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The Mark V Williams' cage for co-ordinated trapping of Murray fishways

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A report to the Murray-Darling Basin Authority
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EXECUTIVE SUMMARY

New fishways that restore longitudinal connectivity along the Murray River will be a major outcome of the Murray-Darling Basin Commission's *The Living Murray* environmental works and measures program. Trapping fish is an important method of demonstrating fishway success and river restoration over time. It is essential that trap construction, fishway trapping and data recording be standardised along the Murray River to ensure results are comparable across locations and time. This report details a staged process for developing the Mark V Williams' cage and standardising trapping arrangements across the 14 Murray River weirs and 5 tidal barrages. It also describes an approach for consistent monitoring across sites that involves data collection by weir keepers.

In April 2008, the Mark V Williams' separation cage was commissioned at Lock 10 representing the final iteration required in applying this innovation broadly across Murray-Darling fishways. The Mark V technology has a number of advantages over the Mark IV within-channel cage:

1. it can operate on the exit of any fishway type (Denil, vertical-slot, lock) and exit configuration,
2. more carp and native fish biomass can be held,
3. the trapped biomass would be held in lower water velocity conditions,
4. native fish are exited into the weir pool rather than into the fishway,
5. the Mark IV cage is more transferable among exits or different fishways, and
6. access and removal of carp is more efficient.

Co-ordination of cage construction has resulted in high quality monitoring cages being delivered at Lock 1 and these can be transferred to other sites. After an audit of all 22 cages along the Murray River the present project identified areas where the long-term weir keeper data collection part of the program can be streamlined. There is also a greater need for protocols in long-term monitoring and data recording at Murray fishways. These protocols are provided herein and are important for demonstrating achievement of the objectives of the fishway construction program and to maximise the benefits of long-term weir keeper data collection and monitoring.

Priority recommendations

- Adopt the Mark V Williams' cage at key weirs fishways (priority is Locks 7–9).
- Adopt a standard mesh size (25 mm square) for weir keeper monitoring and monitoring/reporting protocol at each weir.
- Tri-state monitoring cages require a smaller mesh size of (4 mm square).
- Incorporate monitoring cages into fishway construction contracts.
- Design of new fishway carp cages and tri-state trapping and monitoring arrangements.
- Institute a cage maintenance and replacement schedule.
- Weir staff duties should formally include fishway operations and the state agencies (i.e. SA Water) might also consider a staff member whose primary role is co-ordination of fishway and cage operations.

INTRODUCTION

New fishways that restore longitudinal connectivity along the Murray River will be a major outcome of the Murray-Darling Basin Commission's (MDBC) *The Living Murray* environmental works and measures program (Barrett 2008). The fishways will increase access to new habitats, improve breeding opportunities and dispersal from natal areas, while also promoting genetic exchange and reduced predation below weirs. The tri-state fishway assessment team is documenting the benefits to native fish populations and the major objective of passage for whole fish communities has set a worldwide benchmark in fishway technology (Barrett and Mallen-Cooper 2007, Barrett 2008, Stuart et al. 2008).

To date, the MDBC's 'Sea to Hume Dam' fishway program has completed seven new fishways at Locks 1, 7, 8, 9, 10, and 15, and there are three new fishways at the Murray barrages. Fishways at the remaining riverine structures (Locks 2–6 and 11) and others at the Murray barrages will be completed by 2011. The tri-state monitoring team will assess the fishways using monitoring cages and deliver on the objectives of the A$60 million program.

Trapping fish is an important method in demonstrating fishway success and river restoration over time (Mallen-Cooper and Brand 2007). Fishways can also provide an important opportunity to remove the non-native species, the common carp (*Cyprinus carpio*) (Stuart *et al.* 2006; Jones and Stuart 2008). For both monitoring and carp removal purposes it is essential that trap construction, fishway trapping and data collection are standardised across the many locks and weirs of the Murray River. This report investigates a staged process for developing the Mark V Williams' cage and standardising trapping arrangements across the 14 Murray River weirs and 5 tidal barrages. The report consists of three chapters with each chapter addressing one of the three major project objectives:

1. To assess the feasibility of a new weir Williams' cage (Mark V) design at Lock 10 for broader application on Murray-Darling Basin fishways.
2. To provide central co-ordination for design, construction, operation and maintenance of fishway monitoring cages including a procedure for standardised data collection by weir keepers. This includes generalised specifications for current and future monitoring traps at all Murray fishways and a maintenance/ replacement strategy.
3. To support the tri-state fishway assessment team and lock masters along the River Murray in the design, construction and operation of monitoring and carp cages including data collection.

