Using eDNA to understand the comparative effects of beaver activity and environmental factors on the distribution of migratory fish

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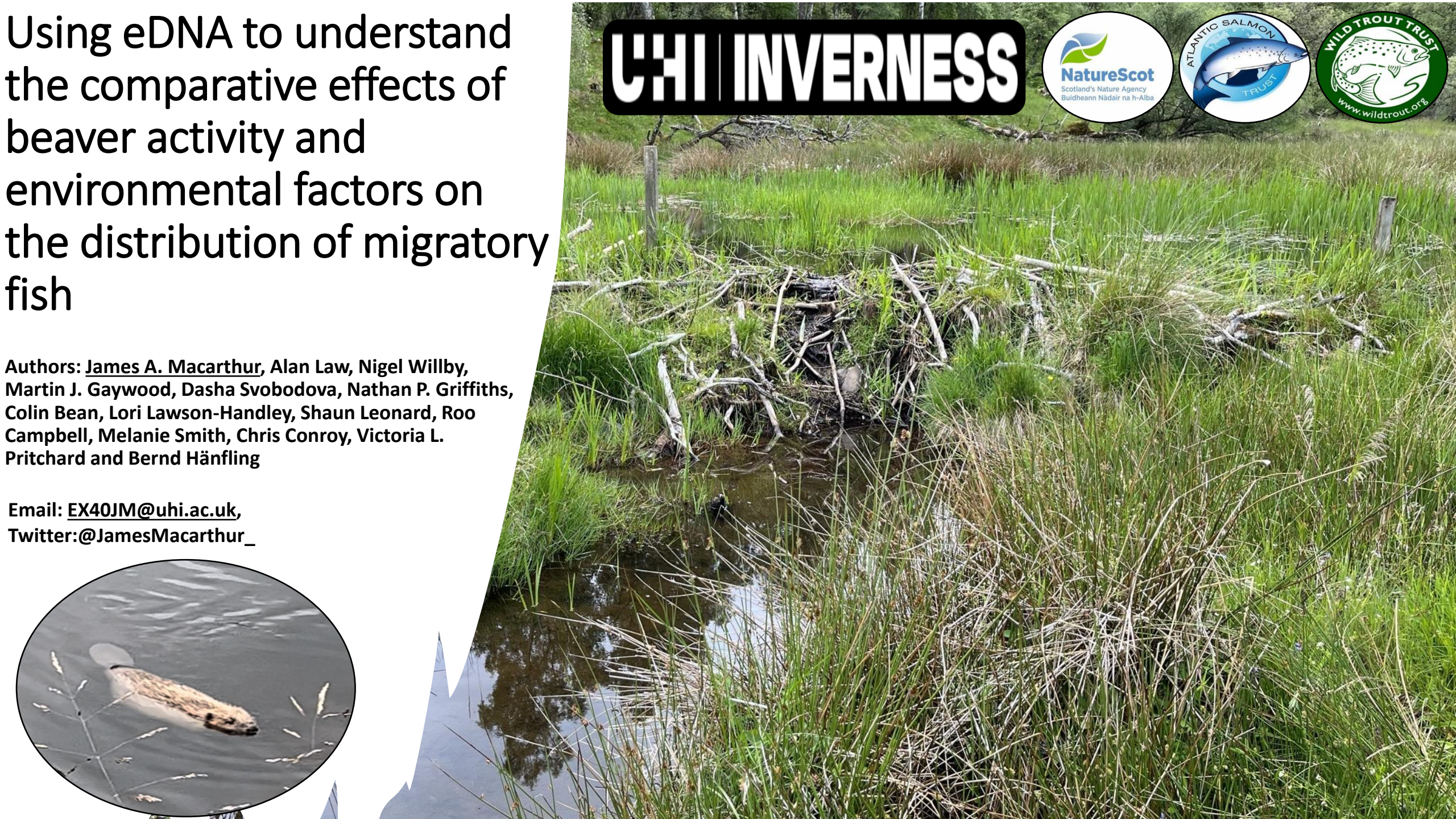


Overview:

- It is widely seen that beavers benefit ecosystems due to the diverse wetlands they create

- Concerns surrounding the impacts of beaver dams on migratory passage and spawning habitat for salmonids (Beaver Salmonid Working Group, 2015)

