10 YEARS ON: OVERCOMING OBSTACLES TO IMPROVING FISH MIGRATION AT COASTAL WEIR AND ROAD CROSSING BARRIERS

M Gordos[1], S Nichols[1], C Lay[1]
[1]NSW Department of Primary Industries – Fisheries

Abstract

The NSW Department of Primary Industries (DPI Fisheries) has been actively improving migration at priority fish passage barriers along coastal NSW for over 10 years. The culmination of these efforts was the recent completion of the award winning Bringing Back the Fish project in 2010 that resulted in improved fish passage at 10 priority weirs and 22 road crossings, thereby improving native fish access to over 1,235 km of additional waterway. The success of the BBTF project is attributed to lessons learned from earlier projects that allowed high priority fish passage barriers to be addressed, despite remediation options at many of these sites being discussed since the 1980's.

The aim of this paper is to demonstrate solutions to common obstacles experienced by DPI Fisheries when attempting to improve fish passage at priority barriers through the use of case studies. Site examples will cover the removal of an obsolete structure (Manyweathers Weir – Richmond River), the redesign of an existing barrier (Coral Avenue, Brunswick River), and fishway installation (Locketts Crossing – Coolongolook River; Clarksons Crossing – Wallamba River). Case studies will be discussed from concept through to completion, including site promotion. With respect to these sites, common obstacles that were experienced and overcome include a lack of stakeholder support, inadequate funding, unrealistic timeframes, heritage significance, poor planning, a lack of suitable surveys, and concern regarding the presence of platypus. With this information in hand, stakeholders including local councils, state agencies, and landholders can strategically address remaining priority fish passage barriers in order to make more fish naturally.

Introduction

Fish Passage in NSW

Within flowing waterways, Australian native fish have evolved to be reliant on a variety of habitat types to complete their life cycle, thereby requiring free movement within rivers and streams and between estuarine and freshwater environments. Of the 55 freshwater species found in New South Wales, 32 are considered 'migratory' as defined by the movement of a large proportion of a population between two or more distinct habitats with a regular pattern (Thorncraft and Harris, 2000; Northcote, 1978). However, all fish species move between varying aquatic niches, thereby requiring habitat connectivity (Barrett, 2008).

While fish migrations are commonly associated with breeding events, additional motivations for species to disperse include the search for food and shelter, and the avoidance of predation and competition. Unfortunately, riverine connectivity has been severely disrupted within Australia by the proliferation of instream barriers to migratory fish that limit habitat and resource availability and threaten the fitness of species to adapt to changing environmental conditions (Pethebridge et al., 1998; Gehrke et al., 2002).

Australian fish are generally poor swimmers and jumpers, especially when compared to their northern hemisphere counterparts (Mallen-Cooper, 1992). As a result, structures such as weirs, dams, gauging stations, road crossings, levees, and floodgates can act as physical and hydrological barriers to migrating fish. Excessive head differential, otherwise known as the 'waterfall effect', is the most common physical barrier where fish are unable to jump over the waterway crossing due to an excessive drop in water level. Hydrological barriers include poorly designed road culverts where high water velocity and turbulence limit a fish's ability to successfully swim through the structure (Vidler and Wardle, 1991, Mallen-Cooper, 1994).

Due to the impacts of fish passage barriers, the installation and operation of instream structures and the alteration of natural flow regimes have been recognised as *Key Threatening Processes* under the *Fisheries Management Act 1994 (FMA 1994)* and the *Threatened Species Conservation Act 1995*. Additionally, the *FMA 1994* requires proponents to incorporate fish passage into the design of new waterway crossings where deemed necessary by the Department of Primary Industries (DPI Fisheries). However, a legacy of poorly designed structures exists that detrimentally affects native fish. Starting in the mid 1990's, NSW Fisheries (now DPI Fisheries) initiated extensive audits of fish passage barriers across the State that encompassed weirs, dams, road crossings, and floodgates; with over 10,000 barriers to migrating fish identified (see I&I NSW 2009).

The first attempt to remediate fish passage in NSW was in 1913 in Sydney with the construction of a fishway at Audley Weir (NSW Department of Fisheries, 1913). Over the past 10 years, DPI Fisheries has actively remediated fish migration barriers along coastal NSW with the assistance of local, State (e.g. CMAs) and Federal Government agencies. Lessons learned from earlier projects allowed higher priority fish passage barriers to be addressed in more recent years, despite remediation options at many of these sites being discussed since the 1980's. Therefore, the aim of this paper is to demonstrate solutions to common obstacles experienced by DPI Fisheries when attempting to improve fish passage at priority barriers through the use of case studies.

