Woodland creation in the presence of beavers

by Jon Burgess

Summary:

Eurasian beavers (*Castor fiber*) are once again living freely in the wild in the UK with rapidly expanding populations. The UK has legal woodland creation targets and much of the natural capital benefit of the new woodlands can be achieved by locating these woods in riparian zones where they can improve water quality and regulate flooding (Forestry Commission, 2024a). Beavers interact readily with trees and so we need to understand how the presence of beavers will impact the delivery of woodland creation.

Practical guidance for the management of beavers and their habitat is available through handbooks and websites (Beaver Trust, 2024), but most focus on managing the habitat for the benefit of beaver or protection of key features. Limited information is available for those wishing to create woodland in areas where beavers are present or anticipated. This brief and non-exhaustive article aims to help people understand the potential impacts of beavers on woodland and sets out a risk-based approach to woodland creation.

Recent UK beaver history

A beaver colony has been present on the River Tay in Scotland since 2006, and beaver were first found to be living wild in England on the River Otter in Devon and have been studied there since 2014 (Howe and Crutchley, 2020). This small population has established family groups and has now colonised the length of the watercourse. Numerous rivers in England also now have wild beaver, including the Tamar, Wye, and Bristol Avon (how the beaver reached these catchments is unknown (Guardian, 2024)) and beaver are increasingly found in the wild on watercourses at great distance from the existing populations. At this rate of spread, it would appear most rivers could foreseeably have beaver populations in the future. This spread is distinct from the licensed releases into enclosures that have been set up across the country.

Beavers are now legally protected in England and Scotland (but not Wales or NI) as a European Protected Species and Natural England have published a management guide (DEFRA, 2022) that outlines the situations and extent to which landowners can manage beaver populations. In certain circumstances it may be necessary and legal to manage the animals (e.g. where they are digging into retaining banks of reservoirs) or remove dams (e.g. when culverts are blocked). Because of the legal protection, it's always best to seek advice before taking any action that could disturb beaver. Local Beaver Management Groups (BMG) are becoming more common and are a good place to obtain more local information and support. Alternatively, Wildlife Trusts are helpful contacts in the early stages before a BMG forms. The Beaver Management website publishes a list of active groups (Beaver Trust, 2024).

UK Forestry Standard (UKFS)

Government policy supports forest managers to undertake sustainable forest management that facilitates the presence of beavers. This is seen in the UKFS (5th edition), which includes the following statement that is supportive of the changes beavers can bring:

"*The ecological processes that shape natural forest ecosystems include vegetation succession, natural regeneration, windthrow, flooding, drought, the activities of herbivores, predation and change caused by reintroduced species such as Eurasian beaver... These processes can make a positive impact by introducing a degree of unpredictability, encouraging structural diversity to develop and assemblages of new species to establish. Allowing ecological processes to operate, and mimicking them within silvicultural systems, can therefore benefit biodiversity – provided this is done within the framework of a forest management plan with clear management objectives.*"

The accompanying UKFS Practice Guide (Forestry Commission, 2024b) includes a section on beaver which is supportive of their presence and recommends that:

"*Where appropriate, establish riparian woodland buffers to aid beaver expansion and management; a 20 m wide buffer is likely to minimise potential beaver conflicts with adjacent land-use interests*".

Are beavers positive or negative?

Positive

Beavers can improve water quality, reduce the risk of flooding and drought, increase biodiversity, and create landscapes more resilient to the impacts of climate change. These benefits can form part of a range of other 'nature-based solutions' to environmental problems faced by society (NatureScot, 2019).

Fifty percent of England's woodlands are unmanaged and this undermines the health and resilience of the woodlands (RFS, 2019). Beavers can undertake actions in woodland that can have similar effects to interventions such as thinning and coppicing. Woodland in which beavers are present is likely to become a more dynamic habitat with increased open space. Enhancing structural diversity is a key element in increasing woodland resilience to the threats of climate change (Forestry Commission, 2022), and the dynamic structure provided by beavers can enhance the resilience of a woodland ecosystem (Fairfax and Whittle, 2020).

