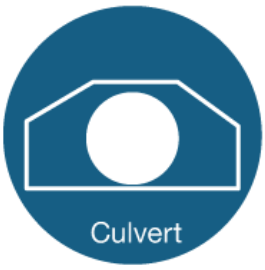
Lessons Learnt 008

Installation of Flexi-baffles to restore fish passage in a very long culvert

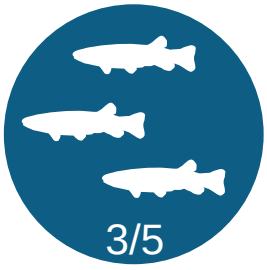
June 2020 V1

This case study forms part of a series that provides key information and guidance about how to potentially improve a fish passage barrier in a New Zealand waterway.

While providing fish passage is advantageous to most fish, removing or remediating a barrier can also affect fish populations by introducing invasive species to new areas.



STRUCTURE TYPE



IMPROVEMENT RATING*

What was the problem?

Reservoir Creek is a small, coastal stream that runs through urban Nelson. Approx. 1.5 km inland from the coast at an elevation of 31 m, the stream is piped through a complex culvert system. The culvert is 1.6 m diameter, 136 m long and has variable gradients ranging from 2° to 30° (Figure 1). The culvert is made up of different materials (concrete and metal) and changes direction numerous times. Fifteen previous fish records show that longfin and shortfin eels (*Anguilla dieffenbachii* and *A. australis*), banded kōkopu (*Galaxias fasciatus*), kōaro (*Galaxias brevipinnis*) and common bully (*Gobiomorphus cotidianus*) were found upstream and downstream of the culvert, while īnanga (*Galaxias maculatus*), and redfin bully (*Gobiomorphus huttoni*) were only found downstream (source NZ Freshwater Fish Database). It should be noted that there is only one record of common bully upstream of the culvert.

It was considered that high barrel water velocities due to the steepness of culvert gradients were impeding successful upstream passage of fish.

We aimed to improve upstream passage for all fish species, especially īnanga and redfin bully that were only recorded downstream, without compromising culvert capacity and causing blockages. We also wanted to provide in-pipe habitat for fish in the form of pools and bed material.

What was the solution?

In April 2018, a total of 79 Flexi-baffles (ATS Environmental Ltd) were secured within the culvert to reduce water velocities and create resting pools within the culvert (Figure 2). Flexi-baffles are a type of flexible baffle made of a recycled polymer and were fabricated to suit the culvert (Table 1). All 79 baffles were 600 mm wide and 100 mm high with 50 mm slits and 45-degree cuts at both ends to allow fish passage around the baffle (Figure 2 and 3). The baffles were attached to the concrete culvert floor with stainless-steel sleeve anchors (M6.5 x 40 mm) and stainless-steel penny washers (32 mm). In the metal section of the culvert we used stainless steel tek-screws (14G x 25 mm) with stainless-steel penny washers (32mm).

The spacing between baffles, and the number of baffles installed, was determined by the culvert gradients (i.e. more baffles were installed in shorter intervals where gradients were steeper) (Figure 1; Table 1).

Flexi-baffles were used as they are easy to install, robust, can shed large debris, can bend in high flows to maintain culvert capacity, can accommodate varying culvert gradients, and in culverts where they have been installed for 5+ years have not required maintenance.

* Improvement rating: 3/5 – Some improvement in upstream and downstream passage and for target species/life stages

