The River Otter Beaver Trial: Natural England's assessment of the trial and advice on the future of the beaver population (NEER018)

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Executive summary

The European Beaver *Castor fiber* was once widespread across Europe and northern Asia. It became extinct in England around the 16th century due to overhunting for its meat and fur. Beavers are ecosystem engineers and, as a keystone species, are able to restore wetland ecosystems and produce a network of environmentally enriched riparian habitats. As a result, there is widespread interest in their reintroduction into England.

Context

A five year licence was issued by Natural England in 2015 to enable the capture and legal re-release, following health and genetic testing, of beavers that had been living wild on the River Otter, Devon. The licence legitimised the presence of the beavers, enabling an authorised trial of a beaver reintroduction. Subsequently, the River Otter Beaver Trial (ROBT) was set up with a project management group to oversee and deliver all aspects of the ROBT and to observe and study the colonisation of a lowland English River catchment.

Scope

The objective of this report is to assess the outcome of the ROBT to inform the decision on whether the beavers are allowed to remain within the River Otter catchment on expiry of the licence.

At conclusion of the initial five year licence a Science and Evidence report was published by the ROBT's Science and Evidence Forum, giving an overview of the research undertaken as part of the ROBT. That report, supplemented by associated peer-reviewed papers, commissioned reports, additional evidence and previous reports published during the ROBT, was used in Natural England's assessment of the trial. This assessment considers whether the ROBT objectives have been met; whether the licence has been adhered to; and whether the International Union for the Conservation of Nature (IUCN) guidelines for reintroductions and other conservation translocations have been followed.

Key conclusions

This assessment concludes that the River Otter Beaver Trial has been a success. The ROBT Science and Evidence Report forms a comprehensive summary of all of the work undertaken during the five year trial. The ROBT objectives have been met and the licence conditions adhered to. All relevant IUCN criteria in relation to reintroductions have been followed to an appropriate degree.

The presence of beavers, at this stage of re-colonisation, is judged on balance to be positive for the River Otter catchment from an ecological perspective. The beavers are surviving and expanding in numbers and range, and appear to be suffering no adverse welfare or disease issues. Relationships with other species are yet to be fully understood, but have so far given no cause for serious concern.

Conflicts between people and beavers have been well managed and their presence has widespread local public support.

It is noted that, due to the short length of the ROBT, the full impacts of certain interactions with habitats and species could not be fully investigated. Therefore, continued monitoring and assessment is advised. The River Otter catchment also presents limited opportunities to evidence impacts around some areas of concern, such as interactions with migratory salmonids. In order to better understand these interactions, studies would need to take place in other river catchments.

Key recommendations for the future of beavers in the River Otter catchment

Natural England recommends that beavers are allowed to remain within the River Otter catchment on expiry of the licence.

Natural England will provide further advice to help inform the Government's decision and future policy on the legal status, future reintroduction and management (including licensing) of beavers more widely throughout England. Until that decision is made, it is recommended that the beavers within the River Otter catchment are monitored and allowed to spread and colonise the remainder of the catchment, or (if resources are available to support local communities) to the neighbouring catchments. A protocol will need to be put in place to ensure that beavers remain contained within the agreed area until the national decision is made. In line with this advice, an appropriate monitoring and management strategy will need to be implemented in the interim.

Contents

1 Introduction

The Eurasian beaver *Castor fiber,* is a semi aquatic rodent and a former native species to England. It is considered to be a keystone species due to the way it can modify landscapes. After the last ice age beavers occurred throughout Europe, including Great Britain. However, the species was widely exploited for fur and other products and was driven to extinction across much of Europe. It probably disappeared from Great Britain between the 12th to 16th centuries (Manning *et al.* 2014; Raye 2015). By the early 20th century only five isolated populations remained in Europe; in France, Germany, Norway, Belarus and Russia. Since that time, the species has been widely and successfully reintroduced to most European countries. Over the 20th century the population has risen from a low of about 1,200 to approximately 1.04 million beavers distributed throughout much of their former native range (Halley *et al.* 2012).

The International Union for the Conservation of Nature (IUCN) defines a reintroduction as 'an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct.' There is widespread interest in species reintroduction, particularly beaver, following their disappearance from Britain. The many arguments made to justify the reintroduction of beaver primarily relate to environmental services, international agreements, conservation strategies, social and economic reasons and moral considerations.

In 2013 a population of breeding beavers was discovered on the River Otter in East Devon. The origin and numbers of these animals was, and remains, unknown. It can be assumed they either escaped from a nearby captive population or were illegally released. As this was not an authorised release - and the origin of the beavers unknown - they risked introducing the tapeworm *Echinococcus multicularis* to the UK. The initial response of the Department of Environment, Food and Rural Affairs (Defra) was to remove the beavers. This proposal was met with a campaign by local residents, conservation and land management organisations and wildlife enthusiasts to retain the beavers on the River Otter.

Subsequently, key interested parties proposed to undertake an approved beaver introduction trial. The River Otter Beaver Trial (ROBT) project management group was set up to oversee and deliver all aspects of the ROBT. This comprised:

- A targeted science and evidence programme.
- A community engagement programme.
- The provision of a well-resourced team of field staff to avoid, mitigate, manage and document any impacts of beavers.

Ministers agreed to permit a formal licensed 'beaver reintroduction trial'. Devon Wildlife Trust (DWT), on behalf of the ROBT partners, was granted a licence by Natural England - under section 16(4) of the Wildlife and Countryside Act 1981 - to introduce and study Eurasian beavers *C. fiber* within the River Otter catchment in East Devon. The project

commenced only after the capture and screening of adult beavers living on the river ensured they were healthy, free of the tapeworm *E. multilocularis* and it was confirmed that the animals were Eurasian and not North American beavers.

The five-year licence was granted on 2 February 2015 following the submission and subsequent review of a detailed licence application. The licence expired in February 2020 and has since been extended until 31 August 2020, to allow for this assessment and a decision by ministers on the future of the beavers on the River Otter.

It was a requirement of the licence that the ROBT complied with the International Union for Conservation of Nature Guidelines for Reintroductions and other Conservation Translocations (IUCN/SSC 2013). The situation on the River Otter was, however, atypical in that beavers were already established and breeding. This impacted on the ROBT's ability to carry out baseline and preparatory work in the chronological order that would be expected in typical reintroduction circumstances. That constraint was recognised from the outset and is acknowledged in this assessment.

The licensed trial had three goals, reflecting IUCN species reintroduction guidelines; a set of trial objectives; and a number of criteria for success and failure (see section 3).

The goals were:

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

The objectives of the ROBT were:

- Identify and assess impacts of beavers on habitats, wildlife, built infrastructure and local communities.
- Identify wider public benefits associated with beaver activity in the landscape.
- Develop an effective management process for a free-living beaver population.
- Understand the ecology, behaviour and population dynamics of a beaver population in a lowland productive agricultural landscape.
- Increase knowledge and awareness with local communities and other key stakeholders of beavers and their interactions in the landscape.
- Provide data and evidence to augment a national knowledge base regarding beaver reintroduction.

An exit strategy was also outlined in the licence application, as per IUCN guidelines. An exit strategy is an important component of any reintroduction project and outlines criteria which, if met, allows the project to be discontinued in an orderly way.

1.1 Why Natural England is carrying out this assessment

Natural England is the government's advisor on the natural environment. We provide practical advice, grounded in science, on how best to safeguard England's natural wealth for the benefit of everyone.

There is a requirement under Article 22 of the 'Habitats Directive' (which remains part of UK law) to study the desirability of reintroducing extinct native species listed in Annex IV of the Directive. Annex IV includes the Eurasian beaver *C. fiber*.

Natural England provides evidence-based, objective advice and recommendations about species recovery and reintroductions. Natural England was asked by Defra to undertake an assessment of the success of the ROBT. This included ascertaining whether the presence of beavers in the River Otter catchment overall has a positive impact on the area, bearing in mind both biological and social aspects. Based on its assessment, Natural England was asked to make a recommendation on whether beavers should be allowed to stay in the River Otter catchment on expiry of the licence.

In 2009 Natural England published NECR002 'The feasibility and acceptability of reintroducing the European beaver to England' (Gurnell *et al.* 2009). The findings of the report were consulted during this assessment and helped to develop a view on the feasibility and desirability of beaver reintroductions in England and what contribution beavers might make to national habitat restoration targets.

Natural England is also responsible for the administration of nature conservation in England. In this role, advice was provided on the ROBT licence application in relation to adherence with IUCN requirements, monitoring, evaluation and research. Natural England was a member of the steering group for the ROBT and also participated in the licence and management sub-groups to discuss progress and any problems. The authors of this assessment were not part of those advisory groups and had no input to the project prior to carrying out this assessment.

1.2 Current situation in England

There are a number of locations in England where beavers are kept within fenced enclosures (Figure 1). Natural England is also aware of small numbers of beavers living in the wild in eight counties in England and one in Wales. Beavers are also present in at least two zoo collections.

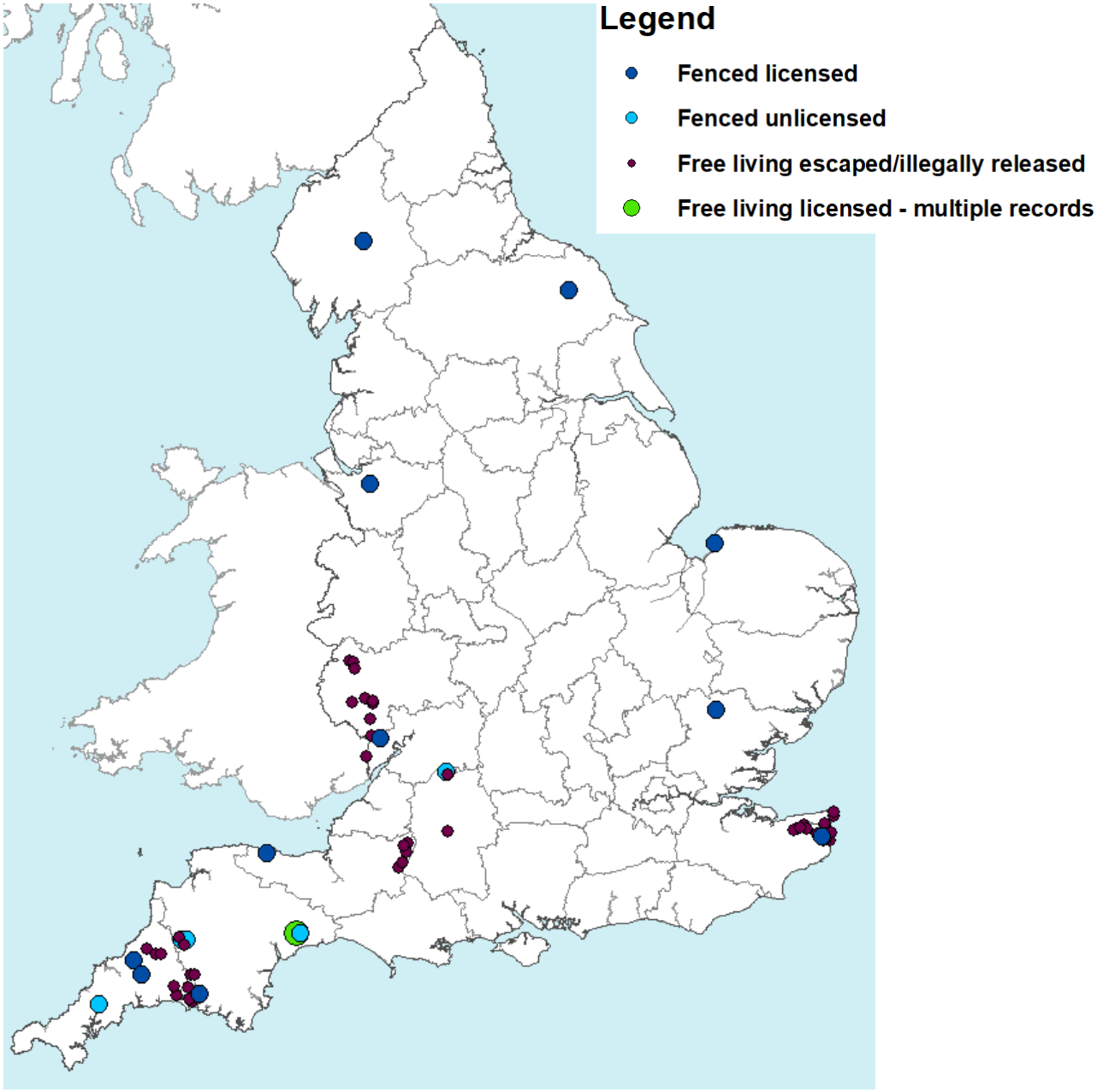

Figure 1 Reported locations of free-living beavers (since 2015) and locations where beavers are held within fenced outdoor enclosures in England (data up to April 2020). Not all reported free-living sightings have been independently confirmed.

1.3 Aims and objectives

The primary objective of this assessment was to investigate whether the ROBT has been a success. Success in this case will be defined in terms of the project outcomes analysed in the context of the IUCN guidelines for reintroductions and other conservation translocations (IUCN/SSC 2013). The IUCN Guidelines have been adopted by the British statutory conservation agencies for implementing conservation translocations policy in Great Britain. Any proposed reintroductions should follow these guidelines. As the original introduction of beavers to the River Otter was not authorised, and did not follow the IUCN guidelines, the ROBT was designed to provide a series of regulating practices that would seek to legitimise and make compliant the reintroduction in this location. It was, therefore,

important to assess whether the project objectives were met and whether the licence authorising the ROBT was complied with.

The aims of this assessment are, therefore, to:

- Establish whether the criteria defined in the IUCN reintroduction guidelines have been satisfied.
- Establish whether the objectives of the project have been met.
- Establish whether the licence has been adhered to.
- Identify any evidence needs/gaps.
- Make a recommendation for the future of the River Otter beaver population.

2 Assessment

The assessment of the ROBT was undertaken using the Science and Evidence report and appendices, produced by the project's Science and Evidence Forum - chaired by Professor Richard Brazier of Exeter University (Brazier *et al.* 2020). Evidence was also drawn from previous reports from the trial, including the River Otter beaver management strategy framework (post 2020) (ROBTSG 2019) and published scientific literature.

2.1 Beaver Biology

With beavers already present and breeding on the River Otter prior to the ROBT, it was not possible to fully comply with the IUCN guidelines for reintroduction and other conservation translocations. This applied, in particular, to the assessment of biological feasibility (Annex 5.1 to the IUCN guidelines). There were, however, certain elements that remained relevant and these are considered below.

2.1.1 Population Establishment

It is important to understand the biology of the introduced species. ROBT was able to draw on a wealth of information available from Europe and Scotland, in addition to the knowledge of the experts who advised the trial. This prerequisite of a reintroduction is therefore considered satisfied.

Beavers were hunted to extinction for their fur, castoreum and meat. The last record of a beaver in Great Britain was in 1780 near York (Coles 2006). The threats that beavers would face from people in modern Britain are expected to be different to those they faced in the past. It is unlikely they would be hunted for the same purposes. However, the removal of the beaver, and the subsequent drainage and engineering of waterways and wetlands, has resulted in a dramatic transformation of our countryside, riparian zones and the connectivity of our watercourses. Beaver, as a keystone species, has the potential to dramatically transform landscapes and could come into conflict with other land and river users in altered landscapes. It is recognised that the interaction between beavers and intensively farmed agricultural land, and semi natural and modified riparian zones, will

have potential impacts that did not widely occur when beavers were present in England in the past. There is still a risk, therefore, that beavers may be persecuted - albeit for different reasons. This has been seen in Scotland, where beavers living on the River Tay have been killed by farmers to protect high-value agricultural land (TBSG 2015).

The reintroduction of beavers on the River Otter had widespread public support and numerous events were held to inform the public about beavers and address any concerns. It is considered that the risk of persecution in this area is low, with no recorded illegal killing. Nevertheless, it is acknowledged that beavers could be persecuted should conflict arise. This would need to be closely monitored to ascertain whether its scale could pose a threat to the overall population of beavers on the River Otter.

Anecdotal reports have suggested that beavers were living, mostly unnoticed, on the River Otter since 2008. Breeding was confirmed in 2013 and nine individual beavers were identified from remote cameras. A subsequent trapping exercise trapped all four known adults and one juvenile in February/early March 2015. The fact that beavers had been living on the river since 2008, and had successfully bred, indicates that the initial ecological requirements for the beavers had been met.

2.1.1.1 Founding population

Deciding the composition of individuals to use to create a founder population is of great importance to the success of any reintroduction. The IUCN guidelines (IUCN/SSC 2013) specify that ‘Founders should show characteristics based on genetic provenance, and on morphology, physiology and behaviour that are assessed as appropriate through comparison with the original or any remaining wild populations.’

Eurasian beaver went through a recent bottleneck caused by hunting pressure. Eight relict populations survived and were previously assigned tentative sub-species status. Although they are no longer considered sub-species (Horn *et al.* 2014; Senn *et al.* 2014), the names for each relict population are now used to identify them. The three western relict populations were named as:

Castor fiber fiber – Southern Norway
Castor fiber galliae – Rhone in France
Castor fiber albicus – Elbe in Germany

The best provenance of beavers for reintroduction into Britain has been subject to much debate. Gurnell *et al.* (2009) proposed that *C. f. galliae* (Rhone relict population) or *C. f. albicus* (Elbe relict population) should be used for southern Britain reintroductions ‘as they are adapted for lowland habitat’. Halley (2011) argued that the origin for British beavers was likely a mix of Scandinavian, French and German populations, and unlikely to have been a single colonisation event. Given that European populations are no longer considered separate sub-species (Horn *et al.* 2014; Senn *et al.* 2014), sourcing beavers from a particular relict population is no longer considered to be of importance. Therefore, selecting founder stock that maximises genetic diversity and levels of adaptive potential, above achieving close phylogenetic relatedness to the historical British population, is likely to be the most appropriate path to follow given the current information (Marr *et al.* 2018).

