Forestry England

Cropton Forest Beaver Trial 2019-2024

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Our 5-year trial

2009

DEFRA rolls out the 'Slowing the Flow Programme' to explore a new approach to flood management, looking at how changes in land management and use in the upper catchment of the River Seven can help reduce flooding downstream.

2015

'Slowing the Flow at Pickering' pilot project begins

'Slowing the Flow at Pickering' was a partnership project, led by Forest Research. With close support from Forestry England, Environment Agency, North York Moors National Park Authority, Natural England, Durham University with involvement from the wider community. The 'Slowing the Flow at Pickering' project was primarily funded by DEFRA.

As part of the project, 23 hectares of woodland, 50 woody dams and 2 large timber bunds were established within the catchment. The aim of these interventions were to reduce the speed of water travelling throughout the catchment. Results were monitored by Forest Research and published as part of their 2015 'Slowing the Flow' report.

To read full report, go to: www.forestresearch.gov.uk/research/slowing-the-flow-at-pickering/ - Nisbet, T., et al. (2015). Slowing the Flow at Pickering. Final report for the Department of Environment, Food and Rural Affairs (Defra), Project RMP5455. Defra, London (32 pp).

OUR TRIAL BEGINS

2019

Cropton Forest Beaver Trial begins

This project intended to further explore the use of nature and natural processes to mitigate flood risk downstream from the trial area.

The core aim of the trial was to monitor the beavers and their interaction with the established natural flood measures. We were keen to see if they would adopt and maintain these structures or build their own which would 'slow the flow' of water through the site following heavy periods of rain. This 5-year trial was licensed by Natural England.

2024

Data shows the beavers are 'slowing the flow' of water through the site.

By reconnecting the beck with its floodplain through damming activities and making a complex mosaic of habitats, the beavers have helped store more water in the upper catchment, reducing the speed of water travelling through the site.

The Cropton Forest Beaver Trial is granted an extension of another 5 years by Natural England following the project's success supporting flood mitigation and biodiversity benefits.

Biodiversity

Forestry England worked with its volunteers and species specialists to conduct a baseline survey of species found on the site, before the beavers were released. Monitoring of these species has been on going throughout the trial.

The site

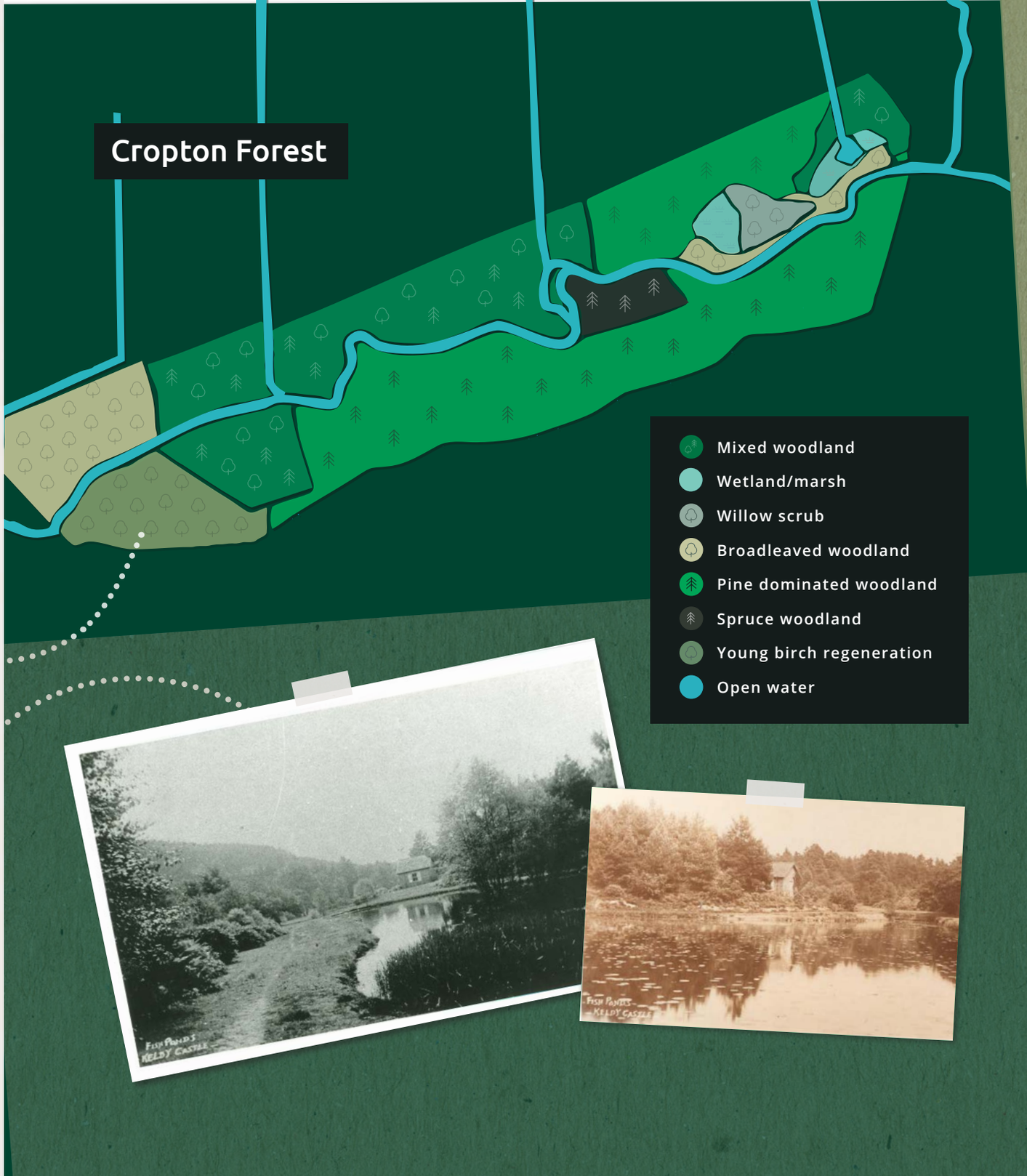
A forest ready for landscape change

The beaver enclosure is situated in 10 hectares of a mostly wooded site. The woodland areas are a mix of broadleaved and conifers. Some areas are dominated by pine with an area of dense sitka spruce on the north bank.. The woodland to the west of the site is dominated by a single age birch, older to the north of the river with young regeneration to the south.

824 metres of Sutherland Beck runs through the beaver enclosure, which before their release was 3-4 metres wide and very shaded along most of its length.

A location rich with historic use

Situated at the top of the site were two ornamental 'fish ponds', which were built as part of a designed landscape. These ponds first appeared on maps of the area in 1890. Prior to the project starting, these ponds had become full of silt and overgrown with willow scrub which had started to take over. The site provided very little standing open water.



Meet the beavers

Something in the water...

Two beavers were officially released into the enclosure on the 18 April 2019. These beavers came from Tayside, Scotland and arrived as a breeding pair. The beavers were already successful within the first year by having two kits – marking the first time that beavers had been born in Yorkshire for over 400 years.

The beaver pair continued to breed successfully producing 11 kits over the 5-year trial period.

- **2 kits in 2019**
- **2 kits in 2020**
- **4 kits in 2021**
- **2 kits in 2022**
- **1 kit in 2023**

To manage the population across the 5-years of the trial, 4 older juveniles were partnered with Scottish beavers and relocated to many other successful projects across England.

One male was moved to Enfield in London but sadly passed away not long after relocation. A female was moved to the Hawk and Owl Trust Reserve in Sculthorpe, Norfolk and went on to have her own family in 2024. The other juveniles were translocated to enclosures in Lincolnshire and the Forest of Dean, both young males and partnered with Scottish females.

The largest dam in England

For the first 3 years of the trial, the main area of activity was in the eastern area of the site around the old ponds and adjacent river.

Phase 1

Following the beavers release in 2019, they quickly built a dam in the river to raise the water levels enough to build their home – a burrow in the bankside with an underwater entrance to protect them from predators.

Phase 2

Starting in summer 2020, the beavers continued the dam out across the flood plain connecting the beck with the old ponds.

Phase 3

Started in winter 2020, the beavers raised the pond edge by about 50cm.

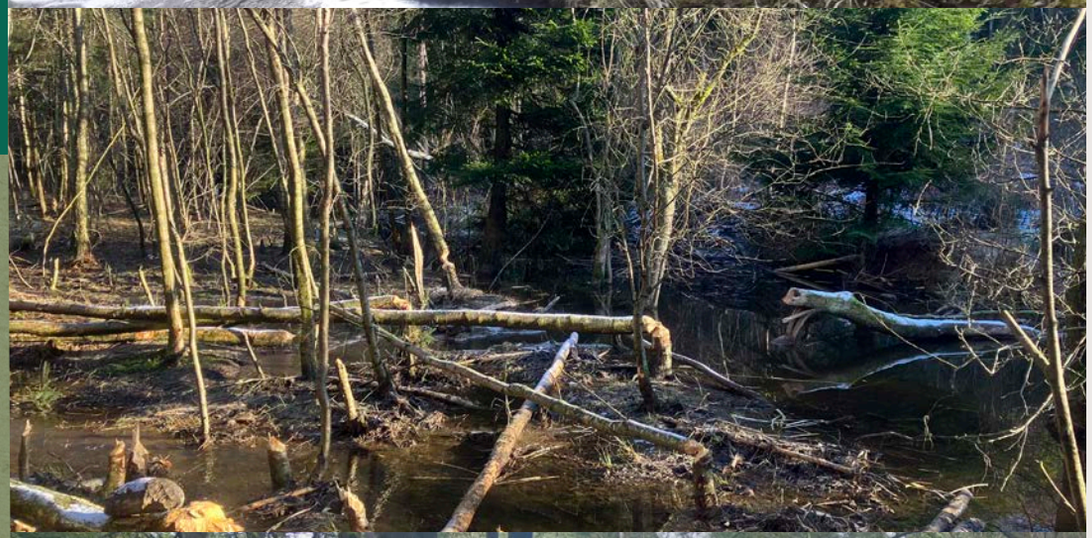
Over the 3 years the dam has developed into the largest natural dam in England and at the end of the trial is over 70 metres long and 2.7 metres tall at its highest point.

Nature's greatest landscape architect

The beavers split irises from the middle of the lower pond into clumps and 'planted' them along their dam. The dam has become a living structure, in many places it is hard to see the stick and earth foundations beneath. The beavers soon set about tackling the willow scrub, being one of beavers' favourite food trees. The combination of feeding and raising water levels removed this growth. They also coppiced various trees on the banks of the pond, opening the space to let more light reach the surface.

Water levels

The upper pond changed a couple of times throughout the 5-year trial. The beavers initially blocked the leak in the pond with silt and horsetails; raising the water levels by about 60cm. In autumn 2022, the beavers dug a channel to drain some of the water from the top pond. This area has developed into a mosaic of water and marsh habitat with deeper channels and pools with a range of aquatic plants on its banks.



A growing family

As their population increased the beavers started using more of the enclosure, spreading out downstream. A second dam was built near the dense spruce plantation. With a stony riverbed here, the beavers built up a foundation of stones, topped with sticks and earth.

The dam connected the river with the flood plain and now in heavy rainfall spreads across the area, running through the spruce rather than down one main river channel. Closer to the riverbank the beavers have ring-barked the spruce. These trees will die leaving standing deadwood; resulting in more light reaching the forest floor, allowing more diverse species to grow, increasing the structural and species diversity of the site.

Re-directing river flow

The beavers have felled many trees, restructuring this part of Cropton Forest. The largest tree they felled was a sycamore over 40cm in diameter. Many of these felled trees have since started regrowing from the stumps – a process called coppicing. Now, in areas where the trees were a similar age and size, we are seeing a more complex and diverse forest structure.

Beaver activity moved to the bottom of the site in late summer of 2023. They created two large dams here, one incorporating the vertical posts that were placed to collect debris and one a little further upstream. The bottom dam has diverted the course of the river causing it to leave its original channel most of the time. Connecting the river to the flood plain here, has flooded an area of the birch woodland. This has refilled an old oxbow, the original course of the river many years ago, creating new wet woodland habitat.

Home sweet home

Collected camera trap footage shows the beavers live in an extended family group with only the dominant pair breeding. They have large lodges situated both at the top and bottom of the site, and all beavers are seen using the whole area.

Study:

University of Exeter

Understanding the hydrology

In December 2018, researchers from the University of Exeter installed core hydrological monitoring equipment at Cropton Forest to gather baseline data on how water moved through the site before the beavers were released.