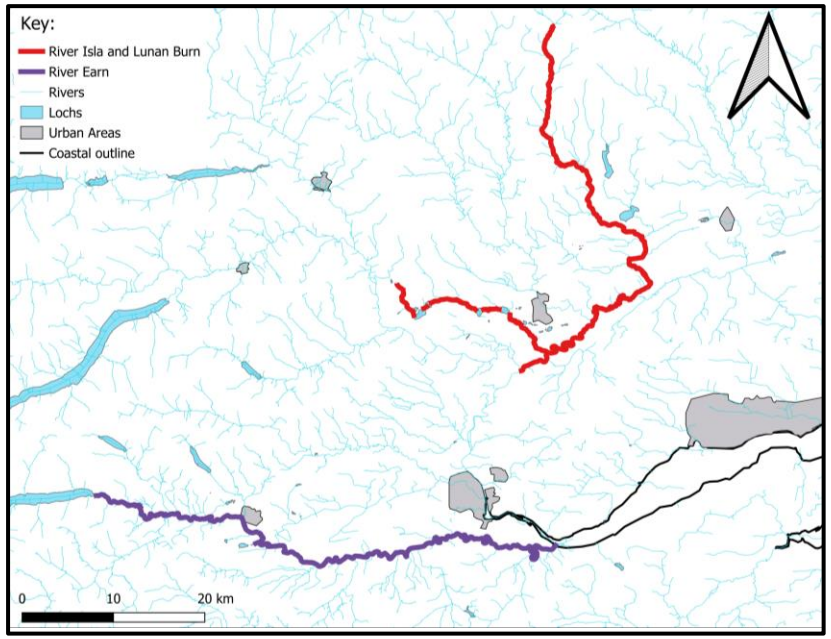
Research question:

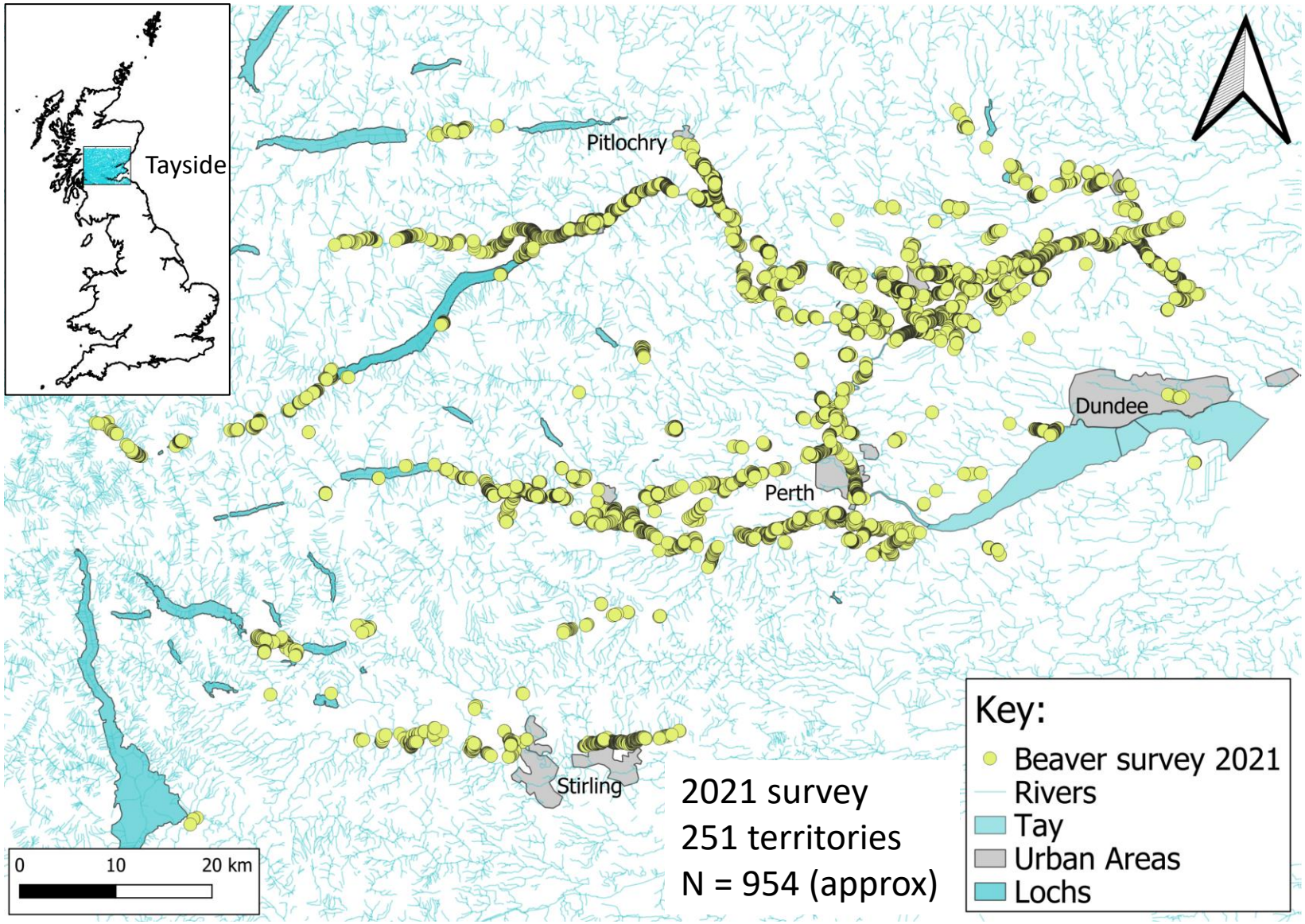
What has been the comparative impact of beaver presence and other environmental variables on the distribution of migratory fish species in Tayside?

