Eurasian Beaver Disease Risk Management and Post-Release Health Surveillance Protocol

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Castor fiber, disease screening, translocation, trapping, reintroduction, medicine, species restoration

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Foreword

This protocol was commissioned to inform potential future releases of beaver in England. Its objective is to mitigate potential disease threats and to promote the welfare of individual beavers.

The management of disease and pathogen transfer is an important consideration in any reintroduction or conservation translocation, as outlined in the International Union for Conservation of Nature (IUCN) Guidelines for Reintroductions and Other Conservation Translocations (IUCN/SSC, 2013) and Reintroductions and other conservation translocations: code and guidance for England (hereafter known as the English code) (Defra 2021). The potential spread of non-native parasites (those that are either non-native to the host or to the local ecosystem) is often a primary concern in any wildlife translocation, but there are also other infectious agents which, under specific conditions (for example, co-infection or stress-altered host immune-competence), may pose a risk to translocated animals.

Translocations are an inherently stressful process for any wild animal. Animals are exposed to many unfamiliar or unnatural conditions of confinement, experience changes in diet, may undergo invasive procedures (handling, general anaesthesia, sampling) and must adapt to a new and unfamiliar environment at the destination. In addition, high population densities in captivity may facilitate the transmission of infectious agents within the population and the intensification of endemic parasites. Disease risk analysis, management, health surveillance and post release surveillance are therefore crucial elements of translocation programmes.

This protocol translates the findings of existing and current research into a practical document which outlines the disease risk management and post release health surveillance approach to be followed by those intending to undertake beaver reintroductions or translocations in England.

Executive summary

Interest in Eurasian beaver (*Castor fiber*) translocation to England for conservation and mitigation purposes has grown in recent years. Any animal translocation presents the potential for health and welfare risks to the animals involved, as well as wildlife, livestock, domestic animals and humans at and around release sites.

The purpose of this protocol is to present a practical approach for undertaking Eurasian beaver translocations in England to both mitigate potential disease risks and to promote individual beaver welfare. In particular, the protocol is designed to minimise time spent by beavers in captivity for the purposes of testing while recognising that temporary housing may be required while suitable release sites are identified or family members are trapped.

Translocation pathways (the step-by-step actions that need to be undertaken in a beaver reintroduction), disease risk analysis findings, testing and mitigation protocols have been identified and documented for beaver translocations and captive care in England.

Disease testing protocols, post-capture and prior to release, are described, taking into account the differing and uncertain origins of some beavers.

Best practice guidance on husbandry, animal welfare and stress management in captivity and release site considerations is provided.

There are differences in the management and monitoring of beavers in fenced enclosures and free-living beavers because enclosed projects are subject to more exacting legal obligations. In addition, post-release monitoring will vary with project type, capacity and resource availability, noting that in wild releases individuals may disperse large distances making individual monitoring difficult.

Management of beavers in the wild is therefore likely to focus on body condition and health status of any recovered animals (predominantly via post-mortem examination).

Pre-release disease screening, captive care observation and post-release surveillance should all be continually and transparently assessed to refine protocols and this guidance will be updated accordingly.

This protocol is arranged in the chronological order of the translocation pathway and should be followed accordingly.

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Introduction

1.1 Beaver status in England

The Eurasian beaver faced virtual extinction across Europe, Russia and Asia in the 19th century due to significant hunting for fur and other products over preceding centuries. Today it inhabits large tracts of its native range following the cessation of hunting and provision of protection, which has enabled natural expansion from relict populations. Translocation and reintroductions have had a significant influence on this expansion (Nolet and Rosell 1998; Halley and others 2012). The Eurasian beaver is native to Great Britain (Scotland, England and Wales) and was once widespread throughout freshwater habitats before being hunted to extinction. Britain represents the most western extent of its native distribution as the species never reached Ireland.

One of the first recorded beaver reintroductions saw wild-caught Norwegian beavers translocated to Sweden in 1922 (Hartman 1995). Since then, numerous translocations, both unofficial and government-sanctioned, have occurred and have restored this species across much of Europe (Halley and others 2021; Saveljev and others 2015). Global population estimates are estimated at ~ 1.5 million individuals (Halley and others 2021), although locally beavers can exist in low numbers and remain absent from some suitable habitats and areas of their former range. There have been numerous beaver reintroductions and additions to populations across Eurasia, though some of the histories are complicated and not always well documented (Macdonald and others 1995; Nolet and Rosell 1998; Dzięciołowski and Gozdziewski 1999; Halley and Rosell 2003; Halley and others 2021).

Interest in beaver reintroduction has been increasing in England due to the species' ability to transform landscapes and return natural function to river systems. A feasibility study (Gurnell and others 2009) confirmed that there is sufficient suitable habitat in England to support Eurasian beaver across multiple catchments in England, with appropriate climatic conditions and sources of wild and captive beavers to support the initial population. A subsequent evidence review (Howe 2021) concluded that the beaver is a suitable candidate for further reintroductions within England.

The restoration of beavers to Britain to date has been via a combination of officially sanctioned releases, licensed enclosed projects, accidental escapes, and unauthorised releases. Beavers have been released in small numbers in England since the early 2000s, mainly into outdoor fenced enclosures (Heydon and others 2021) and at the time of publication there are 44 licensed enclosures and five unlicensed enclosures (Natural England Wildlife Licensing Service (NEWLS) team, pers comm). The only wild-living population of beavers in England that is officially

recognised by the UK Government at the time of publication is on the River Otter, Devon. In August 2020, the UK government announced that this population could remain and expand its range naturally after the successful five-year trial reintroduction (Brazier and others 2020; Howe and Crutchley 2021).

Unofficial beaver releases have the potential to result in serious health risks to animals and humans and have significant consequences, not only for other wildlife, but also for public support for future reintroduction processes.

Natural England and partner organisations are seeking to improve compliance with the English code and appropriate management of the species.

1.2 Project overview

It is anticipated that beavers may be translocated from free-living populations or fenced enclosures in Great Britain to release sites in England for population enhancement or mitigation translocations. Beavers may also be moved between fenced enclosures.

Disease risk analysis (DRA) is a rigorous process which evaluates the risks from disease associated with a proposed activity, such as the translocation of wild animals (Leighton 2002). Disease risk management protocols describe appropriate guidance to mitigate the risks from the hazards identified in the DRA.

This protocol presents the disease risk management and post-release health surveillance protocol for translocations of the Eurasian beaver to and within England, based on DRAs carried out in England and Scotland (Donald and others 2020; Common and others 2024; Girling and others 2019a). Additionally, existing literature on beaver reintroductions, translocation, health and welfare, along with captive management, has been consulted primarily for the Eurasian beaver but also the very closely related North American or Canadian beaver (*C. canadensis*). These two species are genetically distinct with differing numbers of chromosomes preventing hybridisation, but both are remarkably similar in appearance, physiology, behaviour and ecology requirements; therefore, literature is likely to be comparable and relevant.

The purpose of this protocol is to present a practical approach for anyone undertaking Eurasian beaver translocations in England to both mitigate potential disease risks and to promote individual beaver welfare.

1.3 Objectives of disease risk management in beaver translocations

The objectives of this disease risk management protocol are to:

- Provide practical protocols
- Ensure beaver health and welfare in translocation projects in Great Britain
- Mitigate the potential negative effects of the hazards identified by the DRAs on translocated beavers and other species at release sites
- Prevent the introduction of non-native parasites
- Ensure individual beavers are fit for release
- Ensure native commensal parasites are conserved and to allow the development of appropriate host immune responses
- Mitigate stressors in the translocation process
- Gather further information on the identified hazards through continued health surveillance, to inform and continually revise the DRA and best practice protocols
- Detect unknown or unidentified disease hazards that might become evident during or after translocation and captivity through the occurrence of disease
- Promote appropriate health monitoring to enable potential disease and welfare problems to be accurately identified and steer necessary action. This will also increase understanding of the diseases of beavers and assist in planning future projects.

2 Disease risk analysis on conservation translocations of beavers

A peer-reviewed DRA for reintroducing beavers to Great Britain, focussing on infectious diseases, was published in Mammal Review in 2019 (Girling and others 2019a) using IUCN guidelines and qualitative assessment procedures (IUCN/SSC 2013, Jakob-Hoff and others 2014). A further DRA was carried out in spring 2020 (Donald and others 2020) for the translocation of beavers from either Norway or Great Britain using the Sainsbury and Vaughan-Higgins' (2012) method, as developed from previous qualitative DRA methods for wildlife (Davidson and Nettles 1992; Leighton 2002) and domestic animals (Murray and others 2004) and modified by Bobadilla Suarez and others (2017) and Rideout and others (2017). Donald and others (2020) was subsequently updated (Common and others 2024) to consider the risks associated with translocating beavers currently or previously housed in fenced enclosures or in captive collections in Great Britain. Common and others (2024) also considered the additional risks associated with translocation of beavers known to originate either from Europe or of uncertain origins.

Hazards were classified by Common and others (2024) as follows:

Carrier hazards were defined as commensal parasites, or parasites which do not ordinarily cause disease in the host animal following infection. However, when the host is under stress associated with translocation, or is subjected to factors that

affect parasite dynamics, such as alterations in host density, these parasites may cause disease in transit or at the release site.

Transport hazards were defined as those hazards that may be encountered during transport (between the source and destination sites) which may be novel to the translocated animals and/or the release environment. Translocated animals can be a potential vehicle for introduction of these hazards to the destination site. Transport hazards are also those infectious agents moved with materials such as transport boxes, equipment, food and water.

Population hazards were defined as those non-infectious and infectious agents present at both the source and destination sites which could potentially have a negative impact on population numbers at the destination.

Source hazards were defined as a hazard present at the source site which would be novel at the destination site. Conversely, **destination hazards** were defined as infectious agents present at the destination but not the source.

Ninety-five hazards (88 infectious and seven non-infectious) were evaluated by Common and others (2024). Based on known prevalence and potential severity of clinical disease in infected animals (beavers, domestic animals, and sympatric wildlife) and humans, 26 of the 95 identified hazards received detailed analysis. Of the 26 hazards assessed in detail by Common and others (2024), 17 were of high or medium risk of precipitating disease in Eurasian beavers or sympatric mammals, including people, without appropriate mitigation measures (Table 1).

Hazard	Type of hazard	Level of risk*
Echinococcus multilocularis	Source	High
Taenia spp.	Source	High
Hantaviruses - Puumala-virus (PUUV) and Saaremaa-virus (SAAV)	Source	Medium
Brucella spp.	Source	Medium
Trichinella spp.	Source	Medium

Hazard	Type of hazard	Level of risk*
Toxoplasma gondii	Population	High
Road traffic collisions	Population	High
Captivity	Population	Medium
Persecution	Population	Medium
Leptospira spp.	Carrier	High
Yersinia spp.	Carrier	High
Toxoplasma gondii	Carrier	High
Gram-negative bacteria	Carrier	Medium
Streptococcus castoreus	Carrier	Medium
Eimeria (coccidia) spp.	Carrier	Medium
Neostichorchis subtriquetrus	Carrier	Medium
Emmonsia crescens	Carrier	Medium

Table 1. Hazards assessed by Common and others (2024) as being of high or medium risk of precipitating disease in beavers or sympatric mammals, including people without appropriate mitigation measures. All other hazards were of very low or low risk. * Risk levels may vary with the source population selected and are estimated prior to mitigation and disease risk management measures.

Echinococcus multilocularis, or the fox tapeworm, is a hazard of particular concern identified by Campbell-Palmer and others (2015a) and Common and others (2024) as it is a zoonotic pathogen responsible for severe disease and a high fatality rate in humans and a serious public threat in some regions, including central Europe (Malik and ul Bari 2019; Torgerson and others 2010). Beavers imported from areas endemic for *E. multilocularis* may have been infected with the pathogen prior to import. If an infected free-living beaver died and was scavenged by a predator, *E. multilocularis* could become established in Great Britain. As beavers cannot transmit this tapeworm to each other, the risks of disease associated with *E. multilocularis* are

greater when first generation beavers of unknown origin or known to have been imported from endemic areas of Europe are infected. Translocation of beavers known to have been born in Great Britain is therefore strongly preferred and further consideration of management of this hazard is described below.

In addition, Common and others (2024) evaluated *Mycobacterium* spp. as a hazard for domestic and free-living mammals due to the economic losses associated with livestock morbidity and mortality. Common and others (2024) concluded that the risk from *Mycobacterium* spp. associated with beaver translocations was negligible and it is not therefore considered further.

Evidence shows that source hazards constitute the greatest risk of epidemic disease following translocation. Six of the parasitic source hazards – *E. multilocularis*, hantaviruses (Puumala-virus (PUUV) and Saaremaa-virus (SAAV)), *Trichinella* spp., *Taenia martis*, certain *Brucella* spp. and *Francisella tularensis* (which was assessed as being of low risk) - which pose a zoonotic risk of disease in people or a risk of disease in domestic animals are currently not present in Great Britain and are endemic in certain areas of mainland Europe.

Moreover, there may be other, unknown, potential infectious agents (viruses, bacteria, fungi, protozoa and helminths) which are associated with disease following the translocations of beavers. Health surveillance through, for example, post-mortem examination is therefore extremely important to detect hazards not recognised at the time of the DRA.

2.1 Disease Risk Management

2.1.1 The importance of disease risk management in translocation programmes

As stated in the IUCN Guidelines for Reintroductions and Other Conservation Translocations (IUCN/SSC 2013, p 10) (hereafter the IUCN Reintroduction guidelines), ‘The management of disease and known pathogen transfer is important, both to maximise the health of translocated organisms and to minimise the risk of introducing a new pathogen to the destination area.’ While the potential spread of non-native parasites (those that are either novel to the host or the local ecosystem) certainly represents the primary concern in any wildlife translocation (Rideout and others 2017), there are also many other infectious agents which, under specific conditions, (for example, co-infection or stress-altered host immune-competence) may pose a risk to translocated animals.

Translocations are an inherently stressful process for any wild animal. Animals are exposed to many unfamiliar or unnatural conditions of confinement, experience changes in diet, may undergo invasive procedures (handling, general anaesthesia,

sampling) and must adapt to a new, unfamiliar environment at the destination. In addition, increased population densities in captive situations may be stressful and may facilitate the transmission of infectious agents within the population and the intensification of endemic parasites. Disease risk analysis, management and health surveillance are therefore crucial elements of many translocation programmes.

Disease risk management measures to mitigate the risks from disease associated with the identified hazards are described below. Appropriate measures are recommended based on the known or unknown origin of different source populations of beavers being translocated. As stated in the IUCN Reintroduction Guidelines, 'the level of attention to disease and parasite issues around translocated organisms and their destination communities should be proportional to the potential risks and benefits identified in each translocation situation' (IUCN/SSC 2013, p10) and this guidance has been reflected in the recommendations in this report.