Removal of Redundant Structures

Over time, weirs and road crossings can be superseded by newer structures or become degraded to the point that they are no longer used for their original purpose. Best practice management guidelines today require the removal of existing structures when being upgraded or replaced. However, a legacy of redundant assets exists that have been left instream, thereby continuing to block migrating fish. Where a weir or road crossing is no longer providing a significant benefit to the owner or user, the structure can be considered for removal, taking into consideration the environmental impact of such action (see NSW Weirs Policy).

The removal of weir and road crossing barriers is the most effective fish passage remediation option due to the restoration of the natural waterway channel. Additionally, unlike fishways and box culverts, barrier removal requires no ongoing maintenance to ensure that fish passage is maintained at the site. Furthermore, asset removal is generally the cheapest fish passage remediation option, often by an order of magnitude. However, the removal of redundant waterway structures can also be the most contentious remediation option due to perceived social values associated with the weir or road crossing. Even if the community supports removal, environmental considerations may constrain or preclude removal options.

Case Study 1: Manyweathers Weir Removal, Richmond River (2009)

Site Introduction

Manyweathers Weir was located in the lower freshwater reaches of the Richmond River within the township of Casino. The concrete gravity overshot weir measured 67 m across the crest and 0.8 m in height (Fig. 1A). The weir was constructed in 1966 for the purpose of augmenting Casino's town water supply that was being sourced from Jabour Weir, a structure located 1.5 km upstream. Subsequent upgrades to Jabour Weir meant that Manyweathers Weir was never utilised for its original purpose.

Manyweathers Weir restricted fish passage at all times due to a head differential of 800 mm, except during drownout events which occurred 1 – 3 times per year. As a result, the weir limited native fish access to over 1000 km of the upper Richmond catchment. Following the removal of Norco Weir in 2007, Manyweathers Weir became the most downstream barrier on the Richmond River, and thus the highest remediation priority in the catchment.

Remediation History

Manyweathers Weir was constructed on behalf of the Water Resource Commission, with ownership of the weir passing to State Water Corporation in 2007. Minor structural modifications were made to the weir in 1970 to improve the structure's water retention capabilities; however, as the weir was never used for its original purpose, no further modifications or maintenance occurred. Structural stability assessments of the weir in 1998 indicated that the weir was structurally sound; but multiple breaches limited the weir's capacity to pool water during drought conditions (Fig. 1B).

In 2002, NSW Fisheries commissioned a report investigating fishway options at Manyweathers Weir. The preferred fishway design was a vertical slot fishway at an estimated cost of $360,000. Removal options were not discussed as part of the investigation due to perceived heritage values and a presumed lack of stakeholder support from the weir owner, the local council, and the community. In 2007, DPI Fisheries contacted State Water Corporation to canvas remediation options for the weir. During early discussions, State Water Corporation indicated that the weir was considered a redundant liability, and that removal was supported. An agreement was reached whereby DPI Fisheries obtained statutory approval to remove the weir, while State Water Corporation funded and managed on-ground works.

Remediation Obstacles & Solutions

<u>Heritage</u>: Manyweathers Weir was named after Richmond Manyweather, the longest serving mayor of the town. Given the structure's prominent location in Casino where it was visible from the Bruxner Highway Bridge, and due to its association with the former mayor, the Richmond Valley Council listed the weir as a heritage item within the draft Local Environmental Plan. In order to address heritage concerns associated with the weir, State Water Corporation and DPI Fisheries commissioned a Heritage Impact Statement that investigated the impacts of weir removal. The report identified clear local heritage impacts, but determined that the weir was not of State significance and could be removed as long as remediation actions were carried out that preserved the structure's history. State Water Corporation and DPI Fisheries also consulted with the

Manyweather family, while also meeting with the local heritage society. Both the family and the heritage society agreed with the justifications provided by DPI Fisheries and State Water Corporation as to why the weir should be removed, with the proviso that the heritage value of the weir was preserved. One such action was to retain a portion of the weir that was placed at the top of the river bank, upon which a plague was mounted that commemorated the weir and Richmond Manyweather (Fig. 1D).