The beavers living on the River Otter were of unknown origin and blood samples were taken when the beavers were caught for health examination in 2015 to establish the degree of relatedness and genetic diversity. All five beavers were genetically determined as being Eurasian beaver *C. fiber* and assigned with a high probability to either Bavarian or Baden-Württemberg populations. These are German populations of mixed reintroduction origin (Scandinavian, Russian and French; (Frosch *et al.* 2014)). The decision of the best provenance of beavers, were they to be reintroduced across England, falls outside the remit of this assessment. However, the tests have concluded that the beavers present on the River Otter originate from an appropriate source population for a reintroduction in England.

Values of genetic diversity in the River Otter population were lower than for the likely source populations. Examinations of genetic relatedness revealed that all beavers were closely related, consistent to belonging to a single family group. It was not possible to be certain of the exact pattern of relatedness between the animals because they were so closely related, but it was approximately equivalent to being between the first order (e.g. parent – offspring/sibling). To improve the population's genetic diversity the licence issued by Natural England allowed up to five additional beavers to be released into the river. Two beavers from captive enclosures in Devon were released in May 2016 and successfully bred in 2017, producing two kits. Two beavers from the River Tay in Scotland were released in 2019 and have subsequently settled as a pair in a pond adjacent to the river within the River Otter catchment.

It is noted that Appendix 3 of the ROBT Beaver Management Strategy (post 2020) (ROBTSG 2019) recommends that additional animals will be required. This is to ensure the best future genetic health for a founding population within the building phase of the colonisation of the catchment. The literature suggests that the minimum number of founding individuals for a successful reintroduction should be in the region of 20 to 30 individuals; with some protocols suggesting that sourcing approximately 30 individuals from a donor population will capture 95% of the genetic diversity (Frankham *et al.* 2002). The number of founding individuals on the River Otter falls far below this. The level of relatedness between founding individuals is concerning, despite the additional beavers being brought in to increase genetic diversity. However, the ROBT is a trial to assess the suitability of reintroducing beavers and is not a formal reintroduction project.

The beavers on the River Otter are breeding and the population is expanding. The possible impacts of a restricted founder base on the health of beavers over the five-year trial are hard to assess. The population is currently determined to be in a healthy state (see section 2.1.1.2 and 2.3) and no measurable fitness effects of inbreeding have appeared over the five-year lifespan of the ROBT. European beaver populations have successfully recovered and have been restored from very small numbers of founder animals. For example, Swedish populations have recovered from ~11 breeding Norwegian females (with Norwegian populations themselves identified as having restricted genetic diversity recovering from ~120 individuals). Both Swedish and Norwegian populations have recovered without a common display of the more typical abnormalities associated with inbreeding (e.g. dental abnormalities, cleft palates, polydactyla etc) (Parker *et al.*

2002; Rosell *et al.* 2012). Nevertheless, such evidence is anecdotal and does not mean that a more diverse population would not have a better chance of success over longer time scales.

Should beavers be allowed to remain on the River Otter, a more robust and diverse founder base is recommended, to ensure a genetically robust population is present which would be adaptable to disease outbreaks and effects of climate change (IUCN/SSC 2013). Therefore, the conclusions of the management strategy should be followed and further unrelated beavers will need to be introduced into the catchment, bearing in mind the need for sufficient appropriate habitat and availability of suitable release sites.

2.1.1.2 Population dynamics

Evidence and accounts from members of the public and landowners reveal that beavers have been living on the River Otter since 2008, with initial breeding occurring prior to the death of a founding adult male in April 2012. New kits were also confirmed in 2013 and 2014. In February 2015 a detailed survey undertaken by the Animal and Plant Health Agency (APHA) estimated the population to comprise nine individual beavers living in two family groups, including four adults and five sub-adults. In March 2018, the population had grown to an estimated 27 animals living in eight territorial groups. By the end of the trial period in 2020 it is predicted that there will be 17 territorial groups of beavers distributed throughout the catchment (M Elliott, pers. comm.). It is noted in the report that population predictions are made from winter field sign surveys. In small colonising populations, when many areas of feeding activity may be the result of individual animals or young pairs starting to establish their territories, it is more difficult to carry out accurate population predictions.

A Gompertz function graph presented in Appendix 3 of the ROBT Beaver Management Strategy (post 2020) (ROBTSG 2019) outlines the colonisation stages of the River Otter catchment for beavers. Three distinct phases are outlined: the establishment phase; the building phase; and the maintenance phase. This analysis of colonisation is comparable to studies of beaver colonisation events elsewhere in Europe (e.g. Fustec *et al.* 2001). It is suggested that the population is currently coming to the end of the establishment phase, which is characterised by low growth as the animals establish themselves in the new habitat, and about to enter the building phase. The building phase is characterised by a period of rapid population growth where beavers expand into most of the readily accessible areas of suitable habitat. This phase is likely to be associated with increasing conflicts alongside conservation benefits. The building phase is followed by the maintenance phase, where the rapid growth of populations is followed by a decline to stabilise at a density lower than the peak level. Depending on the landscape, and how many additional animals may be introduced into the catchment, population growth may continue for 25 years or more until all available sites have been occupied (Gurnell *et al.* 2009).

Initial indications suggest the population of beavers on the River Otter is doing well, with a 200% increase in numbers from 2015 to 2018 (including the additional beavers released into the catchment), and 130% increase year-on-year in the number of family groups from

two in 2015 to 17 in 2020. This far exceeds the 15 – 20% growth rates reported from elsewhere in Europe (see Appendix 3, ROBTSG 2019), although similar growth was observed on the Tay in Scotland (B Ross pers. comm.). This rate of increase is not sustainable, and is expected to level off once readily available habitat has been occupied, though it is unclear how quickly this will happen. The rate of population increase of two reintroduced populations in Sweden turned negative after 34 and 25 years (Hartman 1994). A study in the Loire Valley in France showed that the number of occupied sites reached a peak and stabilised after 25 years (Fustec *et al.* 2001).

Where data are available, over half of European reintroductions of beaver have been successful. Failed introductions have been attributed to release into unsuitable habitat and too few individuals being released with subsequent poor population growth (Macdonald *et al.* 1995). While the population of beavers on the River Otter appears to be doing well, they are still at a very early stage in the reintroduction timeline. Preliminary minimum viable population density estimates carried out by Macdonald *et al.* (1995) estimated that releases involving 20 to 50 pairs had a greater than 80% chance of survival over 100 years. Whereas, a release of five pairs had only a 40% survival rate over 100 years. Supplementation of reintroductions by additional individuals did show improvements in the chances of survival. Un-supplemented populations only showed a greater than 80% survival chance after 100 years for releases of 50 pairs or more, which demonstrates the need to release further beavers within the River Otter catchment in order to provide confidence in the longevity of the population, should they be allowed to remain.

There are currently an estimated 17 beaver territories on the River Otter. The maximum carrying capacity of the River Otter catchment has been estimated at between 147 and 179 territories (see section 2.2) although this does require further validation. It is anticipated that the actual carrying capacity will be considerably lower, especially taking into account constraints resulting from human interests, such as farming and flood defence.

Key Points – Basic Biology

The ROBT drew upon a wealth of information on beaver biology available from Europe and Scotland, in addition to the knowledge of the experts who advised the trial. Beavers had been living on the River Otter since 2008 and had successfully bred, indicating that initial ecological requirements had been met. Beavers were confirmed as being Eurasian beaver *C. fiber* and originated from an appropriate source population for a reintroduction in England. Initial indications suggest the population of beavers on the River Otter is growing and expanding.

Although it was not possible to fully comply with the IUCN guidelines, given that beavers were already present and breeding on the River Otter prior to the ROBT, the relevant IUCN reintroduction criteria have been satisfied as far as they can be.

The work has contributed to delivering objectives 4 and 6 of the ROBT.

Genetic analysis has highlighted that the population has very limited genetic diversity so, should beavers be allowed to remain on the River Otter, further unrelated beavers should be introduced to ensure a more genetically robust population. Accurate population predictions are difficult to carry out in small colonising populations (as with the River Otter), making it difficult to accurately estimate the total number of beavers present within the catchment.

The evidence available relevant to this section of the assessment supports a recommendation to allow beavers to remain on the River Otter.

2.1.2 Biotic relationships with habitats and species

Beavers are considered to be keystone species, capable of restoring wetland ecosystems and producing a network of environmentally enriched riparian habitats. They directly impact on the habitats and species around them and studies of habitats and species were undertaken as part of the ROBT. The ecological niche of beavers has not been filled by any other aquatic mammal species in England, such as coypu or muskrat. Natural predators of beavers in England, such as wolf and bear, are now extinct, although human persecution may still occur. Restrictions on the spread of beavers is anticipated to be primarily associated with the availability of suitable connected habitat, although factors such as road accidents and pollution could also affect dispersal.

2.1.2.1 Designated sites

A 'shadow' Habitat Regulations assessment was undertaken by Natural England to assess whether there may be any likely significant effects on the European sites of the River Otter or adjacent catchments, should beavers colonise the River Exe, River Sid and the River Axe in Devon/Dorset. The appropriate assessment concluded that there is likely to be no significant adverse effect on the qualifying features of the European sites assessed (see Appendix 1).

There have been no significant detrimental impacts on statutory designated sites or other local wildlife sites during the period of the trial. Therefore, there has been no need to consult Natural England or implement mitigation measures on or in the vicinity of these sites, as per condition 23 of the licence (see Appendix 2).

2.1.2.2 Habitats

Foraging behaviour of beavers on woody riparian vegetation can alter the structure of the vegetation in beaver occupied river reaches. This was studied during the trial at Clyst William Cross using a drone to capture images. The results revealed that areas of riparian woodland, where beavers were foraging, had a structure which differed significantly from riparian woodland not impacted by beavers. Results found that tree stands were not removed completely, but gaps in the canopy were created, as was found elsewhere in Britain (Elliott *et al.* 2017; Gaywood 2015). This was due to the activity of beavers

impacting on willow scrub, breaking up some patches of scrub and creating new areas of open water and marginal vegetation.

Beavers feed on soft herbaceous vegetation, young woody vegetation and the bark of more mature trees. Beaver feeding activity on trees is one of the most noticeable signs of their presence. Such activity was monitored extensively throughout the ROBT with feeding signs recorded on trees on 2,356 occasions. Conflict from beaver felling of trees is discussed in section 2.4. Further work on plant communities has was not undertaken as part of the ROBT. Impacts on aquatic plants will be studied as part of an aquatic ecology PhD undertaken by the University of Exeter and Devon Wildlife Trust. No concerns in relation to habitats have so far been identified.

In relation to invasive non-native plant species, Himalayan balsam *Impatiens glandulifera* is present throughout the River Otter catchment. Beavers have been recording feeding on it, but not enough to be likely to reduce its abundance. The method of dispersal is through seed projection and it is unlikely that beavers would affect its distribution. Himalayan balsam appears to prefer very open seed beds, such as scoured river banks or under winter flooded trees. The creation of more permanently inundated land by beavers is not ideally suited to Himalayan balsam. However, if lots of Himalayan balsam were present initially this could prevent the establishment of other vegetation and lead to winter-bare areas which would repeatedly recolonise with Himalayan balsam each spring.

There is one known stand of Japanese knotweed *Reynoutria japonica* in the catchment and beavers were recorded feeding on it on one occasion. On another site a stand of bohemian knotweed *R. x bohemica* - a hybrid between Japanese and giant knotweed *R. sachalinensis* - is growing within 10 m of the waters edge and was recorded growing within a beaver dam, where it had either been used as a construction material by the beavers or had been washed into the dam. As these three knotweed taxa will grow from the nodes of pieces of green stem, the actions of beavers feeding on it and depositing sections close to the water in feeding stations, or incorporating into dams, could aid the spread of this invasive species. It is advised that this is closely monitored and stands of knotweed close to the waters edge should be targeted for removal if possible. Beavers have also been recorded feeding on rhododendron *Rhododendron ponticum* and cherry laurel *Prunus laurocerasus* using it as lodge and dam building material. Cherry laurel is spread by birds, through the seeds in their droppings, or through layering and suckering. Rhododendron spreads by seed or layers where branches touch the ground. It is unlikely that beavers will promote the distribution of these invasive species throughout the catchment. Foraging may however, reduce the plants viability and cherry laurel in particular is not suited to permanently wet ground. Therefore beavers may have a negative effect on their abundance.

2.1.2.3 Invertebrates

Monitoring macro-invertebrate species numbers and assemblages can provide an indicator of ecological status and is a method used by the Environment Agency to monitor water quality. Data collected by the Environment Agency are available from the 1990s for various sampling locations within the River Otter catchment. The limited time series

available since the start of the ROBT does not yet indicate any change in macro-invertebrates. Additional macro-invertebrate samples were collected during the trial to complement sampling carried out by the Environment Agency, but results are not yet available. Further aquatic macro-invertebrate surveys will be done as part of an aquatic ecology PhD and carried out in a way that will allow the data to be nationally representative. Baseline surveys are to be carried out downstream of beaver territories.

A definitive assessment of any impacts on invertebrates is not possible until new research is carried out. However, none of the invertebrate species recorded through the National Biodiversity Network (NBN) and local record centres listed in the River Otter Catchment Overview (Knott 2019; Appendix 1 of Brazier *et al.* 2020) are considered likely to be negatively affected by changes to habitats brought about by beavers. The Southern damselfly *Coenagrion mercuriale*, a section 41[1] species and a qualifying feature of East Devon Pebblebed Heaths SAC, is considered unlikely to be negatively affected. This is because its specialised habitat within the East Devon Pebblebed Heaths SAC is not likely to be affected (see Appendix 1).

2.1.2.4 Fish

Electro-fishing surveys were conducted in September 2015 on the main River Otter at a site where beavers were present but no dams had been constructed. The aim was to provide control data for beaver dam building activity. Eight species were captured: bullhead *Cottus gobio*, minnow *Phoxinus phoxinus*, stone loach *Barbatula barbatula*, brown trout *Salmo trutta,* three-spined stickleback *Gasterosteus aculeatus*, lamprey species *Lampetra spp*, European eel *Anguilla anguilla* and Atlantic salmon *Salmo salar*.

Quantitative electro-fishing surveys of reaches in the River Tale, a tributary of the River Otter, in October 2016, July 2017 and August 2019 were undertaken, following the construction of beaver dams in the area, to assess the fish community at sites that were either modified or unmodified by beaver dams. The 2016 and 2017 surveys captured six fish species: bullhead, stone loach, brown trout, eel, minnows, and brook lamprey *L. planeri*.

Species diversity depends on geographical location and the river habitat available. The habitat present will drive the fish assemblage. A baseline should be drawn for expected fish assemblages, based on reference conditions for a river, to determine what can be supported by typical natural processes. The River Otter was once recognised as a spawning site for Atlantic salmon, although populations dramatically decreased prior to beaver presence on the river. Historic fish survey data has demonstrated the presence of brown trout, bullhead, stone loach, eel and brook lamprey.

In 2017, the total abundance of fish in the impounded reach (the area above a dam) was around four-fold lower than immediately downstream of the beaver dam and control reaches. In particular, there was a notable reduction in the number of bullhead, stone

[1] Species of principle importance for the purpose of conserving biodiversity listed under Section 41 (England) of the Natural Environment and Rural Communities (NERC) Act 2006.

loach and minnow, resulting in the lowest density and biomass values for these species recorded in this reach. Bullhead and stone loach tend to occupy areas with moderate velocity and coarse substrate where they can seek shelter, feed on invertebrates and spawn. Bullhead in particular are sensitive to in-stream connectivity and are often the reason for fish failing under the Water Framework Directive where barriers to migration are present. The conditions within the impounded reach are not therefore favourable for these species, which is likely to have resulted in the lower numbers seen. As a relatively recently impounded area, there was little woody material providing refuge in the water, used by minnows to seek refuge from predation from brown trout, hence why numbers of minnows may have been reduced. However, biomass of brown trout was particularly high considering their densities in this reach. For example, biomass was similar immediately downstream and upstream of the beaver dam, despite density being more than two-fold greater in the downstream location. This indicates that trout occupying the location immediately upstream of the dam tended to be larger, supporting the common suggestion that beaver ponds provide suitable rearing and/or refuge habitat for salmonids (Collen and Gibson 2000; Kemp *et al.* 2012).

In 2019, further surveys were carried out on the same stretch. The original dam collapsed in the winter of 2017 and another beaver dam was constructed 80 m upstream. The 2019 survey identified the same six fish species as well as three-spined stickleback. Total fish abundance in the beaver pool was approximately 37% higher than the other three reaches and it was the only site to support the three-spined stickleback. There was a notable reduction in bullhead in the beaver pool, where the physical characteristics are not suited to this species. The number of minnow and lamprey, however, was markedly greater in comparison to the other reaches. Increased diversity on the River Tale may be a consequence of increased habitat heterogeneity through the creation of barriers to migration and elevated nutrient/sediment conditions. Density and biomass for brown trout were highest in the reach immediately downstream of the old beaver dam and in the beaver pool respectively. This suggested that the shallow swift flowing conditions near the old beaver dam provided good habitat for juvenile trout, whereas the deeper, slower flow in the beaver pool was suitable habitat for larger salmonids.

