Department of Employment, Economic Development and Innovation

# Waterpark Creek Fishway Project

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Toward Q Tomorrow's Queensland | Queensland Government

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Cover Figure: Top: Waterpark Creek vertical slot fishway. Bottom left: Backpack electrofish sampling in Waterpark Ck. Bottom right: Bullrout, a diadromous species, sampled from Waterpark Creek after fishway construction.

# Contents

# Glossary of Terms

Diadromous - Diadromous fishes are truly migratory species whose distinctive characteristics include that they (i) migrate between freshwaters and the sea; (ii) the movement is usually obligatory; and (iii) migration takes place at fixed seasons or life stages. There are three distinctions within the diadromous category, catadromous, amphidromous and anadromous.

- Catadromous - Diadromous fishes which spend most of their lives in fresh water, and migrate to sea to breed.
- Amphidromous - Diadromous fishes in which migration between freshwater and the sea is not for the purpose of breeding, but occurs at some other stage of the life cycle.
- Anadromous - Diadromous fishes which spend most of their lives at sea, and migrate to freshwater to breed.

Potamodromous - fish species whose migrations occur wholly within freshwater for breeding and other purposes.

# Acronyms

| | |
|---|---|
| DEEDI - | Department of Employment, Economic Development and Innovation |
| FBA - | Fitzroy Basin Association |
| FQ - | Fisheries Queensland |
| GIS - | Geographic Information System |
| FBFBPP - | Fitzroy Basin Fish Barrier Prioritisation Project |
| TL - | Total Length (fish) |
| km - | Kilometre |
| mm - | Millimetre |

# Executive Summary

Barriers to fish passage are detrimental to the sustainability of important commercial, recreational and indigenous fisheries where recruitment is reliant on migration into and from freshwater habitats during a fish's lifecycle. Barriers preventing fish migration can lead to significant changes in fish communities above barriers, including the loss of species diversity. The demise or total extinction of diadromous fish species above barriers, especially top order predators, can upset the balance of aquatic ecosystems, altering fish community assemblages and impacting aquatic species other than fish. Remediating barriers to fish passage through the construction of fishways is therefore a vitally important rehabilitation strategy essential for maintaining not only healthy fish communities, but the entire aquatic ecosystem.

In recognising the detrimental impacts barriers to fish passage have on the health of regions aquatic eco-systems, FBA, in 2007 funded Fisheries Queensland to undertake the first comprehensive fish barriers prioritisation project in the region. The 'Fitzroy Basin Fish Barrier Prioritisation Project' identified 10,632 potential barriers within the FBA region, of which the top 30 barriers to fish passage were prioritised and the cost of remediation determined. From this prioritisation process a list of the top 30 barriers to fish passage in the region was generated, in which Waterpark Creek Weir was ranked the 16$^{th}$ most important barrier to fish passage. Construction of the fishway on Waterpark Creek has opened up 130km of fish habitat upstream.

Pre construction fish community sampling was conducted at two sites above the weir using electrofishing techniques. A total of 342 individual fish comprised of 13 species were sampled at two sites upstream of the weir. In September 2010 a vertical slot fishway to remediate the barrier to fish migration posed by the Waterpark Creek weir was constructed primarily using concrete. In November 2011, fishway sampling using a trap placed at the top of the fishway yielded a significant number of juvenile fish which had successfully ascended the fishway. Post fishway community sampling revealed an increase in overall species abundance but no increase in diversity. There was however a notable increase in the number of diadromous species; from 2 species prior to fishway construction to 6 after construction.

Fish between 21mm and 600mm successfully ascended the fishway, including both juveniles and adults of a range of species. Importantly, these fish that successfully ascended the fishway included diadromous species undertaking facultative or obligatory migrations from saltwater areas downstream to nursery habitats upstream. Notably, a total of 2191 empire Gudgeons were captured during fishway sampling, emphasising the utility of fishways in passing juvenile fish particularly near the tidal interface.

The following are recommendations for future actions based on the outcomes of this report;

- Ongoing fish community sampling in the Waterpark Creek catchment.

# Introduction

During 2008 the Department of Primary Industries and Fisheries (DPI&F) completed the first comprehensive fish barrier prioritisation project within the Fitzroy Basin Association Region. The Fitzroy Basin Fish Barrier Prioritisation Project (FBFBPP), a joint project between DPI&F and the Fitzroy Basin Association (FBA), prioritised barriers to fish passage in the region to ensure that targeted rehabilitation of aquatic habitats has the greatest benefit for the regions fish communities.

The FBFBPP incorporated a three stage selection criteria process which prioritised barriers to fish passage from most important to least important based on the biological, social and economic benefits and the cost of remediation (Moore & Marsden, 2008). From this prioritisation process a list of the top 30 barriers to fish passage in the region was generated, in which Waterpark Creek Weir was ranked 16$^{th}$.

In Australia, the impact of barriers to fish passage such as dams, weirs and road crossings has been identified as a major cause in the reduction of native fish populations (Stuart & Mallen-Cooper 1999, Stuart & Berghuis 2002, Moore & Marsden 2008). Barriers affect fish community condition by preventing movement of fish species which require free passage along river systems to fulfil a number of key life stage requirements (Moore & Marsden 2008). This movement may be essential for:

- Maintaining populations of diadromous species, which require unimpeded access between freshwaters and the sea for reproduction purposes, i.e. barramundi, sea mullet
- Maintain genetic diversity
- Adult fish species to access upstream habitats for feeding and reproduction purposes
- Juvenile fish species to migrate to upstream nursery habitats
- To avoid predators

Many fish species found in the Waterpark Creek catchment are diadromous, requiring free access to estuarine or marine waters to successfully complete their life-cycles. Fish migration between marine and freshwater habitats and within freshwater habitats is therefore a vitally important aspect of the life cycle of freshwater fishes of the Waterpark Creek catchment. Barriers preventing fish passage contribute to the loss of species diversity within fish communities, severely impacting the health of the regions aquatic eco-systems and is one of the main impacts that man has had on the fish communities of the region (Moore & Marsden, 2008).