Platypus: During the removal of Norco Weir in 2007, which was located 2 km downstream of Manyweathers Weir, significant community opposition was experienced by DPI Fisheries particularly over the impacts on the resident platypus population. In anticipation of similar opposition at Manyweathers Weir, DPI Fisheries commissioned the leading platypus biologist in NSW to conduct a survey and impact assessment of weir removal on the resident platypus population. The impact assessment confirmed that platypus were residing upstream of the weir, and that these residents would likely be negatively impacted by weir removal. However, in assessing the impact of weir removal upon the greater platypus population, the consultant determined that the impacts were minor and that the overall project objectives of restoring the natural river channel were justified against such impacts.

Figure 1: A. Manyweathers Weir restricted fish passage to over 1000 km of waterway in the Richmond catchment. B. State Water Corporation considered the weir redundant, with multiple breaches limiting the weir's capability to pool water during drought conditions. C. The weir was removed in its entirety in 2009, with a section of the weir maintained to honour Richmond Manyweather (D).

Water Resource: The final major obstacle experienced was a perception amongst some in the community that a valuable water resource would be lost, with a dry creek bed resulting after removal. Following consultation, Richmond Valley Council indicated that Manyweathers Weir was never used to augment the town's water supply, that all infrastructure to pump water from the weir pool had since been removed, and that yield calculations for the weir pool indicated an insignificant volume of water available to justify pumping. Furthermore, a river bed survey completed for the weir pool confirmed that pools of water up to 4 m deep would remain following weir removal, thereby retaining visual amenity within the river reach.

Remediation Outcomes

The removal of Norco Weir two years prior highlighted a number of potential contentious issues that DPI Fisheries needed to address when proposing the removal of Manyweathers Weir. With this foresight, necessary surveys were commissioned in advance that specifically targeted key stakeholder concerns including the weir's heritage value, impacts on platypus and other fauna, and visual amenity concerns. As a result, minimal community opposition was experienced throughout the three year project, with positive media outputs occurring during and following weir removal. With the removal of Norco and Manyweathers Weir, native fish have improved access to over 1000 km of the upper Richmond catchment. Additionally, the heritage values of the weir have been preserved via the memorial weir section.

Redesign of Existing Barriers

The impact of road crossings on fish migration was generally overlooked from a management perspective for most of the 1900's despite representing the majority of fish passage barriers in Australia. To address this, NSW Fisheries developed guidelines to detail fish friendly road crossing design principles (see Fairfull and Witheridge, 2003). Where fish passage at an existing road crossing barrier is determined to be a priority, redesigning the waterway crossing to achieve improved fish passage can be investigated. Channel spanning bridges are the preferred design option for ensuring unimpeded fish passage as bridges promote natural, unimpeded stream flow. Alternatively, box culverts can be considered as long as the existing waterway channel profile is maintained in order to minimise hydrological flow constriction through the structure.

Case Study 2: Coral Avenue Crossing, Brunswick River (2005)

Site Introduction

The Coral Avenue road crossing (19 m x 8 m) was a two-celled pipe culvert that traversed the Brunswick River near the township of Mullumbimby. The pipe culvert causeway was located at the upper extent of the Brunswick estuary, with the causeway acting as a minor tidal barrage. Additionally, the two pipe culverts constrained the downstream water flow, resulting in excessive water velocities that limited fish passage to over 25 km of upstream habitat (Fig. 2A).

As the structure was located at the tidal limit, the crossing acted as a significant barrier to migrating catadromous fish such as Australian Bass (*Macquaria novemaculeata*) and Freshwater Mullet (*Myxus petardi*). Given the high aquatic habitat value at the site, and the deleterious impact of the crossing with respect to fish passage, Coral Avenue was ranked as the highest road crossing remediation priority in the Northern Rivers CMA region. Coral Avenue causeway was highlighted as a priority fish passage barrier during NSW Fisheries audits in the mid 1990's and early 2000's. Repeated consultation occurred with Byron Shire Council regarding the impacts of the structure on fish passage; however, initial cost estimates to redesign the crossing were considered unfeasible.

Remediation Obstacles & Solutions

<u>Public Safety & Design</u>: In 2004, DPI Fisheries reinitiated conversations with Byron Shire Council to replace Coral Avenue causeway with a fish friendly design. In addition to fish passage, public safety concerns were raised due to the regular overtopping of the causeway during flood events. The causeway provided the only access over the Brunswick River to 19 landholders, with vehicle and public access considered dangerous during elevated flows (Fig. 2B).