Beavers in Tayside:

The exact timeline of beaver escapes/releases in Tayside remain unknown

In November 2021, the Scottish government supported the translocation of beavers to more suitable habitats (Campbell-Palmer *et al*., 2021)



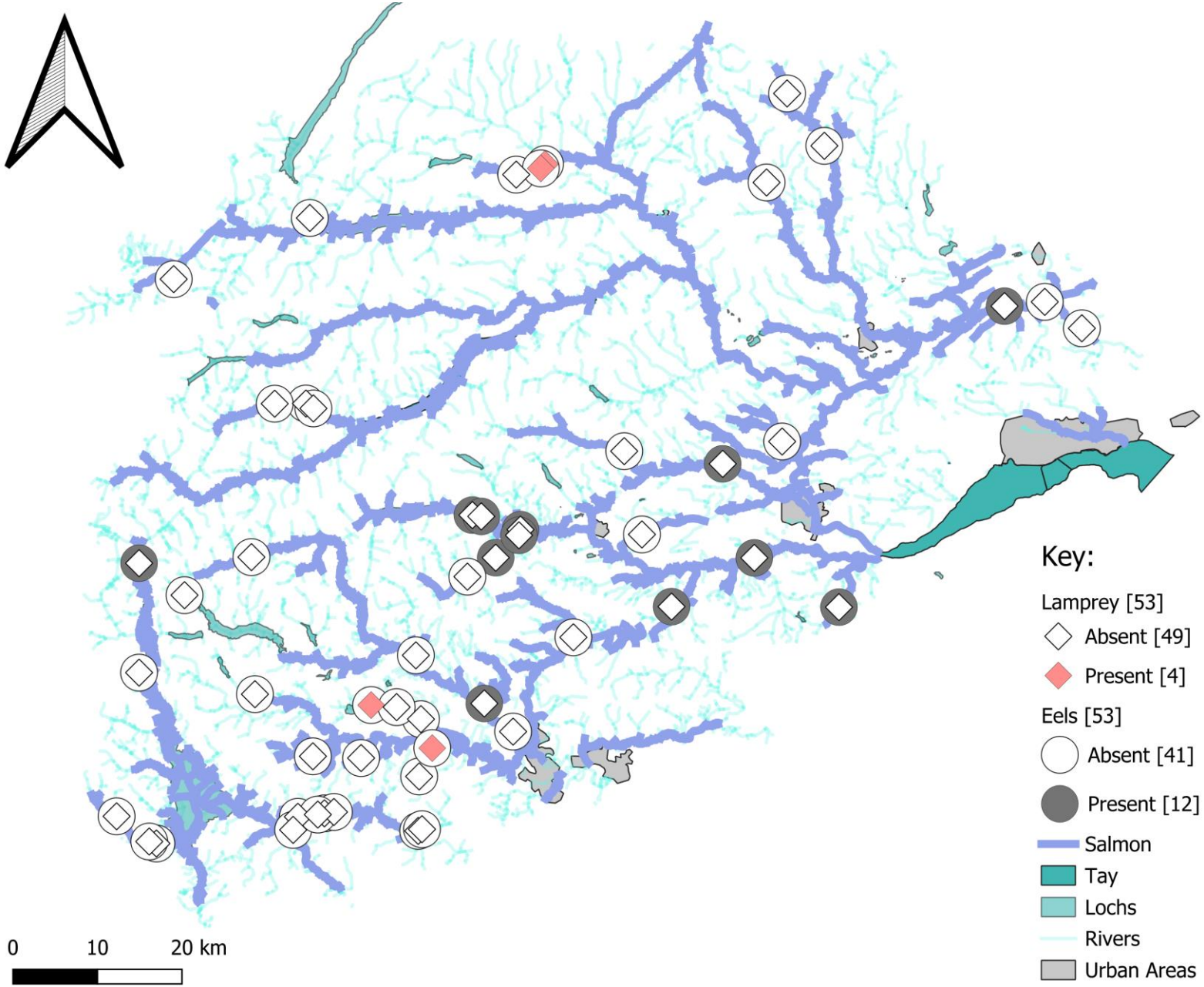


Migratory fish in Tayside:

- Atlantic salmon rod catch in 2023 (32,477) was the lowest since records began (Scottish Government 2024)

- 72% habitat overlap between beavers and salmon within the River Tay Catchment (Beaver Salmonid working group, 2015)

- Limited data on the distributions of other migratory species such as Eels and Lamprey



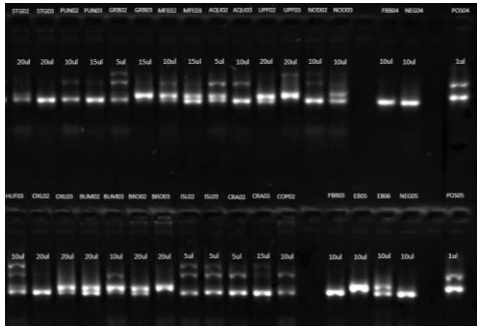
Methods - Environmental DNA (eDNA)

