# Lessons Learnt 006

## Fish passage facilitation by increasing flow and mussel spat rope installation on a dam spillway

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*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?

The Maitai River North Branch Dam in the Nelson Region provides Nelson's municipal water. This has been in place since 1987. The upper catchment provides suitable habitat for seven freshwater fish species (Table 1), three of which are listed as 'At Risk' (Dunn et al. 2018). Physical characteristics of the dam include a weir, spillway chute, flip bucket (creating a hydraulic jump, deflecting water upwards) and an apron downstream (Figure 1). The entire spillway is 22 m high, has a total length of 151 m, and is 20 m wide at the upstream end and 10 m wide at the downstream end. The spillway impedes the upstream passage of kōaro and eels (climbers) and limits the ability of these species to access substantial habitat upstream. Resource consent renewal required council to revisit fish passage provision at the dam, including the provision of passage for climbers.

Key fish passage issues we identified at the Maitai Dam include:

- Very long and steep spillway, which creates a barrier or diminishes upstream fish passage.
- Lack of wetted margins and rest areas for migrating fish during high flow.
- Lack of flow / no flow on the spillway at times during juvenile eel and whitebait migration season.
- High water temperatures in and around the Maitai Dam due to stagnant water.
- Flip Bucket drying out during low lake levels.

### What was the solution?

As there are multiple issues inhibiting fish passage at different parts of the dam, we considered multiple solutions, including:

- Installation of a pump (Figure 2) to deliver water (capacity = 3.5 L/s) from the reservoir to the spillway crest at times when the reservoir water level is too low for spilling to occur. This ensures continuous flow down the spillway during summer migration periods.
- Plugging the drainage outlets in the flip bucket with rubber bungs to maintain the pool that usually forms in this bucket when spilling occurs.
- Installation of 'Xmas Tree'[1] mussel spat ropes (Figure 3) down the total length of the spillway (i.e. 151 m) and downstream of the flip bucket, adjacent to the true right spillway wall, to provide additional cover as well as resting and climbing opportunities for migratory fish. Two spat ropes side by side were installed with approx. 100 mm between them.
- Installation of a short ramp (i.e. aluminium ramp with astroturf lining and two mussel spat ropes) from the lip of the flip bucket to the-spillway apron below, to allow climbing fish to avoid the steep transition into the flip bucket (Figure 4).

[1] A type of polypropylene mussel spat rope for the use of climbing species.

Improvement rating: 1/5 – Some improvement in upstream passage for some species life stages over part of the barrier.

**Table 1. List of fish species that occur in the Maitai River. At risk species are marked with an * (Dunn et al. 2018).**

| Common name | Scientific name |
|---|---|
| Longfin eel | *Anguilla dieffenbachia* * |
| Shortfin eel | *Anguilla australis* |
| Common Bully | *Gobiomorphus cotidianus* |
| Redfin Bully | *Gobiomorphus huttoni* |
| Upland Bully | *Gobiomorphus breviceps* |
| Kōaro | *Galaxias brevipinnis** |
| Brown Trout | *Salmo trutta* |

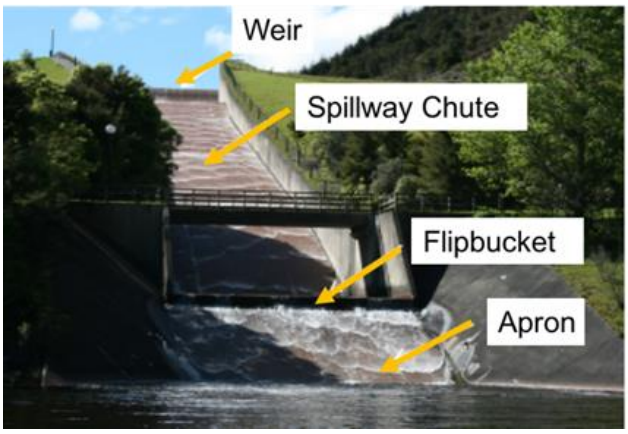


**Figure 1. The Maitai Dam with weir, spillway, flip bucket and apron.**

**Figure 2. We installed the pump at the shady side of the spillway to ensure permanent water flow down the spillway and apron.**

**Figure 3. Mussel spat ropes installed at the shady side of the dam where the pump provides water to facilitate upstream passage of juvenile eels and kōaro.**

**Figure 4. An aluminium ramp with astroturf lining and two mussel spat ropes installed to assist fish passage from the very beginning of the long climb ahead.**

**Figure 5: Resting juvenile eels are using mussel spat ropes for cover in the flip bucket.**

## Monitoring results

Before installation of the fish passage modifications, the spillway was confirmed to be a fish passage barrier as only 55 elvers were recorded attempting to climb the spillway in the 2014-2015 migration season, and none were seen to successfully pass the entire spillway (Doehring & Hay, 2014).

