

# Case study 15. Devon Beaver Project and River Otter Beaver Trial

**Authors:** Elly Andison, Peter Burgess, Mark Elliott

**Main driver:** Species reintroduction, habitat restoration, flood risk

**Project stage:** Underway, constructed in 2011



**Photo 1: Eurasian beaver** (source: Devon Wildlife Trust)

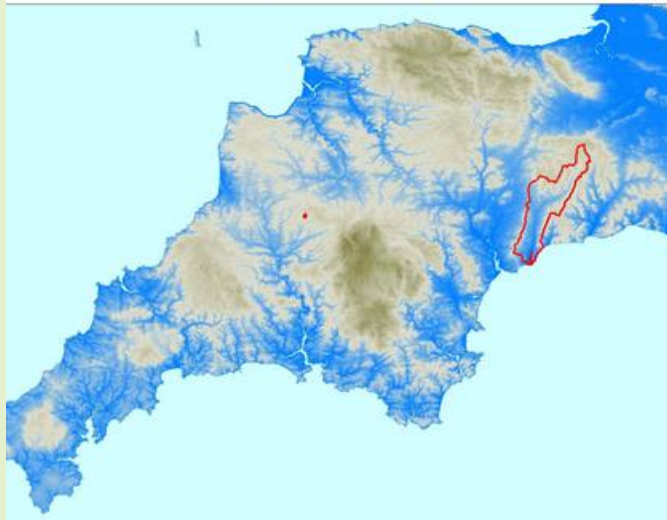
## Project summary:

The Eurasian beaver (*Castor fiber*) is a native species to Britain. After an absence of around 400 years, it has returned to being wild in the British landscape at 2 core locations in Scotland and as a free living population on the River Otter in Devon (Map 1). Devon Wildlife Trust has also been running a beaver project in a securely fenced, private site in western Devon since 2011. The site provides an ideal location to carry out detailed scientific studies into the impacts of beavers on hydrology and water quality. This work complements the catchment-scale data being secured through the monitoring strategy applied to the free-living beavers that form part of the River Otter Beaver Trial in east Devon. This covers the entire 250km<sup>2</sup> of the Otter catchment containing 594km of watercourse. More information on both the Devon Beaver Project and the River Otter Beaver Trial can be found on the Devon Wildlife Trust's website (<http://www.devonwildlifetrust.org/our-projects>).

## Key facts:

Since their introduction into the enclosed site, the beavers have:

- constructed 13 dams holding up to one million litres of additional water within ponds on the site
- influenced an area of 1.8ha equating to 56 litres of surface water storage per m<sup>2</sup> of land (during storm events, peak flows have been 30% lower on average leaving the site than entering)
- delayed the lag time between peak flow into the site and peak flow leaving the site (on average, one hour over a distance of 183m)
- reduced peak flow even in saturated conditions and for the largest monitored flood events (due to the hydraulic roughness of the dams and felled trees, and the leaky nature of the dams)
- resulted in significant and constant base flow from the site (even in periods of drought) through water storage and gentle release effect



**Map 1: Location of enclosed site project (red dot) in west Devon and the River Otter Beaver Trial (red enclosed area) in east Devon (source: Devon Wildlife Trust)**

© Crown Copyright and database rights 2012. Ordnance Survey Licence number 100022021

## 1. Contact details

Contact details	
<b>Name(s):</b>	Peter Burgess and Mark Elliott
<b>Lead organisation:</b>	Devon Wildlife Trust
<b>Partners:</b>	<p>The River Otter Beaver Trial is led by Devon Wildlife Trust working in partnership with the University of Exeter, Derek Gow Consultancy and Clinton Devon Estates. Expert independent advice is also provided by the Royal Zoological Society of Scotland, Professor John Gurnell, Professor Alastair Driver and Gerhard Schwab, an international beaver expert based in Bavaria, Germany.</p> <p>The Devon Beaver Project at the enclosed site in west Devon is also led by Devon Wildlife Trust in partnership with the University of Exeter and Derek Gow Consultancy</p>
<b>e-mail address:</b>	<p>Pburgess@devonwildlifetrust.org</p> <p>Melliott@devonwildlifetrust.org</p>

