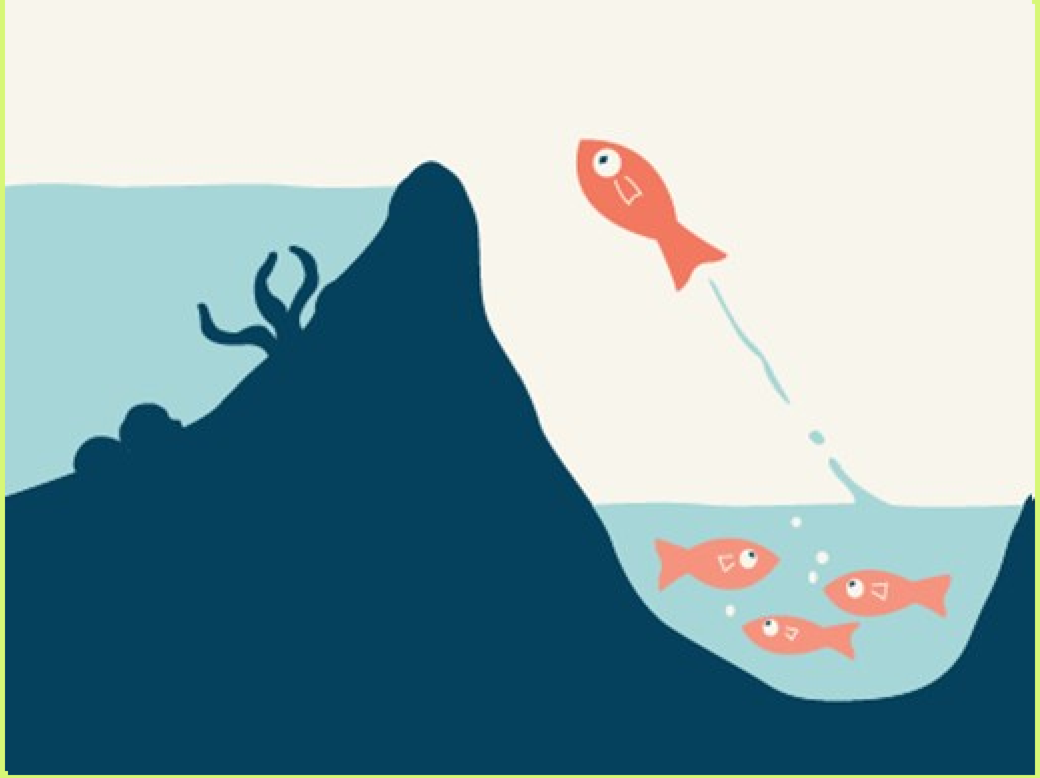
Can't pass or won't pass: the importance of motivation when quantifying improved connectivity for riverine brown trout



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FREE FLOW

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Understanding fish movements

```
>supply power ok 12.8V
database file opened
starting reader after power up
up
upload #8 start: 11/21/2013 13:02:15.99
Site code: AA
--------- upload 8 start ---------
11/21/2013 13:02:15.99 upload 7 complete
11/21/2013 13:03:16.46 supply power ok 13.6V
11/21/2013 13:03:16.46 database file opened
11/21/2013 13:03:16.46 starting reader after power up
11/21/2013 13:08:06.07  00:00:00.00 R 0000_0000000174764599 A1    1  1409
11/21/2013 13:23:03.98  00:00:00.00 R 0000_0000000174764599 A1    1  4459
11/21/2013 13:45:02.51  00:00:00.20 R 0000_0000000180573693 A2    2 12416
11/21/2013 14:22:55.64  00:00:00.00 R 0000_0000000174764599 A1    1 17839
11/21/2013 14:37:53.60  00:00:00.00 R 0000_0000000174764599 A1    1  4462
