CHAPTER 1:

Living with beavers on the River Otter

The River Otter rises in the pastoral landscape of the Blackdown Hills and flows just to the north of Honiton

Catchment Overview

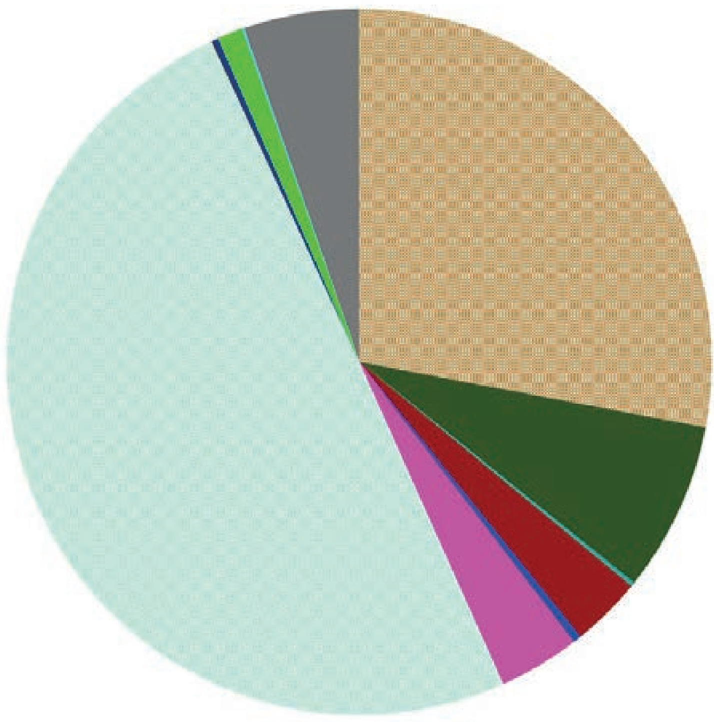
Geography of the River Otter catchment

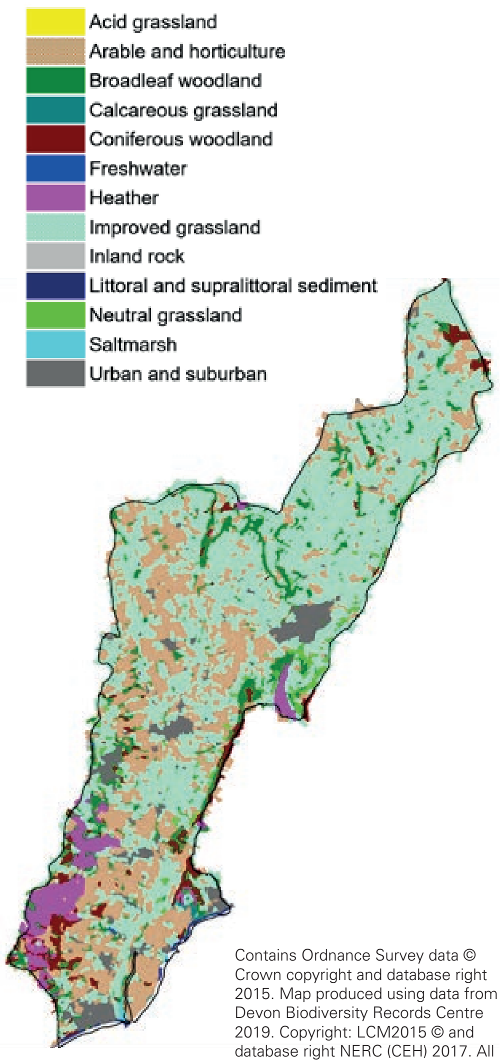
The River Otter rises in the Blackdown Hills, from a *Cretaceous* Upper Greensand scarp at 275 m above sea level, which defines the eastern edge of the catchment as far south as Sidmouth. The western boundary is formed by a ridge of *Permian* Sandstone. Between these two ridges lies an area of *Triassic* Mercia Mudstone which runs to Ottery St Mary. East and south of Ottery St Mary the geology changes to Otter Sandstone. The bedrock is overlain by alluvium and river terrace deposits, with fine sandy and silty soils.

The Otter is a predominately rural catchment, with generally small, dispersed settlements. The only towns are Honiton, Ottery St Mary and Budleigh Salterton. The northern part of the catchment is characterised by rolling hills with small field systems, enclosed by hedgerows, supporting mostly pastoral farms, whereas more intensive agricultural practices, including arable land use, dominate the southern catchment. There are several coniferous and broadleaved plantations on the greensand ridge that runs along the northern and eastern side of the catchment, with more conifer plantations around the East Devon Pebblebed Heaths to the southwest.

Figure 1.1 Land use in the River Otter Catchment

The catchment covers ca. 250 km^2 (25,010 ha). Landuse composes: 50% improved grassland, 28% arable and horticulture and 5% urban and suburban. The remaining 17% is covered by woodland, other grasslands, heathland, freshwater, saltmarsh, littoral sediment, and supra-littoral sediment[1].





Acknowledgements: The following datasets have been used in the derivation of LCM2015 Vector (GB):

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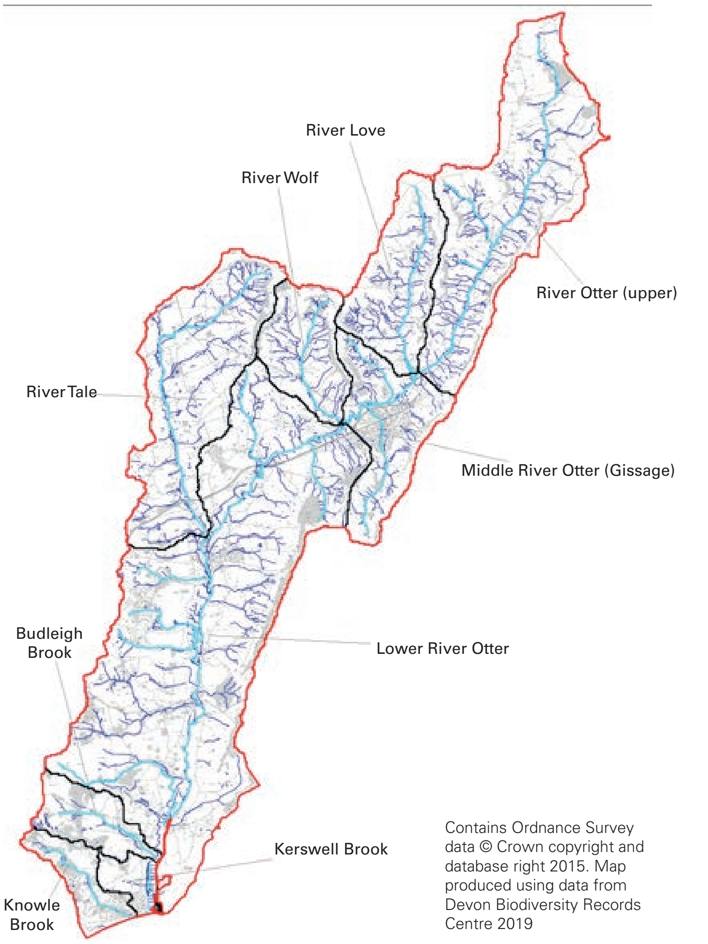
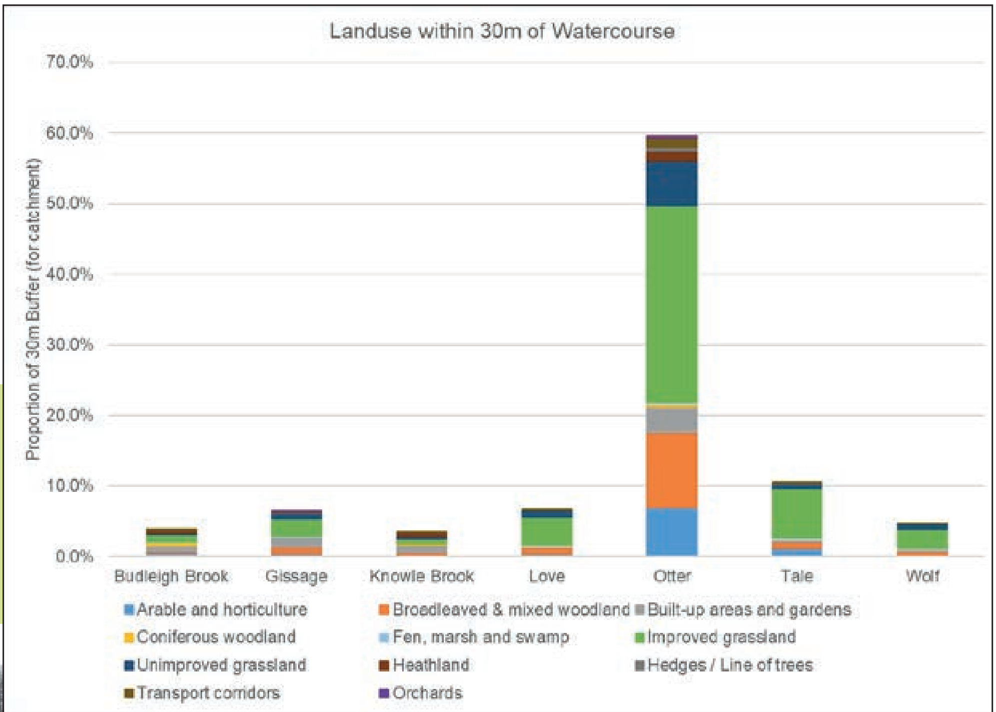
Figure 1.2 Watercourses within the catchment

The River Otter is divided into nine sub-catchments, with the main tributaries being the River Tale, the River Love and the River Wolf all rising from the Upper Greensand scarp, along with the Upper Otter. The main stem of the river is in excess of 65 km in length between the Otterhead Lakes and the sea.



