Spey Catchment: Beaver Feasibility and Potential Release Site Assessment

October 2023

Prepared as part of a wider feasibility study into the potential return of beavers to Cairngorms National Park by:

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*cover photo, main channel of River Spey, south of Blargie © Alan Puttock

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Introduction and Aims

This report was commissioned by the Cairngorms National Park Authority (CNP) to investigate the habitat feasibility of the Spey catchment to support the restoration of Eurasian beavers (*Castor fiber*). Potential release sites for first releases (mid-River Spey area only) have been identified, prioritising landowners that may support any release licence application. Other sites have been investigated and though they may not be proposed as release sites, could support beaver colonisation as any population expands naturally.

Following initial feasibility work and the subsequent decision to proceed with bringing beavers back to the Cairngorms, the Park Authority are keen to undertake further assessment work to inform potential release site selection, likely population dynamics, dispersal routes and areas of likely future colonisation, alongside further assessment of potential impacts (positive or negative). This report addresses some of these aims by building on an initial feasibility study, on ground experience and knowledge combined with the deployment of models developed at the University of Exeter, and many years' experience by these authors of beaver restoration dynamics. We present habitat suitability and beaver dam capacity in support of understanding the distribution of likely beaver populations in the future at the landscape scale across the Spey catchment.

The habitat suitability and the capacity for beavers to dam channels within the study areas was assessed using beaver modelling tools developed by researchers at the University of Exeter (Graham et al., 2020). These modelling tools consist of a Beaver Habitat Index (BHI) model and a Beaver Dam capacity (BDC) model.

There is a requirement to complete an analysis of river catchments to assess their suitability for supporting populations of beaver. Beaver habitat suitability is determined primarily by vegetation suitability which has been classified nationally using a Beaver Vegetation Index (BVI) as well as access to water bodies. Together these two factors have been incorporated into a Beaver habitat Index model (BHI). BHI has been run nationally to develop a high resolution (5m) continuous raster product that can inform local decision making with regard to beaver reintroduction. BHI classifies habitat suitability from 0 (No access to vegetation - not suitable) to 5 (Highly Suitable). It must be clarified that this habitat model is a simplified representation of reality and caveats associated with the model are listed in appendices.

Beavers are also well known as ecosystem engineers, having the capacity to change environments to suit their needs. The beaver engineering activity that has the greatest capacity to modify ecosystems is dam building. Dam building and the creation of ponded surface water has the ability to bring benefits (i.e., for biodiversity, water storage, flow attenuation) but also potentially management and conflict (i.e., localised inundation of land, blocking of critical infrastructure). BDC classifies reaches from no capacity for dam building to a pervasive capacity for damming.

