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Blackrock Creek Fishway –Monitoring Report

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Introduction

Background

In the Mackay region, impacts of barriers such as causeways, road crossings, weirs and dams on fish passage has been identified as a major cause in the reduction of native fish populations and a driver of change to fish community assemblages (Marsden & Kerslake, 2002). Barriers affect fish community condition by preventing movement of migratory (diadromous) species which require adequate passage through aquatic ecosystems to complete a number of key life stage requirements (Moore & Marsden, 2008). This movement may be required for:

- Preserving populations of potamodromus species, to access a variety upstream habitats for reproduction, recruitment and feeding,
- Juvenile fish species to migrate upstream to access nursery habitats,
- To avoid predators
- Provide opportunity for genetic diversity, and
- Maintaining populations of diadromous species, which required free unimpeded access between freshwater, estuarine and marine environments to breed.

Many fish species found in the Blackrock Creek are diadromous. Fish migration between and within freshwater, estuarine and marine habitats is a vitally important aspect of the life cycle of these fish. Barriers preventing migration contribute to the loss of species diversity within fish communities, severely impacting the health of the region's aquatic ecosystems and are considered to be one of the main anthropogenic impacts on fish communities within the Mackay region (Moore & Kerslake, 2002). The installation of fishways is one remediation option that can improve connectivity between fragmented sites. Fishways are designed to reduce the surface drop and water velocities caused by the barrier, creating conditions that fish are able to negotiate and ascend.

In recent years, there has been significant investment by Mackay Regional Council (MRC) and Reef Catchments Limited (RCL) in establishing infrastructure to improve the biodiversity of the region's waterways, including the construction of fishways. Many of the fishway installations consisted of rock ramp designs as this style is relatively inexpensive and easily retrofitted to a wide range of small to moderate sized barriers. Common locations suitable for retrofitting rock ramp fishways have been road causeways. Causeways generally form a small to moderate sized surface drop barrier and often incorporate a velocity barrier, created as water passes through culverts or across the road surface.

In 2016 RCL, in partnership with MRC, commissioned the design and construction of a rock ramp fishway for Old Bowen Road at Blackrock Creek, Pindi Pindi. In 2017 monitoring of this fishway was undertaken to evaluate operational performance. Information gained from monitoring also provided insight into the migratory patterns of local fish species that will help improve fishway design for tropical waterways. This report provides a brief background of the Old Bowen Road fishway and documents the evaluation methods and interpretation of results.

Site Information

Blackrock Creek

The headwaters of Blackrock Creek are adjacent to Eungella National Park draining eastwards past the township of Pindi Pindi then turning north east, entering the sea at St Helens Bay (Figure 1). The upper reaches are in poor condition with grazing adjacent to the creek system with limited riparian shading and zones. As the creek moves into the floodplain, extensive cropping surrounds the creek system with moderate riparian zones. The lower reaches and estuarine areas have moderate riparian and marine plant zones with extensive grazing to the north of the estuarine habitat. Typical habitat upstream and downstream of Old Bowen Road are provided in Figure 2. Blackrock Creek typically experiences increased flow during the wet season and low flows during the dry season. In dry years Blackrock Creek can cease to flow forming a series of refuge pools along the stream network.