A. **B.** **C.** **D.**

Figure 2: Coral Avenue causeway restricted fish passage during base flows due to high velocities through the two pipe culverts (A), and during elevated flows due to excessive head differential (B). C) Prefabricated Doolan Deck bridges were craned into place, thereby reducing onsite construction costs by up to 50 %. D) Coral Avenue bridge provides improved fish access to over 25 km of upstream habitat.

To address landholder access concerns, a channel spanning bridge was proposed. Bridges are the preferred design option by DPI Fisheries for waterway crossings; however, bridges display the highest capital costs to construct. In order to keep construction costs low, a prefabricated Doolan Deck was proposed for the site. Prefabricated bridges can reduce construction costs by up to 50 % as onground civil works are limited to abutment formation thereby often negating the need for site dewatering (e.g. coffer dams). Once the abutments are formed, a crane lifts the prefabricated bridge deck into place in the space of one day (Fig. 2C).

Funding: Given the high priority of the causeway as a barrier to migrating fish, $60,000 of incentive funding was pledged by the Northern Rivers CMA, the NSW Recreational Fishing Trust, and the Cape Byron Marine Park Authority; with Byron Shire Council covering the remaining costs. Additional support was provided by the local Landcare group which revegetated the verges with native trees and understory.

Remediation Outcomes

The redesign of the Coral Avenue crossing over the Brunswick River removed the highest priority road crossing barrier in the Northern Rivers region, thereby improving fish passage to over 25 km of upstream habitat. More importantly, the new bridge design provided a secure access for landholders during high rainfall events.

Fishway Installation

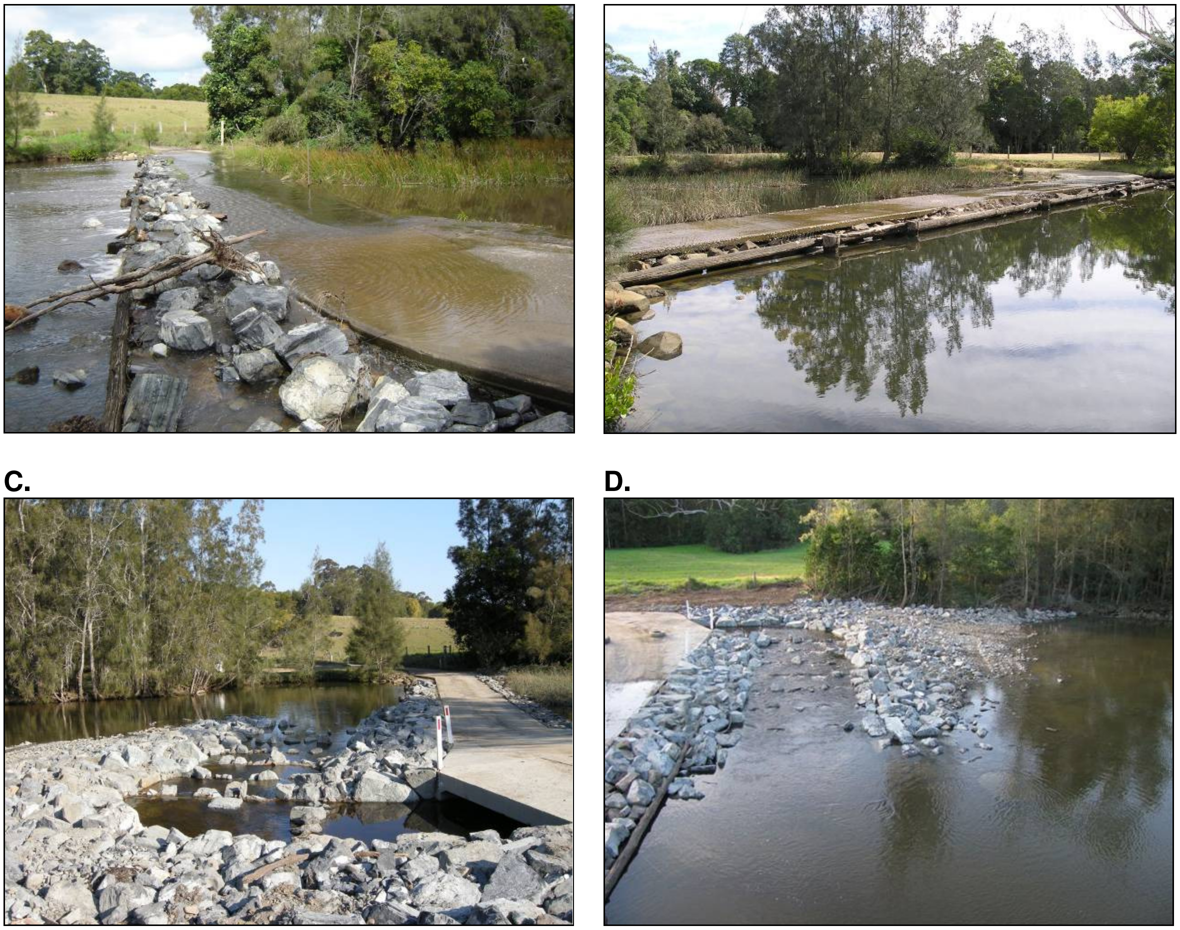
Fishways (also known as fish ladders) are the primary remediation option for low level weirs (< 6 m high), and function by allowing species to negotiate excessive head differentials by providing a series of small hydraulic rises and resting pools that allow fish to "step" their way up and over the barrier rather than having to make one large jump. Fishways can take numerous forms (e.g. vertical slot, denil, rock-ramp), with the correct design depending on the hydraulic characteristics of the water, the fish fauna present, geomorphic characteristics, and budget constraints. Fishways may also be required at road crossings where the river geomorphology has changed to the point that redesigning the crossing would result in destabilisation of the upstream river bed.

