

The Devon Beaver Project

The story so far...



Devon



In March 2011 a pair of juvenile Eurasian beavers (*Castor fiber*) were released into a 3 hectare fenced enclosure on private land in northern Devon.

The objectives of the project are to use beavers to restore an area of nationally important wet grassland and to understand the effects that this native, but UK extinct, species will have on this environment.

This project aims to study the effects that beavers have on these wetlands. This will help to inform future decisions about the potential reintroduction of this species into the wider countryside.

Photo by David Plummer
www.davidplummerimages.co.uk

Introduction to the site

For many years Devon Wildlife Trust (DWT) has been working with, and supporting farmers in, the Culm Measures to restore wet grassland habitats which are vulnerable to scrub encroachment.

Historically species such as the Eurasian beaver and other large herbivores would have naturally helped maintain pockets of open grassland within the landscape. These grasslands would also have had greater agricultural importance and been managed as an integral part of extensive farming systems.

In 2009 a north Devon landowner and DWT started to explore the idea of using beavers as a sustainable way of preventing scrub encroaching across an important Culm grassland County Wildlife Site (CWS).

The site is situated in the headwaters of the Tamar river catchment. Despite previous intensive efforts to manage the scrub, a large proportion of the grassland habitats were still being affected by willow, birch and gorse encroachment. Just under 3ha (7 acres) of the site was selected as being suitable for the experiment and was subsequently fenced.

Beaver release

On 16th March 2011 a pair of beavers were released into the enclosure. The male and female beavers were both selected from captive bred animals of the eastern race of Eurasian beavers that originated in Bavaria. They were two years old at the time of release and were housed together for a number of weeks prior to being moved into the enclosure.

The beavers were placed directly into an artificial log and turf lodge that had been constructed alongside a small pond. All had been carefully designed to help the beavers settle in their new surroundings.

Although the beavers had transponders implanted into them, it was decided, for welfare reasons, that they should not have radio-tracking devices attached to them. Instead they have been monitored using a network of camera traps located in various places within the enclosure.



In the summer of 2010 a 900m fence was erected following specification guidance from Natural England. The fence was made of 125 cm high galvanised 'pig netting', with a 'skirt' of buried weld-mesh running horizontally around the inside of the fence to help prevent the beavers digging underneath. Two strands of electric wire were secured around the inside perimeter of the fence, powered with a large battery with a solar panel charger.





Purple moor-grass rush pastures are a UK Priority Biodiversity Action Plan (BAP) habitat, found predominantly on poorly drained heavy clay soils in the UK where rainfall levels are high.

They include a wide spectrum of different plant communities that have distinct local variation. Where these habitats are found overlying the Culm Measures they are referred to as Culm grasslands. Approximately 3,500 hectares of Culm grassland remain in Devon and have been the focus of considerable conservation efforts since the late 1980's. On this site, the grassland communities most closely match the *Molinia caerulea* – *Cirsium dissectum* (M24c) fen meadow.

Culm grasslands are semi-natural habitats that support a rich diversity of wildlife. The marsh fritillary butterfly is a rare species that has a stronghold in the Culm. The butterfly is found where it's food plant, Devils-bit scabious, is found in abundance alongside sympathetic management.



Wet woodland habitats within the site also hold significant biodiversity value, and changes to these habitats are an integral element of the monitoring programme. Sphagnum moss and wet flush communities comprise a large proportion of the woodland ground flora.



Sphagnum squarrosum
Picture: Nigel Pinhorn.

An intensive and wide ranging programme of ecological, environmental and behavioural research work is being undertaken.



Science and monitoring

Detailed ecological data are being collected to better understand the changes influenced by the beavers. Surveys of vegetation communities, habitat structure and indicator species are being carried out. In addition, data have been gathered to better understand important features such as dead wood and vegetation height. 96 fixed point photographs have been taken every six months to provide a visual record of changes.

Detailed topographical maps have allowed new water features to be accurately measured and pond volumes calculated, so that when assessed alongside water level and flow recording, changes to water retention potential of the site can be assessed.



A drop disk is used to measure vegetation height



A large dam has been cleared at the top of the watercourse which holds back a pond of around 355m²

Photo by David Plummer - www.davidplummerimages.co.uk

Eurasian beavers - a keystone species

A keystone species is a term used to describe a species that has a disproportionately large effect on its environment relative to its abundance. A wide range of wetland ecosystems in Europe would have been dependant on an environment created and shaped by beavers over millennia.

