Fish-Passage Field Findings

April 2019

Lessons Learnt 01: Retrofit of an existing fish pass with flexible baffles to improve fish passage for all species.

This case study is one in a series that provides key information and guidance about how to improve fish passage.

What was the problem?

The original fish pass design, installed in June 2017, considered fish passage by providing a 107 m long by 500 mm wide by 200 mm deep, angled fish “ladder” over a dam wall in Saxton Creek, Nelson, NZ (Figure 1). Rocks were embedded into the concrete ladder with the aim of slowing the flow and introducing nature-like flows.

Unfortunately, the fish pass effectiveness appeared to be poor with concerns post construction including:

- High velocity water in long sections of the fish pass was likely a barrier to fish movement.
- There was a lack of low velocity areas for fish to rest as they migrate upstream.

No fish were observed using the fish pass.

What was the remediation?

Eighty flexible baffles were installed to further reduce water velocity and break up the flow (Figure 1). These baffles were fabricated to fit the triangular design of the fish pass and offset 50 mm from the deep edge of the channel to allow for passage in low flows. Baffles were 450 mm wide and 100 mm high with 45-degree cuts at both ends to allow fish passage around the baffle (Figure 2).

Baffle spacing’s were determined based on the grade of concrete (Figure 3). Grades throughout the fish pass ranged from <0.5% to 10%. Baffles were installed within the fish pass except where grades were <0.5%. Water velocities through the low-grade section (<0.5%) were not considered a barrier to fish. Baffle placement was limited to areas where rock was not embedded. As a result, spacings between baffles did vary.