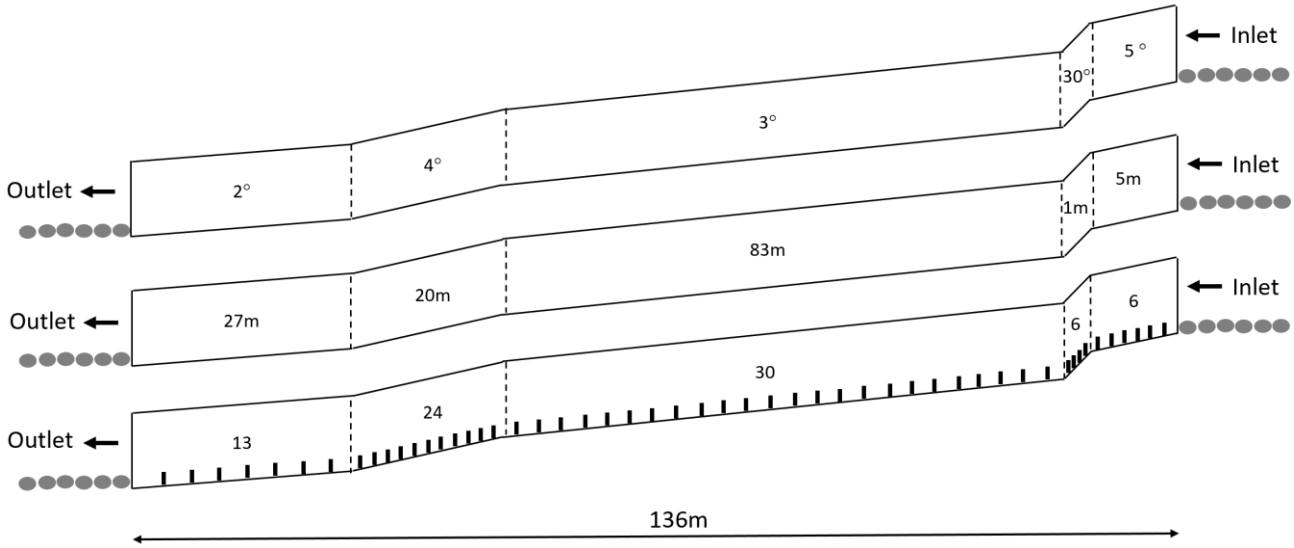


Figure 1. Cross section of Reservoir Creek culvert showing changes in gradient, length and number of baffles installed.

Figure 2. Lower section of the Reservoir Creek culvert before and after Flexi-baffle installation.

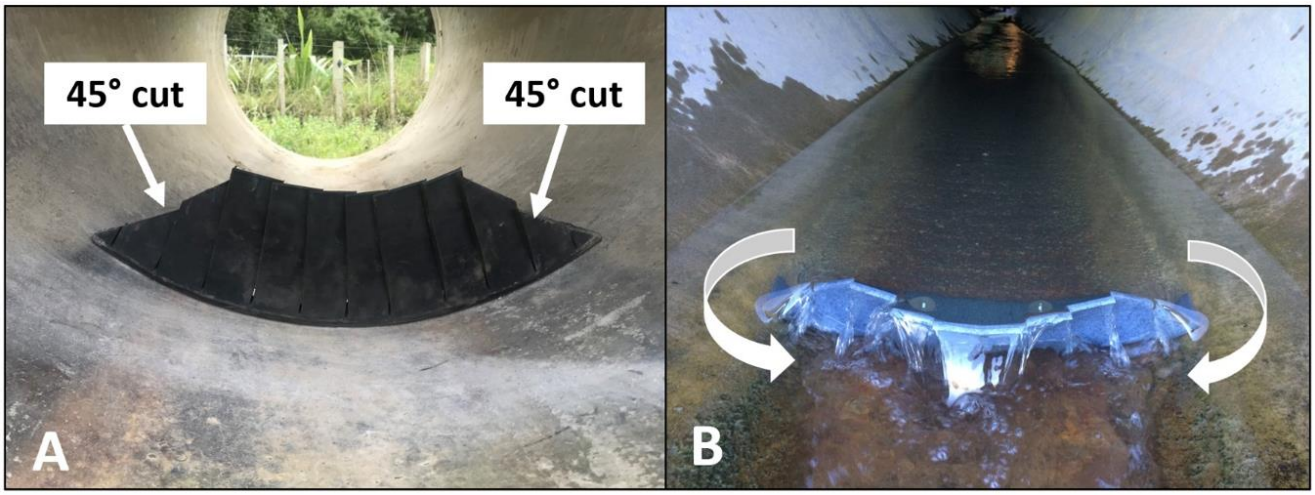


Figure 3. Each baffle is cut at 45° on either side (A) to allow water to spill around the baffle (B) enabling fish passage, even at low flows (Note: photographs are not from Reservoir Creek culvert).

Table 1. Installation guide for Flexi-baffles through round culverts.

	Baffle Spacings (mm)			Baffle Length (mm)
Grade (%)			Diameter (mm)	
0-2	2400		900-1200	450
2.01-4	1200		1201-1800	600
4.01-6	800		1801-3000	900
6.01-8	600		>3001	1800
8.01-10	480			

Note: This table is only a guide and other factors (e.g. flow rate) may need to be considering when determining baffle spacing.