2.1.2 The Translocation Pathway

It is anticipated that beavers for further release projects in England, either in the wild or into enclosures, will include wild-caught individuals from conflict sites in Scotland, individuals from authorised and non-authorised populations in England, rehabilitated animals, and surplus offspring from fenced enclosures. Importation of beavers into Great Britain from Europe is strongly discouraged at the time of writing (Defra 2014) and Natural England do not allow the use of wild-sourced beavers from countries with endemic *E. multilocularis* in release projects. This document therefore only outlines the criteria necessary for the translocation of beavers within Great Britain. Each of these source populations has differing health screening requirements according to source and release area. Different countries within Great Britain may also have differing requirements and these should be consulted if beavers are being moved between countries (NatureScot 2022).

The origin of some beavers in Great Britain is uncertain but is thought to include central and eastern Europe, including Bavaria and Poland (Ritchie-Parker and others 2022). Many species of bird migrate seasonally between Europe and Great Britain and could act as a potential route for parasite transfer. However, parasites infectious for birds may not be infectious for rodents and therefore Common and others (2024) concluded that a geographic barrier exists between continental Europe and England for the purposes of parasite transmission. Within Great Britain, sympatric rodent and other mammalian species have potential to form contiguous populations for parasite transfer. However, as beavers have only recently (within decades) been translocated to Scotland and other parts of Great Britain, Common and others (2024) assumed that there has been insufficient time for parasites to be transferred to all parts of England and that beaver translocations within Great Britain therefore have potential to breach geographical barriers to parasite dissemination.

In addition, some types of captivity may increase the risk from disease to a conservation translocation programme via the breach of ecological barriers to parasite spread (Bobadilla Suarez and others 2017). The close proximity of species that would not normally be in contact due to either geographic or ecological separation may facilitate the transmission of alien (exotic) parasites via, for example, shared airspace, water or fomites, including free-living birds and rodents. Some beavers have been held in private collections and/or zoological collections without adequate biosecurity arrangements and may have had direct or indirect contact with captive, non-native species (including rodents) from which they may have acquired non-native parasites. This additional risk may warrant further investigation in some instances.

Beavers may have passed through differing captive situations and the disease risks associated with these different situations will vary. In light of this, a definition of the different types of captivity is noted below and should be referred to when carrying out risk assessments:

- Temporary bio-secure holding facilities (see section 5)
- Fenced enclosures in naturalistic habitat settings
- More permanent captivity in animal collections (more than two months) or temporary captivity in non-biosecure facilities (described for the purposes of testing and treatment protocols as ‘captivity’ in this document). Relevant animal collections would be those that keep non-native species or species of animal that are currently not free-living in Great Britain.

This document is set out in the chronological order of the translocation pathway – the step-by-step actions that need to be undertaken in a beaver reintroduction.

2.1.3 Source selection

The disease risk analysis by Common and others (2024) identified variations in the hazards and accompanying level of risk associated with different populations of beavers. Consideration of the source of a beaver (and its origins) will determine variations in the recommended pathogen testing and treatment protocols.

2.2 Biosecurity and best practice for trapping beavers

Appropriate licences must be obtained for the trapping, holding and release of beavers. Please consult the relevant statutory nature conservation organisations for further information.

To minimise any handling time or period in captivity, the release site for the beaver(s) should ideally be known prior to trapping.

Biosecure procedures (barrier techniques) are important during the capture and handling of beavers to reduce the probability of transfer of infectious agents both to and from beavers, including potentially zoonotic agents. In addition, as 11 of the 26 hazards evaluated in detail are stress-associated, capture and handling must be as calm, quick and gentle as possible. Further guidance is given below:

- Traps and any associated equipment must be thoroughly cleaned and disinfected before and after use between sites. Please ensure all disinfectants are approved for use by Defra[1].
- The translocation team must wear clean and disinfected boots and clothing. After use on a site, boots must be thoroughly cleaned and disinfected before storing for next use. Disposable gloves must be worn and an alcohol-based hand sanitiser should be available for application before and after handling equipment. The wearing of FFP2 face masks when physically handling beavers is recommended.
- Any staff involved in the capture and handling of beavers should have had no direct contact with exotic rodents (including as pets at home) immediately prior to the translocation. Where this is not achievable, staff should observe the following biosecurity guidance prior to handling the beavers: taking a shower, wearing disposable gloves and clean clothes and an outer barrier layer of dedicated clothing such as overalls and boots as above which should be stored in a dedicated plastic box labelled 'Biosecurity – Beaver'.
- The number of staff interacting directly with beavers should be kept low and speaking and extraneous noise minimised where possible.

Any trapping must be undertaken by trained/experienced personnel, carried out under the necessary licences and have any relevant landowner permission. A range of live traps exist for beavers, mainly via the North American market. However, it should be noted that in England and Scotland only the Bavarian-style beaver trap (see Figure 1) is currently permitted[2]. This trap was developed by Bavarian beaver managers to improve welfare. Features include: a slight gap on closed doors to prevent tail injuries; mainly sheet metal sides to keep animals safe and protected from the elements, this also means traps are darkened which can keep animals

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1 http://disinfectants.defra.gov.uk/DisinfectantsExternal/Default.aspx?Module=ApprovalsList_SI

2 For details of permitted traps see: https://www.gov.uk/guidance/badgers-beavers-otters-and-pine-martens-how-to-trap-humanely

calmer; large enough to enable animal to move around in the trap to feed and groom, for example they are not held in place and can dry off fur.

Figure 1. **A (left) Bavarian trap placement and setting in the field. Any bait must only be placed on the central treadle to avoid animals reaching in and triggering the trap, exposing them to back injuries from trap doors. B (right) Transport crate to enable beaver to be removed from field trap, reducing the need for direct handling.** *Photos* © (R. Needham, R. Campbell-Palmer Beaver Trust)

- Two main principles in beaver trap placement are generally applied: either aim to lure beavers to a trap (active trapping) or place the trap in an area regularly used already by the beavers (passive trapping and 'traffic traps') (Rosell and Kvinlaug 1998). A combination of both may be used to improve trapping success, ie, careful placement of a baited trap on top of an actively used forage trail, typically on the worn tracks leading from the water to an active felling site. Each site should be assessed for appropriate trap placement before trapping. A range of baits can be used for trapping, though variations and preferences may be displayed by different families. Food baits should be refreshed every few days and include leafy branches such as willow or aspen, apples or root vegetables. Enough food should be included to sustain an adult potentially overnight.
- Trapping considerations will need to include: site access, landowner permission, risk of interference/disturbance by public, risk of trap flooding or rolling, distance to carry any trapped animals out, field sign activity type and age, beaver territory (if known), and time of year. Trapping needs to be avoided during the kit dependency period unless targeting an individual known to not be in late pregnancy or suckling offspring. In England this period runs from March 1st to August the 31st (in Scotland this period is March 31st to August 15th).

- Traps must be checked at least twice in a 24-hour period (once in the morning and once in the evening if continually open), or opened in the later afternoon (after 3.00 pm) and checked first thing in the morning (as soon as practicable after sunrise and no later than 9.00 am). Traps should then be closed in the morning until they are reset in the afternoon. However, traps may be left set throughout the day in enclosures, for example, or areas in which human interference is unlikely, providing regular checks are made. Under no circumstances should beavers remain in traps throughout the day. Weather conditions must be assessed in advance and continually monitored, especially for heavy rain and extremes of temperature. Critically, water levels must also be monitored so that fluctuations do not put traps at risk of flooding.
- Clear signage on the trap must deter people from interfering (Figure 2). It is also a licence condition in England that all traps must be marked with the identification details of the licensed person and their contact details.
- Animals must never be carried in a trap due to the potential for injury to both animals and humans. Removing a beaver from the trap is most easily undertaken by allowing the individual to walk into a suitable transport crate (Figure 10). If the animal is to be handled for sampling or treatment purposes at the trapping site, then allow the beaver to walk into a purpose-designed beaver handling net (Figure 3), which includes a quick release open end, for transfer into a hessian sack for handling. Direct handling should be avoided or minimised as much as possible to reduce risk to humans and reduce stress to beavers.
- To minimise prolonged and unnecessary handling, trapped beavers should be visually examined by a suitably qualified person immediately on removal from the trap, if being transported directly to a release site, or on removal from the transport crate if entering a captive holding facility. This is primarily to determine if veterinary attention is required and if the animal is fit for transport. Specific detail in relation to handling can be found in relevant literature (eg Campbell-Palmer and Rosell 2013; Campbell-Palmer and others 2016) and it is recommended that expert advice is sought before undertaking these activities.

Trap ID: SW 567

<u>This is a legal trap</u> set out to live catch beavers as part of an agreed translocation project.

Beavers are being relocated following best practice animal welfare standards.

Traps are monitored on a daily basis.

Please avoid any direct contact as any interference may jeopardise animal welfare.

If you have any concerns, please contact the licence holder [name]: on [phone number/email]

Figure 2. Example sign to place on beaver traps. The purpose of the trapping and any logos of organisations involved should be amended as necessary.

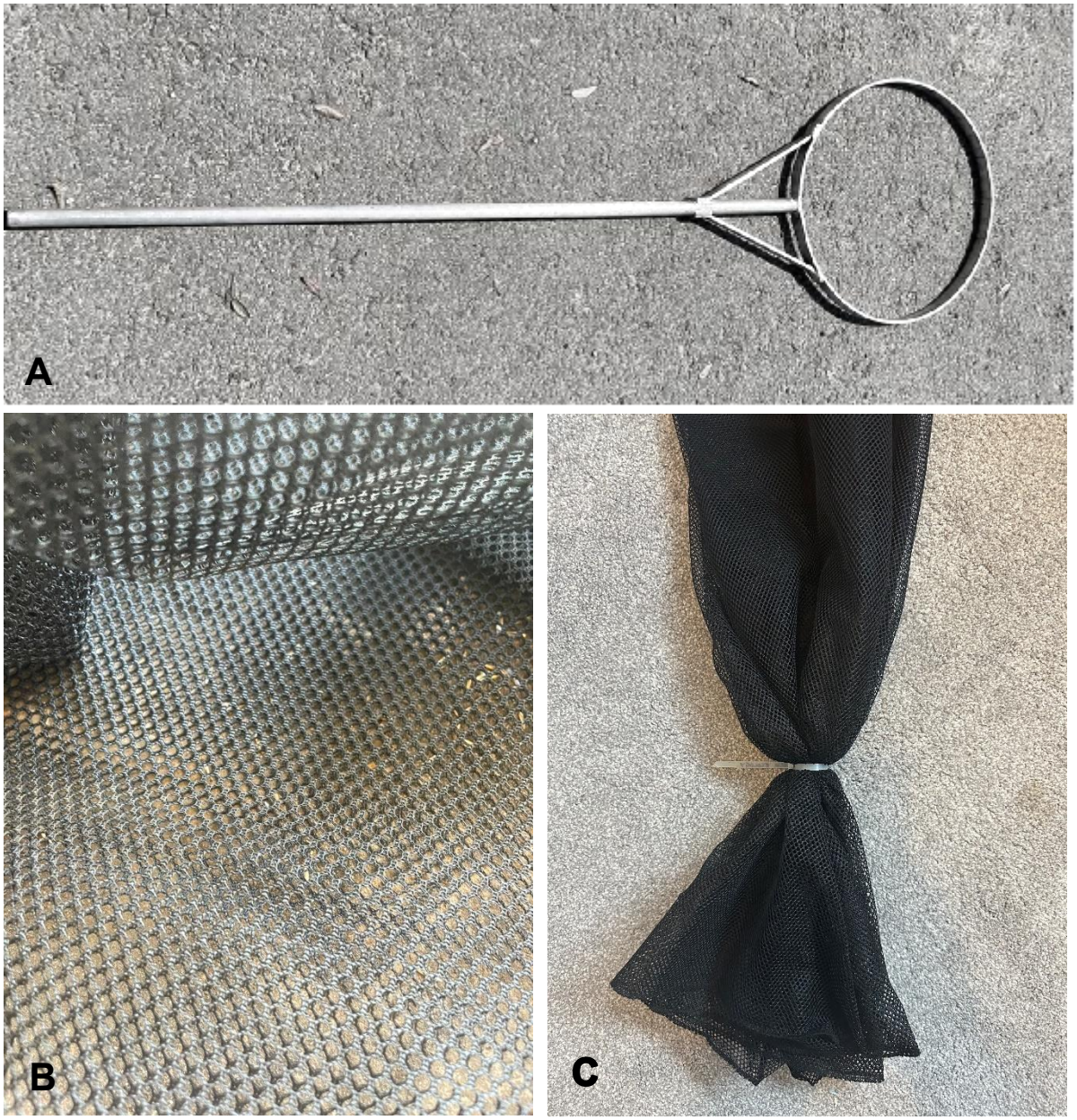

Figure 3. Images of purpose-designed beaver handling net. A (top) Beaver handling net frame constructed from aluminium pole and length of aluminium to create the ringed hoop, welded together, and braced either side of the weld join (as evident above). Net pole constructed from hollow aluminium tube and capped at the end to prevent ingress of soil and debris. Aluminium is recommended as lighter than steel and wooden poles degrade and snap under pressure. *Photo* © Rob Needham, **B (bottom left)** Net is constructed from fine gauge (<6mm) nylon fishing mesh and is tubular in design, *Photo* © R Campbell-Palmer, **C (bottom right)** allowing for the end to be closed with a quick release cable-tie enabling fast and efficient removal of beaver from either end of the net. *Photo* © Rob Needham.

2.3 The disease risk management protocol

2.3.1 Body condition and health assessment of beavers

The first step in the health examination is to assess body condition of the beaver which can give an indication of overall health. Body condition assessment should follow a standardised protocol to ensure a consistent approach, even if examinations are performed by different members of staff. The procedure is described briefly below, and an example body condition and health assessment reporting form is attached at Appendix I.

When beavers are trapped, individuals should be observed from a distance whilst still in the trap. Movement, breathing, any obvious signs of injury, and general behaviour should all be assessed prior to identifying next steps.

An assessment of physical condition should be made based on the appearance and thickness of the beaver's tail as tail dimensions vary with fat deposits (Aleksiuk, 1970; Smith and Jenkins, 1997) and are therefore a good indicator of body condition. During any handling process another reliable indicator of body condition, as opposed to just visual observation, is to feel the spine and pelvis for fat coverage (Figures 4 and 5).

Beavers in enclosures

Regular non-invasive assessment of physical body condition is necessary in captive situations (such as within beaver enclosures) to check welfare of individuals. For example, tail fat deposits (to indicate body condition) can be assessed via camera traps with correct positioning, experience and regular monitoring. Observations of general behaviour, eating and movement may also be possible through camera traps or direct observation from a distance. Fur condition should also be monitored as a lack of grooming, observed as matted or waterlogged fur, and a 'scruffy' or 'unkempt' appearance may be evidence of an underlying health or behavioural issue. Fur condition shows up best on night camera traps.