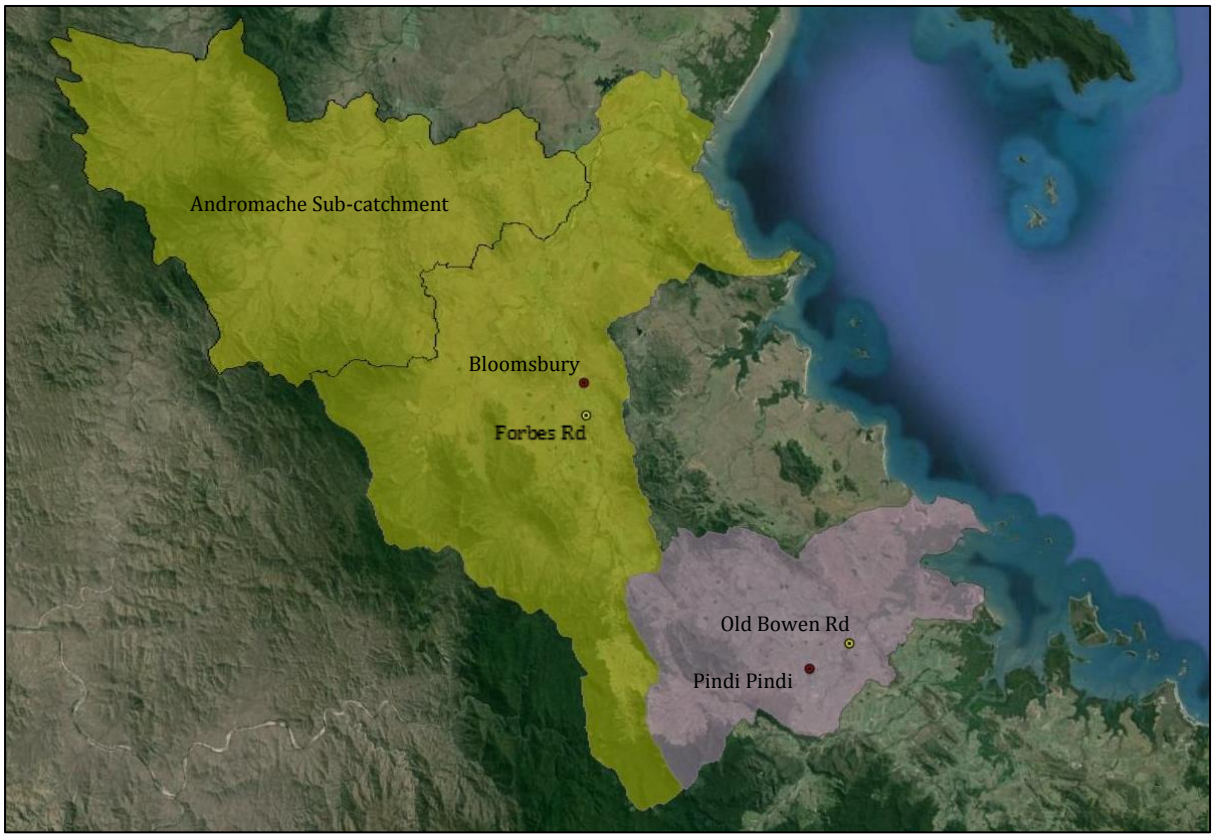

Figure 1. Yellow - O'Connell River Catchment including the township of Bloomsbury, location of Forbes Road fishway and northern Andromache sub-catchment. Pink – Blackrock Creek Catchment including township of Pindi Pindi and locations of Old Bowen Road causeway.

Figure 2. Instream habitat upstream (Right) and downstream (left) of Old Bowen Road, Blackrock Creek.

Barrier Structure

The causeway was of concrete and bitumen construction, consisting of a deck with approach and exit ramps as well as concrete scour protection aprons both upstream and downstream of the deck. The structure is approximately 42 m in length and 6 m wide. Incorporated into the causeway are three separate culvert barrels. Each barrel was set at different locations and elevations. Two of the barrels were functioning, while the third was entirely blocked with sediment and had become obsolete. The two functioning culverts included a 1200 x 500 mm RCBC and a 600 mm pipe culvert. Photos of the causeway prior to the fishway construction are provided in (Figure 3).

The Old Bowen Road causeway was identified in a barrier prioritisation project of the Mackay and Whitsundays region (Moore 2015). The causeway was scored based on the physical, ecological and socio-economic criteria, and was ranked 1st for the Blackrock Creek Catchment and equal 7th for the region.

Figure 3. Views of Old Bowen Rd causeway prior to the fishway installation (left – looking south, right – looking north).

Fishway Structure

The rock ramp fishway was a partial width design, constructed from natural rock and poured concrete. Drops between the ridges were set at 75 mm to create an overall longitudinal fall of 1V:27H. The uniformity of slots (100 mm) between the ridge rocks was achieved with poured concrete and ensured consistent discharge throughout the fishway. Eleven ridges were incorporated into the rock ramp fishway. The arrangement of the fishway is shown in Figure 3Figure 4 and photos of the fishway during construction and shortly after completion are shown in Figure 5.