## 2. Location and catchment description

Catchment summary	
<b>National Grid Reference:</b>	Both projects are on private land so grid reference not included.
<b>Town, County, Country:</b>	Ottery St Mary and Cookworthy, Devon, UK
<b>Regional Flood and Coastal Committee (RFCC) region:</b>	South West
<b>Catchment name(s) and size (km<sup>2</sup>):</b>	River Otter catchment, 250km <sup>2</sup>

	River Tamar catchment
<b>River name(s) and typology:</b>	River Tamar and River Otter
<b>Water Framework Directive water body reference:</b>	No WFD waterbody number found for Cookworthy site. GB108045009170 for Ottery St Mary site
<b>Land use, soil type, geology, mean annual rainfall:</b>	Annual rainfall ranges from more than 1,000mm (40 inches) in the Blackdown Hills to less than 800mm (32 inches) on the coast (Environment Agency 2012)

### 3. Background summary of the catchment

#### Socioeconomic/historic context

The west Devon enclosure site is a first-order stream in a low intensity agricultural landscape. The second project is situated in a more intensively managed agricultural lowland landscape.

#### Flood risk problem(s)

A total of 28,198 people are at high or medium risk to flooding in east Devon (Environment Agency 2011). Devon's Preliminary Flood Risk Assessment identified around 30,800 residential properties as being at risk from surface water flooding more than 0.3m deep from a 1 in 200 year rainfall event (Queenan et al. 2011). This ranks Devon as the eighth most vulnerable area to surface water flooding nationally (Devon County Council 2015).

#### Other environmental problems

Intensively managed farmland in the Otter catchment, combined with friable sandy soils and steep slopes, increases the risk of serious diffuse pollution events arising from soil erosion, resulting in elevated nitrogen and phosphorus levels in watercourses. The enclosure site was initially a species-rich wet grass subject to successional change in vegetation, with the introduction of the beavers being a means of management.

### 4. Defining the problem(s) and developing the solution

#### What evidence is there to define the flood risk problem(s) and solution(s)

There is potential for beaver-generated wetlands to retain significant volumes of water in upper and middle reaches of river catchments. This can provide important landscape storage capacity in times of drought and can help dissipate flood events by slowing and broadening high water flows. This process will, however, be highly dynamic. There are a number of scientific studies supporting this from America (McFarlane et al. 2017) and Europe (Nyssen et al. 2011); the most recent and relevant study for England – based on evidence from the west Devon site – was led by Alan Puttock from the University of Exeter (Puttock et al. 2017).

#### What was the design rationale?

The Devon Beaver Project in west Devon was originally based on vegetation management, with an additional research element to see how the animals affected the landscape in other ways. Significant evidence has been gathered for this site for the effect on sediment retention, water quality and ecology.

The River Otter site is a rigorously and independently monitored trial reintroduction of the Eurasian beaver in England for a 5-year period. This was not a planned reintroduction, but was set up as a result of finding an established population from an unknown source. This then developed into a formal project with additional licenced releases. The aims of the project on the River Otter are to:

- establish a healthy population of Eurasian beavers in a lowland English river catchment
- demonstrate that beavers will have a positive impact on the ecological health of the river system and associated riparian land
- demonstrate that the beavers and their impacts will, on balance, be regarded by the local community and stakeholders as tolerable/positive

Comprehensive studies are ongoing to understand flood risk management effects alongside other factors such as fish passage.

Data and evidence will be gathered and effective management and mitigation techniques developed, building on the [Scottish Beaver Project](#).

There are comprehensive studies ongoing to understand flood risk management effects alongside other factors such as fish passage.

