BEAVER TRUST

The impact of reintroduced Eurasian Beaver (*Castor fiber*) dams on the upstream movements of brown trout (*Salmo trutta*) in upland areas of Great Britain

10 International Beaver Symposium, Inverness,
17th – 19th September 2025

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beavertrust.org
Registered charity number 1185451 in England and Wales

University of Southampton
NatureScot
Scotland's Nature Agency
Buidheann Nàdair na h-Alba
Game & Wildlife Conservation Trust
Salmon & Trout Conservation

INTRODUCTION

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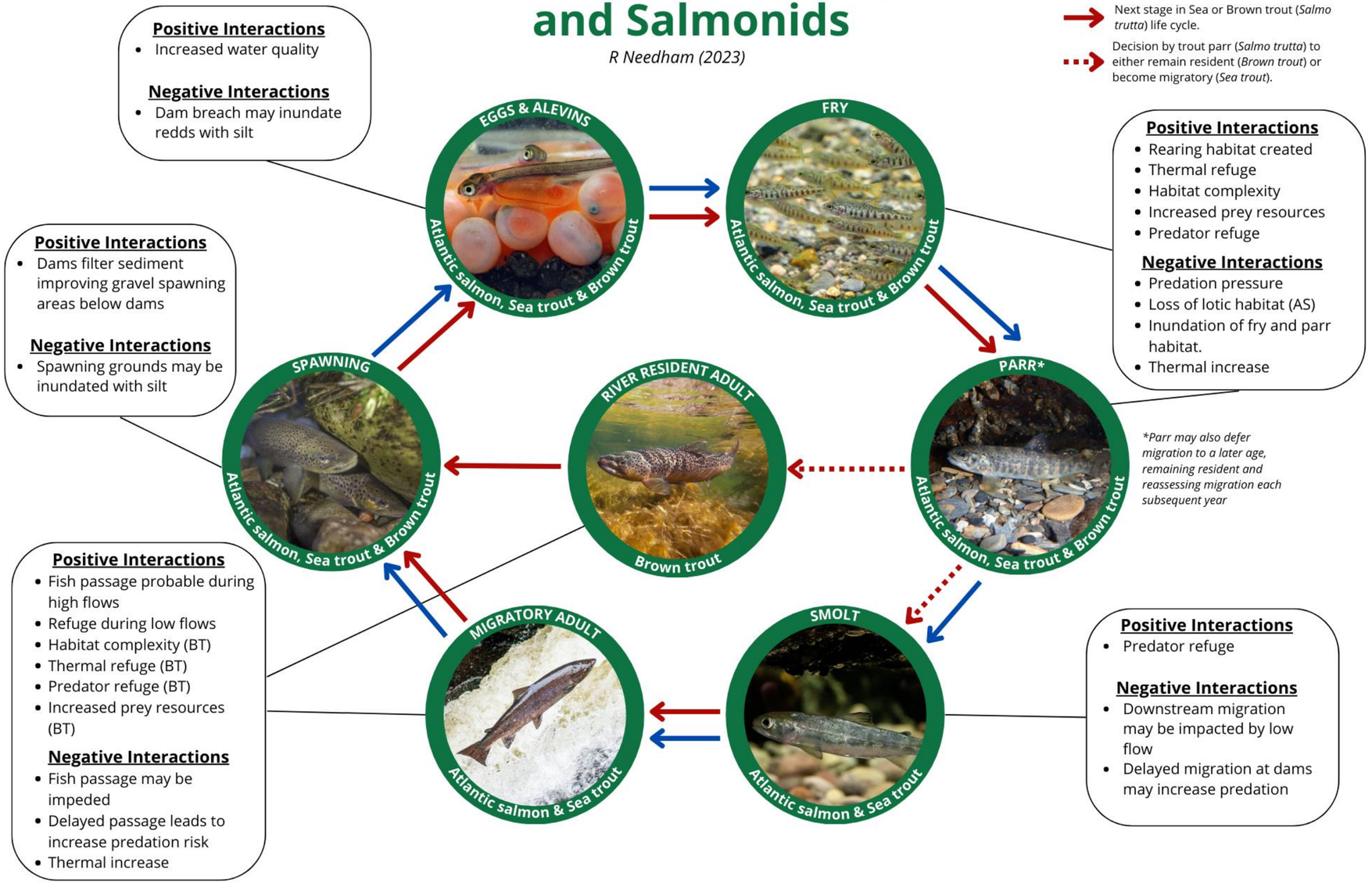
Interactions between Beavers and Salmonids

R Needham (2023)

KEY

- Next stage in Atlantic salmon (*Salmo salar*) life cycle.
- Next stage in Sea or Brown trout (*Salmo trutta*) life cycle.
- Decision by trout parr (*Salmo trutta*) to either remain resident (*Brown trout*) or become migratory (*Sea trout*).