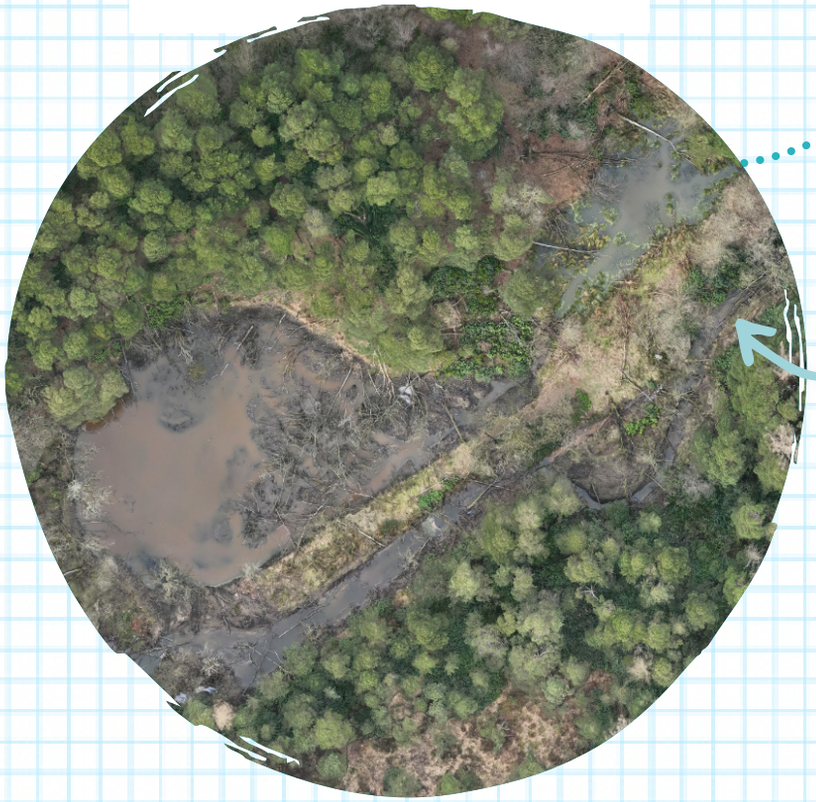
Continued monitoring following the beaver release has enabled us to see the impact they have had on water flow through the site.

The study particularly focused on monitoring water flow to understand beaver impact on this following rainstorm events.

Researchers also undertook regular summer and winter surveys of the site using drones to map observable changes, particularly in relation to wetland areas as a result of beaver dam creation.

An improved hydrological function

From continued observations and monitoring across the 5-year trial, University of Essex found:



Aerial drone surveys indicate the beavers have helped create an expansive and complex wetland environment within the Cropton Enclosure. Their natural landscape engineering has transformed the site. The dams created over the trial have created **extensive wetland areas with surface water covering over 5800m^2.**

Turbidity

Water turbidity levels were on average 30.77% lower leaving the site, compared to water entering the site. However, turbidity patterns were temporally variable, supporting previous research showing that beavers trap large amounts of sediments in ponds, reducing downstream turbidity and suspended sediment levels, but they can also remobilise sediment during their engineering activities.

Drought Resilience

Flows leaving the site in dry periods may be higher than that entering. Whilst this cannot be attributed solely to beavers, the large storage of water in ponds and slow release via the leaky dams is likely to mean beaver activity at the site has increased drought resilience.

A Nature-Based Solution

In combination with pre-existing infrastructure at the site, beavers are increasing water storage, attenuating downstream flow regimes and trapping large volumes of sediment. Beaver sites are highly dynamic and hydrological monitoring continues at the Yorkshire Beaver site as does analysis of the existing datasets. This research seeks to increase our understand how beaver wetlands may act as a nature-based solution, and how learning from this and other sites can inform management and policy associated with the return of beaver to our landscapes.

Flood Mitigation

Early results from the site have been published (Puttock et al., 2021) finding beaver dams (in combination with Slowing the Flow dams) resulted in a reduction in peak storm flows downstream. This supports other research across Britain that suggests beavers could play a vital role in natural flood mitigation and management.

Reduced storm flows and increased low flows indicate beavers have helped create less flashy flows at the site. Combined Before-After and Control-Impact analysis indicates beavers are having water resilience benefits during both wet and dry periods.

Footnote
Based upon the full Hydrological Monitoring Report prepared for Forestry England in July 2024 (Alan Puttock, Kirsty Frith, Gareth Bradbury and Richard E. Brazier)

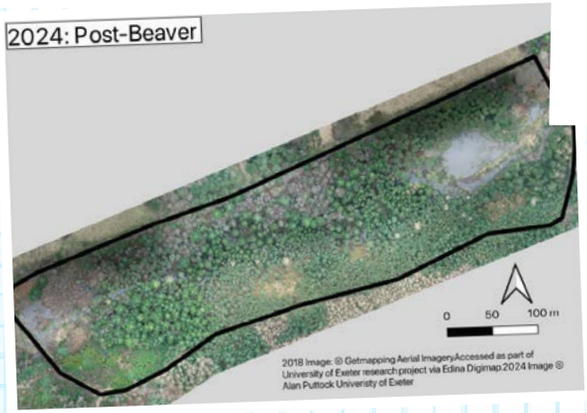


Figure 1. Beaver surface water creation at the site as visualised using a 2024 drone survey and a pre-beaver 2018 aerial image accessed via Getmapping Aerial Imagery.

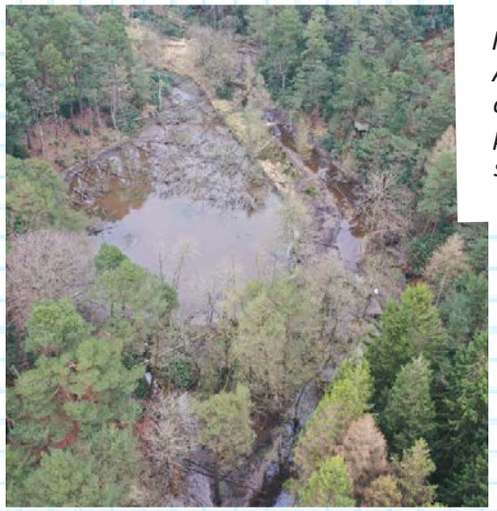


Figure 2. Aerial view of the main pond at the site, 2024.

Figure 3. Beaver surface water creation at the site as visualised using a 2024 drone survey and a pre-beaver 2018 aerial image accessed via Getmapping Aerial Imagery. This shows upper half of the site and the connection between the pre-existing pond and river channel and the expansion into a combined wetland.

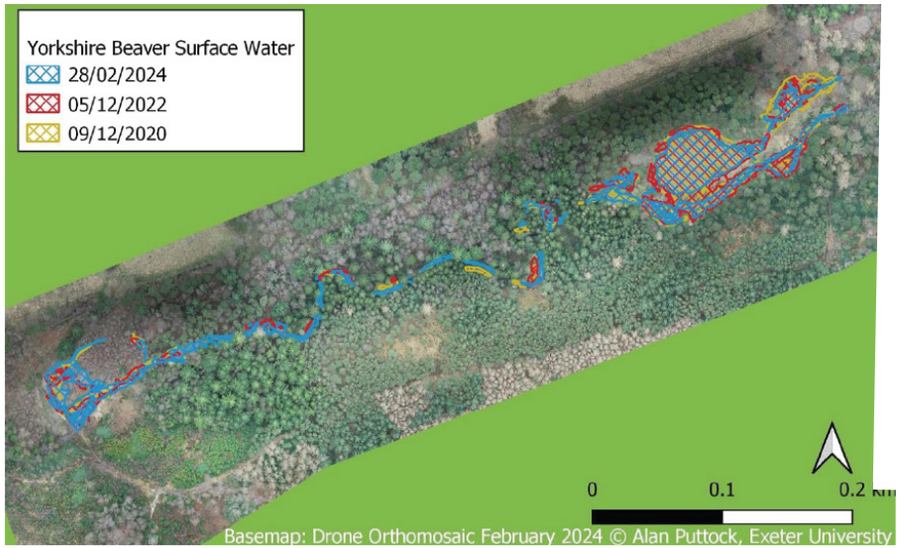


Figure 4. A diagram showing approximate surface water levels (including both ponds and channels/flow pathway) taken from drone surveys undertaken between 2020 and 2024 at the site.

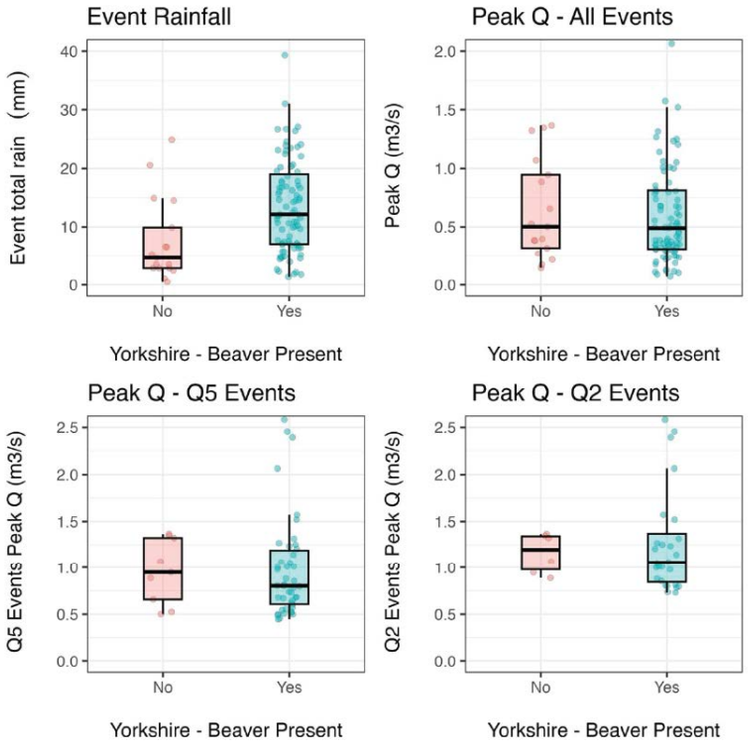


Figure 5. These boxplot diagrams demonstrate that despite an increase in the size of rainstorms experienced following beaver release, small reductions in peak discharge were observed throughout a range of event sizes.

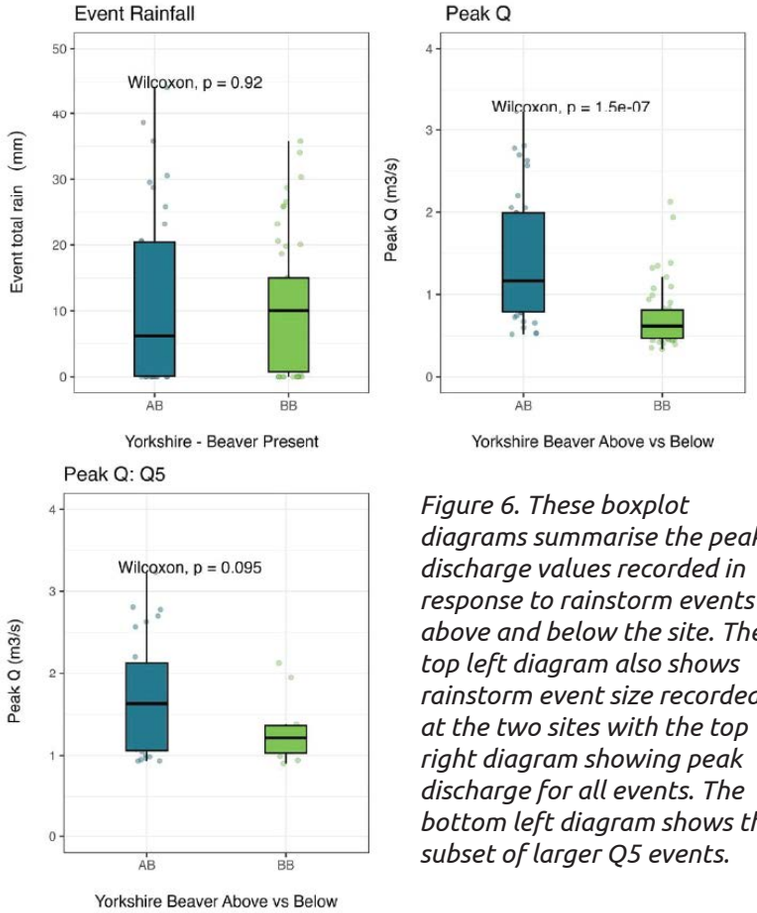


Figure 6. These boxplot diagrams summarise the peak discharge values recorded in response to rainstorm events above and below the site. The top left diagram also shows rainstorm event size recorded at the two sites with the top right diagram showing peak discharge for all events. The bottom left diagram shows the subset of larger Q5 events.

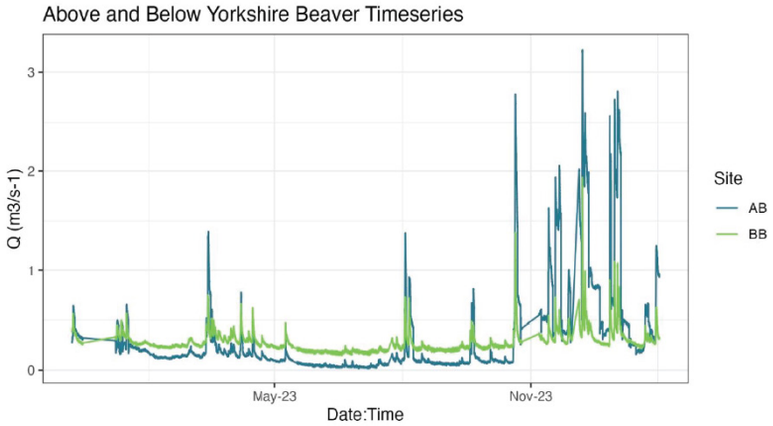


Figure 7. A line chart showing that for the control site 'AB' (Above Beaver) in blue, baseflows were lower and storm peaks higher compared to the impact dataset 'BB' (Below Beaver).

