High-Level Fish Passage Design Considerations

Morgan Warnock
icubed consulting

1 Introduction

Fish passage is a growing consideration within the infrastructure industry; relevant to new projects and as an impetus to improve existing developments to bring them up to more modern environmental standards.

We hinder fish passage primarily with roads, dams, weirs, and other waterway barrier structures, cutting them off from upstream habitat that they may normally migrate to for important parts of their lifecycle; to feed, reproduce, return from spawning grounds, or to find waterholes during times of drought or as ephemeral waterways start to dry up.

When we install barriers in waterways which inhibit fish passage, we prevent fish from migrating to upstream habitats, forever changing the natural ecology, and impacting on the long-term viability of fish species. While this has impacts on species that we rely on for recreation and commercial purposes, including food security, there are other more complicated effects that impact on ecosystems and across landscapes.

The IPCC (Intergovernmental Panel on Climate Change) warns that with a growing demand for water security and an uncertain climate, we can expect significant loss in ecological connectivity, and with that a diminishing population of our native species.

This can be likened to the 'butterfly effect', the theory that small changes to initial conditions can result in consequences in the future. While a small number of individual fish not being able to complete their lifecycle may not seem concerning now; it could have significant unforeseen consequences.

Where it is not possible to avoid constructing a road or dam, waterway barriers can be designed to allow for fish passage upstream and downstream so that fish species can complete all stages of their lifecycle. Fish Passages or fishways come in a variety of designs and sizes, depending on what best serves the environment and need: fish ladders, lifts, rock ramps, and channels or culverts designed with fish-friendly elements.

Below is a very general overview of the different types of fishways traditionally employed in Australia.

2 Traditional Fishway Types

2.1 Pool-type Fishways

Includes vertical slot and cone fishways. Consists of a concrete channel with structures dividing the channel into individual pools, either by use of a baffle with a vertical slot, or a solid baffle with cones along the top.

Example of Vertical Slot Fishway

(Image source: Marsden, T. et. al. (2018). Stung Pursat Barrage Fishway: proposed design criteria and concept. Australasian Fish Passage Services Pty Ltd, 21p.)

Example of Cone Fishway

(Image source: Marsden, T. et. al. (2018). Stung Pursat Barrage Fishway: proposed design criteria and concept. Australasian Fish Passage Services Pty Ltd, 21p.)

2.2 Denil Fishways

A concrete channel with U-shaped baffles inserted at regular and closely spaced intervals along the base of the channel to create a zone of low velocity.

Example of Denil Fishway

(Image source: Department of Environment and Science, Queensland (2021) Biopassage options, WetlandInfo website.)

2.3 Fish Lock or Mechanical Fishway

Essentially a fish 'lift' or 'elevator'. Attracts fish to a chamber downstream of the barrier, which is either closed off and moved, or filled with water, until it reaches the upstream level of the barrier where fish can disperse.

Example of Fish Lift

(Image source: Department of Environment and Science, Queensland (2021) Biopassage options, WetlandInfo website.)