INTRODUCTION

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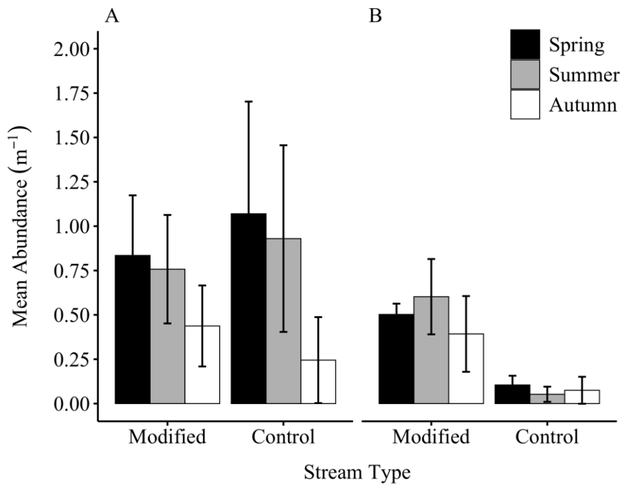
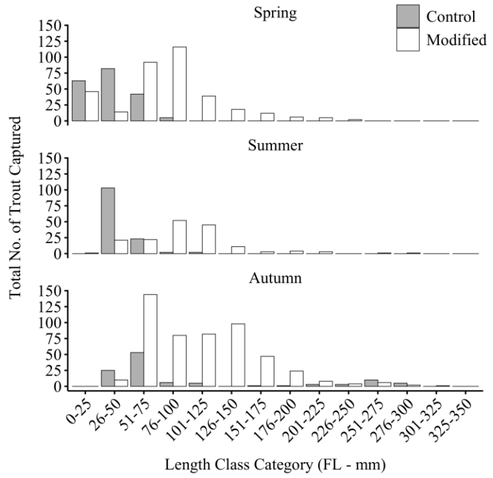
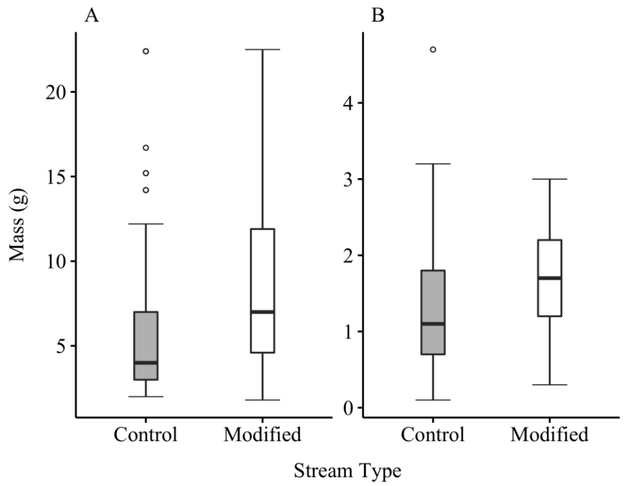
Abundance



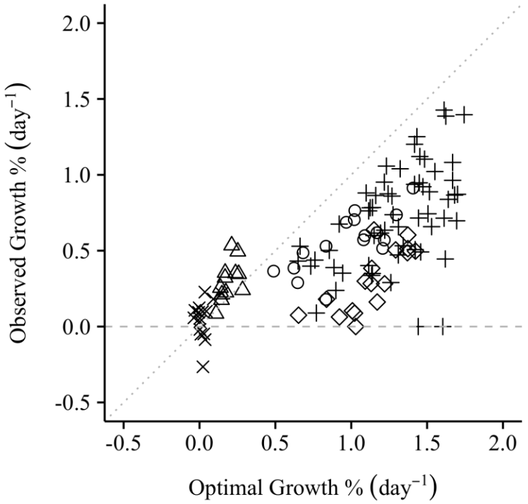
Length Class Frequency



Body Condition



Growth Rates



Canadian Science Publishing

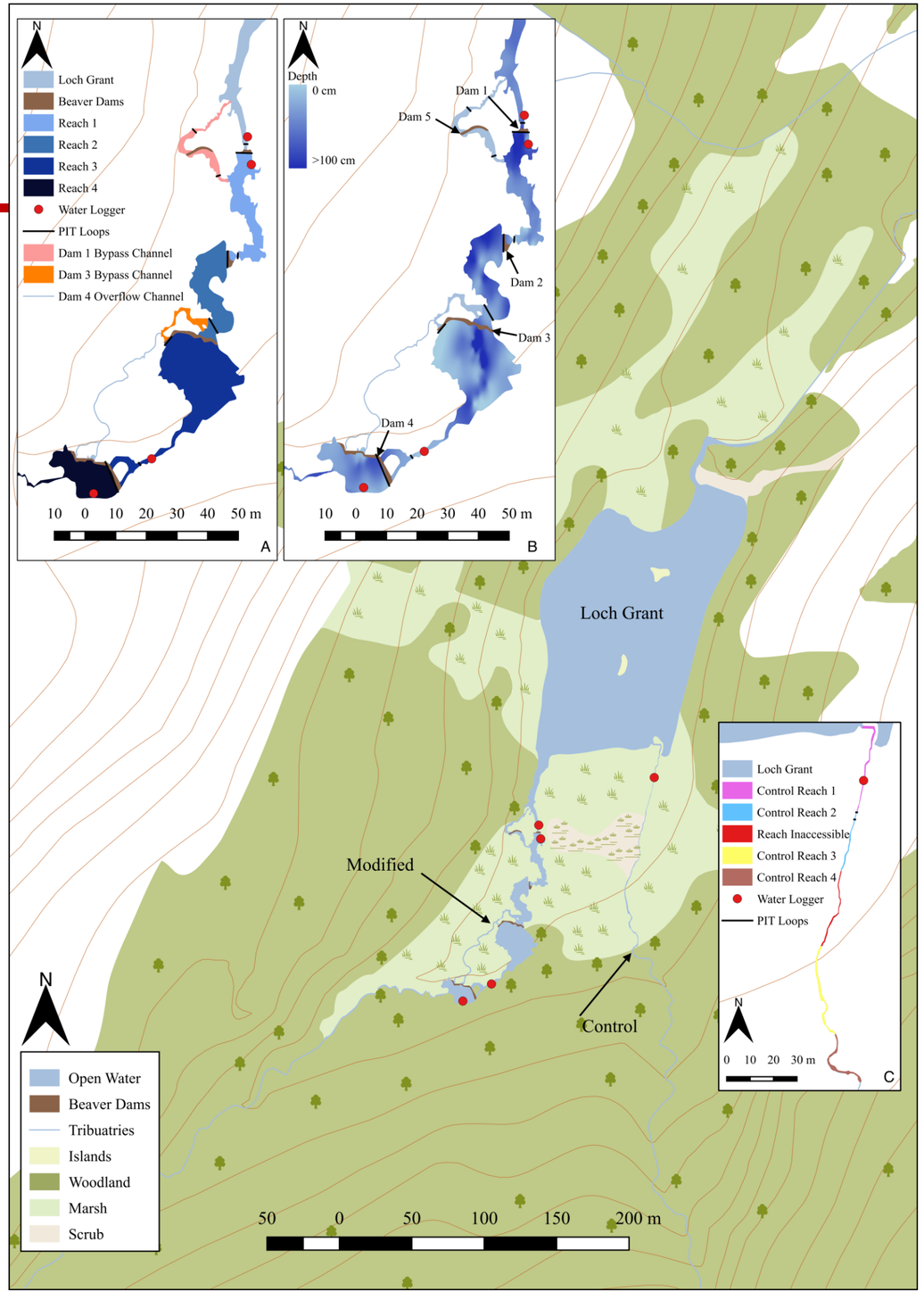
ARTICLE

The response of a brown trout (*Salmo trutta*) population to reintroduced Eurasian beaver (*Castor fiber*) habitat modification

Robert J. Needham, Martin Gaywood, Angus Tree, Nick Sotherton, Dylan Roberts, Colin W. Bean, and Paul S. Kemp

Study Site

- The map illustrates the modified stream post beaver modification and the surrounding landscape and habitat types.
- The inset map illustrates an overview of the site with the loch in the north and control stream to the east of the modified stream.
- The position of beaver dams, passive integrated transponder (PIT) loops (to monitor fish movement), and water data loggers (depth and temperature) are indicated.

