Definition of Favourable Conservation Status for Eurasian beaver, *Castor fiber*

Defining Favourable Conservation Status Project

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About the DFCS project

Natural England's Defining Favourable Conservation Status (DFCS) project is defining the minimum threshold at which habitats and species in England can be considered to be thriving. Our FCS definitions are based on ecological evidence and the expertise of specialists.

We are doing this so we can say what good looks like and to set our aspiration for species and habitats in England, which will inform decision making and actions to achieve and sustain thriving wildlife.

We are publishing FCS definitions so that you, our partners and decision-makers can do your bit for nature, better.

As we publish more of our work, the format of our definitions may evolve, however the content will remain largely the same.

This definition has been prepared using current data and evidence. It represents Natural England's view of FCS based on the best available information at the time of production.

The document *Defining Favourable Conservation Status in England* describes the methodology used by Natural England to define FCS.

1. Introduction

1.1 Favourable Conservation Status Definition for Beaver in England

This document sets out Natural England's view on Favourable Conservation Status (FCS) for **Eurasian beaver, *Castor fiber*** in England. FCS is defined in terms of three parameters: natural range and distribution; population; extent and quality of habitat necessary for long-term maintenance of populations.

Section 2 provides the summary definition of FCS in England. Section 3 covers contextual information, section 4 the units used and section 5 describes the evidence considered when defining FCS for each of the three parameters. Section 6 sets out the conclusions on favourable values for each of the three parameters. Annex 1 lists the references.

This document does not include any action planning, or describe actions, to achieve or maintain FCS. These will be presented separately, for example within strategy documents.

2. Summary favourable conservation status definition

2.1 Favourable Conservation Status in England

The Eurasian beaver is a large, herbivorous, semi-aquatic rodent living in, and in the vicinity of, streams, rivers, marshes, ponds and lakes particularly where there is broadleaved woodland. They live in family groups comprising an adult pair and their offspring.

They are highly adaptable and are able to modify natural, cultivated and artificial habitats to suit their needs. In particular, they may construct dams from tree stems, branches, sticks and mud on watercourses to create their preferred still or slow-moving water with stable water depths. They also construct lodges or burrows for their dens, fell trees and excavate canals. These activities provide beavers with an aquatic refuge, increase their range of movement, ensure lodge/burrow entrances remain submerged, and provide food supplies and/or ease the transport of building materials. This activity, particularly the construction of dams, can result in the creation or modification of wetland habitats, with the evidence available suggesting that, notwithstanding significant adverse effects on some human interests, the net effect on plant and animal diversity appears to be beneficial (Howe 2020; Stringer & Gaywood 2016).

Beavers were widespread in England in the pre-historic period but probably became extinct over seven hundred years ago and were certainly extinct by two hundred years ago. They have been reintroduced to England as part of the River Otter Beaver Trial. In addition to this reintroduced population in Devon, there are also records of beaver in other parts of the country, likely through unauthorised or accidental releases.

Favourable conservation status would be achieved when 5,200 family groups of beaver occupy 5,000 km² of existing suitable habitat throughout England.

2.2 Confidence

FCS parameter	Favourable status	Confidence
Range and distribution	2,950 catchments (see section 4.1 for full definition)	Low
Population	5,200 family groups	Low

Habitat	5,000 km² of habitat within beaver habitat index categories 3-5 (see section 5.1 for definition) in blocks at least 300,000 m² in extent.	Moderate	

3. Species definition and ecosystem context

3.1 Species definition

Eurasian beaver, *Castor fiber*

3.2 Species status

Red list status

An assessment of the risk of extinction.

- **Global**: Least Concern **Source:** Castor fiber. The IUCN Red List of Threatened Species 2016: e.T4007A115067136. Batbold and others (2016) https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T4007A22188115.en
- **European:** Least Concern **Source:** Castor fiber. The IUCN Red List of Threatened Species 2007: e.T4007A10313183. Kryštufek and others (2007)
- **GB:** Endangered **Source:** A Review of the Population and Conservation Status of British Mammals. Mathews and others (2018)

Conservation status

- Listed on Annexes II and IV of the Habitats Directive.
- Listed on Annex III of the Bern Convention

3.3 Life cycle

Eurasian beavers are large, herbivorous, semi-aquatic rodents, becoming fully grown at around three years of age.

