

Statement and Recommendations

INTRODUCTION

1. We, the participants of this workshop, met in Canberra on 3-4 June 2003 to review the latest international and local research information and hands-on experience in relation to the issue of downstream movement and dispersal of fish. In particular, the workshop considered the impacts caused by disruptions to life cycles and natural movement patterns through in-stream barriers and other water management practices.

SUMMARY CONCLUSIONS

2. It is acknowledged that considerable progress has been made in addressing problems with upstream fish movements, however, little effort has been focussed on downstream movement. While there are knowledge gaps (see below under specific recommendations), it is the considered view of the workshop that impediments to downstream migration, and water management and usage, are contributing to the overall decline of native fish populations across the Murray-Darling Basin. An immediate investment is warranted in a range of tangible and practical responses (see below under specific recommendations), and longer term investment to improve the knowledge base and incrementally fine tune the engineering and other measures that can be introduced.

3. We have noted that the recently adopted Native Fish Strategy for the Murray-Darling Basin 2003-2013 includes as Strategy Objective 5, *"To provide adequate passage for native fish throughout the Basin", and sets the target of by 2013 seeing "50% of migratory pathways and 50% of habitat for all native species currently affected by structural barriers reinstated"*; and we call upon the Commonwealth and relevant State and Territory Governments, the Murray-Darling Basin Commission, research institutions and other stakeholders within the Murray-Darling Basin to support the implementation of the Native Fish Strategy to achieve this target.

4. The workshop participants have concluded that while the Commonwealth and relevant State and Territory Governments have at their disposal a range of legislative and administrative mechanisms to address, at least in part, the problems caused by barriers and impediments to downstream movement by

fish, these tools are not being fully utilised for this purpose at present. These jurisdictions are urged to review their opportunities to apply these mechanisms, and to take forward appropriate actions as set out below in the specific recommendations. It is acknowledged that there are potential risks involved in remedying problems with downstream movement, but that the risks are outweighed by the benefits. Risks include facilitating the spread of alien species, diverting scarce resources from competing priorities and the potential for increased costs to water users.

5. It was the firm view of the workshop participants that along with pursuing engineering, legislative or administrative solutions, it will be critical to invest in a communication and education programme about the issue of downstream migration, stressing that the solutions needed in most instances have broad public good and can be undertaken as win-win options, not necessarily penalising any key stakeholders.

WHAT IS THE PROBLEM?

6. Barriers such as dams, weirs, levees, causeways, culverts and road crossings can stop the natural movement patterns of many native fish species within the Basin. Such barriers may prevent native fish from completing key components of their lifecycle. State/Territory agencies have recognised more than 4000 licensed barriers in the Murray-Darling Basin, although only a small number have implemented engineering works or operating procedures to mitigate their impacts on fish movements. The majority of actions addressing fish passage problems have focused on provision of upstream migration of fish past the barriers mentioned above. This workshop represents the first time a concerted effort has been made by a group of experts to consider the issue of downstream movement of eggs, larvae, juveniles and adult fish. *Movement* covers egg and larval dispersal, spawning migrations and return movements, foraging and home-range movement, as well as movements to seek refuge from poor environmental conditions. Migration is a subset of movement and has been defined as *movements resulting in an alternation between two or more separate habitats occurring with regular periodicity and involving a large fraction of the population* (Northcote 1978).



7. In summary, the workshop believes, based on current evidence and the combined international and Basin-wide experience of those present, that impeded downstream movement of eggs, larvae, juvenile and adult fish is contributing to the following problems:

- i. Removal of significant numbers of eggs, larval, juvenile and adult fish from the river population through irrigation and other water diversions;
- ii. High levels of mortality due to entrainment/diversion into unfavourable habitats such as turbines or irrigation channels;
- iii. Ongoing declines of native fish communities leading to reduced regional and Basin-wide economic output and social and cultural values (e.g. fishing, tourism)
- iv. Ongoing declines of native fish communities which is providing enhanced opportunities for the expansion of alien fish populations;
- v. Increasing vulnerability of isolated native fish populations to recover after unpredictable events/catastrophes; and,
- vi. Ongoing reduction of genetic diversity/altered traits through restricted access to spawning sites, limited population size and reduced capacity for egg/larval stages to drift.

