



Australasian Fish Passage Services

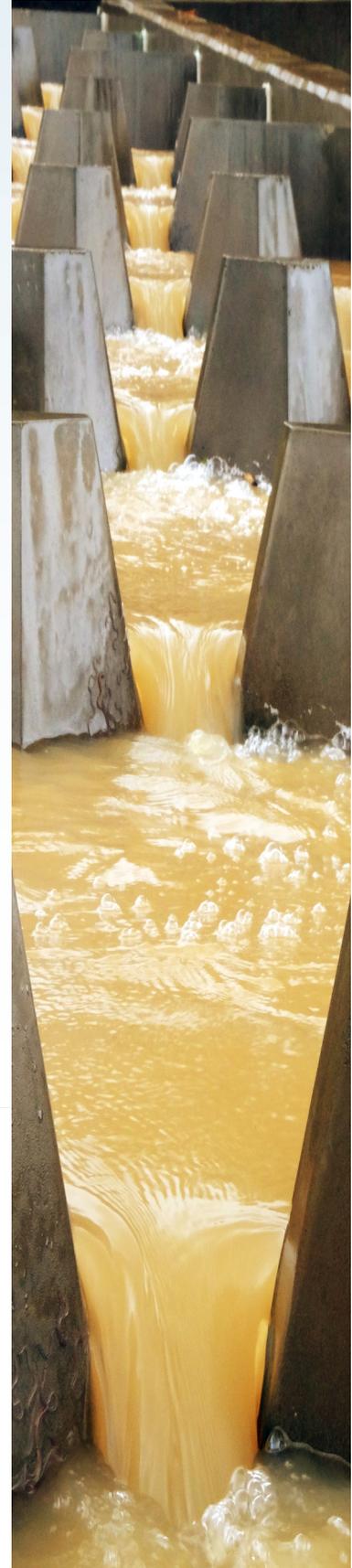
## Cone Fishways Reach Significant Stage of Development

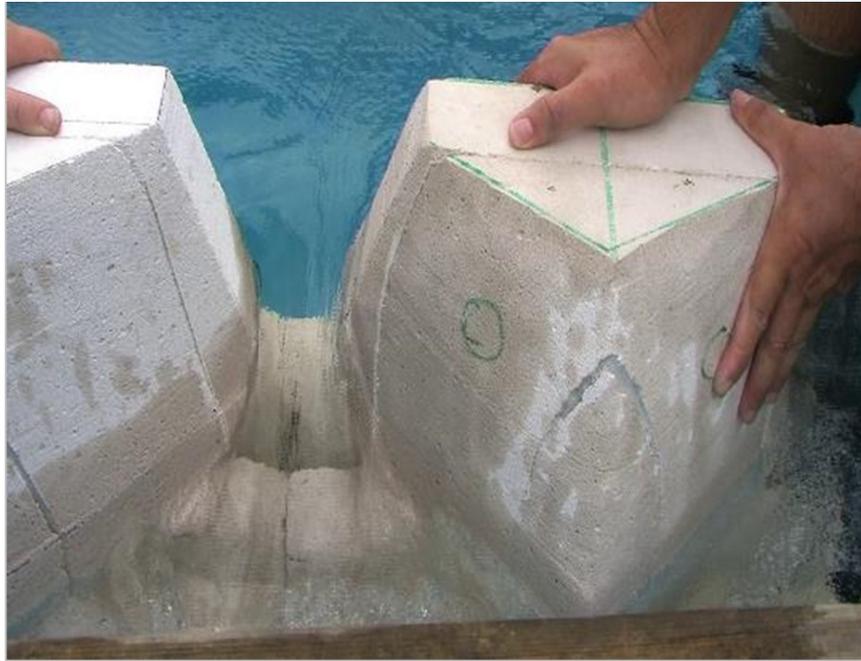
After 15 years of development, cone fishways have reached an important milestone in 2021 with Australasian Fish Passage Services (AFPS) celebrating the installation of their 25<sup>th</sup> cone fishway in Australia and Southeast Asia.

The journey to this milestone began back in 2006, during AFPS staff employment within the Queensland Government. It was here that we developed the first cone fishway design in response to the engineering challenges we commonly faced when constructing rock ramp fishways. Rock ramp fishways are well recognised for passing small juvenile fish in big numbers in coastal streams in Queensland, however, their designs can be problematic, with rock sometimes hard to source in remote areas, hydraulics difficult to fine tune and installation requiring a great deal of skill.