Beavers feel safe in water. They use existing wetlands, and the ponds and canals that they create, to exploit their environment. Within a few weeks of release, regular tracks through the wet woodland floor were forming, and these have gradually evolved into an extensive network of ponds and pools, connected by 'beaver canals' through the woodland. These are used as transport routes to access and exploit new feeding areas.

Dams were gradually created using a combination of mud and cut, often de-barked, willow sticks. Regular maintenance by repairing low spots of the dams, and extending them laterally was observed, gradually increasing the size of the ponds. Features such as fallen logs and site topography were clearly exploited to enable dam construction.

The beavers have focused the majority of their activity in a narrow corridor through which the site's only minor watercourse and associated 'wet flush' is located. Many trees and shrubs have been coppiced by the beavers. This has led to the canopy being much more structurally diverse, and in some areas quite sparse. A linked network of 8 ponds of varying sizes now occupy positions along the entire length of this watercourse.



Photo by David Plummer - www.davidplummerimages.co.uk



One of the 'canals' dug by the beavers connecting ponds and pools



An interesting aspect of their behaviour has been the height above the ground that the beavers travel to source food. Where willow trees have been growing at an angle, beavers have been able to climb and cut branches at least 2 metres above ground level.

The lodge

A beaver lodge is a complex structure designed to provide protection from weather and predation. The beavers were released into a simple chamber that had been constructed with lengths of wood and a capping sheet of tin. The lodge was located adjacent to the only excavated pond. Since release they have gradually transformed the single chamber into a much larger and more complex lodge.

A new underwater entrance was immediately excavated, which was visible during the dry spring of 2011. Since then a large pile of cut willow sticks has now been placed over both the front and rear entrances. Some of these willow sticks have now sprouted, both softening the appearance of the lodge and creating a more solid structure.

Regular pathways around the rear of the lodge are now developing into channels. With continued use and mud manipulation, combined with the gradual increase in water levels caused by dam building, the lodge may soon become an island.

Breeding

In the summer of 2013 one of the adults started using a new structure separate from the main lodge, and sounds of kits could be heard. At around this time the focus of their behaviour shifted to a series of new pools and tunnels just off the main pond, and the adults became noticeably more timid and skittish. A few weeks later at least one kit was seen on the pond.

In subsequent years the project will be proactive in ensuring that the population inside in the enclosure does not exceed the carrying capacity of the habitat, and that the welfare of the animals is safeguarded. However with such a high quality habitat and limited exploitation of the enclosure to date, it seems unlikely that removing animals will be necessary in the near future.