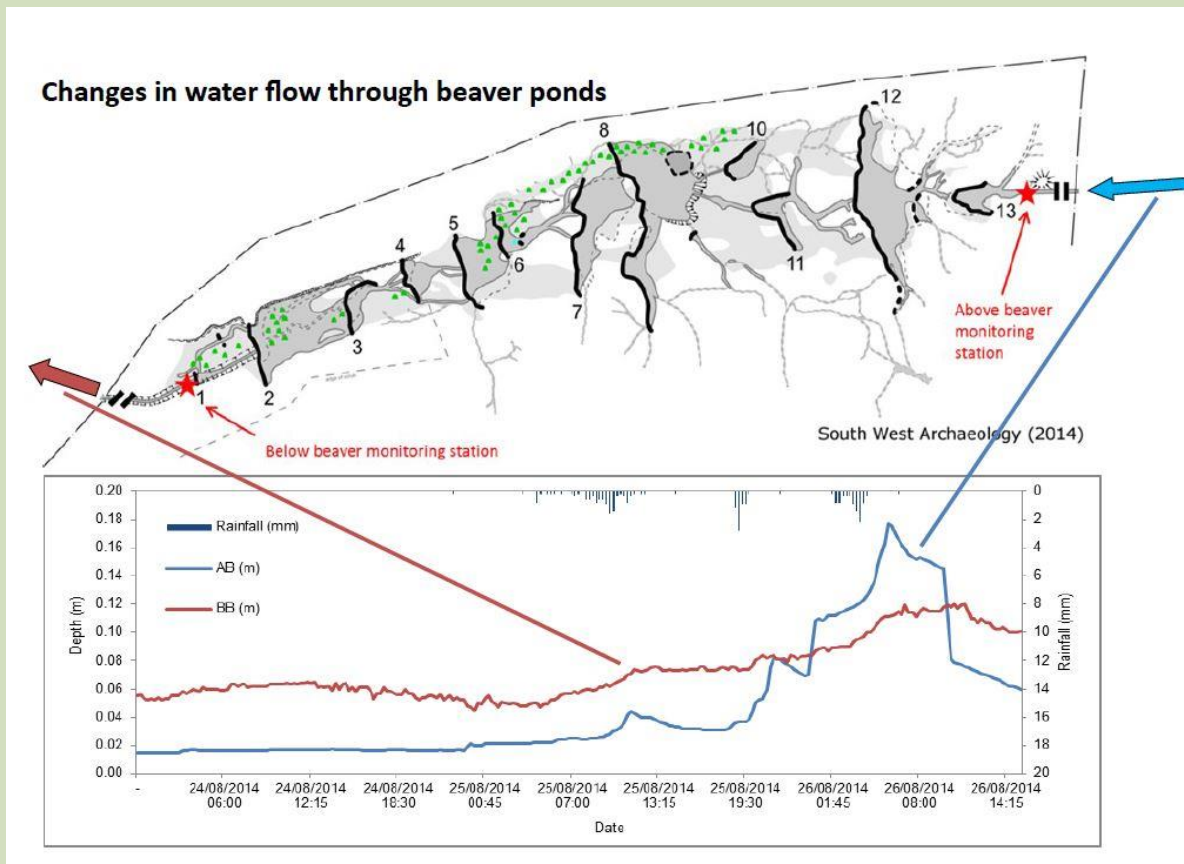
### Project summary

<b>Area of catchment (km<sup>2</sup>) or length of river benefitting from the project:</b>	Tamar: 3ha site with ~200m of watercourse within the site enclosure Otter: 250km <sup>2</sup>
<b>Types of measures/interventions used (Working with Natural Processes and traditional):</b>	Reintroduction of native species Woody material dams, earth dams, habitat restoration and creation
<b>Numbers of measures/interventions used (Working with Natural Processes and traditional):</b>	Not applicable
<b>Standard of protection for project as a whole:</b>	Not applicable
<b>Estimated number of properties protected:</b>	Project is gathering evidence that will inform understanding