Case Study 3: Locketts Crossing Partial Width Rock-Ramp Fishway (2009)

Site Introduction

Locketts Crossing is a single-lane causeway measuring 35 m long by 4 m wide that spans the width of the Coolongolook River in the Wallis Lake estuary (Fig. 3A & B). The original causeway was a concrete capped crossing that acted as a tidal barrage, with the natural tidal limit occurring 1.5 km further upstream. In addition, fish passage was blocked during base flows due to a head differential of 750 mm on the downstream side. The crossing provides the primary access for several landholders located on the eastern side, and thus could not be considered for removal. Locketts Crossing was ranked as the highest priority road crossing barrier in the Hunter Central Rivers CMA due to its location as a tidal barrier, and the fact that fish passage was restricted to over 60 km of high integrity upstream habitat.

A. B.



C. D.

Figure 3: A & B. Locketts Crossing restricted fish passage to over 60 km of upstream habitat due to excessive headloss. C & D. A partial-width rock-ramp fishway was installed on the downstream side of the crossing that led to a single box culvert.

Remediation History

NSW Fisheries had discussed fish passage and tidal flow impacts associated with Locketts Crossing with Great Lakes Shire Council since the early 1980's. In 2003, $10,000 was obtained from the NSW Recreational Fishing Trust to remediate fish passage at Locketts Crossing, with a fishway options assessment being completed in 2004. However, no additional funding could be sourced at the time, with project costs estimated at > $100,000.

Remediation Obstacles & Solutions

Design Options: Locketts Crossing served two primary functions, the first to provide landholder access over the Coolongolook River, and the second to limit tidal intrusion into the upstream pool where water was pumped for irrigation and stock and domestic use. Redesigning the road crossing was initially investigated, with a bridge being ruled out as financially unviable. A 10 m spanning box culvert design was also progressed for the site; however, concerns were raised about the impact of saline ingression upon upstream water extraction, as well as whether the causeway was structurally sound to support the proposed box culvert design.

Following further assessment, a partial-width rock-ramp fishway design was proposed on the downstream side of the causeway that led to a single 3 m wide box culvert (Fig. 3C & D). The rock-ramp fishway and box culvert were designed to provide fish passage during base flows, with landholder access being maintained. Additionally, the invert levels of the fishway and box culvert were set so that tidal flows would not pass upstream, thereby maintaining the upstream freshwater pool. During higher flows, the rock ramp would provide added roughness around the bank which facilitates fish passage until structural drownout occurs. The provision of rock protection on the downstream side of the causeway also further stabilised the causeway, negating any structural stability concerns associated with the smaller box culvert.

During base flow conditions, water leaked beneath the causeway structure. In order to direct flows into the box culvert, Great Lakes Council recapped the existing causeway. Additionally, a trench was dug immediately upstream of the causeway within which a clay-core geotextile fabric was laid that was subsequently backfilled with rock fill. The clay-core fabric provided an impermeable barrier to water flow, thereby directing all low flows through the single box culvert and down the fishway.