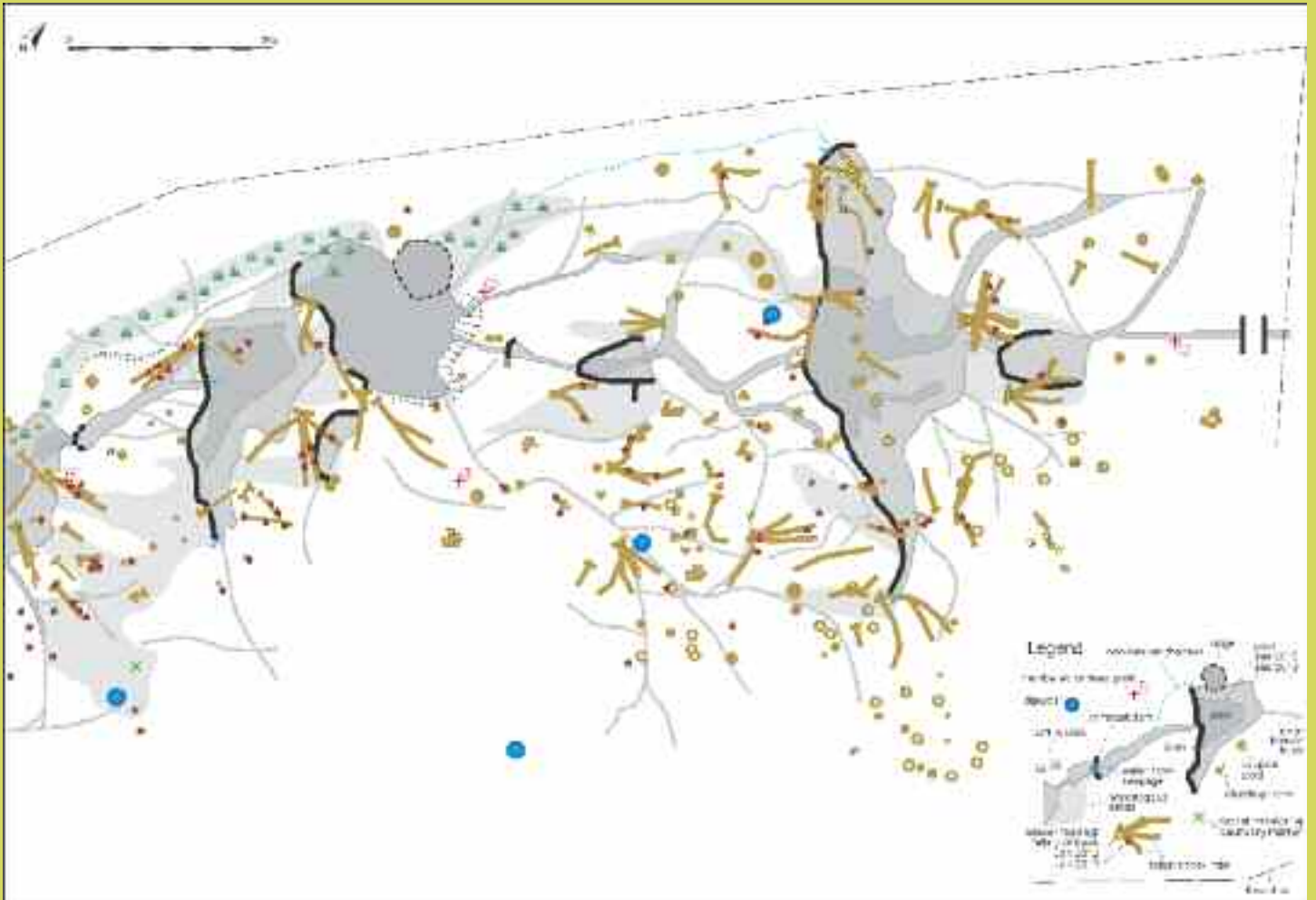
Seasonal changes in behaviour

Beaver diet is strongly influenced by vegetation availability. During the summer months, when soft vegetation is abundant and rich, much of their diet will consist of grasses, rushes, tall herbs and young woody shoots. During the autumn and winter the beavers focus on woody vegetation and bark.

In autumn 2011 the beavers started to cache food in the lodge pond. This consisted of a pile of branches (<7cm diameter) that formed an area of a few metres square in the centre of the pond, close to the lodge. Storing food in this way makes it easily accessible in prolonged periods of cold weather. It does mean that any remaining willow left in the spring begins to shoot, creating an island of living willow.

Beaver behaviour also anecdotally appears to be influenced by water flows. During dry periods when the water levels drop throughout the site, there appears to be very little construction and dam building activity. This would seem logical if a frequently reported stimulus for dam enlargement is the flow of water over low spots in the existing dams.

Nature's aquatic engineers



Prior to works commencing in 2010 open water was restricted to a trickle of water that flowed through the woodland, and only in parts was this a defined channel. In the woodland, a few pools could be found under upturned root plates of windblown trees.

By March 2012 (end of first year) a total of 8 large ponds had been created, with a total surface area of over 900m².

Detailed and accurate plans have been drawn up by surveyors from South West Archaeology. The plans clearly show the extent of the new aquatic habitats and tree removal. Prior to the introduction of the beavers, there was no open water at all in this part of the site with the exception of the small pond excavated adjacent to the lodge. The small inlet stream dissipated into the wet woodland, so all features illustrated have been created by the beavers over two years.



Exploratory pathways through the site have evolved, through beaver activity, into channels – often known as canals. These canals get deeper the more they are used and connect the areas of open water. Beavers have been observed to deepen them by digging and depositing the soil in banks and dams. Within a week of the beavers being released into their enclosure, a completely new watercourse

had been created through the wet woodland floor. Two years later this now forms one of the main channels for the beavers to navigate and for water to flow through the site.

The ponds gradually formed as dams were made from a lattice of mud and sticks placed across any streams flowing through their territory. As water built up behind them, the dams were extended sideways and upwards by dredging mud using their chests and front legs.

The dams are permeable and seep in a number of places along their length. This has resulted in a series of new streams flowing downstream from the various dams, where once there may have been only one. In this way, a whole series of new temporary and more permanent channels are being created through the increasingly wet woodland. If extrapolated across a catchment, the role beavers play in the creation of a more dynamic and braided river system would be very significant.