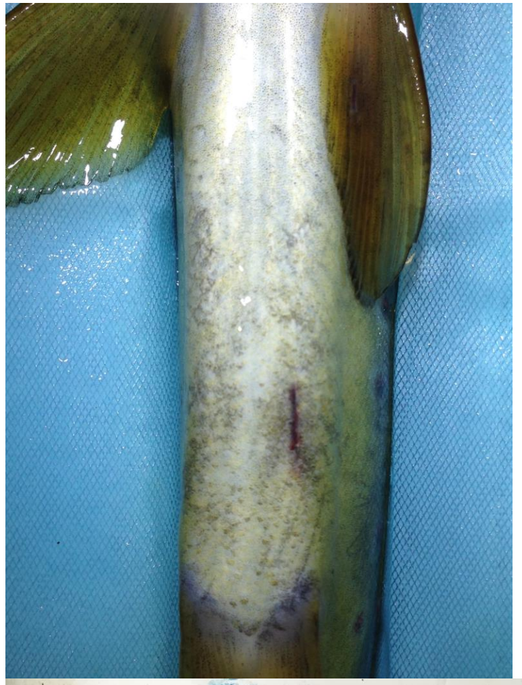


BEAVER TRUST

Dam Dimensions

	Dam Crest Width (m)	Dam Height (m)	Water Depth Below Dam (m)
Dam 1	5.1	0.56	0.47
Dam 2	5.8	0.57	0.26
Dam 3	19.3	0.55	0.13
Dam 4	24	0.97	0.19

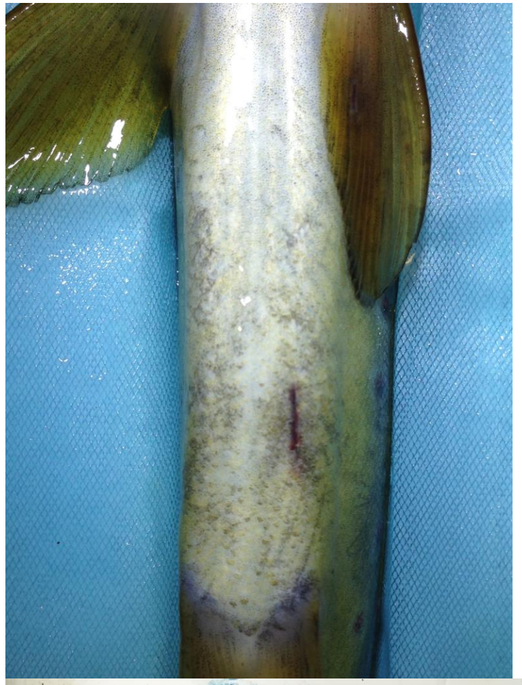
Methodology



Methodology

Survey dates, locations, total *n* of PIT tagged trout, fork length (mm) (mean ± SD) and mass (g) (mean ± SD) of brown trout captured in the modified and control streams and loch between 2014 and 2016.

Year	Season	Location	Total n Tagged	FL (mm) [Mean ± SD]	Mass (g) [Mean ± SD]
2014	Autumn	Modified	83	149.00 ± 36.20	45.00 ± 45.30
		Control	0		
		Loch	36	232.00 ± 45.00	147.00 ± 78.20
2015	Spring	Modified	83	94.40 ± 29.20	13.10 ± 14.80
		Control	22	60.70 ± 6.35	2.80 ± 1.12
		Loch	17	205.00 ± 92.50	143.00 ± 114.00
	Autumn	Modified	103	116.00 ± 42.30	24.40 ± 30.10
		Control	23	174.00 ± 90.70	97.10 ± 91.90
		Loch	51	241.00 ± 63.30	186.00 ± 109.00
2016	Spring	Modified	203	88.20 ± 22.10	10.20 ± 11.50
		Control	9	82.80 ± 13.10	8.42 ± 5.35
		Loch	0		
	Summer	Modified	140	105.00 ± 25.90	16.30 ± 24.40
		Control	10	92.90 ± 21.10	11.50 ± 7.32
		Loch	28	204.00 ± 67.90	116.00 ± 101.00
	Autumn	Modified	57	106.00 ± 23.20	14.20 ± 8.26
		Control	7	71.30 ± 12.90	5.19 ± 1.42
		Loch	28	207.00 ± 64.30	114 ± 87.00
Total			**900**		



