Freshwater Biodiversity

When fish meet fords

In an investigation of how in-stream structures affect migrating native fish, ***Erica Williams, Jacques Boubée,*** *and* ***Josh Smith*** *suggest ways to make fords in streams more user-friendly for the inhabitants.*

Problems with fords

- Typical ford construction impedes migratory native fish
- 'Climbing' fish, such as redfin bullies and eels, are less affected
- Improved ford design can help remedy the problem

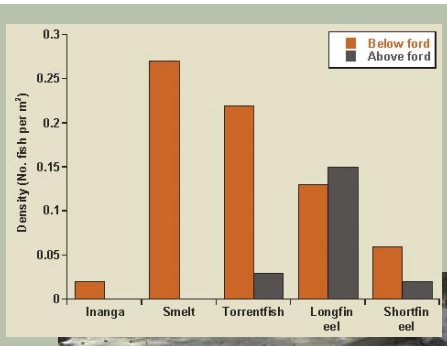
Fords are low-level crossings built into streams to improve access to farms and forestry blocks and on secondary roads in the backcountry. Typically, fords are constructed with a number of small-diameter culvert pipes laid into a concrete slab; often an 'apron' extends on the downstream side. Though they make life easier for farmers, foresters, and travellers, fords can be a 'thorn in the side' for stream-dwelling animals.

Many of our indigenous fish species must migrate to and from the sea to complete their life cycle. Fish migrating upstream encounter various challenges when confronted with an in-stream structure, and often these challenges are faced not in isolation, but in combination. At a ford, a fish is typically confronted with:

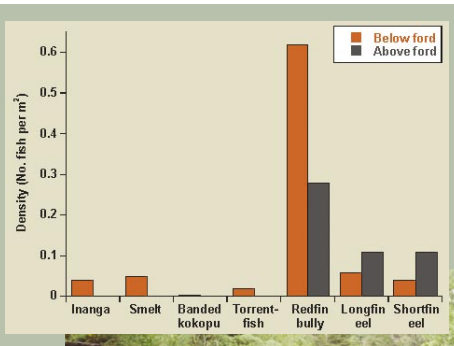
- a vertical drop (or step up for fish migrating upstream)
- shallow water across the apron (especially during summer migration, when water flows are lowest)
- high water velocity through the pipe barrels (compared to the natural stream)
- no resting areas within the structure.

In a study of 23 road crossings, we compared the proportion, size, and species of fish found upstream and downstream of the structures. Eight (35%) of these crossings were fords. We found that although the distribution of eels was not affected, the numbers of inanga, smelt, and torrentfish were generally lower above the fords. Redfin bullies were also affected at one and possibly more sites. We believe that these results reflect the 'climbing' ability of each of these species, with eels being able to climb using the wetted margin to surmount barriers. Redfin bullies are also known to be reasonably good climbers. The other three species are not climbers and, unable to use this mode of locomotion to progress past barriers, are more likely to be affected by in-stream structures.

The pictures and graphs below illustrate three examples of problems with fords. Though the distribution of eels did not appear to be affected, the number of inanga, smelt, redfin bully, and torrentfish upstream of the fords was much lower than downstream.



Ford on the Tapapakanga Stream, only 3 km inland from the sea. Note the shallow water over the apron and vertical drop at the end of the apron. The graph shows that this ford affects the passage of inanga, smelt, and torrentfish, but not eels.



Ford on a forestry road crossing the Awaroa Stream. Note the vertical drop at the end of the apron. The graph shows that this ford affects the passage of redfin bully and possibly inanga, smelt, and torrentfish. Eels are not affected.

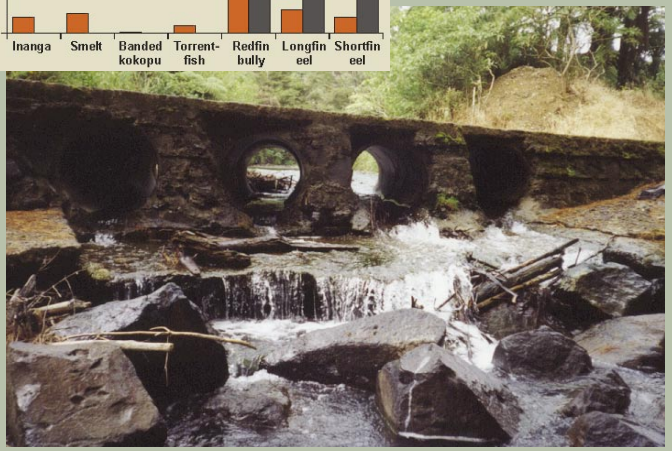


Photo: N. Deans, Fish & Game NZ, Nelson–Marlborough Region

Fish-friendly ford design with an unobstructed channel in the centre.