Beavers live in family groups and, once paired, they tend to stay together until either one partner dies or is displaced by another in a territorial dispute. Beavers shelter and breed within dens in underground burrows or in lodges above ground made of branches, sticks and mud (or a combination of these). The entrances to burrows and lodges are normally underwater. Mating usually takes place between December and February, with kits being born 105-107 days later. Females give birth to one litter each year, typically consisting of between one and four kits, although the number of kits, and their survival, is dependent on factors such as the age of parents, habitat quality, population density and altitude (Novak 1987; Campbell 2010; Campbell and others 2013).

Beaver kits are born fully furred, and although they will feed on their mother's milk for the first two to three months, they will also feed on vegetation within the first week of life. They tend to remain within the family lodge for between one and two months whilst other family members bring them food. Kits become sexually mature at around two years old and they will then usually disperse to establish their own territories and find partners (Wilsson 1971). However, some individuals will remain within their family units for many years as non-breeding animals, especially if there is limited suitable habitat available (Campbell and others 2005).

Dispersing animals may travel great distances along water bodies and will travel across land, although not for long distances. Beavers have been recorded up to 11.7 km from water, although such long movements appear to be rare (Saveljev and others 2002)). Dispersal distances can range from a few kilometres to tens of kilometres, depending on a range of factors including population density and habitat availability (Zurowski & Kasperczyk 1990, Fustec and others 2001). It has been estimated that approximately 80% of dispersing beavers attempt to establish territories within 5 km of their natal territory (Nolet & Baveco 1996, Saveljev and others 2002), though much greater distances (80 km+) have been recorded. The speed of beaver dispersal is affected by topography. Watershed divides may act as dispersal barriers, but this varies depending on topography (Halley & Rosell 2002, Halley and others 2013). Surveys in Sweden and Norway indicate that dispersal occurs more quickly within a watershed than between them (Hartman 1995, Halley and others 2013).

Mortality in beavers can be high in juveniles: a study in Newfoundland of the American beaver (*Castor canadensis*), a very similar species, recorded an average annual mortality of 52% during the first 6 months of life (Payne 1984). But if they survive this period then they can live for an average of 12-14 years (Nolet and others 1997).

3.4 Supporting habitat

Eurasian beavers occupy freshwater habitats, including ponds, streams, rivers, marshes and lakes, particularly where broadleaved woodland is present. Although beavers prefer still or slow-moving water with stable depths of at least 60 cm (Gurnell and others 2009), they are highly adaptable and are able to modify natural, cultivated and artificial habitats to suit their needs. Where their preferred habitat is not available, they will colonise narrower watercourses and construct dams usually made from tree stems, branches, sticks and mud. Dams retain water and create the preferred stable water depths, providing beavers with an aquatic refuge, increasing their range of movement, ensuring lodge or burrow entrances remain submerged, and provide food supplies and/or ease the transport of building materials. Beaver dams are typically built on rivers less than 6 m wide and 0.7 m deep (Hartman & Tornlov 2006) and will vary in size and structure depending on purpose, environmental setting, channel geometry, age and hydrological regime.

Beavers are territorial and are intolerant of animals from other family groups. The average size of a beaver territory is approximately 3 km of shore length, but this can vary from 0.5 to 20 km of shoreline, depending on habitat quality, food resources and the population density in the surrounding area (Macdonald and others 1995; Herr & Rosell 2004; Campbell and others 2005).

Suitable beaver habitat may comprise areas of wet woodland, but in more developed environments they are opportunistic and will forage within grass verges, pasture and agricultural crops. The beaver is a generalist herbivore, feeding on bark, shoots and leaves of woody plants, terrestrial herbs and forbs, ferns and aquatic vegetation.

Most activity occurs within 20 m of the shoreline, although beavers have been known to travel several hundred metres in order to forage on their favoured species. In more low-lying landscapes beavers may use dams to flood the surrounding land and allow access to foraging areas. Beavers may utilise faster-flowing watercourses and steeper gradients in certain situations, for example when populations are expanding, and competition is high. However, they tend not to be found in watercourses with gradients greater than 15%, with optimum gradients usually around 3% (Hodgdon & Hunt 1966; Shelton 1966). Low-quality habitats may only be

used for short periods of time until resources run out or dams are washed away by rapidly increased water levels (Howard & Larson 1985; Webb and others 1997; Schulte 1998; Campbell-Palmer and others 2016).