Funding: Given the significance of the site as a barrier to migrating fish, funding for the fishway and box culvert was acquired from the Australian Government (Caring For Our Country), the Hunter Central Rivers CMA, and the NSW Recreational Fishing Trust totalling over $110,000; with Great Lakes Council covering the costs to recap the causeway. The ability to acquire the necessary funding is attributed to the three year timeframe of the project which allowed necessary surveys and designs to be commissioned that provided workable design options and accurate cost estimates.

Remediation Outcomes

The primary outcome of the project was improved native fish access to over 60 km of high integrity upstream habitat. The rock-ramp fishway and box culvert maintain the upstream freshwater pool, while also providing a dry causeway crossing for the majority of the year which improves landholder access. Importantly, the three year timeframe provided adequate lead time to acquire necessary funding to complete the project, nearly 30 years after initial discussions occurred by NSW Fisheries.

Case Study 4: Clarksons Crossing Removal, Wallamba River (2009)

Site Introduction

Clarksons Crossing formed part of the old Pacific Highway which was decommissioned in 1958 when a new Pacific Highway Bridge was built over the Wallamba River. According to the RTA, removal of the crossing was withheld upon the request of the local council which subsequently assumed ownership of the causeway. The crossing consisted of a two-lane causeway measuring 70 m by 5.5 m wide that was constructed of compacted basalt rubble capped with a concrete slab. Clarksons Crossing was located 3 km downstream of the tidal limit; however, modifications to the causeway over time effectively made the structure a tidal barrage. Between the 1960's and 1980's, three breaches were cut into the causeway decking to stop vehicle access (Fig. 4A & B). During base flow conditions, fish passage should have been possible through the breaches; however, adjacent landholders constructed makeshift concrete weirs across the openings to maintain the upstream freshwater pool, thereby restricting fish access to over 50 km of the upper Wallamba catchment. Clarkson Crossing was ranked as the second highest priority road crossing barrier in the Hunter Central Rivers CMA.

Remediation History

In 1989, a landholder adjacent to the causeway requested action from the State parliamentary member to address significant bank erosion that was attributed to Clarksons Crossing. The angle of the crossing relative to water flow resulted in water being directed onto the landholder's riverbank. Discussions between the landholder, the parliamentary member, and the local council resulted in a resolution to remove the redundant crossing at a cost of $5,000. However, upstream landholders, fearing that removal would allow salt water to intrude upstream, threatened council with liability if the crossing was removed, resulting in the matter being dropped.