PART A: MARK V WILLIAMS' CAGE TRIAL

Background

The Williams' cage was named after Alan Williams, a weir keeper at Torrumbarry, who designed the initial carp separation cage based on his observations of carp behaviour. Williams noted that carp jumped out of the water in a bid to escape, whereas this behaviour is not displayed by native fish. The Williams' cage is designed to separate jumping carp from non-jumping native fish. This aids the selective removal of carp from waterways while allowing passage of native species. The species and abundance of individuals passing through the cage can be assessed and so the cage is an important tool of fish monitoring programs. Williams' cage designs have undergone five iterations. This report describes the design and use of the fifth iteration, the 'Mark V Williams' cage'.

The success of the Mark IV Williams' separation cage (Figure 1) was somewhat reduced because the technology was only suitable within a long (4-6 m) open fishway channel. It was not applicable in Denil, lock or vertical-slot designs where the baffles extended to the exit. To redress this deficiency, Mr Alan Williams of Goulburn-Murray Water built a scale physical model of a new weir pool separation cage (Mark V) in 2007. This model operated as a proof-of-concept. The Mark V design could potentially advance the 'within-channel' Mark IV cages which had a limited rollout. The Mark V design works on the same 'carp jumping' principle but is operated in the weir pool as this location negates an extra long and expensive fishway exit channel.

In addition, the Mark V design has several other potential advantages over previous versions:

1. it can operate on the exit of any fishway type (Denil, vertical-slot, lock) and exit configuration,
2. more carp and native fish biomass can be held,
3. the trapped biomass would be held in lower water velocity conditions,
4. native fish are exited into the weir pool rather than into the fishway,
5. the Mark IV cage is more transferable among exits or different fishways, and
6. access and removal of carp is more efficient.

A short field trial phase was needed with a fully functional cage prior to adoption of the Mark V principle. The aim of this part of the project was to construct and assess a Mark V Williams' cage for broader application and to scope its feasibility at other Murray-Darling fishways.

Methods

A small project team was formed consisting of Ivor Stuart (Kingfisher Research), Alan Williams (GMW) and Noel Christie (Christies Welding Services Pty Ltd, Echuca). The team met at Lock 26 in September 2007 to discuss the Mark V system and sketch a concept plan for application at Lock 10. The construction company then visited Lock 10 to take on-site measurements of the fishway exit and draw detailed cage plans, prior to construction. A 'stop–go' construction process was initiated which relied on

regular inspection from Alan Williams. The cage was delivered to Lock 26 in January 2008. The team then met again on-site to commission the cage in the Lock 26 weir pool and detail the float system and mounting arrangement. The float system was then manufactured, installed and commissioned on-site at Lock 26.

In early April 2008, the cage was transferred to Lock 10 for the field trials. The Mark V cage was installed, commissioned and assessed during the week of 21 April 2008 by a team consisting of the lock keepers (NSW State Water), Ivor Stuart and Alan Williams. The Lock 10 staff then continued monitoring the function of the Mark V Williams' cage. The total cost for cage manufacture and transport was approximately A$18,000.

Design and construction

The design specifications of the Mark V Williams' cage were a 1.8 m square frame built from aluminium to limit the weight of the system. The cage was constructed from 75 mm square tube and was covered on three sides with 25 mm diamond security style aluminium mesh. The fourth side, which would face downstream, had no wall. The whole cage sat on an aluminium sheet base and pivoted longitudinally so the cage could be manually tipped to an angle of approximately 50°. The cage also incorporated a funnel to reduce fish escape. The funnel tipped with the rest of the cage and this innovation enabled release of native fish directly into the weir pool (Figure 1 & 2). The Mark IV Williams' cage, for within fishway channel use, is shown for comparison (Figure 3).

A frame was bolted to the concrete perimeter to fit the Mark V Williams' cage to the fishway exit. The frame incorporated two channels into which the Williams' cage slotted using rollers on each corner. The rollers allowed the cage to be adjusted to the height of the weir pool and also, to raise the trap for monitoring fish numbers. The frame also incorporated a full-width ramp which led fish into the trap and blocked any escape route between the frame and the cage. The application of a generic frame at each fishway site will enable the cage to be fully transferable among fishways.

Figure 1: The new Mark V Williams' cage during construction. Figure A shows the upright fish catching position while Figure B shows the side tipped native fish release position. Numbers indicate: 1) entry funnel position, 2) tipping cage, and 3) carp holding cage.