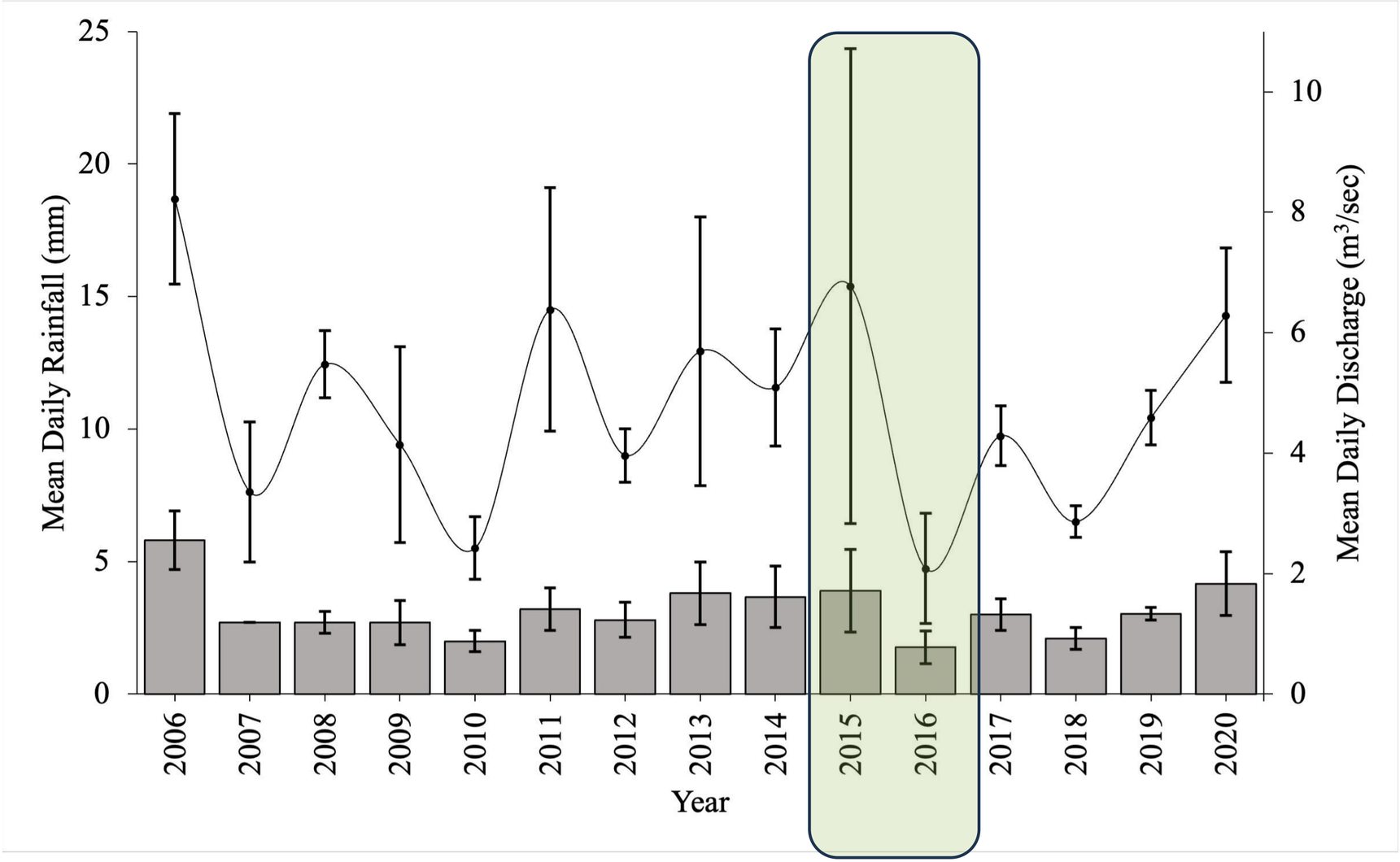
Environmental Factors - Migration

- Water Temperature*
- Flow and Discharge*
- Photoperiod (Day length)
- Water Chemistry and Quality
- Lunar and Tidal Cycles

Low Water Level Flow in August (S. Dugan)

High Water Level Flow in October (S. Dugan)

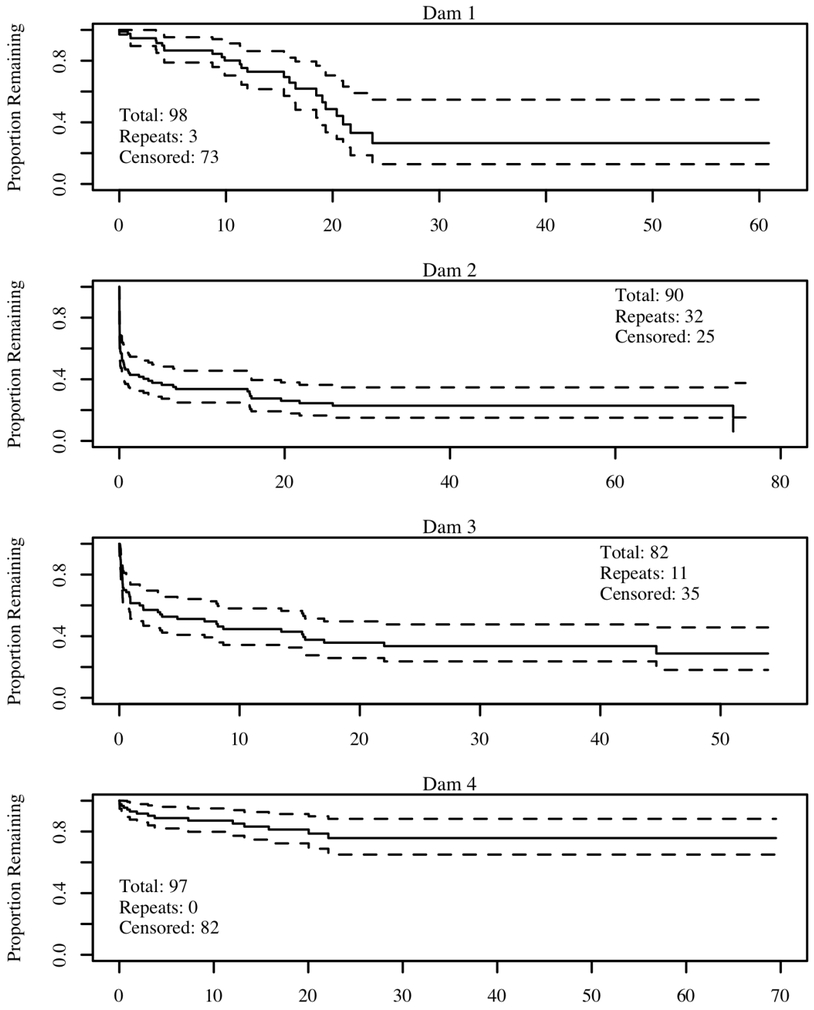
Environmental Factors – Study Period



Coarse resolution environmental data of mean [± SE] daily rainfall obtained from the Lentran Meteorological station and mean [± SE] daily river discharge for the river Enrick at Mill of Tore (NH4504429976, ~ 14km southwest of study site) for the Monitoring Period (October - December inclusive) from 2006 – 2020. Rainfall data is missing for October and November 2007 and December 2010 and 2017.

