Being Baffled at Barriers

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Background

- NIWA's fish passage research has focused on low-head migration barriers such as culverts, fords, weirs, tide & floodgates
- One key theme has been using baffled substrates to promote passage of swimming and climbing fish
- Both inside culvert barrels and as ramps to mitigate fall heights < 1m





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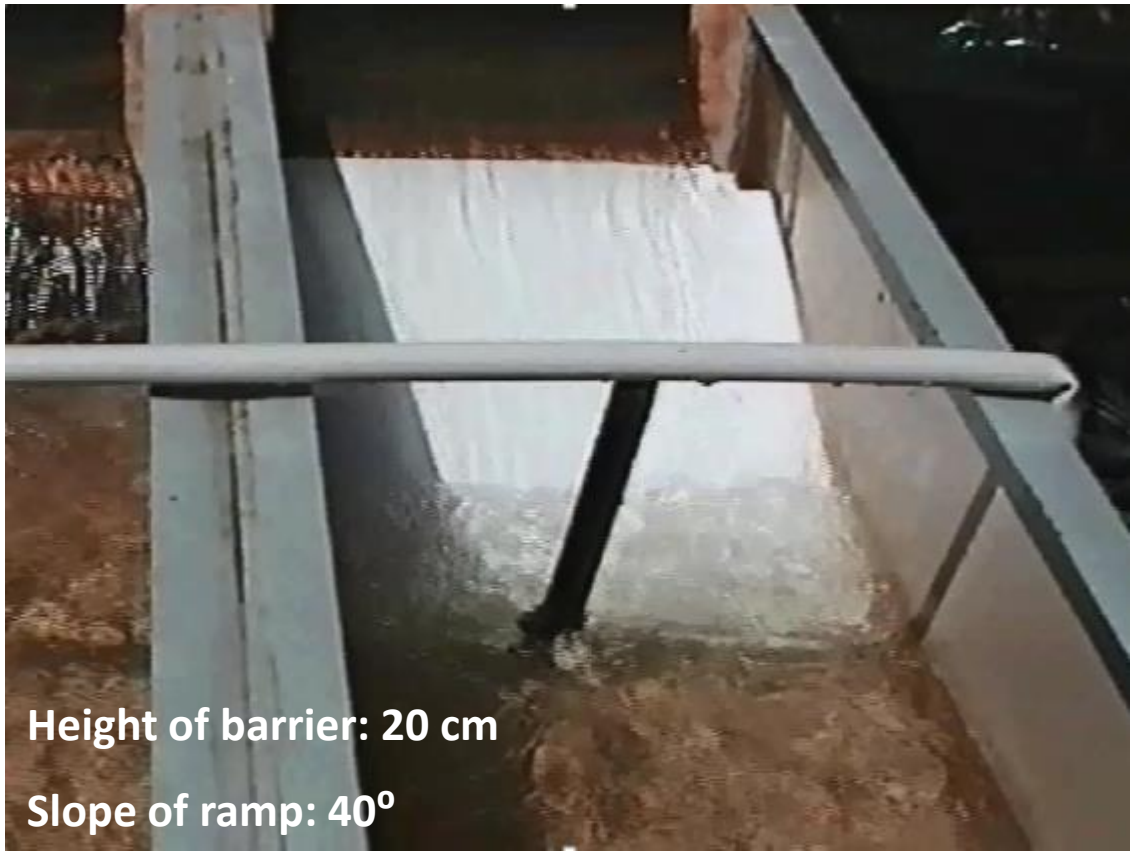
Background

- Original idea arose when investigating inanga and common bully passage over different shaped weirs (circular, vee, rectangular notch)
- Fish passage over all weirs restricted by fall heights of:
  - 10 cm – juvenile inanga and common bullies
  - 20 cm – adult inanga

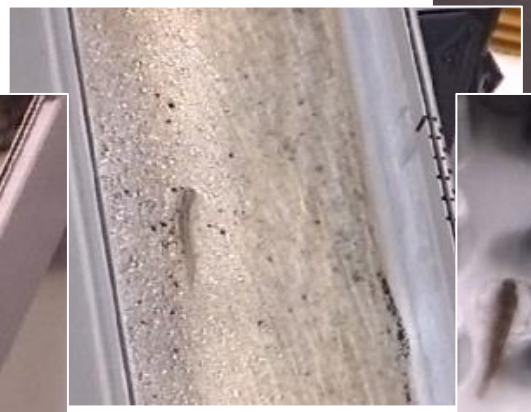


- Addition of a smooth ramp saw all fish pass the weir with a 20 cm fall height

Baker, C. F. (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(2)* 283-290.

