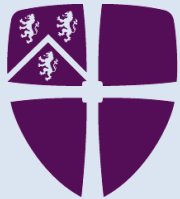


ADULT SALMONID SPAWNING MIGRATION

*Inter specific differences and similarities in
the River Tweed, UK*

Niall Gauld – Durham University



Durham
University



THE Tweed
FOUNDATION

Spawning migration

- ⦿ Like many animals salmonids return to their natal area to spawn.
- ⦿ Salmon enter the river almost all year round
 - Early migrants termed spring salmon
 - Largest migrations occur in the late summer – autumn
- ⦿ Sea trout peak in summer with migration tailing off in late autumn
- ⦿ Timing of river entry important, early migrants migrate further into catchment

Spawning migration *contd*

- ⊙ Initial river entry and freshwater migration is a period of sustained movement
 - both flow and time of day do not affect behaviour
- ⊙ After the fish first stops migration is then observed to be a stepwise upstream process
 - Movements largely occur during periods of darkness

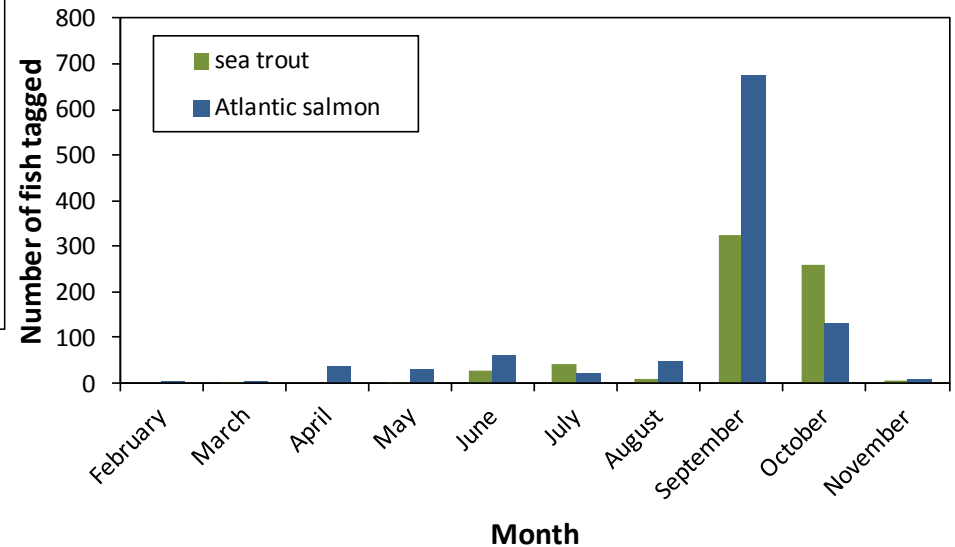
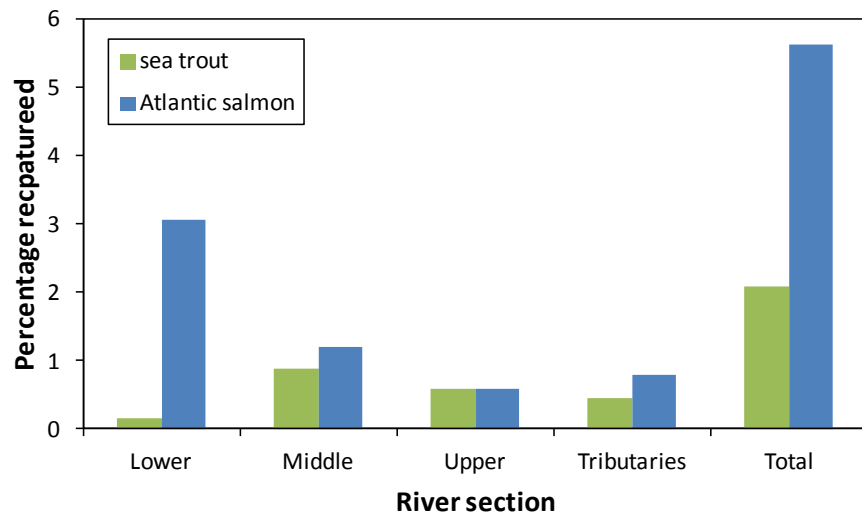
Tracking salmonids in the Tweed

- ⦿ Why track salmonids?
- ⦿ How, when and where?
- ⦿ Results
- ⦿ Outcomes



Why track adult sea trout?

- Sea trout recapture rates are substantially lower in the lower river compared to salmon
- Total sea trout recapture rates are much lower across entire catchment
 - Difference in angling pressure, may explain some of this
 - 34% more salmon tagged than sea trout – sea trout less abundant?
 - Can we adequately explain any variation in behaviour between species?