WHAT WILL HAPPEN IF THE PROBLEM IS IGNORED?

8. Based on the collective experience and expertise of the 45 participants, the workshop has concluded that the following will result if this problem is ignored:

- i. Several of the currently threatened or endangered native fish species and aquatic ecological communities will continue to decline, possibly to the point of being unrecoverable;
- ii. With continuing declines in the breeding success of native fish, this can be expected to place increasing angler pressure on refuge areas, thus exacerbating the overall decline of native fish across the Basin;
- iii. Further processes occurring in the river, in addition to clearing of riparian vegetation, removal of woody debris and installation of instream structures, will be listed under appropriate

legislation as key threatening processes for native fish and other flora and fauna;

- iv. Reduced genetic fitness and diversity, increased genetic isolation and inbreeding depression due to population fragmentation of native fish. The combined impacts will reduce the resilience of the population;
- v. If native fish populations are not assisted to recover then they will not be able to compete with alien species such as carp: restoring native fish populations is part of addressing the carp problem in the Basin;
- vi. Without support (financial, resource and social) for addressing knowledge gaps so that better informed management decisions can be made, the risk of inappropriate developments (both in terms of type and location) will be greater and potentially have an escalating negative impact on native fish populations;
- vii. Delays in addressing the downstream migration problem will mean investment at some time in the future will have to be greater than it would if investments are made now;
- viii. Embarrassment for the Governments of the Murray-Darling Basin agreement that despite a Native Fish Strategy they have failed to turn around the decline of native fish populations in the Basin; and,
- ix. The wider community will not be aware of the problem and we may miss opportunities to engage them in potential solutions.

WHAT ARE THE GOALS, BENEFITS AND OPPORTUNITIES FOR ADDRESSING DOWNSTREAM FISH MOVEMENT AND WHO WILL BENEFIT FROM FIXING THE PROBLEM?

GOALS (in priority order)

1. Rehabilitate populations of native fish;
2. Legitimise downstream movement and abstraction as issues for native fish conservation;
3. Restore downstream movement of native fish;

4. Prevent diversions of native fish from the riverine ecosystem;
5. Improve understanding of downstream movement; and,
6. Ensure existing structures are operated and maintained to maximise upstream and downstream native fish passage.

BENEFITS

- Increase knowledge of native fish ecology;
- Understand the scope and scale of downstream movement;
- Rehabilitate native fish populations;
- Reduce the demand for stocking;
- Maximise use of resources (biological and financial);
- Enhance cultural and social values and benefits;
- Improve connectivity of isolated and/or threatened fish species/communities; and,
- Maintain genetic diversity of fish populations and species.

BENEFICIARIES

- Riverine ecosystems;
- Native fish; and,
- Fishers, tourism interests, lock staff, scientific community, water authorities, land users, future generations, regional communities etc.

OPPORTUNITIES

- Increase the knowledge base of how water use impacts on native fish ecology;
- Establish a set of demonstration sites under an adaptive management framework;
- Build on relationships between engineers, ecologists and water users to formulate criteria for construction, operation and management of structures;
- Set direction for the construction, operation and management of structures;
- Achieve fixes during structure upgrades;

- Training of river operators etc.;
- Removal of obsolete weirs;
- Interaction with rural communities regarding native fish issues;
- Capacity building, information sharing and community education;
- Improve environmental outcomes in related areas of natural resource management;
- Augment monitoring programmes to include downstream issues where practicable;
- Develop Basin-wide design criteria for new structures; and,
- Develop Basin-wide guidelines for prioritising structures for remediation of downstream movement and abstraction.

Specific recommendations

The workshop acknowledged that while there are significant knowledge gaps (see below), there are also a range of very tangible and immediate actions that can and should be taken to begin addressing the problems of downstream movement and dispersal (as outlined above).

WHAT CAN BE DONE NOW?

Communication - education

1. Develop a range of awareness raising and educational tools about downstream movement designed to target key stakeholder groups in the first instance, such as catchment boards/committees, irrigators, recreational anglers, local councils, NGO groups, lock masters etc.; and use appropriate meetings and workshops to present the key 'take home' messages about the issue.
2. Seek a well known public figure with credibility in matters of the natural environment to act as a champion for the issue.