> "Beavers can undertake actions in woodland that can have similar effects to interventions such as thinning and coppicing."

Negative

Beavers dig burrows and channels into banks of waterbodies, fell trees and build dams, which may cause flooding to adjacent land, injury to livestock, damage to crops, property or machinery. Management of the risk from beavers to built infrastructure is a specialist subject not covered here, but is the subject of an upcoming publication by the Environment Agency.

Individually valuable trees such as orchards, veteran trees, and woodland aiming to produce timber, including cricket bat willow, can all be seriously impacted and may need protection. Beavers can disturb agricultural crops and cause economic losses through reduced productivity.

Beaver damage to trees should be considered differently to that caused by other damaging animals such as deer and grey squirrel which indiscriminately harm trees and the development of the whole forest. Deer and grey squirrels range freely across the country, and no woodland is without risk unless actively protected. However, when beavers are present at a site they may only interact with a small percentage of the overall woodland and have a self-limiting distribution restricted to the riparian zone.

Stakeholders
This article is written focusing on the risks from beavers to woodland creation. In reality, it will also be appropriate to consider the impacts of accepting the presence of beavers on your neighbours. It is recommended to work as part of a coordinated landscape group, being considerate of the needs and aims of other landowners who may suffer negative impacts. Stakeholder consultation should always form part of woodland creation design (Forestry Commission, 2014) and the amendments to accommodate beaver should feature within the consultation documents.

Predicting and managing beaver impacts

Information about beavers is available from scientific literature around Europe where Eurasian beaver have been re-established through natural spread. Their behaviour in the wild appears to follow a pattern. When they have an abundance of food and shelter, they will settle and remain within a small range. Studying these patterns of behaviour in Europe allows us to make predictions about the interaction between beaver and woodland in the UK. However, it is worth reminding readers that the UK has a very low woodland cover compared with Europe and this may cause beavers to behave differently.

The predicted impacts from beavers are divided into two categories: 'Felled Trees' and 'Flooded Woodland' and each will be discussed in turn.

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Felled trees
Beavers fell individual trees for either food or for dam building material. Trees will be selected based on either palatability of the species or proximity to where they intend to build a dam. When feeding, beavers show preferences for certain species which feature in their diet more frequently than the species occurs in the woodland ('palatable'), and show an aversion where the species features less frequently ('less palatable'). Whilst certain tree species are preferred, beaver can develop a taste for other species. Their digestive tracts 'learn' to tolerate species initially less palatable when food sources are limited; however, some species seem to remain unpalatable. Overall, they are 'choosy generalists' (Vorel et al., 2015).

Table 1. The known palatability of common species where information exists. Many genera are missing and should be assumed 'Moderate' until more information becomes available.

Palatable	Moderate	Less palatable
Salix (most species)	*Quercus*	*Fraxinus*
Sorbus (notably rowan)	*Alnus*	*Pinus*
Populus (notably aspen and black poplar)	*Acer*	*Abies*
Betula	*Prunus*	Most resinous conifers
Corylus	Orchard fruit trees (most species)	

Once the tree is felled, the beaver will feed on the bark, leaves and small twigs, potentially dragging small branches to feed near water or to take to their young, whilst larger, heavier branches and stems are eaten where they fall. This food forms the majority of a beaver's diet.

Feeding activity will be more obvious close to places of safety where a beaver can retreat if it feels threatened – this means a water body of sufficient depth. Beavers will travel further for more palatable species and can travel up to 200 m in search of food, but seem to do so only if there is insufficient food closer to the safety of the water. For this reason, they are often referred to as 'central zone feeders' and there will be greater impacts on a higher percentage of trees closer to the water body. Regularly, the distance of 20 m from the riverbank is recorded as being the usual foraging distance where 80% of felled material will be found (Pejstrup, Andersen and Mayer, 2023).