Additional Sources: Schwab and others 1992; Rosenau 2003; Rosell and others 2005;

3.5 Ecosytem context

The Eurasian beaver was once widespread throughout Europe and Asia, but over-hunting restricted both numbers and range and by the late 19th century it was reduced to a handful of fragmented populations across Europe. It's estimated that at that time 1,000-2,000 individuals remained (Nolet & Rosell 1998). Since then, protection and reintroduction projects have enabled populations to rapidly expand across much of their former European range, the exceptions being Portugal, Italy, and the south Balkans (Halley & Rosell 2002; Ceña and others 2004). Beavers have been reintroduced to parts of Great Britain, both through official translocation projects and unauthorised or accidental releases.

Beavers produce a dynamic habitat system, resulting in a range of ecological benefits. An analysis of published studies on beavers' interactions with biodiversity, to inform their reintroduction to Scotland, showed that, overall, beavers had a net positive influence on biodiversity (Stringer & Gaywood 2016). However, the reintroduction of beavers may have detrimental impacts on certain species and habitats.

Beavers are a keystone species and can have a significant impact on the landscape, due to their ability to build dams, construct lodges, fell trees, excavate canals and burrow into banks. This can result in the creation or modification of wetland habitats, particularly by impounding water through the construction of dams. A mosaic of beaver impoundments throughout a landscape, at different stages of development, can provide a high level of habitat heterogeneity, and hence biodiversity. Beaver impoundments can also create important habitat features such as standing dead wood (after inundation), an increase in woody debris, and a graded edge between terrestrial and aquatic habitats that is rich in structural complexity and a variety of habitats, ultimately resulting in high levels of diversity.

Beaver foraging can also have a considerable impact on the course of ecological succession, species composition and structure of plant communities largely due to their ability to fell large trees. They generally feed in close proximity to watercourses, so their herbivory is unevenly spread in the landscape. Hence, areas with beavers have a mosaic of different levels of beaver activity and are structurally diverse at many scales. Herbivory of preferred species, such as willow *Salix* spp. and aspen *Populus* spp., may promote the abundance of non- preferred species, altering the species composition of the plant community. Felling of trees leads to a more open canopy in wooded areas with coppiced stands and juvenile forms of woody plant species.

4. Units

4.1 Natural range and distribution
Catchments These are Water Framework Directive River Waterbody Catchments Cycle 2 as defined by the Environment Agency for the implementation of the Water Framework Directive. They are defined as an area of land from which all surface run-off flows through a series of streams, rivers and, possibly, lakes to a particular point in the water course such as a river confluence. There are 4,081 such catchments in England. As beavers are semi-aquatic, and their distribution is centred around watercourses and waterbodies, the number of River Waterbody catchments (hereafter catchments) occupied by family groups are a suitable unit to describe range and distribution.
4.2 Population
Family groups
4.3 Habitat for the species
Km^2