11/21/2013 14:46:56.54  00:00:00.00 R 0000_0000000180573693 A2    1 18450
11/21/2013 14:52:51.53  00:00:00.00 R 0000_0000000174764599 A1    1  4460
11/21/2013 15:07:49.33  00:00:00.00 R 0000_0000000174764599 A1    1  4459
11/21/2013 15:17:53.49  00:00:00.20 R 0000_0000000180573693 A2    2  9224
11/21/2013 15:22:47.31  00:00:00.00 R 0000_0000000174764599 A1    1  4460
11/21/2013 15:37:45.24  00:00:00.00 R 0000_0000000174764599 A1    1  4459
11/21/2013 15:48:50.59  00:00:00.00 R 0000_0000000180573693 A2    1  9223
11/21/2013 15:52:43.10  00:00:00.00 R 0000_0000000174764599 A1    1  4460
11/21/2013 16:07:40.90  00:00:00.00 R 0000_0000000174764599 A1    1  4460
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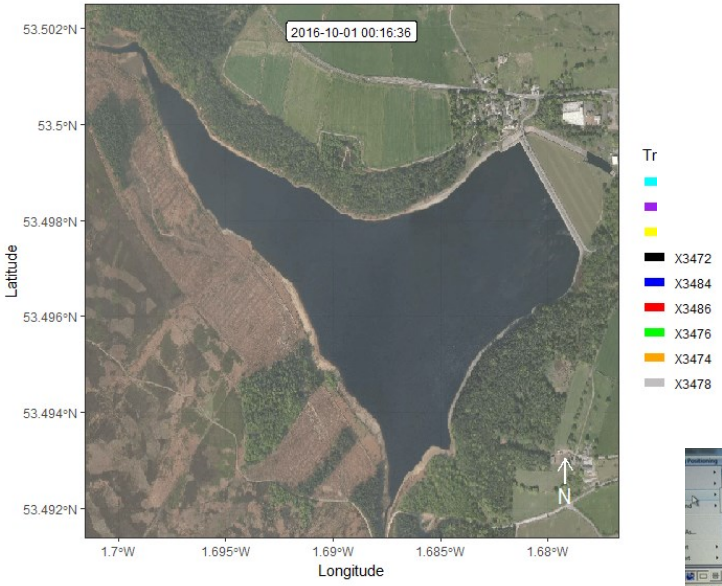

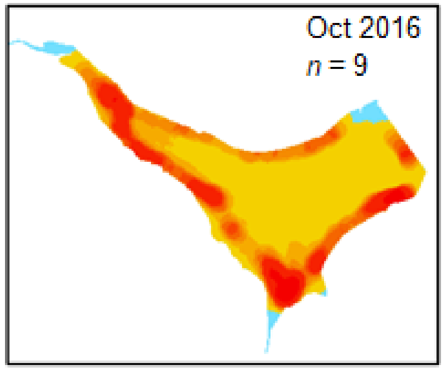

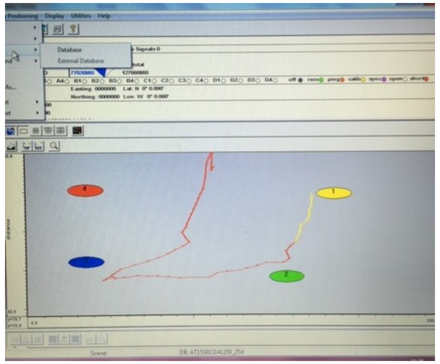

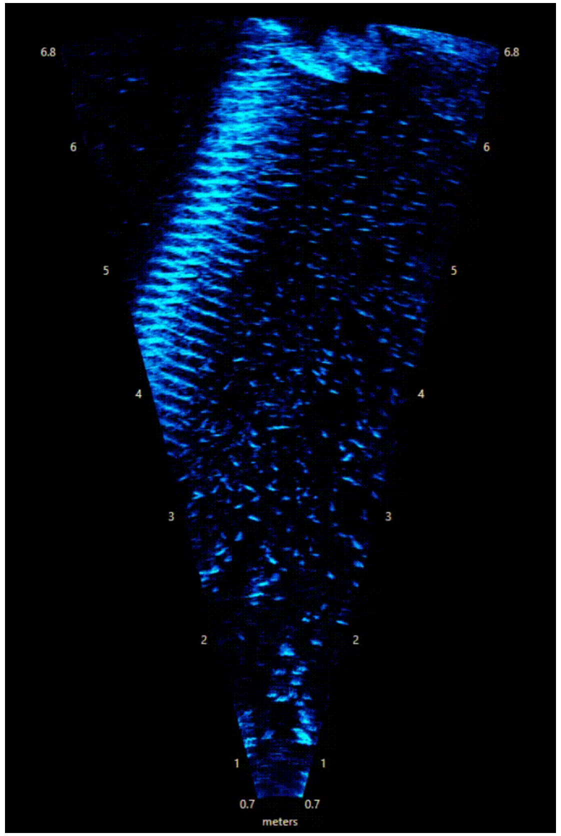

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When removal isn't chosen

What makes a good fish pass???