Background

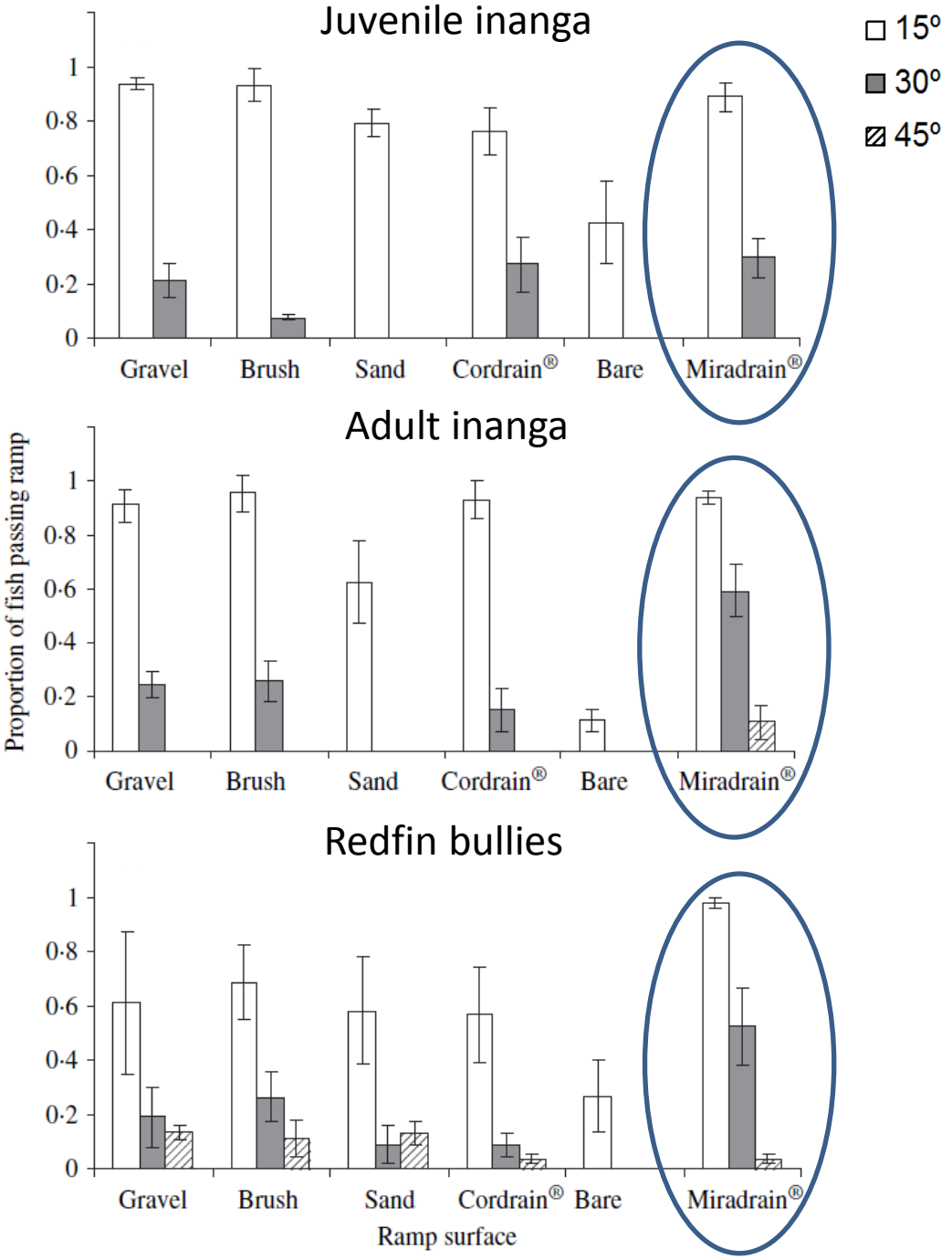
- Using 1.5m long ramps, tested 5 different substrates vs a smooth surface
- Tested juvenile & adult inanga and redfin bullies
- Key feature:
  - Tilted at 10º to provide a wetted margin at all flows for climbing fish species and low velocity water for swimming fish species



Baker, C.F. & Boubée, J.A.T. (2006). Upstream passage of inanga *Galaxias maculatus* and redfin bullies *Gobiomorphus huttoni* over artificial ramps. *Journal of Fish Biology 69:* 668-681.