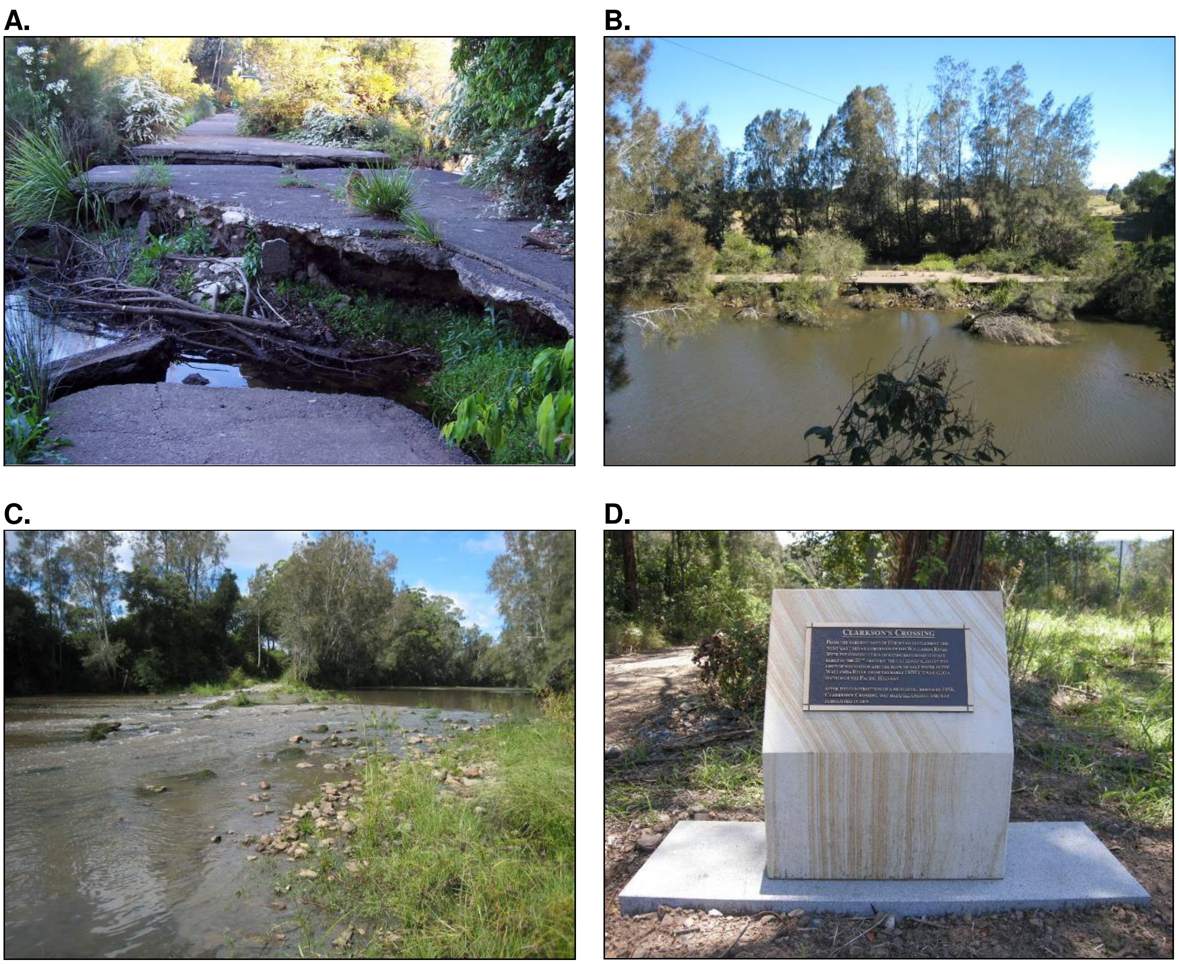


Figure 4: Clarksons Crossing (A, B) was a decommissioned, dilapidated causeway that restricted fish access to over 50 km of upstream waterway. C) Removal of the causeway and regrading of the existing rock rubble improved fish passage while securing the upstream freshwater pool from saline ingress. A memorial was erected along the south bank to commemorate the history of the crossing.

In 2005, NSW Recreational Fishing Trust funds of $10,000 were allocated to the removal of Clarksons Crossing; however, liability concerns of the upstream landholders had yet to be addressed, while total project costs were in excess of the available funding.

Remediation Obstacles & Solutions

Tidal Barrage: The primary concern at Clarksons Crossing was the potential for saline ingression into the upstream freshwater pool, thereby limiting water extraction during drought. A detailed bed survey was commissioned of the adjacent river reach in addition to deploying water monitors to record salinity and water height immediately below the causeway. Results from the survey and monitoring confirmed that saline water extended up to the causeway, and full removal of the structure would result in saline intrusion upstream. Additionally, assessment of the channel geomorphology raised concerns that lowering the upstream water level coupled with reintroduction of saline water could destabilise riverine banks resulting in significant slumping. As a result, the original proposal to fully remove Clarksons Crossing was modified to construct a graded bed control structure with a central low-flow rock-ramp fishway. The proposal called for removing the concrete decking, and grading the existing basalt rubble in the upstream direction to maintain the upstream freshwater pool. Within the graded rock ramp, a central 2 m wide low-flow rock-ramp fishway was constructed to assist fish over the 500 mm head differential. The resulting structure improved fish passage both at base and flood flows, while also reducing pressure on the downstream eroding bank.

Civil Liability: Greater Taree City Council supported removal of the crossing as the structure was not a priority asset and did not form part of a functional road network. Additionally, as the crossing was a popular fishing and camping location, council was potentially liable for injuries sustained at the site due to the dilapidated state of the crossing (Fig. 4A & B). However, given previous threats of civil liability by upstream landholders, Council expressed concerns with the proposed project. To assist with their query, DPI Fisheries obtained advice from the NSW Crown Solicitor regarding Council's duty of care. The Crown Solicitor's advice indicated that Council, as owner of the asset, had the authority to manage the asset under the Roads Act 1993 as desired as long as reasonable mitigation measures were implemented to address potential impacts (e.g. environmental and social). The NSW Crown Solicitor indicated that landholders could sue under negligence, but that Council was likely protected under their duty of care to manage the asset. Upon reviewing this advice, Council agreed to continue with the project.