Beavers feel safe in water and create canals to allow them to exploit their territory

Impacts on habitats and species

Ecological surveys have involved dividing the site into three distinct zones: wet woodland comprising mostly of mature willow trees with some sphagnum and other wet woodland communities; open Culm grassland dominated by purple moor grass with patches of lower scrub; and a transitional community of woodland edge habitats made up of younger birch and willow trees.

The beavers are having a dramatic impact on the mature scrub cover along the watercourse corridor, creating large clearings and glades and increasing the diversity of the ground flora.

Within this site grey willow, hazel and blackthorn are all readily selected by the beavers. The beavers coppice ash, but then do not appear to feed on it or utilise it for building.

The following detailed baseline information has been collected:

- NVC Vegetation Communities
- Vegetation height (using dropdisk)
- Tree volume measure (using Reloscope)
- Proportion of dead wood
- Visual changes (using 96 fixed point photography points)
- Amphibians
- Terrestrial and aquatic invertebrates
- Breeding birds
- Bats
- Moth species
- Marsh fritillary butterfly



Since spring 2013 the beavers have made frequent forays into the Culm grassland, sometimes in excess of 30m from the watercourse. They appear to have been actively selecting young willow scrub from the Culm grassland, leaving the downy birch untouched.

A few stems of gorse have been taken which they have sampled as a food resource, and one stem was found woven into a dam. However despite it being widespread within their area of activity, they do not appear to be having an impact on the gorse component of the scrub.

With time these access routes through the Culm grassland are likely to become water filled channels. Elsewhere the beavers have yet to have any noticeable impacts on those drier parts of the site further from watercourses.

Before



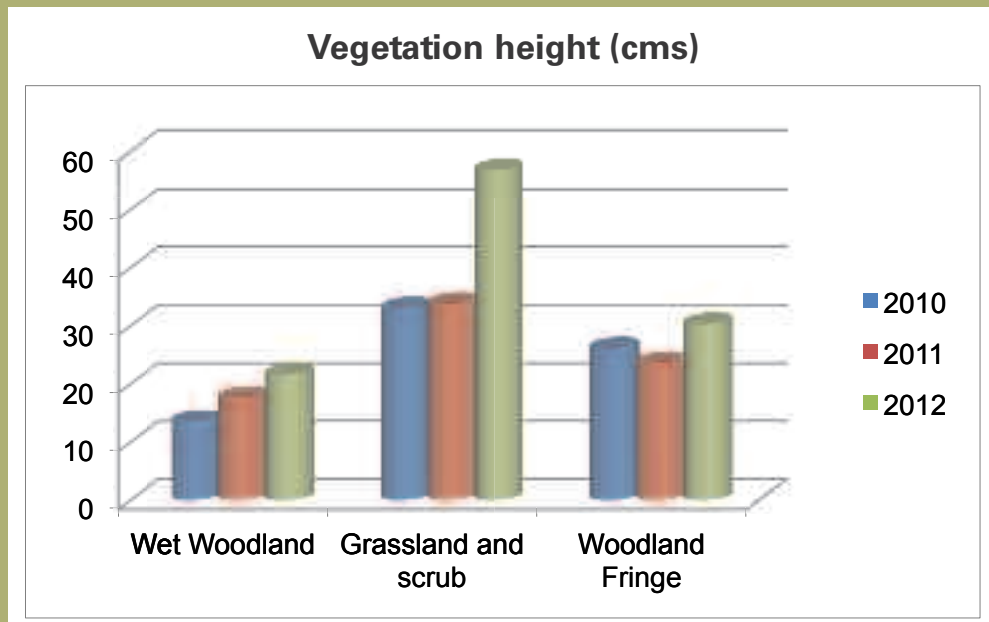
After



Cut willow quickly regrows providing a constant supply of fresh shoots



A mosaic of wetland habitats have been created alongside the existing Culm grassland habitats.



A drop disk is being used to assess changes to the vegetation height. This will tell us how effectively the beavers are changing the dynamic between the grassland and scrub.



Golden ringed dragonfly

The open water habitats are readily being colonised by a wide range of aquatic invertebrates, and this is expected to further increase as the ponds become more stable. 16 species of water beetle, four stonefly species, five caddis fly species, five dragonflies and a range of other groups were all recorded over three visits in the summer 2012.