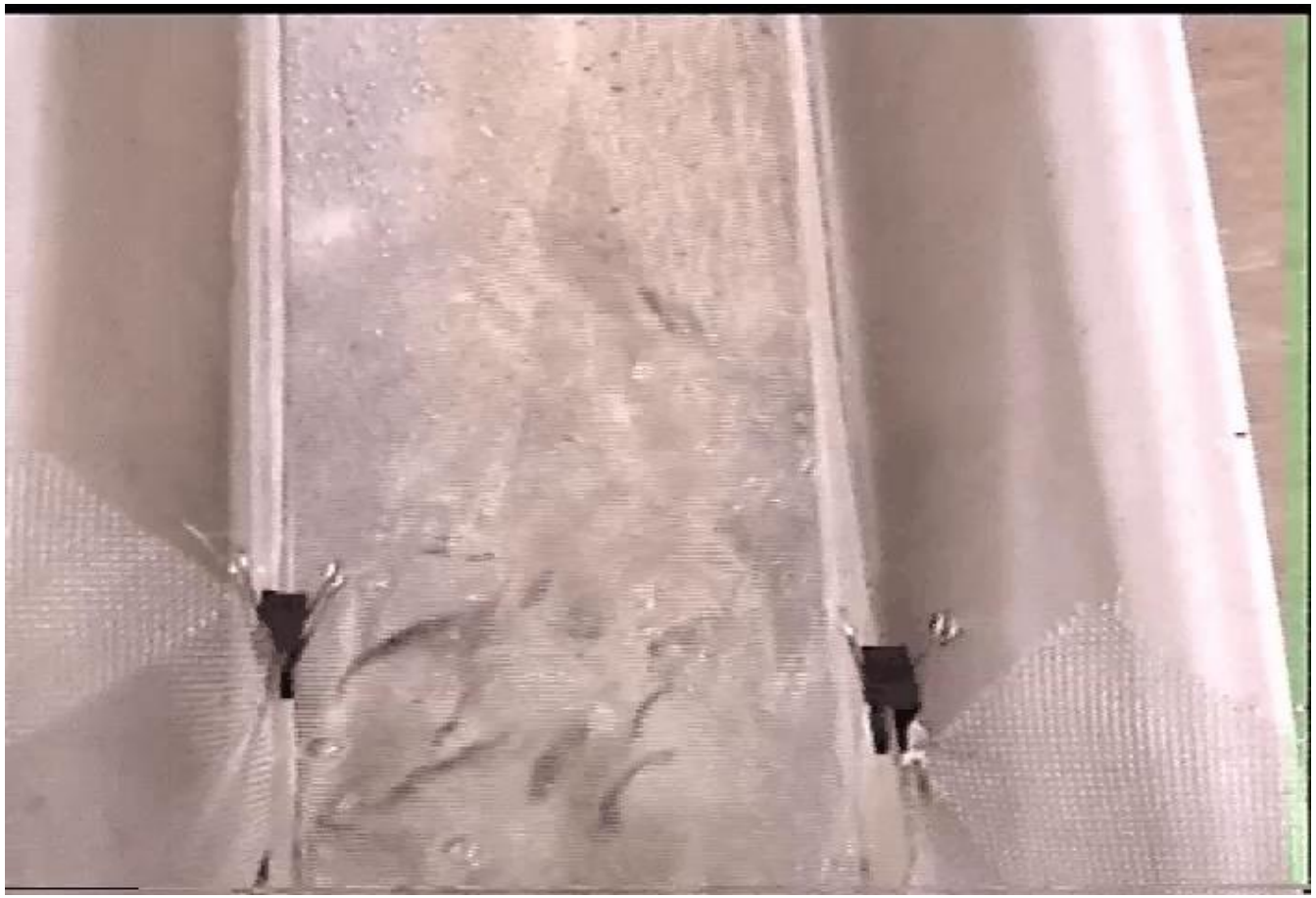
Background

- TC Mirafi drainage product Miradrain® had the highest passage success for all fish
- Lower slopes more effective for both species