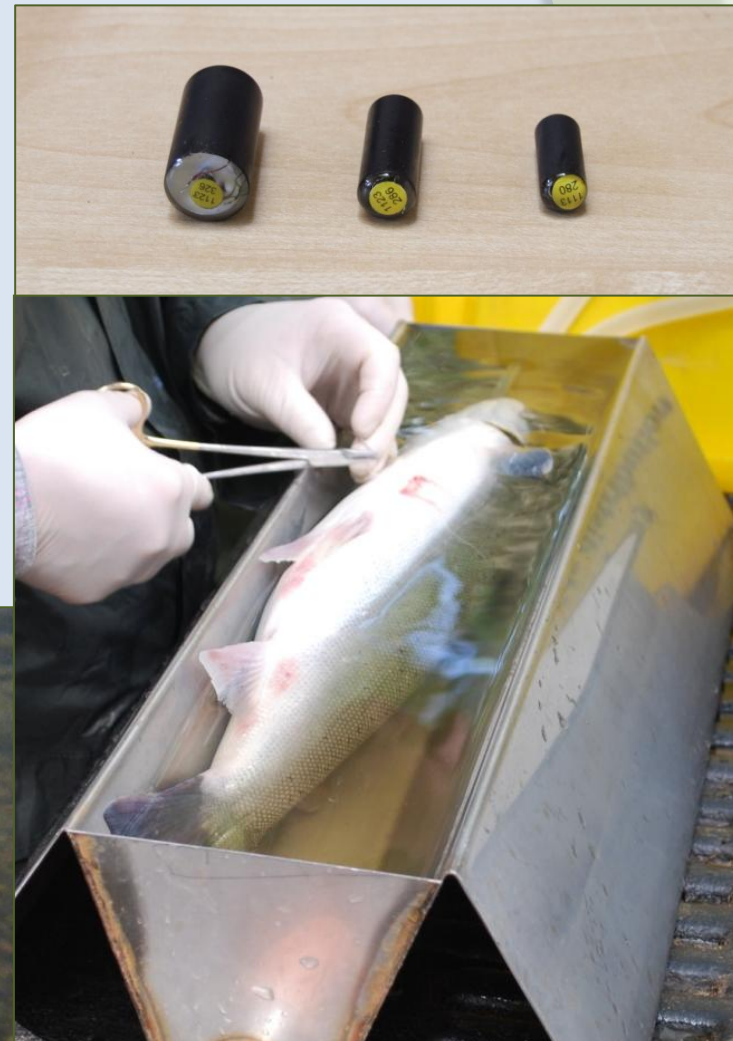
How were the fish caught?

- ◉ Fish netted out of the lower Tweed at Paxton house
- ◉ Fish were netted using net and cobble technique
- ◉ Fish were then tagged with acoustic transmitters and released on site at Paxton



Tagging adult sea trout

- Fish anaesthetised prior to tagging
- Sea trout surgically tagged with 7.4; 9 or 16 mm acoustic tags
- Tag inserted into the body cavity through the ventral surface, anterior to pelvic girdle
- Incisions closed with absorbable sutures
- Fish left to recover and released once they had regained equilibrium and responded to external stimuli
- Carried out under Home Office license