- **2015 High Flows**
- **2016 Low Flows**

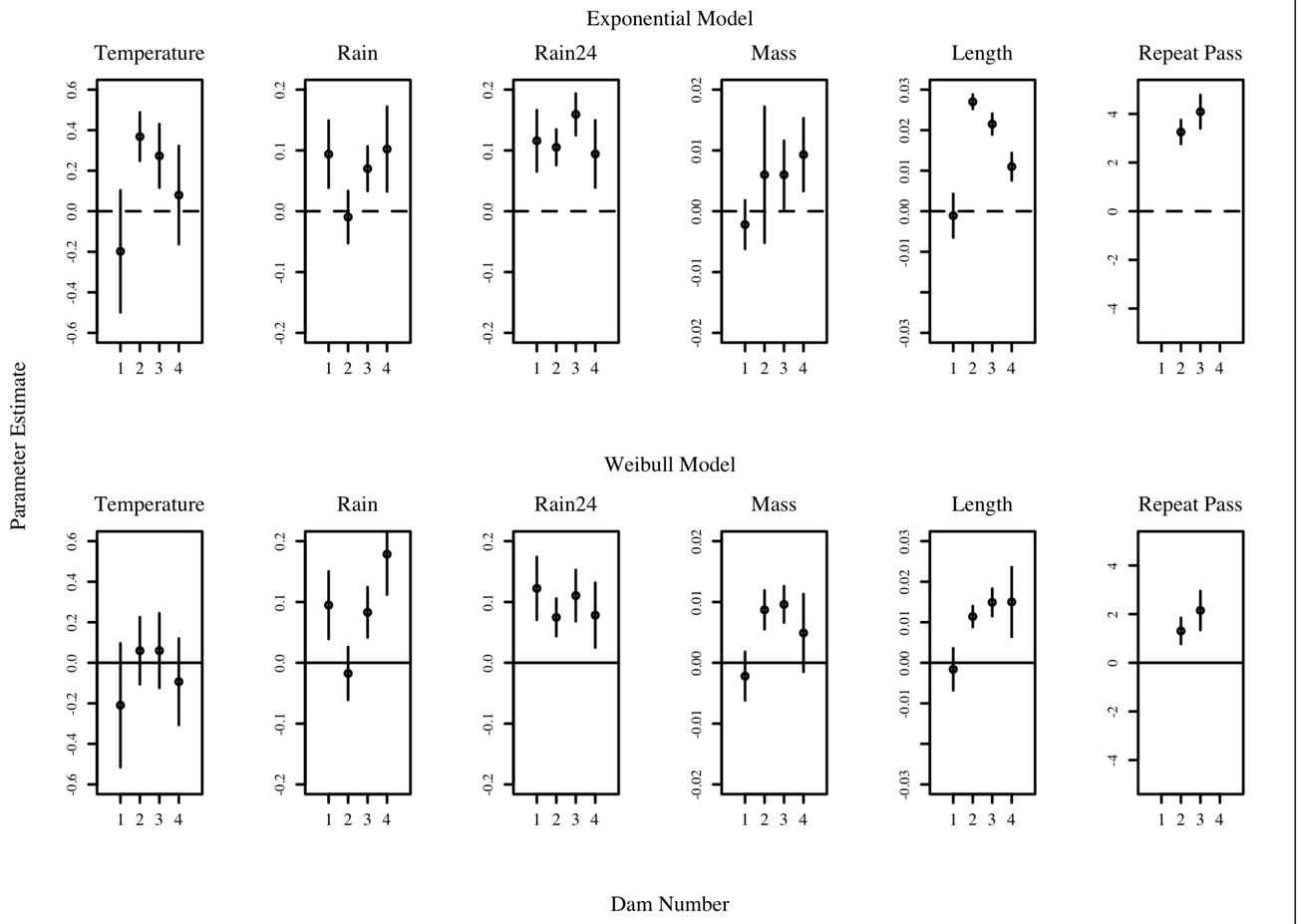
Results – Passage



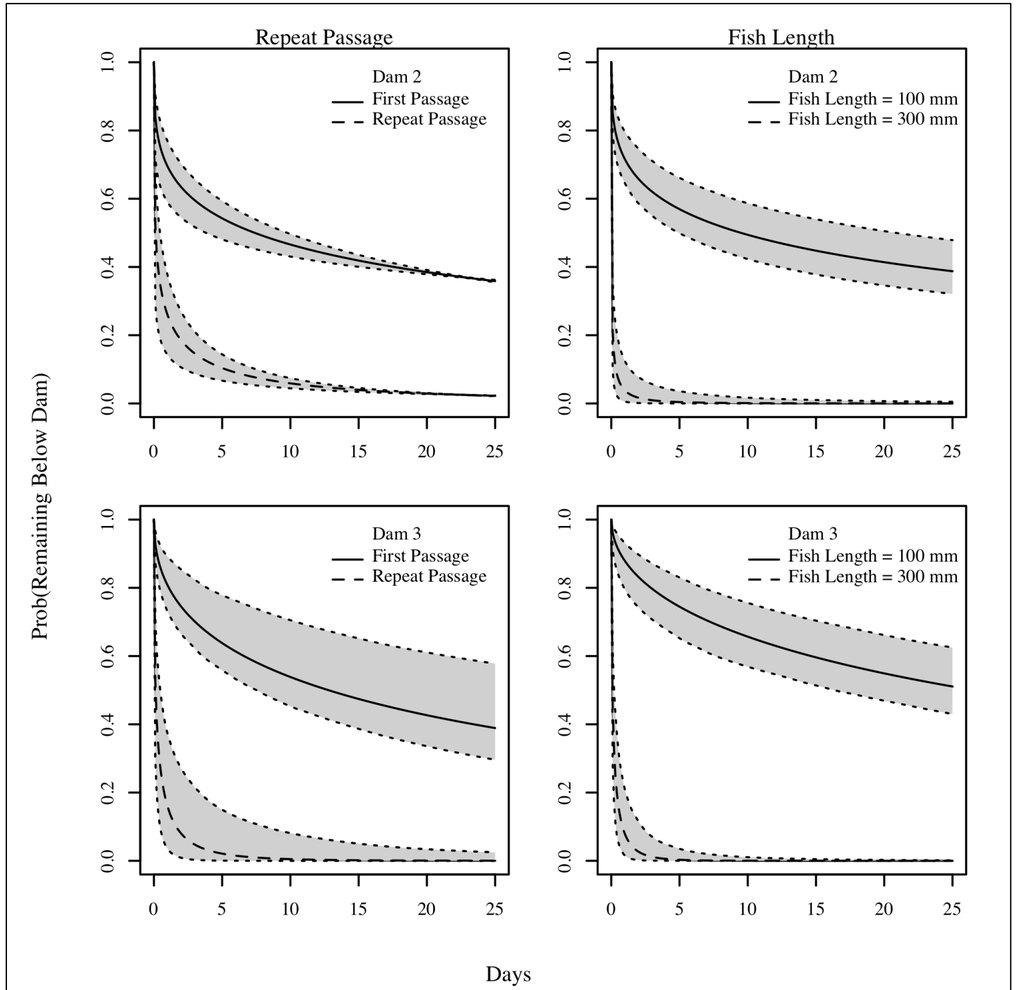
	Dam 1		Dam2		Dam 3		Dam 4	
	2015	2016	2015	2016	2015	2016	2015	2016
Total Dam Passes (including repeat passers)	19	8	61	5	47	0	14	0
Detected Below Dam	59	39	38	22	50	21	72	26
Failed to Pass	40	33	8	17	14	21	58	26
Detected Upstream of Dam	6	0	30	5	NA	NA	14	0
Passed Side Channel	13	6	NA	NA	36	0	NA	NA
Total Passed	19	6	30	5	36	0	14	0
Passage Efficiency (%)	32.2	15.4	79.0	22.7	72.0	0	19.4	0
% Resident Failed Passage	NA	NA	100	76.5	84.6	85.7	43.9	76.00