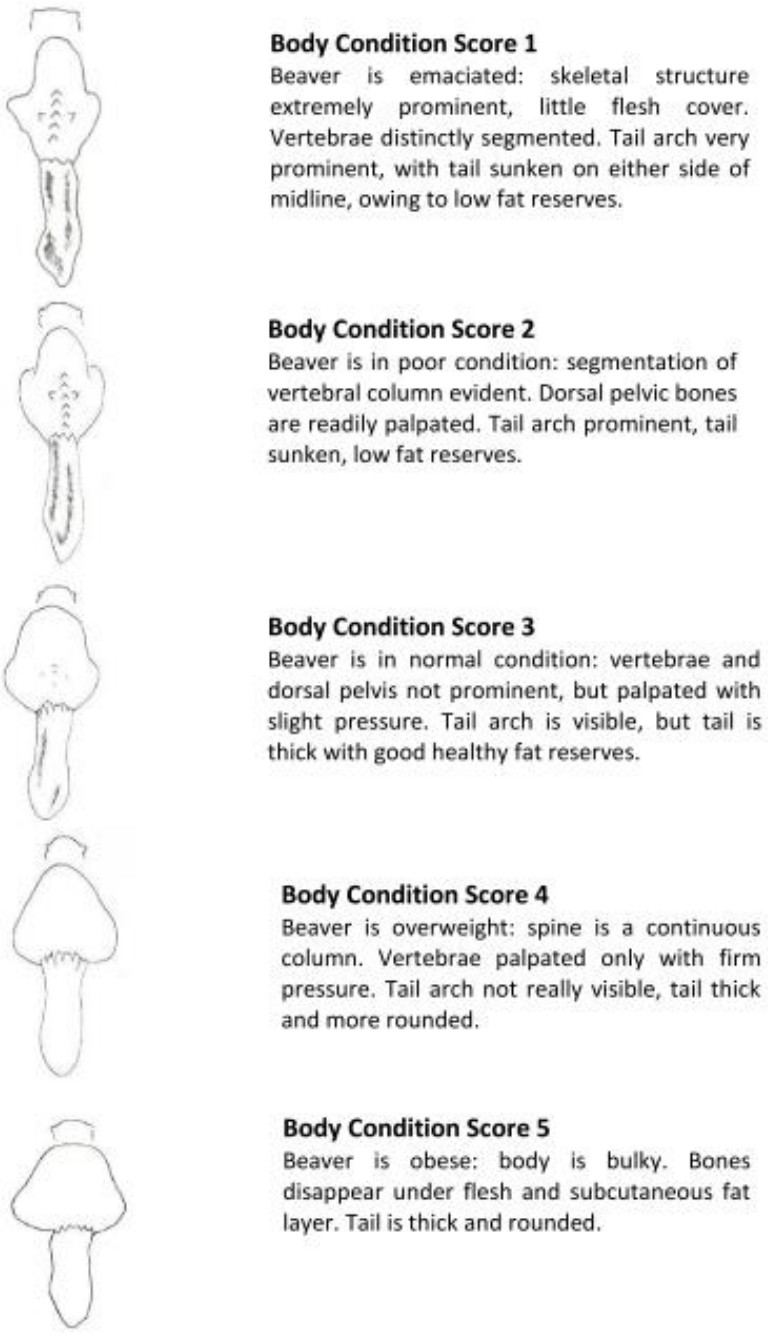

Figure 4. Diagram of beaver body condition score assessment (Campbell-Palmer and Rosell, 2013)

Figure 5. Beaver tail condition assessment. A (left) in normal condition for an adult (score 3) compared to B (right) adult tail in poor (score 2 to 1) condition
Photos © R Campbell-Palmer, Beaver Trust

The beaver should be weighed either in the transport crate (with the weight of the crate subsequently deducted) or a handling sack (see below) and the weight recorded on the reporting form at both initial capture and release (if the beaver has been held in temporary captivity for a period of time).

If the beaver is to be handled for clinical examination or testing, the beaver should be restrained in a natural fibre hessian sack (eg commercially available light weight potato sacks). This method has been developed extensively by the Norwegian Beaver Team and implemented in Scotland over the last decade. This method follows similar principles of handling seals or badgers, for example, without anaesthetic. An individual can be safely restrained, keeping the head firmly in a sack corner and covered, while the sack can be drawn around the body restricting leg and body movements so that the tail region can easily be accessed for blood sample collection, and the animal's sex determined. This method keeps the animal calmer and safely restrained, whilst also protecting animal handlers. Examination should be undertaken as follows:

- A check for a microchip/PIT tag should be undertaken by scanning along the back of neck and shoulders.
- Sex should be identified through expression of anal gland secretions (ensure not castoreum), with thicker white/grey being female and runny brown being male.
- Body condition assessment score should be calculated as per figures 4 and 5.
- Breeding status should be assessed via mammary gland development (if female).
- An estimate of age class (kit, sub-adult, adult) should be made based on weight, size, and breeding status (note that, in certain circumstances, x-rays

of anaesthetised beavers may be warranted to assess whether bone growth plates are fused or not to indicate whether the beaver is an adult).

- Fur should be checked for general condition and ectoparasites. Beavers are diligent groomers, investing much time keeping fur in good quality to ensure effective insulation and buoyancy (Fish and others 2002).
- The skin, in particular the tail and soles of the feet, should be checked for wounds. Veterinary intervention may be required if a wound appears infected (swollen, red-tinged, hot to the touch, discharging pus). The area under the tail should be checked for signs of diarrhoea/blood/discharge.
- Eyes, ears, and nares (nostrils) should be checked for abnormalities of colour, shape, consistency and size such as discharge or inflammation (swelling), although this may be best initially achieved through observation within the trap/transport crate as the head should be kept covered at all times during handling unless a beaver is anesthetised.

A more thorough veterinary clinical examination may be required if there are concerns about an individual, such as suspected injuries, dental problems or further specialist investigation is warranted in individuals of unknown origin (see section 2.3.2). Careful consideration needs to be given to the benefit of sedation/general anaesthesia versus the additional stress this may cause to an individual. Should a veterinary examination be considered necessary, then the following additional measurements and screening are advised:

- Cardiovascular measurements (incl. heart rate and cloacal mucous membrane colour and capillary refill time).
- Respiratory assessment (thoracic auscultation and respiratory rate).
- Venepuncture for haematology and biochemistry.
- Detailed examination of feet, grooming claw, eyes and ears.
- Potential for x-rays to check for growth plates to confirm age, or for gunshot or dental abnormalities.
- Potential for ultrasound or CT scan.

To comply with legislative requirements, only beavers assessed as fit and healthy should be subject to translocation/release (bearing in mind the screening requirements noted in section 3.3.2 below). If a beaver is assessed as unfit for translocation, it should be placed in a holding crate, veterinary advice sought immediately, and treatment or further tests carried out as required in order to facilitate diagnosis.

Figure 6. Examining a beaver safely by using a hessian sack to restrain the individual. The head must be firmly kept in a sack corner and covered, while the sack can be drawn around the body to facilitate further investigation. Keeping the tail warm facilitates blood sampling. *Photo* © R. Campbell-Palmer, Beaver Trust

2.3.2 Screening for infectious agents

Below are the recommended pre-release health screening protocols for beavers, reflecting the potential source populations currently available in Great Britain. The recommended protocols are designed to ensure a pragmatic balance between mitigating the hazards of concern identified by the DRAs and protecting the welfare of individual beavers by minimising the time spent in holding facilities. A flow chart is included at Figure 7 to assist selection of the correct testing protocol. Any questions related to which protocol to use or regarding the options for a specific beaver should be discussed with Natural England.[3]

[3] Please send an email to: beavers@naturalengland.org.uk

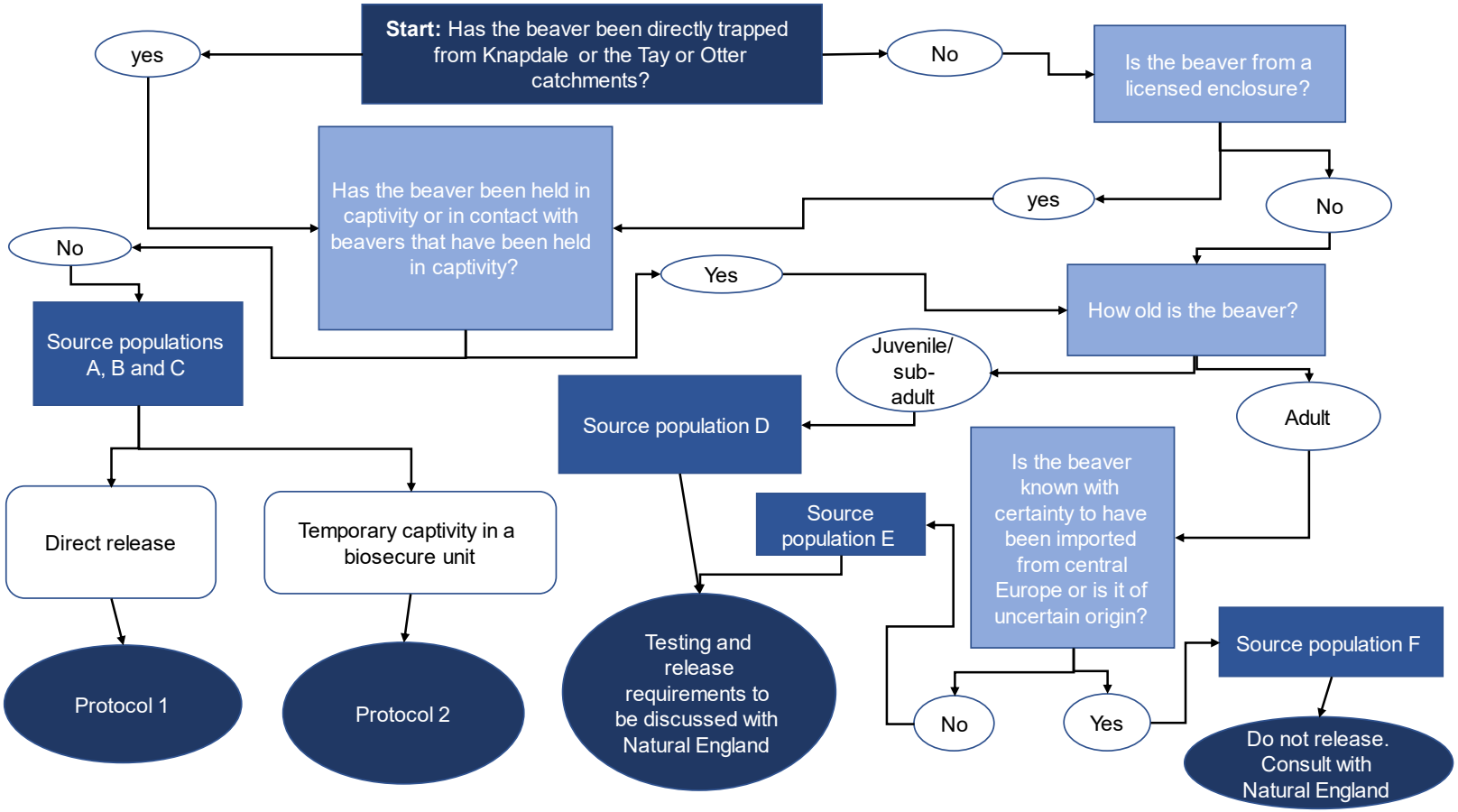

Figure 7. Flow chart to assist selection of the correct testing protocol. The different source populations are defined on the following pages.
See section 2.1.2 for a definition of 'captivity'

Source population A: Wild-caught adult and juvenile beavers from populations in Scotland

These populations are of relatively long-standing origin and have been extensively screened with no infectious agents of concern identified. It is considered highly unlikely that these populations still include any first generation imported beavers which might be infected with novel parasites. Screening cannot completely eliminate the risk of unknown source or other hazards, but on the balance of information known about this population, these risks are considered to be acceptably low.

There is a very low possibility that these beavers may be infected with ubiquitous parasites such as *Cryptosporidium* spp. and *Giardia* spp. that could be infectious to humans, livestock or other free-living mammals at the release sites. However, as these parasites are ubiquitous in the environment and therefore already 'released', and their prevalence in beavers has been shown to be low, the translocation of beavers into a new location is unlikely to change the level of risk to humans, livestock or other free-living mammals. In addition, testing for these parasites by faecal analysis can lead to false negative results and so is of limited value in detecting infected animals. Wild-caught juvenile and adult beavers from authorised populations in Scotland are therefore considered to be of low risk to humans, livestock and sympatric wildlife at destination release sites.

The hazards of greatest concern within this group are carrier hazards i.e. infectious agents that only cause disease in the individual under conditions of stress (Donald and others 2020; Common and others 2024). The most effective mitigation for carrier hazards is therefore stress reduction. The likelihood that beavers will experience disease from carrier hazards is increased by subjecting them to a period in captivity and increased handling, both of which result in increased stress.

It is therefore recommended that, where a release site is available immediately, and the beaver does not need to be held in captivity while family members are also captured, the beaver should be given a health examination and body condition score as directed in protocol one. They should then be moved directly to a release site, provided the results of the examinations indicate this is appropriate.

However, it is understood that immediate release, while desirable, is unlikely to be achievable in most circumstances. In the majority of cases, it is likely that a short period in a temporary holding facility will be required (Section 6) while a suitable release site is identified or to allow further family members to be captured and relocated as a group. In these circumstances, limited pre-release testing is recommended to:

- Gain more knowledge of the health status of the beaver

- Improve our understanding of infectious agents of beavers and their prevalence.

If beavers are to be kept in temporary holding facilities, then please follow protocol two below.

Source population B: Wild-caught adult and juvenile beavers from populations in the River Otter catchment

This population has been health screened and no infectious agents of concern were identified. Screening cannot completely eliminate the risk of unknown source or other hazards, but on the balance of information known about this population these risks are considered to be acceptably low. Protocol one or two is advised, depending on the situation.

Source population C: Adult beavers and their offspring from fenced enclosures known with certainty to have originated from a low risk[4] population and which have not been held in captivity or exposed to novel parasites via contact with other beavers

These beavers are considered to represent the same risk from diseases as beavers in categories A and B as they will have been previously health screened. Screening cannot completely eliminate the risk of unknown source or other hazards, but on the balance of information known about this population, these risks are considered to be acceptably low. Follow protocol one or two.

Source population D: Offspring of adult beavers which are known to have been 1) held in captivity, or 2) in fenced enclosures with other beavers which may have been exposed to novel parasites, or 3) are of uncertain origin

Beavers that have been housed in captive collections that keep non-native species or species of animal that are currently not free-living in Great Britain may have inadvertently been exposed to, and infected with, novel parasites. These parasites could be transmitted to other beavers, including offspring, while living together in shared enclosures.

[4] Low risk populations are defined as beaver populations from Scotland or the River Otter catchment in Devon.

Some beavers in wild populations in England are of uncertain origin and may, in the past, have been kept in captive collections. As a result, they and their offspring may have been exposed to and infected with novel parasites.