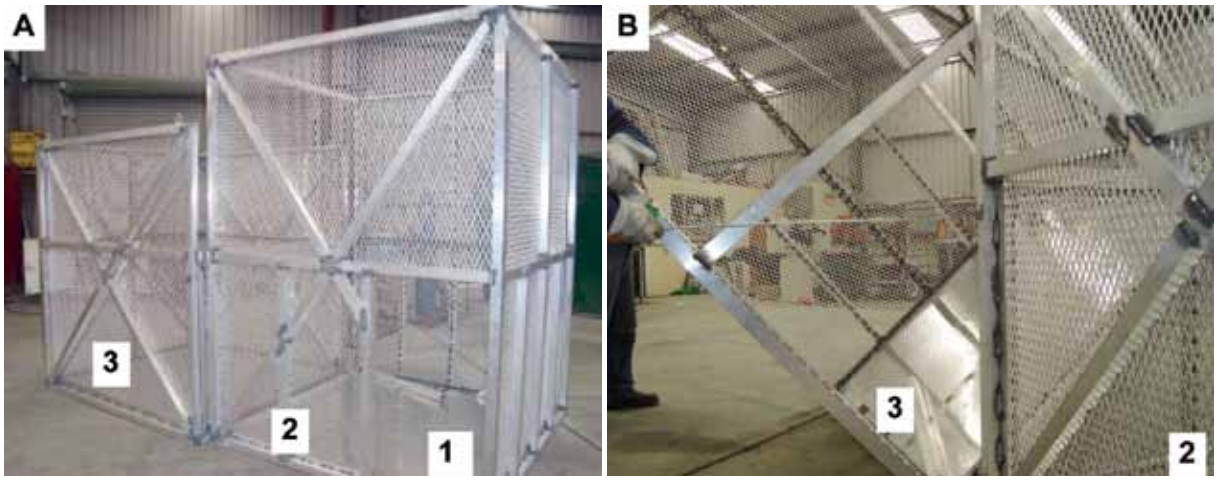


Figure 2: The new Mark V Williams' cage tested at Lock 10 in April 2008. This cage is used within the weir pool and is in the tipped or fish release position. The carp holding cage with the adjustable jumping baffle remains upright in the background.

Figure 3: The Mark IV Williams' cage at Lock 10. This cage can only be used within the fishway exit channel.

Carp holding cage

The second component of the Mark V Williams' cage is the holding trap for jumping carp and this incorporated the jumping baffle. This trap, and specifically the adjustable height jumping baffle, served as the fourth wall for the adjacent Williams' cage. The holding cage was 1.5 by 1.5 m and operated in approximately 1 m depth. The jumping baffle was set at approximately 0.15 m above the water surface and incorporated a full-width sloped aluminium non-return slide (0.4 m wide). This slide facilitated entry of jumping carp into the holding cage and negated their return. The holding cage can be disconnected from the Williams' cage and because this cage utilised floatation (Figure 4) it can be transferred in water to the most appropriate access area for carp processing. Plywood was used to block the other two sides of the cage to create a flow to attract fish.

Initial field trials on the Mark V cage

To test the exit success of native fish, the Mark V Williams' cage naturally collected approximately 30 bony herring and 3 golden perch migrating upstream through the fishway (set from 1520 on 21/4/2008 to 0920 on 22/4/2008). These fish were observed by slightly raising the Williams' cage (Figure 5). None of the fish were handled before the experiment as this would compromise their escape behaviour and fish counts without handling is an important goal of the project.

The bony herring were all approximately 150-250 mm FL with the exception of one larger individual (~350 mm FL). The golden perch were medium sized adult fish (~300-380 mm TL). The cage was manually tipped and all fish were allowed 10 minutes to escape before the Williams' cage was raised again and all the fish had exited. Follow up winter trials conducted each day by Lock 10 staff from April to August 2008 confirmed no fish remained in the Williams' cage after tipping.

Approximately 10 adult carp (to 600 mm long FL) were collected in the holding cage in the same sampling period without bycatch of native fish. There were no observations of non-jumping carp release from the tipping cage although many native fish were released from the tipping cage during the same period. It appears the Mark V technology is functioning to a satisfactory level (Norm Boyd, State Water, pers. comm.), although further testing by weir keepers in spring 2008 may provide useful information.

Figure 4: The Mark V Williams' cage showing flotation in the Lock 10 weir pool.

Figure 5: Catch of bony herring and golden perch in Mark V Williams' cage.

Discussion

The Mark V Williams' cage performed successfully, both from a design and biological perspective and is recommended for widespread adoption at Locks 7-10, 15, 26, Yarrawonga and elsewhere in the Murray-Darling Basin. The Mark V Williams' cage design will enable much broader application of carp control systems across the Murray-Darling Basin compared to the previous in-channel Mark IV design. Sites can now be assessed and prioritised for roll out of the system. The Mark V system, based on basic carp biology, is likely to be a key infrastructure component for controlling carp and the adaptable nature of the cage suits the flexible life history of the fish.

Two aspects were important to maximise the cage function: 1). Formation of a carp cage working team and the staged construction process, with regular 'stop–go' inspections by the team. 2). Support from the weir keepers was also important in refining the present Mark V cage design. This communication enables better co-ordination of the technical aspects of fishway monitoring and carp removal and helped delivery on the aims of the fishway program. Standardised long-term fishway monitoring and carp removal by weir keepers will be important legacies of this project.

Commercial uptake

The MDBC has engaged Dr. Peter Jackson, a fisheries consultant, to liaise with commercial carp fishers to provide direction in ethical disposal of carp at Lock 1 and other sites. Commercial carp removal at a series of fishways and weirs is both practical and structured with the development of the Mark V cage design. Use of the Mark V Williams' cage is being considered at other sites in the Murray-Darling Basin, including the Lachlan and Darling rivers.