Workflow:

1. Collection

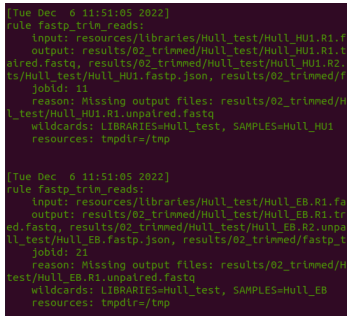
2. Filtration

3. DNA extraction



4. PCR

5. Sequencing



6. Bioinformatics

Key:

- eDNA sites [142]
- Beavers and Salmon
- Beavers Only
- Salmon Only
- Tay
- Rivers
- Urban Areas

Pitlochry

Dundee

Perth

Stirling

0 10 20 km

Tayside

Modelling

Presence-Absence ~

n=93

n=69

n=103

Covariates

Barriers (SEPA obstacles to fish passage) – 74 total

+

Physical variables:
Elevation, PH, Distance from coast, Upstream catchment area, Rainfall (Met Office Climate 2023)

+

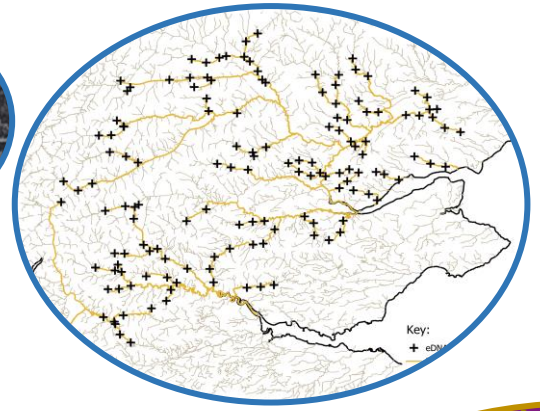
eDNA data 2023 (Presence/Absence)
Eurasian Beaver (n=72)
Northern Pike (Predator)