Barriers to fish passage have the greatest impact on diadromous species, which are usually the first to become locally extinct above large barriers. The reduction or total extinction of diadromous fish species above barriers to fish passage dramatically affects recruitment within the system, reduces populations downstream and alters fish community structure (Stuart & Berghuis 2002, Stuart & Mallen-Cooper 1999, Moore & Marsden 2008).

A number of biological, social, and economic factors contributed to the high priority ranking of Waterpark Creek Weir. These include; the location of the weir - low down in the system close to the estuarine/freshwater interface, excellent upstream fish habitat including diverse riparian and instream habitat, minimal anthropogenic impacts, no upstream barriers to fish passage and the perennial nature of the waterbody. The weir's location within the catchment close to the estuarine/freshwater interface is of particular importance, and may have already

contributed to the loss of species diversity upstream of the weir, by restricting juvenile diadromous fish species from migrating to upstream nursery habitats.

The primary aim of the Waterpark Creek Fishway Project was to alleviate the barrier to fish migration posed by the Waterpark Creek weir. Through the construction of a fishway at this site, the aim was to pass both adult and juvenile migratory fish upstream of the weir to reinstate the indigenous fish community found in the catchment prior to the construction of the weir.

## Site Information

Waterpark Creek originates in the Colcara Range in the Shoalwater Bay Training Area (SWBATA) and flows south into the Coral Sea approximately 20kms north of Yeppoon. Waterpark Creek has a catchment area of 1840km² and consists of three main tributaries; Tee-Tee, Sandy and Valentine creeks (ANGFA, 1996). Sandy Creek is the largest of the tributaries and flows into the estuarine reaches of the larger Waterpark Creek, which itself then enters the complex continuous wetland aggregation of marine, estuarine and freshwater wetlands of the nationally recognised Corio Bay. Corio Bay and the Dismal Swamp (headwaters of Waterpark Creek) form part of the internationally recognised Shoalwater and Corio Bay RAMSAR site (Figure 1).

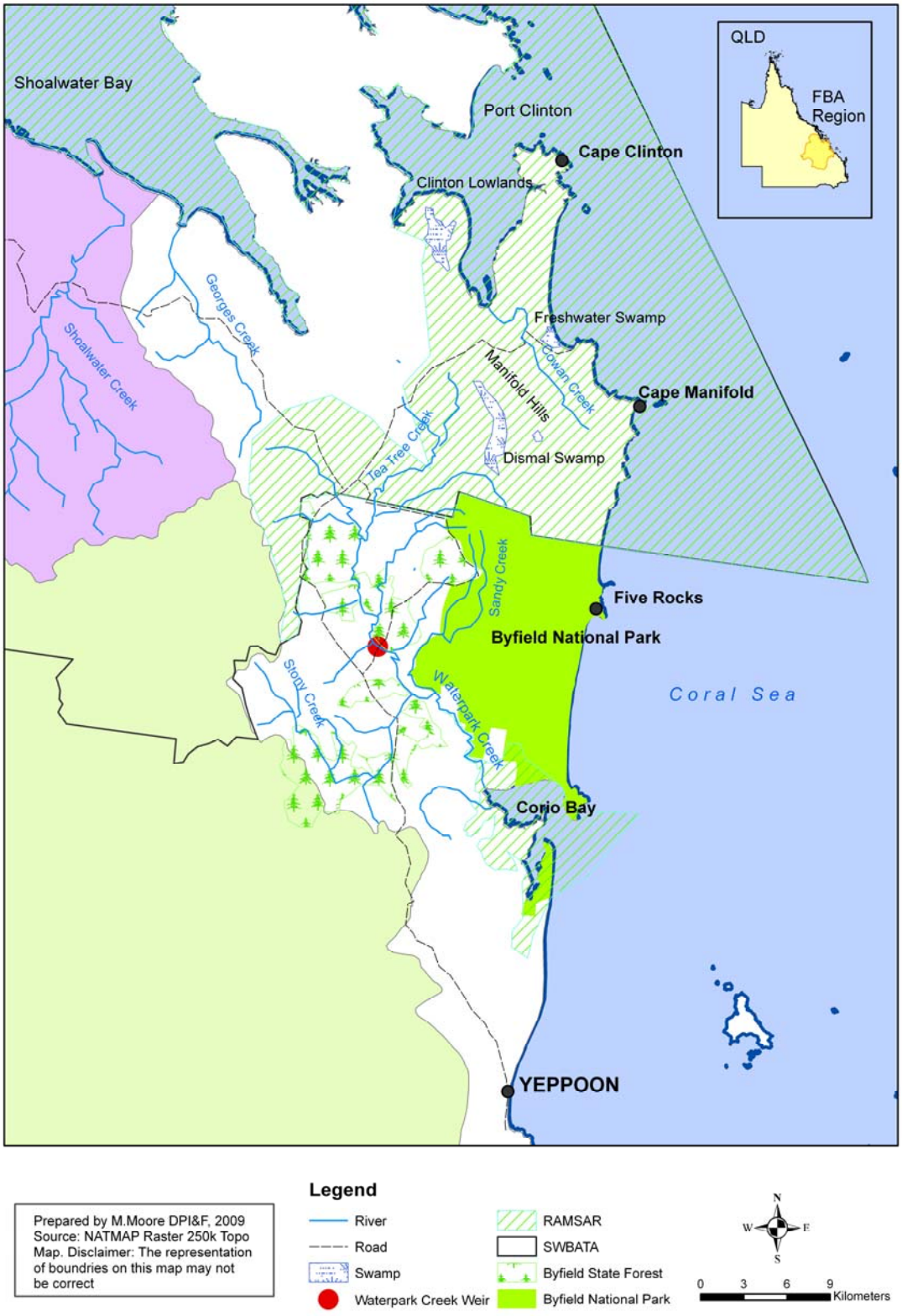


**Figure 1.** Site map for Waterpark Creek fishway project**.**

The headwaters of Waterpark Creek are perennially fed by groundwater input from the Manifold Hills sandmass in the north-east of SWBATA and also by groundwater input from

the sand aquifers underlying and abutting the Byfield National Park (ANGFA, 1996) in the north-west. Byfield National Park and SWBATA have largely protected the headwaters of Waterpark Creek from degradation, and as such, they remain in pristine condition.
The FBA region boasts a sub-tropical climate, typified by variable rainfall, high evaporation rates and prolonged dry periods followed by floods (Cotton Catchment Communities CRC, 2007).