Land-use adjacent to watercourses

Survey work carried out during the Trial shows that 99.8% of feeding signs are detected within 30 m of the banks of watercourses (see figure 5.1).



→ **Figure 1.3** Aerial Photographic Interpretation of the land-use within a 30 m buffer of all of the key watercourses within the catchment identifies the land-uses most likely to be affected by the activities of beavers. The total area of this buffer is 3,378 ha.

← A small buffer strip between floodplain pasture and the river provides a number of benefits.

Beaver colonisation of the River Otter catchment

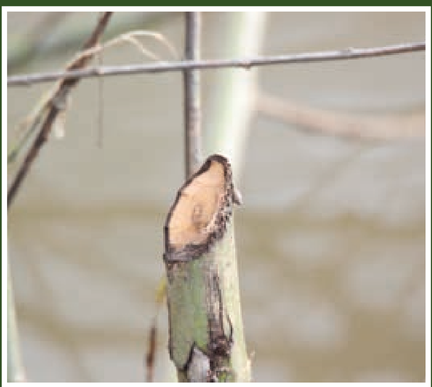
→ The ROBT team were able to increase the efficiency of survey work through the acquisition of a Trimble Geo7 GPS device that allowed the user to input data directly into a Geographical Information System (GIS).

Methods for monitoring beaver distribution

As with many mammals, surveying beaver field signs (gnawed trees, burrows, lodges, canals) is the best way of monitoring the number and distribution of territories. At the start of the ROBT, monitoring techniques developed by the Scottish Beaver Trial were adapted for the River Otter. However, repetition of detailed surveys every 3 months proved impractical across a large catchment which contains a great deal of dense, bankside vegetation. Therefore, the survey technique was revised to record feeding signs on woody material once a year (January-March), capturing a snapshot of the winter distribution of the animals (details published in Campbell-Palmer et al., 2019[2,3]). Data of woody feeding signs collected in the field were used to produce heat maps derived using a 'kernel density algorithm' within a search area of 250 m.

Figure 1.4 Browsing by beavers on trees was recorded into three impact classes using this classification

Photos: Sylvie Meller



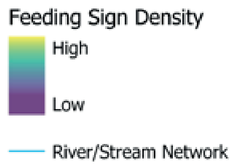
Low Impact – fewer than 20 cuts (branches or stems), all <7 cm in diameter, and / or stripped bark area <10 hands (ca. 0.2 m²).

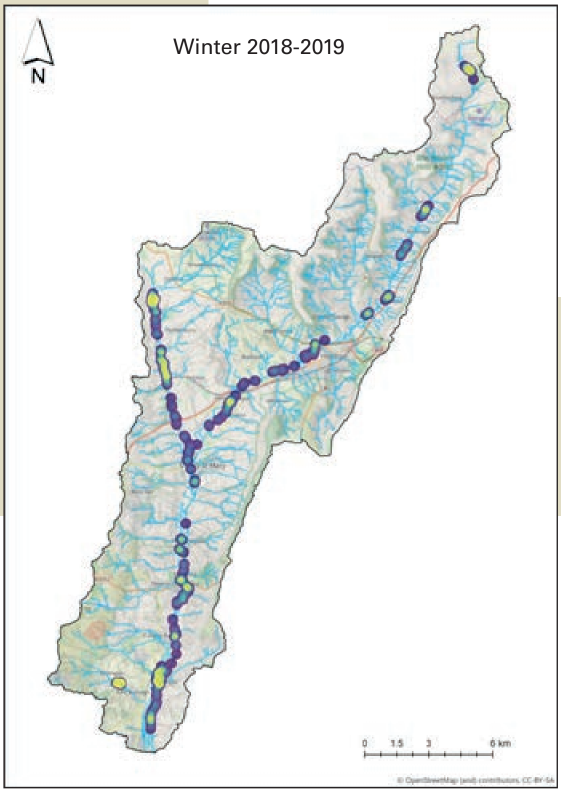
Medium Impact – greater than 20 cuts (branches or stems), or with at least one >7 cm in diameter, and / or a stripped bark area >10 hands (ca. 0.2 m²).

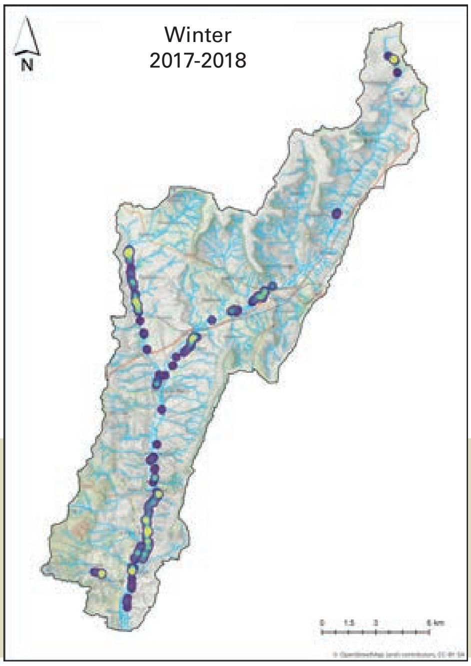
Major Impact – Tree / main stem with a diameter >20 cm, either felled or noticeably incised (i.e. beyond the cambium and noticeably into the sapwood, and not simply bark stripped).

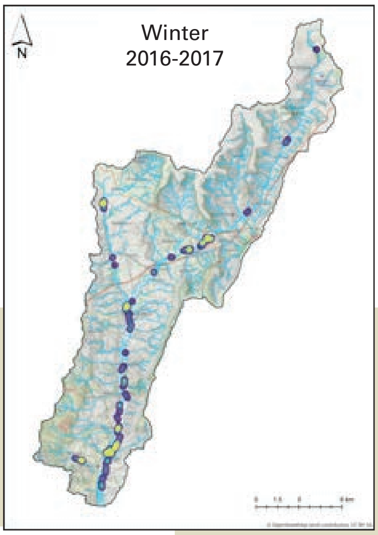
↓ In 2018-19, a total of 78 km were surveyed. Systematic surveys were undertaken annually in those parts of the catchment where beavers were known to be active and where landowners were engaged with the Trial. This area increased over the course of the Trial. It is not considered likely that significant areas of activity have been overlooked.

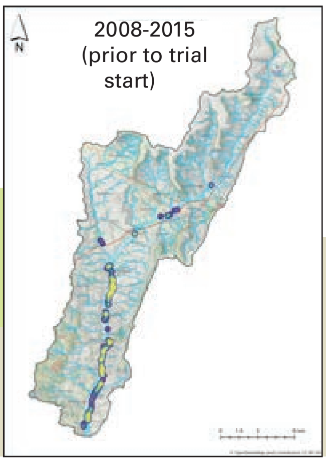
← In the winter 2015-16 survey, data were also collected on older field signs to understand the historic (pre-Trial) distribution. Some field signs clearly pre-dated the start of the Trial and can be aged using regrowth, but for many, it was much harder to determine, and the dataset (heat map) for pre-trial should be interpreted with a larger margin of error.

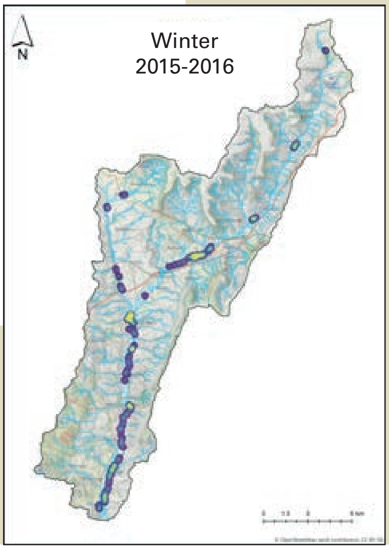












→ **Figure 1.5** Heat maps produced at the end of each survey season in March provide a useful snapshot of feeding signs throughout the catchment.

Analysis of field survey data and territory assessment

Table 1.1 Changes in estimated territory numbers from 2015-2019

Situation in April of:	Focus of activity	Known breeding pairs
2015	2	2
2016	3	3
2017	6	5
2018	8	6
2019	<13	7

Both point data and heat maps, derived from the feeding sign surveys are of great use when evaluating the expanding population of the beavers on the River Otter. Results from 2015 – 2019 clearly show how the population has expanded from a small number of territories located in the lower reaches of the Otter, to occupy much of the main river from the estuary to the headwaters, including the River Tale, the major tributary.

Beavers are 'central place' foragers[4] and therefore the frequency of feeding signs declines with increasing distance from a dwelling. This pattern is reflected in the heat maps presented in Figure 1.5. However, the key limitation of the feeding sign survey is that it identifies beaver presence only where woody material is also present. Therefore, in reaches where woody habitat is discontinuous, feeding density is similarly discontinuous. In these reaches it becomes difficult to differentiate between multiple small territories and fewer larger territories[2,3].

As the population has expanded, it has become harder to determine the numbers of territories from these data. In addition, visual observations and trapping records have been used help gauge the size of the population.

In established populations it may be possible to assign an average number of beavers in a territory to gain an estimate of the population size[5]. In small colonising populations, where many areas of feeding activity may be the result of individual animals or young pairs starting to establish territories, this approach to estimate beaver numbers is less accurate[6].

Future work: Monitoring beaver feeding activity provides a low cost but powerful tool with which to evaluate the population dynamics of beavers at the catchment scale. Whilst radio tagging/tracking can provide much more detailed information regarding the movement and territory ranges of animals, it is costly and comes with many challenges arising from their semi-aquatic and burrowing habits. We suggest feeding sign surveys should be undertaken on other wild-living beaver populations in Britain in order to enable comparison between populations and further develop the use of automated territory detection year-on-year.