Figure 2. Failed fish pass

Figure 1. Retrofitted Fish Pass

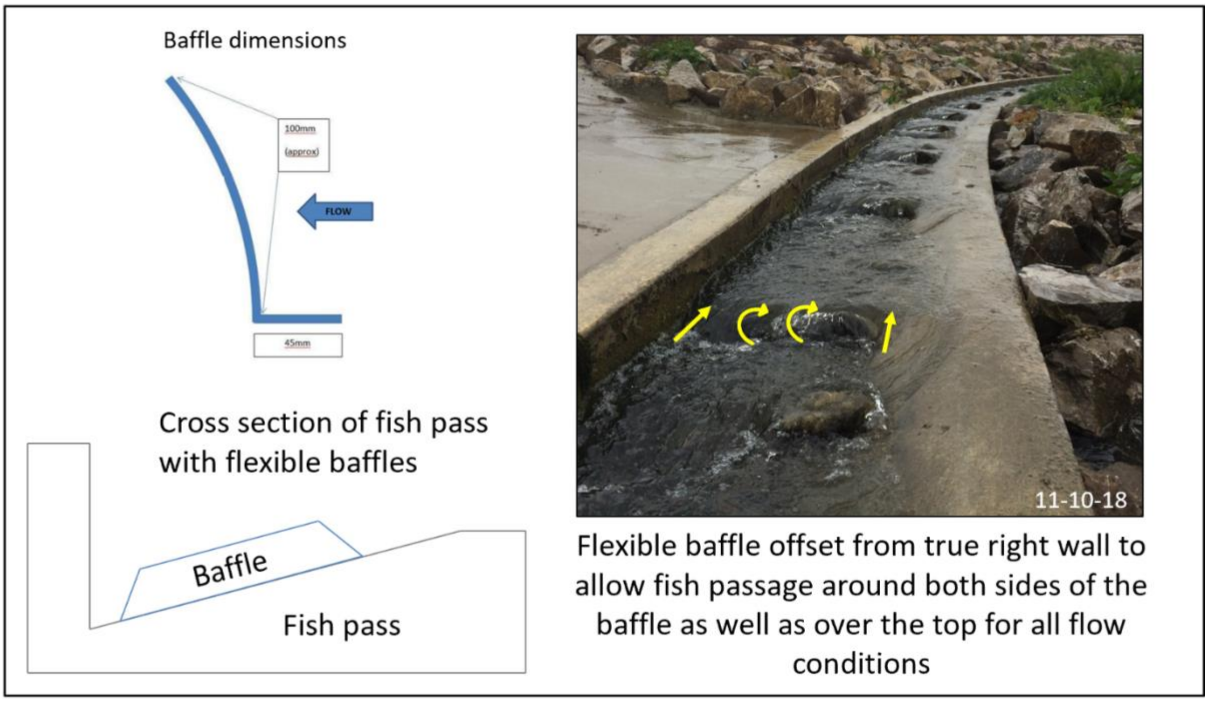


Figure 2. Flexible baffle dimensions and positions within the fish pass

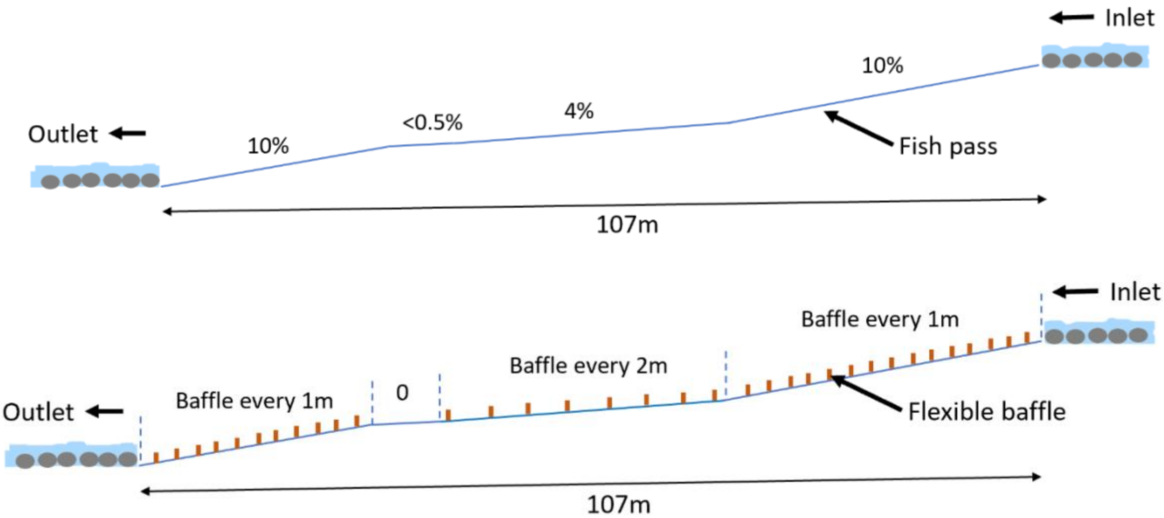


Figure 3. Cross sections of the Saxton Creek fish pass showing the changes in gradient (top) and the spacings between baffles (bottom)