The FBA region encompasses a variety of habitats, with Waterpark Creek being found in the relatively undisturbed Shoalwater Bay region, which contains the largest coastal wilderness area between Nadgee in Southern NSW and Cape Melville on the Cape York Peninsula. Shoalwater and Corio Bays are RAMSAR listed wetlands; the upper part of the Waterpark Catchment is included in this listing, (Environment and Heritage, 1995).

The oligotrophic freshwater wetlands of Shoalwater Bay are the northernmost known habitat of the Honey Blue-Eye (*Pseudomugil mellis*), a nationally listed vulnerable fish species under the Commonwealth Endangered Species Protection Act 1993, while the nationally endangered Oxleyan Pygmy Perch (*Nannoperca oxleyana*) may occur in dune swamps in the area (Environment and Heritage, 1995). Freshwater streams and wetlands of Shoalwater Bay are absent of exotic fish species, a characteristic found in no other catchment on the east coasts of Australia (Aust.Gov, 1994).

The clear water rainforest streams flowing out of Byfield National Park contain the northern most distribution of Ornate Rainbowfish (*Rhadinocentrus ornatus*), the Striped Gudgeon (Gobiomorphus australis) and the Short-Headed Lamprey (*Mordacia mordax*) (Marsden and Kerslake, 2002). This area also contains Dismal Swamp which contains a wide range of wetland types with many similarities to the more extensive sandmass wetlands of southeastern Australia (ANGFA, 2006). This area is rich in biodiversity due to the overlapping distribution of tropical and subtropical species and the protection afforded to the catchment by National Park and military areas.

## Fish Barriers

Prior to the construction of the vertical slot fishway, the Waterpark Creek weir was the only barrier on the creek system (Figure 2). The weir wall is approximately 50m across with a height of 1 meter. The gauging weir 'V' on the right hand side of the creek (facing downstream) is 300mm wide and drops 400mm from the top of the weir wall. Recent alterations made to the site include a 250mm pipe running along the face of the cement apron to pipe water from Sandy Creek (when required). There is also an outlet works on the left hand side of the creek (facing downstream). By removing this single barrier to fish migration approximately 130km of fish habitat will be made accessible.

The cement apron below the weir is 1.25m wide and slopes greatly from the right hand side to directly below the 'V' then runs almost flat to the outlet works then rises on a sharp angle to the left hand bank. This section of water between the weir wall and the road crossing is commonly used as a swimming hole by the public.

**Figure 2.** The weir on Waterpark Creek prior to fishway construction.

## Flow Characteristics

In the past Waterpark Creek has experienced a variety of flow levels, including extremely large flows during the wet season (December to April) and quite low flows during the dry season (June to November) or due to droughts as seen over the past two decades (Figure 2). As there is only one weir on this system there are few limiting factors to the flow characteristics. However this weir does disrupt the natural flow of the creek. During high flows much of the weir is drowned out allowing passage for a number of species, but once the water drops below crest level the amount of passage available decreases. These medium and low water levels may last a number of months which deprives any migrating fish the chance to pass over the weir.

## Fishway Design

After initial site inspections it was clear that the gauging weir on Waterpark Creek was acting as a barrier to the migration of a range of fish species found in the catchment, including nine diadromous species which need to migrate between fresh and salt water to breed. In order to alleviate this barrier to fish migration in Waterpark Creek, a vertical slot fishway was constructed in September 2010. This design was based on flow characteristics, weir structure and available funding (Figure 3).