### How effective has the project been?

- Since their introduction into the enclosed site, the beavers have constructed 13 dams holding up to one million litres of additional water within ponds on the site.
- The area influenced is 1.8ha, equating to 56 litres of surface water storage per m<sup>2</sup> of land. During storm events, on average, peak flows have been 30% lower leaving the site than entering.
- The lag time between peak flow into the site and peak flow leaving the site has been, on average, one hour over a distance of 183m (Figure 1).
- Even in saturated conditions and for the largest monitored flood events, the flood peaks are still reduced due to the hydraulic roughness of the dams and felled trees, and the leaky nature of the dams.
- The water storage and gentle release effect resulted in significant and constant baseflow from the site, even when periods of drought eliminated flows into the site.
- During storms events, each litre of surface water leaving the beaver-modified site contains 3 times less sediment than the water entering the site. On average, 112mgL<sup>-1</sup> of sediment enters the site, but less than 40mgL<sup>-1</sup> of sediment leaves the site.

The River Otter trial is still in its early stages, but baseline evidence has been gathered for a number of topics and there is some evidence of beavers influencing their surroundings.



**Figure 1: Reduced and delayed flood peak below the west Devon enclosure site (source: University of Exeter and Devon Wildlife Trust)**

## 5. Project construction

### How were individual measures constructed?

For the River Beaver Project in west Devon, a male and a female beaver were introduced into a 3ha fenced enclosure in the Tamar headwaters in 2011, where their impacts are being studied in detail.

The River Otter Project was not a planned reintroduction, but was set up as a result of finding an established population from an unknown source. This then developed into a project with additional licenced releases.

### How long were measures designed to last?

The measures are designed to last for at least 10 years – the lifespan of the fence at the enclosed site in west Devon.

Measures and information for both projects are frequently reviewed, and maintenance and mitigation are addressed in a proposed management strategy for the River Otter Beaver Trial. This understanding will add to the recently published 'Eurasian Beaver Handbook' (Campbell-Palmer et al. 2016).

### Were there any landowner or legal requirements which needed consideration?

- Landowner negotiations
- Licencing arrangements
- Consents for environmental permits
- Some animal health work

## 6. Funding

### Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures

<b>Year project was undertaken/completed:</b>	Devon Beaver Project (enclosed site): 2011 River Otter Beaver Trial: 2015
<b>How was the project funded:</b>	<p>Funding for the Devon Beaver Project site has come from Natural England through Higher Level Stewardship (that is, via Pillar 2 of the Common Agricultural Policy). The beavers are owned and managed by the Derek Gow Consultancy. The initial fencing and other infrastructure was funded by Viridor Credits Environmental Company and the Truell Charitable Foundation.</p> <p>Funding for the River Otter Beaver Trial comes from Devon Wildlife Trust, the Royal Society for Wildlife Trusts, Peter de Haan Charitable Trust, Garfield Weston Foundation, the University of Exeter and generous donations from the public.</p> <p>In 2016, Devon Wildlife Trust launched a crowdfunding campaign to encourage the public to donate to the project in return for a series of unusual things such as beaver chips, guided walks or the appearance of the Nora the beaver mascot at an event.</p>
<b>Total cash cost of project (£):</b>	
<b>Overall cost and cost breakdown for WWNP/NFM measures (£):</b>	
<b>WWNP/NFM costs as a % of overall project costs:</b>	
<b>Unit breakdown of costs for WWNP/NFM measures:</b>	
<b>Cost–benefit ratio (and timescale in years over which it has been estimated):</b>	

## 7. Wider benefits

### What wider benefits has the project achieved?

- By the time the water has flowed through the sequence of beaver dams, a high proportion of the diffuse pollutants from agriculture have been removed from the water. These settle out in the ponds.
- The engineering activities of beavers results in a heterogeneous habitat structure, increasing botanical and invertebrate diversity. This provides an increase in food availability for bats, allowing the site to support a higher biomass of bats, as well as attracting rarer species.
- Bryophytes species indicate that beaver habitat offers improved environmental conditions and habitat quality, resulting in an increase in the total number, evenness and rarity of the species present.
- Beavers create a variety of aquatic habitats, encouraging the colonisation of a wide range of aquatic invertebrates, including species associated with pond habitats.
- Information is being gathered in the River Otter Beaver Trial to understand the impact on tourism and

community and fish, and the potential for education opportunities.