Barbastelle bat

Elsewhere in Europe, studies have found that bats¹, in particular, benefit from the extra wetland, grassland and woodland edge habitats created by beaver activity. Detailed surveys of bats have been undertaken on this site, recording all bat activity during a defined transect. Five species of bat have so far been recorded, including daubentons, and most notably barbastelle.



Woodcock

The site supports a diverse range of breeding and overwintering bird species. Spotted flycatchers, grasshopper warblers, lesser redpoll, great spotted woodpeckers, marsh tit and cuckoo have all been recorded within the enclosure since the start of the project. Woodcock particularly seem to be making good use of the wet open woodlands and have been picked up by the camera traps and surveyors.

¹. Ciechanowski et al. Reintroduction of beavers *Castor fiber* may improve habitat quality for vespertilionid bats foraging in small river valleys. *European Journal of Wildlife Research*, Aug 2011. Vol 57, Issue 4.



For amphibians like common frogs there were limited opportunities for breeding prior to the introduction of beavers. A walkover survey in spring 2011 identified ten clumps of frog spawn, mainly in disturbed ground. By the spring of 2013, 310 clumps of frogspawn were counted, and 75% of these clumps were found in the shallow margins of four of the beaver ponds.

As an anecdotal observation at the start of the project, most of the woodland was easily navigable in wellington boots. However, some parts of it are now so treacherous, that surveyors risk sinking to their waists. The range of additional ecological niches that have been created is impressive, possibly at the expense of areas of dense mature willow woodland.



55 mosses and liverworts were recorded in July 2012 including six species of Sphagnum moss which were recorded in the waterlogged woodland areas.



Not all frog spawn is laid in ponds! On this site the phenomenon of star spawn is very common, where female frogs are taken into trees by predatory birds, which leave the eggs behind which then swell in the moist air.

Ecosystem services

There is considerable wider interest in the potential for beavers to influence the environment, and to therefore have an impact on the provision of ecosystem services. In particular the project has made initial investigations into the effects of beaver activity on watercourse flow rates and water quality.

The attenuation of floods during extreme rainfall events, and increased base flows during prolonged droughts, are potential benefits of increased volumes of water being stored in ponds and wetlands. The filtering of water as it passes through the ponds and dams is also hoped to have a beneficial effect on water quality.



