Assessing the impact of river barriers on successful seaward migration of Atlantic salmon, *Salmo salar* along the River Derwent, Cumbria

By Amy Green
2508110G@student.gla.ac.uk

INTRODUCTION

Atlantic salmon is a species of cultural, ecological and economic importance throughout its range[1], but over the last few decades numbers have been in significant decline. The Derwent is a prime example of a declining UK stock, with a 77% reduction in rod catch across a 10-year data collection period.

Atlantic salmon are an anadromous species, spending their lifecycle in both freshwater and marine environments[1]. The highest rates of mortality are thought to occur during the smolt stage since they are undergoing physiological stress due to morphological changes that allow them to adapt to the marine environment and initiate downstream migratory behaviours[1,3].

This species is found to be vulnerable under waterway fragmentation as migration between habitats is essential for completing the life cycle. Installation of hydropower facilities, dams, weirs and other anthropogenic barriers can elevate mortality rates in Atlantic salmon populations and interfere with both downstream and upstream migration passage for anadromous species[2]. Therefore, it is important to explore different management strategies for examples Trap and Transport around barriers to enable successful migration.

STUDY QUESTIONS

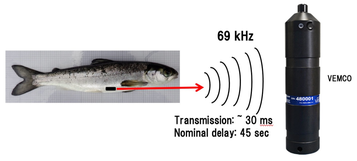
1) What are the habitat specific costs of migration?

2) Do low-head weir obstruction increase the cost of migration? Or influence choice in migration direction?

METHODS

Acoustic Telemetry

Acoustic telemetry uses sound waves that move through water. A tag is placed in a fish, which when passing a receiver gives off a signal, which the receiver will pick up.



Fish capture:

2020: 29 receivers deployed
100 Atlantic salmon tagged

2021: 44 receivers deployed
150 Atlantic salmon
15 sea trout tagged

93 Atlantic salmon/ 15 sea trout tagged
Release 1 (released at St Johns Beck)

57 Atlantic salmon tagged
Release 2 (transported group)

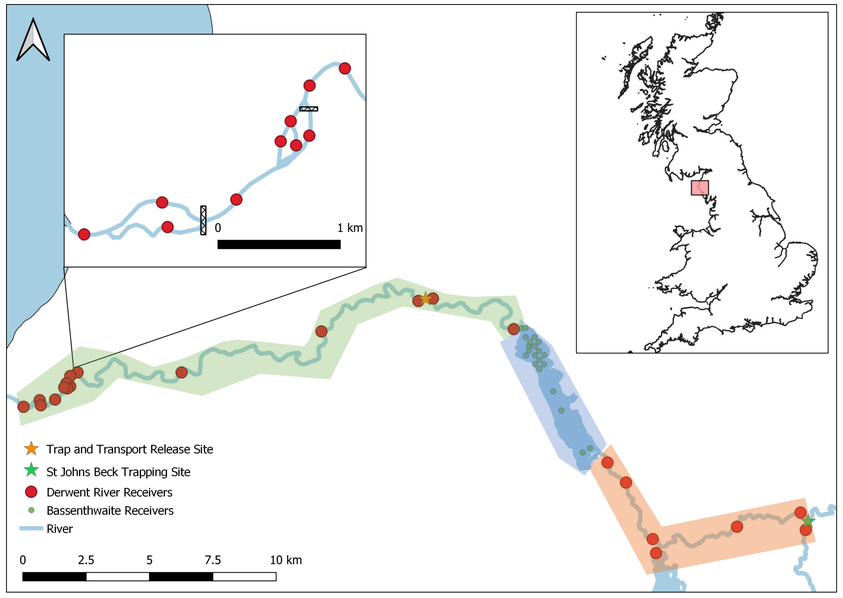


Figure 2. Map of 2021 study design. All tagging conducted at St Johns Beck. Section 1 highlighted in orange, Section 2 highlighted in blue, Section 3 highlighted in Green. Release 1: St Johns Beck, Release 2: Trap and Transport to Isel Village.

RESULTS

1) What are the habitat specific costs of migration?

Table 1. Displaying each section with survival (%) and mortality %/km for 2020 and 2021 field season.

Section	Distance (km)	Survival 2020 (n=100)	Survival 2021 (n=108, Release 1) (n=57, Release 2)	Mortality %/km 2020	Mortality %/km 2021
1	12.52	32 (32%)	71 (65%)	5.43	2.74
2	7.15	15 (15%)	49 (69%)	7.43	4.33
3	29.45	8 (8%)	11 (10%)	1.58	2.63 (Release 1)
	23.77		21 (36%)		2.65 (Release 2)

CONCLUSION

What are the habitat specific costs of migration?

- Overall, very high freshwater mortality in both years.
- Location of highest mortality varied between years (likely related to rainfall which was very low in 2020 and very high in 2021).
- Mortality was highest in a lake habitat.