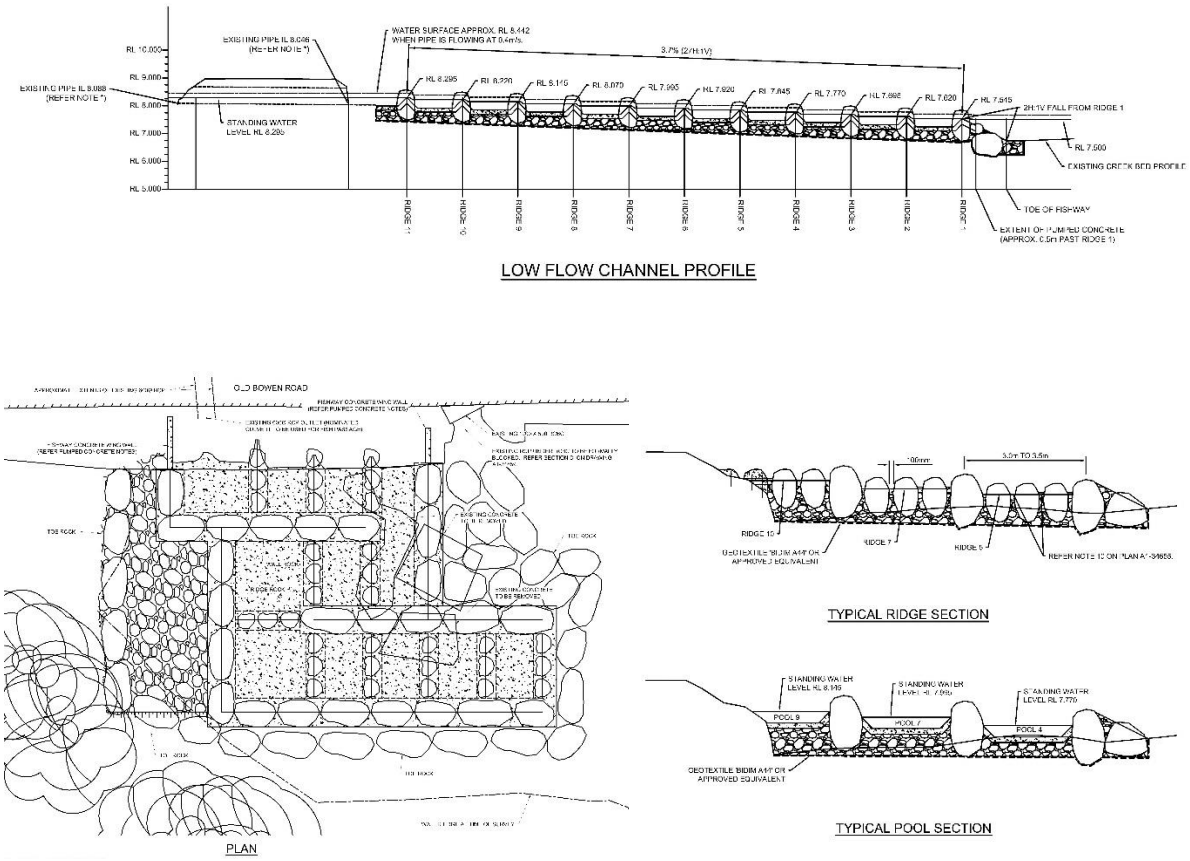

Figure 4. Blackrock Creek fishway schematics.