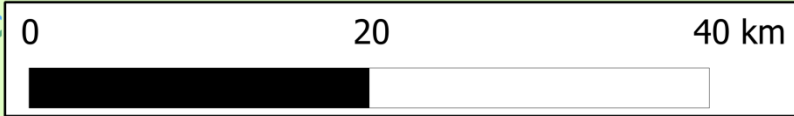
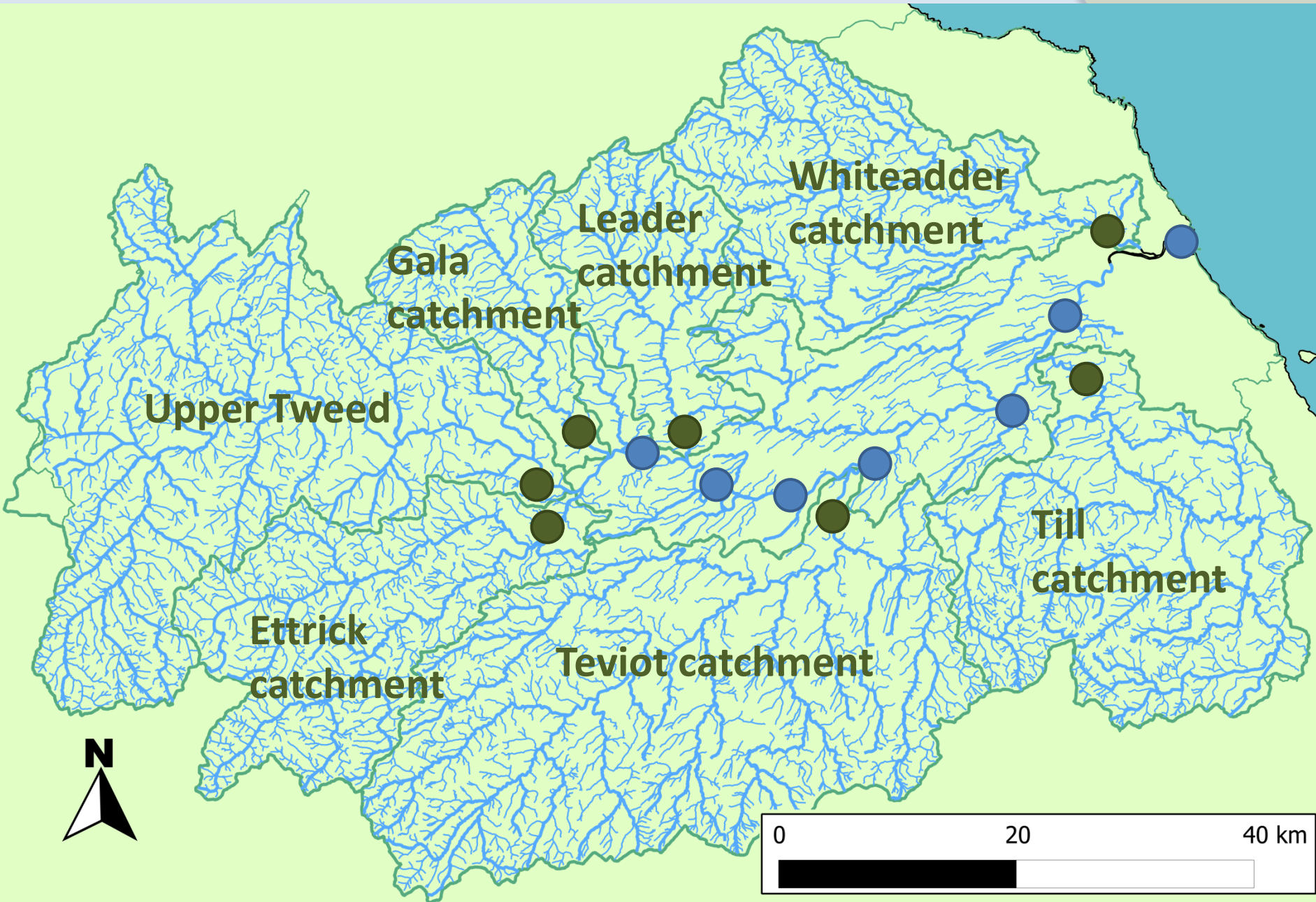


Tagging adult salmon

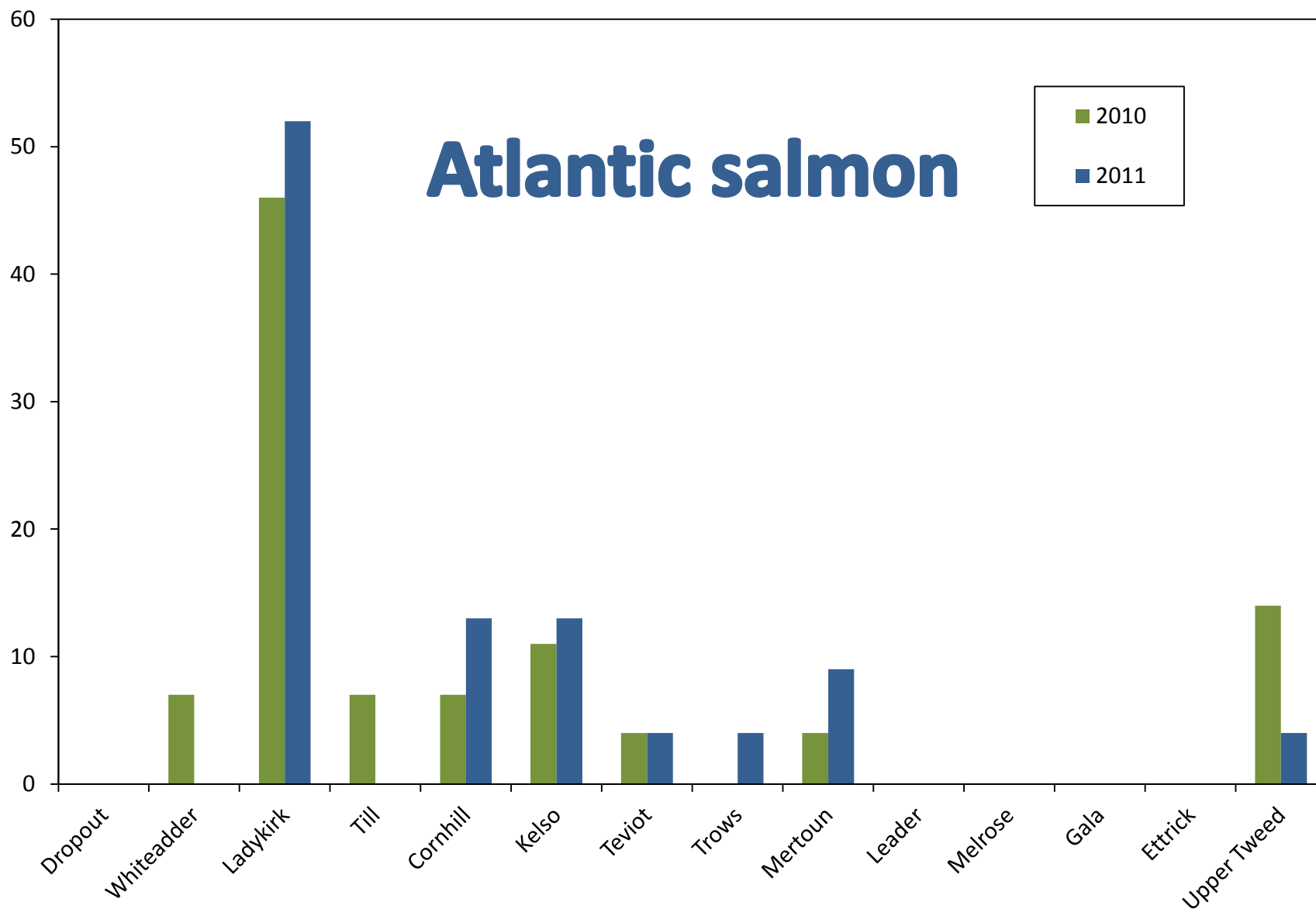
- ◉ Fish anaesthetised prior to tagging
- ◉ Fish were gastric tagged by inserting tag into the stomach via the oesophagus
- ◉ Much less invasive procedure than surgical tagging
- ◉ Carried out under Home Office husbandry exclusion clause
- ◉ Salmon do not feed during freshwater migration, stomach shrinks and partially atrophies
- ◉ Tag regurgitation rate is generally low (14.8%)^[1]