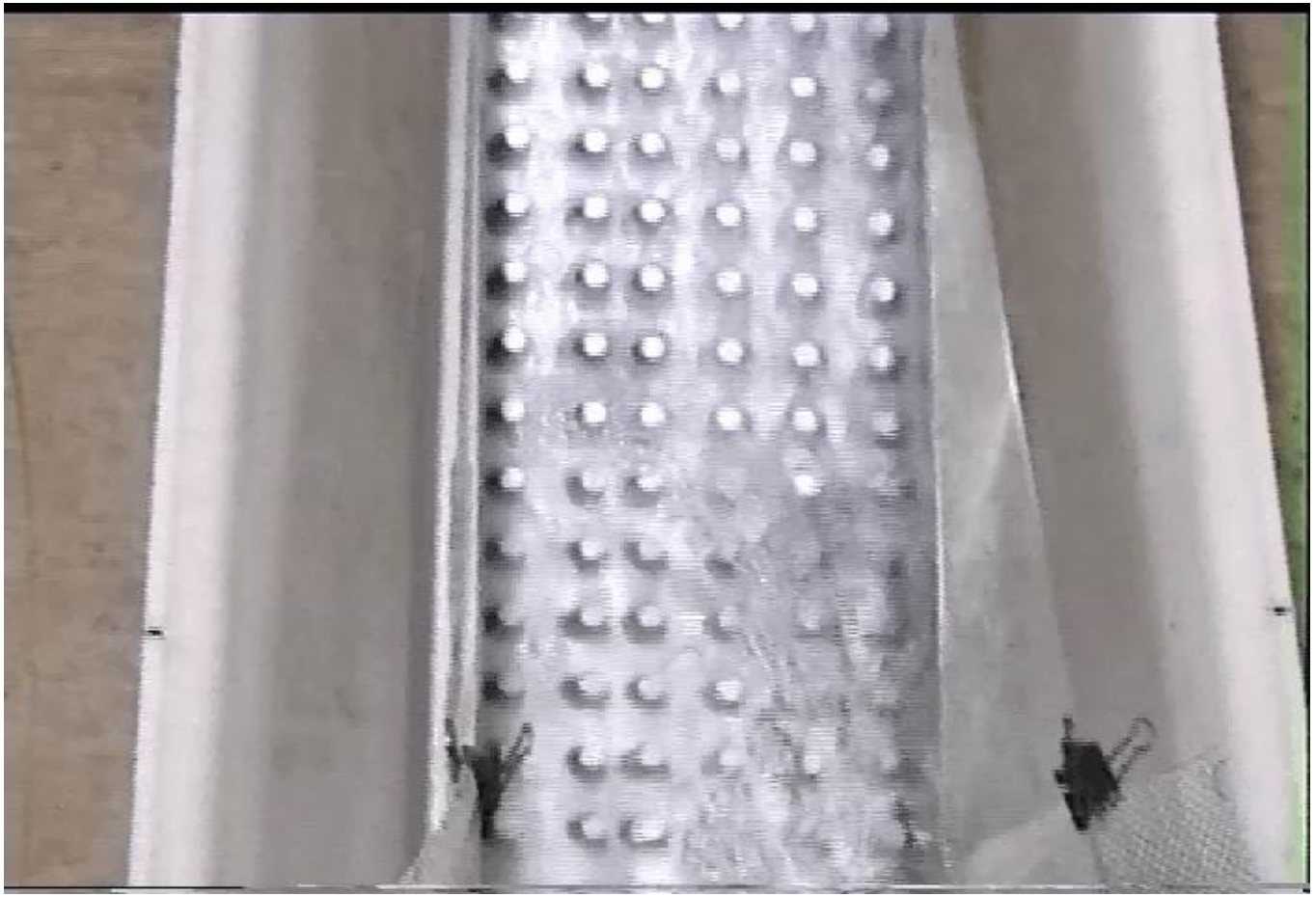
Background

Inanga attempting to pass the 15º ramp covered in sand



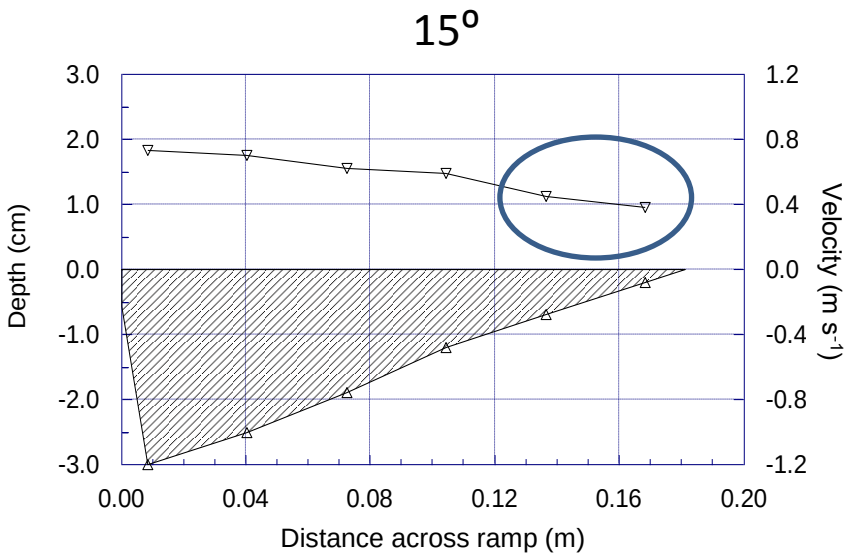