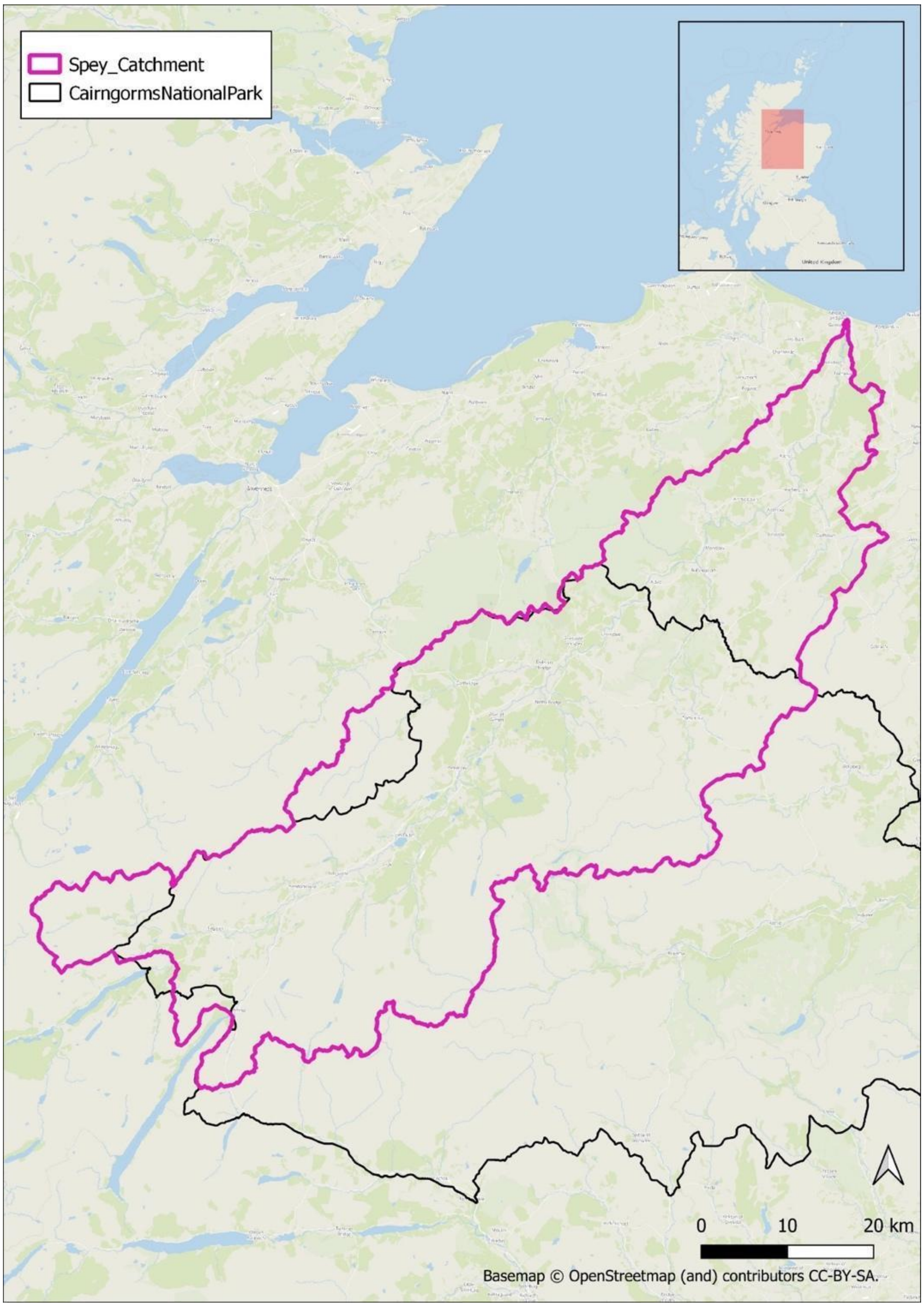

Figure 1. Study areas showing Spey catchment extent (in pink) relative to Cairngorms National Park boundary (in black).

Modelling of Beaver Habitat Suitability Spey Catchment

Beaver Habitat Suitability Modelling

Summary Description: Production of a continuous description of habitat suitability for beaver. First a vegetation suitability index is created using multiple high-resolution spatial datasets from Ordnance Survey, CEH and Copernicus will be combined to provide detailed land cover/vegetation information which is classified based on empirical field observation of beaver habitat and preference. Vegetation suitability is combined with additional parameters describing stream networks and water bodies. Whilst beaver habitat suitability is primarily defined by vegetation suitability, beavers also require water for security and movement. Therefore, accessibility to water bodies (i.e. channels, ponds, and lakes) will also determine the viability of beaver occupancy and therefore are required to classify habitat accurately.

Outputs: This product provides a high-resolution (5m cell size) resource (raster .tiff format) for describing habitat suitability for beaver. This dataset can allow the user to explore which landscapes were most (or least) suite to beaver reintroduction and also to understand where habitat enhancement might be useful to support future reintroduction.

Beaver Vegetation Index (BVI –prerequisite for BHI modelling)

Vegetation is important for classifying beaver habitat (Hartman, 1996; John et al., 2010; Pinto et al., 2009; St-Pierre et al., 2017). It was therefore critical to establish a reliable Beaver Vegetation Index (BVI) using nationally-available spatial datasets. No single dataset contained the detail required to depict all key vegetation types. Therefore, a composite dataset was created from: OS VectorMap data (Ordnance Survey, 2018), The Centre for Ecology and Hydrology (CEH) 2015 land cover map (LCM) (Rowland et al., 2017), Copernicus 2015 20 m Tree Cover Density (TCD) (Copernicus, 2017) and the CEH woody linear features framework (Scholefield et al., 2016).