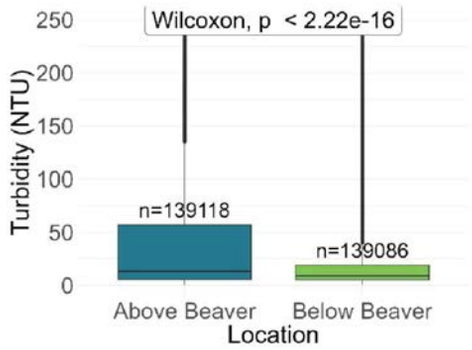


Figure 8. Turbidity water quality results for the monitoring period December 2019 – February 2024 from multi-parameter sondes located above and below the beaver enclosure. The number of measurements (n) and Wilcoxon test p-values are shown. All parameters were significantly different ($p<0.05$) between the above beaver and below beaver instruments.

Study:

University of Leeds

Monitoring beaver impact in 3D

Beaver impacts on the site were monitored using three-dimensional surveys, combining both photogrammetry from drone surveys *(Figure 1)* with terrestrial laser scanning *(Figure 2)*. These both created 3D 'point clouds' of the area and allowed quantification of the rate of change in the enclosure.

These surveys were repeated in the first week in March every year, totalling six separate surveys. These quantified pond water levels, beaver dam height and profile, and the extent of surface water in the enclosure. In 2024, these were supplemented with detailed surveys of each dam with a mobile iPad Pro LiDAR device *(Figure 3)* and brief bathymetric surveys of water bodies.

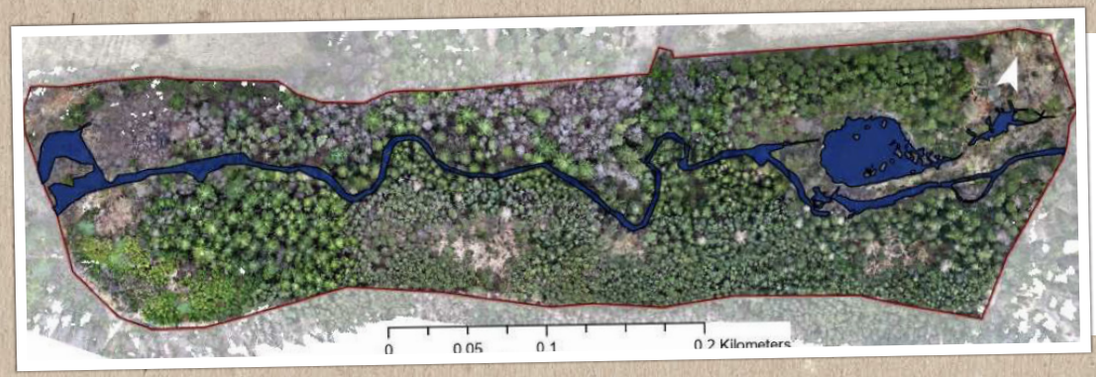


Figure 1: Orthomosaic imagery of the entire compound obtained via drone in 2024. The fence line is in brown and surface water area in dark blue.

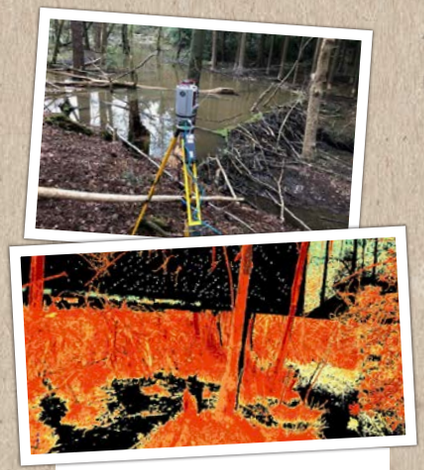


Figure 2: A Terrestrial Laser Scanner (above) and example 'point cloud' of a beaver dam (above)

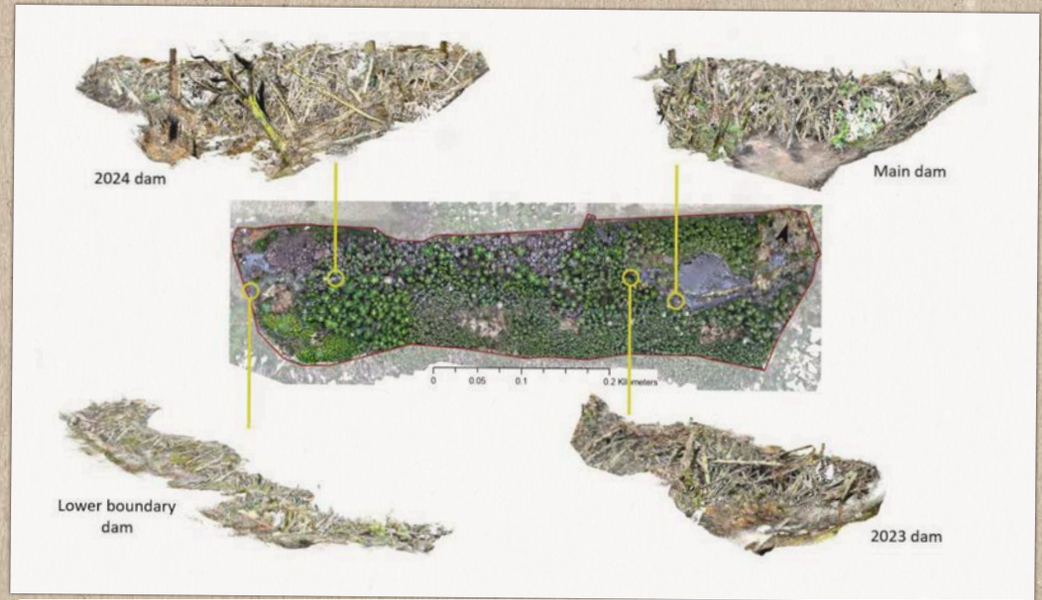


Figure 3: Overview of beaver dams in the compound during the 2024 survey as measured using iPad LiDAR.

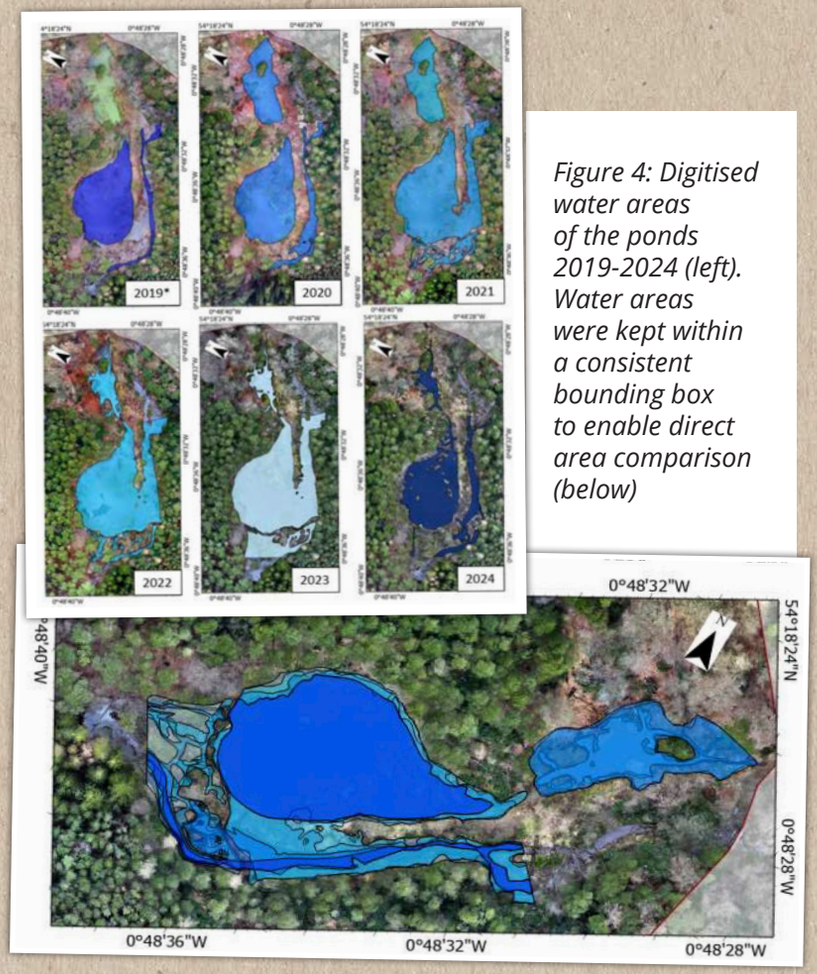


Figure 4: Digitised water areas of the ponds 2019-2024 (left). Water areas were kept within a consistent bounding box to enable direct area comparison (below)

A dynamic wetland area

Pond water levels have changed throughout the trial. The upper pond initially increased to a maximum of 1130m^2 in 2020. In 2024, water area was 271m^2 with the development of a wetland mosaic habitat. Pre-release the lower pond was 2709m^2, eventually increasing to 4589m^2 by 2023.

A changing water level

Both the river and pond upstream of the main dam rose consistently from 2019 to a peak in 2023 with most changes in the first year. The lake level peaked at 0.74 metres above its origin. The river showed larger increases to 3.18 metres above 2019 levels. By 2022 the river and pond were hydrologically connected with the same water surface elevation.

In February 2024, a partial dam breach led to gradually decreasing water levels. The river dropped to 2.14 metres above origin. The pond returned to the pre-release surface elevation. In 2024 in the median recorded sonar water depth was 0.76 metres, though this ranged up to 1.11 metres, suggesting a mean depth of 1.53 metres pre-dam breach and gradual loss of approximately half the pond water after the breach. (Figure 5).

At its peak in 2022, the main beaver dam grew to be 2.52 metres tall from the base of the river to the dam crest (Figure 7). Most dam building at this location took place between 2020 and 2022.

Figure 6 shows the changing slope and height of the main dam between 2020 and 2023 with before and after images.

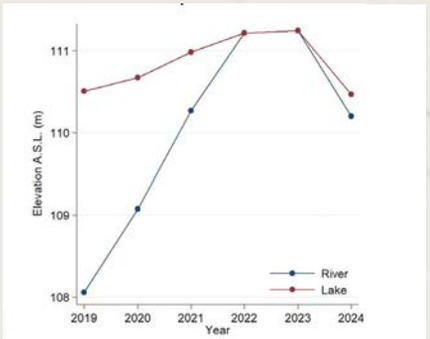


Figure 5

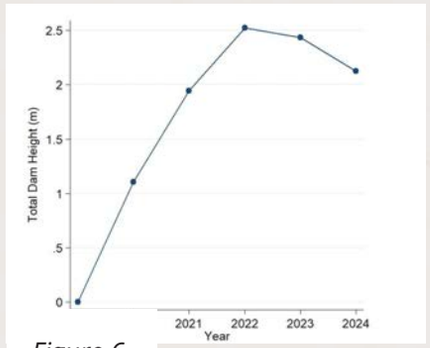


Figure 6

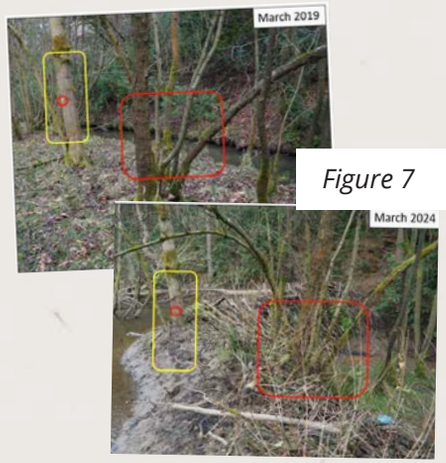


Figure 7

Before vs. after photography

Repeat imagery was taken at several locations on each year of the survey. While not always taken from the same vantage point, the use of plastic survey markers hammered into trees, or clearly identifiable objects enables the comparison of imagery.

Figure 8 was taken looking upstream on the river. This later became the location of the main beaver dam. For a better perspective of the dam, later images were taken from slightly closer to the river. Main construction phases of the dam in 2020 and 2021 can be clearly seen, along with the construction of the downstream dam beginning in 2022.

Figure 9 shows the same location viewed from the other side of the dam looking downstream. The raising water level can be clearly seen up to March 2023 and the dam breach event reveals fine sediment deposited on the upstream side of the dam in 2024.