Background

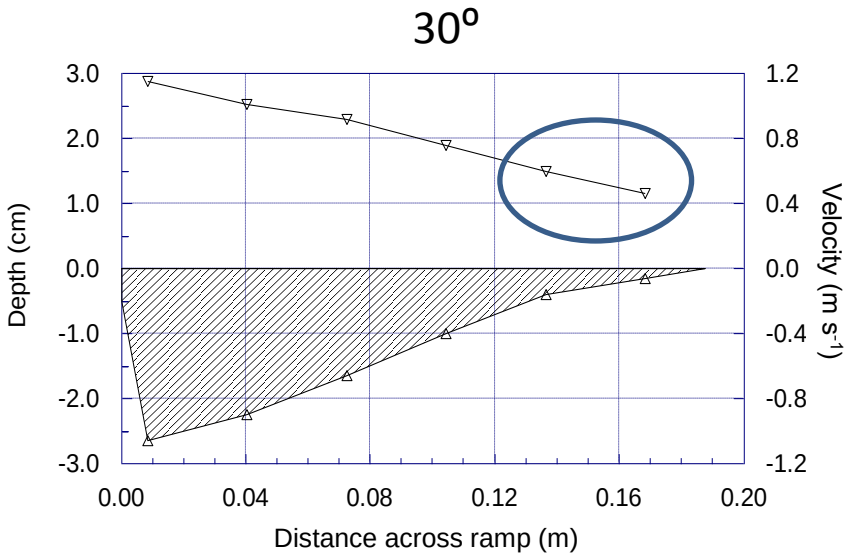
Inanga successfully passing the 15º ramp covered in Miradrain®