Kaplan Meier plots for all four dams with data from 2015 and 2016 combined due to small dataset from 2016. The solid lines represent estimated proportion remaining in front of the dam, and the dashed lines represent 95% confidence intervals. In the legend, total refers to total number of tagged fish detected, repeats are the number of repeat passers.

Results – Passage

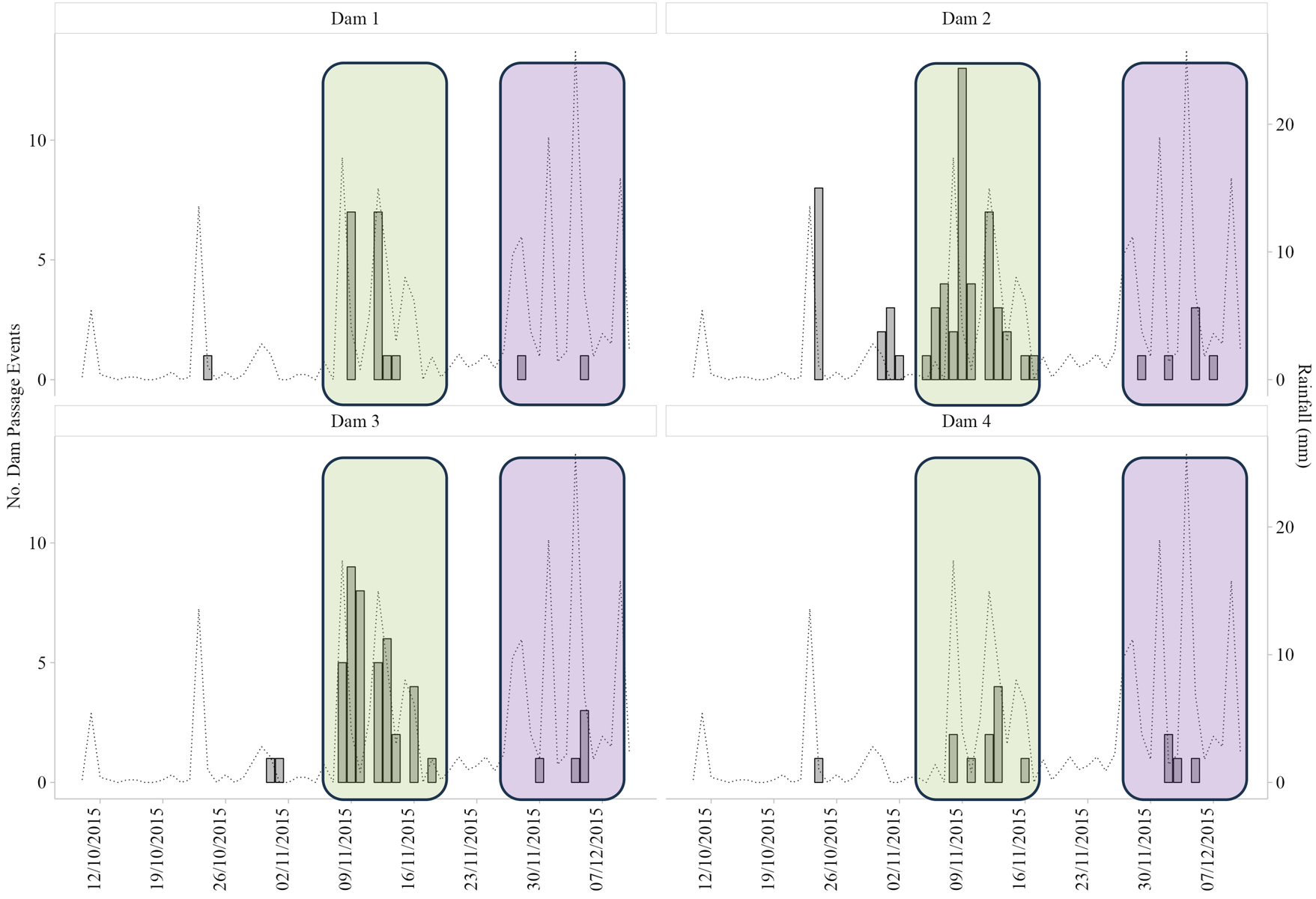


Covariate parameter estimates (b coefficients) for water temperature, rainfall, rainfall with 24 hr lag applied, fish mass, fish length and repeat passers. Open points represent parameter estimates and vertical lines represent ± 2*(SE). If the vertical line does not intersect with zero, that provides evidence that the effect of the covariate is significant.