Downloading water level data from the dipwells



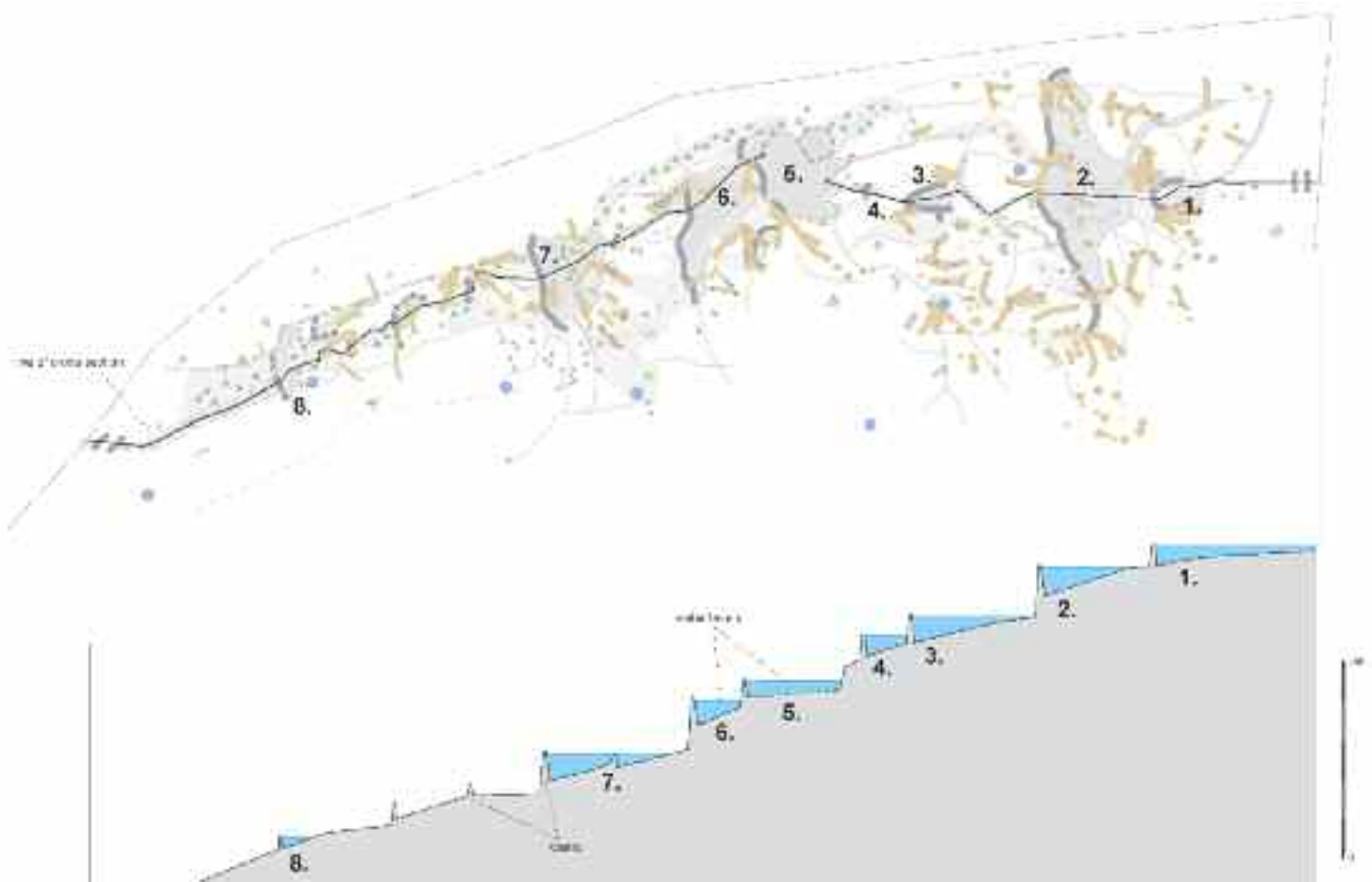
Water quality

Regular water sampling was undertaken between November 2011 and December 2012 looking at a wide range of biological and chemical parameters, at both the watercourse inflow and outflow points. In addition invertebrate sampling is being used to provide water quality scores for most of the ponds and has also been undertaken in 2011 and 2012.

The quality of water entering the site is generally very good, and so the beneficial effects of the beaver ponds and dams removing sediment and other pollutants is insignificant. Indeed some of the chemical and biological indicators are picking up the turbid conditions caused by the beavers themselves and their dredging activities. However their role in reducing elevated levels of pollutants has been identified on a number of occasions.

For example, in the spring 2013 a slick of slurry entered the site from the intensive farmland above. The ponds were observed to effectively hold the slurry back, reducing the visible pollution impacts downstream. This has had a very detrimental impact on the ecological quality of the ponds, which suffered an algal bloom caused by the resultant eutrophication. Although an anecdotal observation, such pollution events could be replicated and analysed using inert material.

Early indications are that water quality would benefit from a low population of beavers on a watercourse with existing elevated levels of some pollutants. It is envisaged that benefits would be more pronounced if beaver dams were abandoned, maybe due to the change of focus in territory. Again this is an exciting aspect that would benefit from more detailed research.



A detailed cross section plan showing the gradient through the site with a vertical exaggeration. Prior to the introduction of the beavers only pond 5 existed

Water resources

The modification of the water flow on this site has resulted in the storage of large volumes of water within this tiny headwater stream. The eight ponds alone have a total volume of 416m³. These vary in surface area from 6m² to 335m², within a 100m length of headwater stream.

If this was extrapolated across a larger proportion of the catchment, the impacts on flood flows and droughts would be highly significant. DWT would like to carry out further recording of flows in the watercourse downstream of the enclosure in future years to quantify this impact.