The main construction phases

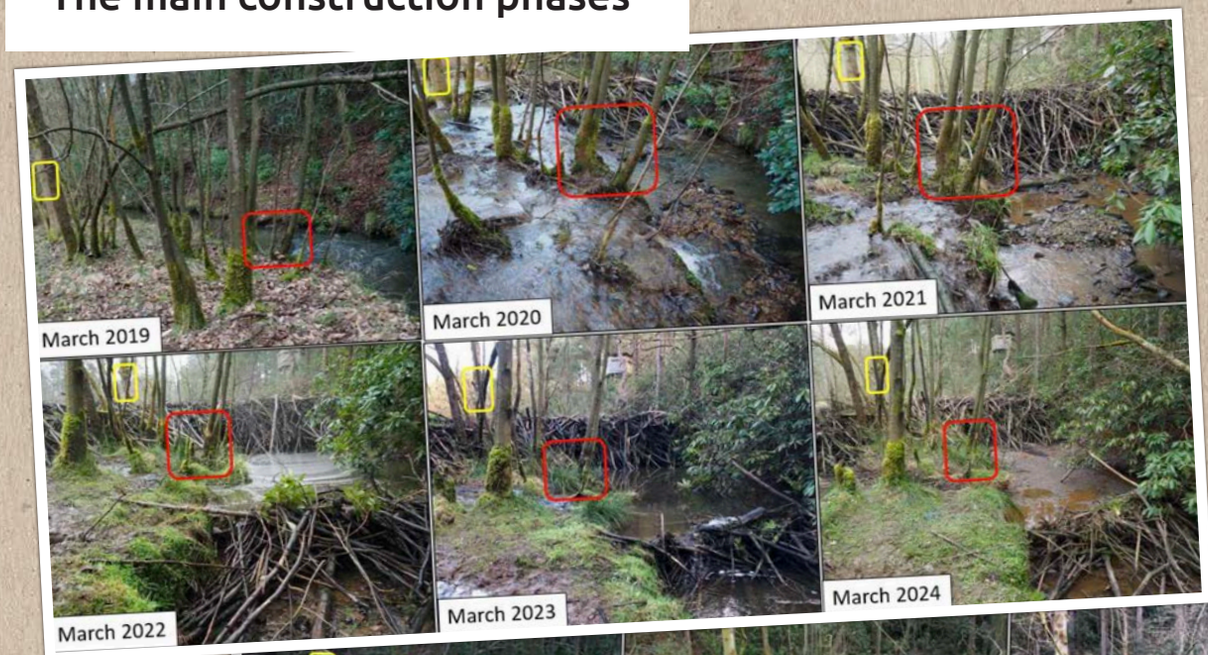


Figure 8

Figure 9

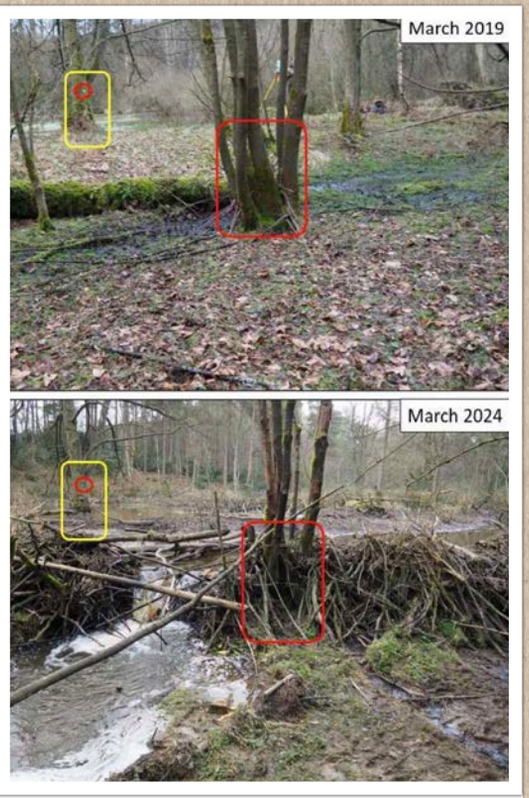


Figure 10 looks upstream at the location of the partial dam breach. A survey disc can be identified in both images (red circle).

Footnote
*Based upon the Geomorphological, Topographic, Photographic & Bathymetric Surveys at Cropton Beaver Release Site (2019-2024) prepared forForestry England (Mark Smith and Megan Klaar)

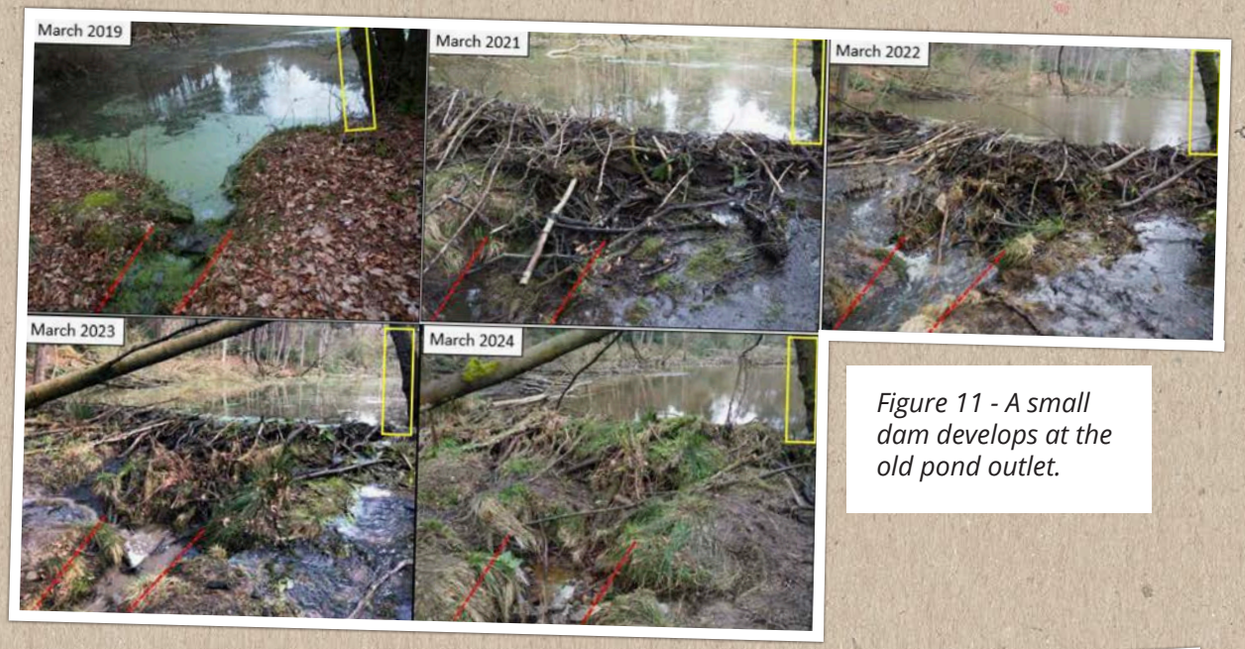


Figure 11 - A small dam develops at the old pond outlet.

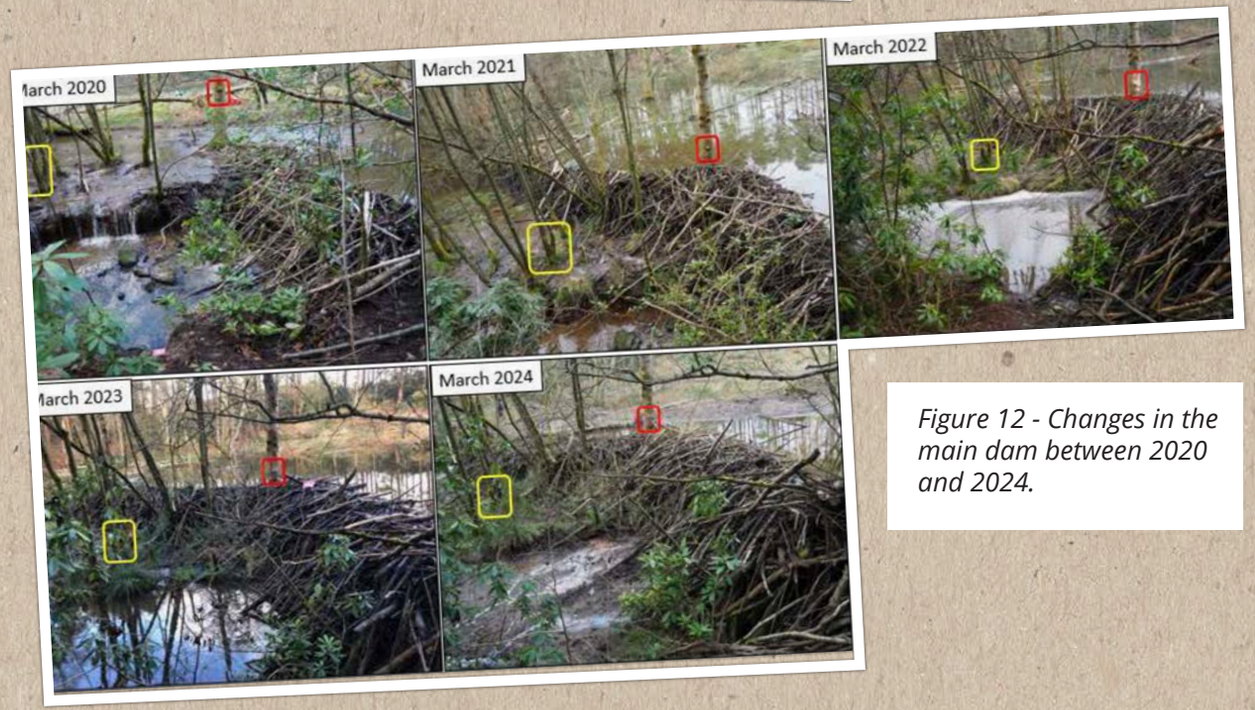


Figure 12 - Changes in the main dam between 2020 and 2024.

Study:

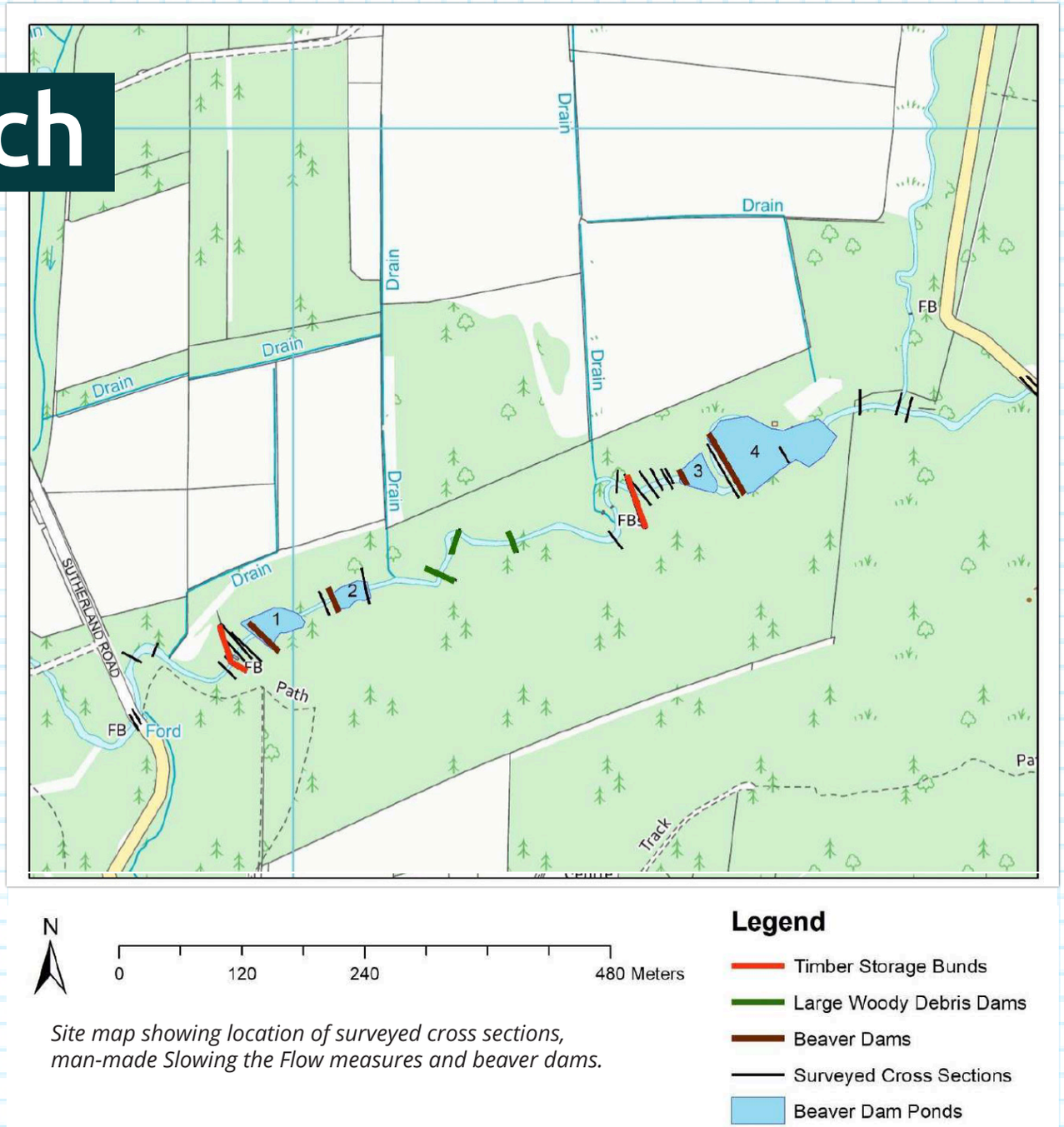
Forest Research

Comparing man-made structures and beaver dams: collecting the data

In 2014, a modelling study was undertaken to look at the potential water storage of the 2 large timber bunds that were installed along the beck as part of the 'Slowing the Flow' project.