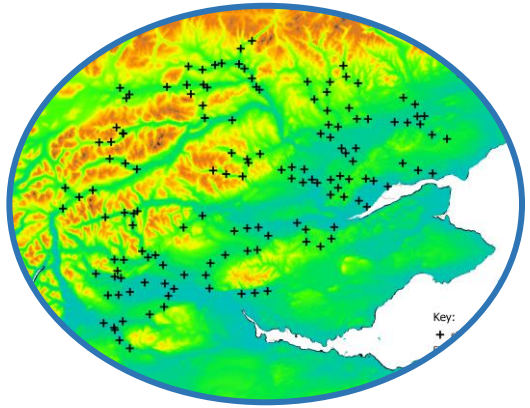
+

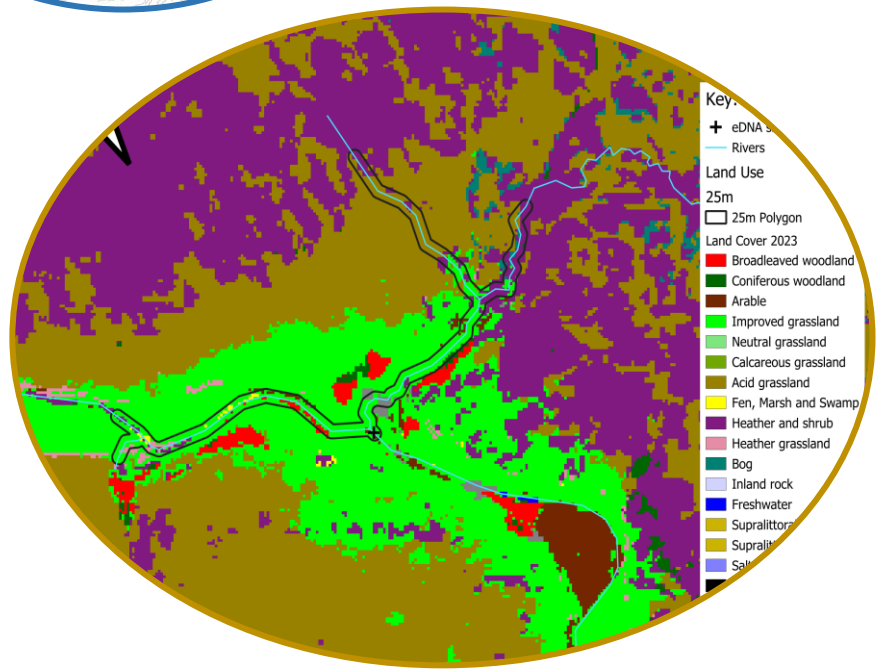
Upstream land-use 1km (CEH 2023 Land cover maps) – converted to %

+

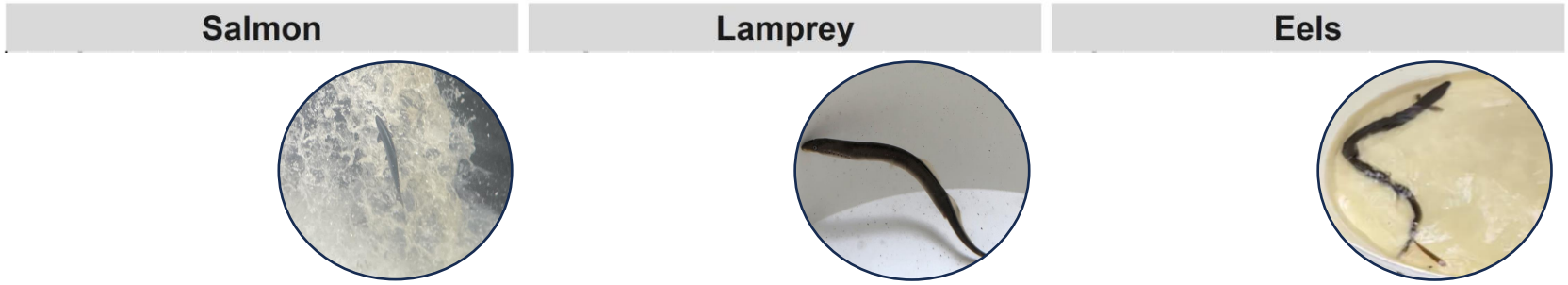
Catchment
(Random Effect)







Final species models across Tayside with beavers (n = 142)



Fixed Variables

- Passable barriers - NFP
- Passable barriers - FP
- Impassable barriers
- Distance from coast (km)
- log(Elevation (m))
- log(Total rainfall (mm))
- log(Upstream catchment area (km))
- Beavers
- Pike
- Broadleaved woodland (%)
- Coniferous woodland (%)
- Agricultural (%)