Easily locatable

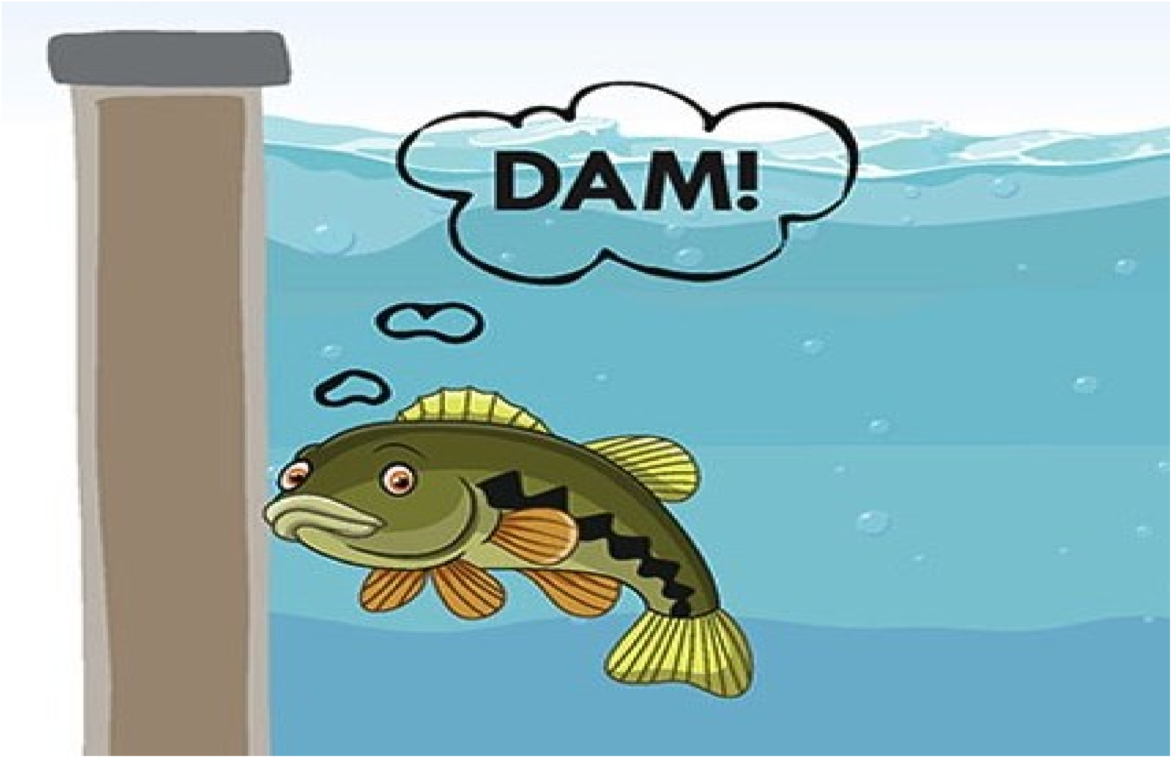
Open all year round

Passable during all flows

Usable by all species

Used by all sizes

Minimal/no time delay at structure



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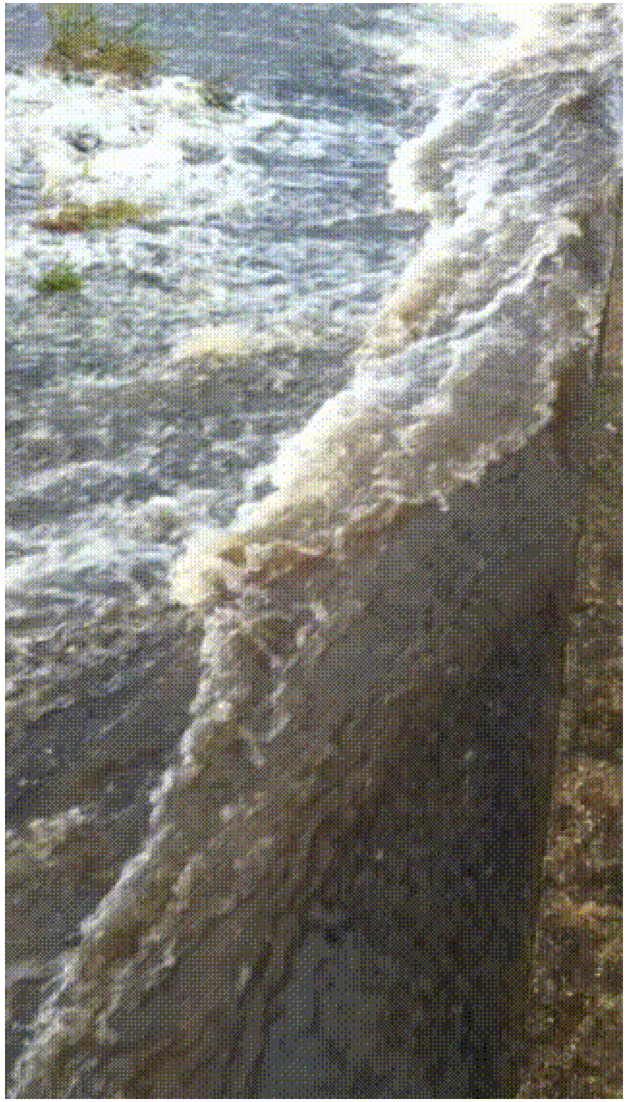
Motivation

"Overall, motivation is potentially one of the greatest drivers of variation in efficiency estimates but it also represents one of the greatest challenges for biologists. "

"One of the greatest challenges of comparing effectiveness of fishway design among studies, and particularly among species, is the limited consideration of variation in patterns of movement and levels of motivation displayed."



"However, a major flaw in assessments of dam crossing efficiency for potamodromous species is that the intention (or motivation) of fish to cross the dam is rarely considered. Thus, such assessments may be under- or over-biased by misinterpreting the fact that not all fish need to go through the fishway"

"Capture of fish downstream from a fishway assumes that they are all indeed motivated to migrate..."

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Homing behaviour

River Research and Applications

RESEARCH ARTICLE

The use of behavioural metrics to evaluate fishway efficiency

M. Ovidio, D. Sonny, A. Dierckx, Q. Watthez, S. Bourguignon, B. de le Court, O. Detrait, J.P. Benitez

First published: 27 September 2017 | https://doi.org/10.1002/rra.3217 | Citations: 7

"In order to encourage the fish to move upstream in the Bocq by homing and/or upstream spawning migration, we decided to carry out intra-river translocations and to tag the fish just before their spawning period."