Vegetation datasets were assigned suitability values (zero to five). Zero values were assigned to areas of no vegetation i.e. buildings and values of five were assigned to favourable habitat i.e. deciduous woodland. Values were assigned based on a review of relevant literature (Haarberg and Rosell, 2006; Jenkins, 1979; Nolet et al., 1994; O'Connell et al., 2008), field observation and comparison with satellite imagery. Vector data were converted to raster format (resolution of 5 m). TCD data were resampled to 5m and aligned with converted vector layers. An inference system was used to combine these four raster datasets to create the BVI. The workflow prioritises the reliability followed by the highest value data.

Examples of highly suitable land (graded 5) include broad-leaf woodland, mixed woodland and shrub; examples of suitable vegetation (graded 4) include shrub and marsh; examples of moderately suitable (graded 3) include coniferous woodland, marsh, shrub and unimproved grassland; examples of barely suitable (graded 2) include reeds, shrub and heathland and boulders, neutral grassland; examples of unsuitable (graded 1) include heather, acid grassland, unimproved grass and boulders, bog; examples of no accessible vegetation (graded 0) include shingle and sand, buildings, rock, urban and saltwater.

Beaver Habitat Index model (BHI)

Whilst vegetation is a dominant factor in determining habitat suitability for beaver, so is proximity to a water body (Gurnell et al., 2008), with beavers being strong swimmers, using water bodies both to provide security, as a means of escaping predators and to access foraging areas. It is thought that most foraging occurs 10 m of a watercourse/body (Haarberg and Rosell, 2006), and rarely above 50 m (Stringer et al 2018). However, greater foraging distances have on occasion been observed and as in Macfarlane et al., 2015 100 m has been accepted as a maximum distance in which the vast majority of foraging occurs. Therefore, to determine suitable habitat for beaver incorporating both BVI vegetation suitability and water accessibility a 100m buffer was applied to water bodies. To do this the OS mastermap river network and OS vector in land water bodies were combined to get the best readily available national waterbody and water course coverage.

Whilst BVI was run nationally on a 5 m scale it is best viewed as a preparatory step for BHI (and later BDC) modelling and is superseded in usefulness by the BHI dataset. It is strongly recommended that most analysis and management applications such as this study use BHI i.e. if there is an area of preferred vegetation such as willow woodland, more than 100 m from a waterbody it is thought inaccessible to beaver and therefore does not form suitable habitat.

Both BVI and BHI use a scoring system of zero to five (Table 1). Scores of five represent vegetation that is highly suitable or preferred by beavers and that also lies within 100 m of a waterbody. Zero scores are given to areas that contain no vegetation or are greater than 100 m from a waterbody. It is important to note that the habitat model considers terrestrial habitat where foraging primarily occurs and that watercourses themselves are also scored zero. It is also important to note that all scores above 1 contain suitable vegetation.

In addition to the raster layer, BHI values are associated with the reach scale Beaver Network river layer as BFI (Beaver Forage Index). Reach BFI values were obtained for two search areas, 10 m (streamside) and 40 m (riparian) from the bank edge. Both search areas extend 100 m up and downstream to account for connectivity of reaches. The mean of the top 50% of BFI values in each search area was extracted to understand the suitability of the best available habitat within a given reach.

Table 1. BVI and BHI value definitions. It is critical to note that all values above 1 are suitable for beaver.

BFI and BHI Values	Definition
0	Not suitable (no accessible vegetation)
1	Likely Unsuitable (unsuitable vegetation)
2	Low/Barely Suitable
3	Moderately Suitable
4	High/Suitable
5	Preferred/Highly Suitable

Beaver Habitat Index maps and summary statistics for study area

Table 2. displays the summary statistics (length and %) of gross habitat category types across the watercourses of the Spey catchment (See Figure 2).