Monitoring results

A mark-recapture trial was completed by NIWA and Tasman District Council (TDC) in 2018 at the Reservoir Creek culvert. Fresh run whitebait (length 45-71mm; mean 51 mm) were placed in the downstream end of this culvert, and over 48 hours none were found to navigate the entire culvert. At the conclusion of the trial, 22 % of whitebait were still in the release pool downstream of the culvert, 77% of the whitebait were recorded in the first 27m of the culvert and 1% had traversed up to 43m within the culvert.

Fish communities within the 150 m reach directly upstream of the Reservoir Creek culvert were surveyed by TDC three times using single pass spotlighting over the 2018 / 19 summer, and once by single pass electric fishing in March 2020. These surveys can be compared to a single pass spotlight survey (February 2008), and two single pass electric fishing surveys (January 2012 and March 2016) of the same reach prior to any fish passage improvements (Figures 4 & 5). Results showed īnanga and redfin bully were found upstream of the culvert for the first time (Figures 4 & 5) and common bully numbers upstream of the culvert increased (Figures 4 & 5) following fish passage improvements. The minimum size of īnanga and common bullies was 50 mm and 40 mm, respectively, suggesting young fish are moving through the culvert.

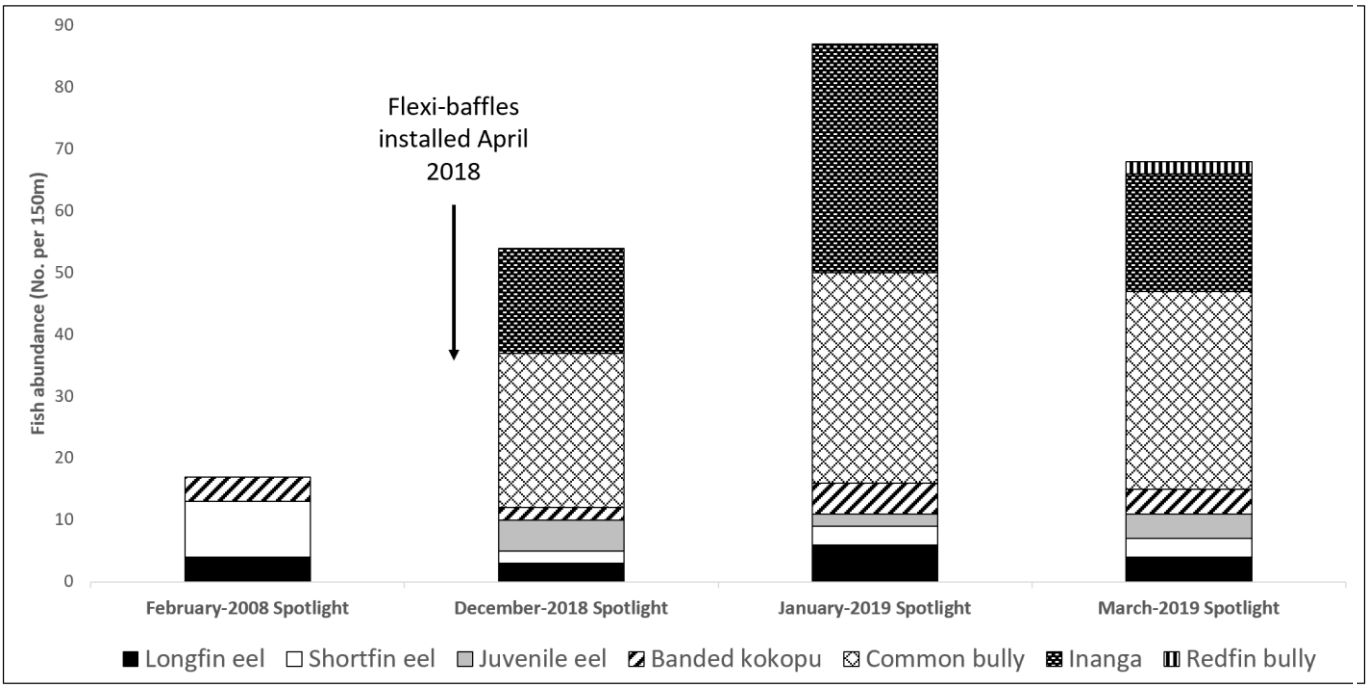


Figure 4. Number of fish observed upstream of the culvert before (Feb 2008) and after (Dec 2018, Jan and Mar 2019) Flexi-baffles were installed.