### **How much habitat has been created, improved or restored?**

Since 2011, the beavers have constructed 13 ponds of varying sizes over 180m of watercourse. The dramatic engineering of the watercourse in this site has provided a perfect opportunity to study the impacts of beaver dams on a wide range of different subjects. Most of the results presented in this case study are from this research site.

## **8. Maintenance, monitoring and adaptive management**

### **Are maintenance activities planned?**

No specific maintenance activities are planned for either site, as the aim is to understand the influence of beavers on the different landscape types. However, for the free living population on the River Otter there is a comprehensive management strategy; methods of management and mitigation and will be put in place during the life of the project where appropriate. These ways of working and techniques will inform any future releases across England.

### **Is the project being monitored?**

Comprehensive monitoring plans are in place for both sites led primarily by the University of Exeter.

Information monitoring at the enclosed site in west Devon is given on the project's dedicated web pages on the Devon Wildlife Trust's website ([www.devonwildlifetrust.org/devon-beaver-project](http://www.devonwildlifetrust.org/devon-beaver-project)). Some of the equipment used for hydrological measurements at the site is shown in Photo 2.



**Photo 2: Experimental 'V' notch design for hydrological measurements at the west Devon enclosure (source: Devon Wildlife Trust and University of Exeter)**

The detailed monitoring plan for the River Otter Beaver Trial can be downloaded from the trial's dedicated web pages on the Devon Wildlife Trust ([www.devonwildlifetrust.org/river-otter-beavers](http://www.devonwildlifetrust.org/river-otter-beavers)).

- The amount of water entering, being stored within and leaving the enclosed area has been monitored by the University of Exeter via a network of instrumented weirs and dipwells.

- Annual vegetation surveys are carried out by Devon Wildlife Trust.
- The University of Exeter has analysed the water quality.
- Southampton University is leading a team of fisheries and engineering specialists seeking to understand the effects of changes to the structure of watercourses as a result of beaver dams on fish populations and any impacts on migration of salmonids.
- Detailed ecological surveys have been made at the enclosure site and the Biodiversity Quality Calculator (developed by Ecosulis) has been used to understand how beavers affect biodiversity.
- There are 4 years remaining for Devon Wildlife Trust to monitor the impacts of the beavers on their environment.

The UK government will decide on the long-term future of Devon's wild beavers based on the evidence provided by Devon Wildlife Trust and project partners on the beavers' impacts on landscape, wildlife and communities in the Otter catchment. Natural England has stated that the outcome of the River Otter Beaver Trial will determine any future beaver reintroduction projects in England.

### **Has adaptive management been needed?**

Beavers are widely referred to as ecosystem engineers as they modify river systems and surrounding riparian areas to create suitable habitat, both for themselves and for a wide range of other species. Beavers are also termed keystone species, having a disproportionately large impact on aquatic ecosystems relative to their abundance. Beavers modify and maintain the environment around them, creating complex wetland ecosystems consisting predominantly of tall herb fen, wet meadows and coppice wet woodland. Management may be required at certain locations and a strategy is in place for the River Otter Beaver Trial that will inform future management strategies. Mitigation techniques are available where appropriate.