Table 2. Summary habitat mapping statistics for the Spey catchment

Habitat Category	Length (km)	% in each category
Likely Unsuitable (1)	2989.7	43.4
Low (2)	950.7	13.8
Moderate (3)	749.3	10.9
High (4)	997.3	14.5
Preferred (5)	1203.4	17.5

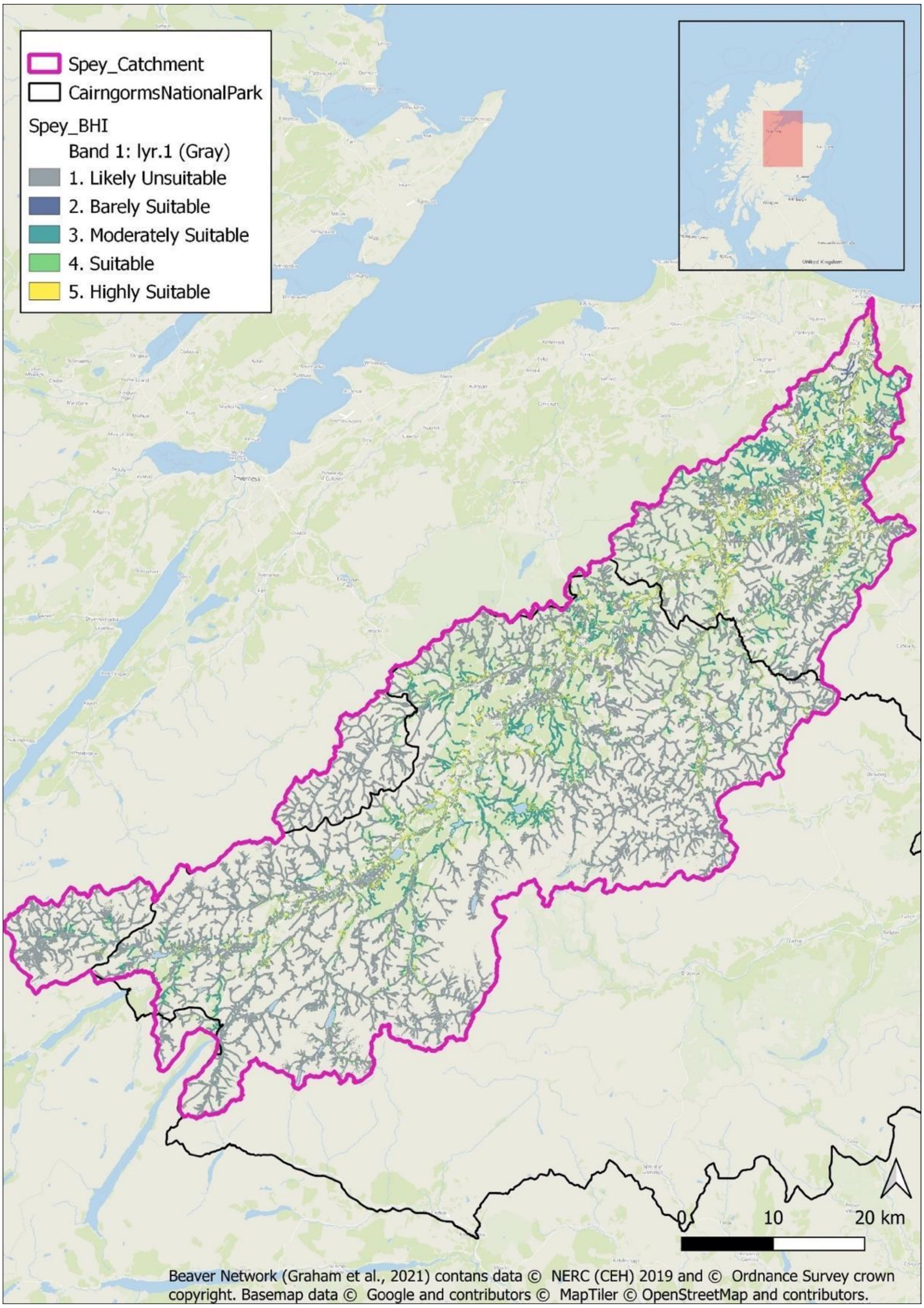

Figure 2. Beaver Habitat Index at a 5 m resolution across the entire study area. Contains Ordnance Survey data © Crown Copyright 2007 and some features of this map are based on digital spatial data licensed from the Centre for Ecology & Hydrology, © NERC (CEH).