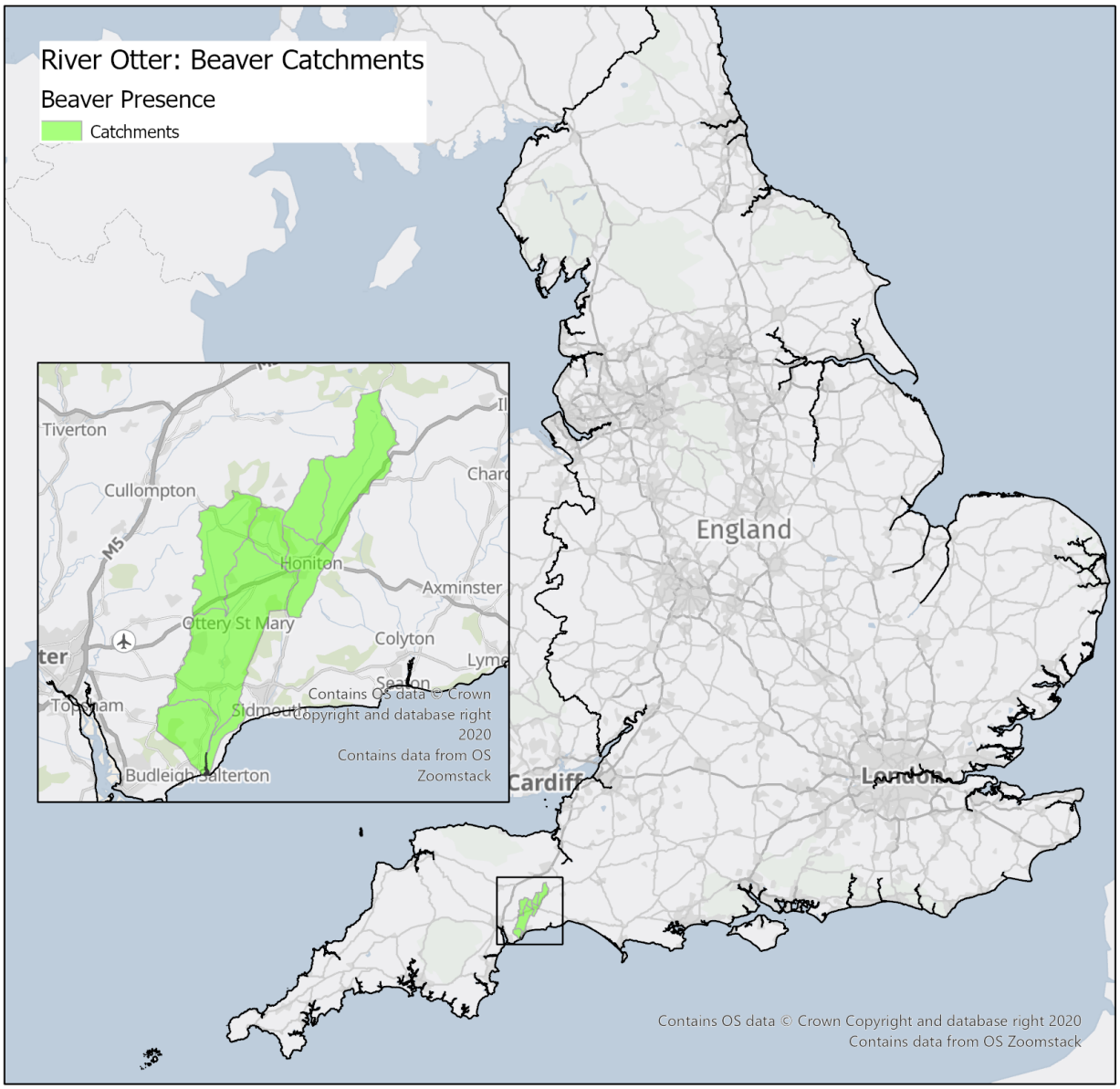
5. Evidence

5.1 Current situation

Natural range and distribution

The Eurasian Beaver has been reintroduced to England as part of the River Otter Beaver Trial. Beavers are present in seven catchments in Devon (see Map 1 below).

Map 1: Current distribution of Eurasian beaver. In addition to the reintroduced population in Devon, there are also records of beaver in other parts of the country, as a result of unauthorised or accidental releases.



Population

The current population in England, disregarding any unauthorised or escaped individuals, is 15 family groups.

Habitat for the species

In 2019 the University of Exeter modelled the extent of suitable habitat for beaver in England on behalf of the Environment Agency and Natural England. The purpose of the modelling was to identify where beavers might occur in England. To develop the Beaver Habitat Index for England, waterbodies were divided into sections under 200 m in length then, for every section, terrestrial habitat within 100 m of the bank was scored using a scale of zero to five according to suitability for beaver. Habitat information was obtained from OS VectorMap data, The Centre for Ecology and Hydrology (CEH) 2015 land cover map, Copernicus 2015 20 m tree cover density and the CEH woody linear features framework. Scores of five represent vegetation that is highly suitable or preferred by beavers. Zero scores were given to areas that contained no vegetation or were greater than 100 m from a waterbody. It is important to note that the habitat model only considered terrestrial habitat where foraging primarily occurs and that watercourses themselves were also scored zero.