Testing for novel parasites is unlikely to be 100% sensitive and so infections may be missed (false negative test results). In addition, some novel parasites may be unknown and testing for them may not be possible. In this situation you will need to consult with Natural England to determine the next steps.

> **Source population E: Adult beavers known with certainty to have originated from a low risk[4] population but which have either been 1) held in captivity or 2) in fenced enclosures with other beavers which may have been exposed to novel parasites**

Although these beavers have previously been removed from low risk populations, they may have been exposed to novel parasites whilst in captivity or in shared enclosures with other beavers. As with beavers in source population D, further guidance will need to be sought from Natural England.

> **Source population F: Adult beavers in England known with certainty to have been imported from central or eastern Europe or of uncertain origin**

These beavers may have been exposed to and infected with: *E. multilocularis* and *T. martis*. As there is no testing modality (or combination of modalities) that has 100% sensitivity in live animals for *T. martis* or *E. multilocularis* and, given reported *E. multilocularis* prevalence of up to 5% in Bavaria (Barlow, Gottstein and Mueller, 2011), these beavers must not be released and further guidance will need be sought from Natural England.

2.3.3 Medical examination and sampling

The protocols below describe the screening that should be carried out for each potential source of beavers as defined above. Therapeutic options, should a beaver test positive for a disease or parasite, are detailed below.

For all protocols, fresh faecal samples should be collected directly from the anus during sexing (if attempted) or as ‘free catch’ samples from containers or housing. Disposable gloves should be worn when collecting a faecal sample and these should be scooped into a faecal sample pot, ideally held by a second ‘clean’ person which will be closed securely and labelled with the date and identification number of the beaver. The sample pot will be placed in two securely sealed transparent plastic bags and kept refrigerated prior to submission to the microbiology laboratory.

Blood samples for haematology, biochemistry and genetic screening should be collected by sterile venepuncture of the ventral tail vein. Keeping the tail warm, eg,

by placing on a heat pad (figure 6), can assist in blood collection, as in cold weather or when removed from water, the vessels will vasoconstrict. Beaver blood typically clots rapidly and should be placed in potassium EDTA anticoagulant sample tubes immediately after being taken, if appropriate for the required tests. If blood is noticeably clotted it is advisable to place the sample into a serum gel tube. A fresh blood smear should also be taken. Test samples should ideally be submitted to a laboratory with reference ranges for beavers. Further guidance can be given by Natural England if required. Test results should always be interpreted with reference to published ranges (Girling and others 2015) and may be of assistance in identifying, for example, inflammatory disease, anaemia, infection with haemoparasites and organ injury (eg kidney or liver disease). However, test results should be interpreted with caution recognising that, on occasions, results outside the reference range may not be of clinical significance.

Any surplus blood should be stored for future testing; 1ml of surplus blood should be placed into a potassium EDTA tube and frozen at -40 or -80˚C for long-term holding. Samples may also placed on a Whatmann card (or similar) if freezers are unavailable. Any further surplus blood should be placed into a plain tube and allowed to clot. It should then be spun in a centrifuge to separate out the serum, which should be removed with a sterile pipette and transferred to a sterile Eppendorf or plain tube. The serum and remaining clot can both be stored at -80C. Samples can be sent to Zoological Society of London (ZSL) for long term storage[5].

Protocol 1: for source populations A to C

Beavers from low-risk populations or licensed enclosures and their offspring which are immediately re-released or moved to a nearby release site following capture.

Required: Body condition assessment (see 2.3.1), age (adult vs juvenile) and health status assessment based on observation of the beaver prior to capture or in the trap. Where more detailed clinical examination can be performed prior to release, please follow the further assessment described at 2.3.1. Faeces recovered from the trap (or collected from offspring when undergoing sexing and passive integrated transponder (PIT) tagging) may be submitted for population surveillance purposes.

[5] Please contact drahs@zsl.org

Protocol 2: For source populations A to C

Beavers from low-risk populations or fenced enclosures and their offspring, for which the disease risks are considered to be very low, but which must be housed in temporary holding facilities.

Required: Body condition assessment as described at 2.3.1 Detailed clinical examination to detect signs of disease associated with source hazards, novel hazards and to ensure the beaver is healthy at the time of release. Further tests should be carried out based upon the findings of the clinical examination results. These may include;

Faecal and blood tests for population surveillance purposes. This could include serology for *Leptospira* spp. and *T. gondii*, and faecal wet prep microscopy for endoparasites and protozoa including *Cryptosporidium* spp., *Giardia* spp., *Eimeria* spp. and *F. hepatica* and faecal bacterial culture for enterobacteria including *Escherichia coli* 0157, *Salmonella* spp, and *Yersinia* spp.

Any surplus blood should be sampled and stored as described under 3.1.6.

Please contact Natural England for specific guidance in relation to beavers falling under source populations D to F.

2.3.4 Therapeutic options

The beaver is known to harbour several species-specific parasites including, but probably not limited to, the beaver beetle *Platypsyllus castoris*, the beaver nematode *Travossosius rufus*, and the beaver fluke *Neostichorchus subtriquetrus*. These commensal parasites do not cause disease in otherwise healthy animals under normal circumstances.

Commensal parasites are an important component of biodiversity and, as such, efforts should be made, if possible, to conserve them at the same time as keeping disease under control. Treatment for commensal parasites, including coccidia (*Eimeria* spp.) is not recommended in the absence of associated clinical signs as it may lead to selection for antimicrobial resistant parasites.

However, commensal parasites may induce disease in the presence of stressors such as captivity, handling, co-morbidity. In particular, it should be noted that stress-induced coccidiosis may progress rapidly in captive beavers and can be fatal without prompt treatment. Staff should therefore be alert to the clinical signs (diarrhoea, often with mucus and/or blood, loss of appetite, lethargy) and instigate prompt testing (via faecal smear) and subsequent treatment if required.

As infections with *Cryptosporidium* spp. and *Giardia* spp. are usually self-limiting, further advice should be sought from Natural England in the event of a positive test result. Speciation of *Cryptosporidium* spp. may be advised as *C. parvum* is considered capable of transmission to other mammal species, including humans.

In all cases, efforts should be made to keep time in captivity as short as possible.

3 Individual beaver identification

All beavers should be uniquely identified prior to release to:

- Enable accurate identification through pre- and post-release management (and treatment where necessary).
- Improve our understanding of the effects of pre-translocation history and management on the post-release fate of beavers and therefore improve beaver translocation methods in the long-term.

In addition, it is also a licence condition for beaver enclosures that offspring born within the enclosure are tagged and sexed to facilitate management of the enclosed population.

The current recommended method is through a PIT microchip inserted subcutaneously (see 3.1.1). The unique identifying numbers associated with the microchip (alongside the sex and suspected age of the individual) must be sent to Natural England in licence returns (where relevant) and to the Beaver Trust[6] for incorporation into the beaver studbook for Great Britain.

As beavers will require handling to be tagged, it is strongly recommended that individuals are sexed and weighed at the same time. Faeces may also be collected for population surveillance purposes as protocols one and two above.

3.1.1 PIT/Microchip tagging

It is recommended that any beavers that are caught and handled are injected subcutaneously with a PIT tag (Figure 8). Also known as microchipping, this technique is widely employed across a wide range of companion animals, wildlife, and livestock (Boarman and others 1998). Such tags are generally considered as

[6] Email info@beavertrust.org with subject title 'PIT-tag number' to include PIT number, sex, age class, collection details and any known relationships to other beavers (along with any known PIT numbers)

minimally invasive to apply, have low incidences of failure rates, and provide permanent identification throughout an individual's lifetime. Several beaver population monitoring studies, in both species, use PIT-tagging and hand-held readers to identify animals at close range (eg Rosell and Hovde 2001; Goodman and others 2012; Havens and others 2013). As best for many mammals, loose skin along the dorsal midline around the shoulders and lower neck region can be lifted up and a PIT tag can be inserted with a 12-gauge needle (Sharpe and Rosell 2003). Beaver skin is very tough, so appropriate pressure should be applied by experienced personnel, though excessive force should be avoided as this may cause injury.

Figure 8. Image showing microchipping of sub-adult beaver. Beavers should be scanned for chips along the back of neck and shoulders for typical placement. *Photo* © R Campbell-Palmer, Beaver Trust

This identification method is recommended for trapped and released animals, given the additional background data that could be provided should any post-release post-mortem examinations occur. PIT-tagging is not a requirement or recommendation for all individuals within a wild population, including any offspring, due to the welfare considerations of trapping and lack of need.

3.1.2 Ear-tagging

Ear-tagging is not recommended for general use given low retention rates and the risk of ear damage, especially in captivity and during handling events. However, it is acknowledged it can be a useful management tool in some instances (Sharpe and Rosell 2003).

Experience of their use in Scotland and in translocated beavers to England over the last 10 years demonstrates that beavers often lose ear tags in the captive environment or quickly after release. As highly sociable animals and diligent groomers, external devices are often subject to increased destructive attention. Poor placement or application of tags can lead to ear damage (Windels 2013).

Figure 9. A - Image showing typical beaver restraint within hessian sack, to extract ear pinnae to insert ear tags. *Photo* © F. Rosell, Norwegian Beaver Project

Figure 9. B - Image showing typical beaver restrained within hessian sack, with ear tags. *Photo* © F. Rosell, Norwegian Beaver Project.

Should ear-tagging be considered necessary (for example should a beaver need to be recaptured or subject to specific monitoring), the beaver should be securely restrained in a hessian sack and the ear gently extracted through a small aperture in the sack (Figure 9 A). Plastic Dalton tags have been used most widely and successfully and are readily available from commercial livestock suppliers. These are sold as looped tags and must be cut and trimmed down before any release to avoid catching on vegetation and damaging the ear flap. The applicator and pinnae must be clean, and the site should be prepared with a suitable antiseptic wipe prior to tagging to prevent infection. Each ear tag should be inserted with the piercing end pointing upwards and away from the beaver's head and any sharp edges rounded off. Plastic tags are preferential as if they are groomed off by other family members an intact hole is often left in the ear flap, enabling new tags to be inserted easily. Ear tags should not be used on kits.

Individual reactions to ear-tagging may range from inertia to flinching and head jerking, but excessive struggling, vocalisation or bleeding should not occur. The key to minimising both beaver reactions and any potential risk of ear damage during this procedure is secure and appropriate restraint (Windels 2013). Tags should not be used on infected or cut ears, or ears with multiple splits.

3.1.3 Other tagging

The use of other tagging devices such as tail or intraperitoneal tagging are not covered further here. Although these may be used for research purposes, their use falls outside of the scope of this document. Natural England would need to be consulted should a project wish to use other tagging devices and an appropriate licence would need to be granted to permit their use.

4 Biosecurity and best practice during transport

It is important to maintain biosecure procedures as outlined in section 2.2 for transport of beavers as well as for trapping. The following guidance should be followed to minimise stress to beavers:

- The vehicles used for transport should be regarded as a quarantine area and cleaned and disinfected before and after use (see Appendix II).
- The vehicle must allow sufficient ventilation and air flow and have a darkened transport area.
- Travel during the cooler morning or evening is recommended during summer months.
- Vehicle temperatures should be monitored, with a thermometer close to the crates. Beavers must not be transported in excessive temperatures (24°C or above, unless in a temperature-controlled vehicle).
- Drivers should be reminded of the need to drive smoothly and carefully and to avoid sudden turns or braking.
- There should be no smoking in or near the vehicle and strong fumes, for example from queueing traffic or petrol stations, should be avoided if possible.
- A well-planned travel route and awareness of any traffic/road diversions is advised prior to departure.
- Beavers can be kept in suitable transport crates for journeys of up to 24 hours, though shorter periods are advised. Inspection during transportation should occur regularly (visual every 2-3 hours).
- Suitable transport crates (Figure 10) are typically sheet metal or metal-lined wooden crates of appropriate dimensions to enable an adult beaver to raise up on its back legs and accommodate tail length without restricting movement. It is recommended that doors are sliding rather than fixed and outward opening. This facilitates catch-up and enables beavers to exit crates without doors swinging back. These are also more secure to avoid escapes.
- Transport crates should have mesh-covered ventilation panels throughout as overheating can be a significant health concern.

- Sufficient absorbent bedding consisting of a deep layer of sawdust and clean, dry, dust-free straw should be placed in the crate. Including some used bedding from an individual being transported in a crate may reduce stress during transportation (Campbell-Palmer and Rosell 2013).
- It is challenging to include a water source in a beaver transport crate as they will typically overturn bowls and cannot drink easily from fixed bowls given the position of their jaw; typically, they must submerge most of their lower jaw to drink properly. Therefore, keeping animals cool on any journey, ensuring constant ventilation, and providing a sufficient volume of apples for moisture is essential.
- Root vegetables such as carrots and parsnips should be added for longer journeys. Any cut browse (preferably willow) should be cut into very short lengths so that it lays on the bed of crate as a mat without generating sharp edges to avoid any potential eye injuries in transit.
- Adults (even from the same family) should be crated separately. Kits can be crated together or with another family member for shorter journeys, but ideally kits should be crated together.
- On arrival, beavers should be given immediate access to water to enable them to submerge for drinking and stress reduction.

Figure 10. Images depicting recommended beaver transport equipment. A (top left) and B (top right) Recommended beaver transport crate. with flush metal insides and multiple ventilation holes covered with small gauge mesh to prevent biting and digging injuries. Animals can be removed from trap by encouraging them to walk into a transport crate lined up with the open end of a trap or secondarily as per C (bottom left) using beaver net, especially if being handled immediately after. D (bottom right) shows sufficiently deep straw layer. *Photo* © R Campbell-Palmer, Beaver Trust

5 Biosecurity and best practice for temporary holding facilities

For the purposes of this document, a temporary holding facility describes an appropriate housing facility to move beavers into after trapping. The set up should reflect any short-term captive care requirements – ie the minimum time required to obtain any disease screening results and reunite a family unit as appropriate. Likely situations in which beavers may need to be kept in holding facilities include:

- fulfilling pre-release health screening requirements
- temporary holding of escaped individuals
- translocation of individuals from conflict sites
- tending injured or orphaned individuals
- rehoming of captive-born offspring of dispersal age to alternative appropriate projects

Stressful events may exacerbate the severity of any infection and impact immunity towards disease and infectious agents (Common and others 2024; Girling and others 2019c). Mitigating these should be prioritised by keeping handling and time spent in captivity to a minimum. Longer-term holding (ie more than 2 months) requires more space, cover, naturalistic diets, water provisions and reduced human disturbance. Provisions for long-term holding facilities fall outside the scope of this document and captive husbandry guidelines should be consulted as appropriate (eg Rosell and Campbell-Palmer 2022).