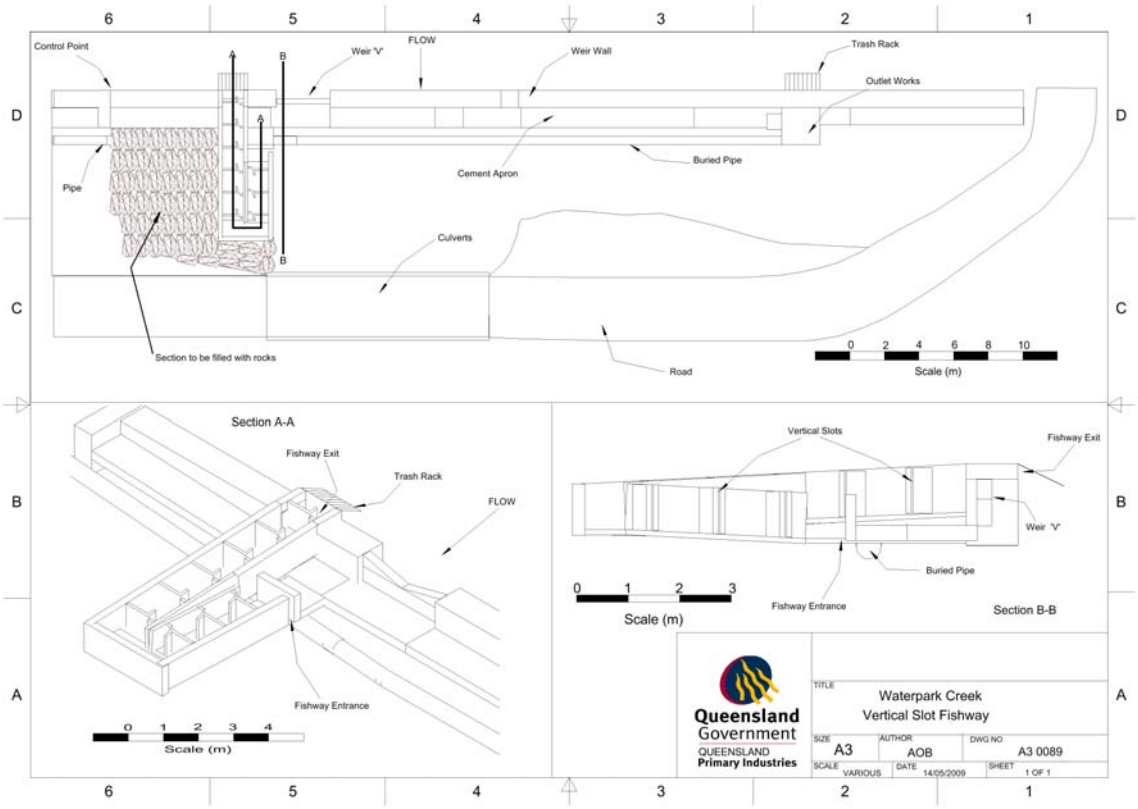


**Figure 3.** Fishway design plans

Construction of the vertical slot fishway began with an excavation of a channel leading away from the cement apron below the weir towards the road (7.5 meters long) followed by a U shape back towards the weir (4.5m long). This channel was 3.2 meters wide to account for the width of the cement walls and the fishway cells. The walls of the fishway were made using concrete and constructed on site. They were 1 meter high (including the 100mm cement base) and constructed on a gentle slope to ensure each cell is 67mm lower than the one in front. Nine pre-made metal vertical slots were installed 1.2 meters apart to create the cells of the fishway, they were fastened to the walls using epoxy and dyna-bolts ensuring they won't move during high energy flows. The cement wall of the weir was cut into to create the exit cell and fitted with the final vertical slot, a trash rack was also fitted to the upstream side ensure debris doesn't enter and block the fishway. The area to the left of the fishway (looking downstream) was filled in with large rock to ensure scouring around the fishway doesn't occur, this will also prevent fish accumulating in the shallows and becoming stranded when levels decrease or succumbing to predation.

**Figure 4.** Waterpark Creek site prior to construction


**Figure 5.** Fishway construction


**Figure 6.** Fishway construction with cells installed

# Methods

## Fish Community Sampling

Fish community sampling was undertaken in Waterpark Creek, consisting of both pre and post fishway construction sampling using a boat mounted electrofisher. Preliminary fish community sampling was undertaken on the 17th and 18th of September 2008. This initial sampling was performed to gather base line data so that future comparisons could be made. Post fishway construction sampling was undertaken on the 8th and 10th of November 2011. This sampling was undertaken to detect any changes in fish community abundance and diversity since the inception of the fishways. Limited sampling was undertaken due to funding constraints. Fish community sampling was conducted at two sites upstream of the weir. Site 1 (Figure 7) was 5km upstream of the weir while site 2 (Figure 8) was at the weir on the upstream side.

**Figure 7.** Site one, Waterpark Creek weir pool

**Figure 8.** Site two, 5km upstream of Waterpark Creek weir

Electrofishing during pre fishway sampling was conducted with a 3.7m vessel (Hypnos II) which operates a Smith-Root 2.55 GPP electrofisher unit, two boom arms with 4 dropper anode arrays and a hull cathode (Figure 9). An operator and a single net person were employed during pre construction sampling using Hypnos II. During post fishway sampling a 4.7m electrofishing vessel (Discopyge II) which operated a Smith-Root 7.5 GPP electrofisher unit, two boom arms with 16 dropper anode arrays and hull cathode was used. An operator and two netters were employed during post fishway sampling using Discopyge II. Sampling was conducted at various water depths and encompassed all habitat types. Sampling was conducted during daylight hours and was standardised by shot time.


**Figure 9**. Fish community sampling using an electrofishing boat

The Electrofishing sampling method employed in this study consisted of 300 second ‘shots’. A ‘shot’ conducted by the vessel utilised a 50m section of pool and included runs mid stream parallel to the bank, which consisted of multiples of 12 seconds of power-on followed by 12 seconds of power-off. Further to this 10 runs into the bank at 5m intervals along the same 50m stretch were employed. A run into the bank consisted of a total of 24 seconds of power on, including, 10 seconds motoring into the bank, holding for 4 seconds at the bank, then 10 seconds reversing from the bank. In areas where a 50m stretch of bank was not available or the stream had insufficient width, a ‘shot’ consisted of multiples of power-on and power-off electrofishing for a total of 300 seconds covering the whole habitat area.

All fish captured during electrofishing were identified to species level, counted and measured to the nearest millimetre (fork length for forked-tail species, total length for all other species). Fish were then released into the area from which they were captured. Only 50 individuals of a single species captured in any single ‘shot’ were measured. The remaining individuals were counted but not measured. Fish observed as affected by the electric field and positively identified, but not netted, were recorded and have been included in any abundance analyses in this report.

## Fishway Sampling

Fishway sampling was conducted on Waterpark Creek to validate to effectiveness of the fishway at passing different fish species and size classes. Fishway sampling consisted of

placing a ‘fish trap’ at the top of the fishway (Figure 10) to record fish species and size classes of fish successfully migrating through the fishway. The trap used for this method was constructed out of 12 mm round bar with shade cloth (4 mm mesh size) covering the frame. One cone shaped entrance was placed into the front of the trap. The trap dimensions were 1040 mm x 720 mm x 800 mm.

Fishway sampling was conducted over four consecutive days; 7$^{th}$, 8$^{th}$, 9$^{th}$ and 10$^{th}$ of November. Significantly, this period is towards the beginning of the wet season and is generally when the majority of the regions fish species are likely to be undertaking upstream migration. The trap was then left overnight at the top of the fishway for approximately 12 hours and checked in the morning and in the evening. All fish captured during fishway sampling were identified to species level, counted and measured to the nearest millimetre (fork length for forked-tail species, total length for all other species). Fish were then released upstream of the fishway.

**Figure 10.** Trap placed at the top of the fishway at Waterpark Ck.

# Results

## Fish Community Sampling

### Pre Construction Catch Summary

Fish community sampling yielded a total of 342 individuals comprising 13 species across two sites up stream of the weir prior to fishway construction (Table 1). The majority of the species recorded were potamodromous (11 species) whilst only two diadromous species were recorded across both sites. The most abundant species recorded during the pre-construction survey was Purple-spotted Gudgeon (*Mogurnda adspersa*), comprising 27.2% of observations across both sites. The weir pool (directly above weir, Site 2) yielded considerably more individuals than site one, 5km upstream. At site one, 101 individuals comprising 6 species were recorded whilst at site two, 241 individuals comprising 13 species were sampled. It should also be noted that no pest fish were recorded during this survey.