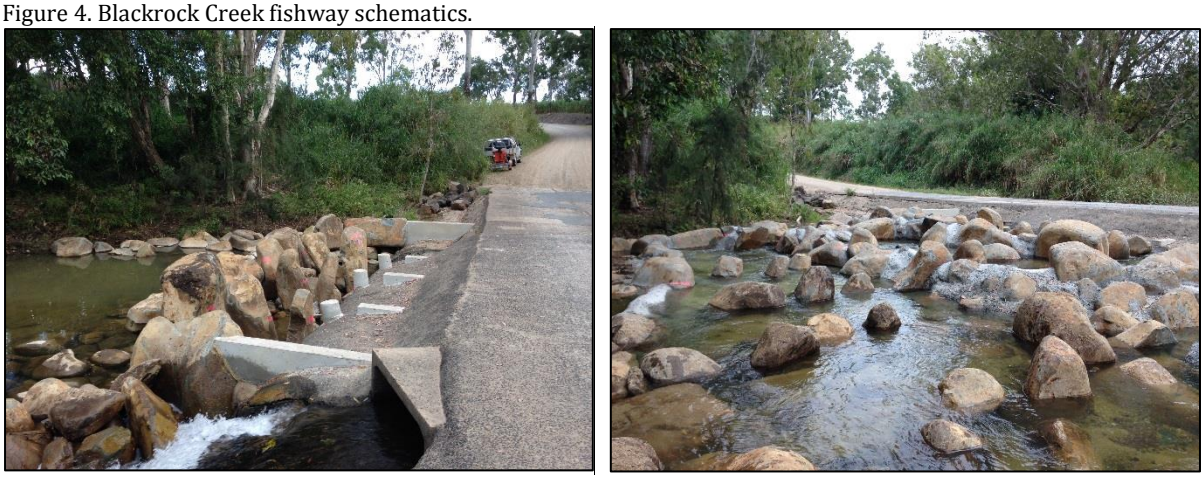

Figure 5. Blackrock Creek fishway during construction (left) and shortly after completion (right).

Fish Species Criteria

Fish community data from within the Blackrock Creek was collected prior to the construction of the fishway (Marsh and Power 2015). Regional fish community data was also reviewed to identify additional species that may utilise the fishway (Moore et al 2007, Catchment Solutions – unpublished data). The catchment supports a total of 39 native and 3 introduced species, ranging in size from species less than 30 mm in length up to large Barramundi that can exceed 1000 mm in length. Table 1 below has been compiled from regional data and sampling data from Blackrock Creek. The table provides a fish species list and the associated swimming ability of each species. All species listed are migratory and some require access between marine and freshwater habitats. Many of the species migrate to breed and all undertake dispersive migrations to maximise habitat utilisation and reduce competition

Table 1.Swimming abilities of fish species recorded from Blackrock Creek and additional freshwater streams in the Mackay and Whitsundays

		Swimming Capability (m/sec)		
Species Name	**Common Name**	**Maximum**	**Sustained**	**Reference**
Acanthopagrus australis	Yellow-fin bream	No data	No data	
Ambassis agassizii#	Agassizis glassfish	0.84	0.09	Pusey et al 2004, Rolls & Sternberg 2015
Amniataba percoides	Barred grunter	1.4	0.1	Pusey at al 1995, Rolls & Sternberg 2015
Anguilla obscura	Pacific short-finned eel	1.4	No data	Rolls & Sternberg 2015
Anguilla reinhardtii#	Long-finned eel	0.87	0.39	Langdon & Collins 2000, Rolls & Sternberg 2015
Arius graeffei	Fork tailed catfish	No data	0.25	Pusey at al 1994
Arrhamphus sclerolepis	Snub-nosed gar	No data	No data	
Awaous acritosus#	Roman-nose goby	0.45	0.15	Pusey at al 2004
Butis butis	Crimson-tipped gudgeon	No data	No data	
Chanos chanos	Milkfish	No data	No data	
Craterocephalus stercusmuscarum	Flyspecked hardyhead	0.85	0.3	Bice & Zampatti 2005, Rolls & Sternberg 2015
Eleotris melanosoma	Ebony Gudgeon	0.19	0.09	Pusey at al 2004
Elops hawaiensis	Giant herring	No data	No data	
Gambusia holbrooki*	Mosquito fish	No data	No data	
Gerres filamentosus	Threadfin silver biddy	No data	No data	
Giurus margaritacea#	Snake head gudgeon	No data	No data	
Glossamia aprion#	Mouth almighty	0.41	0.2	Pusey et al 2004
Glossogobius giurus	Flathead goby	0.3	0.2	Rolls & Sternberg 2015
Hypseleotris compressa#	Empire gudgeon	1.4	0.12	Pusey et al 2004, Rolls & Sternberg 2015
Hypseleotris species 1.#	Midgleys carp gudgeon	0.71	0.07	Pusey et al 2004
Kuhlia rupestris	Jungle perch	1.10	0.18	Rolls & Sternberg 2015, Pusey et al 2004
Lates calcarifer	Barramundi	1.40	0.66	Mallen-Cooper 1992