Salmon: 0 1 2 3 4 5 6 7 8 9

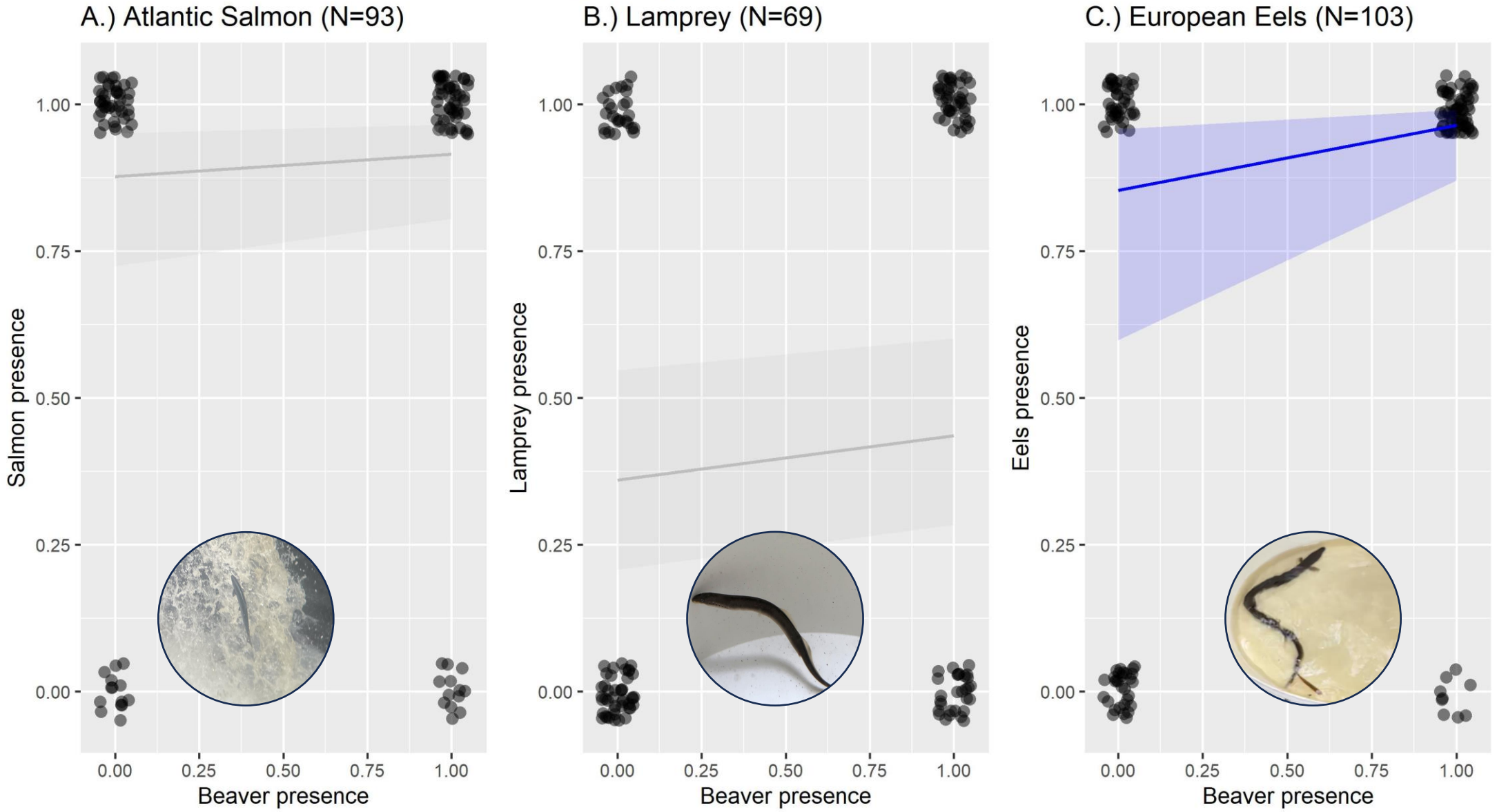
Lamprey: 0 2 4 6 8 10

Eels: 0 5 10 15 20

Incidence rate ratios

Group
- Negative
- Positive

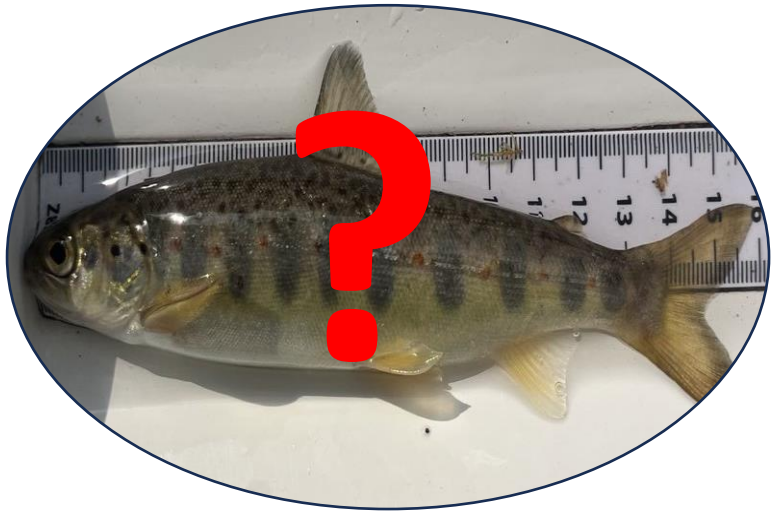
Effects of beavers on migratory fish distributions across Scotland (N=142)

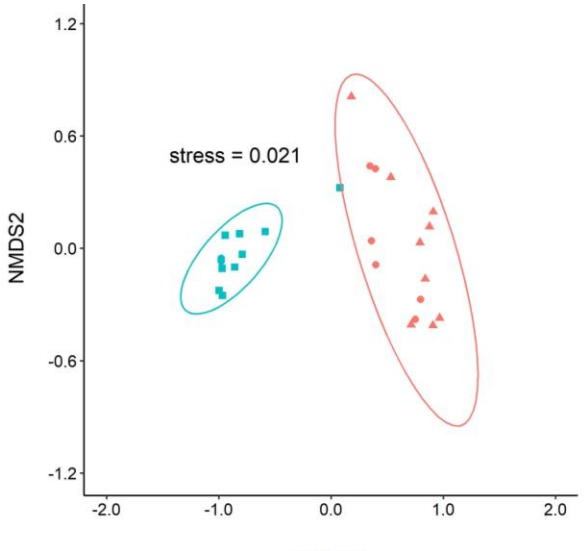


No clear negative effects of beaver presence on the distribution of migratory fish species across the catchments – next steps electrofishing …

Research questions

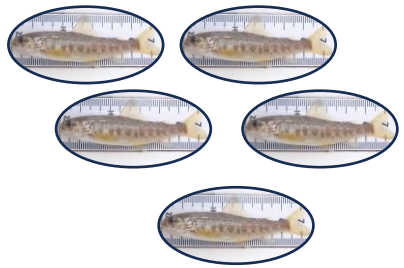
- Are there differences in the fish community composition above and below a beaver dam?