**Table 1.** Summary of number of individuals caught during sampling prior to fishway construction.

| Migration Classification | Common Name | Species Name | Site 1 | Site 2 | Total |
|---|---|---|---|---|---|
| Diadromous | Tarpon | *Megalops cyprinoides* | 0 | 0 | 0 |
| | Sea Mullet | *Mugil cephalus* | 0 | 0 | 0 |
| | Freshwater Mullet | *Myxus petardi* | 0 | 0 | 0 |
| | Striped Gudgeon | *Gobiomorphus australis* | 1 | 1 | 2 |
| | Bullrout | *Notesthes robusta* | 0 | 0 | 0 |
| | Marbeled Eel | *Anguilla reinhardtii* | 12 | 19 | 31 |
| Potamodromous | Purple-spotted Gudgeon | *Mogurnda adspersa* | 33 | 60 | 93 |
| | Empire Gudgeon | *Hypseleotris compressa* | 21 | 55 | 76 |
| | Midgley's Carp Gudgeon | *Hypseleotris sp.1* | 0 | 1 | 1 |
| | Eastern Rainbowfish | *Melanotaenia splendida* | 0 | 56 | 56 |
| | Rendahl's Catfish | *Porochilus rendahli* | 0 | 1 | 1 |
| | Hyrtl's Tandan | *Neosilurus hyrtlii* | 0 | 1 | 1 |
| | Spangled Perch | *Leiopotherapon unicolor* | 0 | 1 | 1 |
| | Mouth Almighty | *Glossamia aprion* | 0 | 5 | 5 |
| | Western Carp Gudgeon | *Hypseleotris klunzingeri* | 0 | 4 | 4 |
| | Ornate Rainbowfish | *Rhadinocentrus ornatus* | 33 | 33 | 66 |
| | Eel-tailed Catfish | *Tandanus tandanus* | 1 | 4 | 5 |
| **Total Individuals** | | | 101 | 241 | 342 |
| **Total Species** | | | 6 | 13 | 13 |

## Pre Construction Community Structure

*Site 1 – 5km Upstream of weir*
A total of 101 individuals comprising 6 species were sampled at this site at a catch rate of 5.05 fish per minute. Of these 6 species only two, Striped Gudgeon and Marbled Eel were diadromous. The most abundant species were Purple-spotted Gudgeon and Ornate Rainbowfish (both 33 individuals). Other species recorded included Striped Gudgeon, Marbeled Eel, Empire Gudgeon and Eel-tailed Catfish.

*Site 2 – Weir pool*
Sampling at the weir pool site yielded 241 individuals representing 13 species at a catch rate of 4.02 fish per minute. The majority of the recorded species were potamodromous (11 species), whilst only two were diadromous (Striped Gudgeon and Marbeled Eel). Purple-spotted Gudgeon, Eastern Rainbowfish and Empire Gudgeon were the most common species (60, 56 and 55 individuals respectively). Other species include Striped Gudgeon, Marbeled Eel, Midgeley's Carp Gudgeon, Rendahl's Catfish, Hyrtl's Tandan, Spangled Perch, Mouth Almighty, Western Carp Gudgeon, Ornate Rainbowfish and Eel-tailed Catfish.

## Post Construction Catch Summary

Post construction fishway sampling saw increases in both species abundance and diversity at both sites (Table 2). The numbers of diadromous species at site one increased from 2 to 3 and increased from 2 to 5 at site two. The numbers of potamodromous species increased from 4 to 5 at site one however they decreased from 10 to 5 at site two. Empire Gudgeons were the most abundant species at both sites. Rendahl's Catfish, Hyrtl's Tandan and Midgeley's Carp Gudgeon were absent from both sites during post construction surveys, however Tarpon, Sea Mullet, Freshwater Mullet and Bullrout were all present post construction having been absent in pre construction surveys.

At site one, 111 individuals were captured representing 8 species at a catch rate of 11.1 fish per minute. At site two, a total of 493 fish were captured constituting of 13 species at a catch rate of 12.3 fish per minute. No pest fish were recorded in the post construction survey at either site.

**Table 2.** Summary of number of individuals caught during sampling after to fishway construction.

| Migration Classification | Common Name | Species Name | Site 1 | Site 2 | Total |
|---|---|---|---|---|---|
| Diadromous | Tarpon | *Megalops cyprinoides* | 0 | 2 | 2 |
| | Sea Mullet | *Mugil cephalus* | 0 | 1 | 1 |
| | Freshwater Mullet | *Myxus petardi* | 0 | 6 | 6 |
| | Striped Gudgeon | *Gobiomorphus australis* | 2 | 0 | 2 |
| | Bullrout | *Notesthes robusta* | 2 | 18 | 20 |
| | Marbeled Eel | *Anguilla reinhardtii* | 4 | 76 | 80 |
| Potamodromous | Purple-spotted Gudgeon | *Mogurnda adspersa* | 18 | 1 | 19 |
| | Empire Gudgeon | *Hypseleotris compressa* | 50 | 247 | 297 |
| | Midgley's Carp Gudgeon | *Hypseleotris sp.1* | 0 | 1 | 1 |
| | Eastern Rainbowfish | *Melanotaenia splendida* | 0 | 139 | 139 |
| | Rendahl's Catfish | *Porochilus rendahli* | 0 | 0 | 0 |
| | Hyrtl's Tandan | *Neosilurus hyrtlii* | 0 | 0 | 0 |
| | Spangled Perch | *Leiopotherapon unicolor* | 1 | 2 | 3 |
| | Mouth Almighty | *Glossamia aprion* | 0 | 0 | 0 |
| | Western Carp Gudgeon | *Hypseleotris klunzingeri* | 0 | 0 | 0 |
| | Ornate Rainbowfish | *Rhadinocentrus ornatus* | 32 | 0 | 32 |
| | Eel tailed Catfish | *Tandanus tandanus* | 2 | 0 | 2 |
| **Total Individuals** | | | 111 | 493 | 604 |
| **Total Species** | | | 8 | 10 | 13 |

## Post Construction Fish Community Structure

*Site 1 – 5km Upstream of weir*

Post construction surveys at site 1 resulted in the capture of 111 individuals comprised of 8 species at a considerably higher catch rate of 11.1 fish per minute (compared to 5.05 fish per minute prior to construction of the fishway). The most abundant species at site 1 was Empire Gudgeons. The numbers of both diadromous and potamodromous species recorded at site 1 increased. Species such as Bullrout and Spangled Perch, which were not present prior to fishway construction, were observed during post fishway sampling (Table 2).