Summary of the effects of beavers on the River Otter

As a keystone species, the ecosystem effects of beaver behaviour can be significant, and are also highly variable. The effects on the environment and also society are dependent on the type, location and intensity of beaver activity, and the current land/water-use in that area.

The nature of beaver behaviour means that conflicts with existing human activities are inevitable. Every attempt has been made to record and report any conflicts that have occurred over the Trial period, although these have not been significant. Where issues have arisen, timely and effective management interventions have been effective in ameliorating them and diffusing conflicts. It is vital that such a management approach is continued if beavers are to be widely accepted and their benefits maximised.

Alongside this Science and Evidence work, the ROBT Steering Group have invested considerable time developing and publishing a Beaver Management Strategy Framework which recommends how beavers and their impacts should be managed beyond 2020 in the event that they are permitted to remain on the River Otter. (ROBT, 2019[7] - **http://bit.ly/ROBT-BMSF**)

Management techniques

▶ **Efficacy of electric fencing**

Beaver damming

The construction of dams by beavers to impound water is one of the most important aspects of their behaviour as a keystone species[8], and the one that has the greatest potential to transform waterways, creating both opportunities and conflicts with existing land-uses.

Six of the 13 established beaver territories have seen dam building behaviour, with the case studies providing more detailed information on the effects of these dams for some of these sites.

The dams have varied in size, shape, construction materials and permanence. A snapshot survey was conducted in October 2019, and the figures provided in this report and summarised in Table 1.2. It is important to stress that many of the dams that have been studied and have caused impacts, no longer exist.

No dams have been constructed in the main River Otter. In the upper River Tale tributary, dams have been built, which regularly erode during high flows and, at times, are completely removed. At present only one dam persists in this location. In September 2019, a new dam was discovered in the River Wolf, one of the other main tributaries, and in an area where beaver activity had not previously been detected, suggesting a new territory was being established.

Three areas have seen temporary dams associated with maize cropping, where dams appear to be constructed to allow access to the maize crop. The maize stems are also used as a dam building material.

In existing wetlands and ponds, even very low dams can increase the extent of surface water and wetland habitats, significantly enhancing their water-holding capacity and ecological value. This has been very noticeable in three territories **(Case studies 1, 2 and 5).**

→ A beaver-created wetland in the Budleigh Brook

Photo: Steve Pease

Watercourse	Number of dams	Height of dam (cm)	Length of Impounded water upstream (m)
Colaton Raleigh stream (Case Study 1)	8	25	109
		40	57
		40	231
		40	42
		15	128
		50	153
		100	81
		30	12
Budleigh Brook (Case Study 2)	6	30	23
		40	44
		120	64
		30	31
		40	60
		170	70
Otterhead (Case Study 4)	11	50	17
		20	20
		40	15
		30	10
		150	104
		20	10
		30	10
		30	20
		20	5
		150	14
		50	21
River Tale (mid) (Case Study 6)	1	60	310
River Tale (upper) (Case Study 5)	1	180	208
River Wolf	1	50	20
TOTALS	**28**		**1,889 m**

← **Table 1.2** A snapshot of all the in-stream dams in the River Otter catchment in October 2019. Any mud dams and retaining banks built off the line of watercourses are not included, although these often work in tandem with these in-stream dams.

← **Colaton Raleigh stream** is a groundwater fed watercourse that originates on Colaton Raleigh Common. The watercourse has been heavily modified by land drainage and runs in a ditch network through floodplain pastures before joining the main River Otter in Otterton. Within this network, beaver dams have been built in 13 locations since September 2016. This is a low gradient drainage system and although high flows and human intervention have regularly changed the dam heights, a few have been washed out in their entirety. Three of the smaller dams have also been drowned out by other dams built downstream of them.

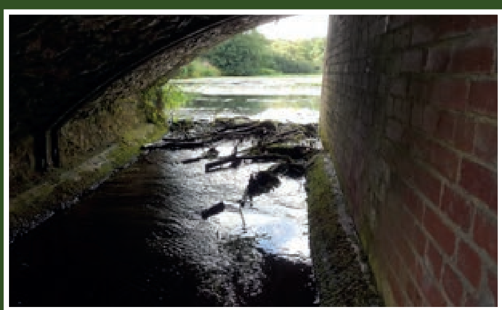
The creation of wetland habitats has been rapid and the management of three dams has been necessary to mitigate impacts on land-drainage / raised water level, including the installation of a flow device (aka a 'beaver deceiver') which is detailed in **Case Study 1**.

In October 2019, eight dams were present and due to the flat nature of the topography, 813 m of the ditch network were impounded by them.

↑ The **Budleigh Brook** rises on Bicton Common before passing through Yettington and East Budleigh. Six dams have been constructed in the channel and two of these have pushed water out of bank, with retaining bunds also built by the beavers on the adjacent floodplain.

These six dams have impounded 292m of the original watercourse and created 0.1ha of open water, in addition to other wetland habitats around the standing water.

At this location the creation of the wetland has been supported by the landowner, and is the subject of research into the beneficial impacts on flood risk in a community downstream (see **Case Study 2**). Impacts on agricultural activities have also been quantified.



→ **Otterhead Lakes.** Dams have been built in seven locations upstream of the top lake/ reservoir, although these are dynamic features due to high flows. In total 11 dams were recorded in various watercourses in this complex in October 2019. Owing to the steeper gradient here, they impounded only 246 m of watercourse (which includes the main lake with slightly elevated water levels at this time).

The beavers are continuing to build a small dam on the outfall structure to the upper lake, and this is removed regularly by volunteers on the site. Beaver dams have also been built in the overflow channel from the top lake. One was around the outfall structure which was removed, and others have been retained.

The potential implications on the water resources and supply infrastructure are discussed in **Case Study 4**.

← The **Clyst William Cross (upper Tale)** site, where additional beavers were released (to improve genetic diversity) in 2016, is where the largest number of dams have been built. In the main River Tale, dams have been built in eight different locations. The high-energy nature of this watercourse has made these dams very dynamic, often ephemeral, features. It is estimated that a total of 22 individual dams were built in eight locations on this reach of the Upper Tale over the 4 year period since 2016. Only one was in place in October 2019; a large 1.8 m high dam structure, which was impounding 208m of the stream and was bypassed by side channels cutting across the river floodplain.

Nine dams have also been built in the adjacent wetland habitat away from the main stream, including in new channels also created by the beavers, and not including the retaining earth bunds built to retain water in flat low-lying land. (see **Case Study 5**).

↓ In the **mid-River Tale,** dams have been built in four locations, often during low summer flows to access adjacent food resources (maize). At two of these sites, dams were unacceptable to some, but not all, of the landowners, and any signs of beavers starting to rebuild the dam were repeatedly removed by ROBT staff; in one case on 10 occasions over a period of three weeks. High flows commonly erode these dams and going into autumn 2019 only one 0.6 m high dam was in place. **Case Study 6** discusses the conflicts with land drainage, and associated issues between neighbours in this flat landscape.

↑ The **Cadhay stream** near Ottery St Mary was the location for the first beaver dams in the catchment. In early 2016, a 0.8 m high dam was built in a drainage ditch impounding water in low-lying pasture where a flood relief channel discharges peak-flows. This was initially removed by the landowner because of the impacts on land-drainage, and then again twice subsequently by ROBT staff. Two other smaller dams were also removed in the same ditch to prevent them becoming established. They have not been rebuilt since.

▶ **Clearing an established dam**

← In the River Wolf a new dam was built across the channel in September 2019. It remains to be seen how it will withstand high flows during the winter. At the time of the survey it was 0.5 m high and impounding 20 m upstream

↑ The increased channel heterogeneity created by beaver dams, creates new riffle habitat for dippers and bullhead.

Photo: David White

Environmental opportunities created by beaver dams

Small water bodies, for example ponds, are disproportionately important (relative to their size) for freshwater biodiversity[9], yet very many ponds have been removed, or lost through succession, from intensively farmed agricultural landscapes over the last 150 years. For example, in 1880 there were 800,000 ponds in England and Wales[10], but by 1996, there were only 228,900 ponds[11,12]. As it has been shown that ca. one third of aquatic species, such as macroinvertebrates, may only be present in ponds[13] and that beaver ponds may host 50% more unique species than other wetlands[14], it is likely that the environmental opportunities, or benefits afforded by beaver pond creation will be significant.

Small dams have been rapidly established and have enhanced wetland features and diversity in the landscape. Across the catchment, damming by beavers has created many new wetlands and ponds. These ponds cover a total area of 1.5 ha with a total bank length of 3.5 km. This newly formed habitat provides essential wetland habitats for many species **(see Chapter 2)**.

↓ Beaver dams create a mosaic of wetland habitats which benefit a wide range of wetland species.

↑ Wetland habitats formed where water spills over and around a beaver dam often support important emergent vegetation communities.

Undesirable impacts on land-use caused by beaver dams

In all of the six established territories where dams have been built, some management has been necessary to mitigate undesirable impacts. It is important to note that the attitude of the affected landowner or user is heavily influenced by the ability to manage conflicts and the efficacy of the management interventions **(see Chapter 4).**

In four of these cases, the landowners have welcomed the presence of the beavers, and the ongoing management of dam heights or locations has mitigated any negative impacts. On two sites, the presence of the dams caused unacceptable impacts on land-drainage in the floodplain. They were removed by, or at the request of, those impacted landowners, without any attempt to first mitigate their impacts. When removing dams, the welfare of the beavers was considered, to avoid impacting on natal lodges.