There is no known limit regarding a beaver's ambition to fell large trees, and substantial gnawing has been witnessed by the author on trees well over 1 m in diameter. Such trees can take them many months, even years, to complete. However, a link between effort expended and food gained means that smaller trees are preferentially targeted (Parker and Rosell, 2012).

Larger trees will display the characteristic 'hourglass' gnawing (Figure 1) until the stem is eventually felled, whereas smaller stems can be severed in a single bite. This first cut is usually made at a height where the beaver sits on its haunches; this leaves stumps typically 30-45 cm high, sometimes with a point that resembles a sharpened pencil (Figure 2).

Generally, younger broadleaved trees remain alive after felling and resprout from buds at the base where the bark is left undamaged. If felled when partially severed, then the tree may respond in the same way as to traditional hedge-laying, the trees sprouting from along the length of the stem (Figure 3).

Observations indicate that beaver seem to leave the tree to regrow before returning to recoppice new stems once large enough (with 47% of feeding activity focused on stems between 1 cm and 5 cm diameter (Campbell-Palmer et al., 2016)), so the greatest risk to the survival of the tree comes from the subsequent browsing by deer (Figure 4).

Action to reduce impacts

Where beavers are predicted on a watercourse adjacent to a new woodland scheme in which they can feed, it is recommended to take precautions and include in the design a selection of the following measures to accommodate them if they arrive:

- Plant a buffer of sacrificial palatable species within the first 20 m of the watercourse to provide food required by the beavers; this may prevent them travelling beyond this zone.
- Plant a mixture of sacrificial palatable species and a suite of less palatable species which can potentially grow on to become canopy trees, creating structural diversity.
- Increase the planting density by 40% within the first 10 m of buffer to allow sacrificial trees to be felled. (Note: be careful to keep dappled shade on the water in line with UKFS guidance).
- Timber trees can begin to be planted beyond the 20 m buffer strip, but include a decreasing percentage of palatable species for the first 50 m as a precautionary measure.
- Use unpalatable species as timber trees where timber is an objective.
- Protect all trees from deer and rabbit browsing (especially new shoots of felled trees) even where beaver are interacting with the trees. There is a useful section on riparian tree protection in the UKFS Practice Guide *Creating and Managing Riparian Woodland* (Forestry Commission, 2024).
- If high value trees (timber, orchard fruit, veteran etc.) are growing near a watercourse, there are easy steps that can be taken to protect them. For a summary, see the section on 'Beaver Foraging' in Beaver Trust (2024).

Figure 1. Recurring beaver activity on an old tree producing the characteristic 'hourglass' shape.

Figure 2. A young oak tree felled by beaver.

Figure 3. A fallen resprouting tree.

Figure 4. The well-known effect of browsing by deer is a significant risk for any tree, including those affected by beaver.

Flooded woodland

Beavers will seek areas where food is available and attempt to establish a territory there. When threatened, beaver need a sufficient depth of water, typically at least 70 cm deep, to retreat into as they are fast and powerful swimmers but ungainly on land. They can engineer their environment to increase water depth by building dams and thereby ensure this place of safety is near the food source. The increase in water depth can cause the surrounding land to flood.

Where the existing water is already deep enough, then dam building is infrequent. A survey of beavers in Scotland found that out of 251 active beaver territories, only 118 dams were identified (Campbell-Palmer et al., 2021).

Figure 5. Beavers display a non-random pattern of felling trees towards the watercourse.

Dam building

Trees will be felled to build the dams. A dam is constructed by felling trees across a watercourse, then weaving in woody material and packing this with mud to create a watertight structure. These can be hundreds of metres wide but are generally only 1-2 m tall (Ronnquist and Westbrook, 2021). This behaviour exhibits less selectivity of species than feeding and instead is based on proximity to where the dam is being built. No size or species of tree is off-limits for a beaver intending to build.

Smaller trees will be included in the structure, but larger, heavier trees at a distance from the dam are less likely to be used. Whilst beavers seem to directionally fell trees, sometimes a large tree can fall away from the watercourse and be too heavy to move, and so the felled tree goes unused (Figure 5). Note that this tree felling activity can endanger an otherwise 'beaver-proof' fence.