*Site 2 – Weir pool*

At site two, a total of 493 fish were captured comprised of 10 species at a catch rate of 12.3 fish per minute. The most abundant species was Empire Gudgeons (297 individuals). Of the 10 species sampled, half were diadromous including Tarpon, Sea Mullet, Freshwater Mullet, Bullrout and Marbeled eel (Table 2).

## Comparison Between Pre and Post Fish Community Sampling

Overall we recorded an increase in species diversity at site one but a decrease in species at site 2. However, the catch rate of fish increased dramatically during post fishway sampling at

both sites, increasing from 5.05 to 11.1 fish per minute at site one and from 4.02 to 12.3 fish per minute at site 2 (Table 3). Importantly, post fishway surveys found an increase in diadromous fish species sampled at both sites. At site 1 the numbers of diadromous species increased from 2 to 3 and increased from 2 to 5 at site two (Table #).

**Table 3.** Pre and post fishway sampling results for species diversity and catch rate.

| Sampling Period | Total Species | | | Catch Rate (fish/min) | | |
|---|---|---|---|---|---|---|
| | Site 1 (5km Upstream) | Site 2 (Weir pool) | Total | Site 1 (5km Upstream) | Site 2 (Weir pool) | Total |
| **Pre Fishway** | 6 | 13 | **13** | 5.05 | 4.02 | **4.28** |
| **Post Fishway** | 8 | 10 | **13** | 11.1 | 12.3 | **12.08** |

For most species, we measured an increase in fish caught per minute during the post fishway survey compared to the pre construction survey at both sites (Figures 11 & 12). Exceptions to this general trend included Marbeled Eel at site 1 and Purple-spotted Gudgeon, Ornate Rainbowfish, Striped Gudgeon, Eel-tailed Catfish, Hyrtl's Tandan, Mouth Almighty and Western Carp Gudgeon at site 2. The largest increase in abundance was observed for Empire Gudgeons with an increase of 476% at site 1 and a 950% increase at site 2.

**Table 4.** Total catch summary for pre and post fishway surveys at Waterpark Ck.

| Migration Classification | Common Name | Species Name | Pre Fishway | Post Fishway | Total |
|---|---|---|---|---|---|
| Diadromous | Tarpon | *Megalops cyprinoides* | 0 | 2 | 2 |
| | Sea Mullet | *Mugil cephalus* | 0 | 1 | 1 |
| | Freshwater Mullet | *Myxus petardi* | 0 | 6 | 6 |
| | Striped Gudgeon | *Gobiomorphus australis* | 2 | 2 | 4 |
| | Bullrout | *Notesthes robusta* | 0 | 20 | 20 |
| | Marbeled Eel | *Anguilla reinhardtii* | 31 | 80 | 111 |
| Potamodromous | Purple-spotted Gudgeon | *Mogurnda adspersa* | 93 | 19 | 112 |
| | Empire Gudgeon | *Hypseleotris compressa* | 76 | 297 | 373 |
| | Midgley's Carp Gudgeon | *Hypseleotris sp.1* | 1 | 1 | 2 |
| | Eastern Rainbowfish | *Melanotaenia splendida* | 56 | 139 | 195 |
| | Rendahl's Catfish | *Porochilus rendahli* | 1 | 0 | 1 |
| | Hyrtl's Tandan | *Neosilurus hyrtlii* | 1 | 0 | 1 |
| | Spangled Perch | *Leiopotherapon unicolor* | 1 | 3 | 4 |
| | Mouth Almighty | *Glossamia aprion* | 5 | 0 | 5 |
| | Western Carp Gudgeon | *Hypseleotris klunzingeri* | 4 | 0 | 4 |
| | Ornate Rainbowfish | *Rhadinocentrus ornatus* | 66 | 32 | 98 |
| | Eel-tailed Catfish | *Tandanus tandanus* | 5 | 2 | 7 |
| **Total Individuals** | | | 342 | 604 | 946 |
| **Total Species** | | | 6 | 13 | 13 |

