Freshwater ecoacoustics in beaver-engineered wetlands

alexander.adams@stir.ac.uk

Alex Adams[1], Alan Law[1], Elisa Fuentes-Montemayor[1], Aileen Mill[2], Nigel Willby[1]

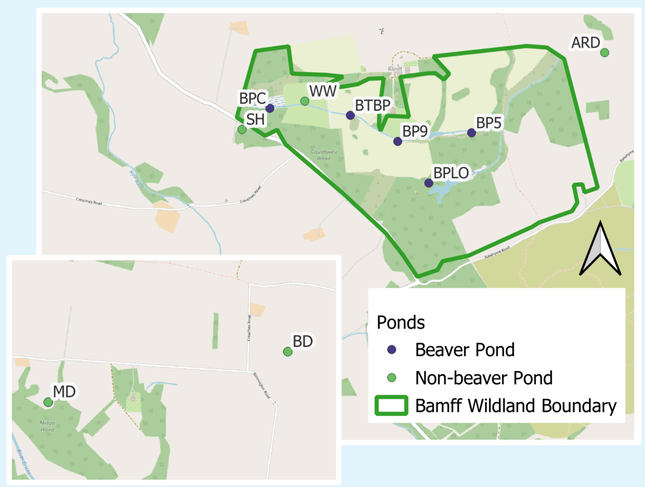
[1]Department of Biological and Environmental Sciences, University of Stirling
[2]School of Natural and Environmental Sciences, University of Newcastle

Introduction

- **Rewilding** often involves the reintroduction of **keystone species**, like the Eurasian beaver (*Castor fiber*).
- Beavers can have widespread ecological benefits for many species, including amphibians, invertebrates, and plants.
- **Ecoacoustics** offers a new, more affordable and less invasive, approach to aquatic biodiversity assessment through environmental **soundscape analysis**.
- Acoustic indices, such as the **Bioacoustic Index,** can be used to quantify acoustic diversity according to the features, abundance, and incidence of sounds.

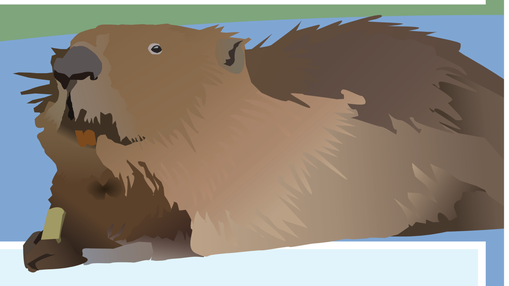
Methods

- Based at the **Bamff** estate in Perthshire, which has had beavers since 2002.
- Five beaver ponds, created by the damming of a stream, plus five "non-beaver" control ponds.
- Each monitored with two **HydroMoth** aquatic recorders.
- Recording 1 min in 10.
- Monthly data collection.
- **Acoustic Indices** calculated for each 1 min audio file.
- **Kaleidoscope Pro** software used to detect and classify recorded sounds.



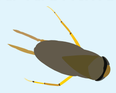
Conclusions

- Differences in BI scores between beaver ponds and non-beaver ponds, at both seasonal and diel scales = differences in **aquatic invertebrate** communities, the major source of biophony in freshwaters.
- **Coleoptera** and **Hemiptera** are acoustically dominant, so may form a greater proportion of the assemblage of non-beaver ponds.
- Less soniferous groups, such as Annelida, Hirudinea, Chironomidae, or Odonata may be more prevalent in beaver ponds.
- Higher scores in winter in beaver ponds may reflect the actions of **detritivores**, present in greater numbers due to the abundance of decomposing organic material introduced via the actions of beavers.
- However, additional environmental and habitat variables may also influence soundscape charateristics, eg: **sediment** depth, ice cover, aquatic **vegetation** density and rate of photosynthesis.