Culvert blocking

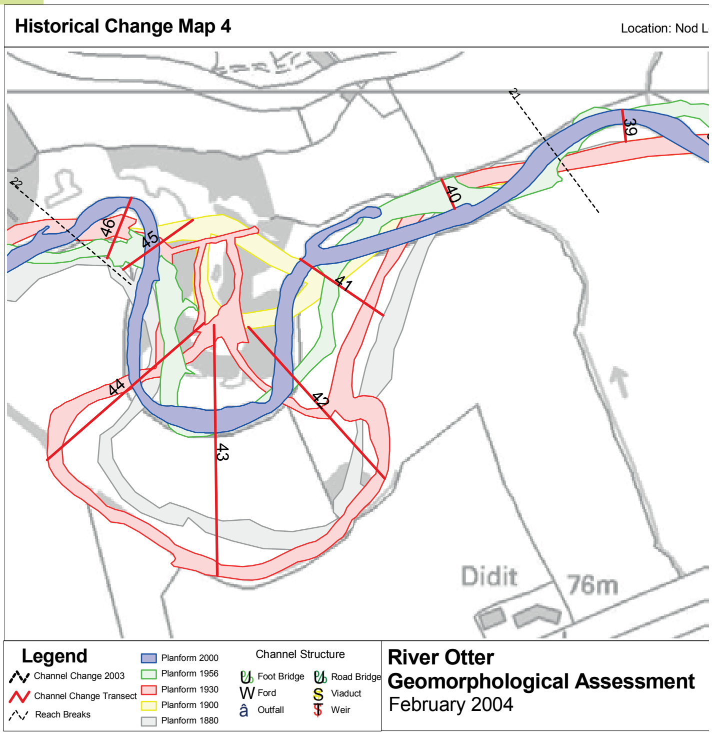
Within the Colaton Raleigh stream, the beavers have used the constricted channel provided by two culverts to attempt to impound water. A small number of beaver sticks have been removed occasionally from one of these culverts. The other culvert has required more frequent monitoring and intervention, as a result of a more concerted attempt by beavers to block it. This management regime remains effective.

Elsewhere beaver activity was thought to be the reason for a blocked culvert, but on closer inspection this was shown to be flood debris which was removed by the ROBT team.

← ROBT Staff clearing a blocked culvert

Riverbank erosion and channel planform changes

A Geomorphological Assessment of the River Otter carried out by the GeoData Institute[12] provides a useful summary of the background (pre-beaver) rates of change in channel planform. It concluded that bank erosion is system wide and occurs over 23% of the bank length and is intrinsically linked to channel adjustment. The primary drivers were identified as periods of increased flood frequency, increased bend curvature, widespread dredging and shoal removal between 1960 and 1990, and the presence of composite banks with the exposure of weaker gravel layers at the toe of most banks. An example of the ongoing change in this highly mobile river was observed prior to the start of the Trial when a major meander just south of Ottery St Mary was cut-off during a storm event, forming a new oxbow lake.



→ **Figure 1.6**
A Geomorphological Assessment of the River Otter includes detailed maps showing changes in planform that have occurred since 1880. (Copyright Environment Agency). This section near Honiton demonstrates clearly the high background rates of change that have occurred in parts of the valley since 1880.

Beaver burrows could increase channel complexity and sinuosity by acting as a focal point for erosion[13]. However, during the Trial we have observed no significant erosion caused by beaver burrows. Localised erosion was observed in two instances associated with beaver lodges. The extent was limited by the presence of established vegetation, stabilising the banks.

In the same period numerous erosion points created by dogs and cattle entering the river were observed. In areas devoid of bankside trees this erosion had greater impact than was observed associated with the two beaver dwellings.

On another occasion, beavers were witnessed digging a burrow and releasing a plume of sediment into the main River Otter. This was within an area of dense tree roots and no obvious signs of bank erosion were subsequently observed.

Beaver dams built in smaller watercourses have resulted in avulsion (channel rerouting) events and minor changes to channel planform. These areas were not covered by the Geomorphological Assessment, and so baseline maps showing historical planform change are not available.

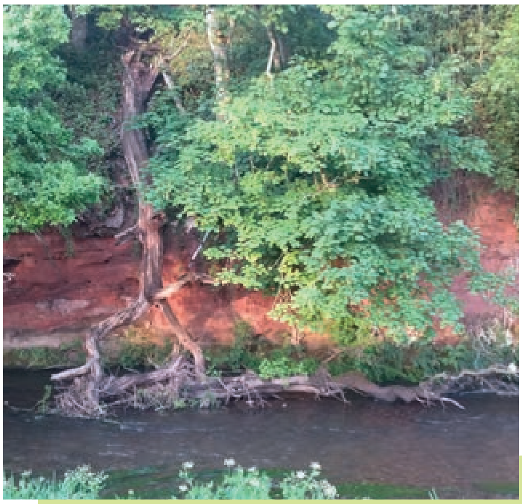
At Clyst William Cross, beavers have constructed several dams within the main channel of the River Tale **(see Case Study 5)**. At this location, the River Tale is an incised 4th order stream with relatively large high-flow stream power. (Stream order describes the size of river and is based on the number and size of contributing tributaries; at its mouth the River Otter is 6th order). Consequently, the dams in this reach are regularly breached during periods of high flow and repaired by beavers during lower flows. The release of impounded water during a dam breach has resulted in the localised erosion of riverbanks immediately downstream of the dams. Consequently, there has been visible change with increased bankfull width and sinuosity, with sediment and gravels re-deposited creating a more mixed channel bed surface than before both upstream and downstream of the dams.

← An avulsion (channel rerouting) event has been observed on the Budleigh Brook where a beaver dam originally built in the stream, now extends across the floodplain. The new network of multi- thread channels has begun to incise, revealing rounded pebbles and cobbles, indicative of previous channel beds, deposited before the channel was artificially straightened and deepened.

▶ **Dams during high flow event**

Mobile woody material in watercourses

Woody material serves important ecosystem functions in watercourses, providing crucial substrate and habitats for many invertebrates, and shelter and food for fish[14]. Larger in-stream timber can cause geomorphological changes, resulting in creation of in-channel features such as gravel bars[15]. Large volumes of woody material can cause blockages or damage to bridges or culverts, increasing flood risk in some locations.



↑ The proportion of in-channel woody material derived from other sources has not been assessed. During the Trial a number of larger trees have been observed entering the channel as a result of bank erosion or storm events, rather than beaver activity, particularly in the area downstream of Ottery St Mary.

Beavers are actively browsing on woody trees and shrubs throughout the River Otter corridor, particularly during the autumn and winter months. Branches are frequently 'processed' by the beavers on the water's edge, and this generates many small beaver 'chopsticks' which are often wholly or partially stripped of their bark and have characteristic cut ends with teeth marks. Feeding stations are recorded on the water's edge, and mobile beaver sticks can be found some distance downstream. In the River Otter these mobile signs are referred to as 'erratics', and are recorded separately to indicate beaver activity upstream, not necessarily at the point of recording.

The felling of entire trees by beavers into the main river has been recorded on fewer than ten occasions. In all instances, they were trees with a trunk diameter of <30 cm, and they all remained attached to the bank.

→ The presence of beaver sticks is a useful way of confirming the presence of beavers upstream. Beaver sticks have been seen in the strand-line on the beach at the mouth of the River Otter, one of many 'firsts' in England for some hundreds of years.

Picture: Roger Auster

Feeding on trees

As well as feeding extensively on soft riverside and aquatic plants, beavers browse on woody vegetation throughout the year, particularly during the winter months[15]. In the River Otter catchment, overhanging tree branches and those within water courses are often favoured, and they will also feed on bankside trees.

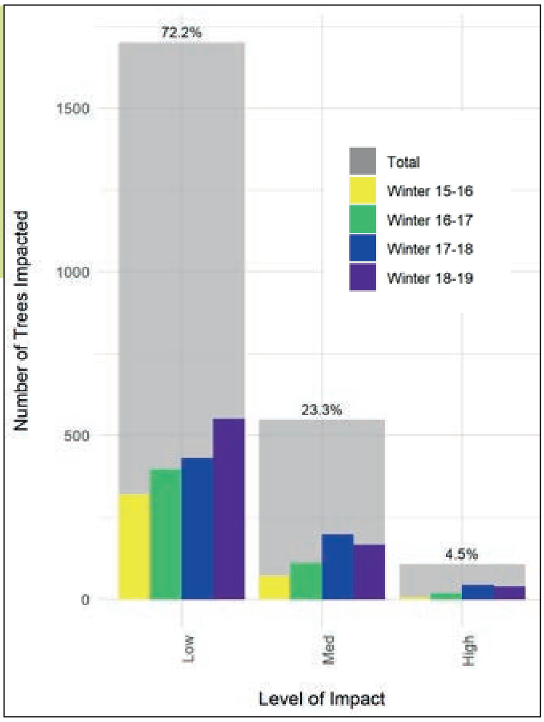
These impacts are easily detectable during the winter months and provide the basis of the systematic surveys. Initially each cut stem was mapped, and details recorded. This soon became impractical, and so each tree impacted was mapped and classified as detailed in Figure 1.4 (above). This classification was designed to represent the time that the beavers had spent at the location, and also to reflect the societal impacts of this beaver behaviour. The species affected and the distances from the watercourse are detailed in Chapter 6.

→ The visual effects of beavers on riverside trees has been subtle in the five years of the Trial, with no significant 'landscape' trees felled by the beavers. Some have been subject to extensive feeding and bark stripping and were protected. Some large poplar trees have been felled by the beavers which was allowed by the landowner. Over the same time period, some large riverside trees have fallen due to other natural causes such as high winds and bank erosion.

▶ **Beaver feeding on large willow**

▶ **Tree climbing beavers**

→ **Figure 1.7** The majority of trees were only subject to low levels of feeding. The number of trees impacted increases as the population expands. Although surveys were conducted annually, annual counts cannot simply be added as the same trees are often browsed over multiple years.



↑ There is a stand of very large native black poplar trees *Populus nigra subsp. betulifolia* within one of the largest beaver territories, but no impacts on these trees has been recorded. In two other territories black poplars have been protected.