As the health status of beavers coming into a temporary holding facility may be uncertain (such as whether they originated from overseas, or they have been in contact with beavers from overseas, or they have been in contact with exotic mammals (including rodents)), they may harbour non-native species of parasites, which have the potential to induce epidemic disease in native rodent species. In addition, it is important to prevent direct or indirect contact between non-native (exotic) species and beavers in temporary holding facilities. It is therefore necessary that biosecure procedures (barrier techniques) are in place within temporary holding facilities to reduce the probability of transfer of parasites to and from beavers, or to other animals and humans. As a minimum, these procedures should involve the placement of a robust quarantine barrier, including changes of clothes, boots, and gloves, with a disinfectant footbath at the barrier line.

In addition, non-pathogenic organisms that form part of the normal commensal gut bacteria in beavers should be conserved to allow the development of appropriate immune responses. It is widely understood and accepted that stress can lead to immunocompromise (Dhabhar and McEwen, 1997; Dickens, Delehanty and Romero, 2010; Glaser and Kiecolt-Glaser, 2005) and stress has been recognised as an

inevitable component of animal translocations which can occur at multiple stages, including capture, transport and captivity (Teixeira and others 2006; Dickens, Delehanty and Romero, 2009; Dickens and others 2010). Overarching activities within temporary holding facilities (such as handling, cleaning, disinfecting, changing water, food and bedding) must focus on minimising stress to the animals during captivity.

5.1 Site location and proximity to captive or free-living mammals

Appropriate biosecurity at the holding facility is essential to prevent the accidental transmission of infectious agents to either beavers themselves or from beavers to other animals or humans. Parasites can be transmitted either directly from animal to animal and indirectly, for example via shared water supply or drainage, contaminated soil or substrates, via the air, or via fomites such as equipment, clothing, free-living rodents and birds. Therefore, the holding facility must not be sited within a facility that holds non-native species or previously imported animals, such as quarantine or isolation facilities for other species. It should also have dedicated staff who undertake appropriate biosecurity practices should they be in contact with other captive animals or exotic rodents (including as pets at home). In addition, beavers may harbour zoonotic parasites so robust hygiene procedures are required to protect staff from potential infection (see 5.4). Additional risk assessment and mitigation measures are advisable for any staff who are immunocompromised, pregnant, or new mothers due to the unknown level of risk posed from zoonotic pathogens. Should staff be suspected to have become ill from a biological agent attributable to beavers then please note the requirement to report this to the Health and Safety Executive[7] (as is the case for anyone working with animals in any job).

5.2 Materials, fencing and water supply

Enclosure pen sizes of a minimum of at least 3 x 3 m are recommended for short-term holding, with at least enough space for two animal care staff to enter and move around the pen comfortably with a transport crate for animal trapping. There should be adequate space for beavers to move around the pen and manipulate bedding as

7 https://www.hse.gov.uk/riddor/carcinogens.htm#:~:text=The%20term%20biological%20agent%20is,other%20hazard%20to%20human%20health

they wish. Pen flooring needs to be strong enough to prevent digging, with any rough surfaces such as concrete covered with a thick layer of straw or bark chippings to reduce tail wear. Walls should be flush to prevent digging or climbing. Beaver pens should be securely separated with solid walls at least 1m high to prevent escapes. Visual barriers (eg external plywood sheets) to reduce external visibility and noise are highly recommended, whilst ensuring good ventilation is maintained at all times, especially in hot weather (Figure 11). A thermometer should be attached high up within the holding facility to record daily high and low temperatures to flag any further considerations associated with temperature that need to be taken.

Access to suitable water provisions must include the capacity for animals to submerge. Metal is recommended for water containers as it is resistant to chewing and easier to clean. A submerged shelf needs to be present at one end so animals of varying sizes can enter and exit easily, but also sit and feed whilst being partially submerged; this is a common foraging behaviour and can increase behavioural security. Water needs to be changed daily and release valves must be quick draining. Careful consideration must be given to the placement of water pools or troughs to ensure that drained water flows away from bedding and feed areas.

Several shelter/cover provisions should be provided, especially if housing a pair or family, to reduce stress and risk of fighting and to allow beavers somewhere to retreat to whilst management procedures, such as cleaning, are being carried out. Straw bales with plywood roofs are often used and must be changed between pen occupancy. At least one shelter should be near the water so beavers can easily retreat to water if disturbed - a key stress-reducing husbandry practice. Shelter floors should be kept as dry as possible by adding dry bedding as required (avoiding excess changing of bedding as this can be very disturbing to the beavers). Additional fresh browse should be added daily or every other day, in excess of feeding requirements, to provide cover and allow building behaviours (See Appendix II for further information on captive care requirements).

As some pathogens may be transmitted through bird faeces (eg *Yersinia* spp.), securing shaded cover (ie corrugated sheeting, very fine mesh or cloth) over enclosure roofs will reduce faeces entering beaver enclosures and reduce the likelihood of potential contamination of water and food sources. Shaded roofing serves an additional benefit by providing cover to beavers, which are known to be heat intolerant due to their aquatic adaptations, such as dense fur and small extremities (Campbell-Palmer and Rosell, 2015).

Figure 11: Beaver quarantine facilities including solid walls, plywood panels to reduce disturbance, plenty of floor covering, excess browse and multiple shelters. Metal cattle troughs with a quick release draining valve facilitate daily

water changes and enable animals to submerge. *Photo* © R Campbell-Palmer, Beaver Trust.

5.3 Biosecurity barriers

There should be a biosecurity barrier at the entrance to the facility where all personnel entering the unit should put on protective outerwear dedicated to the unit. This barrier should consist of a covered, weatherproof area where there will be:

- Overalls and rubber boots. Overalls should be clean and disposable or, if non-disposable fabric overalls are used instead, these should be washed and disinfected daily.
- A foot dip containing an appropriate Defra-approved disinfectant (see http://disinfectants.defra.gov.uk) to a 20 cm depth to ensure boots are adequately covered. Observe minimum contact times (depending on the disinfectant) and concentration (this should be at the minimum General Orders rate specified by Defra). Disinfectant solution tends to be inactivated by organic matter so boot brushes, or foot dips with cleaning bristles are required and the foot dip solution changed as soon as it becomes visibly contaminated or discoloured (at least weekly). Foot dips situated outdoors could be diluted by rain and so should have a lid. Some disinfectants are less effective at lower temperatures, which will need to be taken into consideration when selecting an appropriate disinfectant. Chlorocresol-based products have been shown to be most effective against the farm animal infectious agents of note in beavers (*Salmonella* spp, *Campylobacter* spp., *Yersinia* spp., Coccidia), and are also effective against certain viruses, fungi and protozoa, such as *Cryptosporidium* spp.
- Personnel should thoroughly wash hands (and/or apply an alcohol-based hand sanitiser) before and after entering the facility. Disposable or sturdy rubber gloves capable of being disinfected should be worn within the facility when cleaning, disinfecting, or handling beavers.
- An FFP2 face mask should be worn if coming into close contact with beavers during handling and may also be required when cleaning and disinfecting (this will depend on the disinfectant being used; information should be provided with the product). The use of respiratory wear is beneficial in reducing transmission of pathogens from humans to beavers, eg, SARS-Cov-2.
- Eye wear must be worn when power-washing and may be required for certain disinfectants. Ensure eye wear is thoroughly disinfected before and after use.
- A clinical waste bin for used overalls/gloves, spare clinical waste bags and cable ties.
  Dilute ready-to-use disinfectant spray.

5.4 Disinfection protocols

Thorough disinfection procedures are required in temporary holding facilities to minimise the risk of transmitting infectious agents from potentially contaminated surfaces (eg enclosure pens, water troughs, contaminated substrates). A Defra-approved disinfectant should be used at General Orders concentration[8]. Any guidance or instructions provided with the selected disinfectant (ie relating to PPE) must be adhered to.

Cleaning and disinfecting is potentially quite stressful to beavers housed within a facility therefore advice is provided in the following sections depending on whether beavers are present or not:

5.4.1 Cleaning and disinfection procedures in empty pens

- A thorough deep-clean is recommended when the facility is empty. Enclosure pens and water pools or troughs should be thoroughly cleaned between housing different individuals or family groups (before and after).
- Disinfectants do not work well in a dirty environment so specific measures outlined below should be taken prior to cleaning and disinfecting.
- Power washing or steam cleaning should only be used when the facility is empty due to the potential for the noise to cause additional stress to other housed beavers.
- Ensure appropriate PPE is worn when cleaning and disinfecting. As a minimum, waterproof overalls, boots, and gloves should be worn; face mask and eye wear must be worn when power-washing and may be required for certain disinfectants.
- Remove all bedding/feed/faeces/ground substrate and dispose of appropriately (see section 5.6).
- Use a power wash or steam clean to remove all organic matter if facility is empty. Otherwise use a detergent and a stiff brush to loosen any adherent organic matter.
- Ensure a foot-dip is installed before any disinfecting is undertaken. Boots should be dipped when entering and leaving the facility.
- Apply the appropriate disinfectant at a high pressure and to saturation (run-off point). Observe minimum contact times (depending on the disinfectant) and concentration (this should be at the minimum General Orders rate specified by Defra).
- Allow the facility to dry fully prior to housing.

[8] http://disinfectants.defra.gov.uk

- All disposable PPE should be disposed of in clinical waste bins. Non-disposable PPE should be disinfected appropriately.

5.4.2 Cleaning procedures when beavers are in a facility

- Ensure a foot-dip is installed. Boots should be dipped when entering and leaving the facility. They must also be dipped in between entering different pens within the facility.
- Minimal cleaning and disruption should be undertaken when beavers are within a pen, except for water which should be emptied and changed daily. Old food or browse and very wet or soiled bedding should also be removed. Fresh bedding and browse should be replenished as required.

5.5 Vermin control and storage of food and bedding

Temporary holding facilities should be enclosed as much as possible to prevent vermin such as rodents or birds from entering the facility, whilst allowing sufficient ventilation. Outside walls should be solid and any openings (for ventilation) should be covered with wire and/or mesh of sufficient gauge to minimise birds and rodents entering the facility (although it is unlikely that mice will be totally excluded as juveniles can get through very small gaps (6-7mm) whilst rats can get through gaps of around 20mm).

The recommended daily diet for beavers in captivity includes a regular supply of a range of freshly cut native broadleaf browse, alongside dark-leaved green vegetables, mixed root vegetables and apples (see Appendix II). Any food or bedding that is stored should be placed in secure rodent-proof containers raised off the ground and ideally made of metal, as rodents are capable of chewing through plastic and wood.

Food and bedding storage areas should be frequently checked and any spillage must be removed. Storage areas should be cleaned and disinfected regularly (see section 5.5).

5.6 Disposal of waste material

Any wastewater that is generated in the temporary holding facility (eg during cleaning and disinfecting procedures or when emptying water troughs/pools) should be disposed of into the local waste drainage system according to local procedures.

All waste material, such as bedding, discarded feed, animal waste and ground substrate, should be treated as animal waste and disposed of in accordance with local animal waste disposal protocols.

5.7 Record keeping

It is advised that a daily check sheet is kept for each pen where beavers are housed to keep track of cleaning and welfare aspects. Recommended checks would be:

- Animals seen? Behavioural notes recorded
- Water change undertaken?
- Level of food/browse taken (to keep track of the amount the beavers are consuming)
- Daily temperature (taken at the same time each day)
- Foot bath changed: yes/no
- Any other notes of relevance

A schedule of cleaning and disinfecting, which is considered appropriate depending on the source of the beavers, should be established prior to beavers coming into the facility. All cleaning and disinfecting (eg general cleaning of pens, cleaning in between housing different individuals or groups, deep-clean of empty facility) must be recorded on a designated form clearly displayed in the entrance (biosecurity barrier) of the facility.

5.8 Health surveillance

Refer to section 2.3.2 for required screening protocols. All facilities must have an appointed veterinary surgeon, responsible for assessing the beaver's health, and ensuring the requirements of the Animal Welfare Act (2006) in England and Wales and the Animal Health and Welfare (Scotland) Act (2006) in Scotland are complied with during captivity, and that biosecurity measures are in place and correctly applied.

Section 5.7 above outlines daily checks that should be undertaken. It is important to note any abnormalities in behaviour or appearance of individuals and understand how much food is being taken. Any concerns for a beaver's health and welfare whilst in the temporary holding facility must be reported to the appointed veterinarian immediately. Any beaver that dies in English and licensed captivity should be submitted for post-mortem examination at the Zoological Society of London (ZSL); this ensures as much information is gathered as possible to inform future decision making on diseases in beavers (See section 6.2.5). However, should there be any

suspicion of a notifiable disease[9], the veterinarian or facility must contact Animal and Plant Health Agency (APHA)[10] immediately and directly, and not send the body anywhere until advised on a course of action. Failing to do so would constitute an offence.

Maintaining beavers to high health and welfare standards for long periods in captivity is challenging and requires careful management, please see Appendix II for further information.

6 Biosecurity and best practice during release

Suitable site selection and release procedure are likely to determine the likelihood of long-term occupation and site fidelity. Further information about site selection and enclosure considerations is included in Appendix III. The section below covers both releases into enclosed areas as well as into the wild. The IUCN guidelines (IUCN/SSC 2013) and the English code (Defra 2021) should be followed when assessing any release site, particularly in relation to habitat suitability and social feasibility.

6.1 Release method

Beavers should be released as family units or pairs or released in combinations to encourage pair formation wherever possible to encourage settling and discourage dispersal behaviours. Please see Appendix III for considerations for release site selection.

Beaver releases should be avoided on days or periods of extreme temperature and weather, especially if dependent offspring are being translocated. Water condition at release sites is key, avoiding periods of high or low flow, flooding, and thick ice. Excessive disturbance by people, noise, dogs etc should be avoided both at the time

[9] https://www.gov.uk/guidance/notifiable-diseases-and-causative-organisms-how-to-report

[10] See https://www.gov.uk/guidance/what-happens-when-you-report-a-notifiable-disease-in-your-animals for guidance on reporting a notifiable disease in animals in England, Scotland, Wales and Northern Ireland.

of release and in the following weeks so that beavers are not discouraged from settling (Figure 11).

Figure 12. Image showing beavers being transported to an enclosed release point. Note: travel crates can be heavy if carrying long distances. Noise, movement and people involved should be kept to a minimum, with travel crates covered until time of release. Travel crates should be brought to the water's edge so animals can immediately access water for both drinking and to alleviate stress as soon as possible. *Photo* © R. Campbell-Palmer, Beaver Trust.

If more than one group of beavers is to be released at a site, it is important to ensure that they are released at an appropriate distance away from other releases or established territories to prevent fighting (Campbell-Palmer and others 2016). Note that most enclosed projects will only support one family. Recommended distances between any wild release sites will vary according to current existing beaver habitat use or water body type. On riverine systems or large lakes, a minimum of 1km distance is recommended between separate releases or established territories, evidenced by a field sign search ahead of release.

Measures may be taken at release sites to improve suitability and encourage settlement in an area. Such measures may include supplementary feeding, artificial

lodge creation or temporarily fencing an area to prevent immediate dispersal (electric fencing must not be used due to welfare considerations[11]). However, these techniques are not proven, and both species of beavers have been widely restored across North America and Europe without specific interventions. The primary consideration needs to be appropriate habitat suitability and the absence of other settled beaver territories.