Minor modifications to the Mark V design

A number of small low-cost modifications were identified for future cages during the construction and field testing processes:

- reviewing cross bracing locations,
- simplified hitch point between the holding cage and Williams' cage,
- installation of standard plastic mesh over the aluminium diamond mesh which reduces the chance of fish being caught in mesh,
- review the entrance funnel dimensions at each site, and review float arrangement at each site.

Long-term monitoring of fishways can provide important information for river managers on fish populations, fish response to flows and fishway function (Mallen-Cooper and Brand 2007). The Mark V cage can be operated automatically or manually while also serving as a monitoring cage for assessing movement of native fish. It is important that a standard mesh size is used to ensure monitoring is valid over time and across a range of sites. Given 25 mm mesh has been used at Lock 26 for 16 years, this mesh size would be the most appropriate for the long term monitoring data collected by weir keepers. A smaller diameter plastic mesh can be added to the cage internally as needed.

PART B: CO-ORDINATION OF THE FISHWAY TRAPPING PROGRAM

Background and approach

A co-ordinated is required across the three participating states (SA, Vic & NSW) to ensure the traps for Murray fishways are constructed to standard specifications.. This will minimise duplication of effort at particular sites and ensures trap construction complies with the on-site requirements of engineering quality, maintenance and safety, while applying the most appropriate designs for the target fish species. Some of these aspects may vary on a site-by-site basis but a co-ordinated approach will minimise variation for most purposes.

In June 2007, Mr Graeme Tregenza of SA Water completed a site inspection and questionnaire style audit of fishway traps between Goolwa and Lock 10 (Tregenza 2007). The audit identified a total of 22 traps and specific details for each site including the number and type of fishway trapping cage, the dimensions, and the program of use. A summary of all cage data, including at weirs upstream of Lock 10, are presented in Appendix 1. The audit was useful for identifying gaps in fishway sampling infrastructure, gathering comments about cage performance and identifying priority sites for Mark V Williams' cage use.

The tri-state monitoring team constructed most of the audited cages although some were made by weir keepers. Cages used for fishway monitoring have also been used for occasional manual carp removal but there are few dedicated Williams' cages. Three existing Mark IV in-channel Williams' cage designs are in use at Locks 1, 8 and 10. The Lock 10 cage was designed by Norm Boyd and Ivor Stuart but is not in use pending the Jackson report which will detail carp disposal solutions. A replacement schedule at Lock 26 has identified the need for a new Williams' cage.

Communication and identification of issues

Research agencies and weir keepers were regularly contacted to give and receive any feedback to the multiple agencies and groups involved. These include: River Murray Water, MDBC, Fish Passage Task Force Goulburn Murray Water, NSW State Water, Victorian Department of Communities, SA Water, NSW Department of Primary Industries, Victorian Department of Sustainability and Environment and the South Australian Research and Development Institute. These agencies express a common wish for standardised trap design specifications (i.e. mesh size and funnel dimensions) and monitoring/record keeping protocols for weir keepers. For long-term fishway monitoring the existing fishway cages must be used in a standardised manner and the daily effort (hours of trapping) recorded – *even when the catch is zero.* A lack of rigorous records on effort is a major problem in all areas of fisheries management, research and even commercial fishing.

Fish monitoring data needs to be submitted to the relevant state authority and is a condition of the permit. Without addressing these issues of consistency, there is a considerable risk that fish monitoring data would fail to be collected or that the data quality would not allow for any reasonable comparison among sites or over time.

Other issues raised included an occasional lack of trap maintenance, and varying motivation for trapping fish among the different sites. These problems were often related to the level of feedback about the trapping results and access to regular data summaries. These issues could be resolved with the plan outlined in Table 1, which requires continued involvement of weir keepers in the data collection monitoring program.

Table 1: A plan for long-term fishway monitoring.

1. Distribution/training with a standardised fishway data sheet
2. Distribution of a standardised fishway monitoring protocol (24 h trapping)
3. Standardised cages and mesh sizes for each site
4. Central collection point for monthly submission of data sheets/files
5. Timely feedback of results summaries
6. Monitoring results displayed on the MDBC website
7. Institute a small annual cage maintenance budget
8. Regular training through the annual weir keeper meetings
9. Maintain relevant state fisheries permit, notify compliance staff of trapping operations.
10. Continue training staff in fish tagging and fisheries methods and sub-sampling of fish for tagging (food-safe PIT tags recommended).