- **Do low-head weir obstruction increase the cost of migration? Or influence choice in migration direction?**
- YES! 46.67% tag loss detected between the Yearl (D41) and at the harbour (D44) receiver (Figure 4).
- Alternative routes were used. At Coops weir 6 fish took alternative routes and across 2020 and 2021 a total of 6 individuals took the alternative route (D43) around the Yearl, which could indicate barrier influence on migration pathway choice.

2) Do low-head weir obstruction increase the cost of migration? Or influence choice in migration direction?

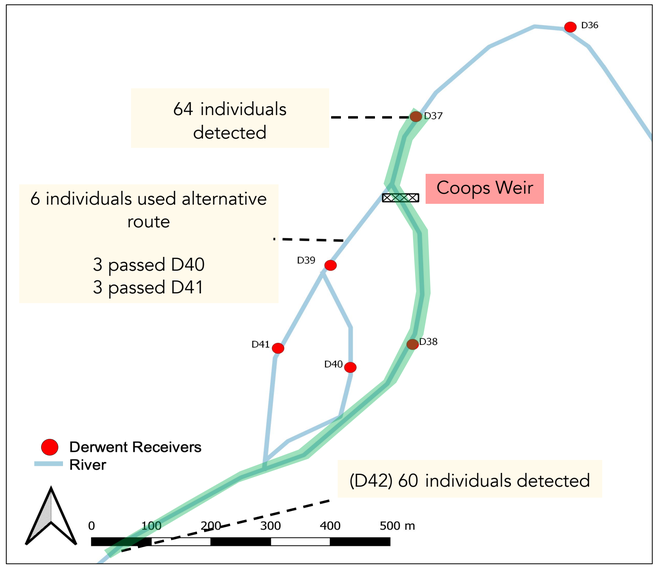


Figure 3. Coops Weir and alternative routes. Main route is highlighted in green. Main route measured 1.22km.

Overall mortality rate through Coops weir segment was 5.12%/km across a 1.22km distance (Release 1: 2.93%/km, Release 2: 6.83%/km), which was slightly higher than the rest of the migration route (cf. Table 1).

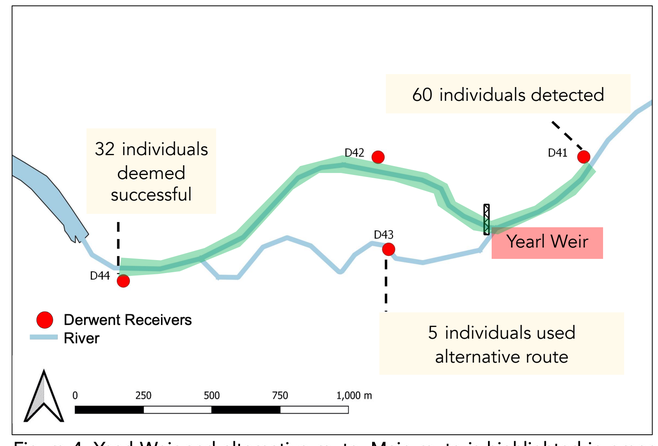


Figure 4. Yearl Weir and alternative route. Main route is highlighted in green. Main route measured 1.44km.

Additionally, across the Yearl weir segment (1.44 km) overall mortality rate for both groups was 32.41%/km (Release 1: 41.15%/km, Release 2: 25.25%/km); this was extremely high in comparison with rest of the migration route and Section 3 overall.

References

[1]Thorstad, E.B., Whoriskey, F., Uglem, I., Moore, A., Rikardsen, A.H., Finstad, B., 2012. A critical life stage of the Atlantic salmon *Salmo salar*: Behaviour and survival during the smolt and initial post-smolt migration. *Journal of Fish Biology* 81, 500–542. https://doi.org/10.1111/j.1095-8649.2012.03370.x
[2]Hill, N.L., Trueman, J.R., Prévost, A.D., Fraser, D.J., Ardren, W.R., Grant, J.W.A., 2019. Effect of dam removal on habitat use by spawning Atlantic salmon. *Journal of Great Lakes Research* 45, 394–399. https://doi.org/10.1016/j.jglr.2019.01.002
[3]Metcalfe, N.B., Huntingford, F.A., Graham, W.D., Thorpe, J.E., 1989. Early social status and the development of life-history strategies in Atlantic salmon. *Proceedings - Royal Society of London*, Series B 236, 7–19. https://doi.org/10.1098/rspb.1989.0009

Acknowledgements
I would like to thank the Environment Agency DEFRA, Natural England, United Utilities, The Derwent Owners Association and Bowland Game : Isel Fishings for funding this project. I would also like to thank my supervisors Colin Adams and Hannele Honkanen at the University of Glasgow for their continued support.