- Promote downstream movement of native fish, recognising that the recovery of native fish populations will allow them to compete better with alien species.

Legislation - administration

- Pursue and promote, as a matter of urgency, the listing of appropriate native fish species and ecological communities under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* and other relevant State/ACT legislation, and the follow-up actions that would be required by such actions. Where States or the ACT have done this already (such as Victoria's listing of the Lowland Riverine Fish Community of the Southern Murray-Darling Basin under the *Flora and Fauna Guarantee Act* and New South Wales listing of the Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River under the *Fisheries Management Act 1994*), promote full implementation of the appropriate recovery plan action statement or threat abatement plan. Promote existing State/ACT legislation relevant to fish passage (**Table 1**).

Programme implementation

- Through the Natural Heritage Trust Extension and the National Action Plan for Salinity and Water Quality, seek to have downstream movement recognised among the management goals and objectives, and support (with communication-education materials * see above) the integration of appropriate actions into regional natural resource and catchment management plans.
- As part of the Living Murray Implementation Programme, pilot test, in collaboration with irrigators and local councils, modified water extraction regimes to establish how altered diurnal or seasonal patterns could benefit the spawning of native fish species.
- For the current and future fish passage installations across the Basin, seek opportunities when monitoring upstream migration to also examine downstream movement patterns.
- Undertake an assessment of each barrier/structure to identify options for assisting downstream movement (engineering, operational, bypass through floodplain

Table 1. Legislation in each Basin jurisdiction and whether it applies to issues of threatened species and communities, threatening processes and fish passage

	Threatened Species	Threatened Communities	Threatening Processes	Fish Passage
Commonwealth				
<i>EPBC Act 1991</i>	Yes	Yes	Yes	Potentially
NSW				
<i>Fisheries Management Act 1994</i>	Yes	Yes	Yes	Yes
VIC				
<i>Flora and Fauna Guarantee Act 1988</i>	Yes	Yes	Yes	
QLD				
<i>Nature Conservation Act 1992</i>	Yes	No	No	No
<i>Fisheries Act 1994</i>	No	No	No	Yes
SA				
<i>Fisheries Act 1982</i>	Yes	Yes	Potentially	Potentially
<i>SA River Murray Act 2003</i>	Yes	Yes	Yes	Yes
<i>National Parks and Wildlife Act 1972</i>	Yes	No	No	No
ACT				
<i>Nature Conservation Act 1984</i>	Yes	Yes	Yes	
<i>Water Resources Act 1998</i>	No	No	No	Yes

wetlands etc.), and establish priorities for attention during the life of the current Native Fish Strategy (until 2013) and Living Murray Programme.

9. Seek to include downstream movement options as part of the demonstration reaches to be supported through the Native Fish Strategy, and showcase these as win-win situations.

10. Identify priority structures which can be addressed as 'downstream passage' demonstration sites.

to determine a population rather than an individual response;

- c) There is a need to ensure that a focus on iconic or endangered fish species does not overlook the less obvious or non-threatened species;
- d) A sustained research and monitoring effort is required. There will be no quick fix; and,
- e) Laboratory investigations have an important part to play, particularly where threatened or hard to locate species are involved, or to trial direct manipulation of factors affecting responses such as flow rate, velocity, turbidity. Laboratory studies will also facilitate the trialling of new designs for structures.

Knowledge gaps

11. Establish a long-term Research and Investigations programme through the Murray-Darling Basin Commission and other relevant organisations and institutions to address the key knowledge gaps listed in **Table 2**. The key research questions have been grouped into three categories which address knowledge gaps dealing with aspects of fish life-history, improving the understanding of systems, and management options/actions. The workshop participants assigned an initial priority rating to each research question (1, 2, or 3 with 1 being highest), but it must be recognised that these priorities may change with increasing knowledge. While the list of research questions is substantial, the problem is not insurmountable and an incremental, long-term approach is required. There is no short-term research programme that will give the 'final' answer.

Several issues/comments were also highlighted which relate to research approaches or considerations that may be important.