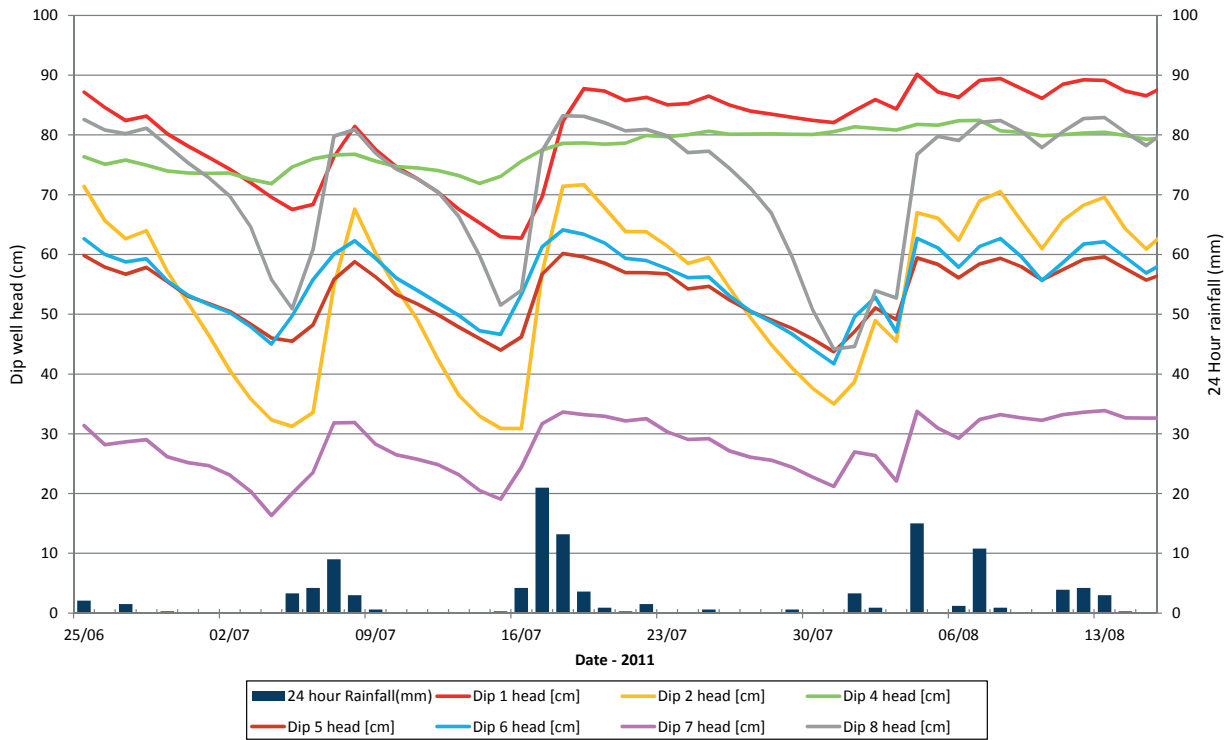
A key feature of these dams which makes them so beneficial for flood risk management is the constant trickle flow that arises from them. A series of ponds that are permanently full would have a much reduced flood alleviation benefit because their capacity to capture floodwater would be restricted. Pond water levels have been observed to drop dramatically and this ensures that there is capacity for new floodwater to be stored during the next significant rainfall event.

Allied to this, and of particular interest, might be temporary abandonment of dams, which leaves the structure in place, but would see much reduced water levels.

In addition to the ponds, canals and streams, water is stored in the surrounding soils. Although previously soils were saturated in much of the site, the network of dams and ponds appear to have actually raised ground levels in a few areas, creating quaking bogs and liquefied soil.

The physical changes to the streams through the creation of smaller multiple channels further reduces flow rates.