Beavers have only relatively recently colonised the River Tale and started to modify the structure of the river. The beaver dam increased water depth, decreased velocity and promoted fine sediment deposition upstream, which can increase habitat heterogeneity to benefit freshwater biodiversity (Stringer and Gaywood 2016; Law *et al.* 2019). Differences in fish composition have been seen, but insufficient data are available to draw conclusive results about any potential positive or negative effects at this stage. For example, increased biodiversity and biomass may not always be seen as positive for a salmonid river. Although, this does depend upon the scale at which an assessment is made and the importance of the river for specific species. There is a clear need to continue to study the fish populations to understand the changes in this area.

Fish passage through the beaver dam on the River Tale was not quantified during the electro-fishing survey, but results indicated that it was not a barrier to the movement of eels. Eels were captured both upstream and downstream of the dam, which is consistent

with results found in Scotland (Gaywood 2015). Observations of brown trout successfully crossing beaver dams during high flows in Colaton Raleigh stream and on the River Tale were also made in 2016 and 2019, indicating that these structures are not a complete barrier for this species in these situations. It is acknowledged that dams will create a barrier in some circumstances and there is a need to further understand the influence of beaver in modified river systems. Beaver dams tend to be more dynamic than anthropogenic structures meaning that any impacts to fish are likely to vary both spatially and temporally. Beaver dams in certain locations within the catchment could potentially prevent fish passage under certain flow conditions, although this is true of many natural barriers in rivers in general. It is also an evolutionary trait built onto the life history of migratory fish. Free passage for fish throughout the year does not always occur under natural conditions, as variable flows may make natural barriers either physically or behaviourally impassable. That said, caution needs to be applied where anthropogenic modification of the habitat has exacerbated or curtailed this natural variability, creating more problematic barriers to fish migration. Consideration should be given to when interventions are needed based on our understanding of fish biology, and it is advised that this is closely monitored in the future. A protocol for the assessment of beaver dams to aid fish passage is outlined in Appendix 7 of the ROBT Beaver Management Strategy (post 2020) (ROBTSG 2019). This is untested and should be subject to a wider peer-review before any implementation.

Although the effects of beaver damming have the greatest potential to influence aquatic quality and fish populations, changes in the canopy structure may also influence fish. Where beavers were coppicing trees on the River Tale it was anticipated that juvenile development stages of the salmonid life cycle could benefit due to increased macro-invertebrate production, providing more potential prey. Insufficient data were available from the period of the trial to assess this, so thus could be an area for future review.

It is important to note that concerns have been raised about the impacts to migratory salmonids by beaver reintroduction in England. Although once recognised as an important river for spawning Atlantic salmon, the species has undergone dramatic population declines in recent years and the River Otter no longer hosts large populations of this species. A salmonid redd count survey was undertaken along the Stowford stream and River Tale at Danes Mill where beavers are present, but no redds were recorded. Therefore it is not necessarily the best riverine system to study the potential impacts to migratory salmonids from beavers.

Sufficient surveys have been carried out to monitor fish assemblages in the River Otter catchment for the ROBT. The initial results on the River Otter appear to be consistent with early results from Knapdale (Gaywood 2015). The period of the trial is likely to be too short to determine any significant or long term changes to fish assemblages as a result of beaver activity and further monitoring will be required. Consideration of the water quality within the River Otter catchment and the presence of man-made barriers to fish passage will also need to be taken into account in any conclusions.

2.1.2.5 Amphibians and Reptiles

Surveys of reptiles and amphibians were not done as part of the trial. Grass snakes were noted in the new wetland habitat in the Danes Croft site. The creation of wetland habitats by beavers has shown to benefit amphibians elsewhere in Devon, particularly frogs (Elliott *et al.* 2017). None of the potential habitat changes brought about by beavers are considered likely to negatively impact native species of amphibians and reptiles in the River Otter catchment.

2.1.2.6 Birds

Bird surveys were carried out at Clyst William Cross in 2017 and 2019. Clyst William Cross is an off-line pond to the River Tale within a water meadow where an additional pair of beavers were released in 2016. The surveys reported that the habitat available continued to favour a diverse range of birds including woodland, riparian and wetland species. No significant difference was found in the species diversity of the site or in the number of territories of individual species. This was probably due to the short time period between surveys, although the number of species had increased in the 2019 survey. Continued surveys over a longer time period would be needed to recognise any significant effects. No negative effects on any bird species have been identified so far or are considered likely given the known ecology of the species present. It is therefore probable that any beaver-mediated influence at Clyst William Cross is unlikely to be unfavourable. No pre-beaver baseline data are available at this site, but open water and wetland grassland habitats created downstream in the lower floodplain of the River Otter have attracted six species of wetland wildfowl, which were absent from the farmed landscape prior to beaver colonisation.

2.1.2.7 Mammals

A survey of riparian mammals was undertaken along the River Tale in 2016 at the beginning of the licence trial. No formal surveys were done for mammals elsewhere in the catchment.

Water voles were reintroduced on the River Tale between 2004 and 2010 following a period of mink trapping and removal. Surveys were carried out in 2016 on the upper River Tale and at the Clyst William Cross site in 2017 and in 2019. Surveys in 2017 found that water vole distribution had not changed significantly from the 2016 survey, possibly due to the fact that beavers had not altered the habitat substantially by that point.

By 2019 the beavers had dredged and built dams across several of the water meadow channels resulting in deeper water and an extended area of wetland, estimated to be over 200 linear metres of new water channel. The surveys demonstrated that the water vole population was still present in most of the same areas as in 2016 and 2017, but had also expanded upstream into the new wetland habitat. Population counts were not undertaken. This complex wetland habitat is particularly favourable for water voles as it provides increased protection from predators such as mink that may concentrate on the main river

channel (Macdonald *et al.* 2002). Therefore, in this instance, the distribution of water voles has benefited from the habitat created by beavers.

Mink are present within the catchment although signs are limited, indicating low densities, which is likely to have arisen from previous control efforts and the presence of otters on the river (Bonesi and Macdonald 2004a). Habitat created by beavers would also benefit mink, and mink will coexist for longer with otters where terrestrial prey is abundant (Bonesi and Macdonald 2004b), so continued monitoring is recommended, particularly in light of the increasing water vole population.

The River Otter supports a healthy population of otters and numerous sightings have been made during the trial. Otters cannot dig their own holts and the presence of otter spraints in the chambers of collapsed beaver burrows in the lower River Otter catchment indicate that they are utilising this new resource. Any increase in fish numbers brought about from changes to the habitat structure of the river would be likely to benefit otters. Therefore, the actions of beavers are likely to be neutral or positive in relation to otters.

Roe deer signs were reported throughout the Danes Croft site during the 2019 mammal survey and were, along with rabbits, browsing within the drier areas of the meadow. Excessive browsing by deer species can negatively affect regeneration of vegetation after beaver felling (Gaywood 2015), but there have been no signs of this currently within the Otter catchment.

The creation of new wetlands are likely to have benefited bat species through creating enhanced foraging habitat. 14 bat species have been recorded throughout the catchment indicating it is a good area for bat species, although no formal surveys have been undertaken.

Key points – biotic impacts

No negative impacts to any designated sites were identified during the ROBT. The impacts of beavers on vegetation communities are consistent with that observed elsewhere in Britain and there are no immediate issues for concern within the River Otter catchment. The results of surveys to examine the effects of beavers on fish, bird, invertebrate, amphibian, reptile or mammal populations are not conclusive, but no major negative impacts were discovered during the ROBT.

Criteria defined in the IUCN reintroduction guidelines in relation to ecological risk were supported by the work undertaken.

The work has contributed to delivering objectives 1 and 6 of the ROBT.

Data collected during the trial on the effects of beaver dams on fish populations are insufficient to enable a definitive assessment. Beaver activity may influence fish species distribution throughout the river. The life stages of the different fish species recorded within the catchment have differing requirements. Because beaver structures may be ephemeral and dynamic in nature, the relationship between beavers and fish

communities should be monitored and assessed over a number of years. The River Otter presents limited opportunity to evidence impacts relating to migratory salmonids. Therefore, further studies will need to be carried out on more appropriate riverine systems.

Data collected during the ROBT are limited in relation to the potential influence from beaver activity on vegetation communities and fish, invertebrate, bird, reptile, amphibian and mammal species and are inadequate to make a conclusive assessment of the impact of beavers on the flora and fauna of the catchment. Research in Scotland and elsewhere indicates that beaver presence can be expected to benefit most native species (Stringer and Gaywood 2016). Such changes to the riparian habitat may also benefit non-native invasive species, so regular surveys are recommended to monitor this.

The evidence available relevant to this section of the assessment does not allow us to provide a conclusive assessment of the effects of beavers on flora and fauna communities on the River Otter. There are, however, no findings that would lead us to recommend that beavers should be removed. If the beavers are allowed to remain, then further monitoring is recommended.

2.1.3 Abiotic impacts

2.1.3.1 Hydrology

The Otter catchment is a predominately rural catchment, dominated by livestock and arable farming, especially in its lower reaches, below Honiton. The steep and rolling terrain of the Blackdown Hills, the primary source of the River Otter, means that heavy rain often runs off rapidly into the river making it rise quickly. No doubt because of this, many of the dams built by beavers in the River Tale tend not to persist through the winter months. Nevertheless, the construction and natural erosion of the dams has resulted in significant changes to river channel morphology, and reintroduced dynamic natural processes which had been lost. Beaver activity is re-meandering and raising the river bed levels. Gravels and larger sediments are deposited behind the dams and are redistributed as the dams erode. This enhances gravel structures such as sediment bars and riffles and encourages localised areas of erosion and scour, increasing habitat variability within the reach. The presence of ephemeral beaver dams on the main channel has reconnected the river with the floodplain, creating new flow pathways in times of flood, depositing nutrient rich silts back onto the floodplain, with the potential to improve water quality downstream. This pattern of change is consistent with observations from Scotland (Gaywood 2015).

Hydrological monitoring equipment was installed within the catchment in four beaver territories where dams had been built. The installations were designed to complement the network of hydrometric monitoring stations managed by the Environment Agency. Preliminary data analysis in the lower Otter catchment has shown that peak flow has reduced since the creation of the beaver dams, demonstrating downstream flood attenuation. At Clyst William Cross, the area of standing water stored on the floodplain has

increased from 1,400 m² to 6,880 m². At Otterhead Lakes the presence of up to seven dams has increased the time taken for the water to enter the reservoir. Studies are in their initial stages and will be affected by the need to manage potential conflict, such as removing or reducing the height of dams, but indicate that beaver dams within the catchment have potential to attenuate floods in certain places, as demonstrated elsewhere (e.g. Puttock *et al.* 2017).

The risks associated with dam failure were also assessed as part of the trial. A hydrograph of a dam on the River Tale demonstrates a dynamic process, where the dam suffered up to four breaches and was subsequently repaired by beavers before it became stable again up to four days later. The most significant degradations observed were not to dams, but to adjacent stream banks, where the water caused localised bank erosion as it flowed around the dam. This was seen on the River Tale where the erosion led to increased channel complexity, providing new habitat types, as beavers rebuilt dams in or adjacent to the site of the erosion. It is worth noting that the erosion or potential collapse of stream banks and rerouting of the water channel may cause conflict in certain situations.

The results of hydrological monitoring across beaver sites in Britain since 2014 are presented in Appendix 3 of the ROBT Science and Evidence Review. At monitoring sites on 1st to 4th order channels, complete failure of established dams was not observed. On 1st to 3rd order channels (where beaver dam capacity modelling has classed reaches as having a pervasive or frequent capacity for damming) dams were commonly stabilised by vegetation over time, becoming integral component parts of the landscape.

The potential influences of beaver dams to mitigate against low flows and increase groundwater infiltration on the River Otter have not been assessed to date. A study of these actions would be useful to aid our understanding of the full range of potential influences.

2.1.3.2 Water quality

The water quality monitoring work in the River Otter catchment involved monitoring the water chemistry and monitoring change in macro-invertebrate species as an indicator of ecological status, as recorded in Water Framework Directive reporting terms.

The trial focused on the Otterhead Lakes, a water supply reservoir, using suspended sediment as the key variable of interest. Beavers established a territory in 2017 and have created an area of wetland above the two existing lakes. In-stream monitoring stations above and below the area of beaver activity and downstream of the obstruction point were established in September 2018. They monitor the rate and amount of water travelling through the site and the turbidity to assess whether beaver dams were trapping sediment. Insufficient time has passed since installation of the monitors to draw any meaningful conclusions from the data collected so far.

The Environment Agency holds a baseline dataset of macro-invertebrate populations in stream beds from 1990. There has been no clear change in the dataset to suggest that beavers have, as yet, had any influence on water quality at the Environment Agency

monitoring sites in the River Otter catchment. Assessment of additional sampling locations, where beaver dams are present, has not yet been completed.

Temperature effects were not monitored in the ROBT due to logistical and financial constraints. Studies elsewhere have found that beaver dams can influence stream temperature regimes, with the potential to affect species such as salmonids (Weber *et al.* 2017). Opportunities should be taken to explore the influence of beavers on temperature where possible.

Key points – Abiotic impacts

The construction and natural erosion of beaver dams has changed river channel morphology and reintroduced dynamic natural processes which is consistent with observations from Scotland. Initial findings show that beaver dams have the potential to attenuate floods in certain places. Water quality surveys have yet to yield any meaningful results.

Criteria defined in the IUCN reintroduction guidelines in relation to ecological risk have been supported by the work undertaken.

The work has contributed to delivering objectives 1, 2 and 6 of the ROBT.

Further data are needed to investigate the impact of beaver dams on river flows and the morphology of channels in the River Otter catchment. Early results indicate the presence of beaver dams may have a positive effect on reducing downstream flooding, however the impacts are likely to vary dramatically from site to site.

There is insufficient information to identify any changes in water quality that could be associated with beavers at this stage in the trial. It is accepted that appropriate effort was made to collect relevant data, but it is too soon to detect any meaningful results. Further monitoring and assessment, including temperature where this can be attributed to beaver presence across the catchment, should be undertaken.

Evidence available relevant to this section of the assessment does not allow us to provide a conclusive assessment of the effects of beaver on hydrology and water quality of the River Otter. There are, however, no findings that lead us to recommend that beavers should be removed. If the beavers are allowed to remain further monitoring is recommended.

2.2 Habitat in the River Otter catchment for beavers

2.2.1 Suitability of habitat

Successful reintroduction programs should eventually produce viable, self-sustaining populations of the target species. As previously mentioned, the fact that beavers were able to initially survive and breed in the River Otter catchment indicates that their initial

ecological requirements were sufficient and had been met. However, given the length of time that beavers were absent from the area, the habitat is likely to be very different than previously. It is important to assess whether there is suitable available habitat to meet the biotic and abiotic needs of the species in the long-term to ensure a viable self-sustaining population.

The River Otter catchment covers c. 250 km², the majority of which is improved grassland. It is divided into nine sub-catchments. Incidences of conflict between beaver activity and habitat use are mentioned elsewhere in this document but, overall, the release of beavers within the River Otter catchment is compatible with permitted land uses. In total there are 594 km of channel (including everything from ditches to river) within the Otter catchment.

Beavers are highly adaptable and can modify many types of natural, cultivated and artificial habitats, but they need freshwater bodies (ponds, streams, rivers, marshes and lakes). They prefer still or slow moving water with stable depths of at least 60-70 cm (Campbell-Palmer *et al.* 2016; Gurnell *et al.* 2009). Where these habitats are unavailable or already colonised by other beavers, they will colonise narrower watercourses and construct dams to create suitable habitat or to flood the surrounding land in order to access desirable foraging sites. At the start of the ROBT, concern was raised that the impacts of the beavers would not be significant enough to allow a meaningful study into their effects and interactions with existing land-uses. This was primarily because the two family groups of beavers had been confined to the deeper parts of the catchment where they hadn't needed to construct dams. However, as the population expanded and individuals dispersed into the upper catchments, dam construction was noted in at least five territory sites with breeding pairs. In 2019 six of the 13 beaver territories had dams.

Beavers are entirely herbivorous and suitable vegetation is required within close proximity to the water's edge. On the River Otter 99.8% of feeding signs were within 30 m of the banks of watercourses, comparable to records in Scotland and Europe (see Campbell-Palmer *et al.* 2016 section 3.5 for a summary). Beavers show preferences for certain species and surveys on the River Otter found that willow was the species most targeted. It has been cautioned that woody plants need several years to regenerate, a lag that could affect the long-term survival of beavers (Fustec *et al.* 2001). However, studies in Scotland found that rapid regeneration of willow and aspen will occur in riparian woodlands in the event of major felling activity by Eurasian beaver, even in the presence of low to moderate browsing by deer (Jones *et al.* 2009). In the milder conditions and longer growing season in the south of Britain, where the River Otter catchment is located, beavers should have access to herbaceous vegetation for a longer period. Therefore, it is unlikely that the quantity of woody browsing material such as willow would be a limiting factor during the winter. Additionally, Nolet *et al.* (1994) found that in temperate landscapes resource consumption, of *Salix* spp. in particular, was exceeded by regeneration (at least at the landscape scale), thus resources are unlikely to be totally depleted even at high population densities.