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Homing movements of displaced stream-dwelling brown trout

J. D. Armstrong, N. A. Herbert

First published: 01 April 2005 | https://doi.org/10.1111/j.1095-8649.1997.tb01372.x | Citations: 32

"In April and May of 1993, 12 of 14 brown trout (202–288 mm), tagged with radio transmitters and displaced over 800–3600 m in a natural river system, returned to the areas from which they were captured. "

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Aim

Better understand the difference in passage behaviour between displaced (motivated) and non-displaced riverine brown trout at a Low Cost Baffle (LCB) fish pass.

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Methods

- Wild brown trout were caught via electric fishing from directly above and below the study weir
- All fish >120mm were tagged with 23mm HDX PIT tags
- Fish were released 200 m downstream of the weir
- Six PIT antennas were installed to monitor the movements of fish up to and over the weir

	Non-displaced	Displaced	Sig.
Fish captured (mm)	133 – 359 mm	127 – 326 mm	$P > 0.05$

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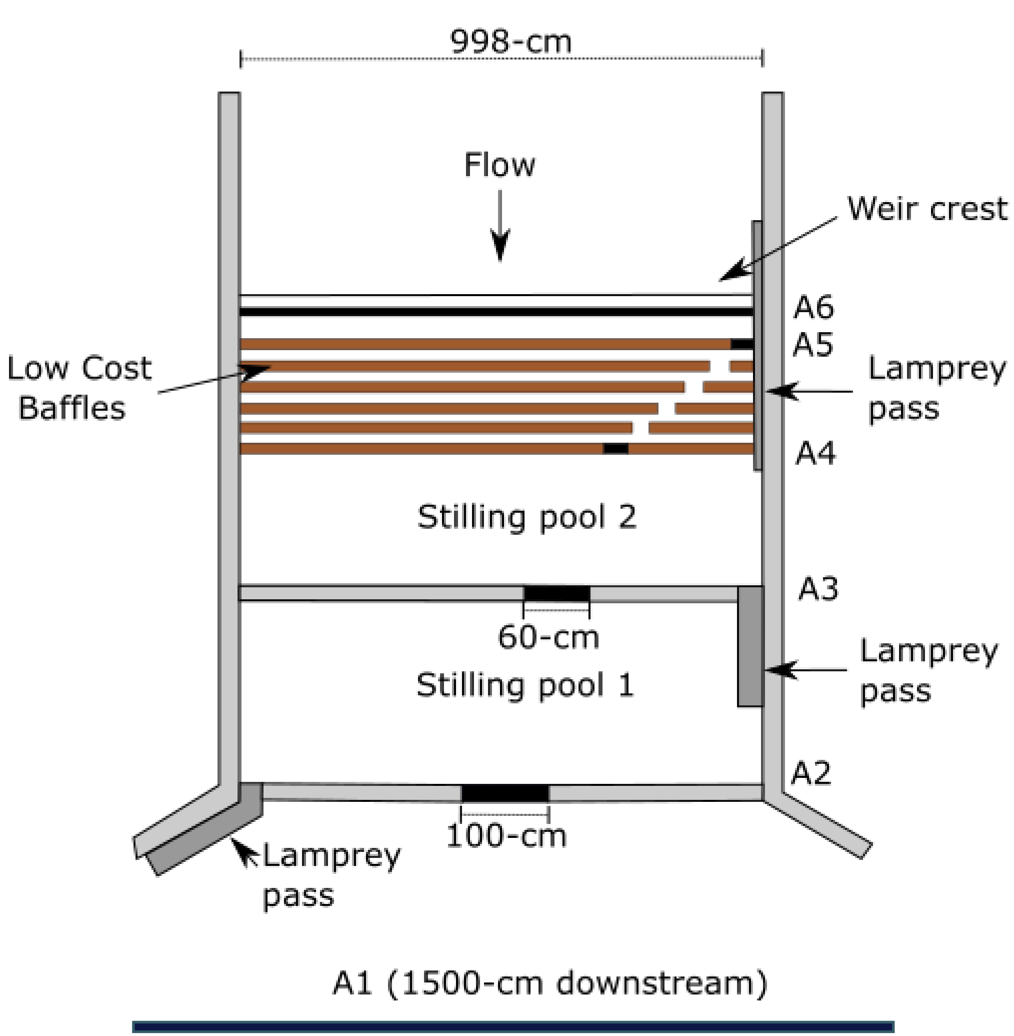
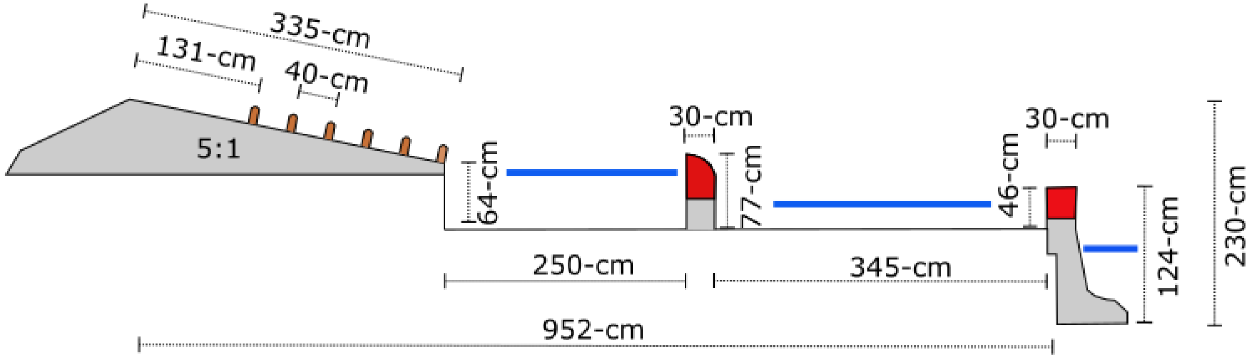
Study site

Top view



Side view



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Efficiency results

	Non-displaced	Displaced	Sig.
Available fish (%)	29% (n = 22/77)	**76%** (n = 94/123)	**P < 0.01**
Entrance efficiency (%)	14% (n = 3/22)	**59%**(n = 55/94)	**P < 0.01**
Fish pass efficiency (%)	100% (n = 3/3)	95% (n = 52/55)	-
Overall passage efficiency (%)	14% (n = 3/22)	**55%** (n = 52/94)	**P < 0.01**
Approaches	**10.00** (*n* = 22)	6.72 (*n* = 93)	**P < 0.05**
Passage fish approaches	2.00 (*n* = 3)	4.09 (*n* = 51)	
Time from release to first approach (days)	0.70 (0.08 – 4.49)	0.62 (0.04 – 30.37)	P > 0.05
Overall passage time (days)	4.12 (1.94 – 25.54)	0.17 (0.01 – 30.90)	-
Time to pass (days)	1.93 (1.66 – 19.14)	0.06 (0.01 – 22.31)	-

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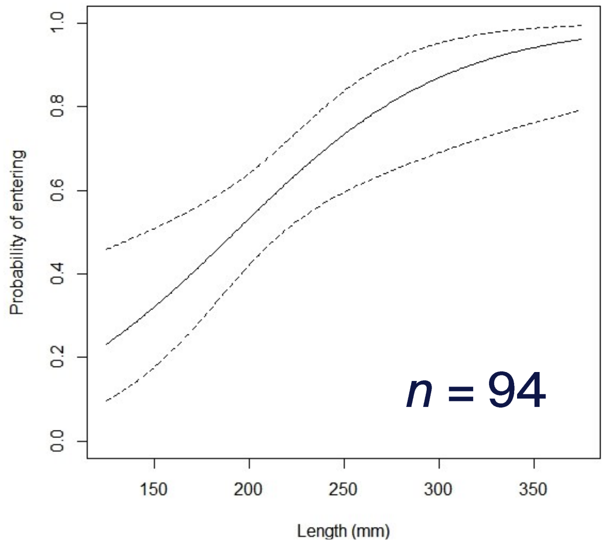
Size

	Non-displaced	Displaced	Sig.