Recent research

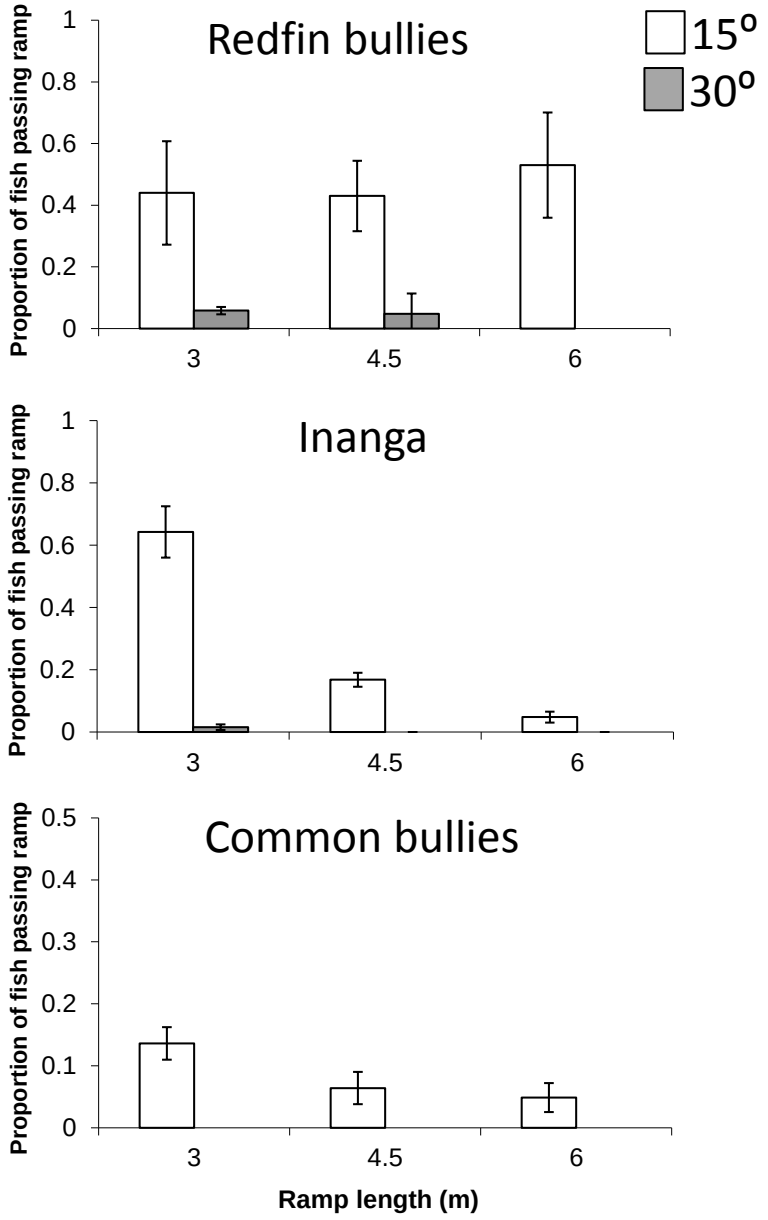
- Using a Miradrain® ramp we investigated the effect of increasing ramp length on inanga, redfin bully & common bully, passage
- Tested gradients of 15^0 & 30^0
- Ramp lengths of 3m, 4.5m & 6m
- Flow between baffle columns uniform so water velocity didn't accelerate with increasing ramp length





Recent research

- Passage of redfin bullies (capable of climbing) was unaffected by increasing ramp length up to 6m
- Good passage of inanga over 3m ramp at 15º
- Poor passage of common bullies at all ramp lengths & slopes
- Ramps >3m applicable for climbing species only



Recent research

- Passage of inanga over 3m ramps in the laboratory similar to that found in the field by Doehring et al. (2011)

3m ramp	% success small inanga (<60mm)	% success large inanga (>60mm)
NIWA Miradrain, 15^{o}	46	81
Doehring Astroturf, 20^{o}	44	-

- For swimming fish passage, if ramps longer than 3m are required, a shallower gradient would be necessary