To overcome these issues, we looked to develop a prefabricated concrete rock fishway, which over time morphed into the concrete cone fishways that we have taken through to production today. Initial concepts were mocked up out of Hebel and tested in a handmade hydraulic flume that was temporarily installed within a local river setting over a range of flows. The trial demonstrated that the concept could achieve flow conditions ideal for the passage of very small fish (<20mm).

Numerous iterations of the original design were tested over time, with the objective of creating ideal flow conditions for very small fish to pass through the fishway. To achieve this, we had to balance the needs of very small fish against the requirements for the casting of concrete. This led us to the faceted design that characterises the cone fishway baffle used today. The faceted design produces a very strong product with the thickness and strength required to withstand impacts from river





**Hebel Prototype Cone Fishway Baffle**

The first real-world installation of the concrete cone fishway occurred in 2006 on Seaforth Creek near Mackay in central Queensland. Many lessons were learned from this demonstration cone fishway that helped to improve the design as it moved forward. For example, we identified during sampling that very small fish were struggling with the vertical drop of water produced between the cones, so we experimented with a sloping face design at the bottom of the slot. This design proved to be more effective at passing small sized fish through the cones, and so the design was modified.

In 2007 we undertook construction of another cone fishway at Flaggy Rock near Mackay, which incorporated the learnings and design modification from the demonstration fishway at Seaforth. This fishway design had the sloping face on the bottom of the slot, however, we found that larger deeper pools with lower turbulence zones that offered refuge areas were required to be able to pass fish over the longer fishway.



**Seaforth Cone Fishway**



**Flaggy Rock Cone Fishway**



**Flinders River Cone Fishway**

This led to future designs, such as the Flinders River cone fishway, having larger pools with dead zones on the edge of the channel which provide small fish a place to rest and regain energy in between their passage through the high velocity slots.

Monitoring of each of these cone fishways enabled us to develop a depth of knowledge about what species use these fishways, how they swim through the slots and how successful the fishways are at passing local fish communities. This invaluable knowledge gave us the confidence to install further cone fishways in other locations outside the Australian sphere, with the installation of a cone fishway on the Pak Peung regulator in Laos, as part of an ACIAR funded project to improve fish passage in Southeast Asia.



**Pak Peung Cone Fishway**



This installation gave as the opportunity to test increasing the headwater operating range of the cone fishway by using triple height cones (900mm high vs 300mm). This design has demonstrated to be quite effective and has increased the headwater operating range for cone fishways from an initial 400 mm to over 1 m.

With many fishways now operating using the cone fishway concept, refinements in the design stabilised through the mid 2010's and AFPS focused primarily on making the design easier to cast and install. As a result, the flat pack version of the cone fishway was developed by AFPS in 2015. The flat pack design enabled the fishway panels to be cast flat, reducing the requirements for a double-sided mould, and incorporated cast-in-place ferrules within the panels, which makes them quicker and easier to install on site. This new AFPS design was utilised for the construction of the Fitzroy Barrage cone fishway in Rockhampton in 2016.



### **Fitzroy Barrage Cone Fishway**

Along with the development of the flat pack panel, the compact design was further expanded by AFPS to include a double-width design, with high and low cones, capable of passing fish over a wide range of flow conditions and headwater ranges. This 'Hi-Lo' design debuted at Glenore Weir in the Gulf of Carpentaria in 2016. One of the great benefits of the Hi-Lo cone design is that during high flows, when there is large quantity of water in the river, the fishway produces a very high discharge that enables it to attract fish more effectively to the fishway entrance, while still maintaining low velocity zones for small fish to pass through the fishway. Monitoring of the Glenore Weir cone proved that it was effective at passing both large and small fish over a wide range of flows.





### **Glenore Weir Cone Fishway**

Since the inception of the flat pack cone fishway in the mid 2010's, AFPS have also developed prefabricated fishway walls that now enable the entire fishway to be pre-fabricated, flat packed and delivered on site for assembly and installation into a pre-dug channel.

The prefabrication of both the walls and baffles of the fishway, enables rapid installation into the dynamically uncertain riverine environments that confine most fishway installations. From breaking ground for the construction of a fishway channel, to the completion of the channel and release of flow down the fishway, completion can be in 8 to 12 working days, reducing the risks from construction in an unpredictable riverine environment.



### **Cone Fishway Baffle and Wall Assembly**





### **Barwon Barrage Cone Fishway Constructed in 10 Days**

Today's concrete cone design is uniquely suited to sites where river managers are particularly sensitive to headwater range intrusion, as it provides a fixed crest that ceases to operate once upstream water levels reach the pre-determined lower operating range. This gives managers certainty that they are not losing precious water below minimum operating levels and enables the fishway to operate automatically without the need for gates to be open and closed.