In 2024, this study was repeated. Topographic data was collected from a cross-section survey of the site, as well as 1 metre resolution LiDAR. Information was compiled on the location, size and characteristics of beaver dams and man-made large wood dams (LWD) and timber bunds within the enclosure. The river channel geometry where the beaver dams, LWD and timber bunds are located was measured, including cross-sections and flow paths.

The hydraulic properties of the river channel and floodplain, including Manning's roughness coefficient was defined along with the hydraulic characteristics of the beaver dams and man-made structures, including their height, length, and width. Design flows with given return periods were modelled using the Flood Estimation Handbook (FEH) and the upstream and downstream boundary conditions were inputted for a range of inflows e.g., river confluence and any outfall structures.

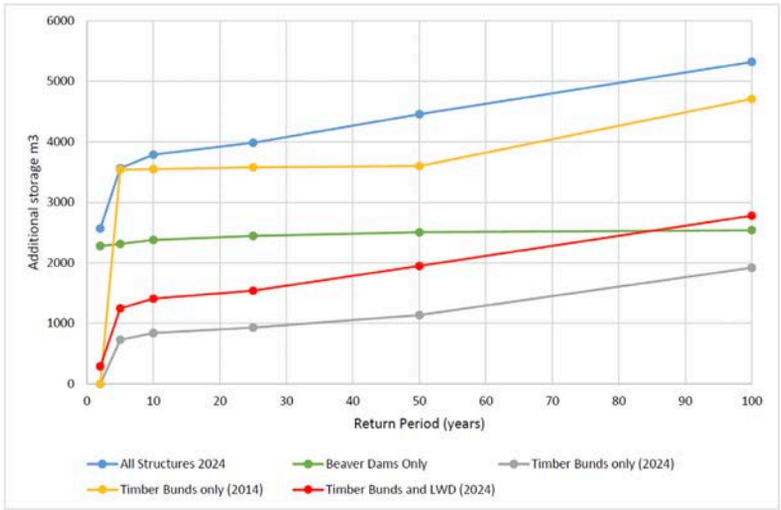


Site map showing location of surveyed cross sections, man-made Slowing the Flow measures and beaver dams.

Comparing additional flood storage potential

Steady-state flow simulations using HEC-RAS were conducted to model the hydraulic behaviour of the river system. Various flow scenarios were simulated, including baseflow conditions, typical flow events, and design flood events, to assess how the beaver dams and man-made timber bunds affect flood storage capacity. In 2024, the modelled reach was 1.2 kilometres in length, with an average channel width of 4 metres in the upstream reach, up to 6 metres midstream and 4 metres in the downstream section.

The two bunds, three LWD dams within the beaver enclosure and four beaver dams were represented within the model by treating them (hydraulically) as bridges. This allowed Forest Research to determine the exact proportion of the channel



Comparison of the additional flood storage potential of man-made versus beaver-built dams

Conclusions

Since their installation there has been a marked reduction in flood storage capacity of the man-made timber bunds dues to degradation and channel erosion at the throttle point of the bunds. This shows that the building of man-made timber structures for the purposes of Natural Flood Management cannot simply be a case of 'build and forget'.

The modelling study shows that the Cropton Forest beaver dams alone make a significant contribution to the potential additional flood storage at the site. In combination, the four beaver dams provide significantly more additional storage potential than the timber bunds in their current condition. However, they fall short of providing the equivalent storage that the bunds provided when they were originally installed and designed appropriately. This difference is likely to further increase as the timber bunds continue to deteriorate and the beavers potentially build more dams.

The total volume of flood storage provided by the two timber bunds in their current condition, the three LWD and the four beaver dams exceeds that of the original timber bunds, across the range of modelled flood magnitudes (1 in 5 year to 1 in 100 year floods).

It is important to note that the river system within the beaver enclosure is constantly evolving. The beavers may build additional dams and thus create more flood storage, while the contribution of the existing bunds and LWD dams are also likely to change as they fall further into disrepair and/or the river channel throttle continues to erode or silt up.

Footnote
*A Comparison of Nature Based Solutions: Beaver Dams versus Timber Flood Storage Bunds at Cropton Forest, N Yorks. (Huw Thomas, Hydrologist, Forest Research, May 2024) *Forest Research is the Research Agency of the Forestry Commission

Study:

Teesside University

How quickly can beavers deliver nature recovery?

Beavers are well known for their dam building which transform ecosystems and improve flood regimes. There is also growing evidence that beavers can create natural wetlands rich in biodiversity. In Cropton, plant diversity and vegetation changes were monitered since the beaver introduction, to measure how fast their activity results in nature recovery within the river corridor.

Within the site, beaver activity has been very unevenly distributed, with initially a focus on the existing ponds and upstream. Since 2023, beavers have accelerated their dam building at the site, covering a longer reach. However, some of the river stretches have remained unaffected. The result is a greater variation of habitats within the site with several transitions between dryland and aquatic habitats. While the dryland has so far experienced little change in plant diversity, the wetlands were colonised by a rich aquatic flora - new species of aquatic plants were observed each time the site was re-surveyed.

The research carried out gives evidential support to policymakers and conservation managers to understand the pace at which beaver re-introduction can deliver nature recovery in river corridors within conifer plantations.

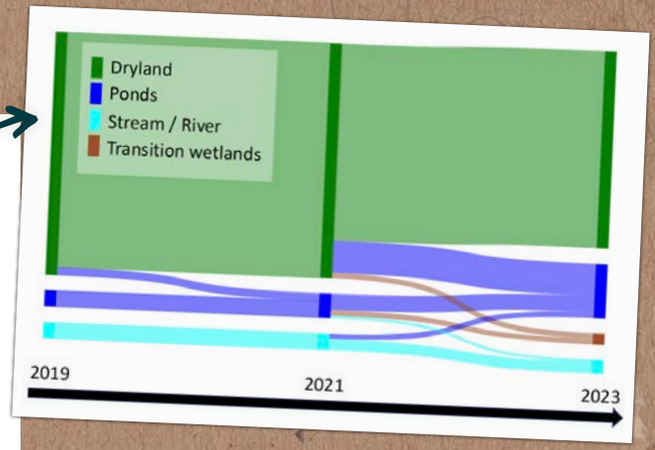


*Figure 1. - Dryland-wetland transitions as observed at 102 fixed points across the site. While there was **little change between 2019 and 2021**, there was an **increase in ponds and transition to wetlands in 2023**. The graph shows how natural disturbance by beavers creates an **increasingly complex environment composed of interconnected habitats.** The expectation is that beavers will create an optimal level of natural disturbance to maximise biodiversity in the longer term, and our results demonstrate this process has started.*

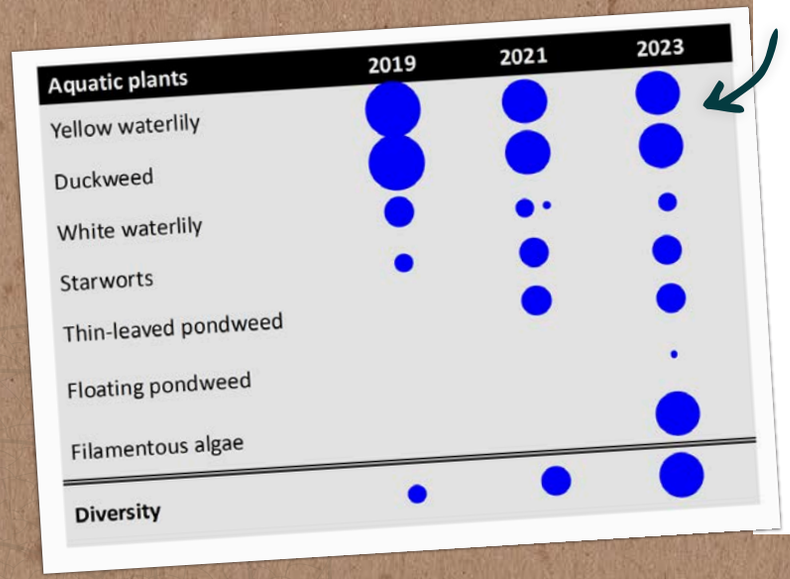
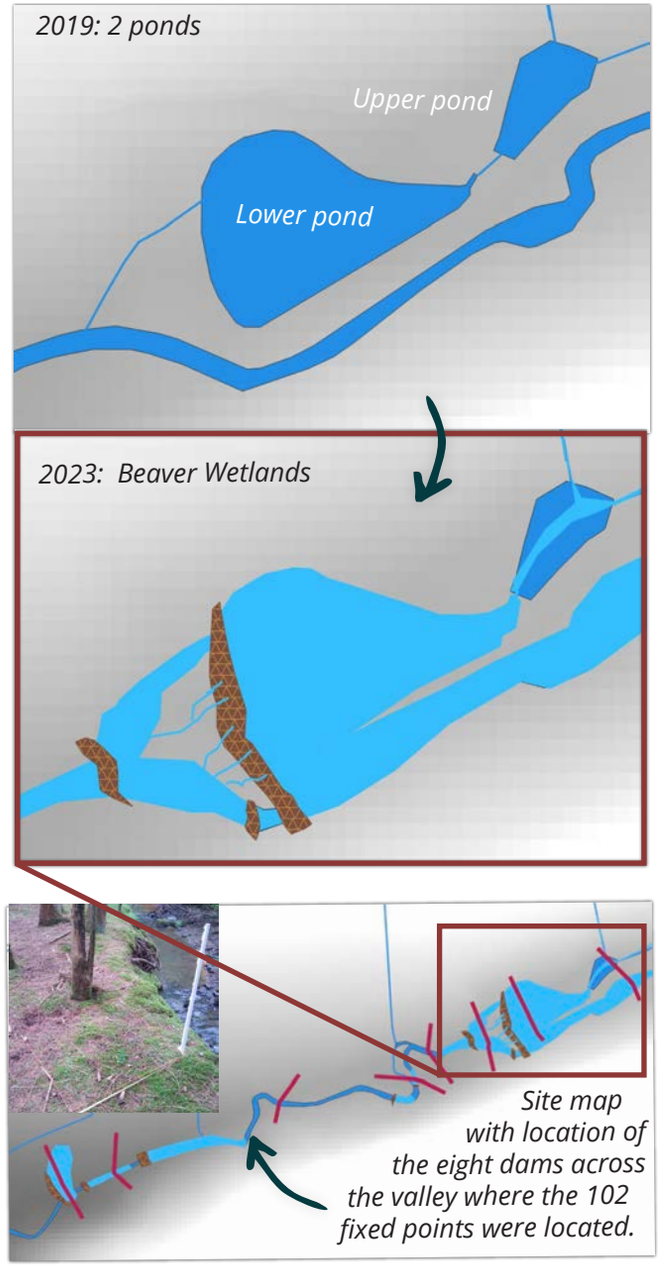


*Figure 2. - The number of truly aquatic plants is steadily growing within the main beaver pond. We found new species for the site every time we surveyed, but there is another type of change to highlight, in addition to this increase in biodiversity. **Initially the waters were overwhelmed by two species,** which is an **indication of ecological imbalance.** With time not only did the pond host more species but also there is **increasingly a balance** of aquatic species living in the pond.*

Figure 3.



Site map with location of the eight dams across the valley where the 102 fixed points were located.

Aquatic plants given the opportunity to colonise the site as a result of beaver activity.

What are beavers up to following introduction?

Thousands of camera trap images have been collected as part of welfare checks - we analysed beaver behaviour within 3,000 video clips. This gave a unique insight into beaver activity during the first year following release. An important event was the birth of two kits in late spring of 2019.

The beavers displayed healthy behaviours throughout, busy with a range of activities. Among the behaviours caught on camera were building and tendering of dams, as well as resourcing the building material such as branches, mud and leaves. They were also seen eating, drinking, and communicating with each other, for example by emitting sounds and slapping their tails.

We were also interested to look at how young beavers learn to be ecosystem engineers. It was interesting to see that they were not captured working during their first year but instead mostly playing and moving around the site.