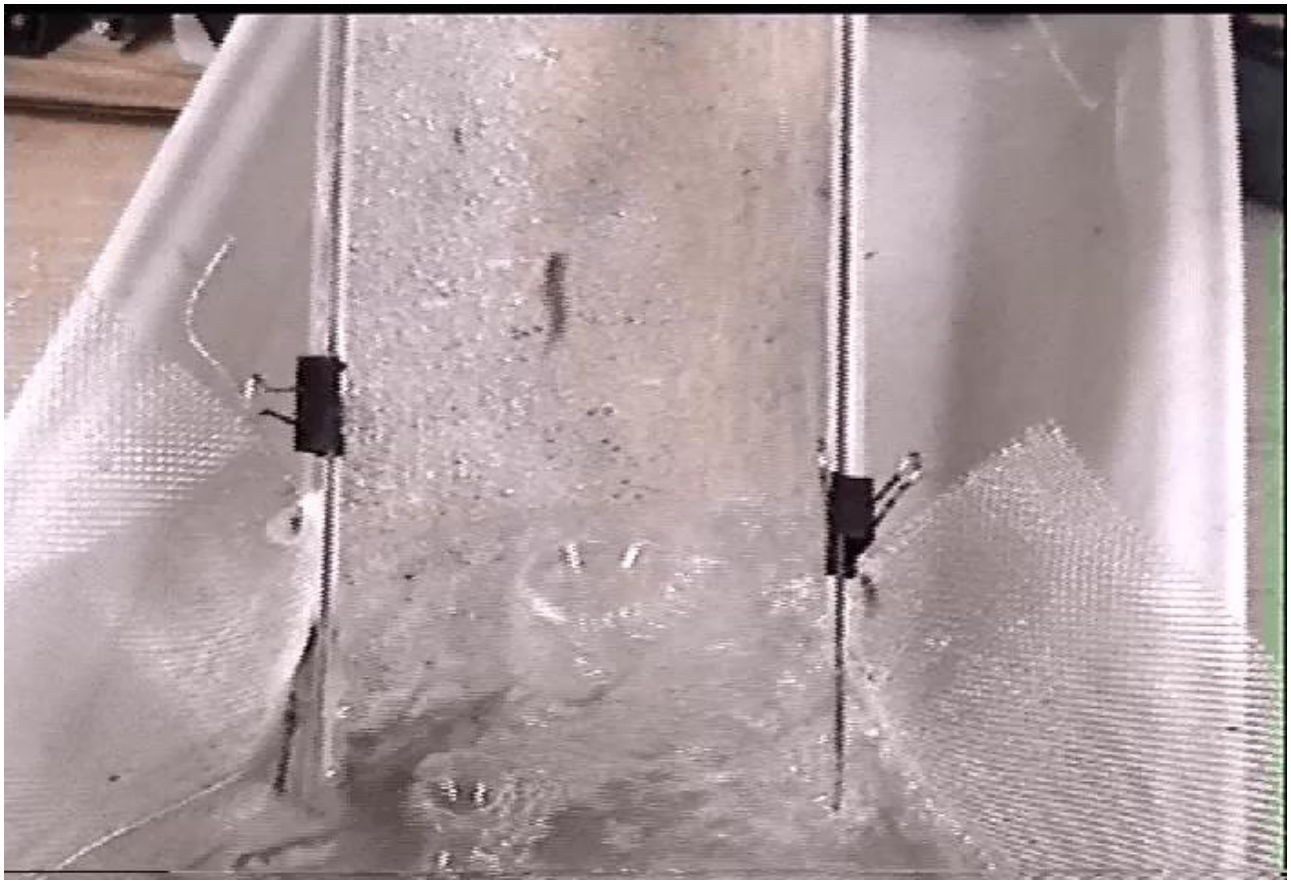
Current research

- Modified ‘Crump’ weir with a V notch and baffled face, good passage for both swimming and climbing fish species
- Concrete structure costly and not always a feasible option
- Ramps based on the V notch crump weir for retrofitting low head obstacles (up to 1m fall height)
- Designed to accommodate different climbing behaviours of our native species


T&T designed weir on Te Awa O Katipaki Stream, Hamilton

Current research

Banded kokopu whitebait, maintain adhesion with the surface while climbing



Current research

Redfin bullies propel themselves forward by detaching and reattaching to the substrate