Table 1: Definition and extent of land within Beaver Habitat Index categories

Beaver Habitat Index	Description	Area km²
1	Not suitable – for example: heathland, improved grassland, unimproved grassland (except neutral grassland), bog	19,532.13
2	Barely suitable – for example: arable and horticulture, reeds, marsh, shrub and heathland, neutral grassland, tree cover density 4-10%	17,599.38
3	Moderately suitable – for example: coniferous woodland, shrub and unimproved grassland, tree cover density 11-50%.	4,644.61
4	Suitable – for example: shrub and marsh, tree cover density greater than 50%	1,680.70
5	Highly suitable – for example: broad-leaf woodland, coniferous woodland and shrub, mixed woodland, orchard, shrub.	6,938.36

The Beaver Habitat Index (BHI) model was tested on current beaver populations within the UK (Graham and others 2020) and reaches within category 5 were found to have far greater probability of containing signs of beaver activity. Reaches in categories 3 and 4 could still

support beaver but were less preferred and had a similar probability of containing signs of beaver activity. Categories 3 and 4 were slightly more likely to have beaver activity than those in category 2. It is possible that there was little variation between index categories 2-4 because beaver populations within the areas of study were still expanding.

Within this FCS definition the figures for habitat in categories 3-5 have been taken to indicate supporting habitat for beaver in England. The River Otter Beaver trial has shown that beavers can thrive within areas where the proportion of highly suitable habitat (beaver habitat index category 5) is relatively low and within habitat falling into lower BHI categories. Only approximately 10% of land cover within the River Otter catchment is the preferred broadleaved and mixed woodland, 50% is improved grassland, 28% arable and horticulture and 5% urban and suburban (Brazier and others 2020). Therefore, a broader definition of supporting habitat has been used including the BHI categories 3 and 4 (which had a similar probability of beaver activity). However, the definition of supporting habitat was not widened further to include areas within BHI category 2 as reaches in this category were less likely to have beaver activity than reaches in categories 3 and 4.

Taking the figures for the area of land within Beaver Habitat Index categories 3-5 in Table 1 above, there is currently approximately 13,000 km² of suitable habitat. However, this is the maximum potential habitat area as local factors will restrict access to water and vegetation and render the habitat unsuitable, in particular human infrastructure such as culverted/constrained sections of watercourse, walls and fences. Similarly, flow conditions in some of the watercourses will render the habitat unsuitable for beaver or suitable habitat may not be in blocks of sufficient size to provide sustainable support for a beaver family group.

Confidence: Moderate

5.2 Historical variation in the above parameters

Fossil records suggest the Eurasian beaver was widespread in Britain two million years ago (Coles 2007). However, the species was probably extinct within England by 1300 (Raye 2015) and was certainly extinct by the end of the 18th century (Coles 2007). The reason for the loss of this species is thought to be unsustainable levels of hunting and persecution. There has been no recent population of beaver in England.

There have been many changes within the landscape since beavers were last thought to be present in England. For example, large-scale urban development and intensification of land-use for agriculture, including clearance of woodland. As beavers are highly adaptable, and are able to modify natural, cultivated and artificial habitats to suit their needs, it is unclear how these changes may have impacted the overall availability of habitat for this species.

In more recent years there has been an increase in habitat suitable for beaver. Woodland cover has increased, including cover of wet woodland. For example, the most recent Countryside Survey (NERC 2008) reported 38,000 ha of wet woodland in England whereas 33,000 ha of wet woodland were reported in 1998.

Confidence: Low

5.3 Future maintenance of biological diversity and variation of the species

In general, if conditions are favourable, it is assumed that when beavers are present within a river, they will eventually spread to occupy most of the suitable habitat throughout the catchment (Halley & Rosell 2002).