[1](Smith *et al.* 1998)



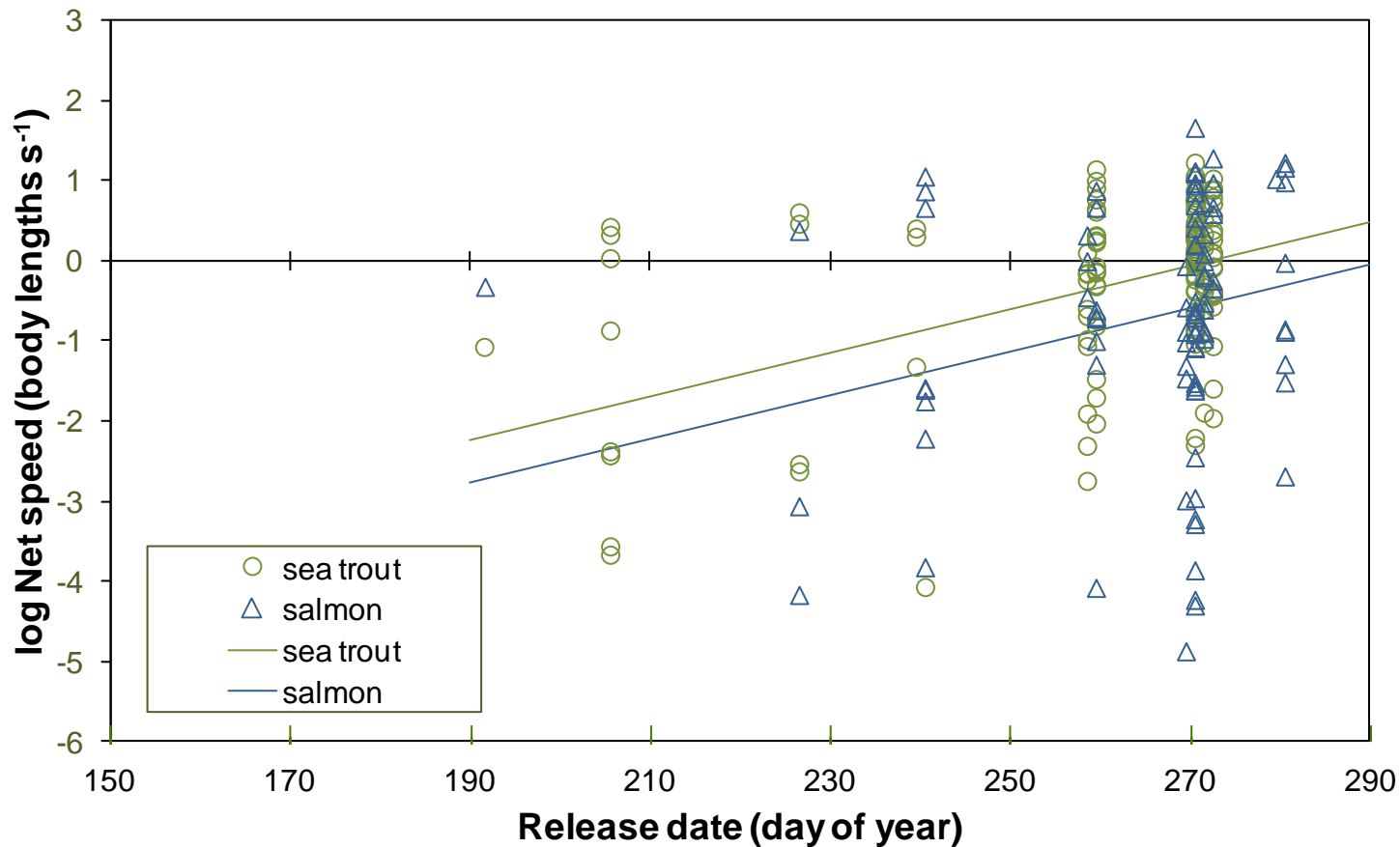
Atlantic salmon



Statistical modeling

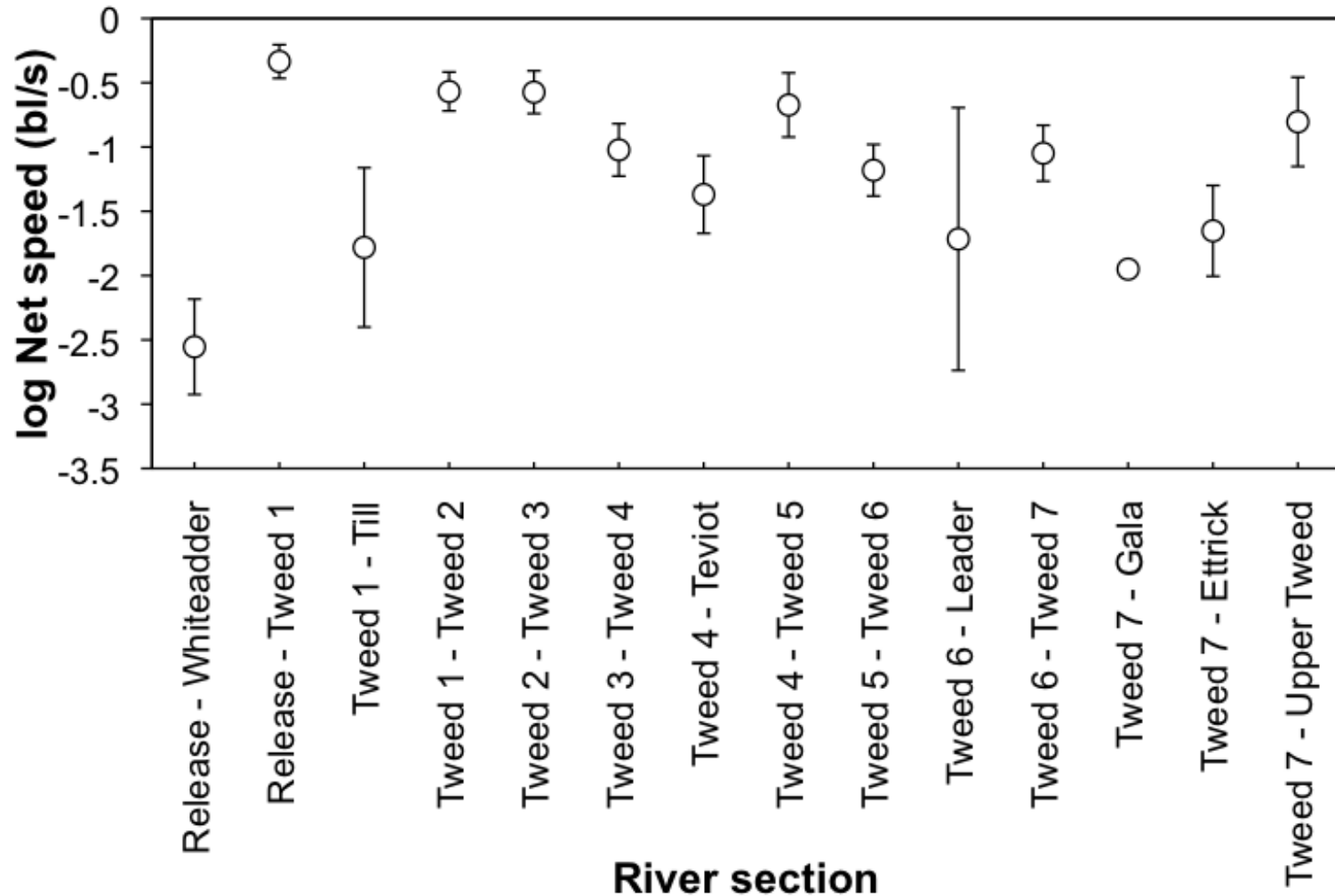
- ⦿ General Linear Mixed-effect Models (GLMMs) used with fish ID as a random effect
- ⦿ Variables such as: species, year, river flow, release date, flow and year interaction and flow and species interaction were used as variables.
- ⦿ Akaike Information Criterion (AIC) was used to select candidate models after stepwise deletion
- ⦿ Models within 6 AIC values of the lowest scoring model were retained ^[2]
- ⦿ Out of the remaining models the model with the least variables was selected as the final model