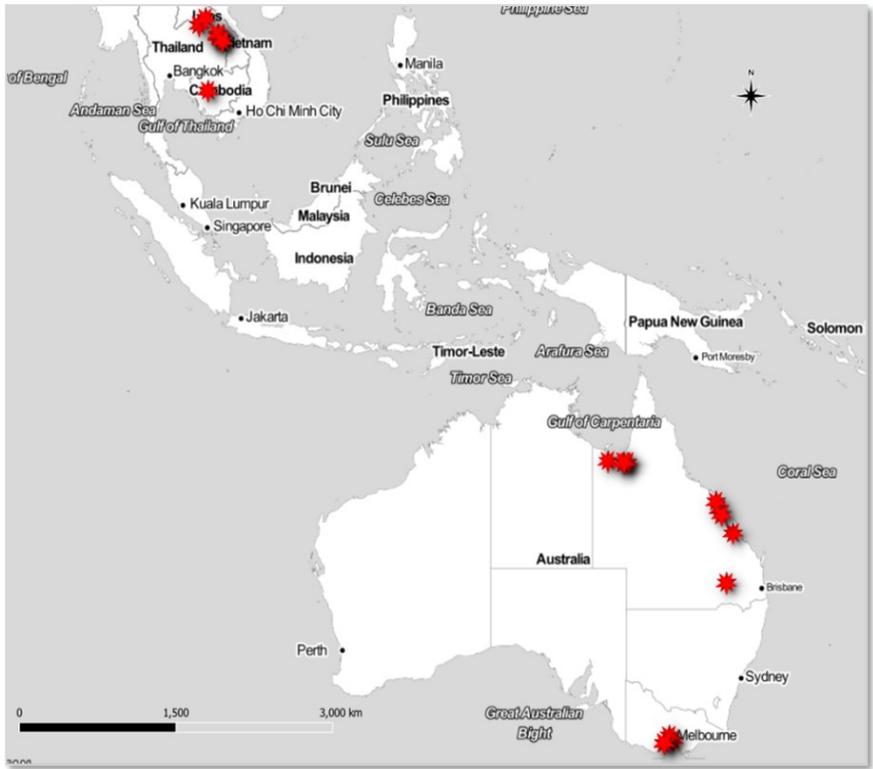
The AFPS cone design is also particularly suited for the passage of very small fish, which has always been at the heart of the design considerations. At tidal barriers where there are typically large numbers of very small juvenile diadromous fish returning to freshwaters, this design has clearly demonstrated that it outperforms vertical slot fishways, due to the hydraulics that are suited to the passage of very small fish.



### **Fish Ascending Barwon Barrage Cone Fishway**



Time and time again, the cone fishway has proven to be a flexible design option for a wide range of environments in both Australia and Southeast Asia, providing passage for small and large-bodied fish at major and minor waterways. The AFPS design has been refined over the 15 years since its initial trials in central Queensland to become a quick and reliable method of providing fish passage past a barrier.



Location of AFPS cone fishways in Australia and SE Asia.



## Acknowledgments

The development of a new fish passage system, such as cone fishways, was not done without the assistance of a great many people and organisations that help to make this new type of fishway possible.

We would like to recognise the contributions of the following groups and individuals:

Queensland Department of Agriculture and Fisheries maintained an enviable fish passage program throughout the 2000's that allowed the development of innovative solutions such as the cone fishway. The many staff within this department encouraged the development of these fish passage solutions, which has led to a great improvement in the movement for fish along Queensland's rivers. Individuals such as Peter Jackson, Claire Peterken, Darren Jennings, Alana O'Brien, Matthew Moore, Andrew Berghuis, Craig Broadfoot, and Richard Stewart made meaningful contributions to development of the cone fishway concept.

The Fitzroy Basin Association, Reef Catchments, Southern Queensland Landscapes and Southern Gulf Catchments NRM groups all provide funding for early development models of cone fishways in their respective regions. These early designs provided low-cost fish passage solutions and great insight into the operation cone fishways in river systems. These real-world experimental fishways allowed the development of the design to the current level of refinement.

Australian Centre for International Agricultural Research provided funding for the installation of cone fishways in Laos, working with partners such as the National University of Laos, Living Aquatic Resources Research Center and the World Bank. This has spurred the development of the cone fishway throughout Southeast Asia. Individuals working on the project such as Lee Baumgartner, Gary Thorncraft, Douangkham Singhanouvong, Khampheng Homsombath, Oudom Phonekhampheng and Khamhou Phanthavong helped ensure the success of these cone fishways in Laos.

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