Long-term fishway monitoring

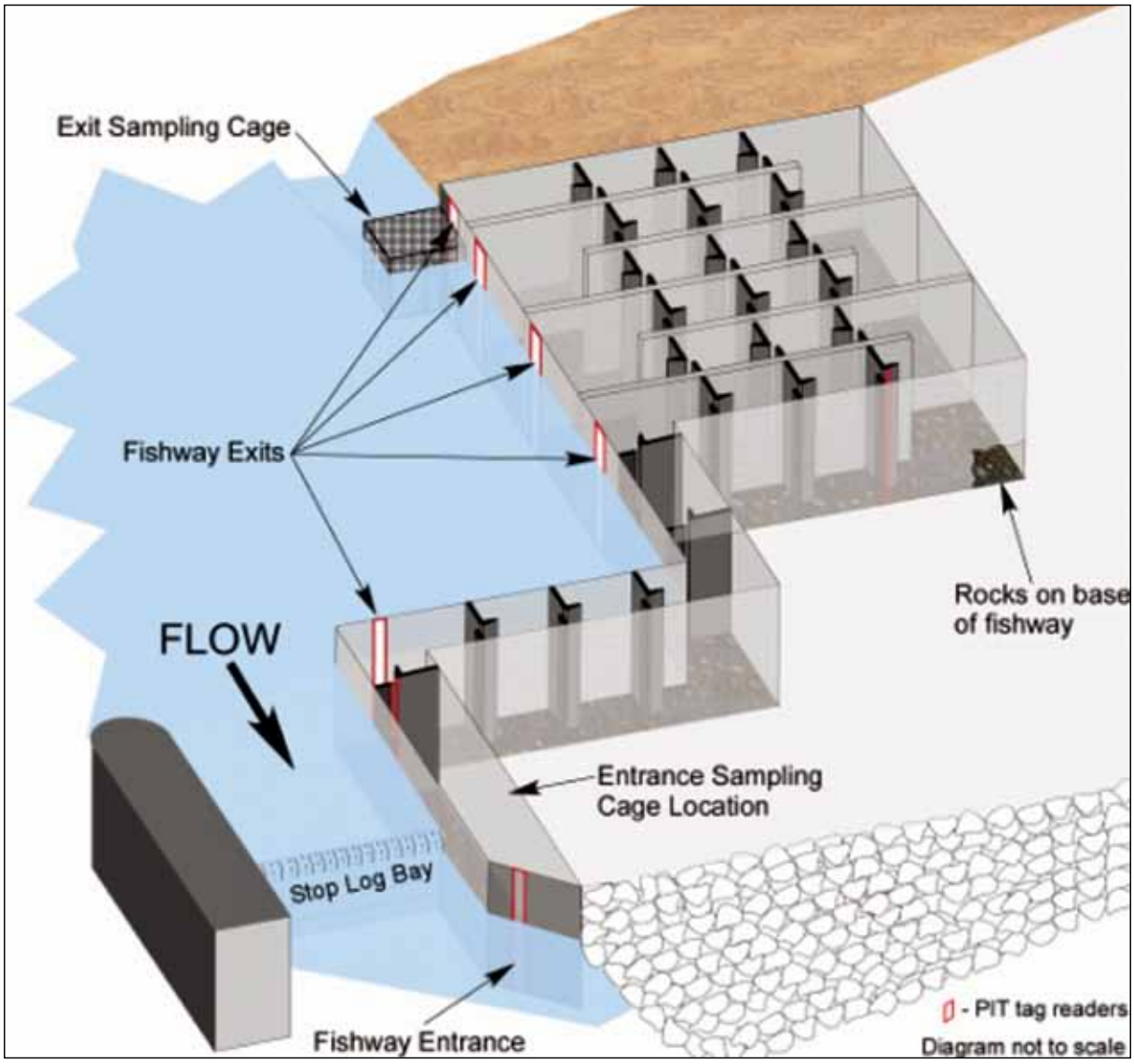
A standard monitoring data sheet is required for lock keepers (see Appendix 1). This includes a record of sampling effort (time fished), which is required for any comparative or detailed scrutiny of fish migration. Importantly, it is the record of effort (hours or days fished) where most confusion is apparent. A zero catch of fish needs to be recorded as '0' and this provides valuable data on the times and cues for fish migration. If the cage is not used then the record is left blank or indicated by a full-stop.

The excel spreadsheet first developed for fishway monitoring at Lock 26 has been distributed to the site staff and this medium provides a straightforward way of delivering the data to the relevant authorities. The spreadsheet has since been modified in conjunction with weir keepers (Locks 1, 8 & 26) and covers the basic data keeping requirements. Recent MDBC fishway and fish training days were crucial in polishing the skills of the staff. Such initiatives could be built on by maintaining training at the annual weir keeper's conference.

Monitoring of the new fishways does not always require the daily fish counts that occur elsewhere (Locks 15, 26 & Yarrawonga). One 24 hour sampling event at the fishway exit (Figure 6) per week or per fortnight provides an adequate long-term data set for fish population monitoring. Sampling effort needs to be consistent and data collected and recorded in a rigorous manner. A simple process is required, such as that outlined in the following box.