Following release and dispersal of the released beavers, transport crates, equipment and clothing should be thoroughly cleaned and disinfected using a Defra-approved disinfectant prior to further use (Section 5.4).

6.2 Post-release health monitoring

Monitoring is an essential part of any release or reintroduction as it measures the welfare and success of released organisms against objectives, assesses impacts, and provides the basis for adjusting objectives or adapting management regimes or activating an exit strategy. Each project should have its own monitoring and evaluation strategy in line with the IUCN guidelines and English code (IUCN/SSC 2013, Defra 2021). Specific licences are also likely to have their own monitoring requirements.

The information below primarily concerns health and mortality monitoring, accepting that there will be other aspects to monitoring strategies for projects which are not covered here.

6.2.1 Trap and release survey

The most direct and active form of health surveillance is to undertake post-release screening via a trap and release programme. Due to the disturbance this may cause to populations, this is only warranted in specific circumstances, for example if there is a disease outbreak. Further information can be found about this type of survey at Campbell-Palmer and others (2015b) and Brazier and others (2020).

6.2.2 Field sign survey and Non-invasive sampling

Field sign surveys are used in post-release health surveillance to identify beaver territories and current habitat use, thereby evaluating the success of a release. See

[11] https://www.gov.uk/guidance/beavers-how-to-manage-them-and-when-you-need-a-licence#:~:text=Electric%20fencing%20can%20injure%20and,for%20up%20to%203%20months

Campbell-Palmer and others (2021) for methodology. Field sign surveys are also important to identify active territories for camera trap placement (Campbell-Palmer and others 2016). It is important to have appropriately experienced personnel to carry out such field sign surveys to ensure field signs are interpreted correctly.

6.2.3 Visual observation / Remote cameras

Once active territories have been identified, or once beavers have been released into an enclosure, locations can be identified for visual observation and positioning of camera traps. Visual observations are possible, especially once emergence times and general behavioural patterns become more familiar. In general, beavers tend to become active outside of their daytime retreats between 6.00 pm and 8.00 pm, returning to their shelters around 5.00 am – 6.30 am, and this is fairly constant throughout the seasons (Hodgdon and Lancia 1983; Stocker 1985). Therefore, lodge or burrow observations can be targeted. Correctly positioned remote cameras (at freshest feed stations, along worn forage trails, or on lodges) can offer an effective, non-invasive means to monitor activity and body condition, and document rarer behaviours such as mating attempts (Figure 13). Patterns of scarring and notching on the tail (often caused by previous territorial fighting) may enable individual identification. With correct placement and timings, reproductive status may be determined through identifying the presence of a heavily pregnant or lactating female and/or kits later in the season.

Should these observations detect beavers post-release that appear to be suffering from a loss in body condition, troubled movement or injury, then expert advice will need to be sought. A previously agreed plan should be in place, detailing how beavers would be trapped, and appropriate facilities identified close by to take them to for assessment. Should dead beavers be identified then please refer to section 6.2.5.

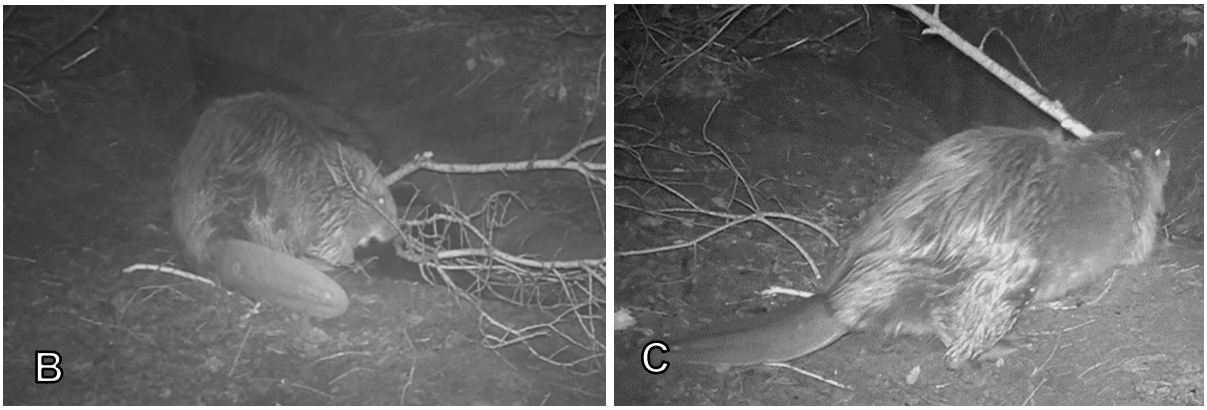

Figure 13. Images depicting suitable camera trap placement. A (top) Camera trap placement should be continually revised and adjusted according to fresh beaver activity – with active forage trails and feeding stations often the most productive and ensuring clear observations to assist with body condition scoring. B (bottom left) Health and welfare, along with collecting data to assist animal management decisions, can be assessed by observation of tail condition including indications of fat storage and degree of beaver nicks and scarring. C (bottom right) Breeding status in late pregnancy and/or lactation in adult females can be determined through presence of visible nipples.
*Photo***s** © Figure A, R Campbell-Palmer, Beaver Trust. Figures B and C, Maria Thompson, Natural England.

6.2.4 Aerial / Drone Surveys

Meaningful analyses have been undertaken from aerial and satellite surveillance of beaver-generated landscapes, especially when it comes to colonisation extent, landscape alteration, and tracking changes over time (eg Townsend and Butler 1996; Cunningham and others 2006; Polvi and Wohl 2012; Malison and others 2014;

Puttock and others 2015). These may identify potential release sites, vacant potential territories, along with current areas of colonisation, but would ultimately require ground truthing and field sign assessment on foot or by canoe. From a health and population perspective, they potentially help to indicate an increasing and expanding population or a decreasing population. They can potentially indicate habitat abandonment if field signs can subsequently be aged via ground truthing. Within an enclosed area, animals may be observed, especially swimming in open water or potentially identified with thermal imaging. Results from aerial surveys vary and depend significantly on topography, vegetation, and beaver activity (typically missing burrows), and are therefore not recommended as a widely applicable survey method. Caution must also be applied to ensure that beavers are not unduly disturbed from drones.

6.2.5 Pathological examination of beavers

The main emphasis of post-release monitoring should focus on the pathological examination of beavers found dead during or after the translocation process (including all captive settings). This is to help establish factors contributing to death in the individual animal, improve understanding of pathogens of beavers, to update the disease risk analysis for future translocations and allow for reintroduction protocol assessment and welfare refinement.

Post-mortem examinations allow the sampling of tissues not easily available ante-mortem, as well as banking of tissues for retrospective analysis should evidence of other infectious disease concerns emerge at a later date.

Reintroduction projects should account for the potential need for post-mortem examinations as part of the monitoring for the project and should have agreements in place with appropriately qualified veterinary practices or institutions. The ZSL are well placed to carry this out and have well-developed post-mortem examination protocols from beaver disease surveillance work to date[12].

[12] Natural England has a contract with the Zoological Society of London (ZSL) to undertake post-mortems of dead beavers for passive disease surveillance. Should a dead beaver be found either in the wild or from an enclosure project then please arrange for it to be sent to ZSL by calling the Natural England Enquiry Service on 0300 060 3900. The cost of the post-mortem will be covered by Natural England. ZSL will undertake a detailed post-mortem, the results of which will inform the disease risk assessment of beavers in England. The results of any post mortem of beavers from enclosures can be shared with the finder on request.

Recommendations for post-mortem examination are included in Appendix IV. The possession and transport of beavers remains an offence after death, and people needing to hold and transport beavers in England should refer to the Natural England general licence GL44[13].

Should a beaver be found dead then ideally two people wearing appropriate PPE should be available to handle and package the beaver carcasses. Carcasses should be placed into two heavy duty strength large compactor bags (1270mm x 2295mm x 2599mm) without contaminating the exterior of the bag. Bags should be expelled of as much air as possible (pointing away from the face) in a well-ventilated area. A 'swan neck loop' and cable tie (or tight knot) should be used to secure each bag before being placed in any subsequent bags. Dispose of gloves and any disposable outerwear immediately afterwards in the last bag. Wash hands thoroughly with disinfectant soap after this procedure. The bag must be clearly marked as 'Beaver carcase' so that it is not opened by an unintended recipient. A post-mortem submission form can be obtained from Natural England, which should include relevant information, including name and contact details, address of temporary holding facility (plus original source location), sex, date of death, a unique reference number (if applicable), and clinical history, if known. Place the bagged beaver in a suitable box and add freezer packs to keep the beaver cool during transport. If beavers are not submitted immediately for post-mortem examination, bagged carcases must be stored in a designated storage area (ie refrigerator) and not in areas where contamination of other items is possible. If refrigeration is not possible, beavers can be placed in a freezer prior to submission if available.

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Appendix I: Body Condition and Health Assessment Form

DATE	
TRAP ID	
BEAVER ID	
CATCHMENT	
TRAPPER/HANDLER	
BEAVER MICROCHIP	
GRID REF	
REASON FOR CATCH UP	

EXAMINATION TYPE	Visual		Handling	

SAMPLE COLLECTION	Hair	Faecal	Blood	Other
SAMPLE ID NUMBER				
REASON FOR NO SAMPLE				

BEHAVIOUR

Normal	Freezing	Aggressive	Lethargic	Drooling/Pawing at Mouth	Other

AGE CLASS	Kit	Yearling	Sub-Adult	Adult	Unknown

WEIGHT (KG)	

SEX	MALE	FEMALE	UNCERTAIN	NOT CHECKED

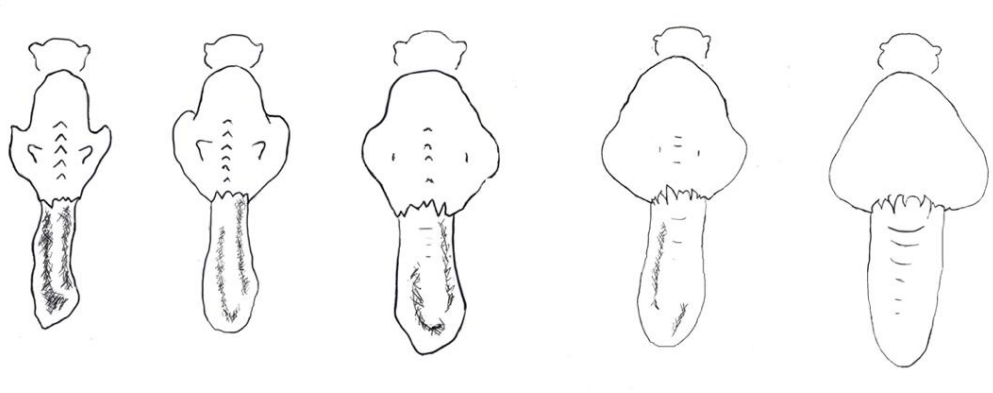
BODY LENGTH (CM)	Nose to Tail	Tail Length	Tail Width (Mid-point)

LOCOMOTION	Normal	Lameness	Not Bearing Weight

OBVIOUS WOUNDS, DISCHARGE OR SECRETIONS

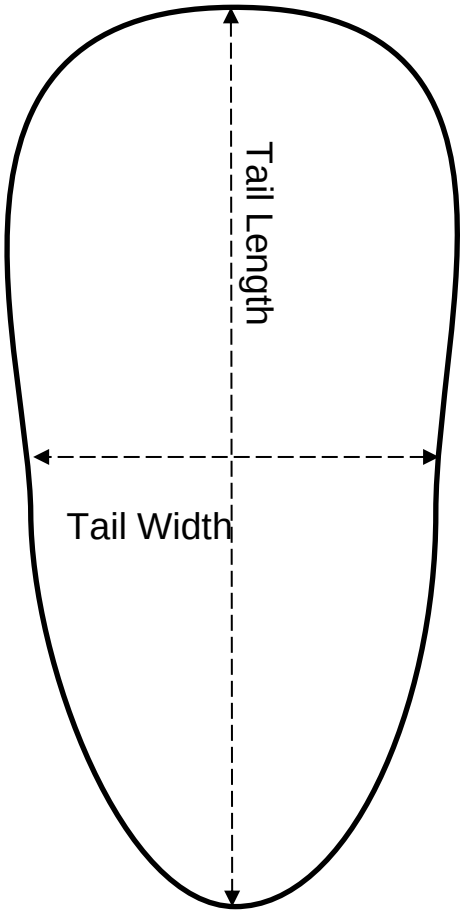
PELT CONDITION Normal/Glossy Dishevelled/Matted Parasites

BODY SCORING (Circle most appropriate description)



Body Condition Score 1	Skeletal structure extremely prominent. Little flesh cover. Vertebrate distinctly segmented. Tail arch very prominent. Tail sunken on either side of midline. Low fat reserves
Body Condition Score 2	Segmentation of vertebrate evident. Dorsal pelvic bones readily palpated. Tail arch prominent. Tail Sunken, low-fat reserves
Body Condition Score 3	Vertebrate and dorsal pelvis not prominent. Palpated with slight pressure. Tail arch visible, but thick with good healthy fat reserves
Body Condition Score 4	Spine is a continuous column. Vertebrate palpated only with firm pressure. Tail arch not readily visible, tail thick and more rounded
Body Condition Score 5	Body is bulky. Bones disappear under flesh and subcutaneous fat layer. Tail is thick and rounded

TAIL CONDITION (Draw any scars/cuts)



NOTES/ADDITIONAL COMMENTS

Appendix II: Captive care husbandry requirements

Captive categories

In the United Kingdom vertebrate animals, including beavers, are subject to legal protection under the Animal Welfare Act 2006, when “under the control of man whether on a permanent or temporary basis”. Failure to protect captive beavers from unnecessary suffering or failure to provide for their basic needs, such as adequate food and water and an appropriate environment in which to live and display normal behaviours, would constitute a criminal offence under the Act. For the purposes of this document captivity has been taken to mean any enclosed beavers, including those in large fenced-in areas of naturalistic habitat.

Beavers may be kept in a range of captive situations (noting that if beavers are originally wild caught, a licence to possess them is required) including:

- Zoological collections (subject to zoo licence requirements)
- Private collections
- Wildlife rehabilitation facilities
- Enclosed beaver projects (subject to Natural England licence requirements in England)
- Temporary biosecure holding facilities

This guidance refers specifically to temporary biosecure holding facilities.

Beavers do not always thrive in captivity or through the translocation process, with the reasons not always obvious. As prey species, beavers may not display obvious fear-associated behaviours; freezing, inactivity, lethargy, and weight loss are some typical stress responses which can be subtle to assess.

While brief episodes of stress are natural in a wild animal’s life, sustained periods of stress are harmful. Continued release of cortisol from the adrenal glands results in immunosuppression. This makes beavers more prone to infections, delays wound healing, and can affect the stability of their essential gut flora.