Leiopotherapon unicolor#	Spangled perch	0.75	No data	Rolls & Sternberg 2015
Liza subviridis	Greenback mullet	1.20	No data	Rolls & Sternberg 2015
Lutjanus argentimaculatus	Mangrove jack	No data	No data	
Megalops cyprinoides#	Tarpon	No data	No data	
Melanotaenia splendida splendida#	Eastern rainbowfish	0.56	0.16	Rolls & Sternberg 2015, Pusey et al 2004
Mogurnda adspersa#	Purple-spot gudgeon	0.70	No data	Rolls & Sternberg 2015, Pusey et al 2004
Mugil cephalus#	Sea mullet	1.60	1.20	Rolls & Sternberg 2015, Pusey et al 2004
Mugilgobius platystomus	Indonesian goby	No data	No data	
Nematalosa erebi	Bony bream	1.40	0.30	Pusey et al 2004, Rolls & Sternberg 2015
Neosilurus ater	Black catfish	1.40	No data	Rolls & Sternberg 2015
Neosilurus hyrtlii	Hyrtl's catfish	No data	0.50	Rolls & Sternberg 2015,Pusey et al 2004
Notesthes robusta#	Bullrout	1.40	0.23	Rolls & Sternberg 2015, Pusey et al 2004
Ophisternon bengalense#	One-gilled eel	No data	No data	
Philypnodon grandiceps	Flathead gudgeon	0.7	0.23	Kilsby 2008, Rolls & Strenberg 2015
Poecilia reticulata*	Guppy	0.95	0.29	Oufiero & Garland 2009
Porochilus rendahli	Rendahl's catfish	No data	No data	
Pseudomugil signifera#	Pacific blue-eye	1.3	No data	Rolls & Strenberg 2015
Scatophagus argus	Spotted scat	No data	No data	
Selenotoca multifasciata	Banded scat	No data	No data	
Strongylura krefftii	Longtom	1.4	No data	Rolls & Strenberg 2015,Pusey et al 2004
Xiphophorus maculatus*	Platy	No data	No data	

*** Pest fish species**

 # Species recorded during Blackrock Creek fish community monitoring

Methods

Fishway Trapping

Fishway sampling was conducted from the 06th—10th March 2017. In total the rock ramp fishway was sampled for 97.7 hours. Trap sets ranged between 6-18 hours and encompassed day light and night time hours.

The fishway trap used consisted of a single cone configuration, constructed from 10 mm round bar with shade cloth (4.0 mm mesh size) covering the frame. Shade cloth wing walls prevented fish from swimming around the trap. The trap dimensions were 1400 mm x 1000 mm x 1100 mm. Sand bags were used to secure the trap and wing walls in place.

All fish captured during a set were identified to species level, counted and measured to the nearest millimetre (folk length of forked-tail species, total length for all other species). If large numbers of a species were captured during a single event, a random subset of 50 fish was measured with the remaining fish counted and contributing only to abundance data. After processing all fish were released upstream, away from the fishway.

Physical Parameters

Water quality parameters including temperature, pH, dissolved oxygen and conductivity were measured using an YSI – Pro Plus multiprobe. The water quality sampling method involved placing the probe into the water at a depth of 0.1 m. After readings had stabilised, values were recorded for each of the water quality parameters. Water quality measurements were recorded from both the top and bottom of the fishway.

Water velocity data was collected from various locations within the fishway, including; ridge slots, pools and the pipe culvert. Ridge measurements were taken by placing the flow meter in the centre of the ridge slots, then averaging the velocity over a 20 second period. The average ridge velocities were calculated from all measurements taken within the respective ridges. Pool measurements were recorded from left, right and centre sections of each pool. The flow meter was positioned at six-tenths the depth of the pool and the velocity was averaged over a 20 second period. Pool velocities were averaged from all measurements taken within each pool. Velocity measurements were taken using a Global Water flow meter (GWFP111). Detailed measurements were only recorded on the first day of monitoring as stream flow remained relatively constant over the monitoring period.

Results

Fishway Utilisation

A total of 409 individual fish at a catch rate of 4.19 fish/hr were recorded during the monitoring period. The catch consisted of 8 native species (Table 2) and 1 introduced species (guppy). Empire gudgeon were the most abundant fish, contributing more than 75% of the catch at a rate of 3.10 fish/hour. Flyspecked hardyhead and eastern rainbowfish were the next most abundant captures recording a CPUE of 0.57 and 0.32 fish/hour respectively. Catch rates of the remaining species ranged between 0.01 to 0.7 fish/hour (Table 2).