← Within the Otterton territory, one stem of a young row of streamside aspen *Populus Tremula* trees has been coppiced.

Picture: Sue Lane

The importance of pre-emptive management

The ROBT was required to report any complaints received to Natural England, and over the five years of the trial, ten complaints were recorded regarding impacts on trees. With feeding signs recorded on trees on 2,356 occasions during the annual systematic surveys, the majority of impacts are not viewed negatively by landowners or farmers – indeed the vast majority go unnoticed.

However, pre-emptive and responsive actions by the ROBT field staff have been vital in preventing and managing potential conflicts. When feeding signs are detected on larger trees, a rapid assessment of potential effects informs the management and advice that is necessary. For example, trees adjacent to powerlines or busy roads would be protected. Any riverside orchards are also assessed and if necessary, protected. This proactive information and support provided to landowners has played a vital role in reducing conflict.

Table 1.3 Numbers and species of tree protected using different methods over the course of the ROBT.

Tree species	Sandy paint or SBR mix	Galvanised weld mesh	Total protected
Apple	8	16	24
Beech	1	0	1
Birch	2	0	2
Black poplar	2	1	3
Oak	1	1	2
Poplar	5	2	7
Willow	14	12	26
Wisteria	0	1	1
Total protected	33	33	66

→ In one site, a strip of willow and poplar trees, originally planted for bankside protection, were subject to regular beaver feeding. In these situations, rotational coppicing of trees might sometimes be used to reduce canopy height and help stabilise the bank. The beavers were providing this coppicing effect, although the landowner was concerned about some of the larger trees and so these were protected.

↑ In an adjacent catchment (The Tone), an attempt was made to publicise 'damage by beavers', however this transpired to be an elaborate hoax. Despite this, the Daily Telegraph and local BBC Spotlight covered the story.

↑ Riverside orchards need to be protected from beaver feeding. At one site, the visual impacts of the tree guards remain a concern for the landowner, as does the fact that the beavers are taking the fallen apples before they are collected.

Burrowing

A riparian beaver territory may contain many burrows[8], and their submerged entrances make them difficult to detect. Occasionally burrows have been located during the annual systematic feeding signs survey. As their entrances are typically below the water level, burrows detected are frequently those that have partially collapsed, revealing a chamber containing beaver gnawed sticks and/or bedding material or active lodges with material, covering the top of the chamber.

The natal burrows detected in the main River Otter have almost all been built into tree roots, presumably making them more stable, discrete structures.

There are <2 km of engineered floodbank in the catchment; protecting the former estuary from tidal inundation. Burrows have been built into the lower 'berm' alongside these, but not into the flood banks, demonstrating the additional benefits of setting-back engineered structures from the main river allowing for the creation of a multi-stage channel.

When beavers colonised Otterhead Lakes **(Case study 4)**, the risk of burrows impacting the engineered dams was identified. The profile and situation made impacts on the lower engineered dam unlikely, but the beavers had established a lodge in the upper lake, where the engineered dam was more overgrown and the profile steeper. Due to the age of the structure, the construction method was unknown, and so a precautionary approach was adopted, with the vegetation cleared from the dam, discouraging beaver burrowing and facilitating routine inspections. No burrowing has been detected.

→ Most burrows have been detected in semi-natural strips of bankside vegetation where they go unnoticed by land-users and had no detrimental impacts.

↑ Conflicts have arisen on one site where land is grazed close to the riverbank. Two burrows have collapsed where cattle and sheep are present, and these required back-filling by the ROBT Field Officer. This conflict could be mitigated by providing a riparian buffer strip with restricted livestock access.

↑ To alert the operators of heavy machinery, flags were installed at one site when they were harvesting maize.

Impacts on infrastructure

Environment Agency infrastructure

↑ Environment Agency monitoring equipment is routinely surveyed - no beaver impacts have been recorded in any of the infrastructure throughout the River Otter catchment.

- In 2015 the Environment Agency identified sites in the River Otter that had the potential to be negatively impacted by beaver activity. A Memorandum of Understanding between the Environment Agency (EA) and DWT outlined a mechanism for monitoring these key EA assets for signs of beaver impacts. These sites were:
- eight hydrometric monitoring stations;
- four Flood Defence structures;
- 12 stretches of small stream, which were identified as *potentially* at risk of impact for flood defence and/or fish passage where mitigation may be needed (if considered appropriate); and
- the Land Drainage embankment that runs along the west side of the estuary.

As well as the potential impacts of dams and blockages which are easier to detect, surveys also identified burrows that could undermine the integrity of engineered structures such as embankments, dams and flumes.

Initially, checks were made every two months but these became more risk-based over time. September through to March are the most effective months for such monitoring because:

↑ In 2016, a beaver dam built in the floodplain ditch network into which a flood-relief channel discharges, resulted in standing water at the bottom of the scheme on the adjacent floodplain pasture. The farmer and ROBT staff removed this dam.

- Beavers are particularly active building dams in the late summer and early spring;
- Key flood routes and culverts need to be clear prior to high winter flows;
- The bankside vegetation is dying back allowing easier access and visibility; and
- Autumn high flows are important periods for salmonid migration.

It is vital that those working with beavers are aware of key infrastructure within the catchment so that a rapid and appropriate response is made at any time of year in advance of, or in response to, signs of impact. Risk maps for the catchment should be proactively produced with partner organisations to enable this. In 2017, additional sites were added to the list by Clinton Devon Estates, and the list of sites monitored was formalised and they were given unique code numbers to reflect the reasons for their inclusion, and to make liaison with the relevant specialists easier.

Throughout the Trial period, although beavers were active around some EA assets, no negative impacts on any of the infrastructure was recorded.

↑ **Rights of way and paths**

There are 46 km of Public Right of Way which lie within 30 m of all the watercourses within the catchment. The footpaths in the vicinity of Otterton in the lower part of the valley are very heavily used with, for example, >100,000 people recorded in 2017/18. There have been three instances where trees have been felled by the beavers onto these footpaths in the four years between 2015 and 2019. In each case, the landowner, Clinton Devon Estates were swift in their removal. In total, this response took approximately one day of an Estate worker's time with a chainsaw. No other impacts on footpaths have been identified.

Picture: Ed Lagdon, Clinton Devon Estate

↑ **Other access routes**

One farm access track used by local residents as a permissive path to avoid walking on the road has been flooded to a maximum depth of 30 cm on occasions during the winter of 2018/19. This was due to the height of a beaver dam in a heavily modified watercourse, within a floodplain. The presence of the beavers and dam was being accepted by the landowners, but when this track became waterlogged, the dam was managed to bring the water-level down by up to ca. 50 cm. This same dam was submerging the corner of a pasture field and fence-posts, and so its reduction also alleviated this issue. In this situation, regular monitoring and management was straightforward. However, more sustainable, expensive solutions could be employed at this location such as raising the track level with stone, or installing a flow device. At the current time, this 'little and often' management has been the most cost-effective mitigation option.

↑ **Highways impacts**

A single highways impact was detected during the 5-year trial. A beaver dam built within 20 m of a small country lane caused impounded water to encroach slightly onto the edge of the road. The Highways team at Devon County Council were made aware and did not identify a need to intervene. The landowners, Clinton Devon Estates, have occasionally reduced the crest level of the dam to lower water levels and mitigate this impact, and allay the concerns of a local resident. The location is adjacent to the Estate's Forest yard with 24 hour access required.

← Road Traffic Accidents involving beavers

There has been one case of a beaver being hit by a car during the Trial period. This was identified as a result of an anonymous report of a dead beaver by the road in March 2018. The body was recovered, and a post-mortem examination conducted. There were no signs of any car parts near the beaver and no skid marks could be seen on the road.

The accident occurred where the main River Otter passes under a B-road just north of Honiton. It is thought the accident coincided with high river flows, which may have forced the beaver onto the road to bypass a weir located close to the bridge.

← Electricity or telecommunications infrastructure

There have been no recorded negative effects on electricity or telecommunications infrastructure. On two occasions large riverside willow trees growing adjacent to powerlines were being gnawed by beavers, and were proactively protected to prevent any detrimental impacts. In one case, in consultation with the landowner, Western Power Distribution decided to coppice the willow tree, as is normal practice when trees grow within ca. 3 m of power lines.

In total, this work took less than two days of the ROBT Field Officer's time including liaison and advisory work with the landowners.

← Forestry

There have been no recorded impacts of beavers on any forestry plantations. There is one location in the River Otter catchment where a plantation coincides with a presence of beavers. This poplar plantation in the lower reaches of the main river is within 5 m of the top of the river bank. The bank in this location is relatively high and steep, but the tree species and the proximity to the river where beavers were present (albeit at low levels) meant that this had been identified as a relatively high-risk location for impact. The trees closest to the river have been checked as part of every annual winter survey, with no feeding signs detected.

Agricultural impacts

Impacts of beaver activity on agriculture in the catchment have been recorded over the five years of the ROBT. The impacts have been localised and are divided into three categories: direct feeding on agricultural crops / fruit trees; the impacts of burrows; and the impacts of raised water levels.

Direct impacts of beavers feeding on agricultural crops

Impacts on maize (Case Study 6)

Beavers have fed on two separate maize fields in the mid-Tale territory, as well as on two maize fields near the Budleigh Brook site and on a field adjacent to the River Wolf. At one of these locations the beavers travelled 30 metres across a woody buffer strip, farm track and under a fence to access a maize field. The beaver track (approximately 0.3 m wide) led 40 metres into the maize field.

The area of crop impacted by the beavers tracking through and eating maize in the mid-Tale was estimated at 15 m^2 which would be estimated to be a gross margin loss of £1.33 for one harvest according to the data in the *John Nix Pocketbook for Farm Management*[16].

At one site there was evidence that beavers had been under a riverside fence and accessed a small area of root crop, although there was no significant damage to the crop.