Dams require maintenance, and where this does not happen, dams deteriorate and can be abandoned, or they may get washed out at peak flows. Therefore, water levels can rise and fall over time. Beavers will keep maintaining dams as long as they remain in the territory, which they will tend to do as long as food sources remain available. Beavers tend to build a series of dams creating numerous ponds near each other, which can change, grow, or deteriorate over time as individual dams become obsolete with the water level changing accordingly (Figure 6).

Flooding

Where dams are built and the water backs up behind the dam, the depth of water increases and, depending on the topography, the surrounding area may be flooded. This can happen slowly with an accumulation of small ponds, or dramatically when a perched stream bursts its banks and floods a lower-lying area. Where woodland is flooded, this can cause extensive tree mortality, resulting in deforestation and the creation of open water.

Species intolerant of flooding will quickly die, whilst species tolerant of prolonged waterlogging may survive and spread. If a woodland does not contain any tolerant species, then it may be lost entirely.

Flooding-tolerant species

It is important to make a distinction between tolerance to temporary and permanent inundation. Many species tolerate short periods of flooding when in flowing oxygenated water, but where standing water stagnates, trees die much more quickly. The only native species able to withstand prolonged flooding are alder, black poplar, and some willows, but even these may fail in permanent standing water.

Some tree species can survive with extremely shallow root systems located in an aerated surface profile where the roots are still able to function. This can be a zone above groundwater, or hummocks amongst standing water. With as little as 10-20 cm of rooting depth, some trees can survive, even where this is waterlogged soil above the water table (Dobson, 1995). It is often the vital mycorrhizal connections that are lost in waterlogged soils.

Table 2. Species able to survive with limited rooting depth (Glenz et al., 2006).

Water tolerant species where rooting depth <10cm	**Moderately tolerant where rooting depth >10cm**
Alnus sp.	*Quercus robur*
Salix sp.	*Crataegus monogyna*
Poplar, including *P. tremula*	*Sorbus aucuparia*
and *P. nigra*	*Acer pseudoplatanus*
Pinus contorta	*Fraxinus excelsior*
Picea abies	*Corylus avellana*
Betula pubescens	*Acer campestre*
Taxodium distichum	*Pinus sylvestris*
Ulmus minor	*Betula pendula*

Figure 6. Following raised water levels, these willows became unstable and fell; they developed roots into the water and sprouted upwards from the stem. Once the dam was breached, the water level dropped; the roots are now exposed.

The species regarded as having some tolerance are shown in Table 2.

To create an inherently resilient woodland, a diverse mixture of tree and shrub species should be used. The list in Table 2 gives an adequate number of species that can be mixed, but care should still be taken to select the species that match the soil and local climate and are mutually compatible.

Risk assessment when predicting flooding by beavers

Due to the significant impacts of flooding on woodland, we need to respond carefully if beaver activity could possibly initiate flooding. The following section offers a method to carry out an assessment of the risk that beaver may cause a site to flood. This risk is distinct from the tree felling for food described above, which may also occur. Following standard risk assessment processes (HSE 2024), this requires an assessment of the likelihood and then the severity of the risk, which in this case is flooding.

Desk-based research can help understand the height of the land. Flood maps, overland flow pathway maps and LIDAR images can reveal the lowest lying areas of land. Useful maps are freely available from the government's Farming Advice Service by searching online for 'Agricultural Land Environment Risk and Opportunity Tool'.

Table 3 shows a list of factors and suggests the impact they may have on the likelihood of flooding occurring, and Table 4 lists the factors affecting severity. The length of the article prevents an explanation of each of the factors shown, but these are all linked to the current understanding of the likelihood of flooding and the severity of effects in the scientific literature.

Table 3. Factors affecting the likelihood of flooding.