A beaver habitat index model (BHI) has been created by Exeter University to quantify beaver habitat suitability over large areas (Graham *et al*. 2019). The BHI uses vegetation alongside proximity to water bodies. Model validation across the River Otter, River Tay

catchment in Scotland and River Carey sub-catchment of the River Tamar in Devon, has revealed that reaches with higher average BHI scores are more likely to be occupied than lower scoring reaches. This is, therefore, a valuable predictor of occupancy. Table 1 shows the area of habitat available in the River Otter catchment in relation to its suitability.

Table 1 Areas of beaver habitat suitability in square kilometres derived from the beaver habitat index model in the River Otter catchment (H Graham pers. comm.)

Habitat Definition	Area (km^2)	% Catchment area
Preferred	17.85	7.53
Moderate	31.62	13.34
Low	47.94	20.22
Not suitable (no accessible vegetation)	139.68	58.92

Nearly 60% of the catchment comprises unsuitable habitat (including areas >100 m from freshwater and inaccessible to beaver). Of the remainder, approximately 7.5% of the catchment area contains preferred beaver habitat. This equates to approximately 125 km of preferred habitat in the catchment (made up of c. 150 m reaches) or 17.85 km^2 (H Graham pers. comm.). Modelling suggests that at this early stage colonisation for the River Otter catchment, reaches with preferred vegetation are 1.7 times more likely to be occupied than reaches with moderate suitability vegetation, and 2.3 times more likely to be occupied than reaches with low suitability vegetation (Graham *et al.* 2020).

It is difficult to know how much habitat is needed for a population of beavers to be successful. It will vary in relation to climate, vegetation type and population dynamics. This explains the wide-range of colony densities reported in the literature, from 0.08 to 0.57 colonies per km river length, or 2 km river bank (for a comprehensive summary see Gurnell *et al.* 2009). Nolet and Rosell (1994) and Swinnen *et al.* (2017) both suggest an average of around 3 km of wooded banks is required per beaver territory, with a minimum needed of 2 km per territory. The numbers quoted in these papers correspond with what was seen anecdotally in the River Otter catchment. The BHI model indicates there is 125 km preferred habitat, which would equate to space for 41 territories, assuming the 3 km of wooded banks required per territory.

Due to the difficulties in radio tracking beavers, visual observations and feeding sign heat maps (Figure 2) were used to obtain approximate measurements of territory size in the River Otter catchment. Caution must be applied when comparing figures in the literature to that seen on the River Otter. Other studies have been estimated from areas where beavers are below carrying capacity and will, therefore, occupy the best habitats first. Beavers are highly adaptable and can survive in habitats with only very minimal riparian woodland, as reported in agricultural landscapes where mainly crops are available in

Tayside, Scotland (B Ross pers. comm.). However, it should also be noted that beaver territories observed on the River Otter can occupy significantly less territory than reported elsewhere in Europe, in some cases just a couple of hundred metres of wooded banks per territory. This was observed where there was highly suitable habitat in smaller streams. The beavers could be less mobile along the stream but could venture sideways into riparian woodland, hence why, in certain situations, the area of woodland can be more useful in describing required resources than length of wooded banks. Also, dispersing individuals or new pairs can often occupy less optimal habitat and can (possibly only temporarily) live in reaches with only very patchy woodland. This was seen in the mid reaches of the River Otter where the riparian vegetation is quite sparse but a number of animals have settled. The caveat to this is that as the animals cannot be radio-tracked it is uncertain whether these are numerous small groups or a single family with a very large territory (H Graham pers. comm.).

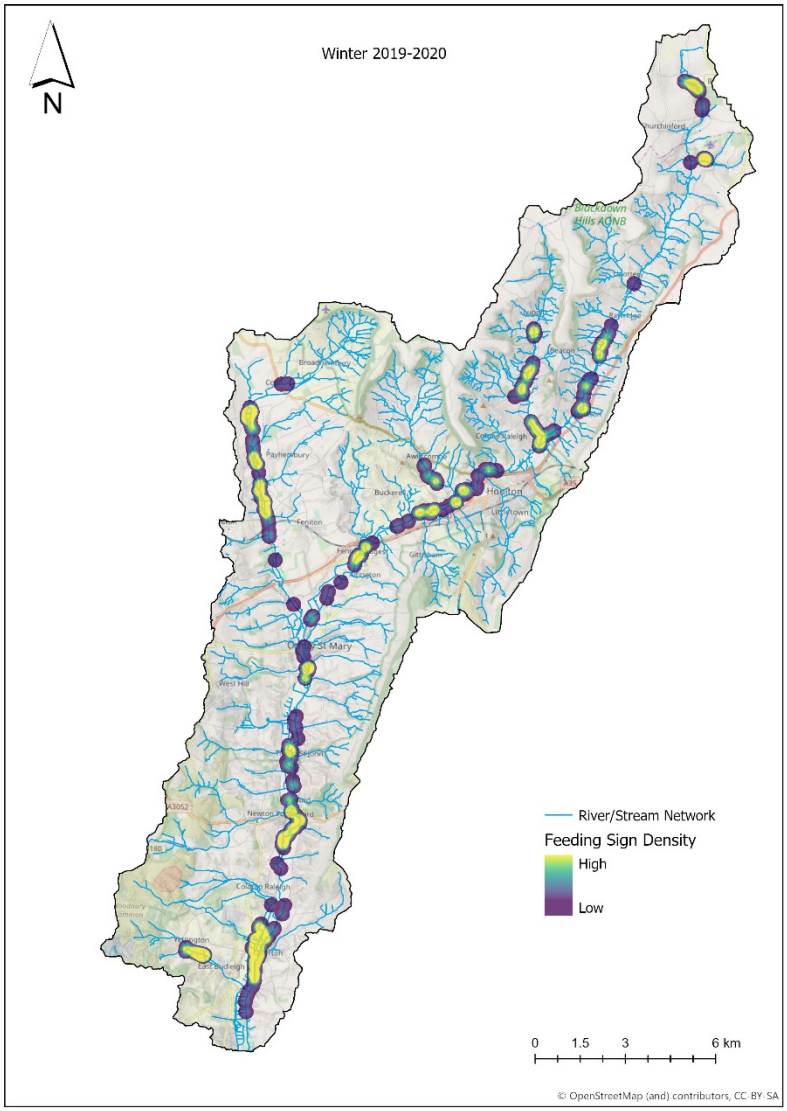

Figure 2 Beaver feeding sign heat map within the River Otter catchment for winter 2019/2020 (H Graham pers. comm.)

It is likely that both habitat quality and stream size affect territory size. Where streams are large and can be patrolled easily, the territories tend to be large (as observed in the lower reaches of the Otter; H Graham pers. comm.). In the smaller headwater territories the

sizes are typically smaller, as the energy expended during patrol is larger. This is comparable to that found in the Czech Republic where territory sizes contained a mean of 1.7 km of channel but with a range from 333 m to 4.9 km (Vorel *et al.* 2008). Graf *et al.* (2016) carried out radio tracking of beavers in Norway and found that total channel length in territories ranged from 1.47 – 7.43 km, with a mean of 3.55 km. This also indicates that wooded banks alone probably don't give a full picture of habitat requirements, but can still be a valuable indicator.

Work was presented in the Science and Evidence Report that estimated the carrying capacity in number of territories of the River Otter catchment, based upon habitat suitability and ecological requirements of the beaver, as specified in objective 4 of the ROBT. The territory capacity model predicted the catchment could host between 147 and 179 territories. It is noted, however, that the observed capacity is expected to be considerably lower as beavers are unlikely to conform to the modelled arrangement of territories, and the model assumes that animals cannot exit the catchment. Sufficient resource for 41 territories is mentioned above, but this is a very crude assessment. It is important to note that the human social carrying capacity, the level of 'inconvenience' humans would be prepared to put up with, is also likely to be lower than the estimated maximum number of territories. The model does not predict likely beaver capacity as a more detailed understanding of, in part, resource use and population dynamics is required.

In conclusion, modelling of available habitat (BHI) and maximum territory capacity indicate that the River Otter catchment is likely to be large enough, and there are sufficient resources available, to support a viable and self-sustaining beaver population.

2.2.2 Connectivity and Dispersal

Beavers prefer to stay within or very close to watercourses, but as populations expand they will disperse overland to adjacent catchments. In the River Otter catchment there are a small number of headwaters where the catchment boundaries are very diffuse to beavers owing to the presence of permeable semi-natural wetland habitats spanning catchments. The adjacent catchment to the west is the River Exe which includes the Culm tributary. One beaver, released into the catchment to improve the genetic make-up of the population, entered the headwaters of the River Culm. It is likely that the beaver travelled approximately 3 km overland, including 1 km over intensively grazed pasture, to achieve this (M Elliott pers. comm.). Once the situation became apparent, the beaver was recaptured and taken back to the River Otter catchment.

The River Sid catchment to the east is considered an unlikely dispersal route due to the presence of plateaux without watercourses between the catchments. To the north, the River Otter rises in the Blackdown Hills, where the stream gradients are much steeper, so dispersal via this route is considered unlikely. To the north of the Blackdown Hills lies the River Tone and the Somerset Levels. The coast lies to the south, which is a possible route for dispersal. Any animals exploring the estuary and coastline could access the Exe Estuary to the west or the River Sid to the east, although dispersal by sea is generally thought to be accidental rather than a known dispersal method.

There are no major barriers to beaver dispersal within the catchment but there are several weirs which may force beavers to find alternative ways around. There was one report of a road traffic accident involving an individual beaver, where the River Otter passes under a B-road. It is thought high flows in the river at that time forced the beaver onto the road to bypass a weir located close to the bridge. Ear tagging of individual beavers allows individual identification and provided evidence that a kit born near Otterton in 2016 dispersed 50 km upstream to Otterhead Lakes as a one-year-old to subsequently settle and produce offspring, thus demonstrating good connectivity within the catchment.

2.2.3 Future changes

South East Devon is considered to be within the former indigenous range of the beaver. Rising sea levels may impact on the lower reaches of the catchment and a managed realignment project has been announced for the lower River Otter catchment[2]. There are reports of Canadian beavers thriving in estuarine habitat (Hood 2012), but it is unknown if Eurasian beavers settle in the same habitats. It is likely that any newly created wetland/marsh habitat with low salinity levels created from the realignment would be opportunistically used by the beavers in the River Otter.

Key points – habitat in the River Otter catchment

Overall, it is concluded that there is sufficient area and suitable habitat within the River Otter catchment itself to support a population of beavers that would be viable and self-sustaining in the long-term. No major concerns surrounding the connectivity of habitat within the catchment to beavers have been identified, and there are no known future changes to the habitat which are likely to detrimentally affect the beaver population.

Criteria defined in the IUCN reintroduction guidelines in relation to habitat and climate requirements have been supported by the work undertaken.

The work has contributed to delivering objectives 1, 4 and 6 of the ROBT.

Due to the difficulties in radio tracking beavers, accurate records of beaver movement and territory sizes within the catchment are difficult to obtain. It is not known how many beavers are required to form a viable population and, subsequently, how much habitat is needed to support such a population. However, data collected during the trial indicates habitat use by beavers within the River Otter catchment is similar to successful beaver populations observed elsewhere in Britain and Europe.

Any future changes in land use are unlikely to significantly affect the beaver population in the short to medium-term (i.e. the next few decades).

The evidence presented relevant to this section of the assessment supports a recommendation to allow beavers to remain on the River Otter.

[2] http://www.lowerotterrestorationproject.co.uk/index.html

2.3 Welfare and disease

The health and welfare of individual animals is an important consideration during all stages of a reintroduction process. Both can have a high impact on the success of a reintroduction. The welfare of the beavers living wild on the River Otter is a key responsibility of individuals involved in the trial. The legislative regulations and policies on animal welfare in England need to be adhered to. All conservation translocations should also be designed to avoid the spread of harmful pests and diseases.

2.3.1 Welfare

The beavers on the River Otter were already living in the wild at the start of the trial, but needed to be captured for disease screening. Trapping was also carried out throughout the trial to allow post-release health monitoring to ensure beavers were capable of coping with the restoration process, in line with the Animal Welfare Act 2006. In total there have been 43 trapping occasions (with some individuals being trapped multiple times). Trapping and screening protocols were carried out by appropriately experienced personnel.

Trapping was undertaken using Bavarian beaver traps which meet the humaneness standards of the Agreement on International Humane Trapping Standards (AIHTS). No injuries from the traps were documented during the study. No mortality under anaesthetic was reported.

Examination of the general body condition of beavers trapped throughout the trial found no cause for concern, indicating no adverse welfare concerns. Trapping took place during the winter period, typically when beavers are at their lowest body condition. The observation that one breeding female had documented litters of four and five kits is potentially indicative that excess resources exist in this landscape to support good body condition over the winter period and high litter sizes. Weights and body conditions were all good to very good, beavers were surviving in good health year-to-year and producing high kit numbers. This indicated that beavers were easily obtaining food and habitat resources and were well adapted to the landscape.

Five beavers were brought into the River Otter catchment for release to enhance the genetic diversity of the population. The following considerations were made in relation to finding appropriate release sites: i) the mobile and territorial behaviour of beavers, ii) the presence of some deep water, iii) the possibility of using soft release methods and iv) the attitude of the landowners. Different approaches were undertaken in relation to the release of each individual.

In May 2016 a pair of captive/enclosure bred beavers were released into an off-line pond in an area of semi-natural wetland habitat less than 50 m from the River Tale. This area was selected as it offered good habitat away from the main body of the river, reducing the risk of territorial conflict with existing beavers, given that there were no fresh beaver signs in the vicinity of the release site. Artificial lodges were constructed on the edge of the release pond, but the beavers soon constructed their own lodge and only returned to the

artificial lodges to collect bedding. These beavers settled well and subsequently bred in 2017 and 2019.

In 2019 a male and female beaver were translocated separately from the River Tay in Scotland and released directly into the River Otter. The male beaver was released in an area upstream of adjacent territories. He continued to move upstream and out of the river catchment. The female beaver was released into the lower reaches of the River Otter in an unoccupied space between territories. Following release she moved downstream and was found dead near the estuary three days later. Post mortem examination was inconclusive but suggested the impact of saline water was a factor in the death (M Elliott pers. comm.). Both these animals likely exhibited flight responses in relation to their release in an unfamiliar area. The male beaver was recaptured and relocated to a pond off-line from the main River Otter. Electric fencing was used to encourage the animal to remain in this pond and in November a female beaver, also from Scotland, was released into this area. They now appear to have settled as a pair.

The welfare of translocated beavers was carefully considered in the trial and changes to procedure were implemented following the unsuccessful releases. It is however acknowledged in the report that finding suitable release sites for any further reintroductions may be difficult. This will need to be a consideration in light of recommendations to enhance the genetic diversity of the population in the future (Section 2.1.1.1).

Other known causes of mortality during the trial have been due to a road traffic accident at a location where the River Otter passes under a B Road. The incident may have coincided with high river flows, which may have forced the beaver onto the road to bypass a weir located close to the bridge. Also, the remains of a beaver were found washed up on Chesil Beach. The presence of an ear tag confirmed it to be an individual from the River Otter, but cause of death could not be established due to the degradation of the body. Neither of these incidences of mortality appear to pose particular welfare concerns.

There are three post mortem reports provided in the appendices of the Science and Evidence Report, two of which were conducted by a private veterinary practice and one by APHA. Ideally pathological examination should be conducted in a thorough, methodical, systematic manner, in which all organs and tissues are examined, and detailed information collected, so that comparative analyses between findings are possible. Unfortunately, as far as can be ascertained from the reports this was not carried out, although it is appreciated that the bodies may have been too decomposed to gain useful information in some instances. However, it is recommended that more detailed post mortems should be carried out on any deceased beavers found in the future.

There were no other known incidences of mortality or injury of beavers during the trial. There are no outstanding concerns relating to the welfare of individual beavers from monitoring, management or habitat suitability during the trial or beyond the period of the trial, should beavers be allowed to remain.

2.3.2 Disease

The management of disease and known pathogen transfer is important, both to maximise the health of translocated organisms and to minimise the risks of introducing a new pathogen to the destination area (IUCN/SSC 2013). Beavers, like all wild mammals, may harbour zoonotic and other infectious agents. The diseases identified as being of primary concern at the start of the ROBT were *E. multilocularis*, giardia, tularaemia and rabies. The majority of these diseases are not present in the UK and risks of introduction are generally minimised through appropriate sourcing of beavers and health screening procedures. As the origin and health status of the original River Otter beavers were unknown and therefore of concern, particularly if they carried non-native parasites or diseases, the licence required the beavers to be captured for health surveillance. Only beavers certified as healthy and fit for release by a qualified veterinary surgeon were to be released. Specifically, the licence required that they must be confirmed as being free from *E. multilocularis*. In addition to the initial health screening, post-release health monitoring was also carried out throughout the trial.

Health screening prior to beaver release had two primary functions. Firstly, to ensure that any individuals were screened to ensure they presented a low risk of transmitting non-native parasites and diseases of concern; and secondly to ensure they were healthy and capable of coping with the release process (in line with the Animal Welfare Act, 2006). An additional consideration of the screening was to assess the body condition and draw some inference on the adaptability of the trapped beavers to survive in an English landscape after an absence of over 400 years.

The disease screening undertaken appears to be based on prior knowledge of beaver diseases and parasites. Best practice under IUCN guidelines would be to carry out a disease risk assessment prior to testing and release of the beavers. A disease risk assessment is the systematic evaluation and identification of risk factors responsible for a disease, estimation of risk levels and highlighting possible ways to counter the onset and progression of a disease within a population. It is a qualitative analysis of the magnitude of any negative effect and the probability of that effect occurring. As this process was not followed for the disease screening of the River Otter beavers, there is a risk that parasites or diseases may not have been considered or tested for.