Fish captured	133 – 359 mm	127 – 326 mm	P > 0.05
Available fish	185 (142 – 290)	213 (135 – 326)	P > 0.05
Entered (mm)	213 (192 – 254)	226 (147 – 303)	-
Ascended (mm)	213 (192 – 254)	228 (147 – 303)	-

- No significance difference between available or not (within groups)
- Significantly larger **displaced** fish entered the weir in comparison to **displaced** fish that approached but did not enter.
- Only three **displaced** fish that entered the pass did not pass (171, 259 and 274-mm).

Displaced entrance probability



Binary logistic regression model	**Coefficient**	**Standard error**	***z* statistic**	***p***
Non-translocated approach	−0.008	0.006	−1.383	0.167
Translocated approach	0.005	0.005	0.899	0.369
Non-translocated entrance	0.007	0.012	0.544	0.586
Translocated entrance	**0.018**	**0.006**	**3.130**	**0.002**
Translocated passage	0.012	0.016	0.765	0.444
Translocated overall passage	**0.018**	**0.006**	**3.153**	**0.002**

Note: All null models were significant $p < 0.05$. Note: Too few non-translocated fish passed the impediment ($n = 3$) to perform a regression on passage and overall passage.

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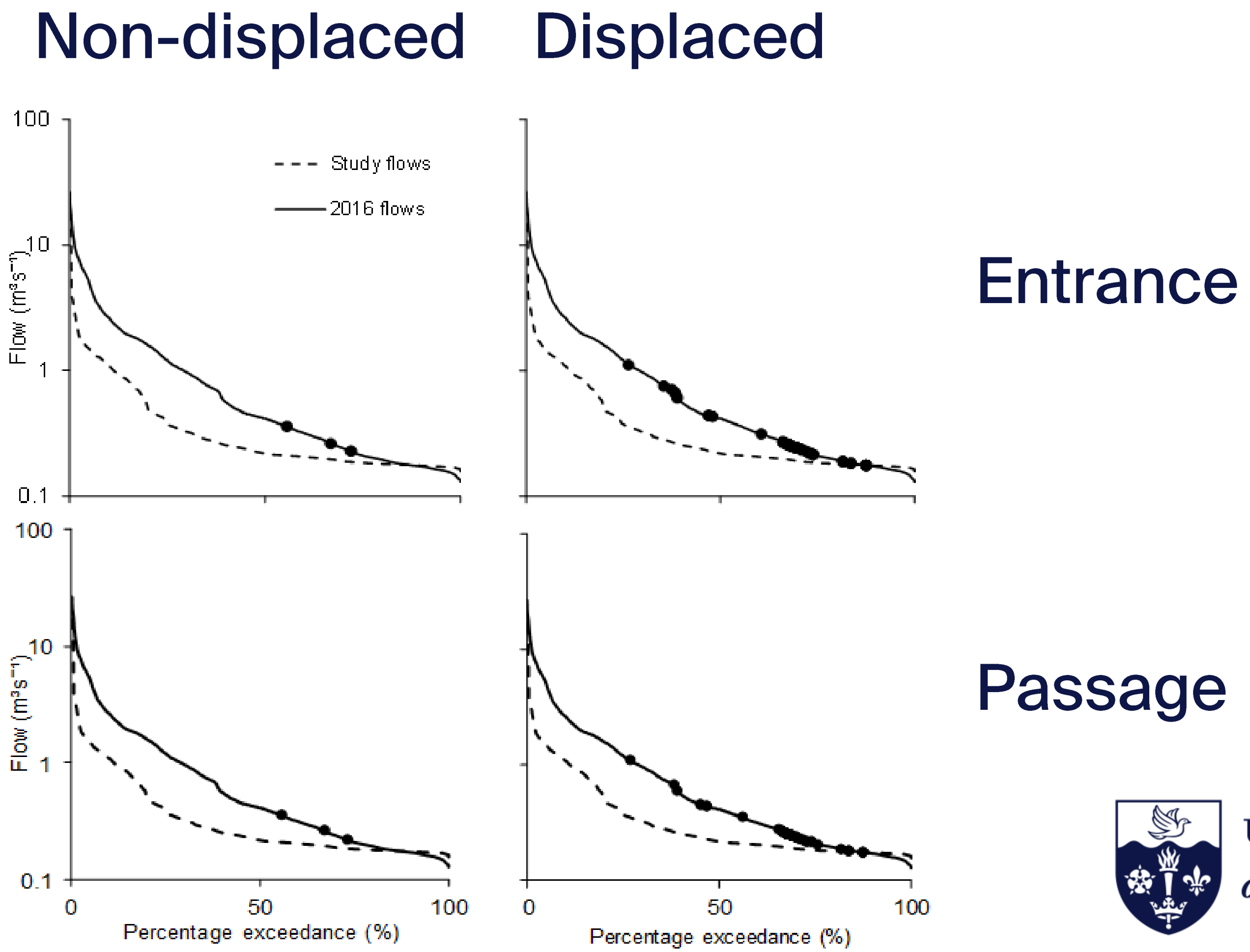
Environmental conditions

Displaced fish 1st approached, entered and passed the weir on a wider range of flows than non-displaced fish



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Cox proportional hazard ratio

- Research group (i.e., capture location) was found to have the greatest influence on the probability of passage (odds ratio = 60.89), with translocated fish having a 60 times higher probability of passage than non-translocated fish.
- Fish size had a positive influence, with a 1-cm increase in length estimated to increase passage by 3%.
- Flow was indicated to have the largest negative influence on the probability of passage, with an increase of 1 $m^3 s^{-1}$ predicted to reduce probability of passage by 99%.
- Subsequent approaches were also predicted to reduce the chance of passage by 27.5%.

	Coefficient	Hazard ratio	Standard error (coefficient)	*z*	*p*