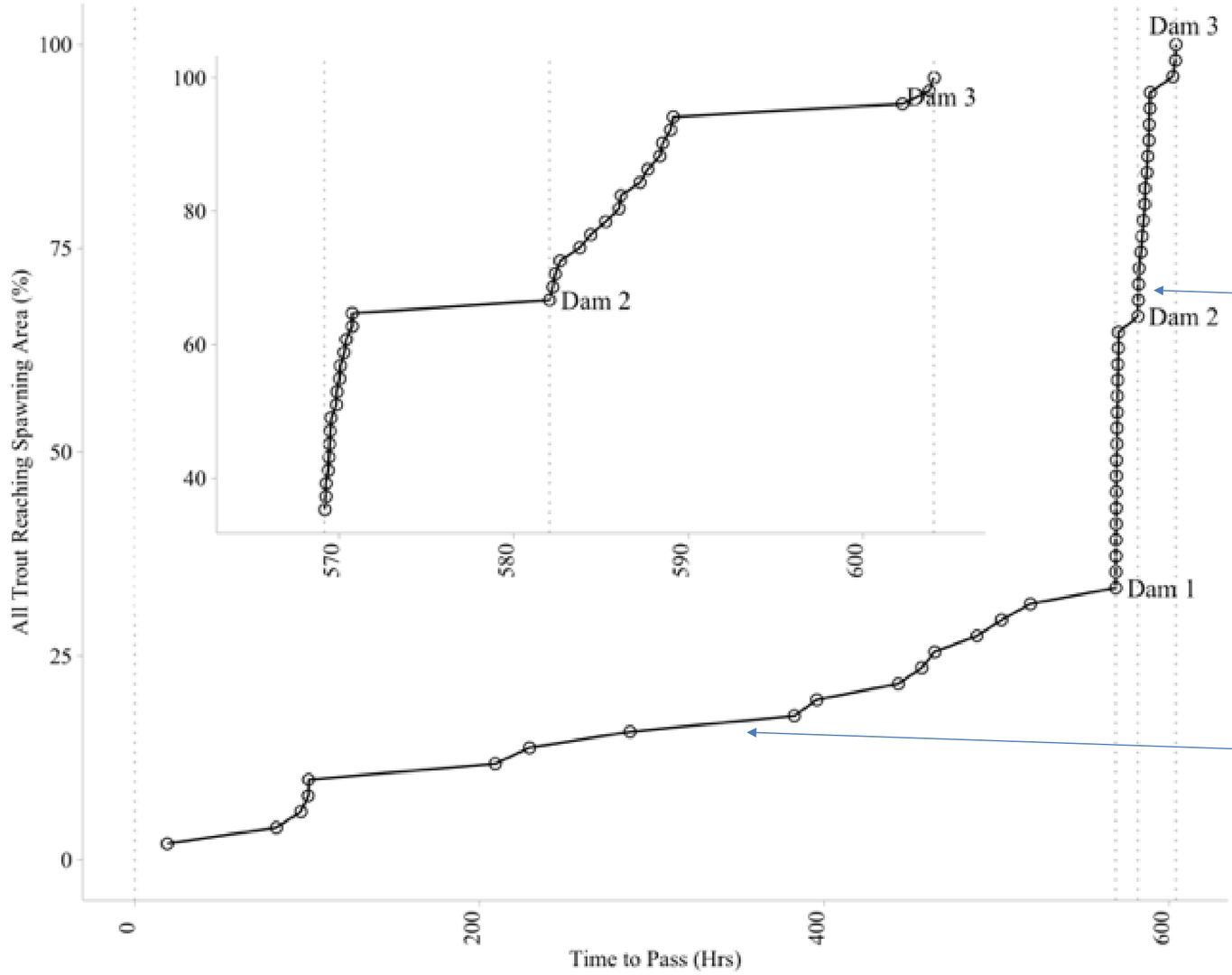
Passage prediction plots for: (1) fish that passed a dam for their first time and for fish that had already passed a dam, and (2) fish with fork length of 100 mm vs fish with fork lengths of 300 mm. The solid and dashed lines represent estimated proportion remaining, and the grey areas represent 95% prediction intervals.

Results – Passage – Rain24



- Passage events correlate with rainfall events
- Evidence of main peak migration period
- Evidence of a secondary migration run follow a gap in rainfall

Results – Migratory Delay



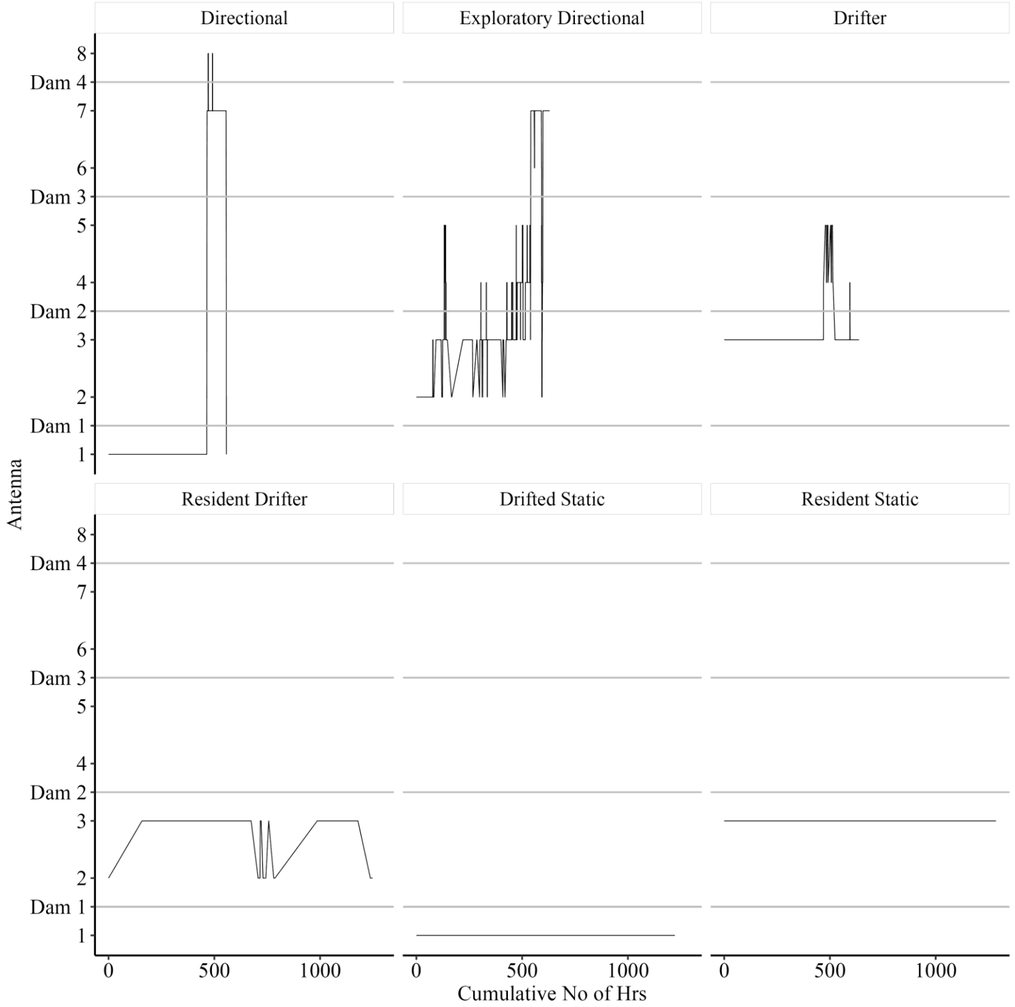
Suitable environmental conditions facilitate passage