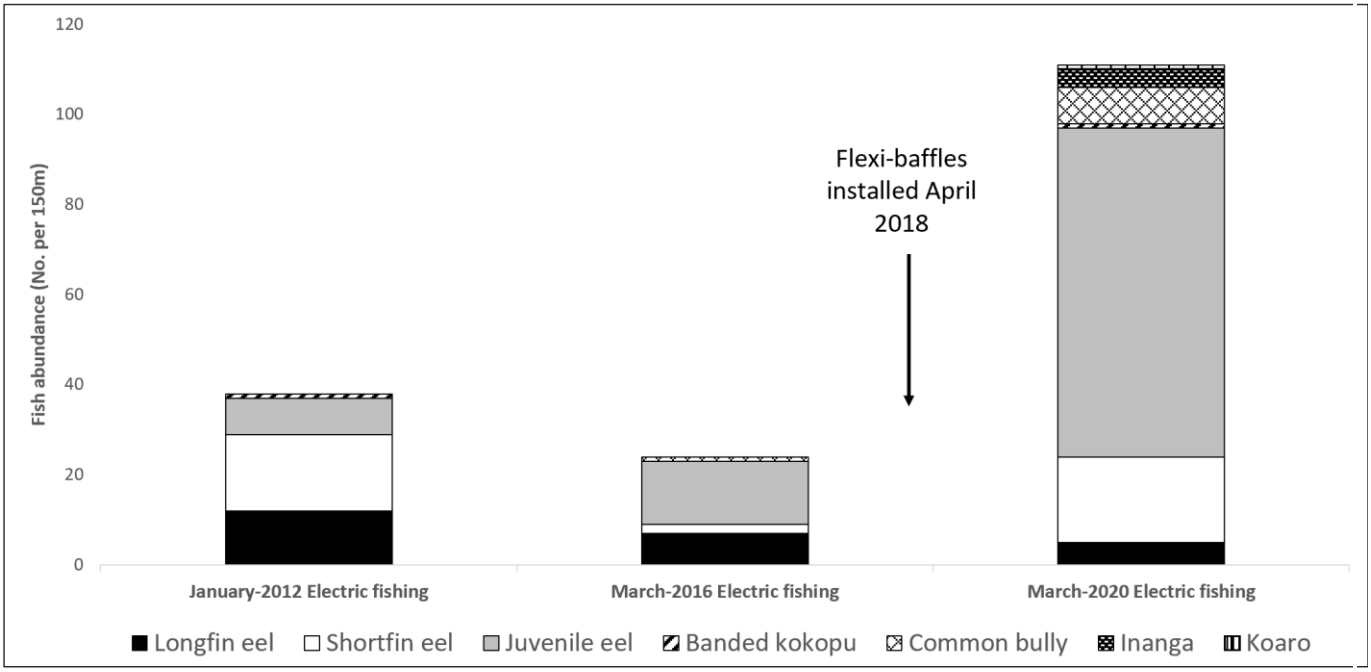


Figure 5. Number of fish observed upstream of the culvert before (Jan 2012 and Mar 2016) and after (Mar 2020) Flexi-baffles were installed.

TDC undertook five additional single-pass spotlight fish surveys 150 m upstream and 150 m downstream of the culvert during October and November 2019. Overall, fish species were comparable both upstream and downstream of the Reservoir Creek culvert (Table 2). The results further confirmed the findings of earlier surveys that young fish were gaining access through the culvert (Table 2).

Table 2. Results from weekly 2019 spring spotlight fish surveys 150 m downstream and 150 m upstream of the culvert.

