design and monitoring program that allows objectives and hypotheses to be tested.

The process for undertaking a management or restoration project is outlined in **Figure 1** and follows the general path of:

1) Defining the problem
   - Describe past and existing fish communities and habitat condition.
   - Evaluate threats to fish communities and habitat — what are the factors limiting fish diversity?
   - Prioritise reaches for management.
   - Determine appropriate management objectives and develop hypotheses for testing the success of the project.

2) Developing the plan
   - Assess options for habitat management or restoration to meet objectives.
   - Develop the management or restoration plan.

3) Implementing, monitoring and evaluating the plan
   • Implement the plan, including pre-restoration monitoring.
   • Monitor the effects of the management and restoration activities and evaluate the outcomes by testing hypotheses.

The guidelines are targeted for an audience at the level of local Councils and waterway managers. They do not give the precise level of detail required to undertake a specific restoration project at a community implementation level (although detailed technical information and links to other technical guidelines are provided), but will assist this process by providing the framework and general information for approaching such a task.

Both studies have identified a number of key knowledge gaps and suggested projects to help fill these gaps.
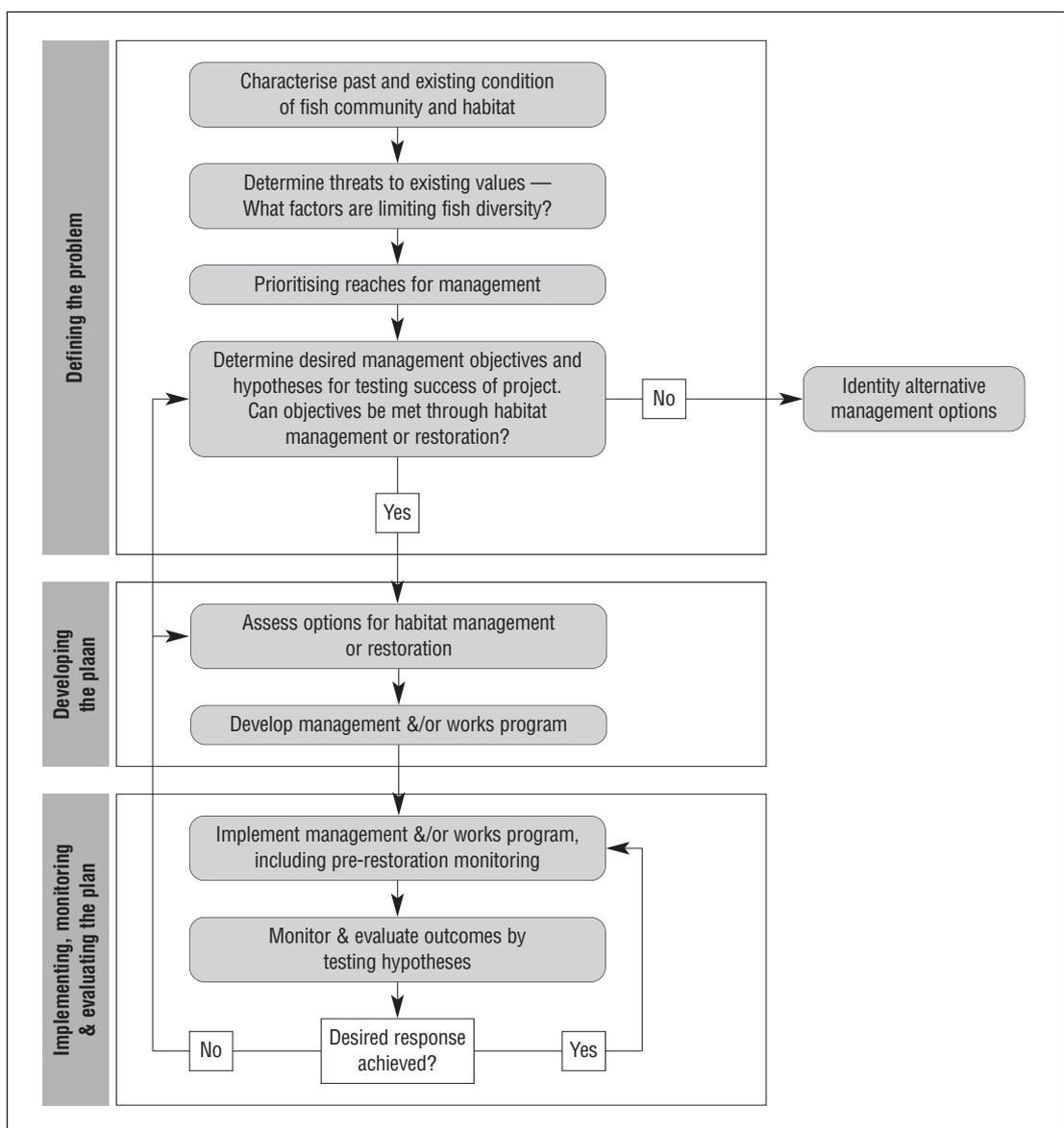

Figure 1. Process flow chart for undertaking fish habitat management & restoration