Release group	4.109	60.894	1.407	2.92	**0.003**
Fish length	0.031	1.0320	0.010	3.10	**0.001**
Flow	−5.165	0.006	1.869	−2.72	**0.005**
Total approaches	−0.321	0.725	0.084	−3.81	**<0.001**

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Additional brown trout studies

Study	Available (%)		Ratio	Overall passage efficiency (%)		Ratio
	Non-displaced	Displaced		Non-displaced	Displaced	
This study	29	76	Resident 3.4 : 1 Displaced 1.5 : 1	14	55	Resident 16.5 : 1 Displaced 2.5 : 1
Study 1	22	59		20	71	
Study 2	32	56		50	80	
Study 3	42	81		21	43	
Overall	**35**	**69**		**23**	**60**	

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Conclusion

- Quantitatively demonstrated that displaced river-resident fish enabled a far more accurate and robust assessment of fish pass performance to be performed than if only non-displaced fish were studied.

- By using displaced fish we are abiding to the guiding principles underpinning the humane use of animals in research by reducing the number of animals required to get a meaningful result.

- The use of displaced fish could allow for a quicker assessment of a structure saving cost on equipment maintenance and time associated with visiting site.

3 R's
- Replacement
- Reduction
- Refinement

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Conclusion

- Quantitatively demonstrated that displaced river-resident fish enabled a far more accurate and robust **assessment of fish pass performance** to be performed than if only non-displaced fish were studied.

- The use of displaced fish could allow for a **quicker assessment of a structure** saving cost on equipment maintenance and time associated with visiting site.

This method helps identify reasons for passage failure.

But need to remember

Connectivity is multidimensional

Thank you for listening

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REGULAR ARTICLE | Full Access

Can't pass or won't pass: the importance of motivation when quantifying improved connectivity for riverine brown trout *Salmo trutta*

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