Minor cases of beavers grazing on grass have been detected during survey work.

Impacts on orchards

No commercial orchards were impacted by beavers during the ROBT. Impacts on three small orchards in large rural gardens were reported, and the trees were protected. One small tree was deeply incised by the beavers, impacting on its ability to withstand strong winds, and it was replaced at a cost of £18 (including stake and tree guard).

Beavers have been recorded feeding on windfall apples in two areas, and an electric fence was used on one site as a deterrent.

Impacts of burrows (Case Study 6)

The mid-Tale site is also the only location where beaver burrows have impacted on agriculture. Two small collapsed burrows in the pasture were seen as a risk to the livestock and were infilled by ROBT staff.

On the opposite bank where the maize field was due to be harvested, there was a risk of forage harvesters causing burrow collapses, and damage to farm machinery. To keep harvesting machinery away from potential burrows, bamboo canes with flags attached were placed at 10 m intervals along a 50 m strip. The flags were clearly visible above the maize, mitigating the risk of damage to farm machinery. The standardized approach for the assessment of costs based on data from the *John Nix Pocketbook*[16] (see below) can be used to estimate the gross margin loss of leaving an unharvested strip against the watercourse. In this case a 5 m strip along 50 m of watercourse (0.025 ha) is estimated to be worth £22.10 for one harvest.

Other burrows detected during the Trial, including in the estuary, were in woody buffer strips alongside the river and did not cause conflict with agriculture.

Impacts of raised water levels on agriculture

In low-gradient intensively drained agricultural land, impacts on land-drainage can be locally significant. As shown in the Case Studies and in the Beaver Management Strategy Framework, it is possible to manage these impacts at relatively low capital cost. However, there may be an ongoing commitment of time which can be significant.

Where effects on agricultural land occur, a standardised approach to assessing the financial impact on the agricultural business was developed. This approach applied the Gross Margin data from the widely used and regularly updated *John Nix Pocketbook for Farm Management*[16] and *Organic Farm Management Handbook*[17] to the area of land affected (the approach is outlined in Appendix 1). There were two cases of this occurring within the ROBT where it was possible to provide an estimate of the gross margin (details available in **Case Studies 1 and 2).**

The Trial has recognised other potential variable costs which may result from the impacts of beavers, including; variations in financial support for farmers; staff time costs (such as those resulting from increased time to move cattle if an access route is waterlogged); costs of machinery repair (caused for example by a tractor driving over a beaver burrow); losses for landowners from reduced farm rents; wear and tear to farm tracks (if for example beaver damming increases the route required to a milking parlour on a dairy farm); fence repairs from felled trees, etc. Due to the context-dependent nature of these secondary costs, they will need to be assessed on a case-by-case basis.

← Cadhay Stream

In winter 2015/16 a series of three beaver dams was constructed in a drainage ditch in the floodplain north of Ottery St Mary. One of the three dams was 80 cm in height and 0.5 ha of the low-lying adjacent pasture was flooded and waterlogged for a number of weeks during the winter period. This dam was removed by the tenant farmer and ROBT staff. Due to the season, there was no direct financial impact on the farm business, except the time taken by the farmer to manage the dam.

← Colaton Raleigh Stream (Case Study 1)

The Colaton Raleigh Stream site received the greatest intensity of beaver management resources.

Beaver dams built in the drainage ditch that carries the Colaton Raleigh stream through this floodplain pasture have raised water levels periodically since 2016, flooding areas of pasture, particularly during the winter months. A flow device was successfully installed to manage water levels behind one dam, and management of other dams is ongoing.

0.89 hectares of grazing land for a spring-calving dairy herd was flooded upstream of the beaver dam before management interventions were initiated. After management intervention, the flooded area was reduced to 0.054 ha. Had the management intervention not been made, the estimated gross margin loss from such an area of land would have been ca. £1565 over a year. Following management, the estimated gross margin loss is up to £95 over a year. These estimates were made using data for a self-contained spring-calving dairy herd[16].

▶ Managing the effects of industrious beavers

→ Downstream of the main dam, side channels formed and re-entered the stream through a farm access gateway between two fields which became unusable as a result. Rather than lose the benefits to the wetland and watercourse, the decision was made to move the access crossing point at a cost of £900 **(see Case Study 2).**

← Budleigh Brook (Case Study 2)

The sequence of dams on the Budleigh Brook upstream of East Budleigh have had a measurable impact on the peak flows downstream and the raised water levels have impacted on 0.4 ha of Grade 1 arable land.

A backlog of water behind a beaver dam prevented the sowing of 0.4 ha of organic 'first early' potatoes. The estimated gross margin forgone was £1495. Additionally, seed potatoes had been purchased that could not be planted. This constituted a further cost of £600. These estimates were made using data for organic first-early potatoes[17].

The first early potatoes are one of two cash (as opposed to cover) crops from a 5-year rotation cycle. The second of these in the following year is usually barley. If the same area of land were affected in the following year (which is unknown at the time of writing), it is estimated from data for spring barley[17] that this would constitute a lost gross margin of £227.

↑ **Otterton area (Case Study 3)**

A dam in the Colaton Raleigh stream near the confluence with the River Otter has increased water levels in the corner of a pastoral field, equating to less than 50 m^2 area. A series of fenceposts in this field corner have also been partially submerged during wet periods which is likely to reduce their lifespan. This dam was impacting on an access track, which combined with concerns by local anglers about potential sea trout passage in autumn, has led it to be reduced in height on a regular basis.

Mid River Tale (Case Study 6)

Beavers constructed dams during low flow summer months 2018 and 2019 to access riverside maize crops which they foraged upon. This raised water levels in the stream, causing concern to landowners upstream. The grazed riverside fields are very low lying, and a drinking bay in the river was flooded, with a resulting accumulation of silt.

The initial removal of the dam by the neighbours was followed with extensive support from ROBT staff, regularly removing maize and sticks from the river prior to the harvesting of the maize, and the higher autumn river flows which resolved the issue. It is assumed that the removal of temporary dams built to access maize in late summer is unlikely to have any significant detrimental impact on the welfare of the beavers.

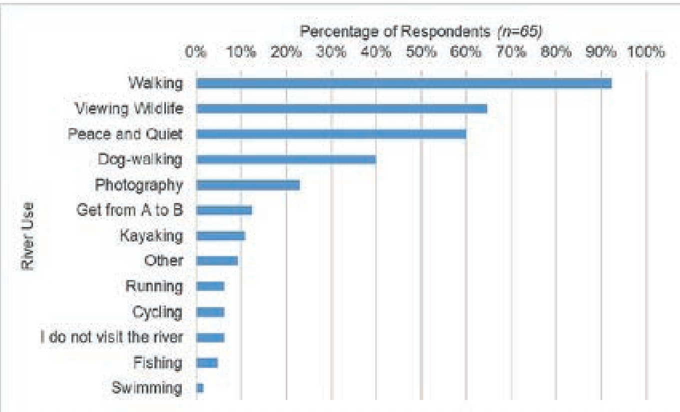
Quantitative and qualitative assessment of the socio-economic value of beavers in the River Otter catchment

Ecotourism and 'Beaver-Watching'

A family of beavers established a territory in a highly accessible public location served by a network of public rights of way. This location quickly became well publicised and generated considerable interest with some visitors travelling long distances to witness the first wild beavers in England for over 400 years.

A mail-return questionnaire of residents in this community combined with interviews with local businesses were used to study the potential impacts of beaver-watching in the village, alongside data from riverside footpath counters installed by East Devon Area of Outstanding Natural Beauty. Beyond the summary provided here, further details are available in **Case Study 2** and a full report with further findings and the methods is attached in Appendix 1.

→ **Figure 1.8** Mail-return questionnaire respondents' use of the River Otter. Respondents were able to select multiple answers.



Footpath use

Residents in the community were asked how they used the river near to their village. Walking was the most frequently cited activity by the respondents, followed by viewing wildlife. Fewer than 10% of respondents indicated that they did not use the river. A number of respondents indicated that the presence of beavers had influenced their use of the river.

→ **Table 1.4** Mail-return questionnaire respondents' responses as to whether their use of the river had been influenced by the presence of beavers.

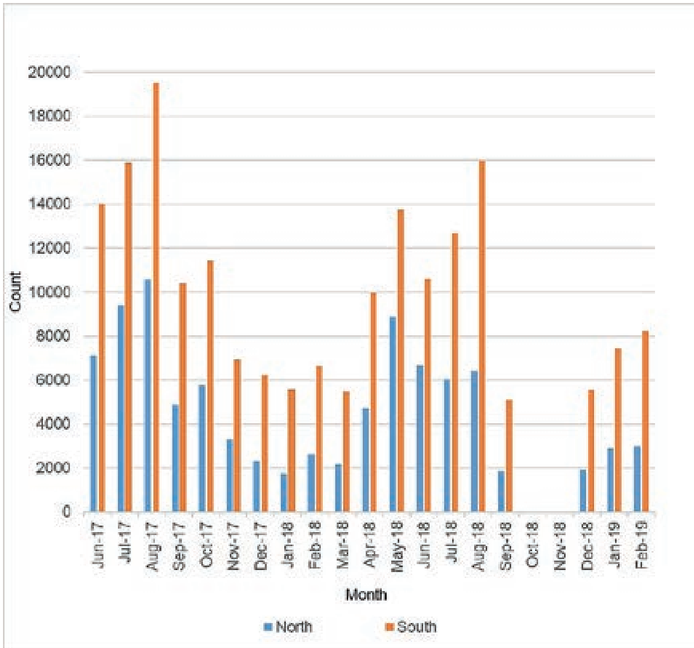
Has River Use Been Influenced?	Further Details Given
YES (n=23)	Increased time by the river
	More watchful for beavers on walks
	To see signs of beaver activity
	To see the beavers
	More likely to take visitors
	More walks in the evening
	More wildlife to see so more enjoyable walks
	More early morning walks
	More careful with the dogs on walks
	Dogs can't swim in the river anymore
	Now walk different stretches of the river as it has got too busy
	Walk less frequently
NO (n=32)	Use the river anyway
	Not changed frequency of river use
	Am a resident in the village

Two footpath counters were installed by East Devon Area of Outstanding Natural Beauty on the riverside footpath in June 2017, one to the North of the road bridge which provides access into the village, and one to the South. Data were collected until February 2019 (with the exception of October and November 2018 due to technical issues). The footpath counter data have been treated separately rather than combined as it is unknown how many visitors will have passed both counters on the same visit.