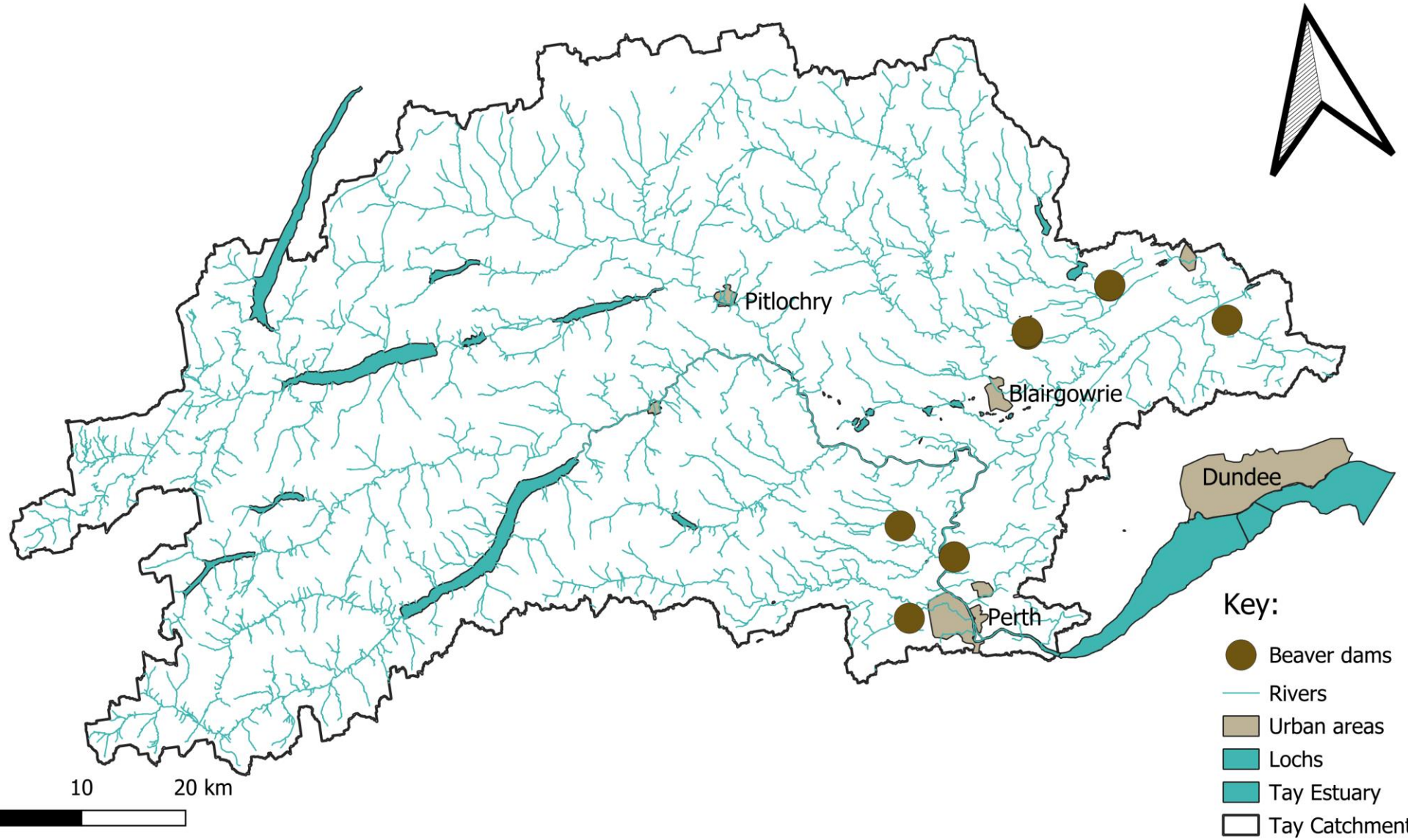
- Are there differences in the body condition of fish above and below beaver dams and within the ponded habitat?

- Are there differences in the population structure of salmonids above and below beaver dams?



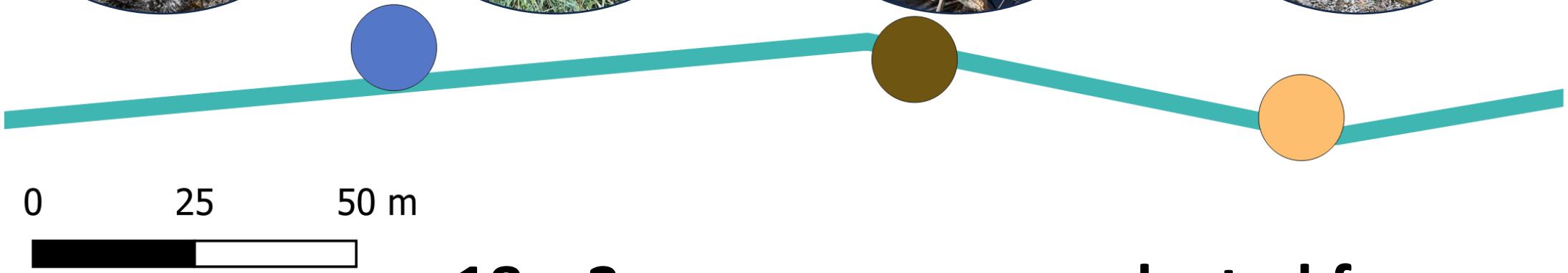
Dam selection

- Beaver dams were provided by the 2025 NatureScot/Beaver Trust field signs survey
- Dam selection informed by historic salmon distribution and 2023 eDNA survey



Sampling design

Above (N = 6) **Pond (N = 3)** **Dam (N = 3)** **Below (N = 6)**



18 x 3-pass surveys conducted from 28/07 – 14/08 across 6 dam sites

Preliminary Results

- 2345 fish caught consisting of 7 species
- Salmon fry caught upstream of all 6 dams and in 2 ponds
- Salmon parr caught in all 3 ponds
- 5 eels caught in one of the ponds

Three-spined stickleback


Brown trout


Atlantic salmon


Lamprey (*Lampetra*)


European eel


Minnow


Stone loach

Take home points:

- Promising initial electrofishing results
- No clear negative impacts of beaver presence on migratory fish distribution across Tayside
- eDNA can be applied across a **catchment scale** to understand the factors influencing the distribution of migratory fish species

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