Table 2. Fish species recorded during fishway monitoring of the Old Bowen Road rock ramp fishway on Boundary Creek

Common Name	Species	Abundance	CPUE (fish/hr)	Size range (mm)
Diadromous Species				
Bullrout	*Notesthes robusta*	1	0.01	275
Empire gudgeon	*Hypseleotris compressa*	303	3.10	29-46
Long-finned eel	*Anguilla reinhardtii*	3	0.03	150-370
Potamodromous Species				
Agassizis glassfish	*Ambassis agassizii*	7	0.07	37-52
Eastern rainbowfish	*Melanotaenia splendida splendida*	31	0.32	28-80
Flyspecked hardyhead	*Craterocephalus stercusmuscarum*	56	0.57	30-71
Guppy*	*Poecilia reticulata*	1	0.01	20
Midgleys carp gudgeon	*Hypseleotris species 1*	3	0.03	25-30
Mouth almighty	*Glossamia aprion*	2	0.02	112-134
Purple-spot gudgeon	*Mogurnda adspersa*	2	0.02	42
	Total	**409**	**4.19**	

*** Denotes pest fish species**

Physical Parameters

Water quality

Water quality parameters measured during the monitoring period were typical of the habitat, time of day and season, and were all within acceptable levels for fish movement (Table 3).

Table 3. Water quality readings recorded during monitoring of Old Bowen Road rock ramp fishway on Boundary Creek.

	Temperature °C		pH		EC us/cm		DO %sat	
Sample Date/Time	**US**	**DS**	**US**	**DS**	**US**	**DS**	**US**	**DS**
6/03/2017 8:45	27.4	27.4	7.24	7.31	299	299	70.4	77.5
6/03/2017 15:45	29.1	29.1	7.47	7.48	309	309	97	102
7/03/2017 9:00	27.6	27.6	7.28	7.34	296	297	72.9	76.7
7/03/2017 15:20	29.9	29.9	7.47	7.45	309	309	95.6	99.5
8/03/2017 11:20	27.7	27.8	7.39	7.41	294	294	77.4	80.7
8/03/2017 16:30	28.7	28.7	7.44	7.47	299	299	87.6	89.8
9/03/2017 9:00	26.6	26.6	7.3	7.31	284	284	69.3	74.2
9/03/2017 16:00	26.5	26.5	7.45	7.47	285	286	79.1	80.3
10/03/2017 9:00	24.8	24.7	7.4	7.39	284	284	73	75.2

Water velocity

Average water velocities between the pools and ridges were relatively consistent throughout the fishway (Figure 6). However, within individual pools and ridges velocities varied considerably. Among the individual ridge measurement the minimum velocities ranged between 0.1 – 0.2 m/s and the maximums ranged between 0.8 – 1.9 m/s. Notably, maximum ridge velocities tapered off downstream of ridge 6 (Figure 6), where the tailwater pool had drowned out the lower ridges. Minimum pool velocities ranged between 0.0 – 0.1 m/s, with maximums ranging between 0.3 – 0.7 m/s. Minimum and maximum velocities associated with the pipe culvert relate to measurements taken from the bottom and mid/surface water readings.