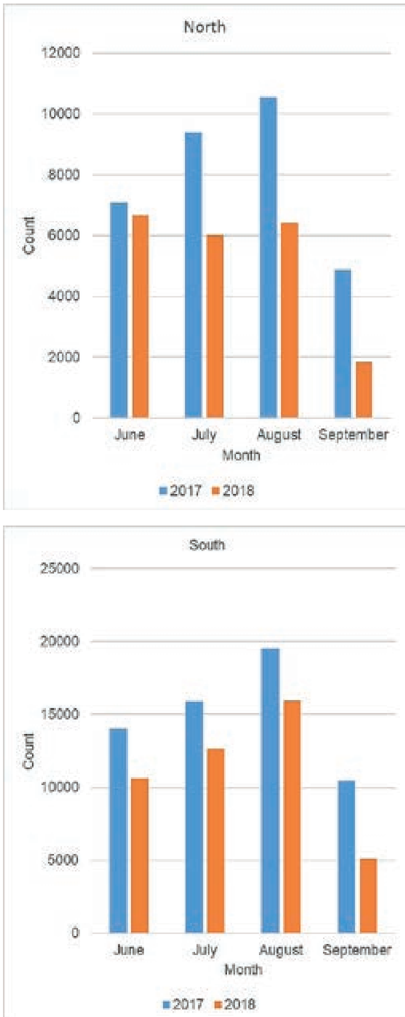
↑ During the summers of 2016 and 2017, up to 50 beaver watchers would gather on the riverbank at dusk opposite the main beaver lodge near Otterton.

In general, the footpath south of Otterton saw a higher number of monthly footpath counts, with both counters indicating increased use of the footpath in the summer months coinciding with the presence of beavers. In the summer of 2017, a family of beavers (with kits) was easily observable as they had established a lodge upstream of the village. In the winter of that year, the beavers then moved away from this location. As such, it is possible to compare the peak 'beaver-watching' months of June to September between a year where beavers were present and easily observable, and a year in which they were not.

For both footpath counters, a statistically significant reduction in footpath counts was identified between 2017 and 2018. This difference correlates with the movement of beavers away from the vicinity, which seems the most likely explanation. However a number of factors may have contributed towards this reduction in footpath use, such as differences in weather conditions.



↑ **Figure 1.9** Footpath count data between installation in June 2017 and February 2019 (Data: East Devon AONB).



← **Figure 1.10** Differences in footpath counts between the summers of 2017 and 2018 heading north from Otterton village towards the main beaver watching location and south towards the Estuary (Data: East Devon AONB).

Visitors to the village

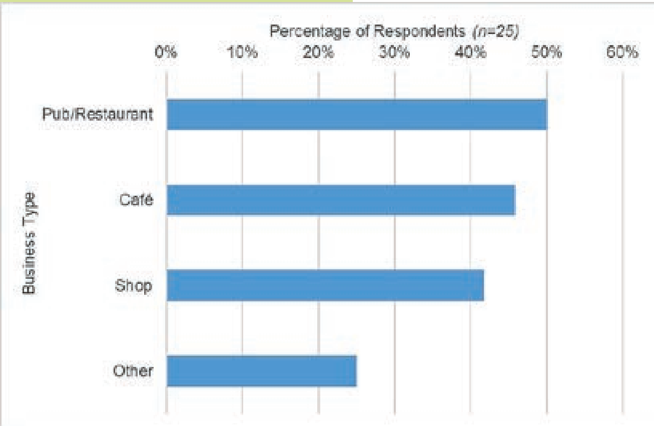
The residents' questionnaire asked whether they had observed a change in visitor numbers since 2017. The majority of respondents felt that there had been a change, 90% of whom claimed this to be an increase. 87% of those then attributed the change to the presence of beavers, whether totally or in part. Further details are in **Case Study 3** and Appendix 1.

Impact on businesses

Businesses in Otterton reported largely positive impacts in interviews, the scale of which differed dependent upon the degree to which businesses had 'used' the presence of beavers as an opportunity. Impacts included: an increase in custom; beaver-related products and merchandise; holding beaver-related event days at local businesses; the use of beavers in marketing; the potential for future beaver-related initiatives. (See **Case Study 3** and Appendix 1).

The mail-return questionnaire asked respondents in which business types they would be likely to spend money as part of a typical 'beaver-watching' experience near to the village. If respondents answered 'Other' they were asked to specify their answer. Of those who did so, 14 respondents stated that they lived in the village so they wouldn't use these businesses, two said spending in businesses wasn't necessary or that they wouldn't do so, one identified a specific business in which they would spend money, and one said they would take a picnic.

→ **Figure 1.11** Businesses that respondents indicated they would spend money in, as part of a 'beaver-watching' experience near to the village.



'Beaver-Watching' Willingness-To-Pay Value Estimates

'Willingness to pay' is a frequently used method of assigning financial values in environmental economics where the value of goods and services is not easy to obtain through conventional 'markets'. It enables, for example, the value of an experience such as a visit to a nature reserve to be estimated.

The questionnaire asked what residents would be willing-to-pay for a 'typical' beaver-watching experience on the river near to their village.

From those who provided an answer to the question, the average value obtained per respondent was £7.74 (with a range £5.78 to £9.70). Three value estimates of 'beaver-watching' activity have been calculated using this average figure cost, as illustrated in Table 1.5

These willingness-to-pay values have been obtained from residents; it is unknown whether this value would differ for visitors to the area which may include higher travel or accommodation costs.

→ Otterton Mill, situated alongside the River Otter, is one of the businesses that has benefitted from beaver reintroduction. Additional visitors, who have come to see the beavers, have generated more business, leading to opportunities for new, beaver-focussed events and products. e.g. Beaver Bitter.

Method		Footpath Counter	Value Estimate	Lower Estimate	Higher Estimate	Notes
1	Willingness-to-pay values applied to differences in footpath counts between summer months of 2017 and 2019 (North = 10,925; South = 15,506)	North	£84,559.50	£63,146.50	£105,972.50	- Assumption that the difference is due to the movement of beavers away from the area.
		South	£120,016.44	£89,624.68	£150,408.20	
2	Willingness-to-pay values applied to 0-40% of the total number of footpath counts.	North	Between £0 and £285,358.32	Between £0 and £213,097.04	Between £0 and £357,619.60	- Assumption that beaver-watchers contribute 0-40% of footpath use. >40% was deemed as unlikely due to existence of other footpath uses. - No footpath data recorded for October or November 2017.
		South	Between £0 and £639,611.93	Between £0 and £477,643.02	Between £0 and £801,580.84	
3	Willingness-to-pay values applied to 19.17% of total footpath counts as 19.17% of mail-return respondents indicated they used the river for 'viewing wildlife'.	North	£136,758	£102,126.80	£171,389.20	- Assumption that wildlife viewing was beaver related.
		South	£306,534	£228,910.40	£384,157.60	

↑ **Table 1.5** Descriptions of 'beaver-watching' valuation methods and value estimates obtained.

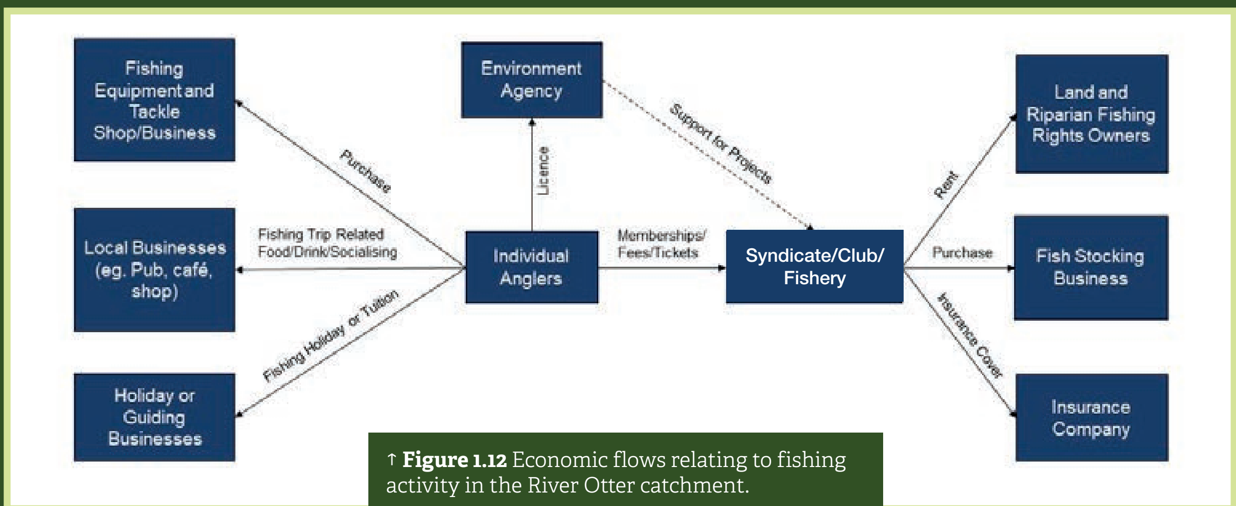
Fishing economics in the catchment

Most fishing in the River Otter catchment is recreational fly fishing for trout (brown and sea) with limited coarse fishing. Engagement with fisheries, syndicates, and individual anglers throughout the catchment and scrutiny of publicly accessible data held by the Environment Agency[18,19] were used to examine key economic focal areas including: fishing licence sales; fishing rents/rights; syndicate memberships; day/guest fishing tickets; fishing effort; fish stocking; insurance; individual angler expenses and other factors (details are provided in Appendix 1).