Exploratory behaviour

Loch Migrating Individuals (n = 17)

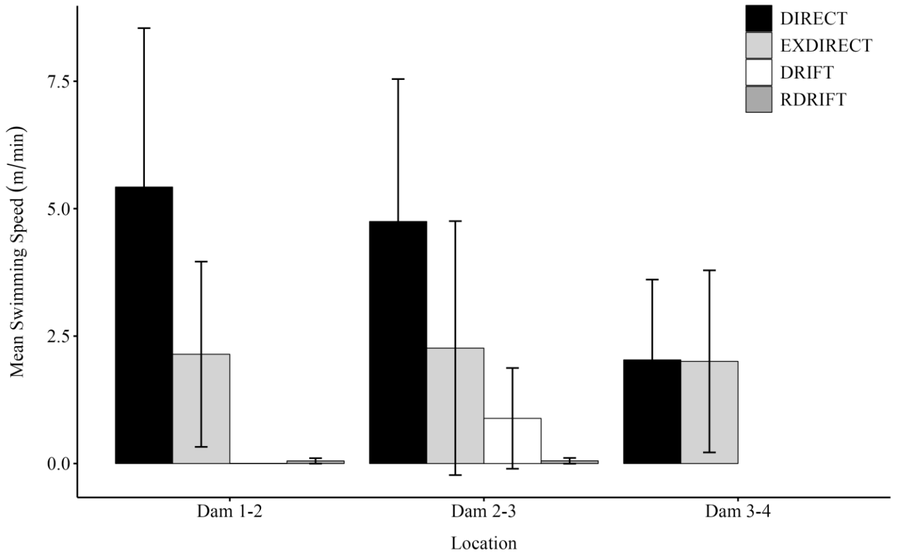
- 570 hrs to pass Dam 1
- 12 hrs to pass Dam 2
- 21 hrs to pass Dam 3

Results – Motivation

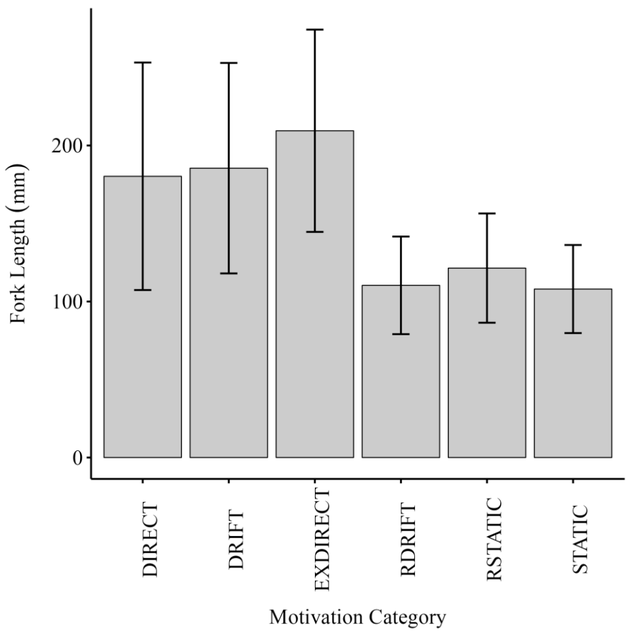


Movement patterns of six individual brown trout. Movement patterns of six individual brown trout during the 2015 Monitoring Period demonstrating the different behaviours observed for individuals in the modified stream and how they were grouped into one of six categories: (1) Directional, (2) Exploratory Directional, (3) Drifter, (4) Resident Drifter, (5) Static and (6) Resident Static. Location of beaver dams are illustrated in relation to antenna locations with zero representing the Loch.

- Motivation a key factor in passage success
- Age and size being a determining factor



Mean swimming speed (m min^{-1}) between Dams 1 - 2, 2 - 3 and 3 - 4 for each movement category including 'Directional' [black bars], 'Exploratory Directional' [light grey bars], 'Drifter' [white bars] and 'Resident Drifter' [dark grey bars]. Error bars denote standard deviation.



Mean [± SD] fork length of trout captured from the Loch, Modified stream and the control stream, for each movement category. Error bars denote standard deviation.

Results – Population Resilience?

- 166 individuals detected in beaver modified system in 2015
- 166 individuals detected in beaver modified system in 2016

- 53 individuals detected in control system in 2015
- 23 individuals detected in control system in 2016

- 80 Individuals reached available spawning habitat in beaver modified habitat in 2015
- 39 Individuals reached available spawning habitat in beaver modified habitat in 2016

Summary

- Positives & Negatives
- Site & species specific
- Environmental factors variables
- High flows facilitate passage
- Floodplain connectivity creates bypass channels
- Individual motivation
- Fish size
- Repeat passage
- **COMPLEX!!**

THANK YOU

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Any questions?

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