Adult speeds – lower Tweed

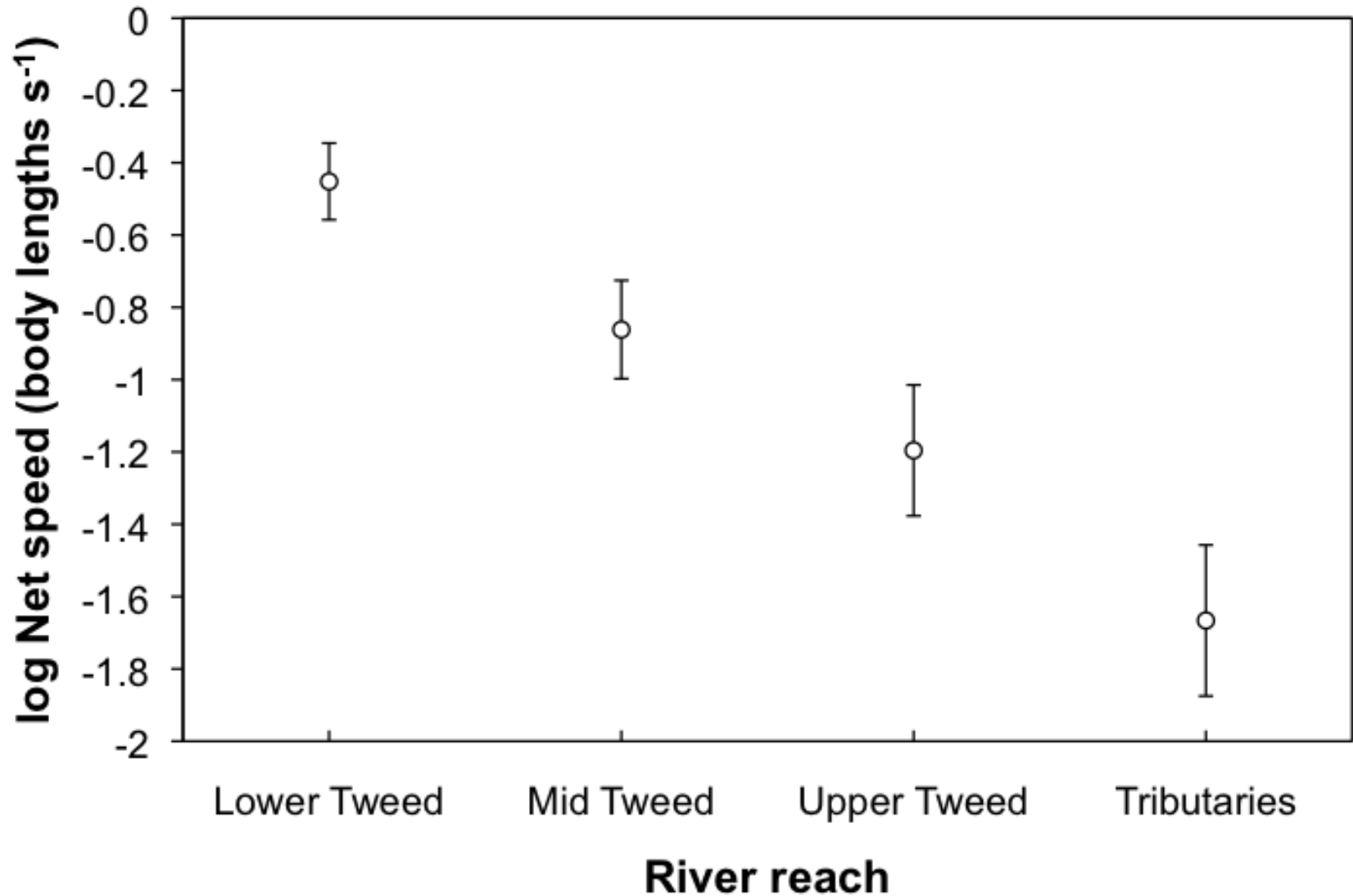


(General Linear Mixed effects Model: $n=223$, $df=5$, $t=-6.041$, $p<0.0001$)