1. Day 1, 9 am, set exit cage
2. Day 2, 9 am, retrieve exit cage
3. Identify, count and release all fish (fish can be classified as either adult
4. [>30 cm long or juvenile <30 cm long]). For Murray cod a 60 cm class is used.
5. Record data (effort, fish species, number of fish, size of fish, environmental variables).
6. Send data sheets or excel file to appropriate state agency for collation, analysis and reporting.

Figure 6: A schematic diagram of the Lock 8 fishway showing the locations of the sampling cages. Long-term sampling by weir keepers should only be conducted at the fishway exit.



PART C: DELIVERY OF TRI-STATE MONITORING CAGES

Lock 1 fishway monitoring traps

As part of the tri-state assessment program each new fishway is assessed by trapping fish at the entrance and exit for approximately two weeks. At Lock 1, there is a single deeper exit channel and this requires a new trap design. To ensure delivery of an appropriate sampling cage a team was formed to liaise with SA Water and draft concept trap specifications. The cages were then designed by Andrew Pickworth (ARI) and Ivor Stuart (Kingfisher Research) with input from multiple agencies represented by the tri-state team. Lock 1 staff were also consulted and Brenton Erdmann SA Water provided an engineering overview. Construction material, location of cages, lifting arrangements and load were identified as the main issues requiring resolution.

After a period of discussion the two cages (for entrance and exit; Figures 7 & 8) were manufactured by Andrew Pickworth from stainless steel with sloping perforated sheet floors. The traps incorporated heavy lifting points, perimeter bristles to reduce escapement and double doors for removing fish. These innovations are now standard components of new designs. The traps were of a high quality and functionality and were delivered on-time for the fishway commissioning in November 2007. The traps have been used by the tri-state fishway team for compliance monitoring and may be used for other fishway sites, such as Lock 3.

Figure 7: The Lock 1 entrance sampling cage being lowered into position.

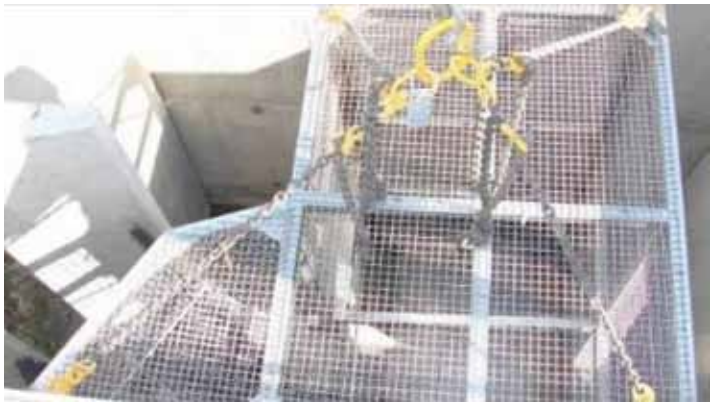


Figure 8: The Lock 1 exit sampling cage with carp.

Lock 1 Williams' carp cage design

At Lock 1, there is a particularly large biomass of carp that annually migrates upstream. In 2005, a Williams' carp separation cage was designed by the Department of Commerce, with advice from the tri-state team and others. Co-ordination during construction and sampling was important for both projects (assessment and carp removal) to be completed successfully. The Lock 1 Williams' carp cage was delivered in November 2007 and sampling was co-ordinated with the tri-state fishway team.

CONCLUSIONS

The development of the Mark V Williams' cage was the final instalment in applying this innovation broadly across Murray-Darling fishways. The technology has again proven useful in controlling carp migration in fishways and is ready for a broader roll-out across the Murray-Darling Basin. A central co-ordinator has been important in facilitating communication for design, construction, operation and maintenance of the fishway cages (Figures 9 & 10). The project also identified areas where the long-term weir keeper data collection program can be streamlined.

The audit of existing sampling cages can be used for current and future monitoring traps and for their maintenance or replacement. Weir keeper support is crucial in trap concepts and design, and in their long-term operations and assessment. As such, there is a need for a close relationship between river managers, researchers and weir operations staff. Provided herein are the protocols for fishway monitoring and Williams' cage designs, however, the long-term impetus for supporting fishway monitoring is also a strong consideration for River Murray Water. Demonstrating achievement of fish community restoration, a key objective of the fishway construction program, will likely be reliant on the long-term weir keeper monitoring data.

Recommendations

- Adoption of the Mark V Williams' cage at key weirs with fishways (priority is Locks 7–9).
- Adoption of a standard mesh size (25 mm square) for weir keeper monitoring and monitoring/reporting protocol at each weir.
- Tri-state monitoring cages require a smaller mesh size of (4 mm square).
- Incorporation of monitoring cages into the fishway construction contract.
- Design of new fishway carp cages and tri-state monitoring trapping arrangement.
- Institute a cage maintenance and replacement schedule.
- Weir staff duties should formally include fishway operations and the state agencies (i.e. SA Water) might also consider funding a staff member whose primary role is co-ordination of fishway and cage operations.