Next Steps

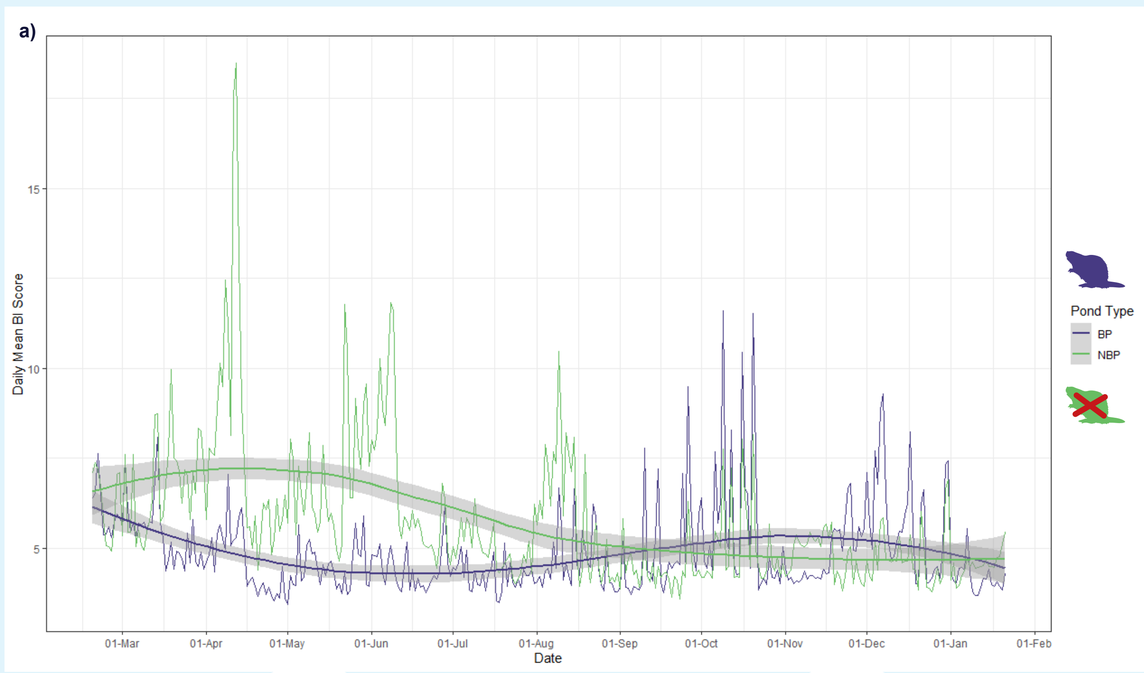
- Incorporate environmental, meteorological, and habitat data into analysis.
- Develop acoustic classifier for freshwater invertebrates to aid identification of sources of aquatic biophony to species or genus level.



Key Research Questions:

1. How does beaver engineering affect the biodiversity of freshwater ecosystems in an agricultural landscape?
2. Can soundscapes be used to characterise wetlands and provide an indication of their structural heterogeneity and ecological complexity?

Results



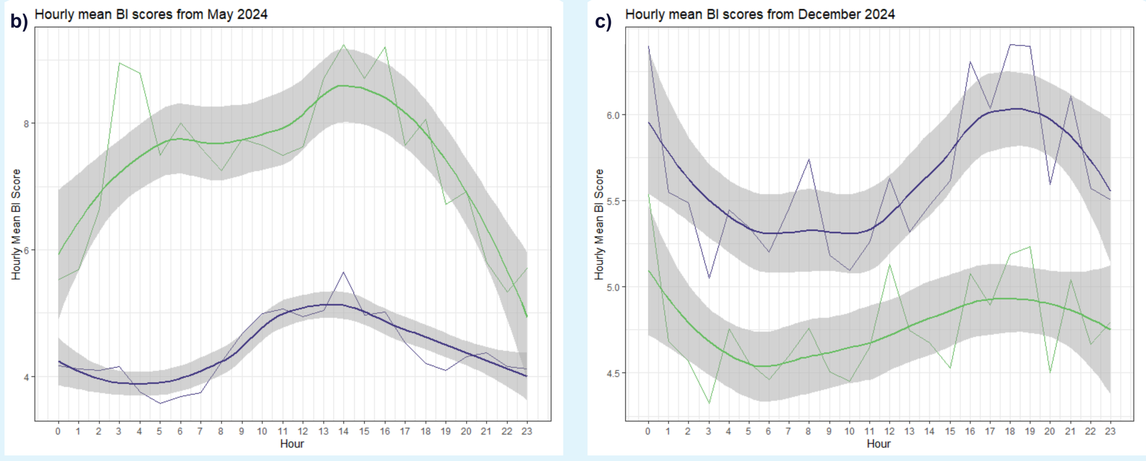


Fig. 1. Bioacoustic Index (BI) scores from recordings made in beaver (BP) and non-beaver (NBP) ponds, March 2024 to February 2025.