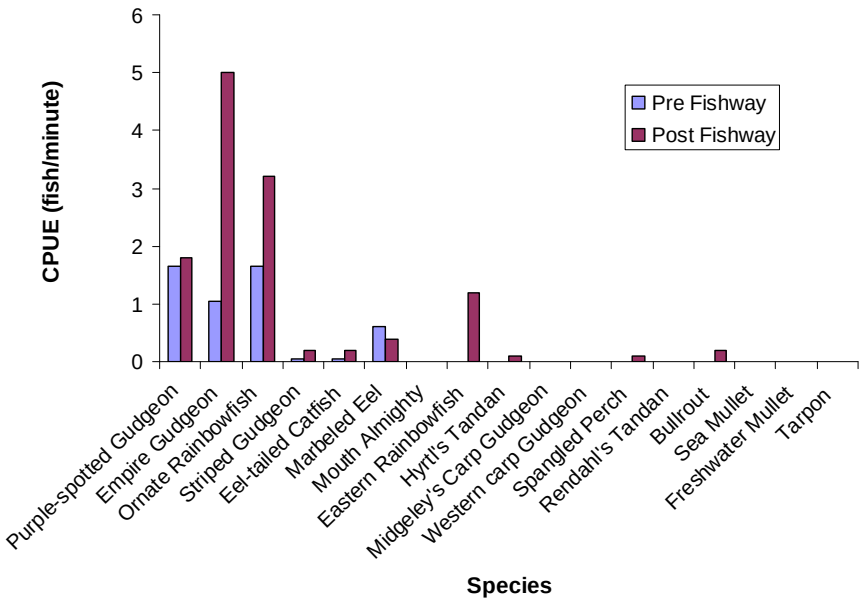


**Figure 11.** Comparison of results from pre and post fishway sampling at site 1, Waterpark Ck.

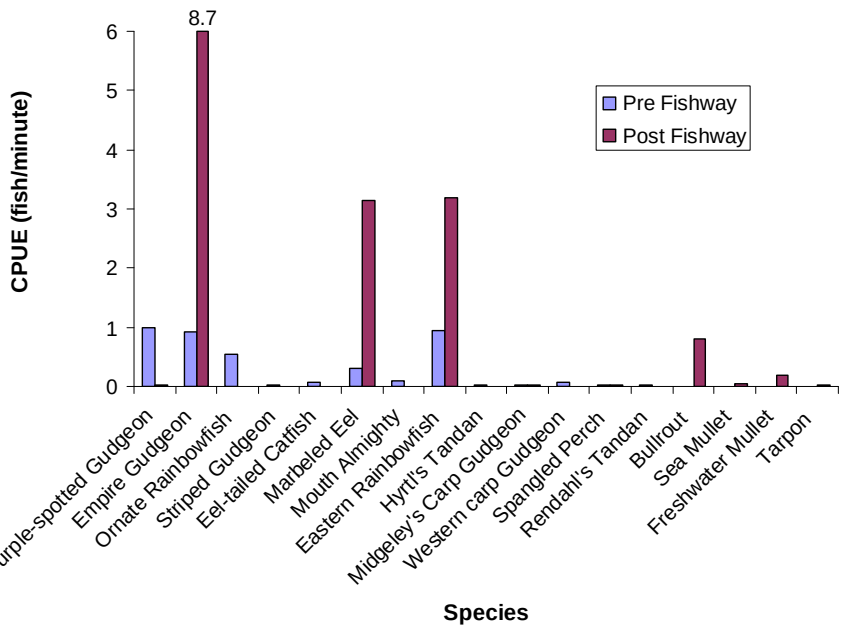


**Figure 12.** Comparison of results from pre and post fishway sampling at site 2, Waterpark Ck.

## Fishway Sampling Catch Summary

Fishway sampling was conducted using a mesh trap placed at the top of the fishway. It yielded predominantly Empire Gudgeons which made up 98.9% of the total catch (Table 5). The majority of the Empire Gudgeons measured were between 20 and 40mm total length, demonstrating that the fishway is able to pass juvenile fish. Of the 2000 Empire Gudgeons recorded in the trap during the period 08:25 to 16:55 on the 10$^{th}$ of November (operation 6), a sub-sample of 50 individuals were measured to the nearest millimetre whilst the rest were counted but not measured. Furthermore both juvenile and adult Marbeled Eels (diadromous) were caught in the trap during fishway sampling, showing that the fishway is effective in passing both small juveniles (40mm, 59mm, 69mm) as well as adults (600mm). Other species

caught in the fishway trap included two other diadromous species, Bullrout and Striped Gudgeon, as well as potamodromous Eastern Rainbowfish and Hyrtl's Tandan.

**Table 5**. Results of fishway sampling with number of individuals from each size class recorded.

| | Size Classes (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **<10** | **11 to 20** | **21 to 30** | **31 to 40** | **41 to 50** | **51 to 60** | **>61** |
| Empire Gudgeon | 0 | 0 | 116 | 125 | 2 | 0 | 0 |
| Marbeled Eel | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| Striped Gudgeon | 0 | 0 | 9 | 7 | 1 | 0 | 0 |
| Eastern Rainbowfish | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Bullrout | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Hyrtl's Tandan | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

## Total Catch Summary

A total of 946 fish representing 13 species were sampled during pre and post construction sampling at Waterpark Creek. Of the fish sampled, 18.06% were diadromous species including Tarpon, Sea Mullet, Freshwater Mullet, Striped Gudgeon, Bullrout and Marbeled Eel (Table 6). Overall there was an increase in the number of individuals captured once the fishway had been constructed. Although there was no overall increase in the number of species, there was an increase in the number of diadromous fish upstream of the weir after the construction of the fishway (Table 6), increasing from two species to six. The most abundant species recorded during sampling was Empire Gudgeons (373 individuals) followed by Eastern Rainbowfish, Purple-spotted Gudgeons and Marbeled Eels, with 195, 112, and 111 individuals respectively. No pest fish were captured during the study.

**Table 6.** Species diversity and catch rate per unit effort for pre and post fishway surveys across both sites.

| Migration Classification | Common Name | Species Name | Total Individuals | Total Catch Rate (fish/min) |
|---|---|---|---|---|
| Diadromous | Tarpon | *Megalops cyprinoides* | 2 | 0.02 |
| | Sea Mullet | *Mugil cephalus* | 1 | 0.01 |
| | Freshwater Mullet | *Myxus petardi* | 6 | 0.05 |
| | Striped Gudgeon | *Gobiomorphus australis* | 4 | 0.03 |
| | Bullrout | *Notesthes robusta* | 20 | 0.15 |
| | Marbeled Eel | *Anguilla reinhardtii* | 111 | 0.85 |
| Potamodromous | Purple-spotted Gudgeon | *Mogurnda adspersa* | 112 | 0.86 |
| | Empire Gudgeon | *Hypseleotris compressa* | 373 | 2.87 |
| | Midgley's Carp Gudgeon | *Hypseleotris sp.1* | 2 | 0.02 |
| | Eastern Rainbowfish | *Melanotaenia splendida* | 195 | 1.50 |
| | Rendahl's Catfish | *Porochilus rendahli* | 1 | 0.01 |
| | Hyrtl's Tandan | *Neosilurus hyrtlii* | 1 | 0.01 |
| | Spangled Perch | *Leiopotherapon unicolor* | 4 | 0.03 |
| | Mouth Almighty | *Glossamia aprion* | 5 | 0.04 |
| | Western Carp Gudgeon | *Hypseleotris klunzingeri* | 4 | 0.03 |
| | Ornate Rainbowfish | *Rhadinocentrus ornatus* | 98 | 0.75 |
| | Eel-tailed Catfish | *Tandanus tandanus* | 7 | 0.05 |
| **Total Individuals** | | | 946 | 7.28 |
| **Total Species** | | | 13 | |

# Discussion

The construction of the Waterpark Creek fishway has effectively allowed the upstream migration of a number of diadromous species (juveniles and adults) above the weir. The fishway has also resulted in an overall increase in abundance of both diadromous and potamodromous species above the weir. The significant increase in diversity and abundance of a number of diadromous species after the construction of the fishway demonstrates that this project has been successful in addressing its primary aim. Extrapolation of these results suggests that the diversity and abundance of indigenous species throughout the catchment has also increased, however further surveys are required to establish the extent to which the fish have spread throughout the catchment.