Heritage: Clarksons Crossing was originally constructed in the early 1900's, initially as a bed level crossing, and subsequently upgraded over time to the elevated causeway that was decommissioned in 1958. Questions were raised over the heritage significance of the crossing prior to removal. DPI Fisheries found no record of heritage significance in the local or State Heritage Registry. Despite this, DPI Fisheries approached the local heritage society and proposed that a memorial be erected at the top of the southern approach to commemorate the history of the crossing (Fig. 4D).

Funding: The initial $10,000 of funding from the NSW Recreational Fishing Trust in 2005 was intended to fund the entire Clarksons Crossing removal; however, site survey costs alone exceeded $35,000. The extended three year project timeframe afforded by the Bringing Back the Fish Project provided the opportunity to source additional contributions from the Australian Government, Hunter Central Rivers CMA, and Greater Taree City Council. The total cost to remove Clarksons Crossing and regrade the existing bed material approached $70,000, with works completed in 2009 nearly 20 years after the initial crossing removal proposal.

Remediation Outcomes

Removal of Clarksons Crossing and insertion of a low-flow rock-ramp fishway resulted in improved fish passage to over 50 km of upstream habitat. Additionally, the modified project design maintained the upstream freshwater pool, thereby appeasing upstream landholders while also removing a redundant council asset. The bed control and low-flow fishway are considered part of the river bed which is Crown land. No future maintenance is planned for the site, with the bed control structure expected to adjust over time to a natural equilibrium. Landholders were notified of this management approach prior to removal.

Conclusion

These case studies provide specific examples of obstacles that did, or threatened to delay proposed fish passage remediation actions. Below are listed more general, overarching guidelines that will assist project planning and implementation.

<u>Accurately document the problem</u> – The impacts of fish passage barriers upon native fish have been known for decades, especially with regards to weirs and dams; however, the extent of the impact was unknown as no comprehensive audit had been conducted. Starting in the mid-1990's, NSW Fisheries and subsequently DPI Fisheries initiated extensive fish barrier audits of weirs, dams, regulators, road crossings, floodgates, and natural barriers to document where the structures were and their significance as a barrier.

<u>Prioritisation</u> – Once the problem has been accurately documented, the next step is to prioritise actions to maximise ecological outcomes relative to existing or proposed funding. Prioritisation is critical in providing funding bodies with a transparent process of how a site was selected, while also attempting to maximise ecological outcomes.

<u>Clear definition of issues</u> – Project managers need to clearly identify during the initial stages of the project what the main issues are, and how to address them (e.g. via surveys, community consultation, etc.). As the project progresses, additional issues may become relevant that will require further assessment. Attempt to separate the main issues from minor roadblocks, keeping in mind that your perceptions may not be as important as the perception of stakeholders that you are engaging.

<u>Surveys</u> – Attempt to have as much information on hand prior to engaging the general community. A lack of information suggests a lack of comprehension of the site issues which can result in lost confidence at contentious sites. Where additional information is required, obtain it immediately and provide the stakeholders with a timeframe for delivery.

<u>Tailor your approach</u> – No two remediation sites are exactly the same. An approach that was successful at one site may disenfranchise stakeholders at another location. Take the time to learn what the stakeholders value, and ensure to ask what concerns they may have.

<u>Timeframe</u> – Fish passage remediation projects can be completed within a single year, but generally all necessary funding will be required up front which is often not the case.

Instead, a minimum two years, preferably three years or longer is recommended to allow for surveys, designs, stakeholder communication, statutory approval, and funding acquisition. Additionally, as fish passage works generally require instream activities, delays of several months to a year or longer may occur due to persistent rainfall and elevated flows.

<u>Funding</u> – In most cases, adequate funding is not available at the start of the project. Provision of surveys and detailed designs will result in accurate cost estimates that will improve the project's chance of securing required funding.

<u>Statutory approvals</u> – Determine early in the project what statutory approvals will be required, and initiate discussions with relevant government agencies as soon as possible regarding the proposed scope of the project to determine legislative requirements and mitigation measures that may need to be implemented.

<u>Onground works</u> – If the project has been properly planned, onground work is generally the easiest step. Ensure that stakeholders are updated on project progress, especially if delays are experienced. Also ensure that statutory requirements are adhered to, providing final reports to government agencies as required. Once works are completed, continue to monitor the site to confirm that project objectives have been realised.

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