There was no evidence of any serious zoonotic diseases that were tested for in any beavers, either during the initial health screening, post-release health monitoring or screening of additional beavers for release into the catchment. Four beavers tested positive for exposure to *Leptospira* spp., but without clinical signs of disease. Subsequent testing showed waning of the antibody response with no clinical disease being evident, suggesting these animals were not persistently infected. A study of beavers from the River Otter, Scotland and Europe found that *Leptospira* spp. infection in wild Eurasian beavers occurs at a low level and does not appear to cause significant morbidity or mortality. Consequently, Eurasian beavers acting as a *Leptospira* spp. reservoir host should be considered an uncommon event (Girling *et al.* 2019).

Not all animals were disease screened each year and the difficulty of preserving samples in the field meant that some animals could not be screened for all targeted parasites. Not all known individuals were initially trapped. Those that could not be trapped were the offspring of the adults captured and therefore it was considered very unlikely they would be hosts to *E. multilocularis* given that it had not been confirmed in the parents (*E. multilocularis* cannot be passed from beaver to beaver). However, the majority of animals were sampled throughout the trial period. In particular, where significant zoonotic conditions were concerned (e.g. *giardia* spp., *salmonella* spp.), they were tested and the tests were negative for those parasites.

Key points – Welfare and disease

Health and disease monitoring throughout the ROBT demonstrated that beavers generally had good body condition and were not harbouring any serious zoonotic diseases, suggesting that they were well adapted to the landscape and sufficient resources to support the population were available.

Due to the nature of the trial situation, the IUCN Guidelines on conservation translocations in relation to disease and parasite considerations (Annex 5, IUCN/SSC 2013) could not be followed in the normal way. However, appropriate steps through trapping and testing were taken to address the key issues identified in relation to disease, and health and continued monitoring found no further problems.

The work has contributed to delivering objectives 4 and 6 of the ROBT.

As a full disease risk assessment was not undertaken for the disease screening of the River Otter beavers, there is a risk that parasites or diseases may not have been considered or tested for. For any future reintroductions it is recommended that a full disease risk analysis is undertaken and consulted upon.

The evidence available relevant to this section of the assessment supports a recommendation to allow beavers to remain on the River Otter.

2.4 Social feasibility and socio-economics

In order for reintroductions or translocations to be successful there needs to be public support. Human interests relating to beaver reintroduction will vary and consequently the project plan needs to accommodate the socio-economic circumstances, community attitudes and values, behaviours and behavioural change, and the anticipated costs and benefits of reintroduction (IUCN/SSC 2013). The River Otter beaver trial had a high level of public support from the beginning. This was the driver for the commencement of the trial, although some sectors such as agriculture and fisheries did raise concerns. It is important to establish whether public support has changed throughout the trial, whether it is likely to remain positive in the future, and what the environmental costs and benefits are likely to be.

2.4.1 Social feasibility

In the first 4 and a half years of the trial a total of 384 events were hosted or attended and an estimated 18,000 people were engaged directly with information about beavers. At 18 events identical questionnaires were provided pre and post event asking for people's views on beavers. Differences between the questionnaires indicate that objective, evidence-based engagement activities in beaver reintroductions did influence attitudes positively. It is unknown whether this favourable response persists after the events.

A number of studies were undertaken during the trial in order to understand social attitudes and people's perspectives in relation to reintroducing beavers. These studies have not necessarily focused on the River Otter catchment and form more of a national view.

A nationwide online opinion survey carried out in 2017 (Auster *et al.* 2019) asked a set of questions on wide-ranging themes including beaver impacts on habitats and economics. Overall, 86.25% of respondents supported reintroduction to Great Britain, 7.44% were opposed, and 6.31% were undecided (Figure 3). Lower scores were produced from respondents whose occupations were in farming and agriculture or fishing and aquaculture.

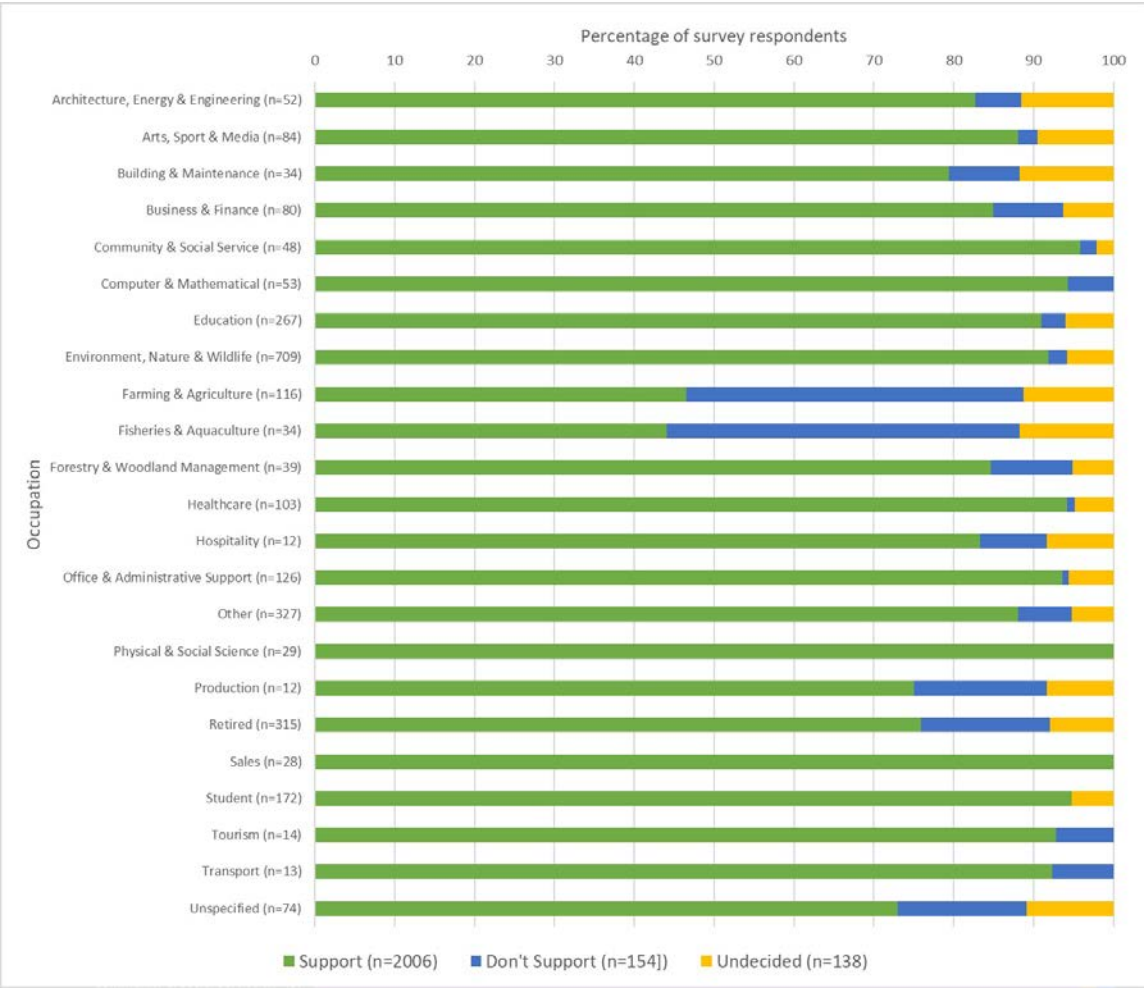

Figure 3 Levels of support for beaver reintroduction in relation to the occupations of all respondents in the 2017 nationwide questionnaire (Auster *et al.* 2019)

Within the River Otter catchment, public perceptions were captured on an *ad hoc* basis (interviews with affected landowners) and through more formal exploratory studies (an online questionnaire of residents within a community downstream of beavers at risk of flooding). An attempt was made to publicise damage by beavers in an adjacent catchment, but this was found out to be a hoax (Brazier *et al*. 2020 p15). The 2019 ROBT annual report mentions that a group of landowners had asked for beavers to not be allowed to stay, which was due to perceptions over flooding risk (M Elliott pers. comm.).

The middle reaches of the River Otter catchment are intensively farmed and characterised by deep, fertile, floodplain soils which are extensively drained. Dams were built by beavers during summer low flows to allow access to an adjacent maize crop, and this impacted drainage in low-lying floodplain pasture. This led to disagreements between the neighbouring landowners which were addressed through evening meetings, volunteer surveys and the use of electric fencing to discourage beavers from foraging on the maize crop. While it was a short-term problem linked to beavers foraging on the maize, intensive action from ROBT staff was needed to monitor and manage beaver activity and maintain clear channels of communication between neighbouring landowners. This case demonstrates that appropriate mechanisms are currently in place to liaise between affected individuals and project managers.

2.4.2 Socio-economic opportunities and risks

2.4.2.1 Cost benefit analysis

The social, economic and environmental impacts of reintroducing beavers were identified within the ROBT science and evidence report. A cost benefit analysis was carried out, but not to a level where it can be assessed to be satisfactory and in line with government guidance; UK Treasury's Green Book, the official government's guidance for project appraisal and evaluation[3]. Environmental impacts, including impacts on agriculture and infrastructure, were identified and were qualitatively discussed, as were some of the social and economic impacts, but in less detail. Only one of the socio-economic benefits was quantified and valued (eco-tourism). Neither the environmental benefits nor the costs were quantified or valued, but the evidence of the impacts of the trial are thoroughly described. A statement is given in the report: '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.' However, given that there is limited information on the magnitude of costs and benefits it is not possible to draw this conclusion at this stage.

The ROBT was supported by a small team of trained and supervised volunteers. They were critical in providing additional time and support in specific situations, but volunteering was not mentioned as a benefit in the cost benefit analysis. Also, the level of labour to address conflicts was not properly quantified, and the value of educational activities and mental health benefits of increased walking/outdoor activities was not included.

[3] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

2.4.2.2 Tourism

An independent investigation of the impacts upon tourism activity within the River Otter, and exploration of the economic factors involved within a village on the River Otter was carried out during the trial (Auster 2019 in Appendix 1 of Brazier *et al.* 2020). The following methods were undertaken in order to investigate the impacts; i) a mail return questionnaire, ii) interviews with local businesses, iii) footpath counters, iv) supplementary results taken from visitors to the Cornwall Beaver project and v) additional supplementary findings from the nationwide attitudinal survey (Auster *et al.* 2019).

The results of this study indicate that there are sustainable economic opportunities for local communities from the presence of beavers, although the benefit of 'wildlife tourism' may have been undervalued in the report. It is unclear at this stage to what extent these opportunities may diminish once the novelty of beavers declines.

2.4.2.3 Fishing

Fishing in the River Otter catchment is largely recreational and focused on brown trout, with a limited amount of coarse fishing. Engagement with fisheries and syndicates throughout the catchment and publicly accessible data held by the Environment Agency were used to examine key economic focal areas. A true total economic value of fishing within the catchment is difficult to obtain due to a number of limitations. It is assumed that the annual figure is likely to be at least £100,000, as well as the capital value held in fishing rights. To date, reported impacts of beavers on fishing within the River Otter catchment have been limited and mostly relate indirectly to people visiting to observe the beavers and disturbing fishermen. The most likely source of potential impact would be if there were good populations of migratory salmonids (salmon and brown trout). Given the low numbers and subsequent limited fishing of these species in the River Otter, data collected on the River Otter has limited applicability to other situations. It is also important to note that salmon and brown trout populations, and associated fisheries, are currently at a very low status. A lack of economic impact now is not an indicator of the situation if these stocks were to recover.

2.4.2.4 Agriculture

Negative economic impacts have been identified through loss of farmland due to flooding from the presence of beaver dams. Six of the 13 established beaver territories have seen dam building behaviour. In some cases the presence of the dams has been tolerated. For others, action had to be taken by ROBT staff to remove or reduce the height of the dam to mitigate undesirable impacts. Where dams have been tolerated, landowners have accepted the loss of land to wetland creation in some situations (e.g. Budleigh Brook). This is in part down to the type of landowner and their level of acceptance to loss of earnings from affected land. Devon Wildlife Trust also paid for loss of earnings in some instances, which is likely to have influenced landowner's acceptance to impacts from beavers.

One dam caused flooding on an organic potato field, costing approximately £2,100 in profit forgone and unplanted seed potatoes, plus £900 cost to relocate a farm access gateway.

This farm is situated upstream of a village at risk of flooding. The potato field is in a five-year cropping rotation with two high value crops. The estimated total potential gross margin loss from the two cash crops in the waterlogged field was £1,722. This is weighted against the fact that if just one property at high flood risk downstream is downgraded to moderate risk as a result of beaver activity, the estimated benefit is £2,446 over five years - a net gain of £724. If one property at very high risk is downgraded to high risk as a result of beavers, the estimated benefit is £4,076 - a net gain of £2,304. There is, therefore, potential for the economic benefits of reduced flood risk to outweigh the economic costs at the flooding site. This creates an imbalance between those who derive benefit from the presence of beavers (local residents at risk of flooding) and those who are exposed to continued costs, but derive little or no benefit (in this case the farmer). In order for this to be a practical solution in the future, mechanisms will be required to address the imbalance between the two parties.

In another instance construction of a dam within a drainage ditch in the lower floodplain of the River Otter caused flooding of 0.89 ha of low-lying farmland. Although this was deemed acceptable by the landowner for the first part of the winter, all available grazing land was required the following spring. Subsequently, a flow device was installed at a cost of c. £500 after dam notching (reducing the height of the dam) was not deemed to be an acceptable long-term solution. Impacts of the losses were calculated as £1,566 per year which were reduced to £95 with the flow device. This was temporary, however, as another dam was built and more flooding occurred. At this point the landowner was content to retain the beavers and allow wetland habitat to be created.

Key points – Social feasibility and socio economics

The effects of beavers on the environment and society are dependent on the type, location and intensity of beaver activity, and the current land/water use in that area. During the period of the ROBT there were situations of economic opportunities and economic losses. Intervention by ROBT staff or landowners mitigated most conflict situations and avoided significant economic losses. The ability to manage conflicts, and the availability and expertise ROBT staff to assist in a timely manner, is likely to have contributed towards a mostly favourable outlook to beavers by landowners and river users in the River Otter catchment.

Criteria defined in the IUCN reintroduction guidelines in relation to social feasibility were supported by the work undertaken.

The work contributed to delivering objectives 1, 2, 5 and 6 of the ROBT.

Detailed information on the magnitude of cost and benefits of beavers in the River Otter catchment is limited. It is hard to conclude that the benefits of beavers outweigh the costs at this stage, or whether they will do so in the future. It is important to note that those who benefit from beaver reintroduction may not always be the same people who bear the costs, and this imbalance does have potential to cause problems in the future.

In conclusion, recognising the limitations of the information available from the ROBT and accepting that some people may be adversely affected, in general the views of local people have been favourable and problems associated with beavers have been of limited scale and well-managed. On balance, the evidence presented relevant to this section of the assessment supports a recommendation to allow beavers to remain on the River Otter. It will, however, be important to make sure there are mechanisms in place to manage future problems and support people who are adversely affected.

2.5 Monitoring, information dissemination and continuing management

2.5.1 Monitoring

A monitoring programme was designed for the trial licence application. The aim of the monitoring was to: enable a measurable assessment of the impact of the introduction of beavers to the River Otter catchment; and provide a framework for in depth research studies on physical processes, biodiversity and socio-economics. Due to the fact that beavers are a well-studied species in Europe and North America, the research programme was developed to provide complementary data to established studies, rather than repeating previous work carried out elsewhere.

It is important that any monitoring programme is an integral part of trial design, designed to: measure progress against the stated objectives; assess impacts; and provide the basis for adjusting objectives or adapting management regimes or activating an exit strategy. The IUCN reintroduction guidelines (IUCN/SSC 2013) outline six essential elements of post-release monitoring. Monitoring undertaken during the trial - assessed against these elements - is set out below:

Demographic performance – An objective to understand the ecology, behaviour and population dynamics of the beaver population. Annual surveys monitored population growth and spread of beavers throughout the catchment. Adjustments were made to the monitoring survey technique after it became apparent that surveying field signs every three months was impractical across such a large catchment. Subsequently, the survey technique was revised to record feeding signs on woody material once a year during January to March. It is acknowledged that this approach is less accurate in small colonising populations, as feeding activity may be the result of individual animals or young pairs moving throughout the catchment or starting to establish territories. As the population has expanded, it is also acknowledged that it became harder to determine the number of territories from these data, despite the increase in area being surveyed over the course of the trial. Anecdotal visual observations and trapping records were also used to help gauge the size of the population. Recording field signs is considered an acceptable way of monitoring the population in this instance, given the intensive effort required and welfare considerations for any capture mark recapture studies or difficulty in obtaining accurate counts for visual observations (Campbell-Palmer *et al.* 2016). Failure to get landowner

permission to carry out surveys was not considered a major limitation. Only a low number of landowners refused access, and much of the catchment has public access. Obtaining landowner details was difficult, but often landowners contacted ROBT staff when they noticed signs of beavers on their land (M Elliott pers. comm.). Trapping surveys undertaken throughout the trial were valuable for understanding the identity of individuals using particular territories, and confirming survival of trapped individuals. It could not be ascertained how many beavers had not been trapped. Ear tags provided a means of identification through camera trapping to monitor animal behaviour and movement, and any animals without ear tags could be noted. This resulted in detailed surveys across the catchment to detect beaver activity and numbers. Therefore, monitoring of population growth and spread was undertaken at a suitable level. Further work is recommended in the report to undertake feeding sign surveys on other wild-living beaver populations in Britain, to enable comparison between populations and further develop the use of automated territory detection year-on-year.