It is not possible to obtain a robust assessment of the economic value of fishing in the catchment due to a range of factors. For example, effort returns are incomplete or absent, incomplete records are held, and there are challenges in identifying and engaging with all anglers. However, it is assumed the annual value significantly exceeds £100,000.

The economic flows pertaining to fishing within the catchment have been identified and provide a profile of fishing-related economic activity. By doing so, we identified that if beavers are found later to impact on the recreational fishing economy (either positively or negatively) this would likely occur by first influencing an individual angler's activity. This could then have knock-on impacts on factors such as syndicates and/or riparian rights.

The impacts of beavers on angling within the River Otter catchment that were reported were limited (see Appendix 1). Predominantly impacts were indirect, such as where anglers reported that they had had their fishing session disturbed by the presence of 'beaver-watchers' some of which were perceived as confrontational toward anglers (and *vice versa*). In one instance, this led to a syndicate reporting that fishing had been affected in 40% of their stretch of river to the owner of fishing rights, who subsequently reduced the rent in that year. In terms of direct impact, one angler reported that a beaver-felled tree had obstructed their ability to wade through the river.



↑ **Figure 1.12** Economic flows relating to fishing activity in the River Otter catchment.

Summary cost-benefit analysis

A summary cost-benefit analysis is presented in Table 1.6 based upon the results of the ROBT. From the observations we have made in the Trial, the benefits of the presence of beavers in the River Otter are believed to have outweighed the costs. The most significant economic benefit is likely to be in flood alleviation. It has not been possible to address all the potential costs and benefits and so this represents as close a picture as is possible within the boundaries of the Trial.

It is important to recognise that, socially, those who benefit from beavers are not necessarily those who may incur a cost. For example, a community downstream of a beaver dam may benefit from flood alleviation, whilst the backlog of water behind the dam may encroach upon agricultural land **(see Case Study 2)**. Significant costs relate primarily to impacts on agricultural land immediately adjacent to beaver territories. Additional costs relate to impacts on trees of landscape or sentimental value, particularly those associated with gardens adjacent to beaver territories. However, we believe such impacts where they arise can be minimised through management.

Thus, if beavers are to remain in the River Otter (or become more widespread), management will need to take an holistic approach to financially support negatively affected parties whilst maximising benefits of beaver reintroduction. The *Beaver Management Strategy Framework* proposed by the ROBT Steering Group[7], in conjunction with *The Eurasian Beaver Management Handbook*[6], provides the basis for such a strategy.

→ Table 1.6 Summary cost-benefit analysis of the observations from the River Otter Beaver Trial. N.B. Costs or benefits not observed during the ROBT have not been included in this table (though work pertaining to a wide range of impacts is cited throughout the report.)

Impact Theme	Benefit (↑) Or cost (↓)	ROBT Observations	Details	Key References
Flood Alleviation	↑	• Reduction in flow rates downstream of beaver dams observed, particularly after high rainfall events. • In one case beavers dammed upstream of a community with properties at risk of flooding.	• Chapter 3 • Case Study 2 • Appendix 3	8,20–23
Water Quality	↑	• Improved water quality downstream of beaver dams. • Reduced nitrate, phosphate and suspended sediment. • Increased dissolved organic carbon.	• Chapter 3 • Case Study 4 • Appendix 3	20,24–27
Wildlife Habitats and Species	↑	• Creation of complex wetland habitats due to damming at three sites. • A County Wildlife Site has seen an improvement in its habitat quality status since beaver presence. • Tree felling increases light penetration and canopy height variability. • Increase in species surveyed at dam sites including wildfowl. • Use of beaver wetlands by water vole.	• Chapters 1 & 2 • Case Studies 1 & 5 • Appendix 2	14,28–34
Ecotourism & Business	↑	• Increase in visitors to villages where beavers are visibly present. • Business opportunities such as merchandise, events and use in marketing.	• Chapter 1 • Case Study 3 • Appendix 1	35–38

Impact Theme	Benefit (↑) Or cost (↓)	ROBT Observations	Details	Key References
Agriculture and small orchards	↓	• Waterlogging of productive land by beaver dams at three sites, with one impacting upon an organic potato crop and another upon land used for a spring-calving dairy herd. • Feeding on maize in three areas. • Time and costs incurred for management interventions undertaken by the landowners / farmers. • Feeding on apple trees observed on three sites, but tree protection has been effective in most cases • Feeding on trees and shrubs of sentimental value has occurred occasionally.	• Chapter 1 • Case Studies 1, 2, 3 & 6 • Appendix 1	6,39,40
Fishing/ Fishery	Varied	• Economic factors within the catchment identified. • Limited observations of beaver impact in the ROBT. In one location, conflict between anglers and 'beaver-watchers' had been reported. • Increased diversity of habitat for fish. • Higher abundance of brown trout, minnow and lamprey in beaver-impacted reaches assessed. • Reduction in bullhead in impounded reaches assessed.	• Chapters 1 & 2 • Appendices 1 & 2	41–44
Management interventions by ROBT team *	↓	• Management interventions undertaken by the ROBT. These vary from a single advisory visit to highly intensive and ongoing support. • Pre-emptive measures such as protecting important / vulnerable trees	• Chapter 1 • Case Studies 1,2,3, 4,5 & 6 • Appendix 1	6,7

* The costs associated with the management interventions and advisory work undertaken during the ROBT do not necessarily reflect the costs that might be incurred outside a Trial situation. The greater the allocation of resources on this is likely to reduce the levels of conflict.

Costs associated with management and operation of the River Otter Beaver Trial

The time and associated costs incurred by the ROBT team have not been fully quantified or assigned to every case study or beaver site introduced in this Science and Evidence report. Data were collected during the Trial on the time taken by the ROBT team and partner organisations working on each site, but meaningful analysis has proved difficult owing to the complex, multi-faceted nature of the support provided. Beaver activity has often spanned large reaches of river systems and has also required a mixture of outreach, engagement, volunteer oversight, and practical mitigation works (as well as the research reported herein). A significant proportion of time has been spent monitoring beaver activity in the field, and only a small component of this has been deployed toward direct mitigation intervention. It was therefore considered too complex (and potentially misleading) to assign costs to particular scenarios or specific beaver sites.

Two members of staff from Devon Wildlife Trust were employed over the course of the Trial period, equating to approximately 1.5 Full Time Equivalents (FTE), with an additional, modest, non-salary budget. The majority of time was spent delivering indirect activities, providing support and information to a range of stakeholders, enabling them to understand beaver behaviour and the associated risks and conflicts. The remainder being directly associated with monitoring the beavers, and assisting landowners in mitigating impacts, as have been outlined earlier in this chapter and in each of the Case Studies.

This is in addition to the time spent on education, communication, fundraising and management by other DWT staff.

The successful delivery of the practical elements of the Trial has been made possible by considerable support from partner organisations, especially Clinton Devon Estates, who have deployed staff time to assist in the management and mitigation of beaver activity – for example clearance of trees alongside footpaths. The Estate estimates that this equates to a total of 16 days over the five years of the Trial. A further 10 days are estimated to have been spent assisting with trapping.

The Trial has also been supported by a small team of trained and supervised volunteers who have been critical in providing additional time and support in specific situations. In total 3 volunteer days have been contributed for protecting trees from beaver activity in two territories **(Case studies 3 and 6).**

At Otterhead Lakes **(Case study 4)**, 2.5 days of volunteer time has been spent clearing beaver dam material from the outfall structures. This has been an ideal opportunity to use the Forest School students based on the site, who are also benefitting from being involved with this activity. The most extensive other volunteer task excluded here, has been analysing and extracting information from video footage collected at beaver sites, showing beaver activity and other species present.

We recognise and are very grateful to the farmers and landowners who have engaged positively with the Trial and given their time and expertise in support of the project and assisting with practical activities to manage conflicts. Staff from the Environment Agency have been involved with five sites where dams have been constructed and have maintained oversight on others.

The installation and maintenance of research equipment, and the collection of a wide variety of data has been led by a team of four from the University of Exeter, supervised by Prof Richard Brazier. Three of these researchers have contributed all their time to the project, with a fourth just working over the last 6 months. Prof Brazier has contributed ca. 0.25 FTE over the project, including significant *pro bono* time spent to write grants to fund the research reported herein.

Consultants and partner organisations have also provided much of their time and energy for free. Dr Roisin Campbell-Palmer, and Dr Simon Gurnell from the Royal Zoological Society for Scotland have provided extensive time for health screening and production of their reports (Chapter 5 and Appendix 5). The University of Southampton have also collaborated on the collection and analysis of fisheries data over the course of the Trial, some of which was funded by the Trial. Additional expertise by national specialists like Professors John Gurnell and Alastair Driver has been provided but not fully quantified.

In addition, many individuals and organisations have been involved with the steering groups, working groups and forums and have provided this time for free, for which we are very grateful.

Key documents in Appendix 1

- River Otter Catchment Overview (DBRC – September 2019)
- Infrastructure Monitoring Locations (DWT / EA – October 2017)
- Beavers and Agriculture (UoE – November 2019)
- Beavers, a Rural Community and Ecotourism (UoE – November 2019)
- River Otter Fishing, Economics and Beavers

The appendices are available to view at https://www.exeter.ac.uk/creww/research/beavertrial/appendix1/

NB. These appendices will be updated with other relevant supporting documents, not necessarily listed here.

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