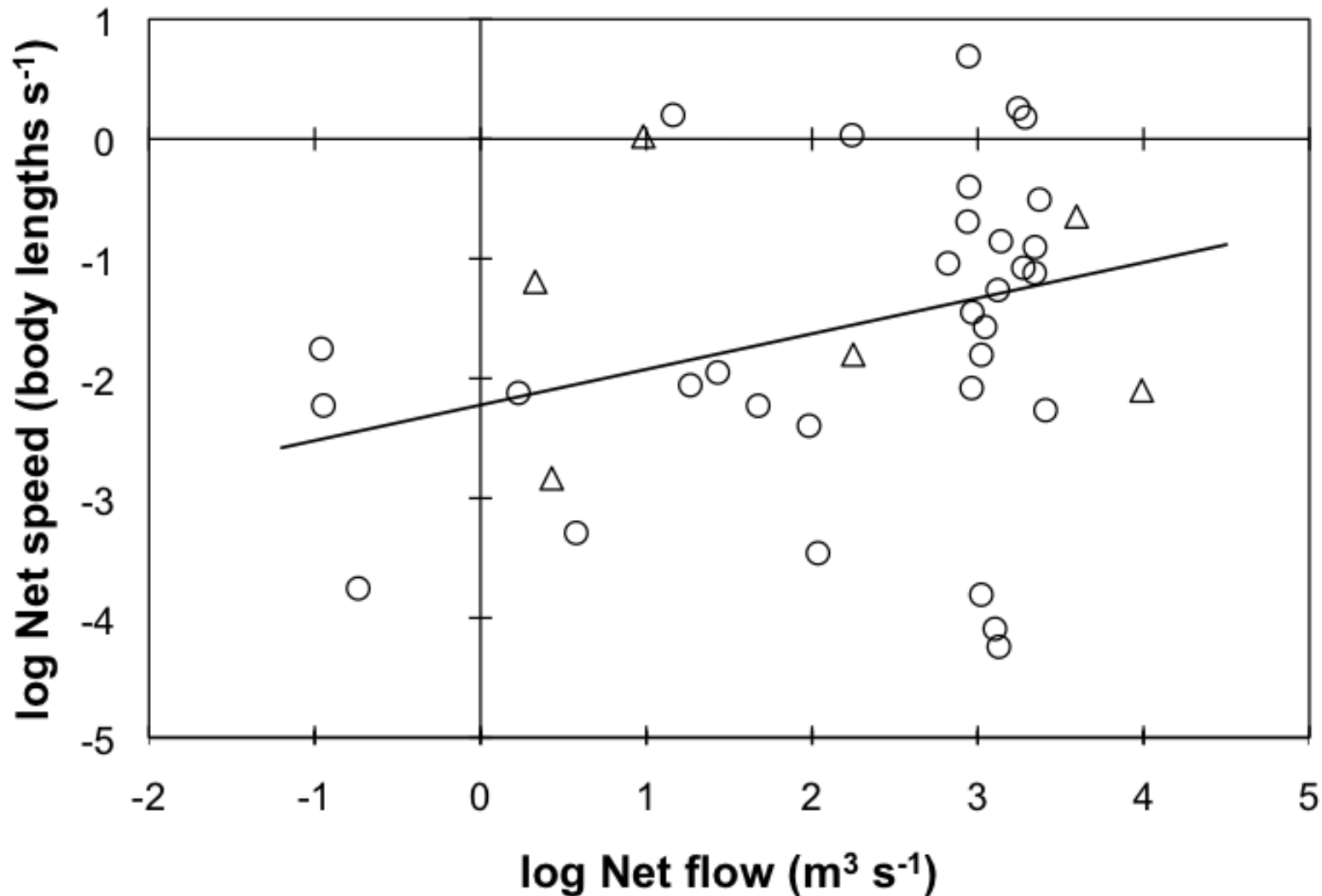
Adult speeds – Tweed Catchment



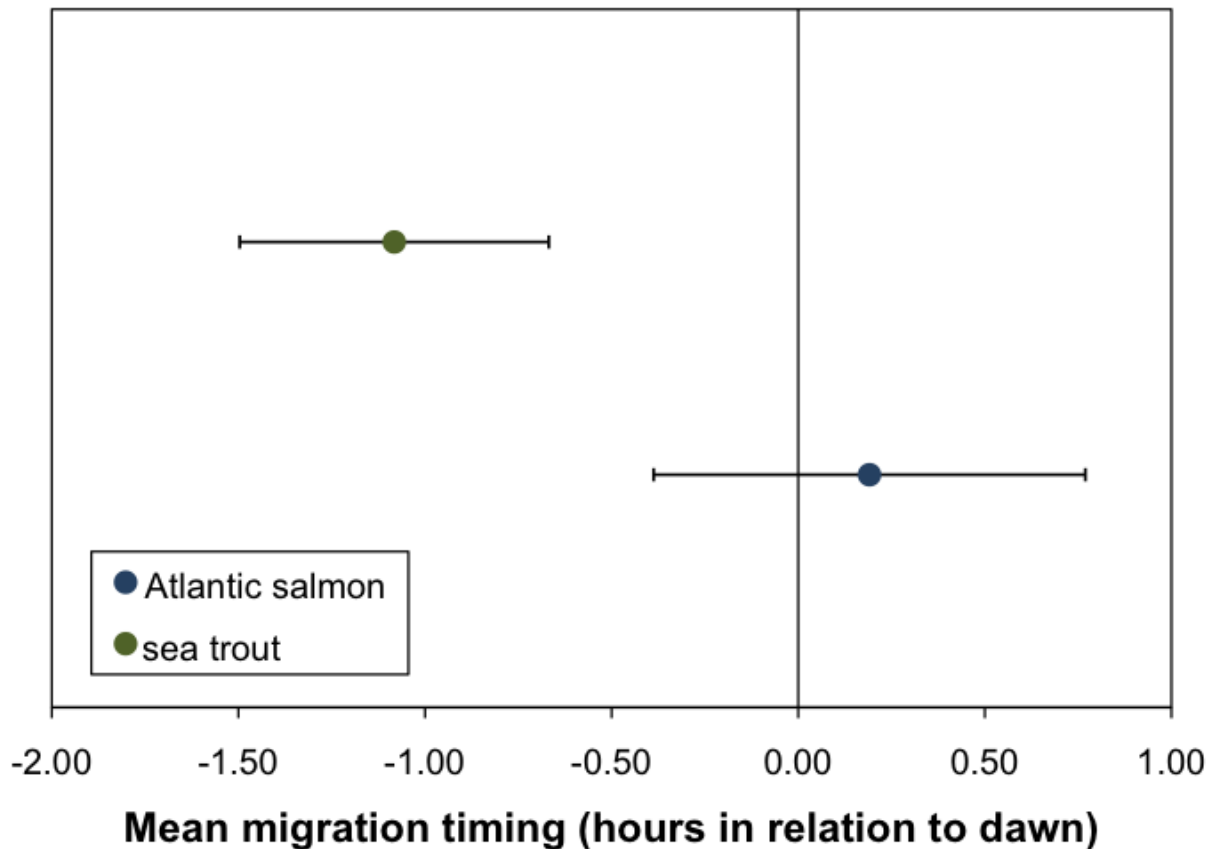
Adult speeds – Tweed Catchment



Migration in tributaries



Diel migration



- ⊙ No strong evidence of variation in diel migration between species.
- ⊙ However, most migration was undertaken during night (Pearson's Chi-squared : $n=392$, $\chi^2=9.8$, $df=1$, $p<0.005$)

Kelts

- ⦿ In 2011 the logging equipment was kept in the river until spring to track kelts
- ⦿ 25% of the adults tagged in 2011 were shown to leave the river as kelts
- ⦿ Kelt movements were recorded between the 19th of October and 29th of January
- ⦿ 50% kelt sex ratio based on sexing during tagging

Conclusions

- ⦿ During the two years adults were found to use every tributary of the Tweed
- ⦿ The River Teviot was the highest used tributary in both years
- ⦿ Early migrants of both sea trout and salmon migrate at a slower rate than later migrants
- ⦿ Sea trout move at a higher rate than salmon in the lower half of the Tweed
- ⦿ Migration rate tends to slow as fish progress into the river system
- ⦿ Flow conditions in the tributaries are positively related to flow rate but position within the river rather than flow rate appears to govern migration speed in the mainstem
- ⦿ No apparent difference in migration rate between species beyond movements in the lower river.

Limitations and further work

- ⊙ Try to understand why the Teviot is highly used
 - Larger population than other tribes?
 - Consequence of having a larger catchment?
 - Possibility of running a smolt trap on the Teviot
- ⊙ Attempt to expand the range of tagging dates
 - most tagging restricted to late summer and autumn.
 - Possibility of missing discrete runs from other population components such as River Till “whitling” and spring salmon
 - However, costly and restricted by external constraints

Limitations and further work *contd*

- ⦿ Surgically tag both sea trout and salmon in future studies
 - Greater parity between each species handling and stress
 - Removes possibility of tag regurgitation
 - Limited by trained manpower, reliant on Home Office Personal License holder
- ⦿ Possibility of using sensor tags
 - Study ECG or EMG of sea trout and salmon to examine swimming effort – more complicated surgical procedure
 - Accelerometer or depth tags can be used to look at finer scale variations in movement beyond net speed measurements
 - Much more costly than regular acoustic transmitters

Thanks

- Dr Martyn Lucas & Dr Ronald Campbell
- Tweed Foundation staff
- LNS partners
- River Tweed Commission Bailiffs
- River Tweed Boatmen
- River Tweed landowners
- Members of lab 16 at Durham