Figure 9: Weir keepers from Locks 10 and 26 during commissioning of the Mark V Williams' cage.

Figure 10: Commissioning of the Lock 1 fishway and sampling cages.

ACKNOWLEDGMENTS

I thank the many weir keepers who contributed to this project: including Alan Williams (Lock 26), Danny Burke, Norm Boyd, Jeremy (Lock 10), and Graeme Tregenza (Lock 1). The tri-state fishway assessment team also contributed to the project and Andrew Pickworth (Arthur Rylah Institute) manufactured the Lock 1 assessment cages. Brenton Erdmann (SA Water) also helped in many aspects of cage design and application. My sincere thanks to Alan Williams for designing and testing the Mark V Williams' separation cage and to Noel Christie for aluminium fabrication. Thanks to Lee Baumgartner, NSW DPI, for comments on the draft report and helpful discussions. The Living Murray Program of the Murray-Darling Basin Commission funded this project. Thanks to Sheridan Lockerbie (MDBC) for useful editorial comments.

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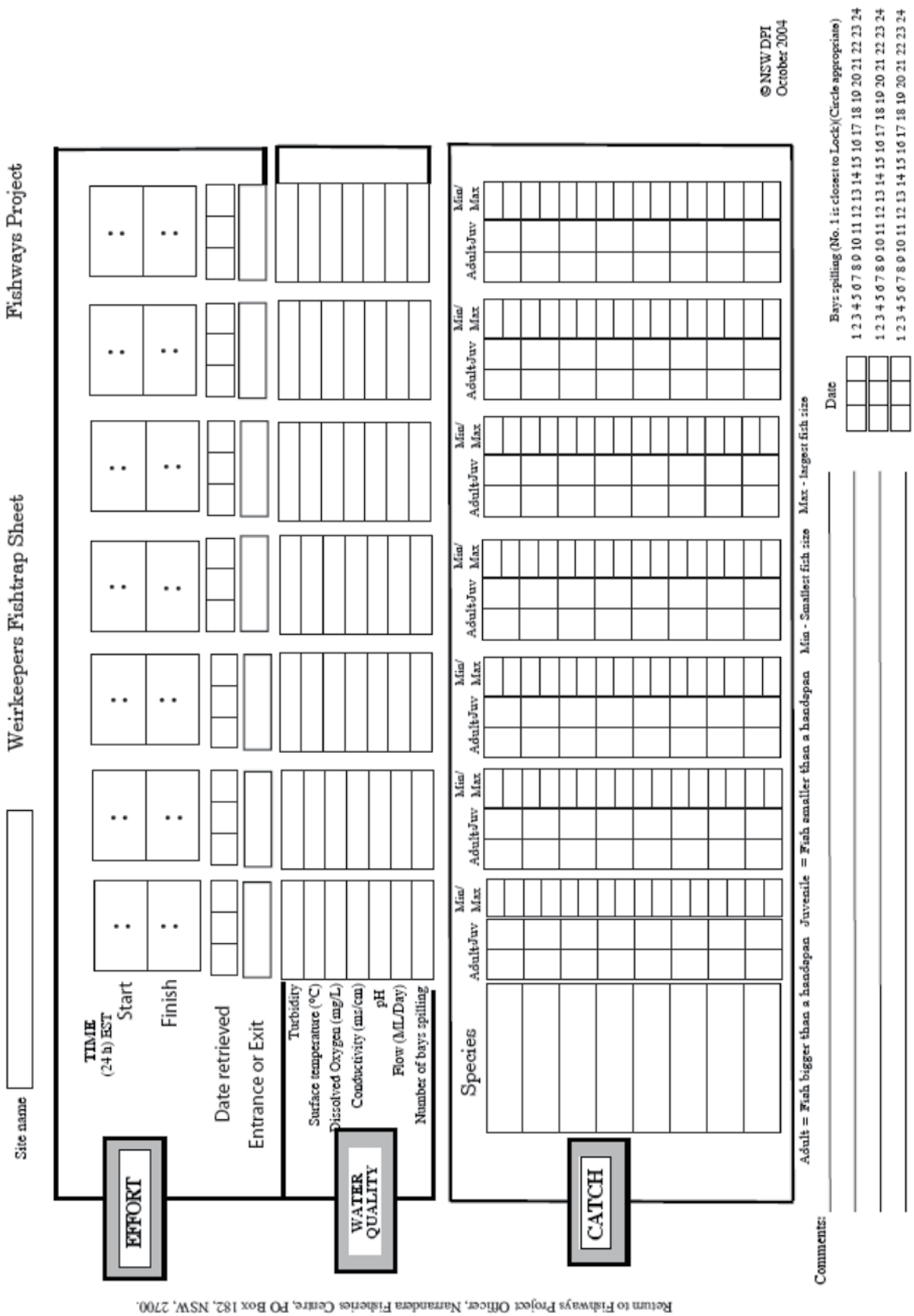
APPENDIX 1: EXISTING MURRAY FISHWAY MONITORING TRAPS AND WILLIAMS' CARP CAGES