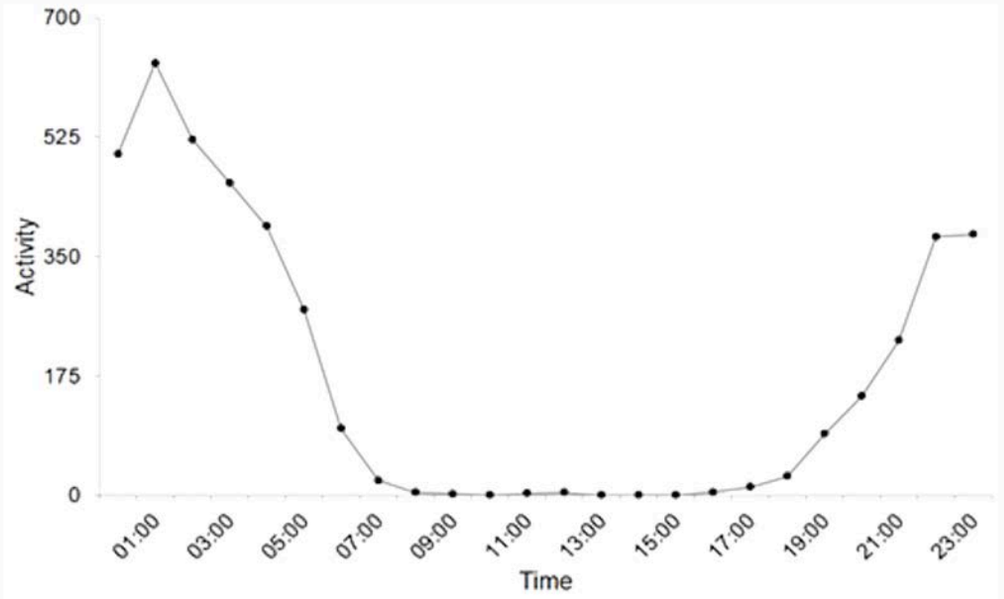


Figure 4. - The full body of observations has shown that the beavers were extremely regular in their daily activities with the period of rest being between 7:30am and 4:30pm. All activities were captured outside these times.

Initial dam building

Beaver's tree felling in process

Footnote
*The team involved from Teesside university:

- Dr Ambroise Baker – Senior lecturer in Ecology and interested in nature recovery and how plants, biodiversity and complex ecosystems respond to environmental change.
- Austine Otabor – PhD student focusing on monitoring abiotic, biotic and socio-ecological change during re-wilding. He provided assistance with field data collection.
- Laura Waistell – Graduate student who completed a BSc (Hons) in Environmental Science and who worked on analysing beaver behaviour during the first year following introduction.

Wildlife cam footage

12 trail cameras were placed on site during the trial to monitor the beavers' health and behaviour.

Newly created beaver pond

Felled tree

Two kits playing -

https://youtu.be/ni01hnINsUQ

Beavers scent marking -

https://youtu.be/o9PgBYcjKUo

Gathering soil -

https://youtu.be/Dw8jzsN8TE8

Study:

University of Hull

Investigating impacts of beaver reintroduction using environmental DNA (eDNA)

What is eDNA?

"eDNA" is the DNA left behind by organisms as they interact with their environments, for example, shed cells and waste material. eDNA can be sampled by collecting water, soil or air, then sequenced in a process known as "metabarcoding". eDNA detected within a waterbody reflects the aquatic and semi-aquatic species living within it, terrestrial species that interact directly with it (e.g. through drinking, urinating etc. (Harper et al., 2019), and animals living in the surrounding environment. eDNA metabarcoding is revolutionising biodiversity monitoring due to the ability to accurately and sensitively detect entire communities of species, without causing harm to the environment (Deiner et al., 2017; Didaskalou et al., 2022; Lawson Handley, 2015).

What did we do?

Nineteen water samples were collected in May 2022: 10 within the Cropton Forest Beaver Trial enclosure and 9 at nearby Pickering Beck (Fig. 1a). Water samples were filtered to capture eDNA, and DNA extracted and sequenced, targeting vertebrates only. DNA sequences were matched to a reference database, to assign them taxonomically (Figure 1b).

Figure 1
a) Sampling water from above the main dam. Two litres of water is collected from each sampling point for eDNA analysis.
b) Overview of eDNA workflow

What did we find?

Fish

- Nine species were detected in total, with six species detected at Cropton, and seven detected at Pickering Beck (Figure. 3a)
- Brown trout, bullhead, river lamprey and three-spined stickleback were detected at both sites.
- Tench and common carp were only detected at Cropton, while European eel, minnow and stone loach were only detected at Pickering.

Mammals

- Fourteen species were detected in total, with 12 species detected at Cropton (including beaver), and 11 detected at Pickering Beck (Figure. 2b).
- Wood mouse, bank vole, brown rat, common shrew, field vole, grey squirrel, red deer, roe deer and water shrew were detected at both sites.
- Beaver, badger and otter were only detected at Cropton, while mole and water vole were only detected at Pickering.
- Beaver eDNA was detected at all Cropton sites, apart from CR10, which is just upstream of the enclosure.

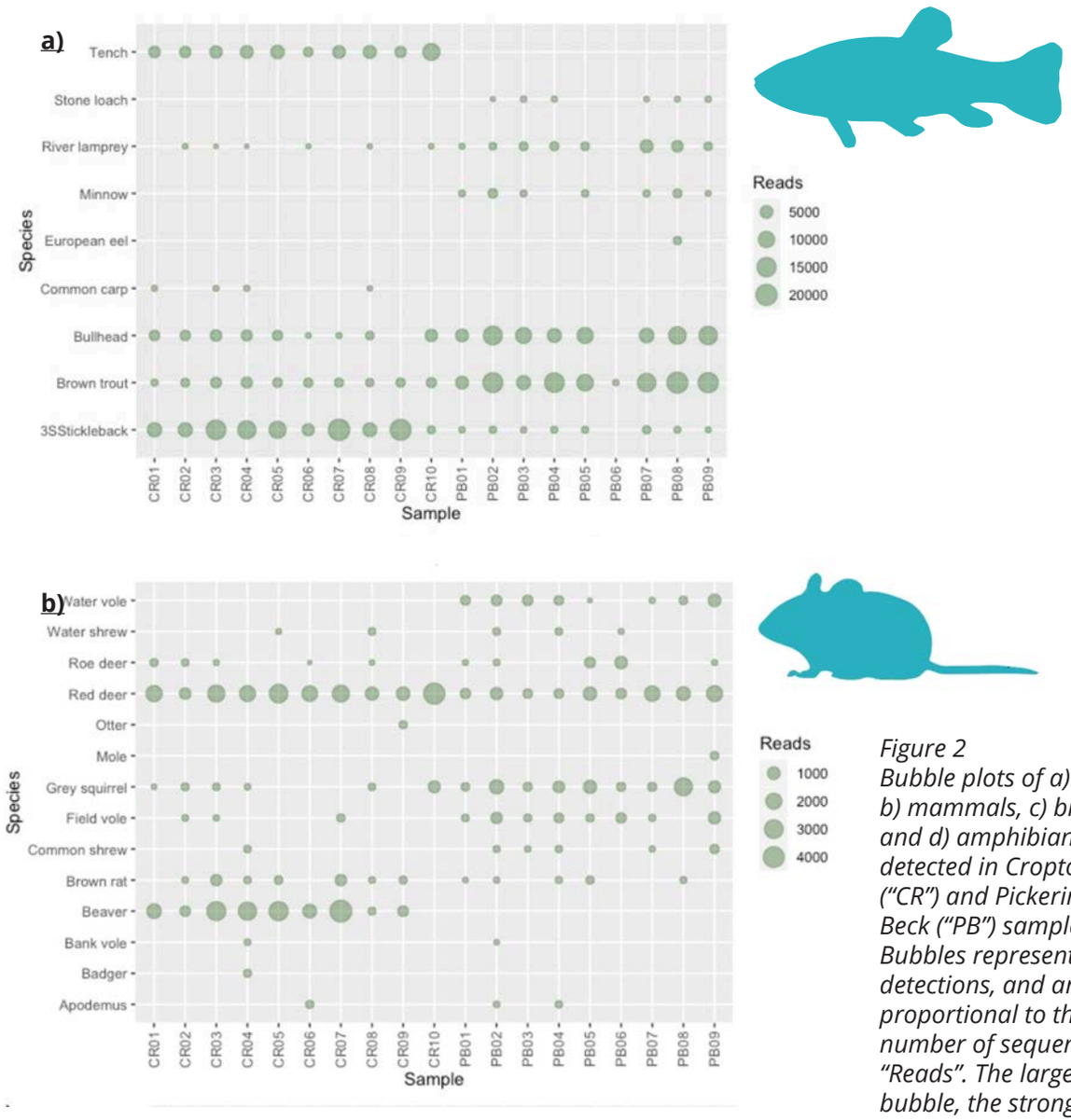
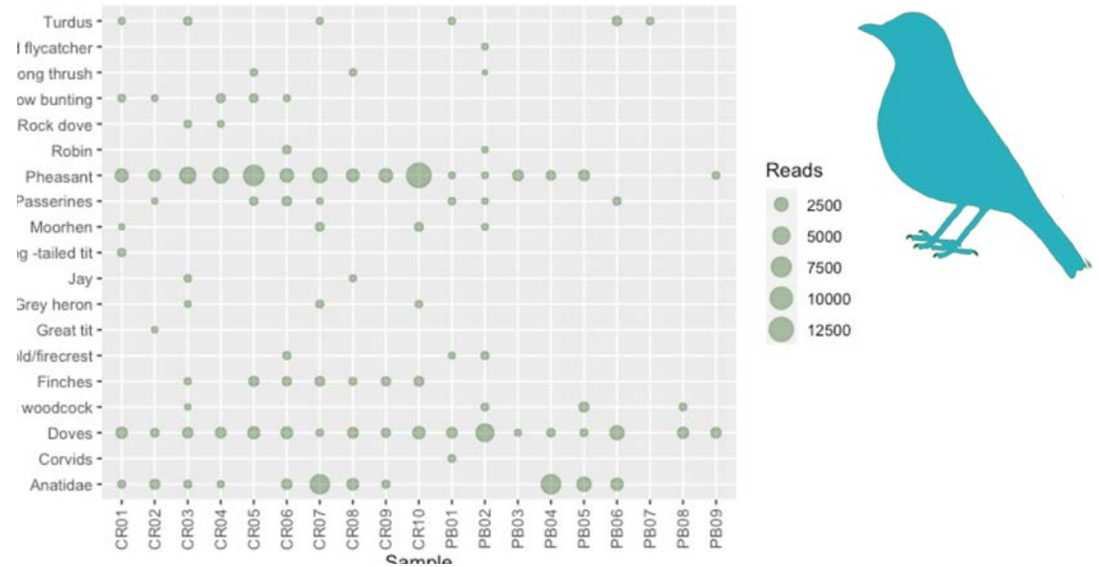


Figure 2
Bubble plots of a) fish, b) mammals, c) birds and d) amphibian taxa detected in Cropton ("CR") and Pickering Beck ("PB") samples. Bubbles represent detections, and are proportional to the number of sequence "Reads". The larger the bubble, the stronger the eDNA signal.

Birds

- Nineteen bird taxa were detected in total, with 17 detected at Cropton, and 12 detected at Pickering Beck (Figure. 2c).
- Snow bunting, rock dove, long-tailed tit, jay, grey heron, great tit, and Fringilla (finches) were detected at Cropton only, while spotted flycatcher and Corvidae (likely carrion crows) were only detected at Pickering.
- All the bird taxa detected in the enclosure were also detected in the bird survey at Cropton, carried out by Gibbons in 2020, except for snow bunting.

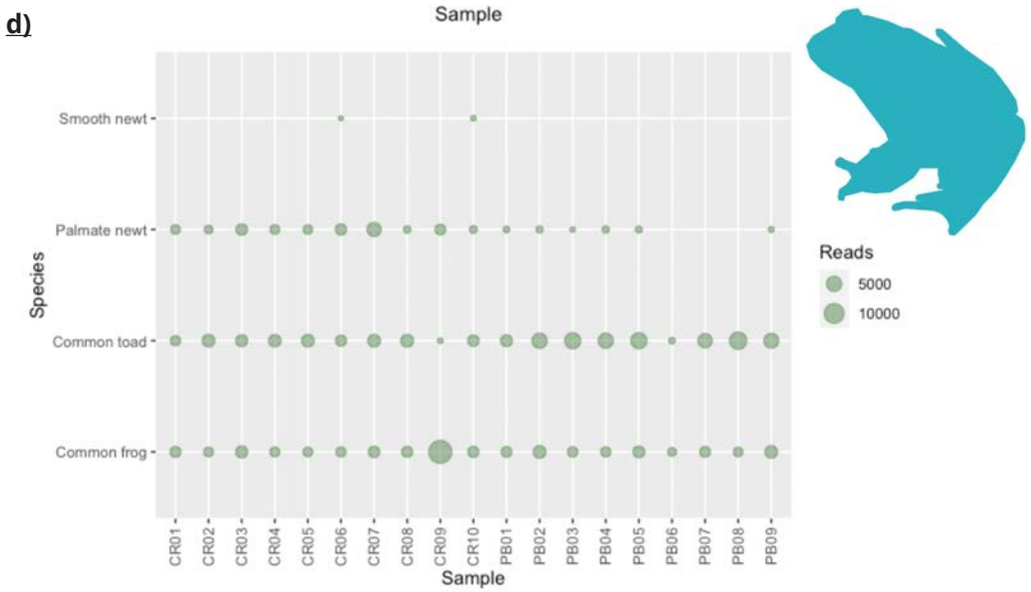
c)