Height of vertical drop

The height of the vertical drop at a structure is often singled out as an important variable inhibiting fish passage. Other research at NIWA has found that 40–60% of adult inanga were capable of passing over weirs 10 cm high, but no passage was possible over a height of 20 cm.

Our information collected to date indicates that the proportion of fish making it past structures generally decreases as the height of the vertical drop increases. However, we found some non-climbers even where a ford had a vertical drop of more than 50 cm. How did these fish get past such a drop?

Age structure of fish above fords

We compared the size of fish captured below and above the fords to see whether all life stages were successfully passing the structure. This study showed that the fish captured above fords were large and therefore older than the fish found below the structures. This indicates that either these structures can only be negotiated by the larger (stronger) fish, or else passage is only occasionally possible. We believe the latter to be the case, with passage occurring during large floods when the whole structure is over-topped, or culverts drowned. Therefore, at the very least, fords delay the passage of fish (until flooding) and restrict the availability of habitat in which young fish can grow.

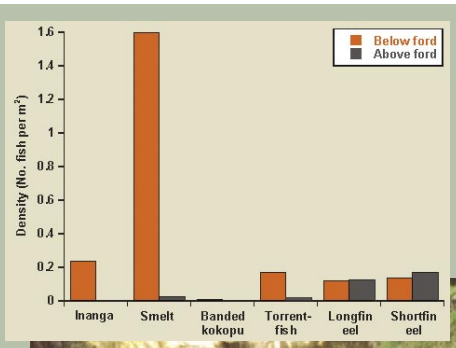
Useful links

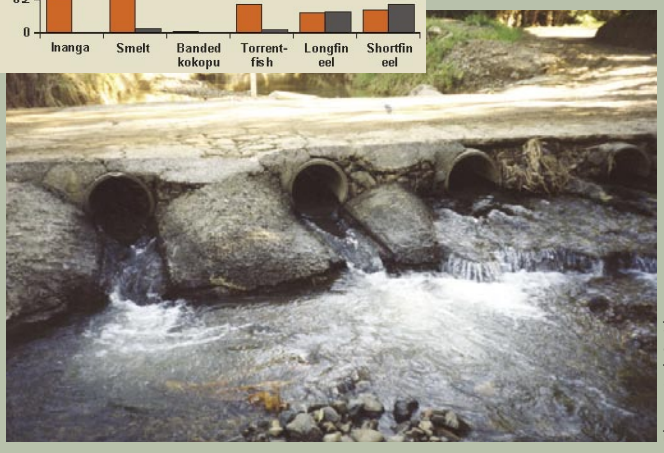
Learn more about the native fish species in this article with the Atlas of New Zealand Freshwater Fishes at www.niwa.co.nz/rc/freshwater/fishatlas/

The solution

Where possible, fords should be replaced by bridges, but as cost and topography may prevent this, we recommend that at least one section of the ford structure be made passable at low flows. This can be achieved by including a low-flow channel with a permanent, non-eroding rock base in the structure (as shown above).

To ensure that the structure remains passable over time, large rocks should be installed downstream of the structure to help prevent erosion. The ford should be monitored to be certain that fish are successfully passing it, and remedial action should be taken if floods cause erosion.





Photos: Josh Smith

Ford on the Hauarahi Stream. Note the particularly high velocity at the pipe outlet. The graph shows that this ford affects the passage of inanga, smelt, and torrentfish, but not eels.

Further reading

Baker, C. (2002). Whitebait can't jump. *Water & Atmosphere 10(1)*: 26–27.

Baker, C. (2003). Effect of fall height and notch shape on the passage of inanga (*Galaxias maculatus*) and common bullies (*Gobiomorphus cotidianus*) over an experimental weir. *New Zealand Journal of Marine and Freshwater Research 37*: 283–290.

Boubée, J.; Jowett, I.; Nichols, S.; Williams, E. (1999). Fish passage at culverts – A review with possible solutions for New Zealand indigenous species. Dept. of Conservation, Wellington. 112 p.

Boubée, J.; Williams, E.; Richardson, J. (2000). Fish passage guidelines for the Auckland Region. *Auckland Regional Council Technical Publication 131*. 40 p.

The authors are all based at NIWA in Hamilton, where they are members of the Freshwater Fisheries Team. *They thank FRST for funding in the 'Sustainability of Aquatic Ecosystems and Water Resources' programme (C01X0215) and Marganne Allen, Jason Hamil, Jonny Horrox, and Takeshi Ito for technical assistance.*