	Species and estimated size range	Survey date and number of fish found				
		30/10/2019	6/11/2019	13/11/2019	21/11/2019	28/11/2019
150m Downstream	Longfin eel (250-800mm)	4	4	5	3	3
	Shortfin eel (200-400mm)	11	3	2	1	4
	Unidentified eel (180mm)					1
	Juvenile galaxiid (40-60mm)	32	10	36	10	7
	Inanga (60-80mm)		1	1	1	5
	Common bully (60-80mm)		3			3
150m Upstream	Longfin eel (300-400mm)		1	1	1	1
	Shortfin eel (200-410mm)	4	3	1	2	6
	Unidentified eel (150-250mm)	2	7	4	3	4
	Juvenile galaxiid (40-60mm)	9	9	13	13	17
	Inanga (50-90mm)	2	2	4	1	4
	Common bully (60-90mm)		14	2		7
	Koaro (110mm)					1

Several inspections within the culvert barrel have been carried out to assess baffle durability. During those inspections, anecdotal observations showed fish in pools between baffles and swimming upstream around the 45-degree cuts in the baffles and may be using baffles as refuge (Figure 6).

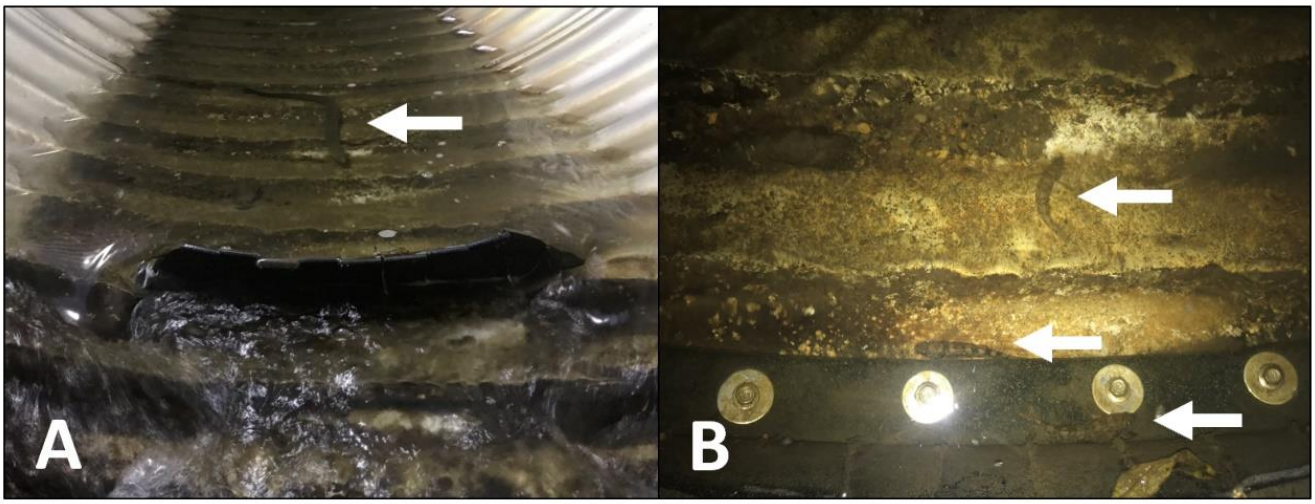


Figure 6. Photo A shows an eel in a pool upstream of a Flexi-baffle. Photo B shows three common bully in a pool upstream of a baffle near the top of the culvert.

Did it work?

Yes, installation of Flexi-baffles has improved fish passage through a long, round culvert, especially for īnanga and common bully.

Ongoing monitoring is continuing at the Reservoir Creek culvert to help understand the effectiveness of this type of remediation.

Lessons learnt

1. Flexi-baffles have shown to improve upstream fish passage for all expected species and life stages found downstream, through a long, complex culvert, with two new species being recorded upstream (īnanga and redfin bully).
2. Subsequent culvert inspections, two years following the installation, have found all baffles remain secured to the culvert base, therefore, the fixing methodology used for this installation appears appropriate.
3. To date, there have been no reports of blockages within the culvert barrel as a result of the installation of Flexi-baffles and no maintenance has been required.
4. Ideally, some bed material should be retained to create a more diverse environment within the pipe. Minimal bed material has been retained at this culvert. This is likely due to the upstream gravel trap stopping the natural movement of material downstream as well as the steep gradient of the culvert.
5. Due to the steep and long nature of the culvert fresh run whitebait may take longer than 48 hours to navigate this culvert. If mark recapture trials are undertaken in long steep culverts consideration should be given to running it for longer and using a variety of life stages including young and older fish.

For further information

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This is Version 1.0 and was created in June 2019.