After installation and modifications in 2015, we observed elvers climbing the spillway during three spotlight surveys in the summer of 2016 (Table 2). These elvers ranged in size from ~80-130 mm long (estimated lengths). Elvers were the only fish seen on or near the spillway, aside from medium to large trout and eels consistently observed

patrolling in the vicinity of the bottom of the spillway in the plunge pool below, and occasionally also in the reservoir above. Two kōura (freshwater crayfish) ~50 mm long were seen crawling down the spillway and at the spillway crest. Video surveillance was used to monitor fish movements over the spillway crest. Although we observed a few elvers within five metres of the spillway crest on each survey occasion, only two were seen to have passed beyond the crest (Table 2), with one of these entering the reservoir and swimming away during observation. There were high numbers of elvers in the flip bucket. These elvers appeared to be resting in the flip bucket, presumably after climbing the first section of the dam apron. Some may also have returned to the flip bucket after unsuccessful attempts to climb the spillway to the weir crest (some elvers we observed moving downhill on the spillway toward the flip bucket, but it was not clear whether this was due to the disturbance of being spotlighted.) The flip bucket provides a predator free resting pool for these elvers before they attempt the climb up the spillway (by contrast, they are exposed to predation risk from large eels and trout lurking near the bottom of the spillway apron).

**Table 2. Total number of elvers observed on and in the vicinity of the Maitai Dam spillway during spotlight surveys on three different sampling occasions in January and February 2016.**

| Survey date | Number of elvers on the spillway | Numbers of elvers beyond the spillway crest | Number of elvers holding in the flip bucket |
|---|---|---|---|
| 26 Jan 2016 | 21 (incl. several descending) | 0 | >100 |
| 10 Feb 2016 | 14 (incl. 3 descending) | 0 | ~8 seen |
| 15 Feb 2016 | 24 (incl. 2 descending) | 2 | >30 |

The spat rope was being used for cover by resting elvers, particularly in the flip bucket pool (Figure 5), but also on the spillway. The spat rope was also observed being used by a few elvers to assist in climbing the spillway; most of the climbing occurred in the wetted splash zone on the spillway, away from the spat ropes.

## Did it work?

Yes. Despite the low numbers of young eels recorded completing the climb, the remediation modifications have improved instream infrastructure to provide for fish passage by creating a suitable flow environment year round. Before the installation of the pumped water supply and bungs in the flip bucket drains, the spillway was often dry for long periods during summer. For example, during the summer migration season (December to March) the reservoir levels were usually below the spillway level, so the spillway was dry. Consequently, there was no opportunity for fish passage during much of the migration season. The spillway was not spilling during any of the spotlight surveys discussed above confirming all elvers observed attempting to climb the spillway, including the two seen successfully beyond the spillway crest (Table 2), were only able to climb due to the pumped water supply.

## Lessons learnt

1. Constant water flow is required to provide for fish passage during peak migration periods.
2. Mussel spat ropes provided cover for juvenile eels at certain parts of the dam and also aided upstream passage for some individuals. However, the majority of climbing occurred in the wetted splash zone on the spillway, away from the spat ropes. Nonetheless, we consider spat ropes an effective tool to remediate fish passage.
3. Given the apparent degree of difficulty for elvers to scale the spillway, and the apparent low numbers of elvers to have successfully reached the reservoir via this route, it would be prudent to continue (and intensify)

existing trap and transfer operations to augment fish numbers passing the dam. Trap and transfer also has the advantage of avoiding concentrating migrants in locations that are easily predictable by predators, rendering them vulnerable to predation.

4. The spillway with a total length of 151 m and 22 m height can be considered a significant barrier despite the fish passage remediation measures described above. We suggest the installation of further rest areas along the spillway, such as low flow areas or further fish passage remediation along the true left of the spillway.

5. Further monitoring during migration periods would be useful to identify if other species attempt any up and / or downstream movement.

## For further information

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***References:***

Doehring, K.; Hay, J. 2014: *Fish passage assessment of the Maitai River North Branch Dam and South Branch weir.* Prepared for Nelson City Council. Cawthron Report No. 2601. 38 p. plus appendices. http://nelson.govt.nz/assets/Building-Planning/Downloads/Resource-Consents/publicly-notified/2016/maitai-pipeline/165122-App-L-Maitai-River-fish-passage-assessment-and-recommendations-Cawthron-2601.pdf

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