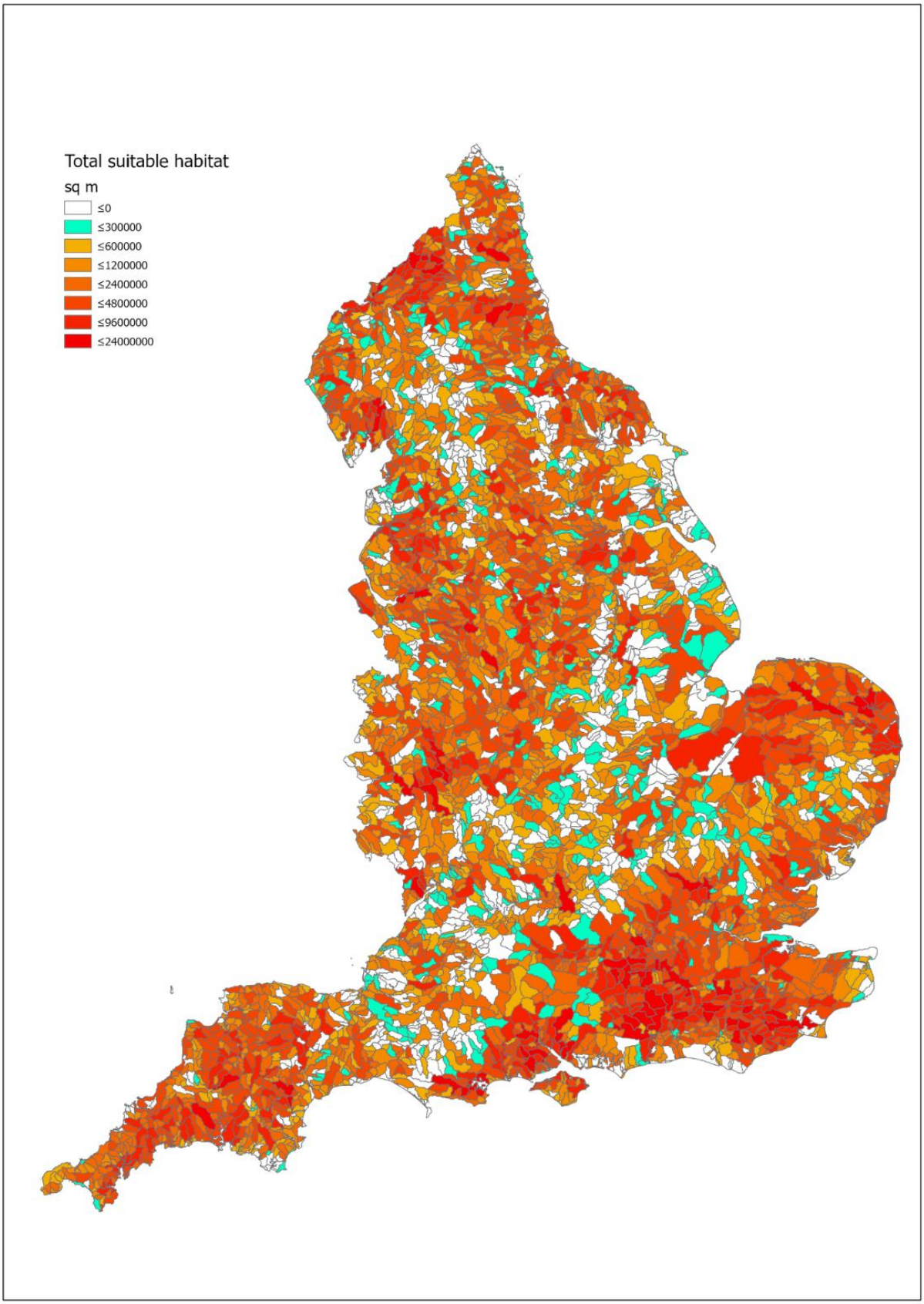
Because there is a lack of data on the historical range and populations of beaver, and currently there are only small-scale reintroductions, the information from the Beaver Habitat Index modelling has been used to produce values for the favourable range and distribution and the favourable population. If, in a favourable situation, beavers will spread to occupy most of the suitable habitat then the favourable range and distribution and favourable population should reflect the availability of suitable habitat.

Natural range and distribution

The Beaver Habitat Index data were examined by Natural England to derive an estimate of the areas which might be expected to become occupied by beaver family groups. Areas with a gradient greater than 15%, unlikely to be occupied, were removed from the dataset. Some blocks of habitat were divided by the rivers themselves. Where the rivers were 5 m wide or less the blocks of habitat were amalgamated to create a single block of habitat. Where the rivers were over 5 m wide the blocks of habitat were left separate. Further detail on the analysis completed can be found in Annex 2.

The average size of a beaver territory is 3 km of shore length and the BHI model covers land up to 100 m from the bank. Therefore, an average beaver territory would be represented by 300,000 m^2 of habitat within the data. Catchments with at least one block of habitat, or part of a block of habitat, greater than 300,000 square metres in extent within BHI categories 3-5 were identified. The analysis shows that 2,959 of 4,081 catchments have blocks of habitat suitable for beaver. This is 72.5% of all catchments. However, as this figure is derived from modelled information it must be treated with caution. Therefore, the proposed favourable natural range and distribution is a rounded figure of 2,950 catchments.