Amphibians

- Four amphibian species were detected in total, with common frog and common toad detected in every sample from both Cropton and Pickering (Figure 2d).
- Palmate newt was detected in all Cropton samples, and in all but three Pickering samples.
- Smooth newt was detected in two Cropton samples only.

d)



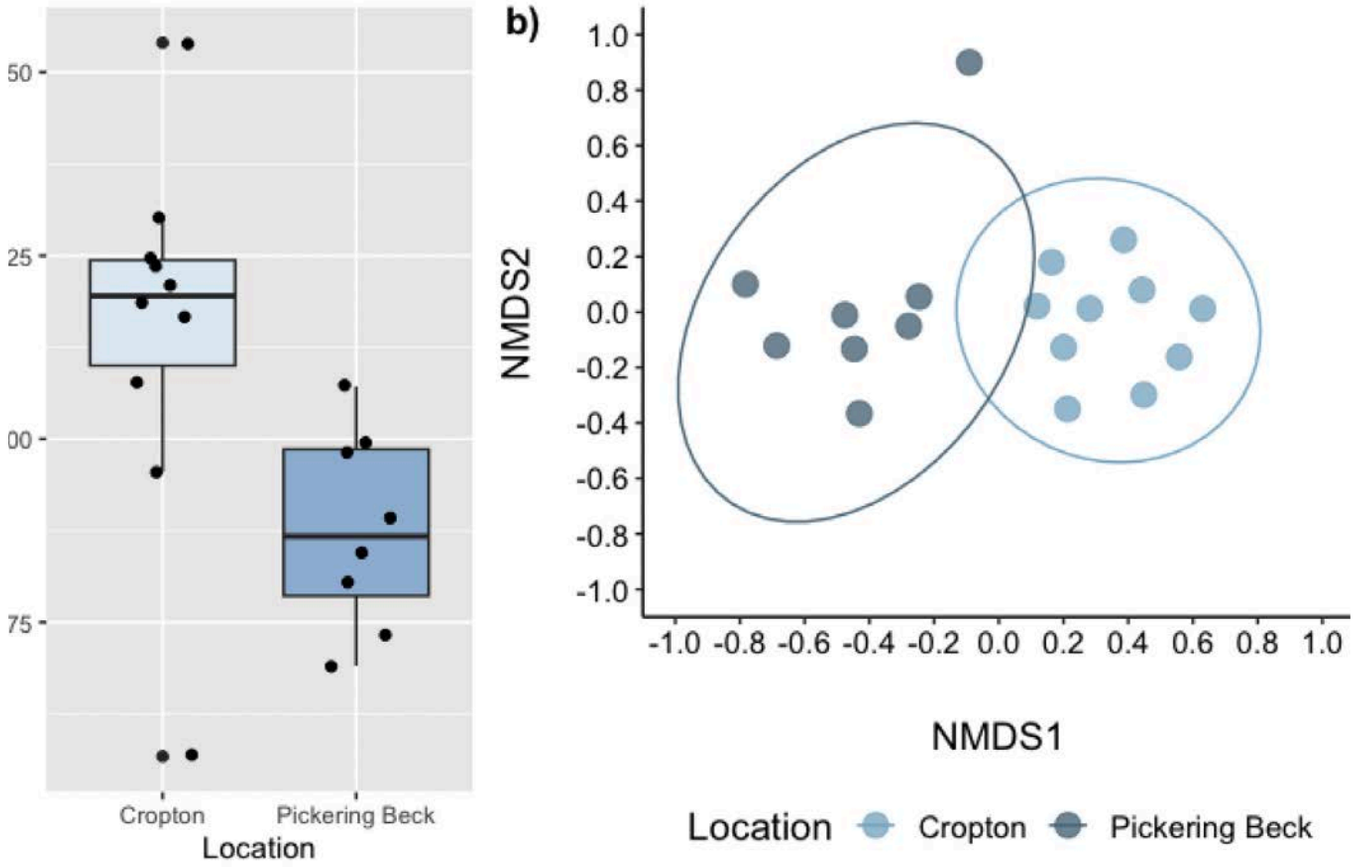


Figure 3
Vertebrate diversity at Cropton and Pickering Beck. a) Boxplot illustrating within-site diversity (estimated with the Shannon Diversity Index) is significantly higher at Cropton than at Pickering Beck (T Test P <0.05). b) Non-Metric MultiDimensional Scaling (NMDS) plot based on presence-absence of taxa, illustrating diversity within and between locations. The two locations are significantly different in composition (PERMANOVA, P<0.001). Each dot, in both figures, corresponds to an eDNA sample.

Next steps...

This small-scale survey provides a snapshot of the biodiversity present in Cropton and neighbouring Pickering Beck.

The results indicate that vertebrate diversity is slightly higher at Cropton, despite the enclosure itself presenting a considerable barrier. This likely reflects the mosaic of standing and flowing water habitats present in the beaver enclosure.

Further research is ongoing to understand whether this is a general pattern across reintroduction sites.

Footnote
*Lori Lawson Handley and Tom Spencer

Evolutionary and Environmental Genomics Group (EvoHull)
School of Natural Sciences
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Bats

Across the period of the trial, we monitored the effect the beaver activity was having on populations of bats within the enclosure site. The studies consisted of three methods, a transect, fixed point recording, and an examination of the bat boxes already located on site.

The transect and the fixed-point surveys were carried out in June, July and August and the bat boxes were checked twice in a year, once at the end April/early May and again in late September/early October. Bat box checks were disrupted by the Covid outbreak, and 3 visits could not take place in 2020 and 2021.

Results were analysed to identify species manually with some sent through to the British Trust for Ornithology for specific identification of the Myotis species. For analysis purposes, all Myotis bats were grouped together. Where more than one species of bat was recorded in a single file, each record was counted as an individual bat. Multiple passes within a file were still only counted as a single bat.

What did we find?

Species on Site

The impact of the beavers resulted in the following species becoming prevalent within the location.

- Natterer's (Myotis natteri)
- Daubenton's (Myotis daubentonii)
- Whiskered/Brandt's (Myotis mystacinus/Brantii)
- Common pipistrelle (pipistrellus pipistrellus)
- Soprano pipistrelle (Pipistrellus pygmaeus)
- Brown long-eared (Plecotus auritus)
- Noctule (Nyctalus noctula).

Noctule bat by endoscope during covid restrictions

Understanding the changes

Transect

The total number of bat passes counted across the 20 points provide a good indication of the overall level of bat activity. A plot of the totals (Figure. 1) shows a steady increase in bat activity across the transect in the 5 years of the project.

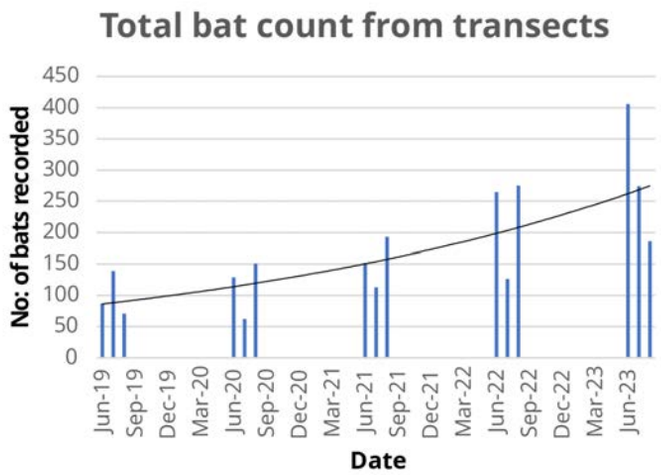


Figure 1 - Total bat counts from the monthly transects.

Fixed point

3 sites were chosen for the detectors, one by the original pond to the east, one in the centre and one at the west of the site. The results of the three individual recording sites show marked differences.

The eastern recorder was placed at the bottom of the lower pond and the site was quickly incorporated into the first large dam the beavers built. Almost all the beaver activity took place in this area in 2019 to 2021. The results from this recorder have been quite dramatic with bat usage increasing almost 10-fold. The increase is such that the numbers have, for practical purposes reached saturation point, i.e., almost continuous bat activity throughout the night on one week. This is mainly down to the increase in Pipistrelle activity with Myotis numbers being very variable. July values seem consistently below those of June and August (Figure. 2).

The central recorder has had very limited beaver activity, and the bat activity has shown a moderate increase based on a line of best fit. The tree cover is largely of pines and fir which have not been attractive to beavers and hence the habitat away from the stream has remained relatively constant. (Figure. 3)

The western recorder has remained consistently flat around the original index until the July and August 2023 (Figure 4.) This appears to be a direct reflection on the fact that there has been almost no beaver activity in this area until the winter of 2022/3 when firstly a dam was created at the very western end of the site close to the outlet grill, with a large second dam created further upstream. Following the creation of these dams and the removal of a considerable amount of birch by the beavers, there is a dramatic increase in bat activity with index figures of 116.4 in July and 336.5 in August 2023. These are the two highest figures for this recording point, and this is also reflected in the dramatic change to the Pipistrelle and Myotis number of bats using the location.

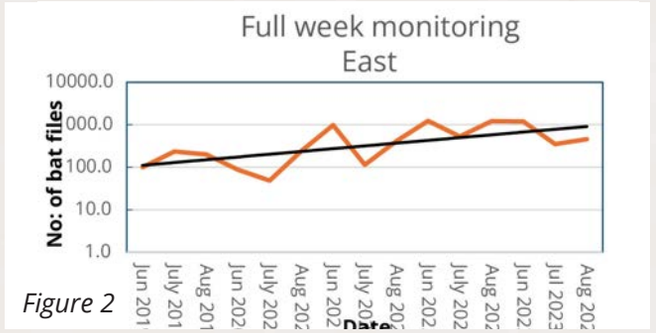


Figure 2

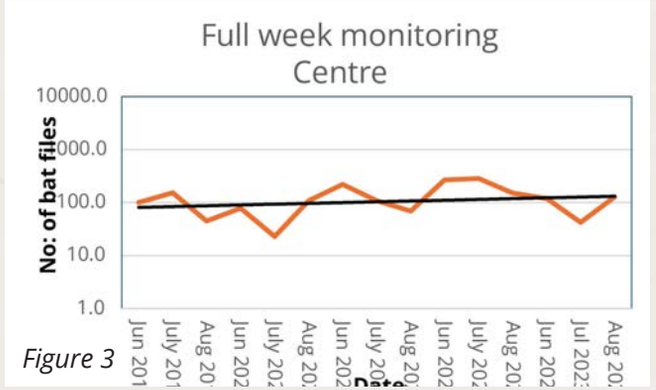


Figure 3

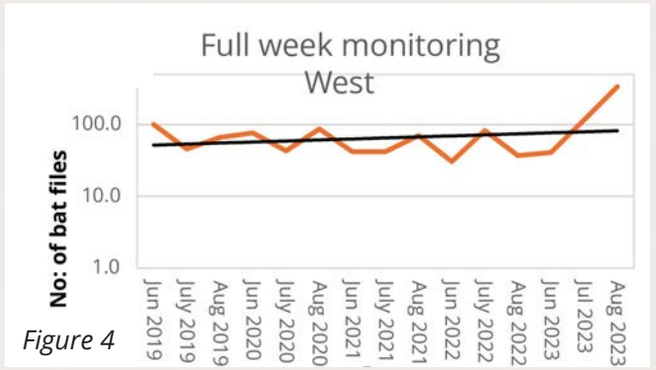


Figure 4

Figures 2, 3 & 4 - Total bat numbers plotted based on index of first month of recording (June 2019 =100) for eastern recorder, central recorder and western recorder.

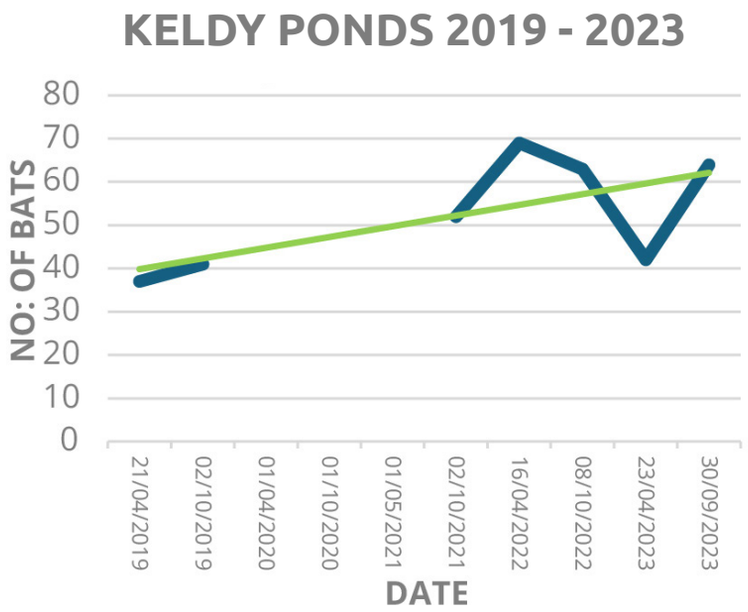


Figure 5 - Numbers of bats using the boxes have steadily increased across the period

Conclusions

The results demonstrate that the beavers have had a positive impact on the level of bat use of the site because of an improvement of the habitat for feeding i.e, an increase in invertebrate prey on the site. The level of Myotis detected by the eastern recorder adjacent to the pond is consistently lower in July than June and August. This is likely to be partly as a result of the growth of the water lilies which make the water unsuitable for low level hunting by Daubenton's bats in July and August. The reason for a higher value in August may be the addition of weaned pups adding to the numbers.