Beaver Dam Capacity Modelling of Spey Catchment

Beaver Dam Capacity (BDC) model summary

The Beaver restoration assessment tool (BRAT) was developed in North America (Macfarlane et al., 2014, 2015) to determine the capacity for river systems to support Beaver dams. The BRAT model has been further deployed in a range of different river systems to aid both Beaver recolonisation and beaver dam analogue led restoration. The BRAT model not only provides an invaluable tool for designing effective, empirically based, restoration strategies but it also indicates where Beaver dams might be constructed and therefore where they may cause potential management/conflict issues. The BRAT model structures the framework of the model around the river network itself and using a fuzzy logic approach which builds in the considerable uncertainty that is associated with beaver habitat/dammable reaches. Furthermore, it provides a range of output values to predict the dam capacity which has implications for beaver preference towards a given location.

We have therefore used the BRAT framework to develop an optimised beaver dam capacity (BDC) model for Great Britain; and although many of the datasets used are specific to GB, these could readily be adapted to enable its use globally.

The BDC model estimates the capacity of river systems to support dams at the reach-scale (ca. 150 m). The model also highlights reaches that are more likely to be dammed by beaver and estimates the number of beaver dams that could occur for a catchment at population carrying capacity. As such, this highly detailed tool would provide understanding of where dams are most likely to occur and in what densities, supporting future work on the conflicts and opportunities that might accrue from beaver reintroduction.

The model infers the density of dams that can be supported by stream reaches (111.1 m ± 52.5) across a catchment. Using low-cost and open-source datasets, the following attributes are calculated for each reach: (i) stream gradient, (ii) low (Q80) and high flow (Q2) stream power, (iii) bankfull width, (iv) stream order, and (v) the suitability of vegetation, within 10m and 40 m of the bank, for beaver dam construction. These controlling variables are combined using a sequence of inference and fuzzy inference systems which follow an expert-defined rules system that allows for the considerable uncertainty often associated with these types of complex ecological processes.

Each reach was classified for damming capacity using five categories from none, defined as no capacity for damming to pervasive where a maximum capacity of 16-30 dams could theoretically be constructed in a km of channel. It is important to note that the model assumes both reach and catchment population carrying capacity for beaver. Therefore, in reality the maximum number of dams indicated in a category class is unlikely to occur. A full list of BDC classifications is included in Table 3.

Table 3. BDC classifications and definitions.

BDC Classification	Definition
None	No capacity for damming
Rare	Max capacity for 0-1 dams/km
Occasional	Max capacity for 1-4 dams/km
Frequent	Max capacity for 5-15 dams/km

Pervasive	Max capacity for 16-30dams/km

Beaver Dam Capacity Model maps and summary statistics for the study area

Table 4. displays the summary statistics (length and %) of gross dam capacity category types across the watercourses of the Spey catchment (See Figure 3).

Table 4. Beaver dam capacity summary statistics for the Spey catchment

Dam capacity category	Length (km)	% in each category
None	936.0	13.6
Rare	3418.8	49.6
Occasional	1326.1	19.2
Frequent	468.1	6.8
Pervasive	741.4	10.8