Behavioural monitoring - Successful monitoring of the behaviour of translocated individuals depends on comparative data from either comparable natural populations or the same individuals before removal from their source population. There is a wealth of information from Europe on the behaviour of Eurasian beavers which can be used as a comparison to the behaviour of the original beavers on the River Otter. Radio tracking beavers is fraught with technical and welfare difficulties due to their general ecology and behaviour (Campbell-Palmer and Rosell 2015). Therefore, anecdotal visual observations and field sign surveys were relied upon.

High definition video of the additional pair of beavers introduced in 2016 was used to collect data on many aspects of their behaviour and was used to detect reproduction rates and anecdotal interactions (including with other species). A trial was set up using a team of volunteers to try and assess breeding success across all family groups, but was unsuccessful due to the difficulty of monitoring beavers in the wild. The trial benefited from records from local naturalists, who collected anecdotal information, such as the structure of family groups (M Elliott pers. comm.).

In relation to the beavers translocated into the catchment, observations of behaviour could only be undertaken if the beavers remained in the same general area as the release site. Later on in the study, electric fencing was used to encourage beavers to settle in the same place to enable this. The two beavers translocated from Scotland were re-found after they dispersed from the release site (one deceased) due to the level of engagement the project initiated with landowners and members of the public in the area.

Ecological monitoring – This objective was to identify and assess impacts of beavers on habitats and wildlife. Surveys were undertaken during the trial on these ecological factors (see section 2.1). Due to the way the trial was initiated, baseline information across the catchment could not be comprehensively gathered because beavers were already present. Consequently, pre-existing survey data from across the catchment, carried out for other reasons, was collated and utilised. A determination of all observed impacts was made to assess whether they are beneficial, benign or harmful and the management strategy covers potential harmful impacts (see below). As noted in the section above, the impacts

of beavers within the catchment are only starting to be realised. Further monitoring to realise the true impacts is required, but it is deemed that an acceptable level of monitoring was undertaken during the trial to provide a base for further surveys.

Genetic monitoring – detailed genetic monitoring of all beavers captured at the start of the trial was undertaken to a sufficient standard. Samples were collected from the additional beavers reintroduced into the catchment, but analysis has not yet been carried out.

Health and mortality monitoring - An initial detailed health screening test was done at the start of the trial. Throughout the trial period beavers were trapped in order to monitor the continued health of the population, mindful of appropriate welfare considerations. All mortalities of beaver during the trial were recorded and post mortems conducted where possible. The monitoring undertaken allowed an assessment of whether the establishing population was experiencing disease, adverse welfare conditions or mortality. No issues were identified.

Social, cultural and economic monitoring - People's attitudes towards the translocation, both from a local and national perspective, have been studied and changes in people's perceptions during the trial were also monitored satisfactorily. An objective of the licence application was to assess and quantify the associated costs and benefits of beaver in a cultural English landscape, including impacts on agriculture, forestry and infrastructure, which was done. Further economic benefits such as eco-tourism, education and the value of ecosystem services were also monitored. A summary cost benefit analysis was undertaken to monitor economic impacts of beavers, although not all costs or benefits have been valued. It is, however, assessed that suitable effort was made to monitor attitudes of local communities towards the beavers, and any benefits or costs have been identified at a preliminary stage.

Several monitoring opportunities mentioned in the monitoring programme, in Appendix II of the licence application, were not carried out. This was acknowledged as a possibility in the initial document. Monitoring protocols have evolved over the course of the study and it is accepted that certain monitoring opportunities may not have been possible. This was particularly the case where it was not known where beavers were likely to settle within the catchment and subsequently influence the environment. Amendments to the monitoring protocols were discussed and agreed at the ROBT steering group meetings, which Natural England representatives attended.

2.5.2 Continued management

Management can refer to both the management of the reintroduced population in order to facilitate its success, as well as management of undesirable impacts. Apart from releasing additional beavers into the catchment - to improve genetic diversity of the founding population - the majority of the management strategy for the ROBT focused on management of any undesirable impacts. The licence required that a management strategy was developed in consultation with major riparian landowners/right holders and

statutory bodies. Objective three of the ROBT was to develop an effective management process for a free-living beaver population.

The IUCN guidelines were fully taken into account by those undertaking the trial, and the licence conditions provided a mechanism for Natural England to enforce any required actions.

The document entitled ‘Beaver Management Strategy - A strategy for addressing the risks associated with a free living beaver population on the River Otter, River Otter Beaver Trial, January 2016’ (ROBTSG 2016) provided a framework to manage beaver impacts and conflicts for the duration of the licensed period. Although the document was finalised after September 2015 (the date required by the licence condition), consultation with Natural England and other bodies commenced well before this date and the publication of the Strategy was produced shortly after - in January 2016. Key risks, impacts and conflicts were considered and kept under review as the trial progressed, but it was not considered necessary to adapt the strategy significantly during the trial. A five-stage hierarchical process was utilised to deal with issues as they arose, and some pre-emptive avoidance work was also undertaken at high risk locations.

Five stage process:

- New beaver activity reported to the project team triggers an assessment of the impacts. An initial site visit may be carried out and this may result in increased monitoring and/or preventative action.
- If the impact is significant enough, a discussion will be held with statutory agencies and/or the landowner.
- If a significant impact is of concern to the landowner, or one of the statutory agencies, detailed discussions would be held and a Site Impact Report initiated.
- Mitigation measures are investigated, implemented and trialled.
- Compensatory works or payments are investigated and options to remove the beavers explored as a last resort.

2.5.2.1 Complaints, reparation and funding

The 2016 Strategy details the procedure for dealing with and responding to complaints. The threshold for complaints is simply a stakeholder expressing concerns about the impacts. New beaver activity was initially reported to the Project Team by stakeholders/landowners and a dedicated hotline and email address was made available for this purpose. The level of response depended on the nature and significance of the impact and the stakeholder’s perspective. Complaints were forwarded by the Project Team to Natural England and discussed at the quarterly licensing group meetings. A summary of the complaints received and how these were dealt with are detailed in the 2016-2019 ROBT Annual Reports. The 2020 Annual Report had not yet been published at the time of the writing of this report, but three additional complaints were received during this time period (M Elliott, pers. comm.).

Each year a small number of complaints were received (three to five) and all but one appear to be have been resolved to the stakeholder's satisfaction - either through awareness and acceptance, pre-emptive action, one-off management, adapted management or ongoing management. The complaints relate to either flooding of agricultural land or tree damage. The Project Team continues to seek resolution for one landowner where the visual/management impacts of tree protection measures is still under discussion.

The conflicts, complaints and issues associated with beaver impacts are not considered to have been significant during the course of the trial in terms of scale. Although it should be noted that, whilst at a catchment scale the impacts may have been small, for an individual stakeholder the problem may have been significant. There was a report where anglers had encountered disturbance from beaver watchers and the interaction was perceived as confrontational from both sides. The overall low level of conflict could be attributed to various reasons:

- The specific nature of the River Otter catchment, for example, there is relatively little agricultural flood plain in the lower reaches of the catchment.
- The high investment in education, awareness and support for local communities/landowners.
- The timely and significant level of support provided to try and resolve each complaint.
- The population has not yet reached carrying capacity and is still at relatively low levels in an area where there are few conflicts.

As far as can be ascertained, the licensee has taken responsibility for the reparations needed and addressed the issues in a timely manner. Throughout the duration of the trial sufficient funding was secured from a combination of sources to address the issues. Funding for key elements of the project work was ultimately underwritten by DWT. Funding gaps were identified and filled as the trial progressed, sourcing additional capital from both external funders and DWT core funds.

2.5.2.2 Management undertaken during the trial

The Science and Evidence Report summarises the management measures undertaken in order to address issues and resolve complaints. The Annual Reports provide further detail on these measures, which primarily relate to managing impacts associated with beaver dams and tree damage.

Beaver Dams

In October 2019, 28 dams were recorded in six of the thirteen beaver territories. By this date it was estimated that around 80 dams had been constructed since the start of the ROBT, at 55 locations on seven different landholdings, with <10% causing any conflict. In all the territories where dams had been built, at least some management was necessary to mitigate undesirable impacts. Usually only one or two dams within a family group caused an issue, and the impacts were always greater on low-lying floodplains - where a single, small dam can have a relatively large impact. Different mitigation measures were

utilised/trialled depending on the impact or risk of flooding. Land drainage for agriculture on floodplains was impacted at five sites which all resulted in management interventions by the landowner and/or ROBT staff.

There were no negative impacts recorded on Environment Agency infrastructure, although one dam in a flood relief channel in Ottery, which could have compromised its function, was removed by the landowner before detailed assessment of its impact could be made. ROBT staff removed any later structures to deter activity there. In a water supply reservoir, some clearance work by volunteers was necessary to keep spillways/outfall structures clear. One small culvert required regular clearance of beaver sticks and one small country lane experienced water encroachment, which was successfully resolved by occasional reduction of the height of the dam by the landowner. One farm access track (and permissive path) flooded periodically and regular management of the dam was carried out to address this.

Tree damage/foraging

Ten complaints were recorded that related to tree damage (including some large specimens). This led to a total of 66 trees requiring pre-emptive or responsive protection with low toxicity beaver repellent sandy paint or weld mesh. Three small riverside orchards saw beavers feeding on windfall apples and trees. Pre-emptive tree guards were installed to protect further trees from damage. At one site an electric fence was installed as a deterrent. Some issues remained with regard to the visual impact of the guards and problems with managing the long grass inside the guard. On three occasions trees were felled onto footpaths and they were removed by the landowner. Beavers foraged on crops in three territories, mainly with losses of a small quantity of crop which did not cause any particular concern.

Burrowing

No significant erosion caused by beaver burrows were noted during the trial. Beaver burrows can act as a focal point for bank erosion and would need to be monitored and assessed in the future, although the River Otter is considered to be a highly mobile river and is subject to natural bank erosion and channel adjustment. Following pre-emptive vegetation management to the lower engineered dam at Otterton Lakes to dissuade burrowing, none was detected at this location. Care is needed in interpreting this as an effective method for deterring burrowing. It is not a tried and tested technique and burrowing does regularly occur on non-vegetated reaches of river. Two small collapsed burrows, discovered in a pasture field, were filled by ROBT staff, as they were seen as a possible risk to livestock. In the same location a field margin of maize was left unharvested to mitigate the risk of damage to agricultural machinery.

Effectiveness of management activities

Significant time and effort was invested in advising and supporting landowners and resolving issues in a timely way. Most of the measures were successful, at least in the short-term. Others required adaptations and project staff were able to monitor the success

of those measures. The techniques utilised in the main followed the best practice recommendations for beaver management (Campbell-Palmer *et al.* 2016). It should be noted that the final stage of the 2016 Strategy - the use of trapping/translocation or lethal control - was not an option that needed to be explored during the trial, given that the catchment was well below carrying capacity and any conflict was resolved using other means.

2.5.2.3 Management Costs

The number of staff/volunteer hours for beaver management has not been fully quantified in the reports. During the trial one full time equivalent member of staff was employed for this catchment. A small team of experienced volunteers (approx six) also supplemented the work force and landowners sometimes carried out activities themselves (e.g. removal of felled trees onto footpaths). However, the contracted staff and volunteers were not solely employed to deal with beaver management activities as they also carried out significant engagement, education and monitoring activities.

Capital costs for mitigation measures have so far been low, with a single flow device being the highest single capital cost (£500) and tree protection measures (weld mesh and paint) also purchased. Other costs include: £900 to move a farm access gateway which had become flooded; £200 to remove poplar trees which beavers felled onto a farmer's fence; and the construction of a boardwalk at a County Wildlife Site to improve site access (cost unknown). In addition, the costs of flooding part of an organic potato field totalled £1,495 for profit foregone and £600 for seed potatoes unplanted. In time, some maintenance or replacement of these mitigation measures may be required. The continued time commitment of staff/volunteers/landowners can be significant and may not be sustainable as the population rapidly expands. In this case more costly, highly engineered solutions may be required in certain circumstances. Additionally, it should be noted that the cheapest overall option may not be the option that is preferred by the landowner, or the option with the lowest impact on the beavers. It should also be noted that it is possible that more management and mitigation was carried out due to the trial status of the project and potentially, as people learn to live with beavers, the need for engagement and support is reduced for the smaller, simpler and less costly mitigation measures.

2.5.3 Information dissemination

The River Otter beaver trial has a dedicated website hosted by DWT which provides information about the trial alongside general information about beavers and where to see them. Annual update reports were produced for each year of the trial (2016-2019) and are available on the website. An annual report to cover the 2019-2020 period will be published this year.

A number of scientific publications were produced during the trial, contributing to the body of information on beaver reintroductions, ecosystem services, impacts on biodiversity and socio-economics. A PhD entitled 'Quantifying the impact of beaver reintroduction on

aquatic ecology' commenced in 2019 and will be studying the effects of beavers on the River Otter.

A River Otter beaver management strategy framework was produced to help inform decisions regarding the long-term management of beavers, the wetland habitats established and the general activities in the River Otter in the future.

Necessary documents associated with licence conditions were submitted to Natural England in a timely manner.

Key points – Monitoring, information dissemination and continuing management

The level of monitoring undertaken was sufficient to measure progress against the stated objectives; assess impacts; and provide a basis for adjusting objectives or adapting management regimes or activating an exit strategy. The steps and processes set out in the Management Strategy provided an effective mechanism to assess if a reported 'impact' was of a level requiring action and, consequently, to manage the conflicts associated with the beaver population during the ROBT. Information from the trial has been disseminated in an appropriate way.

Criteria defined in the IUCN reintroduction guidelines in relation to monitoring after release, continuing management, and information dissemination have been supported by the work undertaken.

The work has contributed to delivering objectives 1, 3 and 6 of the ROBT.

The number of staff/volunteer hours for beaver management has not been fully quantified in the reports so the true effort/cost of the management cannot be fully calculated.

Overall, the evidence presented relevant to this section of the assessment supports a recommendation to allow beavers to remain on the River Otter.

3 Conclusions

3.1 Overall approach to the ROBT

The ROBT Science and Evidence Review forms a comprehensive summary of all of the work undertaken during the five year trial period. Relevant experts were drawn in to undertake surveys and interpret results during the ROBT, and detailed information is available in the associated appendices. It is considered that all relevant information has been included and any knowledge gaps highlighted appropriately. Future studies to address certain knowledge gaps have been recommended, or already put in place.

3.2 Have IUCN criteria been met?

The licence application for the ROBT specified that it would adhere to the IUCN guidelines for Reintroductions and other Conservation Translocations (IUCN/SSC 2013). This document sets out a framework that was followed, wherever possible, in the licence application. The situation in the River Otter is atypical in that beavers were already established and breeding. This constrained the ROBT's ability to carry out baseline and preparatory work in the chronological order that would be expected in typical reintroduction circumstances. Throughout this document consideration has been given to adherence to the IUCN guidelines and where this was not possible, whether a suitable alternative approach was followed. A summary is provided below relating to relevant criteria from the IUCN guidelines.

Monitoring programme design and exit strategy – These were both included in the licence application and accepted at the time of granting the licence.

Biological feasibility - A wealth of information exists on the biology of Eurasian beavers. This was drawn upon during the trial and effort was made to progress our understanding of this species through appropriately designed monitoring and study. It is accepted that sufficient information has been collected in relation to this criterion.

Habitat - In order for beavers to exist and thrive in the River Otter catchment there needs to be suitable habitat. Work was done through field surveys, modelling and visual observations to ascertain that sufficient habitat is available to support a viable and self-sustaining population now and in the future.

Animal welfare and disease - The health and welfare of the released animals and their progeny was monitored appropriately throughout the trial. Welfare concerns in relation to the method of release for additional animals released in the catchment were identified and acted upon appropriately. Due to the nature of the trial situation, a full disease risk assessment was not undertaken for the disease screening of the River Otter beavers, so the guidelines were not followed in the normal way. However, appropriate steps, through trapping and testing, were taken to address the key issues identified in relation to disease and health, and continued monitoring found no further problems.

Social feasibility and socio-economics - Extensive effort was made during the trial to understand local and national community perceptions, interests and concerns in relation to the beavers. A full cost-benefit analysis was not carried out, but economic opportunities and negative economic impacts were identified and investigated during the trial.

Monitoring, information dissemination and continuing management - The post release monitoring programme, designed and carried out during the trial, covered the essential elements outlined in the IUCN guidelines. Information gathered during the trial was disseminated appropriately in order to i) create awareness and support for the trial, ii) meet statutory licensing requirements and iii) contribute to the science surrounding beaver reintroductions. Timely advice, pre-emptive avoidance and mitigation measures were employed and adequately resourced by the Project Team in order to manage any conflicts. Management measures have been adapted where required.

3.3 Have the trial objectives been met?

The objectives of the ROBT are outlined below along with an assessment of whether they have been met:

Objective 1. *Identify and assess impacts of beavers on habitats, wildlife, built infrastructure and local communities. In particular this will concentrate on recording any impacts on farming, wildlife, fish populations, water management infrastructure, roads, paths and the people that live and work in the valley.*

This objective has been delivered through: i) monitoring of the habitats and species affected by beavers, ii) close monitoring of any infrastructure deemed to be at risk from beaver activity and iii) liaison with local communities to understand their views and concerns. It is acknowledged that there are gaps in knowledge, where the ROBT did not present the opportunity to answer certain questions, or the timeframe was not sufficient to appropriately assess any potential impacts.