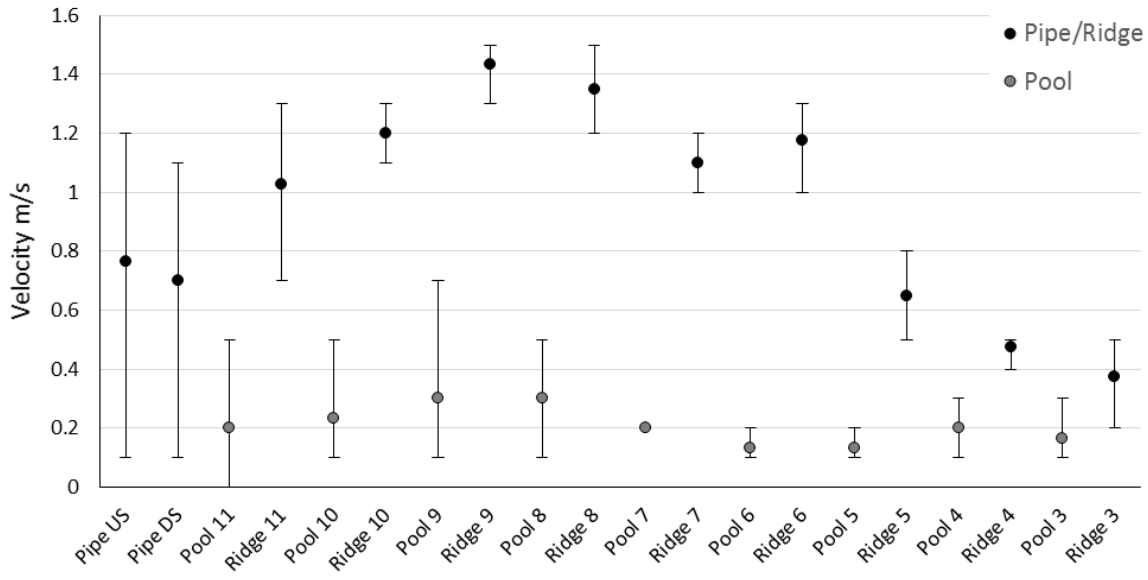

Figure 6. Average water velocity measurements recorded during fishway monitoring of Old Bowen Road fishway in Blackrock Creek. Error bars represent the minimum and maximum readings from each respective location.

Discussion

A total of 8 native and 1 introduced species were recorded during the monitoring period. This species diversity was similar to the diversity recorded during previous fishway monitoring programs conducted throughout the region (Power and Marsh 2015, Thorncraft and Marsden 2003, Power 2016, McCann & Power 2017, Catchment Solutions unpublished data). Catch rates recorded from Old Bowen Road fishway were slightly lower than recorded during previous trapping of another rock ramp fishway on the adjacent O'Connell River. In 2015 catch rates at Forbes Road fishway (Figure 1) on the O'Connell River were 7.7 fish/hour (Power and Marsh 2015). Sampling at Forbes Road in 2017 did however, only recorded catch rates of 3.63 fish/hour (Power and McCann 2017). Given the similar catch rates at both locations, it's likely that the reduced fish movement observed was the result of fewer fish moving at the time of sampling.

Stream flows are often cues for fish migration and greater levels of fish movement are generally associated with flow events (Pusey et al 2004, Catchment Solutions unpublished data). The conditions at Blackrock Creek, while elevated above base flow, were not associated with a defined flow pulse. It is likely that the fish moving at the time of sampling were not associated with migrations, rather opportunistic movement between local habitats within the reach of the fishway. This is supported by the species composition recorded, with the majority of the catch consisting of potamodromous fish.

Velocity measurements within the Old Bowen Road fishway varied within, and between pools and ridges. All of the species captured during the fishway monitoring have undergone swimming performance assessment in laboratory conditions (Table 1). In the majority of cases the minimum velocities through the ridge slots were greater than the maximum swimming speeds recorded for the respective species. Excluding bullrout, empire gudgeon and pacific blue-eye, all of the species had recorded maximum swimming speeds <1.0 m/s, whereas the minimum velocity through the ridge slots was generally >1.0 m/s. It is likely that fish are utilising the turbulent flow boundary layers to negotiate the higher velocities. This highlights the need for field based swimming trials to determine the swimming performance of native fish. Such information will provide greater accuracy when assigning design specifications for fishways, particularly for new barriers where no worsening to the level of fish movement is expected to result from the structure.

Old Bowen Road fishway was retrofitted to an existing culvert structure. The low light levels associated with the culvert barrel may still act as a psychological barrier for some species. It is possible that low light conditions may have contributed to the absence of some species during the current monitoring. While these conditions may be unavoidable when retrofitting fishways to existing culverts, consideration should be given to installing open grates over fishways that require the installation of new barrels.

Conclusions

Monitoring of Old Bowen Road fishway identified that fish are able to negotiate the fishway and pass the barrier. Species utilisation and catch rates were relatively consistent between the Old Bowen Road and Forbes Road fishways, but lower than previously recorded at Forbes Road in 2015. Within the scope of the project it was not possible to determine a specific factor for the reduced fish captures, however it's likely that stable river flow (i.e. no flow pulse) contributed to the lower numbers. Low light conditions may still act as a physcological barrier to fish movement at this site and any new or retrofitted fishways that require the installation of culvert barrels should consider the use of open grates to increase light levels.

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