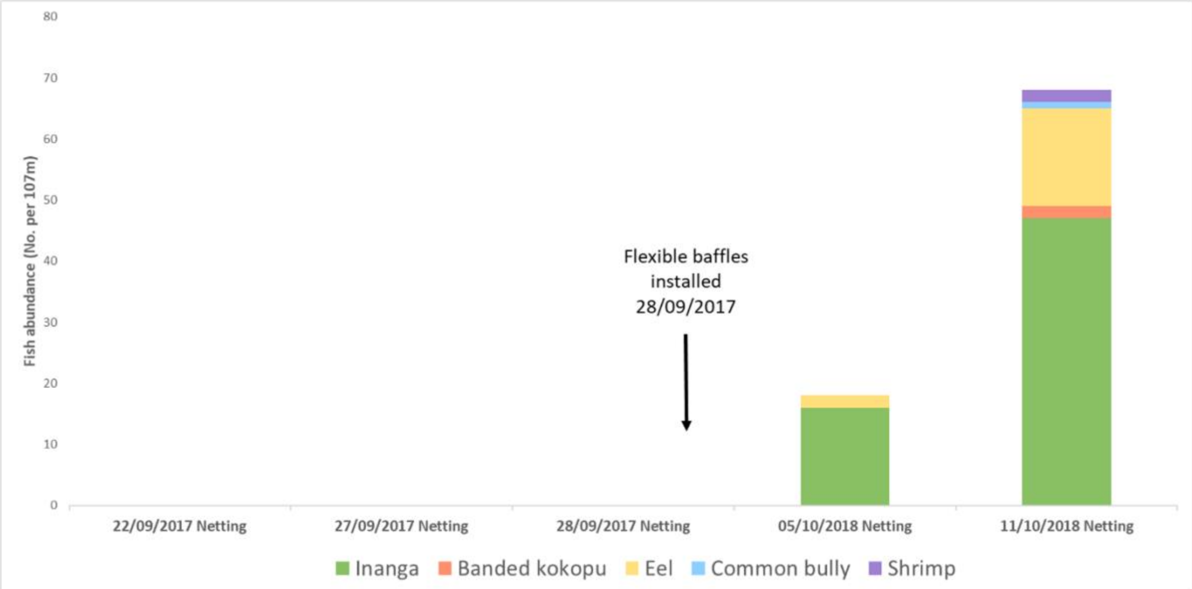
Monitoring results

Prior to the retrofit with baffles, the fish pass was dewatered three times to assess whether fish were successfully using the structure or not. As the water was drained, nets at the outlet were used to capture any fish retreating out of the pass. The residual pools were then searched with hand nets. On all three occasions no fish were found within the fish pass (Graph 1). It was possible that fish were not migrating at the time of these assessments, however this seems unlikely given inanga (Galaxias maculatus) were observed in Saxton Creek below the fish pass, indicating that fish were migrating.

One day after baffle installation, the fish pass was electric fished. Several inanga were found between the baffles within both the 4% and 10% gradient areas.

Two surveys using hand nets were conducted one-year post-baffle installation over the entire fish pass. This involved "guiding" fish to a downstream stop net repeatedly over short distances e.g. between two baffles at a time. Overall, fish species and abundance were noticeably different to pre-baffle installation within the fish pass (Graph 1).

Further to the sampling within the fish pass, a spotlight fish survey in Saxton Pond upstream of the fish pass was completed on the 11-12-2018 by Fish and Wildlife Services for Nelson City Council. Roughly 150 meters of the pond edge was surveyed. Species observed included inanga, shortfin eels, longfin eels, unidentified bullies, banded kokopu and a common bully (Table 1). It was estimated that over 1000 inanga were present (Table 1). Prior to the fish pass construction, connectivity between Saxton Creek and Saxton Pond was poor. There are no historic fish survey records in the pond to compare with the 2018 spotlight data. However, the pond was drained before the fish pass was constructed in 2017 and the only species found during the fish salvage were longfin and shortfin eels.



Graph 1. Results of fish abundance monitoring in the Saxton Creek fish pass before and after baffle retrofit.

Table 1. Results of a spotlight fish survey upstream of the Saxton Creek fish pass following baffle retrofit.

Survey date	Location	Species found	Number of fish	Size range
11-12-2018	Upstream of fish pass in Saxton Pond	Inanga Banded kokopu Unidentified eel Longfin eel Shortfin eel Common bully Unidentified bully	1000+ 2 50 37 7 1 20	40-80mm 35-130mm 80-300mm 300-850mm 300-400mm 50mm 40-50mm

Did it work?

Yes. Survey results following the installation of flexible baffles suggest that several fish species can move freely up the fish pass. Juvenile eels, banded kokopu (Galaxias fasciatus) and Inanga have been found within, and upstream of the fish pass. Inanga occupied the fish pass the day after the retrofitting of baffles. The presence of "poorer" swimming fish species like Inanga within, and above the structure, suggests the fish pass will likely provide passage for fish species of all swimming capabilities.

Figure 4. Fish caught during a hand net survey of the Saxton Creek fish pass on the 11-10-18. Species pictured above include inanga, eels and a common bully.

Lessons learnt?

- Flexible baffles can be retrofitted to structures that are both long in length and of a steep grade to improve fish passage.

- Rocks embedded in concrete are not always the most effective solution for reducing velocity on concrete surfaces. It is crucial that fish (especially the poorer swimming species) have low velocity pools to rest in as they swim upstream. This is particularly important on steeper gradients and in structures that are long. Regardless of their orientation or size, rocks embedded in concrete are unlikely to always create resting pools for fish on steep gradient concrete and thereby guarantee successful fish passage

- The results did suggest that fish were able to pass through the low-grade section of the fish pass that was left with rocks only. This section was <0.5% grade. This indicates that rocks embedded in concrete structures can provide passage for fish species when there is a **depth of water**, **low water velocities** and a **low gradient** e.g. <0.5%. When installing rocks in such applications, the fish passage guidelines should be followed as to what size rocks should be installed and where they should be placed (*NZ Fish Passage Guidelines*).

- When capturing fish from within a fish pass/culvert fitted with baffles it is best to isolate individual pools between baffles and chase the fish over short distances to a downstream net. Fish chased over several meters use baffles as cover/refuge to evade capture. Due to limitations in the catching methods post baffle installation, numbers of fish caught within the fish pass may underrepresent actual numbers present.

Further information/ Contact

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Reference: Franklin et al. (2018) New Zealand fish passage guidelines. NIWA client report (*https://www.niwa.co.nz/freshwater-and-estuaries/research-projects/new-zealand-fish-passage-guidelines*)

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