High	Medium	Low
Stream bed flat to 1.5 degree (3%) gradient.	Stream bed gradient between 1.5 and 3 degrees (3-5%).	Stream bed gradient >3 degrees (>5%).
Watercourse less than 6 m wide.		Watercourse wider than 6 m.
Watercourse normally slow flowing.	Intermediate flow rate.	Watercourse rapidly flowing.
Abundant woody building material freely available.	Some material available.	No woody building material available.
Watercourse <70 cm deep.	Watercourse 70-100 cm deep.	Watercourse >100 cm deep.
Space for multiple dams to create wetland complex.		Limited space allowing for vulnerable single dams.
Vegetation already species of wet ground.		Vegetation indicating free draining drier soil.
Shallow water table <30 cm.	Intermediate depth of water table 30-100 cm.	Deep water table >100 cm.

Actions

As part of normal woodland creation design, landowners should check land is suitable for woodland creation and assess for all other normal constraints (FC, 2021). The Land Information Search tool can be helpful for this (FC, 2018). Then assess these areas for the impacts of beavers.

Once this flood risk is better understood, then the land can be zoned according to risk profile. Each of these can be treated separately (Table 5):

- *High risk*. It will be imprudent to create woodland here; instead, leave this zone as open space for future open water. This may be naturally colonised by some tree species in areas where they are able to survive, but the chances of being able to establish a woodland successfully in this space are low. Start the 20 m riparian buffer described above from the outer edges of this zone.
- *Medium-high risk*. Land likely to become seasonally flooded only during peak flows or where the water level will reduce rooting depth to <10 cm. Map this zone and exclude anything other than wet woodland creation dominated by waterlogging tolerant species.
- *Medium risk*. Land sporadically flooded or where the water table is likely to remain below the surface, providing a rooting depth of at least 20 cm. Here, a range of trees can be used to create mixed woodland based on species known to survive with shallow rooting depth (see Table 2).
- *Low risk*. Create a mixed woodland using a wide range of species with at least moderate tolerance of seasonal flooding. Consider the provision of palatable species.

Table 4. Factors impacting the severity of flooding, should it occur.

High	Medium	Low
Riverbank <1 m above stream bed (waterlogging risk).	Riverbank 1-2 m above stream bed.	Riverbank >2 m above stream bed.
Surrounding land below the riverbed and forming a significant part of the planting area.	Surrounding land <50 cm above the riverbed.	Most surrounding land significantly higher than the riverbed (>100 cm above).
Land flat prone to be fully flooded.	Land with some raised areas.	Land in flood zones uneven with pronounced hummocks that provide rooting areas above the water table.
Small scheme <2 ha.	Scheme size 2-10 ha.	Large scheme >10 ha.
Riparian woodland <20 m wide forms majority of scheme.	Riparian woodland between 20-100 m wide.	Woodland >100 m wide with small percentage formed by the riparian zone.
Clay soil and/or impeded drainage such as compaction or iron pan.	Loamy soil.	Sandy free draining soil.
High chance of flooding on mapping (1 in 10 year).	Medium chance of flooding on mapping (1 in 20 year).	Low chance of flooding on mapping (1 in 50 year).

Conclusions

It is the author's opinion that the actions of beaver can be predicted to the extent that we can design new woodland to accommodate them whilst still

Table 5. Risk matrix.

		Severity		
		High	Medium	Low
Likelihood	High	High	Med-High	Medium
	Medium	Med-High	Medium	Low
	Low	Medium	Low	Low

achieving our objectives for sustainable forestry. There are risks that come from working alongside this 'novel' species, but experience so far in the UK shows that woodland is still present in areas where beavers have been living wild for a decade.

Once we have assessed the risk and taken sensible precautionary actions, it gives us the confidence to spend the time and effort establishing new woodland in places where we are confident it can thrive. If the structurally diverse woodland that is likely to form will be compliant with the aims of a woodland creation grant, then we should have the confidence to explore this.

It is also possible that land where beavers are active and that becomes less productive for agriculture could be well-suited to conversion to riparian woodland, which can much more easily accommodate a family of beaver. This can reduce conflict by providing the landowner with a viable land management option for which grant aid could be available for enhancing the natural capital on the site.

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