Figure 1: Catchments with beaver habitat index categories 3-5 in blocks of at least 300,000 m^2. Note, blue catchments may hold beaver family groups because they include habitat linked to habitat in other catchments so forming habitat blocks at least 300,000 m^2 in extent.



Population

Following the analysis above, the number of habitat segments in BHI categories 3-5 greater than 300,000 m^2 in extent is 5,230. Therefore, the proposed favourable population for beaver is 5,200 family groups

Habitat for the species

There is currently 4,922.4 km^2 of habitat within the habitat segments identified in the analysis which can provide suitable habitat for beaver family groups. A rounded figure of 5,000 km^2 has been taken as the figure for supporting habitat for beaver.

Confidence: Low

5.4 Constraints to expansion or restoration

Evidence from Europe shows that beavers can be successfully reintroduced back into areas of their former native range and have great capacity to expand their populations (Halley & Rosell 2002).

Following a reintroduction programme, the major constraint to an expansion of beaver populations to occupy their natural range and distribution would be human management or persecution. Otherwise, beavers could be expected to expand to occupy all suitable habitat within England.

As beavers are being re-established by reintroduction, there is the possibility that low genetic diversity within founding populations may be a constraint to establishing favourable populations. There have been no systematic studies on the effect of inbreeding on beavers, but scientific evidence suggests that inbreeding and low genetic diversity are detrimental to thriving populations and can lead to reduced fitness, such as the loss of adaptability to changing environments (Babik and others 2005, Durka and others 2005, Senn and others 2014, Horn and others 2014). However, populations in Europe that have recovered from very low numbers do not show any apparent effect on viability or fertility and do not commonly display the more typical abnormalities associated with inbreeding. The risk of reduced fitness could be addressed by ensuring appropriate genetic diversity among founding populations, bolstering diversity through adding further individuals in the initial years following reintroduction and/or ensuring that founding populations can mix.

Experience from Scotland (SNH 2015) has demonstrated that, overall, beavers have a very positive influence on biodiversity. Their ability to modify the environment means that beavers not only create new habitat but also increase habitat diversity at the catchment scale as their impacts are dynamic and change across space and time. Beavers are most likely to have detrimental impacts on certain woodland habitats and dependent species, particularly woodland with large, old trees and their associated communities such as lichens and saproxylic insects.

Confidence: Moderate

6. Conclusions

6.1 Favourable range and distribution
Beavers will be in favourable status when 2,950 of the 4,081 catchments within England are occupied by beaver family groups.
6.2 Favourable population
5,200 family groups.
6.3 Favourable supporting habitat
5,000 km² of habitat within beaver habitat index categories 3-5 in blocks of at least 300,000 m².

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Annex 2: Beaver suitable habitat identification methodology

The following describes the examination undertaken by Natural England of the Beaver Habitat Index (BHI) data produced by the University of Exeter (Graham and others 2020) in order to derive an estimate of the areas which might be expected to become occupied by beaver family groups.

The BHI identifies grades of habitat that are within 100 m of inland water across England; it is a raster data layer with a 5 m grid resolution. The BHI grades range from 0 to 5, this analysis uses only grades 3 to 5 (moderately suitable to highly suitable). Only areas of habitat greater than 300,000 sq m are considered suitable.

1. Remove all BHI area grades 0 to 2
2. Identify all areas of terrain with greater than 15% incline and remove these areas from the suitable habitat
3. Due to some habitat areas being split by rivers, or due to the conversion of raster to polygon two adjacent polygons may be considered distinct, a process is used to identify habitat within 5 m (one grid cell) of another area using the “near” tool in ArcPro.
4. Select all habitat segments that are greater than 5 m from another and where the area is 300,000 sq m, or where the distance to other habitat is less than or equal to 5 m and retain this dataset for later use.
5. Select all habitat less than or equal to 5 m from another and buffer these by 2.5 m. Dissolve these areas in ArcPro; this joins all parts that are adjacent or within 5 m and considers them grouped. Remove all areas with less than 300,000 sq m in size.
6. Remove the buffers by clipping using the stored dataset from above (see 4).
7. Select only areas of 300,000 sq m or greater.

Further information

Natural England evidence can be downloaded from our **Access to Evidence Catalogue**. For more information about Natural England and our work see **Gov.UK**. For any queries contact the Natural England Enquiry Service on 0300 060 3900 or e-mail **enquiries@naturalengland.org.uk** .

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