Fish between 21mm and 600mm successfully ascended the fishway, including both juveniles and adults of a range of species. Importantly, these fish that successfully ascended the fishway included diadromous species undertaking facultative or obligatory migrations from saltwater areas downstream to nursery habitats upstream. These diadromous species included Tarpon, Sea Mullet, Freshwater Mullet, Striped Gudgeon, Bullrout and Marbeled Eel. Hence the recruitment process of diadromous fish species into regions above the weir is occurring. This is significant from a biodiversity point of view but also from a commercial and recreational fisheries point of view. Sea Mullet (*Mugil cephalus*) is a commercially important fish species (see Queensland Fisheries, 2011) that will benefit from the 130km of fish habitat that has been made available with the construction of the fishway on Waterpark Creek. Sea Mullet, Freshwater Mullet and Tarpon are all important recreational fish species that are diadromous and will benefit from gaining access to upstream nursery habitats in the Waterpark Creek catchment.

One significant finding from this study has been the large number of juvenile Empire Gudgeons ascending the fishway. During fishway sampling, 2191 juvenile Empire Gudgeons were caught in the trap at the top of the fishway. Empire Gudgeons are known to have relatively poor swimming performance (Donaldson et al., in prep), therefore it may be presumed that if juvenile Empire Gudgeons are able to ascend this fishway, then juveniles of other species may also pass through to upstream habitats.

Overall, the diversity and abundance of diadromous species was higher during post fishway sampling. Presumably this is a result of fish from downstream areas moving upstream through the fishway to areas above the weir. Prior to the construction of the fishway only two diadromous species were sampled above the weir; Striped Gudgeon and Marbeled Eel. In contrast, post fishway sampling recorded six diadromous species including Tarpon, Sea Mullet, Bullrout and Freshwater Mullet, in addition to the species sampled pre fishway. This is an important result as the passing of diadromous species was a key aim of this project and has clearly been achieved. It should also be noted that although sampling protocols for pre and post fishway surveys were consistent, the sampling equipment used was different. Post fishway sampling was conducted with a larger vessel which has a broader range and therefore should be considered when comparing results from both sampling events.

The presence of Freshwater Mullet (*Myxus Petardi*) in the Waterpark Creek catchment is significant as they have not previously been recorded in the catchment. Prior to the post fishway sampling undertaken during this project, the most northerly record of Freshwater Mullet was from the Burnett River (Allen et al., 2002; M. Moore pers. comm., 2012), approximately 270km to the south. Although this is unlikely to be a direct result of the implementation of the fishway, it is an important finding for our understanding of the distribution of freshwater fish species in Australia.

# Conclusions

It is clear that the vertical slot fishway constructed on Waterpark Creek has been successful in facilitating the upstream migration of both potamodromous and diadromous species. Most importantly the number of diadromous species found upstream of the weir increased significantly after the construction of the fishway. In addition to an increase in species diversity after the fishway was constructed, there was also an increase in abundance.

The sampling of a significant number of juvenile fish undertaking obligatory and facultative migrations highlights the apparent importance of the Waterpark Creek catchment as a nursery habitat for indigenous freshwater species. Access to these nursery habitats afforded by the fishway may not only have flow-on effects for the abundance and diversity of species in the Waterpark Creek catchment but also nearby catchments which may benefit from an increase in recruitment rates of diadromous species.

The results of this study demonstrate the benefits provided by the construction of a fishway close to the tidal interface in a system where there is quality habitat upstream…

## Recommendations

- Ongoing fish community sampling in the Waterpark Creek catchment.

## References


Allen, G.R., Midgley, S.H., Allen, M., and Museum, W.A. (2002). Field guide to the freshwater fishes of Australia (Western Australian Museum Perth).

Australian & New Guinea Fisheries Association Queensland (1996). Shoalwater Bay, *In stream*, Vol 15, No. 1. (www.angfaqld.org.au/Sample.pdf)

Donaldson, J., Fulton, C., Ebner, B. 2012. Biophysical coupling in tropical stream fish assemblages: flow performance drives species habitat selectivity. *In preparation.*

Environment and Heritage Section, Department of Defence. (1995). *Shoalwater and Corio Bays Area - Queensland*. Site accessed on the 02 June 2008. URL Address: http://www.wetlands.org/reports/ris/5AU044en.pdf

Marsden, T.J. & Kerslake, M. (2002). *Sandy Creek Weir Assessment Fisheries Survey*. Queensland Department of Primary Industries and Fisheries, Mackay.
Moore, M., Marsden, T., 2008, *Fitzroy Basin Fish Barrier Prioritisation Project*, QPI & F Mackay

Moore, M.T. and Marsden, T.J. (2008). Fitzroy Basin Fish Barrier Prioritisation Project. Queensland Department of Primary Industries and Fisheries, Mackay.

Queensland Fisheries. 2011. Stock status of Queensland's fisheries resources 2011. Queensland, Department of Employment, Economic Development and Innovation: 114pp

Queensland Government Environmental Protection Agency, 2003. *Wetlands, more than just wet land, Shoalwater & Corio bays*. (http://www.derm.qld.gov.au/register/p00239aa.pdf)

Stuart, I.G. and Mallen-Cooper, M. (1999). An assessment of the effectiveness of a vertical-slot fishway for non-salmonid fish at a tidal barrier on a large tropical/subtropical river. *Regulated Rivers: Research and Management* 15:575-590.