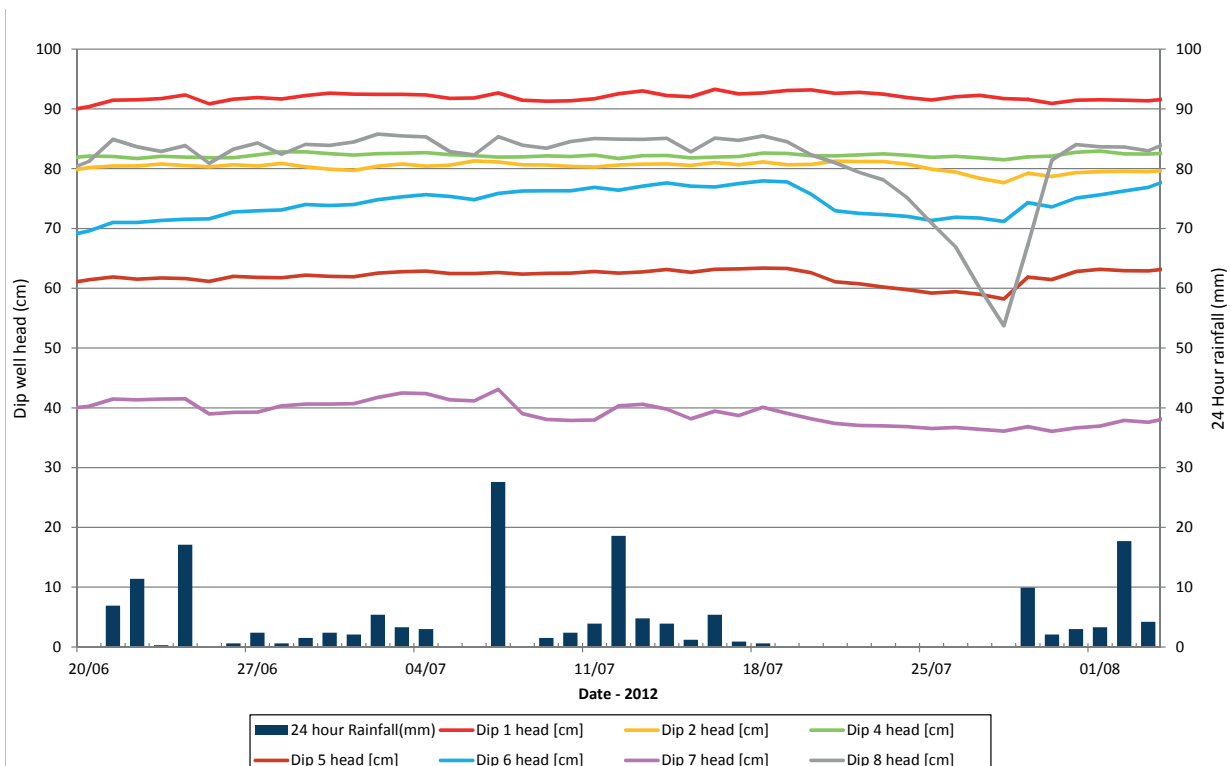




A network of eight dipwells were installed in the spring of 2011 to monitor ground water levels in different parts of the site.

The dipwell data are already revealing changes to groundwater that are occurring. When the graphs of soil water levels in 2011 (above) and 2012 (below) are compared, it appears to show that the levels are fluctuating less, presumably because the beaver dams are holding water back. If this trend could also be shown in the stream, it would strongly indicate that beavers could reduce flood peaks and also increase base flows during droughts.

This area of research is already yielding interesting results and it is hoped to expand it further in future years, incorporating the watercourses upstream and downstream of the enclosure.





Next steps

The Devon Beaver Project has made significant progress in our understanding of the effects of beavers on wetlands of international wildlife value. A dynamic influence has been introduced that has created new and valued habitats, whilst helping to maintain existing features. Very encouraging early results have been secured that illustrate the value of beavers in the delivery of important public goods – water resources being the most prominent, and salient in the face of our changing climate. The breadth and depth of survey and monitoring work that has been completed is unparalleled in the Culm. However it is too early to make any robust conclusions from this site alone. Nevertheless, the vast majority of our analyses strongly point toward the benefits of beavers to this site, where a new and previously unachievable diversity of wildlife has been supported.

Devon Wildlife Trust will coordinate future survey and monitoring in the spheres of ecosystem service delivery, the impacts on Culm wetland ecology, and also beaver behaviour and habitat exploitation. This is and continues to be an extremely exciting initiative, providing all concerned with a wealth of new knowledge and insight.

Acknowledgements and links to other projects

This project would not have been possible without the funding of Viridor Credits Environmental Company and the Truell Charitable Foundation.

A huge debt of gratitude is due to the landowners John and Elaine Morgan whose dedication and enthusiasm for the project knows no bounds. Derek Gow and Rebecca Northey (Derek Gow Consultancy) have provided considerable expertise on the ecology of beavers, as well as providing the beavers themselves.

Scientists from the Scottish Beaver Trial have been supportive of the Devon Beaver Project throughout, and there has been considerable exchange of ideas and experience. The Scottish Trial is due to report in 2014, after which a decision will be made about the future of the species north of the border. Particular thanks are due to Simon Jones and Roisin Campbell-Palmer.
www.scottishbeavers.org.uk

The Beaver Advisory Committee for England (BACE), which is helping to co-ordinate the gathering of information needed to inform the debate on beaver re-introduction.
www.beaversinengland.com

The Welsh Beaver Project is investigating the feasibility of bringing beavers back to Wales. www.welshbeaverproject.org

Many of the great photographs of the beavers and habitats included in this document were taken by David Plummer.
www.davidplummerimages.co.uk

The aerial photos were taken by Flyonix using a camera mounted on a remote controlled helicopter. www.flyonix.com

Contact the Devon Beaver Project at:

Devon Wildlife Trust
Cricklepit Mill
Commercial Road
Exeter EX2 4AB

melliott@devonwildlifetrust.org

01409 221823

pburgess@devonwildlifetrust.org

01392 279244



Funded by Viridor Credits
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