## **9. Lessons learnt**

### **What was learnt and how could it be applied elsewhere?**

- Beavers are highly effective for managing and creating wetland habitats. They will often create new wetland habitats by damming watercourses in those areas where there is no deep water and their willow coppicing activities maintain open mosaic habitats.
- The creation of these habitats is providing evidence that demonstrates benefits for flood attenuation (that is, slowing the flow). There are also a suite of other benefits including water quality improvements, biological diversity and abundance. Evidence continues to be gathered and features studies in relation to flood risk benefits and interpretation of the location of dams.
- Reintroduction of this species should be considered at a catchment scale rather than at a site scale, with the species often only moving into headwaters and suboptimal habitats as part of the colonisation of the wider catchment.
- Deep water should always be present on a release site. Beavers are very mobile animals and are likely to move out into the wider catchment if they are released into suboptimal sites, unless constrained by fencing or other occupied beaver territories.
- Release of beavers into the wild currently requires a licence from Natural England.
- Keeping beavers in large enclosures for a number of years can be achieved with high specification, purpose-built fencing.

All types of influences are being studied. This will allow a balanced, scientifically understood approach to any further introductions. The River Otter Beaver Trial will include recommendations on management methods. Further information on the application of mitigation methods can be found in Campbell-Palmer et al. (2016).



## 10. Bibliography

CAMPBELL-PALMER, R., GOW, D., CAMPBELL, R., DICKINSON, H., GIRLING, S., GURNELL, J., HALLEY, D., JONES, S., LISLE, S., PARKER, H., SCHWAB, G. AND ROSELL, F., 2016. *The Eurasian Beaver Handbook: Ecology and management of Castor fiber*. Exeter: Pelagic Publishing.

DEVON COUNTRY COUNCIL, 2015. *Flood risk – state of environment Devon and Torbay*. Exeter: Devon County Council. Available from: <http://www.naturaldevon.org.uk/wp-content/uploads/2016/02/Flood-Risk-2015.pdf> [Accessed 22 March 2017].

ENVIRONMENT AGENCY, 2011. *Flood Risk Maps. Risk of flooding from rivers and sea – South West River Basin District*. Bristol: Environment Agency. Available from: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/456947/LIT8976\\_FloodRiskMaps\\_SouthWest\\_RiversSea\\_v2.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/456947/LIT8976_FloodRiskMaps_SouthWest_RiversSea_v2.pdf) [Accessed 22 March 2017].

ENVIRONMENT AGENCY, 2012. *East Devon Catchment Flood Management Plan. Summary report*. Exeter: Environment Agency. Available from: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/294049/East\\_Devon\\_Catchment\\_Flood\\_Management\\_Plan.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/294049/East_Devon_Catchment_Flood_Management_Plan.pdf) [Accessed 22 March 2017].

MCFARLANE, W.W., WHEATON, J.M., BOUWES, N., JENSEN, M.L., GILBERT, J.T., HOUGH-SNEE, N. AND SHIVK, J.A., 2017. Modeling the capacity of riverscapes to support beaver dams. *Geomorphology*, 277, 72-99.

NYSSSEN, J., PONTZEELE, J. AND BILLI, P., 2011. Effect of beaver dams on the hydrology of small mountain streams: example from the Cheval in the Ourthe Orientale basin, Ardennes, Belgium. *Journal of Hydrology*, 402 (1-2), 92-102.

PUTTOCK, A., GRAHAM, H.A., CUNLIFFE, A.M., ELLIOTT, M. AND BRAZIER, R.E., 2017. Eurasian beaver activity increases water storage, attenuates flow and mitigates diffuse pollution from intensively-managed grasslands. *Science of the Total Environment*, 576, 430-443. Available from: <http://www.sciencedirect.com/science/article/pii/S0048969716323099> [Accessed 22 March 2017].

QUEENAN, D., BOLT, J. AND RAINBOW, R., 2011. *Devon County Council. Preliminary flood risk assessment report*. Final report. Exeter: Devon County Council. Available from: <https://new.devon.gov.uk/floodriskmanagement/flood-investigations-reports-and-studies/> [Accessed 22 March 2017].

### Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's [Joint Flood and Coastal Erosion Risk Management Research and Development Programme](#).