Beavers are highly social species within their family groups, exhibiting strong social bonds. Single-housed and/or long-term separation, for example of an injured individual separated from the family for treatment, potentially leads to increased welfare challenges. They can be highly aggressive with non-related/non-compatible beavers which can make animal grouping challenging. Unless establishing a new pair, which should be a careful and supervised process with adequate room for escape, family groups should be kept separately and ideally not share joint boundaries. If this is unavoidable, these boundaries should be heavily fortified.

To mitigate for potential stressors in the translocation process, the following husbandry practices are recommended and have been developed from experiences in other beaver restoration projects, including transportation, captive care and release methodologies.

Captive Care

Captive care requirements vary with enclosure type, health, origin and status of each individual. There is no doubt that in larger and more naturalistic enclosures, beavers can express a wider range of behaviours and experience more natural diets, though this is often accompanied with the loss of an ability to monitor individual welfare and administer veterinary care. Whilst no captive setting can fully replicate the wild, beavers have high drives to build, chew and modify; therefore, preventing or significantly reducing this behavioural expression can be viewed as impacting directly on their welfare.

Behavioural concerns

Evidence of negative behaviours resulting from unsuitable captive conditions determines whether there is a need to identify and evaluate welfare indicators for this species. Activity time budgets, the allocation of time that animals spend on various activities throughout their daily lives, for captive beavers have yet to be fully investigated or compared to wild counterparts. This could be used to indicate areas of concern with further investigation (Veasey 2006). Captive individuals may experience a range of stressful events including capture, transportation, restraint and examination, and close proximity to humans and other animals (including scent).

More recent experience at captive facilities associated with the *Methow Beaver Project*[14] and beaver translocations in Scotland describe individual variations in behaviour, with some animals readily accepting short captive periods and engaging in eating, gaining weight, and resting behaviours, whilst others can be unsettled and lose weight (K. Woodruff, pers. comm.). Disturbed beavers tend to retreat to the water, tail slap, grind their teeth, or ‘freeze’ if water is not immediately accessible.

Rehabilitated / orphaned individuals

[14] https://methowbeaverproject.org/

As beavers become more widely present in England, the likelihood of injured and/or orphaned individuals passing through various wildlife rehabilitation facilities will increase. To date, small numbers of injured and orphaned (or found) kits have been reported in both Scotland, Kent and Devon. These cases have varied in successful recovery and release. This highlights the need for beaver-specific holding facilities to be developed, the requirement for further training in captive and veterinary care.

Release options also need careful thought. Kits cannot be immediately released alone if their territory is either unknown or parents absent. Kits can therefore require longer captive care so that they reach a body weight and size capable of independent survival (see below), but noting that these young individuals are highly unlikely to be able to hold a territory of their own and may be at risk of attack by other beavers.

Beavers are social animals and young individuals do not tend to fare well alone for long periods in isolation. Wilsson (1968) also notes in his ethological studies how he found it difficult to keep wild beavers alone for any length of time in captivity. Some wildlife rehabilitation staff (Anne G. Miller, Alabama Wildlife Center) recommend dedicated volunteers making surrogate fake-fur ‘beaver mothers’ for orphans in their care in which milk bottles were inserted, also providing the kits with a source of warmth and comfort. Heat retention in young kits without other family members is a big concern, though overheating of kits in summer months should also be monitored closely. Access to cool water so animals can regulate their temperature is vital, but they also need to be able to dry off and groom in a dry shelter.

Cross-fostering and hand-rearing of orphans (< 3 months) is poorly documented and advised against. It is better to match offspring that are similar in size with any other unrelated kits present, which will provide company and warmth. Orphan kits kept singly have been recorded to develop listlessness, appetite loss, diarrhoea, and eventually decline, and death is also common (Wilsson 1968). Cases of successful captive care are also documented; this seems highly dependent on kit age, diet offered and captive care experience (Zbigniew and others 1995). The costs and benefits of hand-rearing should be carefully evaluated, including any long-term implications, resource availability, social factors, and individual welfare. Older kits (>6 months) and yearlings can be more successfully rehabilitated and re-released, ideally with minimum weights of >10kgs, especially into enclosed projects with suitable hydrology (ie stiller rather than high flow situations). Some rehabilitators in Canada have been known to keep kits for up to 2 years before they are ready for release, even longer than otters in the UK which are generally only released when older than 18 months (Seddon, pers. comm, O’Brien and others 2018). Wildlife rehabilitators therefore need to consider this prolonged

period of captive care, chances of survival and whether this is reasonable on animal welfare grounds.

Captive care routines

Techniques such as monitoring of food taken and observation through camera traps should be used daily. Continual disturbance, excessive noise, and/or unpredictable events have all led to reduced welfare and body condition in captive beavers. A major indication of unsettled or stress responses is continually retreating to water and/or spending excessive amounts of time in water, especially during the day. However, it should be noted that preventing access to water is also considered a stressor; water access should not be prevented, especially during hot weather. Excessive water use can lead to heat loss and, especially in young animals, stripping of waterproofing and skin shedding in extreme cases (R. Campbell-Palmer personal observation).

Enclosure cleaning regime and hygiene requirements will vary greatly depending on how naturalised an enclosure is and the type of water provided. For example, in more naturalistic enclosures with stream-fed ponds, water changes and cleaning requirements will be very much reduced. Pool size and number of animals will determine the regularity of water changes, especially with non-filtered systems. Emptying and refilling pools with large volumes of water may not be viable to maintain water quality, so alternative water treatment methods should be employed. Static water bodies will quickly become fouled; ideally larger pools should use a constant input/output water system. Debris such as uneaten food and faeces should be scooped from the water every day. Water in smaller pools/tubs should also be changed on a daily basis. It should be noted that cleaning and water changes can be stressful to beavers and moving quietly and calmly will reduce stress (Campbell-Palmer and Rosell 2015; Pollock and others 2015).

Beavers should be allowed to build their own shelters without regular disturbance. These must be monitored to ensure they are not continually damp throughout, with fresh bedding provided as required.

Animal grouping

Animals from different families must not be housed together, unless trying to establish a new breeding pair. As a highly territorial species, this requires a carefully controlled and staged introduction protocol to ensure that there is only one female and only one male involved, and that there is adequate room for

escape should aggression occur. When establishing new pairs, a single male and female of similar size should readily accept each other, particularly if they are of dispersing age (~20 months+). Records of beavers fighting to the death are quoted, but more typically it is the infection of wounds in captivity that can lead to fatalities, though they can be fairly tolerant to minor wounds and abrasions. Fighting wounds may become infected by bacteria, leading to diseases, including septicaemia and bacterial endocarditis. These may result in cardiovascular compromise, dramatic weight loss, and condition loss, which in turn may prove fatal (Saunders 2016).

Ideally, if trapping/capturing and relocating a family group, the trapping interval between all family members should be kept to a minimum. There have been several instances in captivity of infighting or non-acceptance of offspring when some time has passed between the trapping of individual family members. Individuals from the same family have been accepted even with trapping intervals of several weeks (Gow 2002; R Campbell-Palmer pers. comms), but this may not always be the case. A thorough trapping period should ensure all members of the same family have been trapped over as short a time frame as possible, so that family members are not separated too long, leading to conflicts when they are reunited, but also for wild populations, so that dispersing beavers do not act as mate replacements (Svendsen 1989; Mayer and others 2017). Severe fighting between two females previously housed together but then separated for some time has been described (Wilsson 1968). In a limited number of cases adult males released with offspring and a ‘new’ female partner have attacked sexually immature male offspring. Careful monitoring of behaviours and body condition should be undertaken, even if animals initially go together without little cause for concern. Pairing of animals has occurred more successfully at the release site rather than in captivity. Wild releases of family units have been successfully undertaken in Scotland and enclosures within England, with additional considerations on release site selection of ponds/open water bodies over river and stream releases.

Shelter and substrate/ building

For any enclosure, bare concrete or abrasive flooring should be avoided for long periods as abrasion causes damage to foot pads and tails (Figure 14). Coverage of bark chippings, sawdust, straw and/or lots of browse material is highly recommended. Regular fresh browse is crucial for shelter, feeding, gnawing and encouraging beavers to engage in a range of building activities, all of which can help reduce stress (eg Henderson and others 2015). Beaver constructions should be left in place as long as they do not cause a risk to any animals or keeping staff, or provide means of escape, or present a hygiene risk. The provision of multiple shelters constructed of straw bales, plywood or wooden pallets as side walls and roofs provide good foundations on which beavers can build. Any substrate should allow for digging and manipulation, to provide

exercise and facilitate natural behaviours. Beavers will split any light timber into shreds to form their own bedding materials but should be provided with dry straw as needed.

Figure 14: Tail abrasion sore caused by time on concrete flooring in image A (left) and an example of deep layer substrate for temporary captive care in image B (right). *Photo* © R Campbell-Palmer, Beaver Trust

Water

Being semi-aquatic, beavers should always be provided with suitable access to water (beyond drinking facilities) for swimming, submerging, feeding, and grooming. As a potential prey species beavers will often naturally enter and remain in the water to avoid capture, which should be taken into consideration before planning any catch-up procedure. The ability to provide suitable water sources, along with means to regularly clean them, especially without subjecting animals to high levels of disturbance, is often a significant challenge in captivity. Beavers defecate, urinate, feed, and drink in water, therefore hygiene is crucial with regular water changes a critical component in reducing bacterial build up.

Any water provisions, as a minimum, should enable an adult animal to fully submerge and stretch out, therefore the minimum suggested dimensions are 60cm depth and width, with a length of more than 1m. However, larger provisions are recommended where possible. Within any water provisions, a submerged step needs to be provided so that individuals can sit and feed in water comfortably. This is especially crucial for younger/smaller animals, including outer steps to facilitate access.

It is possible to keep beavers out of water for short periods of time, for example, on veterinary advice after surgery; however, behavioural and ethical consequences must be taken into consideration. Under such circumstances a heavy metal, non-tippable water dish must be provided with soiled water regularly replenished.

Dietary requirements

In the wild, beavers exhibit seasonal and spatial variations in their diet, eating a wide range of plant species which cannot typically be represented in captivity. Grasses, sedges, and herbs are significant parts of beaver summer diets that are difficult to provide in many captive circumstances.

Whilst diet variation is recommended in captivity, sudden and significant changes in diet should be avoided to prevent the disruption of gut microflora. Browse is a vital component of beaver diets and long-term provisions should be planned in advance, whether in the form of daily cut material, a planting strategy within the enclosure, and/or enclosures large enough to function as a natural habitat. The nutritional value of browse will vary with species and time of year, but it is also vital to provide the high-fibrous diets beavers are evolved to cope with and allow captive beavers to express a fuller behavioural repertoire. Captive North American beavers fed only a diet of one to two tree species lost body weight at rates of 0.1–0.6% per day (O'Brien 1938). Many captive beaver diets are predominantly composed of apples and root vegetables. Though cheap and readily sourced, large daily quantities are advised against for long-term captivity, with experience of animals displaying significant loss of condition and weight loss on these carbohydrate-heavy diets (S. Girling and K. Woodruff, pers. comm.).

Beavers need to eat large amounts of food each day because their digestive efficiency can be low, especially for woody plant material (Currier and others 1960). As beavers will often forage more biomass than they consume, for behavioural and ecological function reasons, a variety of food should be provide as often as required, as diversity in diets is important.

Recommended Daily Diet:

Range of native broadleaf species to browse on as often as necessary (eg willow, aspen, rowan, popular, hazel, ash, beech etc). Note that broadleaf species are a winter food source for beavers with low nutritional value so should not form the only component of any captive diet and the following are also recommended:

Dark leaved green vegetables (eg 1-2 heads of kale, cabbage)

Mixed root vegetables >1kg (including carrots, turnip, parsnips, sweet potato)

Apples ~ 4-6

Note that diets should be adjusted according to number of animals, but also amount consumed per day eg increase browse, dark greens and root vegetables if all taken.

Monitoring health and body condition

Body condition and weight changes are valuable measures that may indicate underlying health or welfare issues. Weights vary depending on the time of year, mainly due to food quality and quantity (Hartman 1992), with all age classes losing weight and body condition over the winter period, apart from kits born that year which will generally increase in weight (Campbell and others 2005). As captive individuals tend to receive a more constant and unvarying feeding regime, they may not display significant seasonal variation. Therefore, sudden or progressive weight loss is likely to indicate an underlying medical condition.

Beavers have large digestive systems to assist the processing of woody material, so that even in poor body condition an unfamiliar observer may still describe them as ‘fat’. Animals in good condition will have plump tails, as opposed to thin and sunken (see Appendix I and section 2.3.1). Beaver tails function as fat storage and so tail dimensions vary depending on deposition and mobilisation of fat (Aleksiuk 1970; Smith and Jenkins 1997). During any handling process another reliable indicator of body condition, as opposed to just visual observation, is to palpate the spine and pelvis for fat coverage.

Beavers are diligent groomers, investing much time keeping fur in good condition to ensure effective insulation and buoyancy (Fish and others 2002). A lack of grooming, observed as matted or waterlogged fur, and a ‘scruffy’ or ‘unkempt’ appearance may be evidence of an underlying health or behavioural issue.

Poor body condition - Weight loss is a common feature, which could be due to an underlying illness or the failure of an animal to cope or feed.

Poor coat condition – grooming and grooming of others should keep the fur shiny and smooth. If the coat appears unkempt it may be an indication that the animal is not grooming due to an underlying problem.

Change in behaviour – Changes may be noted in the behaviour of monitored beavers. Unwell animals may appear subdued or lethargic.

Table 6: Indicators of suspected ill health and recommended steps

Condition		Description	Monitor/Seek Help
Change in behaviour		Subdued/lethargic/sleeping while exposed	Monitor and seek veterinary advice if prolonged
Body condition		Sudden/obvious weight loss	Seek veterinary advice (see scoring below)
Musculoskeletal	**Lameness**	Reluctance to bear weight while at rest	Monitor but if the condition deteriorates or no improvement is noted within 3 days seek veterinary advice
Musculoskeletal	**Lameness**	Severely lame: unable to use leg or place weight on leg. The animal may stop frequently	Seek veterinary advice
Fur		Unkempt coat/ungroomed	May indicate underlying health problem, monitor and seek veterinary advice if continues
Skin		Wounds to fur and tail are not uncommon	Monitor, assess animal management plan and time of year. Removal of sub-adults may be required
Skin		If bone is exposed	Seek veterinary advice
Skin		If wound covers a large surface area (>10cm^2)	Seek veterinary advice
Head	**Eyes**	Discharge, bulging eye, eye continually	Seek veterinary advice

Condition		Description	Monitor/Seek Help
		kept closed or animal rubbing eye	
Head	**Ears**	Discharge, shaking head, head tilt or circling	Seek veterinary advice
Head	**Nose**	Discharge	Monitor if clear, seek veterinary advice if becomes discoloured
Respiration		Open mouth breathing	Seek veterinary advice
Respiration		Increased chest or abdominal movement to compensate for respiratory problems	Seek veterinary advice
Dental	**Dental disease**	Pawing at mouth, any swelling, chewing to one side and/or dropping majority of food from mouth	Seek veterinary advice
Gastro-intestinal	**Diarrhoea**	It may be difficult to ascertain if an aquatic rodent has got diarrhoea. Look at area under tail being soiled and/or has obvious mucus or blood	Seek veterinary advice

Appendix III Considerations for Release Sites

The IUCN guidelines (IUCN/SSC 2013) and the English code (Defra 2021) should be followed when assessing any release site, particularly in relation to habitat suitability and social feasibility. The release of beavers in England, either into the wild as mitigation translocations or into fenced enclosures, requires a licence from Natural England. Further information can be found at: https://www.gov.uk/government/collections/beaver-licences.