Fishway	Present cages	Cage material	Dimensions, funnel & mesh size	Modification Needs	New cage needs	Priority
Yarrawonga	Monitoring cage	Stainless steel	25 mm sq. mesh	Nil	*In-channel* Williams' cage (automated?)	Medium
Lock 26	1. *In-channel* Williams' cage (automated) 2. Monitoring cage	Mild steel Stainless	2.36 X 1.96 X 1.36 m 0.2 X 0.4 m exit 40 mm square with 25 mm square overlay 2 X 2 X 1.1 m 25 mm square	Needs new cage	New Williams' cage needed.	High
Lock 15	3. Combined *weir pool* monitoring cage/Williams' cage (non-automated)	Mild steel		Adjustable jumping baffle Low visibility (perspex) back	Nil	High
Lock 10	4. Combined *in-channel* Mark IV monitoring cage/Williams' cage (non-automated)	Stainless	2.1 m X 2 m X 1.3 m: Williams' trap with 0.4 m high native fish exit gate Funnel exit 0.4 high X 0.3 wide Holding cage 0.9 m high X 2 m sq.	Nil	Nil	Low
Lock 9	5. Monitoring cage (ex Goolwa) 6. Tri-state Monitoring cage (ex Lock 8)	Mild steel Mild steel	No details 2.5 X 1.95 X 1.5 m Funnel exit 0.4 X 0.3 m Mesh 50 mm square & 4 mm square overlay, rubber floor	Needs overhaul or replacement Minor repairs	Combined weir pool monitoring cage/ Williams' cage (non-automated)	High
Lock 8	7. Combined monitoring cage/ Williams' cage (non-automated)	Stainless		Non-functional Needs modifications	Combined *weir pool* monitoring cage/ Williams' cage (non-automated)	High
Lock 7	8. Tri-state Monitoring cage (ex Lock 8)	Mild steel	2.5 X 1.95 X 1.5 m Funnel exit 0.4 X 0.3 m Mesh 50 mm square & 4 mm square overlay, rubber floor	Minor repairs	Combined *weir pool* monitoring cage/ Williams' cage (non-automated)	High
Lock 3	Nil			Nil	Combined *in-channel* monitoring cage/ Williams' cage (non-automated)	Low

Fishway	Present cages	Cage material	Dimensions, funnel & mesh size	Modification Needs	New cage needs	Priority
Lock 1	9. and 10. Tri-state monitoring cages (top and bottom) 11, 12 and 13. In-channel Williams' cage and 2 holding cages 14. Tri-state monitoring cages (ex Lock 8)	Stainless steel Mild steel – galvanised Mild steel	1.7 X 2.2 X.1.35 m Funnel exit 0.4 X.0.3 m Sloping perforated sheet floor 50 mm sq. mesh and perforated sheet 2.5 X 1.95 X 1.5 m Funnel exit 0.4 X 0.3 m Mesh 50 mm square & 4 mm square overlay, rubber floor	Nil		High
Tauwitchere Barrage	15, 16 and 17. Two tri-state monitoring cages for v-s fishway and rock ramp	Mild steel	v-slot top cage 2X 2 X 1.7 m 5mm mesh over 200 mm sq. Funnel exit 0.4 high X 0.3 wide v-slot btm cage 1.45 X 3.58 X 2 m with 5 mm mesh over 20 mm sq. Funnel exit 0.4 X 0.3. Rubber floor. Rock fishway entrance trap: 3.445 X 1.615 X 2 m double funnel (0.39 wide X .15 m high). Rock fishway exit trap' 4 X 2 X 1.5 m double funnel (0.3 wide X 0.4 high). 5 mm square mesh. Rubber floor.	Nil	Nil	Low
Goolwa barrage	18 and 19. Two tri-state monitoring cages	Aluminium	Aluminium frames and perforated floor covered in 6 mm black knotless soft mesh. Both traps 3.465 X 2.46 X 2.2 with double funnel. Funnel exit 0.39 high X 0.15 wide			Low
Hunters Ck & Boundary Ck	20 and 21. Two cages needed when construction is complete (2008)					Low
Berri workshop	22. Large riverine Williams' cage from 2005 trials at Lock 1	Mild steel	5 X 1.95 X 2.2 m 50 mm square weld mesh	Can be used or modified as required elsewhere – as holding cage		Low

- Standard mesh on Williams' cages to be 25 mm square.
- Generic traps used where possible for transferability.
- No downstream facilities incorporated.
- Bony herring devices may be included on a site-by-site basis.
- Non-automated Williams' cages prioritised for supervised sites where daily monitoring is conducted. Automated cages to be used otherwise.

APPENDIX 2: STANDARDISED FISHWAY MONITORING SHEET FOR LOCK STAFF



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BASIN AUTHORITY