Current research

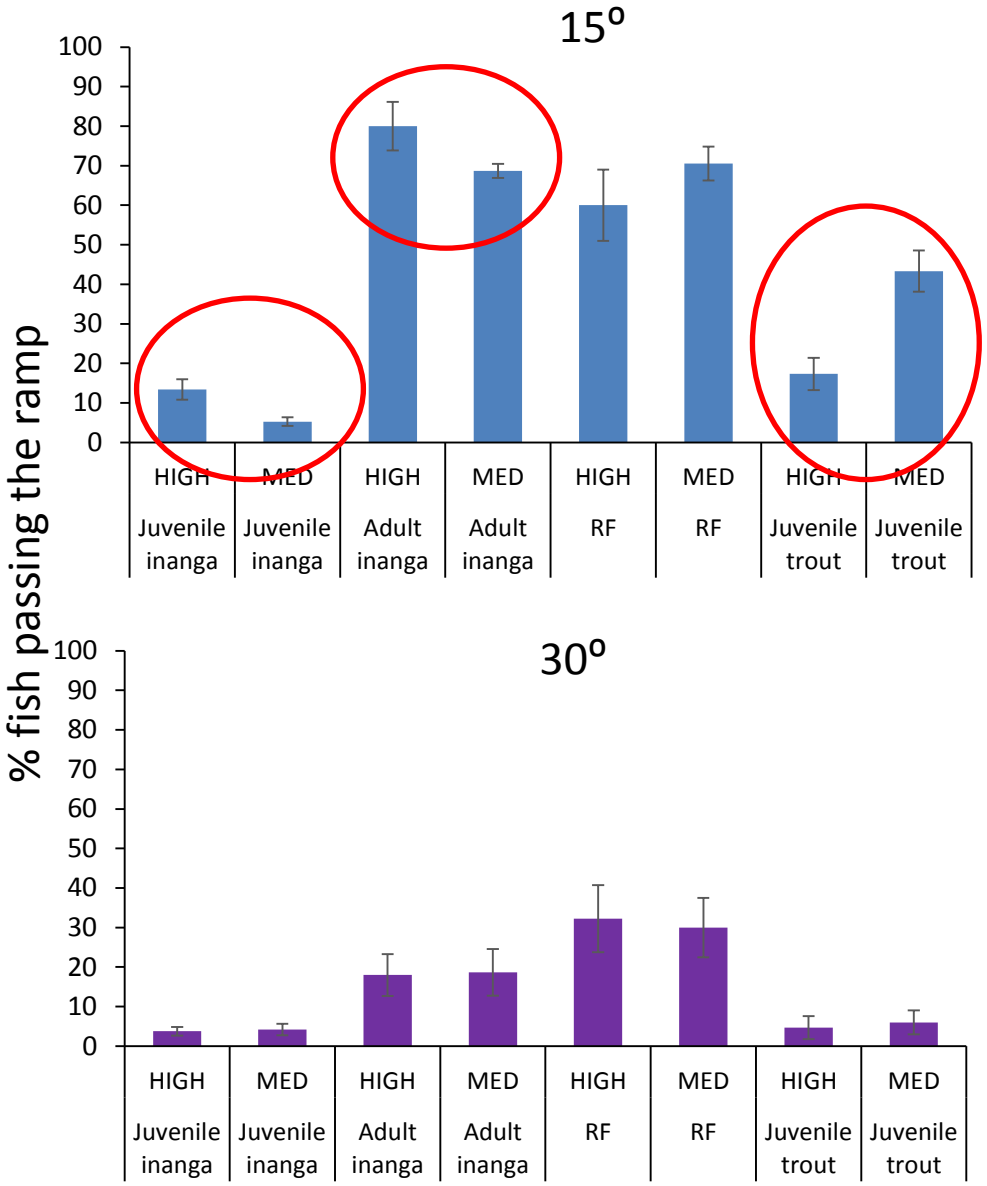
Sharp edges a big problem for climbers that detach and reattach to surfaces

Current research

- Designed to accommodate both juvenile swimming and climbing fish
  - Wetted margin all flows
  - One face fully baffled
- One face partially smooth to promote passage of larger climbing species (e.g. adult lamprey)
- Rounded crest (key for species that climb by detaching and reattaching to the substrates)
- Upstream passage for adult fish e.g. galaxiids still not catered for

Current research

- 15^0 ramp, juvenile & adult inanga had higher passage success with a faster flow
- Opposite was seen with juvenile trout
- Flow effect not seen on the 30^0 ramp
- Passage increase with faster flow due to hydraulics and motivation?
- Passage of whitebait low but 5% still able to pass the 30^0 ramp
- No effect of flow seen with redfin bullies



Current research

- Trials are on-going
- Will be testing a range of fish species including:
  - Common bullies, rudd, koi carp, perch & gambusia
- Manipulate components to try to maximise native fish passage whilst minimise passage of pest fish species

Summary

- Baffled ramps offer a cost-effective solution for re-establishing fish communities upstream of low head obstacles
- Smooth wetted margins essential for climbing fish species, and low velocity water necessary for swimming fish species
- Fish seek specific cues from flow and water velocity gradients, and research is needed to understand what hydraulic features motivate and enhance native fish passage
- Future research hopes to exploit unique features of native fish swimming and climbing behaviours to create passes which minimise exotic fish passage

Acknowledgements

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