- BI is a function of the sound level (dB) and number of occupied frequency bands within the biophonic range, a high value indicates greater variation between the loudest and quietest bands.
- Calculated using the Loess method, 95% confidence interval = shaded area.

a) Calculating daily mean BI scores reveals temporal trends on a seasonal scale.

- NBP show peak in spring/summer, BP peak in autumn/winter.

Calculating hourly mean BI scores for an average day in b) May and c) December reveals temporal trends on a diel scale.

- May - Higher scores during daylight hours, greater diel variation in NBP than BP.
- December - Higher scores in BP than NBP, less contrast between day and night.

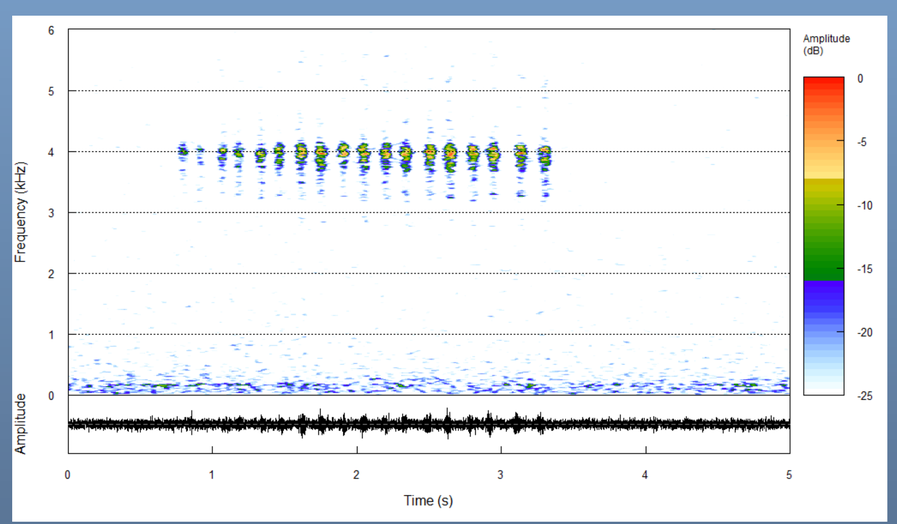
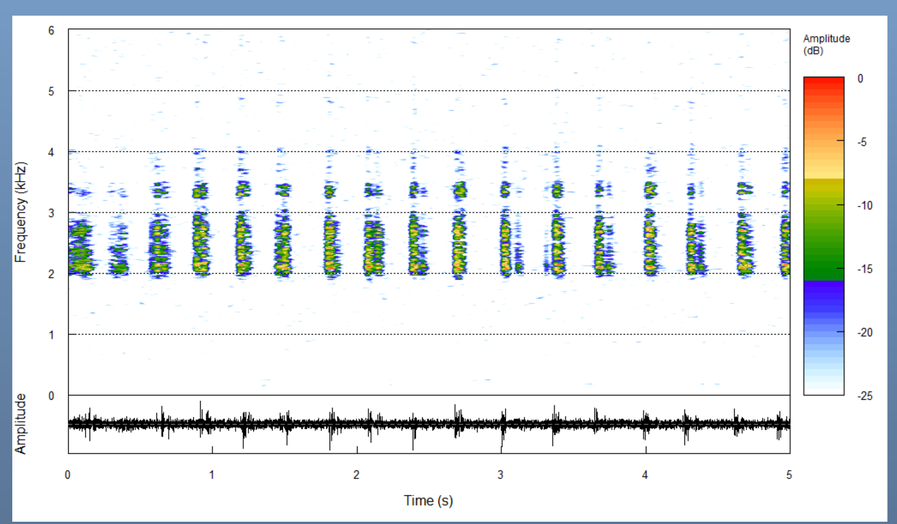


Fig. 2. (left and right) spectrograms of two sounds recorded in one of the study beaver ponds in February 2024.

Early efforts at acoustic classification point to these being stridulations emitted by members of the Corixidae family of aquatic invertebrates, more commonly referred to as lesser water boatmen.

(Sampling frequency 48000, window length 4096)



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