- a) There has been no research undertaken on the impacts of high dam structures on downstream movement and only a single study on the impacts of undershot and overshot weirs;
- b) Marking techniques such as radiotelemetry and pit-tagging are important for monitoring individual fish movement. However, there is a need to mark a significant proportion of the fish population and then monitor movements



Table 2. Key research questions to address knowledge gaps for downstream movement of fish.

Life-History	
Research Question:	Priority
What is the purpose/function of drift for eggs and larvae? Is it: <ul style="list-style-type: none"> • migration to different habitats? • dispersal away from spawning site? • feeding/foraging movements? 	1
What distances do larvae move?	1
What triggers larvae to drift?	1
It is critical to build a comprehensive understanding of life history for most species, starting with iconic (Murray Cod) or threatened species (Trout Cod, Murray Hardyhead) and not forgetting diadromous spp.	1
Where do larvae settle out and why? Is it habitat related, larval development stage related or other?	1
Can we identify critical sites for spawning/recruitment to give these sites special management attention?	1
What is the purpose of downstream movement for adults and juveniles? Is it for migration, feeding or other reasons, and what are the consequences if they cannot move downstream?	1
A better understanding of the geographic variation in fish life-history is needed so that local or regional solutions can be used where necessary.	2
What happens to the larvae of Golden and Silver perch which at present are not being detected in large numbers?	3
There is a need to resolve taxonomic issues (Carp gudgeons etc.) so that research programmes can accurately address life-history difference between closely related species.	3

Understanding	
Research Question:	Priority
What are the impacts of barriers on drifting eggs? Is there a relationship between mortality due to weirs and other environmental stressors such as: <ul style="list-style-type: none"> • thermal pollution, and • hydraulic factors/effects? 	1
What are the injury and mortality levels for each species caused by weirs and other barriers, and what are the effects of: <ul style="list-style-type: none"> • structure type; • passage mechanism (through or over), and • pool effects? 	1
Knowledge is required for all dimensions of movement (temporal, vertical, lateral and longitudinal).	1
A robust large-scale conceptual model of fish community dynamics is needed for the Basin.	1
There is a need to examine adult behavioural modification caused by structures (eg refusal to pass over a structure) and experience with capture techniques and those structures, and the relationship of such behaviours with flow.	1
What are the impacts of sex and size classes/life history stages on movement patterns?	1
There is a need to understand and document the relationships between fish populations within the Basin.	2
What are the impacts of impeded downstream movement on other aquatic species (including invertebrates)?	2
Are there indirect impacts of increased predation due to 'stunning' of fish when going over low-head weirs?	2
How much positional control do larvae have about where they drift in the water column	3
What are the food chain impacts of losing larvae?	3

Table 2. cont. Key research questions to address knowledge gaps for downstream movement of fish.

Management Options / Actions	Priority
Research Question	Priority
There is a need to document the present level of mortality across the Basin at staffed structures.	1
There is a need to review the literature related to prevention of entrainment for aquatic fauna and prepare a scoping document for use by managers and engineers (see Appendix 1).	1
What are the effects of low-head hydro-electric plants on downstream movement ?	1
What is the relative mortality of different engineering approaches ? There is a need to review the literature and then conduct targeted studies for Australian fish species and structures/ivers.	1
Which fish species and what life-history stages are in irrigation channels?	1
There is a need to investigate options for environmental flows to address downstream issues.	1
What are the best management options to assist downstream movement – operational versus engineering	1
There is a requirement for an assessment of the economic value of fish or habitat 'lost'. What is the dollar value of the fish that are in the river ? What would it cost to breed and rear the fish that are removed or killed ? How much would it cost to restore the lost habitat?	1
What is the impact on fish of removing 70-80% of water from the river ? Water abstractors are licensed to remove or divert water, not water and fish.	1
Is there a requirement for national regulation for protection of fish throughout the Basin to ensure they cannot be removed from natural channels?	1
There is a need to measure larval extraction rates through irrigation, town water offtakes etc to gain a clearer understanding of the impacts of water larval extraction on the fish population, and to design improved approaches to reduce this impact, if warranted (see above also regarding 'pilot testing').	1
Downstream movement could be a vector for alien fish species to disperse, and innovative management arrangements could be used to limit range expansion of alien species.	1
Are there biases present in the current sampling methods, and if so, how can these be overcome to give realistic estimates of abundance and species composition of fish moving downstream ?	3