Looking at the historic bat box data from 1998-2011 there are no noctule records. These bats are now regularly recorded in the bat boxes in small numbers. This may be because of the site being much more open for a largely free flying bat or an increase in prey levels.

*Based on research carried out by Nick Gibbons. Raw data is available on request.

Birds

The dawn chorus

Bird surveying followed standard British Trust for Ornithology (BTO) methods, with the site being walked such that all the areas of interest were within 50 metres of the walked routes. 6 morning visits and 1 night visit were undertaken between end of March and early June to give the best possible chance of identifying all the early and late breeders and migrants present. All birds noted were recorded on large scale maps using standard BTO activity symbols.

Greg Conway (BTO) has pointed out that any result needs to be interpreted with caution due to the natural variability of bird populations from year to year and that this would have been best done with a similar local area being surveyed as a control. The lack of similar habitat close by and the impact of the restrictions may have made this difficult, but it is something we need to take into consideration of the comparisons. It is worth looking at some of the variations over the 5-year period by using data from other local databases.

*Based on research carried out by Nick Gibbons and Keith Wimbush.

Comparing forest and wetland bird species

There is a clear big decrease in the number of Great tit territories. This is against the trend found in the BTO Breeding Bird Survey results for Yorkshire and Humber where this species is increasing. Looking at the distribution of the territories on site, it appears the loss is in the central area of the site where there has been minimal beaver activity, so this decline is a bit of a mystery. Chaffinch has declined from 16 to 12 territories and again the 'missing territories' appear to be in the same location as the Great tits.

The loss of quite a large area of scrub willow and birch around the edge of the two eastern ponds does not seem to have had any significant effect on bird densities in this area.

There appears to be an increase in birds associated with wetland habitats, although this has been a much slower colonisation than expected. There has been just a single record of Moorhen and a single record of a pair of Greylag geese. Water rail is beginning to appear on a more regular basis on the trail cameras from 2022 and Mandarin duck have been noted in 2022 and 2023. Grey wagtail has increased from one territory to two with a pair utilising the new open wet area at the west end of the site where beavers started serious work late in 2022. Kingfisher are an increasing late summer/autumn visitor from casual records.

As expected, there will be winners and losers from the beavers' activities. They have removed a considerable area of scrub willow from within the original ponds which may affect certain species. However, as they have created a mosaic of open water and wet woodland, we would expect to see an expansion of the wetland species that seems to be slowly colonising, giving an overall increase to the site's biodiversity.

Fresh water invertebrates

River fly life

Surveys were undertaken using the recognised sampling technique for the River Fly Life Partnership, looking for the presence of eight target species groups.

These target species are:

- Cased Caddisflies
- Caseless Caddisflies
- Up winged flies Mayfly (Ephemeridae)
- Blue winged olive (Ephemerellidae)
- Flat Bodied (Heptageniidae)
- Olives (Baeitdae)
- Stoneflies
- Freshwater Shrimp (Gammarus)

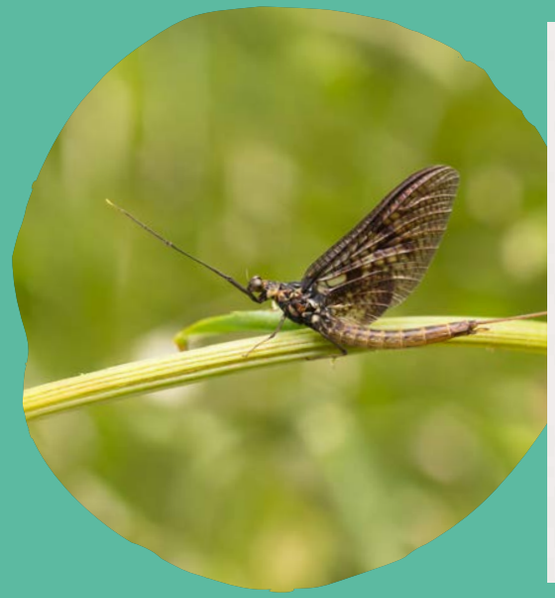
Sutherland beck is a typical upland stream from a moorland catchment. Nutrient poor and heavily shaded from both conifer planting and natural trees and shrubs. In consequence in 2018 there were small numbers of indicator species present.

Some of the sample sites had to be changed throughout the 5 years because of beaver activity. Species like mayfly have benefitted from the beavers' tree felling by opening up the river to more sun. This allows more macrophyte growth on the stream bed, providing more grazing material for aquatic invertebrates, leading to an increase in population.

Brown Trout that were naturally present within the stream have benefitted from the beaver activity and the size of the fish increased quickly over a short time. A heron was observed fishing on each visit.

A dynamic river habitat

The flow changes resulting from beaver activity have impacted survey results. The indicator species require site specific conditions to thrive. For example, Mayfly larvae require good clean organic silts and fine sands to burrow into. As beaver activity changed the habitat to create suitable conditions for mayfly larvae, over 50 were counted. In some areas, beaver activity changed flow regimes resulting in less clean sand and silt presence, in these areas mayfly numbers were reduced. This pattern was observed across all eight indicator species, which given the dynamism of the site is to be expected.



Conclusion

The eight indicator species have been quick to adapt to the changing stream. The surveys have also shown an increase in diversity of other species including brook lamprey, dragonfly larva, sticklebacks and blood worms.

*Based on research carried out by John Shannon, David Croft and Jennifer Grant.

Dragonflies and Amphibians

Dragonflies and Damselflies

In 2018, four species of dragonfly had been recorded at the ponds. The number of species were limited by the lack of suitable habitat, as the ponds were overshadowed by the surrounding woodland and choked with vegetation, leaving little open water. In 2021, the number of species recorded had doubled to eight. The activities of the beavers producing a more open habitat which was suitable for a greater number of species to colonise.

By the end of 2023, a total of 13 species had been recorded of which at least eight were considered breeding. The most notable of these being the striking Golden-ringed Dragonfly, normally associated with moorland streams and bogs, it appears content to breed in beaver ponds also. Three species recorded in 2018, Southern Hawker, Broad-bodied Chaser and Large Red Damselfly continue to breed and are now joined by Azure Damselfly, Four-spotted Chaser and Common Darter.

The expectation is that these populations will increase as habitats mature, as will the number of species breeding.

*Based on research carried out by Keith Gitten

Species	2018	2020	2021	2022	2023	Grand Total
Southern hawker	x	x	x	x	x	5
Brown hawker	x		x	x		3
Common hawker				x		1
Emperor dragonfly			x	x		2
Beautiful demoiselle				x		1
Azure damselfly			x	x	x	13
Golden-ringed dragonfly		x	x	x	x	4
Common blue damselfly				x	x	2
Emerald damselfly					x	1
Broad-bodied chaser	x			x	x	3
Four-spotted chaser			x	x	x	3
Large red damselfly	x		x	x	x	4
Common darter			x	x	x	3
No. of species	4	2	8	12	9	37

Amphibians

In 2018, 6 clumps of spawn were recorded in the bottom fishpond. In 2019, following a year of beaver activity, the amount of spawn was uncountable, with frog and toad activity all round both ponds. This had a knock-on effect up the food-chain with up to 15 herons visiting the site, increased otter footage and footage of rats and owls taking frogs and toads. Following the 2019 peak year for amphibians, levels have now stabilised at a much higher level and amphibians are found using more areas of the site than before the beaver release. The creation of a beaver pond at the west of the site in late 2022 saw the first records of amphibians at this location.

Small Mammals

Longworth Survey

One hundred Longworth live traps were placed in a variety of habitats across the site, baited with wheat, peanuts, sunflower seeds, carrots and blowfly pupae, with a ball of hay for bedding. These traps were set for 2 nights each year in September. The timeline shows small mammal populations changed across the site over the 5 years of the trial.

2018

Baseline Survey

In the first year of the survey, wood mice were the most caught small mammal. This was likely because the woodland, mostly made up of conifer trees. This favours wood mice as they are largely nocturnal compared to other small mammals so need less ground cover for protection from predators.

2019

Beavers Introduced

After beavers were introduced to the area, the number of wood mice caught near the first pond dropped slightly. This might have been due to the disturbance caused by the beavers, but the change was small and could also be part of natural population fluctuations.

Interestingly, a common shrew was found living in an artificial beaver lodge near the second pond. The beavers, however, didn't use this lodge and built their own soon after being released.

2018-22

Other Species

Throughout these years, a few other small mammals were also caught, but in small numbers. These included:

- Bank vole
- Field vole
- Common shrew

2023

Highest Diversity Recorded

In 2023, six different small mammal species were recorded—the highest diversity seen so far. These included:

- Bank vole
- Field vole
- Common shrew
- Pygmy shrew
- Water shrew

Water shrews had been suspected on wildlife cameras in previous years, so it was exciting to confirm their presence.

*Based on research carried out by Yorkshire Mammal Group.

Notable Animal Behavior

In 2022, several wood mice released near the second pond returned to the beaver dam instead of heading back into the woods. This suggests they may be living in the dam structure.

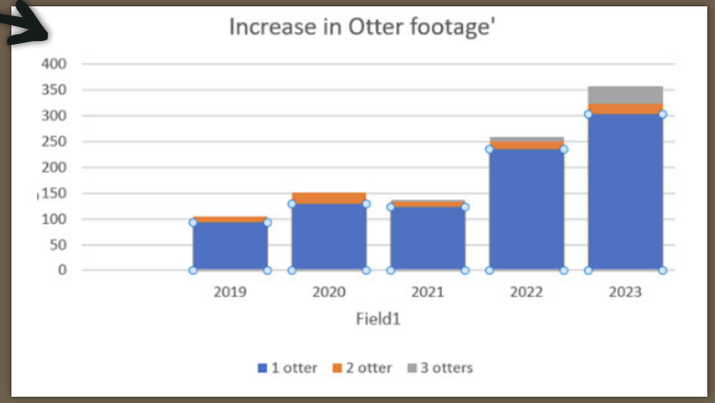
In 2023, a wood mouse released in a deciduous woodland area ran across a beaver dam into a coniferous woodland. This shows that mice are using the dams as bridges to cross the stream and expand their foraging area.

Overall Impact of Beavers

The presence of beavers appears to have had a positive effect on small mammal populations. Their activity has created more varied habitats, which support a wider range of species. There has been no evidence of a negative impact on the number of small mammals, and the new habitats should benefit even specialist species like water shrews.

Otters

Otters have been monitored throughout the trial using camera traps. Otter footage has more than doubled in the trial period.



Footage of otters captured in 2024 is more than double that of 2023 (not shown on graph), with otter cubs caught on camera in the enclosure in both 2022 and 2023.

Botany

The headlines

- The top pond has transitioned twice throughout the 5 years with species dominance changing in response to changing water levels.
- Wild daffodils on the bank below the main dam have reduced due to changing conditions but have increased around the top pond due to changes in light levels.
- At the start of the trial period (2019) the bottom pond was dominated by willow, waterlilies and duckweed. Now, lily cover is reduced with more open water and less duckweed and willow.
- There has been an increase in some wetland species including water starwort, lesser spearwort, tufted forget-me-not, marsh bedstraw and sedge species across the site. With increased water levels and change in canopy cover, there has been a decrease in heath species.
- As part of the natural landscaping the beavers carried out, we have seen Irises ‘planted’ along the length of the main dam to fill gaps and provide stability to the dam structure.
- In 2023, a new wetland area was created at the bottom of the site as water levels rose behind the beaver dam. This is being colonised with wetland species from the ponds at the top of the site, either transported through seeds in beaver droppings or through the water flow.
- Areas of dense birch scrub at the bottom of the site have been opened up, creating a rich mosaic of wetland, open areas and scrub. This area has seen greater light reaching the forest floor encouraging other species to regenerate.

Conclusion

The most significant conclusion of the botanical surveys is that the habitats are still changing rapidly in response to beaver activities. They have created a dynamic mosaic of habitats with continually changing species and distributions across the site.

Thank you

This project wouldn't have been possible without the help of many people. Forestry England would like to thank all the volunteers who together have put in hundreds of hours work surveying the site and checking the fences twice a week to ensure everything is safe. Without you the project wouldn't have been the success it has been. We would like to pay a special tribute to David Croft who showed immense enthusiasm for the trial and the freshwater invertebrate research but very sadly passed away before the end of trial.

A huge thank you to the team at Flamingo Land Zoo for your very important part in the project, housing the initial pair for health screening before the project and looking after the juveniles before they were relocated to other projects.

Thank you also to Derek Gow for helping to inspire the project in the first place and to Dr Roisin Campbell-Palmer and later The Beaver Trust for all your help and advice throughout the project.

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