Site selection for wild releases

Where beavers are released into a river catchment, consideration should be given to the implications of beaver dispersal from the immediate release site and the presence of any established beaver territories. Beavers may disperse from the immediate release site but settle within the catchment. This results in a successful translocation, just not release site fidelity. Within any catchment, the first colonisers will select the most favourable habitat (Campbell and others 2005), and this element of individual choice in habitat selection is also an important element in species restoration. The ability of animals to exercise choice can be instrumental in stress reduction (eg Morgan and Tromborg 2007). Therefore, although it is important to identify a release site which has appropriate habitat for beavers, the primary consideration for wild releases should be the suitability of the catchment to support an establishing and expanding beaver population. Field sign surveys are essential in release site selection where beavers are already present in a catchment to ensure, with confidence, that beavers are not being released into occupied territories and therefore subject to additional stress and potential aggression (both released and resident individuals).

A thorough understanding of both ecological requirements and beaver behaviours is key in appropriate site selection (eg Hale and others 2020). Numerous studies have investigated and highlighted different variables as being key habitat characteristics for beaver colonisation, with a range of conclusions, useful in identifying release sites and potential future management issues (Touihri and others 2018). Habitat quality and food availability are key determinants in species distribution which can be readily modelled (Graham and others 2022).

Release site preparation – wild releases and enclosure area selection

The primary consideration, as mentioned above, for both enclosed and wild releases is the availability of appropriate habitat to support the beavers being released and their progeny. An assessment of likely human-beaver conflict situations should also be undertaken and risk assessments and mitigation measures thought about to reduce any potential negative impacts.

Although, in the medium to long term, habitat quality can be improved by planting beaver-favoured tree species, such as willow, aspen, and poplar species, which are all readily sourced, propagated, and planted cheaply and which establish quickly (Hall and others 2015), the site should be suitable at the time of release. A diversity of understorey shrubs and small trees can also provide a key food resource.

Competition for food resources has been documented between beavers and large herbivores, such as deer and livestock. Heavy livestock grazing (sheep and cows) can vastly reduce woody vegetation available to beavers and also prevent its regrowth (Parker and others 2000). If significant, this may lead to site abandonment by beavers and increasing dispersal. Instances of excessive deer numbers within enclosed projects in England have demonstrated that selective foraging on coppice has significantly reduced food availability for beavers. If present, deer must be monitored within enclosures and regularly managed through lethal control and/or installation of deer leaps.

The creation of artificial burrows and lodges is not normally a requirement for release if the habitat is suitable but can be helpful in some situations. Each project must check their licence conditions to see what is required. Immediate shelter on release can be provided more readily through felling of trees and shrubs into the water course and/or creation of brash piles directly on and overhanging the shoreline.

Enclosed projects – long-term captive care and fencing requirements

The following criteria are important when assessing the suitability of an enclosure site to support beavers in the long term:

- There needs to be appropriate forage resource to include multiple levels of vegetation (from semi-emergent, understory and tree coverage), all with high regeneration capacity;
- Permanent water, at least one metre in depth, not exposed to significant water level fluctuations or extremes;
- Water flow energy must not be so excessive that it may damage the fence when in spate or prevent long-term dam construction if required;
- Hydrological feature assessment is required to ensure future dams do not flood the enclosed space and create water lying along the fence-line; alternatively ensure access for continual monitoring and dam management to prevent this occurring;
- Bank substrate should allow for burrowing and avoid completely low gradient banks throughout and/or have complex habitat and felled material to increase shelter creation opportunities.

Enclosure size in England, away from typical zoological collection types, has ranged from 1.8 to 56 hectares, varying with individual circumstances and beavers present. Retention fencing specification and maintenance for long-term captivity is critical to avoid escapes. Enclosures need to be fenced to the satisfaction of Natural England who will agree the exact specification when assessing the licence. Larger enclosures are required to provide

for a breeding pair and growing family unit. Size and fence-line will be determined through habitat quality, hydrological features, topography with future assessment of where water storage areas may occur, practicality of fence-line and land ownership restrictions. Size must allow for forage provisions for future family expansion without intra-family competition. Smaller and/or less complicated enclosures (ie <3 hectares) are more likely to result in increased escape attempts as beavers naturally hold much larger territories. These should also be monitored more intensely for changes in beaver behaviours, body condition, field signs next to fence-line and vegetation resources.

Depending on the enclosure size, the location of the fencing and any likely future water level created via beaver damming, an overhang on the fence or extended fence height (eg deer fencing) is highly recommended. On the upstream and downstream ends of the enclosure especially, or any section laying in close proximity to the water's edge, an overhang should be standard. It is also recommended that smaller enclosures have an overhang throughout as beavers may never be far from the fence line. Overhang fencing mesh should extend 120cm vertically up the timber work with a 50cm section at the top, which will be set at 45 degrees into the inside of the enclosure as an anti-climb device. At the base of any fencing, it is crucial that an anti-dig mesh curtain is laid on the surface of the ground attached to the base of the vertical mesh with hog rings or equivalent, and pegged to the ground surface to extend at least 90cm into the enclosure. The wire mesh should overlap at least 10cm preventing beavers from getting through at the join. Alternatively, mesh fencing can be sunk underground to a minimum depth of 60cm. This is recommended where the fence is close to water (or is likely to become close to water after beavers have started damming) to prevent burrows extending out of the enclosure. Where any water courses flow into or out of an enclosure, metal grill fencing will be required with a spacing of no greater than 10cm between the bars. It should be noted that the banks of any in- and outflows into an enclosure need additional underground meshing to prevent burrowing in and around the water course. Mesh size should be a maximum of 10cm and lock joined so the gaps cannot be distorted and expanded (Figure 15).

Consideration must be given for allowing access to other protected species and ensuring that other burrowing animals do not create possible escape routes. If protected species, such as badger or otter, are present advice should be sought from someone with experience of creating or managing beaver enclosures.

Figure 15: A: Beaver fencing showing an overhang and 90cm mesh skirt; B: an example of fencing with mesh skirt which is also then buried beneath the ground; C: an access gate with overhang and anti-climbing metal where overhang not possible, noting gate is also set on a concrete plinth to prevent digging; D:showing repeated fence pacing and digging behaviours which should be regularly monitored and appropriate management action taken (highly motivated by close proximity of fencing to an external water course). *Photo* © R Campbell-Palmer, Beaver Trust.

Appendix IV: Post-Mortem Examination Guidance

All beavers found dead should be examined according to a standard post-mortem protocol and findings noted on a post-mortem examination form, of which an example is provided in Appendix V.

The post-mortem examination procedure is briefly outlined below. Firstly, the history, preservation, storage and identification details, age and sex will be recorded. The following steps should then be followed:

1. Microchip scanning to check identification and provenance if translocated (and confirmation of absence on radiography if not read)

2. Whole body radiography, two views at 90 degrees (dorsoventral, right lateral) to identify any trauma or ballistics which may have contributed to death.

3. Gross post-mortem examination, paying particular emphasis for any evidence of echinococcosis. Any suspected cysts should be sampled and examined by histopathology and PCR test to identify the species of suspected cestode.

4. If shot/bullets have been found on examination, if possible, isolate and identify the ballistic, its composition and calibre.

5. Weight/measurement of following organs to maintain biometric records:

    a) Thyroid
    b) Spleen
    c) Gonad - left and right
    d) Heart
    e) Lungs
    f) Liver
    g) Kidneys
    h) Pancreas
    i) Thymus
    j) Adrenal - left and right
    k) Uterine horn - left and right

6. Histopathology of the following organs routinely:

    a) Liver
    b) Kidneys
    c) Lungs
    d) Heart
    e) Spleen
    f) Stomach
    g) Pancreas

h) Small intestine (duodenum, jejunum and ileum)
i) Large intestine and caecum

7. Histopathology of any other organs showing evidence of disease

8. Panhantavirus PCR of lung and/or kidney tissue

9. Culture of swabs from visceral organs on Farrell medium for *Brucella* spp. Also potential for PCR testing on tissue samples.

10. Quantitative PCR for *Leptospira* spp. on a fresh kidney sample where clinical signs are suggestive of leptospirosis

11. Muscle digestion or preferably quantitative PCR on muscle for *Trichinella* spp. is desirable especially if provenance is unknown.

12. Microbial culture of swabs from viscera where gross pathology is suggestive of bacterial infection

13. Faecal parasitology including:

    a. PCR for *Giardia* spp.

    b. PCR for *Cryptosporidium parvum*

Physical examination and typing for intestinal nematodes and trematodes and any evidence of internal parasitic infection.

Other samples may also be collected for histopathology, parasitology, bacteriology where indicated, and genetic studies.

Appendix V: Post Mortem Examination Form

BEAVER (*Castor fiber*) POST MORTEM EXAMINATION FORM

Date found	PME no. / /
Date received	PM date
County	Radiograph number
Location	Release date
NGR	
Microchip number	Other Tag:
Contact	
PME start time	PME finish time
Clinical History: Died / Found dead / Euthanised	
Apparent cause of death:	
Preservation: Fresh / Mildly autolysed / Autolysed / Mummified	Storage: Fresh / Refrigerated / Frozen
Age: Adult/Juvenile/Kit	Sex: Male / Female / Unknown

Carcase weight (g)	Nose-cloaca (mm)	Cloaca-tail tip (mm)	Tail width at mid-length (mm)
Tail tip - hair line (mm)		Nose tip-hair line @ tail base (mm)	
Tail width at base (mm)		Body condition: (1-5) (Beaver specific method – Appendix)	
Fat deposits over flanks (1-3):			
Adrenal (L) (g)	Adrenal (R) (g)	Spleen (g)	
Gonad (L) (mm)	Gonad (R) (mm)	Spleen (mm)	
Thyroid (L) (mm)	Thyroid (R) (mm)	Thyroid (g)	
Pathologist:		Heart (g)	
		Lungs (g)	
		Liver (g)	
		Kidneys (g)	
		Pancreas (g)	
		Thymus (g)	
		Uterine horn length (L) (mm)	R (mm)
		Uterine horn width (L) (mm)	R (mm)

Key: NAD = no abnormality detected; NE = not examined:

Circle relevant number for each body system and describe observations/abnormalities in detail below.

1 NAD NE skin/app	6 NAD NE cardiovascular	11 NAD NE endocrine
2 NAD NE sensory	7 NAD NE respiratory	12 NAD NE reproductive
3 NAD NE muscular	8 NAD NE lympho-ret	13 NAD NE nervous
4 NAD NE skeletal	9 NAD NE hepatic	14 NAD NE gastrointestinal (dental)
5 NAD NE cavities	10 NAD NE urinary	

RADIOGRAPHY – at pathologist's discretion

Radiograph number: Date performed:

Interpretation:

ROUTINE SECTIONING

LUNGS – Both lungs should be incised throughout the entire surface at 1cm intervals to detect the presence of cysts/granulomas/other lesions (*Mycobacterium* spp./*Emmonsia crescens*)

If found the following samples should be taken:

- Material from the lesion for mycobacterial culture
- A charcoal swab of the lesion
- A section of the lesion taken and placed into an Eppendorf tube at -80C

SKELETAL MUSCLE – Sectioning of the skeletal muscles should be undertaken to detect the presence of cysts (*Echinococcus multiloccularis*/ Taenia spp./*Trichinella* spp*./Sarcocystis* spp.)

LIVER – sectioning of the liver at 1cm intervals should be undertaken to detect the presence of cysts (*Echinococcus multilocularis*/*Taenia* spp./*Trichinella* spp.)

ROUTINE SAMPLES

HISTOPATHOLOGY – Samples of each should be collected into 10% Formalin

Tongue	Spleen	Large intestine
Thyroid	Kidneys	Pancreas
Heart	Gonads	Brain
Lung	Oesophagus	Adrenals
Liver	Stomach	
Trachea	Small intestine	

PARASITOLOGY – (*Giardia duodenalis, Stichorchis subtriquetrus, Cryptosporidium parvum, Eimeria spp., Travossosius rufus, Fasciola hepatica*)

Wet prep – (section and content in petri dish labelled P, section in Eppendorf -80^{o}C)

Large Intestine	Small Intestine	Stomach

Caecum	3g faeces	

ECTOPARASITOLOGY – (place into bijou - 70% ethanol – room temperature)

Label number	Location

Packaging bag checked for parasites?

ORGAN SAMPLES – (4x duplicate samples - Eppendorf -80C)- (Includes *Francisella tularensis*, *Leptospira* spp., *Toxoplasma* spp.)

Lung	Liver	Brain
Kidney	Small intestine	Heart
Spleen	Large intestine	Lymph node

TRICHINELLA TESTING – (IF FRESH CARCASE – 10g+ of biceps femoris, 10+g triceps brachialis, section of masseter. Samples individually double bagged and labelled. Refrigerate (approximately 4°C) for 1-2 days)

Hindlimb muscle

GENETICS – (sample in bijou at -20C)

Muscle (4cmx4cm cube)

SEROLOGY – (At least 2x samples - Cryovial -80)

Peritoneal fluid	Clotted heart blood	Pericardial fluid
Pleural fluid	Unspecified body fluid	

BACTERIOLOGY – (sections from organs with

Screen (Charcoal swabs labelled B- includes Brucella spp.)

Heart	Lungs	Liver
Kidney	GIT	Brain

Lesions (sections from organs with lesions into petri dish labelled B, cut surface charcoal swabs and impression smears on slides)

Lesions:

ECOTOXICOLOGY/TOXICOLOGY – (Representative sample in glass pot -20C)

Routine

Liver	Fat

Extra (if suspicion of poisoning)

Liver	Stomach Content
Kidney	Brain

OTHER SAMPLES

AGEING – (1 premolar tooth should be removed and stored in 70% ethanol OR alternative arrangements made)

Premolar tooth

SECRETIONS – (Placed into Eppendorf and stored at -80C)

Urine

CORTISOL STUDY

Hair sample into envelope stored at -20C

ARCHIVE – Carcase suitable to be sent to NMS? (if yes, label NMS, beaver, PM number, and store -20)

Stored? _____

www.gov.uk/natural-england