Objective 2. *Identify wider public benefits associated with beaver activity in the landscape. This includes the potential benefits of beaver dams storing floodwater, reducing pollution, which will be the subject of a PhD with Exeter University. This objective also includes investigating other benefits such as increased economic activity for local tourism businesses.*

Monitoring of the potential ecosystem services provided by beavers, through storing water in headwaters/floodplains and improving water quality, started during the trial. It is too early at this stage of beaver colonisation of the River Otter to identify what impact, either positive or negative, the beavers may be having in this catchment. However, measures put in place to monitor these criteria will provide useful information in the next few years. Studies were carried out to measure the potential benefits to local businesses from the presence of beavers on the river.

Objective 3. *Develop an effective management process for a free-living beaver population. Protecting important structures, trees and trialling flow devices in any dams will*

form the basis of mitigation measures. These techniques and the decision making steps that will be taken are introduced in the "Beaver Management Strategy" published in January 2016.

The steps and processes set out in the Strategy provided an effective mechanism to manage the conflicts associated with the beaver population during the trial. As the population expands, the effectiveness of any measures will, to some extent, depend on the resources that are put in place for continued advice and management. Not all of the steps outlined in the strategy were necessary or tested during the ROBT period (e.g. translocation or culling). It is noted that experienced and knowledgeable staff are required to give advice for the most effective results.

Objective 4. *Understand the ecology, behaviour and population dynamics of a beaver population in a lowland productive agricultural landscape. Research will seek to understand how the beavers colonise the catchment and utilise the resources within it and will enable the carrying capacity for the catchment to be calculated. Monitoring the population of the beavers and how they form territories will be a key aspect of this objective.*

Monitoring and assessment was undertaken throughout the trial to monitor the behaviour and ecology of beavers and how they are colonising the River Otter catchment. A territory capacity model was developed to identify the maximum number of territories that the catchment could support.

Objective 5. *Increase knowledge and awareness with local communities and other key stakeholders of beavers and their interactions in the landscape. Public engagement and local education work will seek to explain the ecology and behaviour of beavers to local people and ensure decisions about their future are based on factual information.*

Extensive engagement with local communities and other key stakeholders was undertaken throughout the duration of the trial.

Objective 6. *Provide data and evidence to augment national knowledge base re beaver reintroduction. The knowledge gained as part of the ROBT will be disseminated to various national and international audiences. There are numerous projects around Britain seeking to restore beavers to wetlands, and advice and experience will be provided to these where appropriate.*

The information gathered from the trial was disseminated appropriately. The initial knowledge gained from studying the various aspects of beaver reintroduction in the River Otter has provided an important contribution to the knowledge base surrounding beaver reintroduction into Britain.

In summary it is concluded that all the trial objectives were satisfied so far as possible during the period of the trial, although significant evidence gaps remain. Evidence gaps in particular, relate to our understanding of the changes that a fully established beaver population may bring to habitats and species within the River Otter catchment. Due to the

nature and constraints of the ROBT and, specifically, the relatively short time period studying a small but growing beaver population, these evidence gaps are only likely to be filled with further study over a longer timeframe.

3.4 Have licence conditions been met?

The licence conditions specified within the licence issued by Natural England (see Appendix 2) were adhered to throughout the course of the trial. Natural England received relevant information and updates throughout the trial and were contacted when the licence conditions required. While all conditions were adhered to, the following warrant further explanation:

Licence condition number 3 required a management strategy be produced and agreed with Natural England by 30 September 2015. Although the document was finalised after September 2015, consultation with Natural England and other bodies commenced well before this date, and the publication of the Strategy followed in January 2016.

Licence condition number 9 specified that information on sex, genetic profile and approximate age of each beaver released from captivity must be obtained and documented prior to release. Sex and age have been recorded and samples obtained for genetic testing, but analysis has not yet been undertaken. It is understood that limitations with genetic analysis have precluded this during the trial (M. Elliot pers. comm.), but this should be possible in the near future.

Licence condition number 13 specified that the release of beavers must be undertaken in accordance with best practice, e.g. using ‘soft release’ techniques. Soft release techniques are where the beaver is held in a temporary fence for a period of time, which is only really possible in off-line ponds. The two beavers released directly from Scotland were not released in this manner due to the unavailability of off-line ponds at the time of release. Discussions were held with the ROBT management group and Natural England and locations for release were, instead, based upon habitat suitability and the lack of any existing beavers holding territories in those areas. In this instance, it is considered that the release of the two beavers was carried out in accordance with best practice, despite soft release techniques not being used. As these are specified as an example in the conditions it was considered that there was no breach of the licence condition. Dispersal from the release point was expected as part of typical behaviour to seek and establish territories, however dispersal was greater than anticipated in the case of these two beavers.

The licence application included three goals and a number of criteria for success and failure which are listed below:

Licence application goals:

- To establish a healthy population of Eurasian beavers into a lowland English river catchment.
- To demonstrate that beavers will have a positive impact on the ecological health of the river system and associated riparian land.

- To demonstrate that the beavers and their impacts will, on balance, be regarded by the local community and stakeholders as tolerable / positive.

It is considered that these goals were met during the course of the trial.

Criteria for success:

- Survival of introduced animals is similar to successful reintroduction programmes elsewhere in Europe at similar period of population establishment.
- A stable or increasing core population is achieved within the limits of the study site.
- The impacts on landowning and riparian interests have been fully assessed, and the cost of mitigation quantified.
- The beaver population demonstrates a positive contribution to ecosystem function.
- Beaver reintroduction is integrated with other habitat management/restoration operations.
- The impact on the economy of the area as a result of the presence of beavers is neutral or positive.
- Local support sustained/increased.

Beavers are in the early stages of colonisation of the River Otter catchment, consequently only limited information has been gathered in relation to some of the above criteria. However, the findings from the trial at its conclusion are consistent with the above criteria, supporting an assessment that the trial has been a success.

Criteria for failure:

- Mortality levels preclude establishment of genetically distinct breeding populations.
- Significant and unsustainable damage is incurred by the ecosystem within the study site.
- Landowners within the catchment or surrounding area provide evidence of significant economic loss as a result of beaver activities.
- Significant reduction in community and stakeholder support.

Beavers are in the early stages of colonisation of the River Otter catchment, so it is acknowledged that this assessment is made within the timescale of the project life. However, up to the point that the trial concluded none of the criteria for failure have been met.

An exit strategy is a key requirement of any translocation plan and was included within the licence application. The exit strategy was to be implemented either during the trial, in the event of insurmountable problems, or at the end of the trial in the absence of a firm commitment for beaver management in the long-term.

The licence application specified the exit strategy would be implemented in the event that:

- Unsustainable and detrimental effects arise as a result of the reintroduction of beavers to the trial area.

- Unforeseen and unpredicted circumstances dictate the removal of the beaver population from the trial site.
- Any significant change occurs to the required funding or management structure of the project that threatens the project viability.
- Any significant change occurs to the legal status of the Eurasian beaver that would have a detrimental impact on the project or its management.
- There is unacceptable risk to human health, livestock or other wildlife.
- There is any apparent risk to the health of the released animals or their progeny.
- The trial carries clear majority objection from impacted landowners.
- A decision on sourcing beavers for British reintroductions determines Bavarian beavers should be removed or replaced.

None of these situations arose during the ROBT.

3.5 Conclusion of assessment

In conclusion, Natural England considers that overall the ROBT has been a success. All relevant IUCN criteria in relation to reintroductions have been followed to an appropriate degree, the trial objectives have been met where possible, the licence conditions adhered to and the success criteria met.

The assessment has identified gaps in evidence, particularly in relation to the potential impacts of beavers on habitats and wildlife. Many of these evidence gaps require study over a much longer timescale than was possible during the ROBT. A comprehensive review of the potential positive and negative effects resulting from the activity of beavers, drawing on experiences in Scotland, is provided in Gaywood (2015). Taking into account both the findings of the ROBT and Gaywood (2015) it is concluded that, despite the uncertainty associated with these gaps in knowledge, there is a low risk of serious negative impacts occurring to habitats and wildlife within the River Otter catchment from beavers remaining in the long-term.

The presence of beavers appears, on the whole at this point in time, to be positive for both the wildlife and the people living in the River Otter catchment. The beavers are surviving, the population is expanding and there is no evidence of adverse welfare or disease issues. Conflicts between beavers and human interests have been effectively managed and their presence has retained widespread public support. While we cannot confidently predict what will happen as the beaver population expands to fully occupy the catchment, there is no reason to suggest that beavers will not continue to be a positive influence overall, or that problems cannot be resolved satisfactorily, if appropriate measures are in place to support and facilitate this.

4 Recommendations for the future of the beavers on the River Otter

Based on our assessment of the information presented in the ROBT Science and Evidence Report, the associated appendices, other information disseminated from the trial and relevant scientific papers, Natural England recommends that beavers are permitted to remain in the River Otter catchment after the expiry of the licence in August 2020.

The ROBT has, on balance, been a success and it is likely that beavers will continue to constitute a positive influence on the River Otter catchment. It is acknowledged that a number of significant uncertainties remain (as outlined in section 3). The beavers on the River Otter have thrived and have been positively received by the public. Any conflicts or issues were relatively minor and have been successfully managed. As outlined in section 2.2, we believe the habitat within the catchment is suitable to support a long-term viable and self-sustaining population of beavers. We do not foresee any future significant or unresolvable socio-economic problems associated with beavers remaining within the River Otter catchment; so long as adequate support is made available for comprehensive local management strategies to be put in place. Therefore, we recommend that the population is allowed to remain.

Natural England will be providing further advice to help inform the Government's decision and future policy on the legal status, further reintroduction and management (including licensing) of beavers more widely throughout England. Until that decision is made, it is recommended that the beavers within the River Otter catchment are monitored and allowed to spread and colonise the remainder of the River Otter catchment. Beavers dispersing out of the catchment should be captured and released appropriately back into the River Otter catchment unless provisions are put in place to support local communities in the neighbouring catchments to adapt to the colonisation of these areas by beaver. There is habitat within the River Otter catchment to allow the population to continue to grow, based on the expansion seen to date on the River Otter and within Tayside in Scotland (Campbell-Palmer *et al.* 2018). Also, there is sufficient habitat to sustain a viable beaver population without the need to expand into adjacent catchments.

A series of considerations and recommendations are listed below, based on the premise that beavers are to remain within the River Otter catchment until a national decision is made (similar considerations apply, but to an enlarged area, if the beavers are allowed to expand to neighbouring catchments during this interim period):

Initial recommendations (covering the period up until a decision is made by Government on the future of beavers in England):

1. A protocol, resources and responsible body need to be identified and in place to ensure beavers remain contained within the catchment;
    - Monitoring requirements will need to be considered, e.g. to understand and track dispersal.
    - A capture and release protocol will need to be developed.

- Appropriate protected species licences will be needed if beavers need to be trapped and relocated back into the catchment.
- Responsibility, funding, regulation and enforcement for the above will need to be clearly set out.

The territory capacity modelling indicates that the population is well under maximum carrying capacity. The speed of beaver dispersal is affected by topography. Watershed divides may act as dispersal barriers but this varies depending on topography (Halley and Rosell 2002; Halley *et al.* 2013). Surveys in Sweden and Norway indicate that dispersal occurs more quickly within a watershed than between them (Hartman 1995; Halley *et al.* 2013). However, dispersal out of the River Otter catchment is possible and has already been demonstrated. Should there be a lengthy gap between the decision on the River Otter and any national policy decision on reintroduction, additional resource may be required to trap and return animals to the River Otter in order to manage this issue.

2. Appropriate advice and management support will need to continue to be implemented to help resolve any problems caused by beavers;

    - The expanding population and estimates of any increases in levels of conflict will need to be factored into the strategy.
    - The level of ongoing support, education, advice, mitigation and management required will need to be set out.
    - Responsibilities, accountabilities and funding will need to be identified.

3. Monitoring the population and health status of beavers should continue during this interim period;

    - Continued monitoring is recommended, for example, to identify any mortality that occurs as a result of persecution or management practices that could affect the population or lead to welfare issues.
    - Funding for monitoring and assessment to fill relevant knowledge gaps should be identified.

Future recommendations (if the Government decides beavers can remain on the River Otter):

1. ‘Initial recommendations’ 2 and 3 will continue to be relevant if the Government decides that beavers can remain in the wild.

2. As outlined in this assessment, there remains a need for caution as colonisation of the River Otter catchment by beavers is in its early stages. This presents opportunities to monitor potential benefits, such as ecosystem services, as well as potential negative impacts through conflict with stakeholders and potential environmental risks. The beaver population also needs to be carefully monitored in relation to ecology and behaviour. Although the population appears to be doing well currently, it is only just moving out of the establishment phase, characterised by low population resilience, into the building phase, characterised by more rapid population growth. Therefore, continued long-term monitoring on the favourable status of the population is required.

3. Research is recommended to address the key evidence gaps highlighted in this report. In particular, quantitative information needs to be collected in relation to the impacts on plant communities, invertebrates and fish communities. More detailed scientific study on potential benefits or impacts to birds and mammals would be useful. Further monitoring in relation to changes to hydrology and water quality should also be undertaken.

4. Continued monitoring and health screening of the population should be carried out, as recommended by the IUCN Reintroduction Guidelines (IUCN/SSC 2013), to monitor for signs of emerging diseases, adverse welfare conditions or mortality. Post mortems of deceased individuals should be carried out in a thorough, methodical, systematic manner, in which all organs and tissues are examined, and detailed information collected.

5. Future genetic sampling is recommended to evaluate genetic diversity of the population, in particular, to assess the contribution of additional individuals that are released, and to inform future beaver population management recommendations. For the population to thrive in the long-term, natural dispersal throughout the Otter catchment and to other catchments would be optimal, especially if those catchments contained beavers of different genetic stock to the founding population in the Otter catchment.

6. A suitable awareness raising and management strategy will need to be implemented with advice, mitigation and management available to all stakeholders. Responsibilities, accountabilities and funding should be clearly laid out.

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6 Appendix 1: Summary of ‘shadow’ Habitat Regulations Assessment to assess the potential impact of River Otter Trial beavers expanding their range into the River Axe and River Exe catchments

Table 1 European sites potentially affected and risk of significant effects alone (when considered in the context of the prevailing environmental conditions at the site, but in isolation of the combined effects of any other plans and projects)

European Site(s):	**Risk**	**Qualifying features of the SAC at risk**	**Is there a likely significant effect on the feature that requires appropriate assessment?**
Culm Grasslands SAC (UK0012679)	Effect on hydrology/species/impact on woodland.	Northern Atlantic wet heaths; *Molinia* meadows on calcareous, peat or clay-silt soil; marsh fritillary butterfly.	No – there is no risk of a significant effect occurring.
Dawlish Warren SAC (UK0030130)	Effect on hydrology/species/impact on woodland.	Shifting dunes along the shoreline with *Ammophila arenaria* (‘White dunes’); fixed dunes with herbaceous vegetation (‘Grey dunes’); humid dune slacks; Petalwort, *Petalophullum ralfsii*.	No – there is no risk of a significant effect occurring.
East Devon Pebblebed Heaths SAC (UK0012602)	Effect on hydrology/species/impact on woodland.	European dry heaths; Northern Atlantic wet heaths; Southern damselfly.	No – there is no risk of a significant effect occurring.

European Site(s):	**Risk**	**Qualifying features of the SAC at risk**	**Is there a likely significant effect on the feature that requires appropriate assessment?**
East Devon Heaths SPA (UK9010121)	Effect on hydrology/species/impact on woodland.	Dartford warbler, nightjar	No – there is no risk of a significant effect occurring.
Exe Estuary SPA (UK9010081); Exe Estuary Ramsar (UK11025)	Effect on hydrology/species/impact on woodland.	Avocet, black-tailed godwit, dark-bellied brent goose, dunlin, grey plover, oystercatcher, Slavonian grebe, waterbird assemblage (wintering).	Yes – there is a risk of a significant effect occurring (see Table 2 for further information).
Exmoor Heaths SAC (UK0030040)	Effect on hydrology/species/impact on woodland.	Vegetated sea cliffs of the Atlantic and Baltic coasts; Northern Atlantic wet heaths; European dry heaths; blanket bog; alkaline fens; old sessile oak woods.	No – there is no risk of a significant effect occurring.
Exmoor & Quantock Oakwoods SAC (UK0030148)	Effect on hydrology/species/impact on woodland	Alluvial forest.	Yes – there is a risk of a significant effect occurring (see Table 2 for further information).
River Axe SAC (UK0030248)	Effect on hydrology/species/impact on woodland.	Water courses of plain to montane levels with *Ranunculion fluitantis*.	Yes – there is a risk of a significant effect occurring (see Table 2 for further information).

Table 2 Assessment of potential adverse effects

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
Exe Estuary SPA and Ramsar Waterbird assemblage	Extent of supporting habitat – bogs, marshes, water-fringed vegetation, fens.	These habitat features make up 10% of the SPA/Ramsar and are used by water birds at high tide. Beavers may utilise the wet ditches, and dam construction is likely in these small channels. Where dams are built they provide areas of deeper water, raise the water table locally and slow the overall speed of the water flow. The overall effect leads to create structurally complex wetland habitats. The diversity of habitats at beaver ponds reduces avian predation threats and increases food availability. Nummi and Holopainen (2014) found that the number of water bird species per pond per year was significantly higher during beaver inundation than before beaver activity as was water bird abundance. It was concluded that the beaver acted as a whole-community facilitator for water birds and that favouring beavers is a worthwhile tool in restoring wetlands to promote water bird communities. The activities of formerly native and keystone riverine species such as beaver, should they colonise the Exe, may make a positive contribution towards supporting the water bird assemblage. Should there be ecological changes, these are likely to be within acceptable	None required. However, ongoing continued monitoring is advised and future management of the beaver population may need to be considered.	Yes. No adverse effect is foreseen on the basis of this assessment.