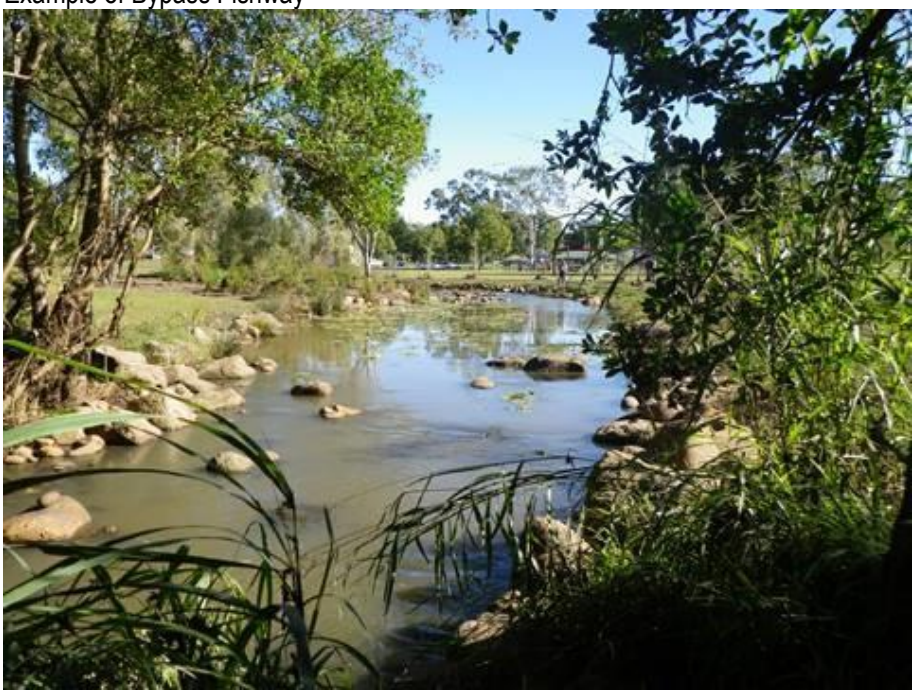
2.4 Nature-Like Fishways

Include rock ramp and bypass fishways. Designed to mimic the structure of natural streams. Rock ramps incorporate careful placement of rocks to simulate a natural stream environment with pools, rapids and small falls. Bypass fishways are often earthen channels that slowly meander around the barrier, and include rocks, plants and flow-control structures that make them very similar to nature.

Example of Rock Ramp Fishway

(Image source: Fishway News Victoria, Werribee River rock ramp fishway (2016), Renae Ayres)

Example of Bypass Fishway



(Image source: Department of Environment and Science, Queensland (2021) Biopassage options, WetlandInfo website.)

2.5 Fish-friendly Culverts

Culverts can include specific design elements or methods to make them easier for fish to pass through. Although it greatly depends on the environment, to provide suitable passage conditions this could include culverts that are recessed into the channel bed to allow build up of natural material within the culvert, or by the inclusion of baffles or rock ramps within the culvert.

Example of Fish-Friendly Culvert

(Image source: Department of Environment and Science, Queensland (2021) Biopassage options, WetlandInfo website.)

3 Key Considerations

1. Speak to an expert – a fish ecologist should be consulted very early to understand the impacts and requirements for the area.
2. Understand the ecology of the waterway – the design of your fishway will depend on the species, lifecycles, and size of fish you have in your waterway.
3. Confirm the hydraulics – especially for larger, or more complicated fishways, it is important to understand how the flows are moving through your structure; particularly ensuring that conditions (velocity and turbulence) are acceptable for the swimming ability of the fish you are trying to pass.
4. Mimic nature – incorporate habitat elements, resting pools, and roughened surfaces in your design; for some fishways it will still be a long and arduous journey for the fish, so assisting them along the way will result in a more successful fishway that meets fish passage objectives.
5. Consult with Fisheries – often you will have a state departmental body such as Department of Agriculture and Fisheries (DAF – QLD) or Department of Primary Industries (DPI – NSW) approving your waterway barrier application or design; understand their requirements.
6. Allow for post-construction monitoring – fishways are not a ‘set and forget’ structure, they require ongoing monitoring by a suitably qualified expert to ensure they are working the way they should, and any required alterations can be actioned.

References

Department of Environment and Science, Queensland (2021) Biopassage options, WetlandInfo website: https://wetlandinfo.des.qld.gov.au/wetlands/management/fish-passage/technologies/fishway-options/

Fishway News Victoria, Werribee River rock ramp fishway (2016), Renae Ayres: https://fishways.wordpress.com/types-of-fishways/werribeeriver_rockrampfishway_rayres/

Marsden, T. et. al. (2018). Stung Pursat Barrage Fishway: proposed design criteria and concept. Australasian Fish Passage Services Pty Ltd, 21p. : https://www.csu.edu.au/research/ilws/publications/technical-reports/Stung_Pursat_Barrage_proposed_fishway_design_criteria_and_concept.pdf