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		conservation limits. Therefore, the risk of a significant adverse effect can be ruled out.		
Exmoor & Quantock Oakwoods SAC Alluvial woods.	Extent of supporting habitat; open space; grazing/browsing.	This habitat feature is found on flood plains alongside the rivers and streams of this site. Beavers can impact bankside trees, through feeding damage. However, evidence suggests that beavers do not eradicate streamside woodland in temperate zones, but feed selectively on available trees (Nolet, Hoekstra and Ottenheim 1994), their effects on broadleaved trees being akin to coppicing with affected trees re-growing. Nolet, Hoekstra and Ottenheim (1994) also noted that the proportion of standing trees affected by beaver browsing can be very low (1-5%) and is therefore likely to be within acceptable conservation limits at this SAC. The SAC's Conservation Objectives require areas of permanent/temporary open space within the woodland feature, typically to cover approximately 10% of area. Open space created by beavers can contribute to this (Natural England, 2019a). Where numbers of other herbivores are high, the impacts of beavers may be exacerbated if subsequent browsing of regrowth by other herbivores prevents coppice re-growth and tree regeneration. Hence, careful	None required. However, ongoing continued monitoring is advised and future management of the beaver population may need to be considered.	Yes. The risk is low enough to ascertain no adverse effect on site without any mitigation.

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		management of deer and livestock in wooded areas colonised by beavers may be required to take account of the potentially positive impact of beavers on the woodland habitat. Inappropriate deer grazing is already a pressure on the parts of this SAC so this assessment assumes that action to reduce this pressure will be ongoing. Beaver activity may increase areas of standing water and subsequently should have an overall positive impact on alluvial woodland trees. Long-term inundation of woodland could promote the growth of willow, which can grow well even in standing water. Death of trees which are unable to cope with raised water levels will lead to an increase in standing dead wood, which is important for biodiversity and generally present at low levels in British woods. Beavers also feed on a wide range of plant species – up to 90% of their diet during the summer months, including grasses, ferns, shrubs and non-native plant species such as Himalayan balsam (Nolet *et al.* 1995). Grazing of alluvial woodland vegetation by beavers is considered likely to be within acceptable limits. SAC Conservation Objectives state that low levels of grazing and browsing is beneficial and desirable to promote both a diverse woodland structure and gaps for continuous seedling establishment (Natural England, 2019a). As above, this		

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		assumes that any unacceptable grazing pressures are being currently managed and there will be little risk of a combined negative effect should beaver grazing occur in the future. The character of the tree and shrub plant community may alter over time with sustained regular beaver browsing. But, beaver will limit their population size by being very territorial, to ensure there is a sustainable food supply and hence the risk of a significant adverse impact is very low. Continued monitoring and assessment of the impacts of Beaver activities and low level management may be required. Overall the impact of beavers on this feature at this site is unlikely to have a significant adverse effect.		
River Axe SAC Water courses of plain to montane levels with *Ranunculion fluitantis.*	Extent of in-channel habitat; riparian tree cover; woody debris; sediment regime.	This site lies only on the lower section of the river which is slow flowing and has high bed stability with few trees along its bank, allowing light to reach the riverbed, and a range of natural features including deep pools, islands and meanders. The reintroduction of beavers into a new catchment can have a significant impact on the aquatic ecology through damming, however this is proportional to the number of dams built. At the River Otter catchment, dams were only built on the smaller tributaries within six of the 13	None required. However, ongoing continued monitoring is advised and future management of the beaver population may need to be considered.	Yes. No adverse effect is foreseen on the basis of this assessment.

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		beaver territories, and none on the main stem of the River Otter (Brazier *et al.* 2020). In addition, results from Natural England's 'dam capacity model' (which shows the likelihood of dams being built in a given river section), indicates that dams are rarely built in deep, slow moving water (Graham *et al.* 2019). Where dams are built they provide areas of deeper water, raise the water table locally and slow the overall speed of the water flow. The overall effect leads to more extensive wetland areas behind the dam and implications for the type of fauna and flora within that area. Beaver ponds will trap sediment, reducing the amount deposited downstream, creating a diversity of sediment storage areas. Woody material that falls into streams ('woody debris') plays an important role in increasing river habitat diversity, providing shelter for fish, supplying a food source for aquatic invertebrates, and for slowing the passage of nutrients downstream. The SAC conservation objectives recognise this and aim to restore the presence of coarse woody debris within the structure of the channel. In its smaller watercourses, temporary debris dams should be a positive feature of channel dynamics (Natural England 2019b). Beaver ponds and dams can improve the local water quality by storing large amounts of organic matter, nitrogen and phosphorus which can be highly beneficial		

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		to aquatic species. Beaver dams can also increase the self-purification capacity of a watercourse by slowing and filtering the water downstream. There can be negative impacts if too much sediment is stored resulting in changes to the river bed ecology due to increase siltation, or in the event of dam failure where woody debris may cause blockages downstream. Beavers can also impact bankside trees, through coppicing, by changing the canopy structure and degree of shading. However evidence suggests that beavers do not eradicate streamside woodland in temperate zones, but feed selectively on available trees and only affect between 1-5% of the standing tree crop (Nolet, Hoekstra, and Ottenheim 1994). Beavers also feed on a wide range of plant species – up to 90% of their diet during the summer months, including grasses, ferns, shrubs and non-native plant species such as Himalayan balsam. Encroachment of this non-native invasive species is an increasing issue at this site which is affecting the favourability condition status. Beaver feeding activity is unlikely to have any effect on its abundance of distribution, either positively or negatively (Brazier *et al.* 2020). There is a risk that changes in the ecosystem from beaver activities could increase habitat suitability resulting in increased encroachment, however as dam building is unlikely in this stretch of the		

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		catchment, there is unlikely to be significant ecosystem changes. Beavers can also create bankside burrows which could impact the structure of the river banks and add further sediment into the river channel. Burrows may increase channel complexity and sinuosity by acting as a focal point for erosion. The extent of damage will depend on the water flow and substrate type. During the River Otter Trial there was no significant erosion observed caused by beaver burrows. Evidence provided by the River Otter Beaver Trial is limited to a relatively small number of incidents related to a small but growing population within the 5 year period. However, where this might occur as result of the activities of a formerly native and keystone riverine species, this can be considered to be a naturally acceptable source of re-sedimentation that is needed to create and sustain key in-channel biotopes (Natural England, 2019b). The SAC's Conservation Objectives currently aim to restore the extent and pattern of in-channel and riparian biotopes (habitats) to that characteristic of natural fluvial processes (Natural England 2019b). On balance, the activities of formerly native and keystone riverine species such as Beaver, should they colonise the Axe, will make a positive contribution towards the restoration of these habitats and their supporting natural processes.		

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		Should there be ecological changes driven by beavers, these are likely to be within acceptable conservation limits at this SAC. Although it can be ascertained that, on the basis of the information currently available, there will be no adverse effect on the integrity of the site, it is recommended that there is ongoing monitoring of any impacts there may be in the event of a large and growing beaver population. Low level management may be required in order to sustain significant populations. Overall the impact of beavers on this feature at this site is considered unlikely to have a significant adverse effect.		
River Axe SAC Sea lamprey; brook lamprey; bullhead.	Extent of supporting habitat. Population abundance.	Sea lamprey spawn in fresh water and complete their life cycle in the sea. They need clean gravel for spawning, and marginal silt or sand for the burrowing ammocoetes. Features such as dams as well as polluted sections of river may impede migration to spawning grounds, they are relatively poor at ascending obstacles. Brook lamprey require the same habitat for spawning/ammocoetes but are an obligate freshwater species. They are smaller and may be able to better navigate some obstructions, however, for others they will not have sufficient power to overcome some of the	None required. However, ongoing continued monitoring is advised and future management of the beaver population may need to be considered.	Yes. No adverse effect is foreseen on the basis of this assessment.

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		obstructions that a larger sea lamprey may be able to traverse. The bullhead is a bottom-living fresh water fish that favours fast-flowing, clear shallow water, with a coarse substrate (gravel/pebble), which is well-oxygenated, unpolluted and where there is sufficient cover. The presence of beavers may be beneficial or detrimental to fish, depending on the species, its lifecycle stage, the topography and local conditions. However evidence suggests there will be very little impact on streams/rivers greater than 10 m wide as damming is largely unknown (Campbell-Palmer *et al.* 2016). In smaller streams sediment storage behind a beaver dam may result in reduced turbidity and silt deposition downstream, however if located immediately downstream of spawning gravels increased silt deposition may negatively impact bullhead. Small stream reaches are optimum bullhead habitat and also likely to be favoured by beavers. Beaver dams also have a physical presence on a river and could impede migration of fish upstream/downstream, dependent on site conditions and may vary for different habitats and species of fish. The		

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		beaver dams will however create increased complexity of habitats within the reach. Over time there may be differences in the distribution and composition of fish species, dependent on the conditions, however dams are not permanent, and may become eroded or washed away once beavers stop maintaining them and move on to other areas. The River Otter Beaver Trial provided limited opportunities to study the impacts of beaver dams on fish populations and habitats. Although it can be ascertained that, on the basis of the information currently available there will be no adverse effect on the integrity of this site, it is recommended that there is ongoing monitoring of any impacts there may be in the event of a large and growing beaver population. Low level management may be required in order to sustain significant populations. Due to the development of increased habitat heterogeneity, although there could be negative impacts at some sites, these are likely to be offset by additional gains within other areas of the habitat mosaic. Overall the presence of beavers is considered likely to result in a neutral effect on these SAC species. The SAC's Conservation Objectives currently aim to restore the extent and pattern of in-channel and riparian biotopes		

Feature potentially affected	Conservation objectives potentially affected	Analysis of potential effects on the attribute of the project as proposed	Analysis of additional measures that can avoid or reduce the effects on the attribute	Can 'no adverse effect' on the feature be ascertained?
		(habitats) to that characteristic of natural fluvial processes (Natural England 2019b). On balance, the activities of formerly native and keystone riverine species such as beaver, should they colonise the Axe, may make a positive contribution towards the restoration of these habitats and their supporting natural processes. Should there be ecological changes, these are likely to be within acceptable conservation limits. Therefore, the risk of a significant adverse effect can be ruled out.		

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7 Appendix 2: Conditions of the licence

Conditions of the licence granted by Natural England under section 16(4) of the Wildlife and Countryside Act 1981 at the start of the River Otter Beaver Trial in 2014. Further amendments were made to the licence during the period of the trial to amend the list of Additional Authorised individuals named on the licence. The number of additional Eurasian beavers permitted to be released into the River Otter catchment (condition 1) was amended in the reissued licence to account for the number of beavers that had already been released.

Licence Conditions

Licensed Numbers

1. Within the licence period, this licence permits:

    - the release of up to five (5) additional Eurasian beavers (*Castor fiber*) into the River Otter catchment, Devon.

    and

    - the re-release into the River Otter catchment of any number of beavers already resident in the River Otter catchment, following their temporary capture for the purposes of marking and/or monitoring.

General

2. The licensee will follow protocols and processes laid out in their “Application to Natural England”, October 2014 and information provided subsequently (‘Response to Natural England request for further information (2/12/2014), January 2015). Any major deviation from these protocols and processes must first be agreed in writing with Natural England.

3. A management strategy developed in consultation with major riparian land owners / right holders and statutory bodies that have a role in the management of riparian features must be produced and agreed with Natural England by 30 September 2015.

4. The licensee must ensure that all appropriate permissions are in place to undertake the licensed activities and that these are in place prior to the licensed activity commencing.

5. All beavers to be released must be the Eurasian beaver (*Castor fiber*) and have either been taken under licence from the River Otter or sourced from a legally taken and held captive population.

6. The release of additional beavers not formerly living on the River Otter may only be undertaken with specific written permission from Natural England.

7. ‘Additional’ beavers to be released must be certified as healthy and fit for release by a qualified veterinary surgeon and/or a suitably qualified and experienced zoologist. Specifically they must be confirmed as being free from the Taenid *Echinococcus multilocularis.*

8. All beavers released must be marked with digital identification chips and an individually identifiable ear tag. This includes any beavers caught subsequently during the project that are found not to have an identification chip.

9. Information on sex, genetic profile and approximate age of each beaver released from captivity must be obtained and documented prior to release.

10. Information on approximate age and sex must be obtained for all field caught animals.

11. Any known deaths of beavers must be reported to Natural England. If the carcass is available a post mortem must be carried out by a suitably experienced veterinary surgeon and the report copied to Natural England.

12. Any reports of beaver in adjacent catchment areas must be reported to Natural England and followed up by the licensee. If confirmed, all reasonable attempts must be made by the licensee to trap and identify the beaver. Natural England must be involved in the decision of what to do with any captured beavers.

13. The release of beavers must be undertaken in accordance with best practice, e.g. using ‘soft release’ techniques.

Release site

14. Prior to release of beavers, written permission must be obtained from the landowner/s of the release site/s.

Access to land occupied by beavers

15. Before any beavers are released, the licensee must satisfy Natural England that it has secured written permission from sufficient relevant owners of land on or adjacent to the River Otter to allow access onto land for the purposes of monitoring impacts and the health of the beavers, carrying out reparations in the event of damage caused by beavers and (if necessary) access to remove beavers from the river.

Monitoring

16. Prior to the release of beavers, a monitoring programme designed to determine and study the positive and negative impacts of the beavers on the River Otter and the surrounding land must be agreed with Natural England. The monitoring programme may be reviewed and amended from time to time with the agreement of Natural England.

Negative impacts

17. Before any beavers are released, a procedure for documenting and dealing with any complaints as a result of the release must be agreed with Natural England.

18. The licensee must inform Natural England, as soon as reasonably practicable, of any complaints received in respect of the beavers or their activities.

19. For the duration of the trial, the licensee will be responsible for dealing with reparations and/or damage/flood prevention as a result of beaver activity on the River Otter and its tributaries. Sufficient funds must be confirmed and ring-fenced for these purposes.

Exit strategy

20. Natural England reserves the right to terminate the trial if it deems this is necessary for whatever reason and will make the final decision on any proposal by the Project Management Group to invoke the exit strategy.

21. Before any beavers are released, a written guarantee that the licensee will underwrite the costs of an exit strategy must be in place

22. Before any beavers are released, the licensee must make public to all interested and relevant parties the existence, criteria and content of the exit strategy.

Protected sites

23. Any impacts of beaver activity on or adjacent to protected sites must be closely monitored and Natural England kept informed.

24. Natural England must be consulted on any proposed remedial or mitigation measures on or in the vicinity of protected sites.

Public awareness

25. Provision must be made for interested and relevant parties to communicate with the Project Management Group.

Reporting

26. Natural England must be provided with annual reports providing an update of the progress of the project against its published objectives by 31 March each year.

27. The number of ‘additional’ beavers released and the number of ‘resident’ beavers re-released into the River Otter catchment after temporary capture as part of monitoring must be reported separately to Natural England.

Standard conditions

28. The Licensee shall permit an officer of Natural England, accompanied by such persons as he/she considers necessary for the purpose, on production of his/her identification on demand, reasonable access to the site for monitoring purposes and to be present

during any operations carried out under the authority of this licence for the purpose of ascertaining whether the conditions of this licence are being, or have been, complied with. The Licensee shall give all reasonable assistance to an officer of Natural England and any persons accompanying him/her.

29 The licensee is responsible for ensuring that operations comply with all terms and conditions of the licence.

NOTES

a. The provisions of the Animal Welfare Act (2006) and the Wild Mammals Protection Act (1996) must be complied with at all times.

b. Natural England checks compliance with licences and the attached conditions.

c. Amendments to the list of people authorised to act under this licence can be made by completing their details on line or by contacting Natural England. Additional authorised persons must not undertake licensable activities until their name is listed on a valid licence.

d. You are advised to carry a copy of this licence with you at all times whilst undertaking licensed activities.

e. Nothing in this licence confers a right of entry to any land or property.

f. Animals should be released at a location and a time where the risk of injury to themselves, other animals/birds or people is minimised.

The licence was extended in March 2020 to August 2020. This was updated to confirm to the current licence format and situation, including removing conditions that were no longer relevant. The following new conditions were added:

AC05. All beavers caught during the project that are found not to have an identification chip, including any beavers trapped on adjacent catchments that are likely to have dispersed from the River Otter catchment, must be marked with a digital identification chip where trained personnel are available. Where trapping is carried out for the purpose of health screening sufficient trained personnel must be present to enable chips to be fitted if the health of the beaver permits it.

AC11. Gathering the science and evidence: DWT will continue to monitor the spread and impact of beavers in this lowland English landscape and report any additional observations following the publishing of the science and evidence report (January 2020).

AC12. Results of any population monitoring or animal health and welfare monitoring (as outlined in section 7 of Appendix 7 of the River Otter Beaver Management Strategy

Framework) carried out during the period of the licence must be submitted to Natural England.

Natural England is here to secure a healthy natural environment for people to enjoy, where wildlife is protected and England's traditional landscapes are safeguarded for future generations.

Should an alternative format of this publication be required, please contact our enquiries line for more information: 0300 060 3900 or email enquiries@naturalengland.org.uk.

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