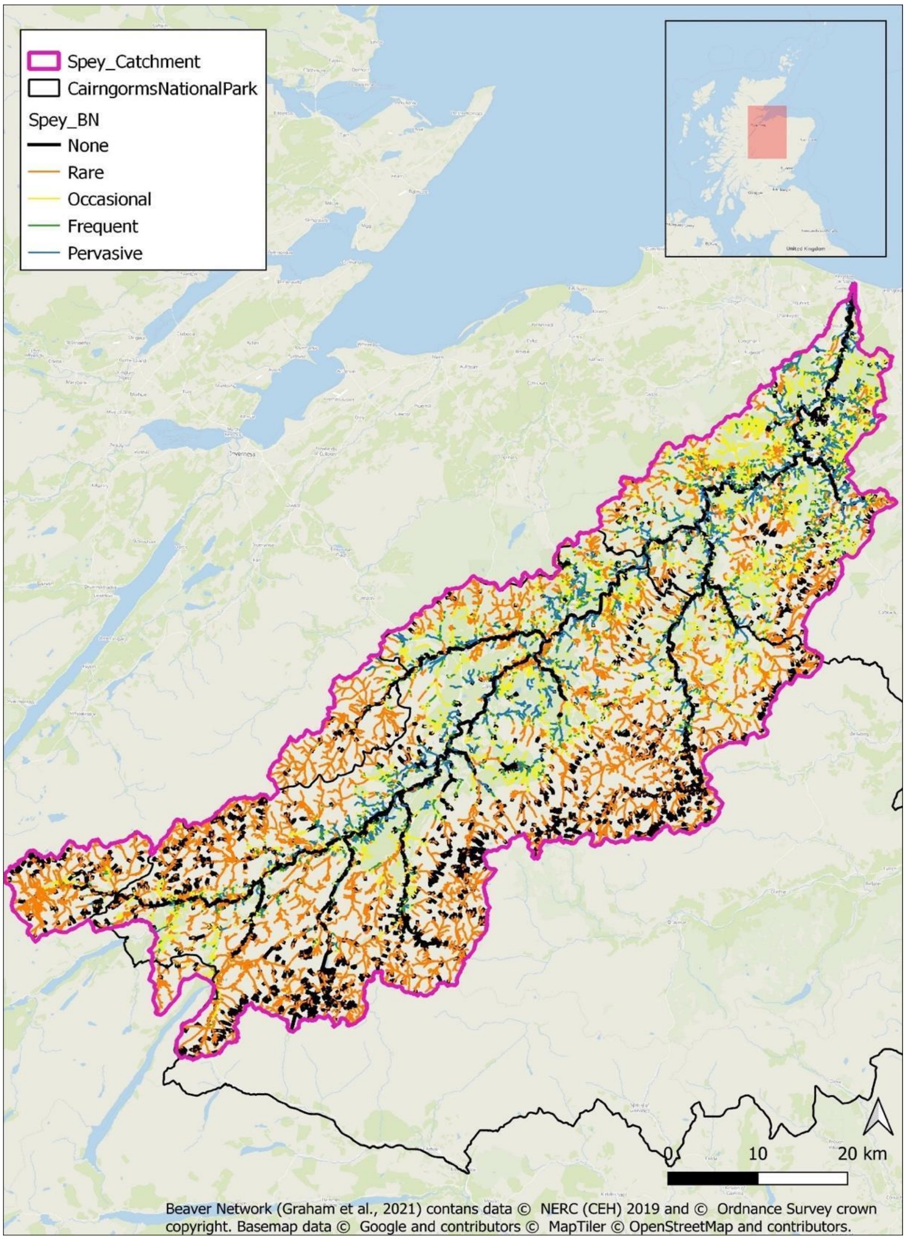

Figure 3. Beaver Dam Capacity model results for study area with catchments of interest highlighted. Contains Ordnance Survey data © Crown Copyright 2007, and some features of this map are based on digital spatial data licensed from the Centre for Ecology & Hydrology, © NERC and © Ordnance survey crown copyright.

Beaver habitat and dam capacity model summary

The model results presented herein, illustrate that throughout the Spey catchment, including within National Park, there are extensive areas of highly suitable habitat to support beaver populations. Additionally, there are many smaller reaches, with good habitat and suitable hydrological conditions where beavers could create dams, particularly in the more lowland areas. However, model results also show the main Spey and tributaries to be too large and powerful for beavers to dam. Similarly, many of the upland areas, particularly those within the NP lack suitable habitat and are also too steep to support beaver damming. These model outputs show the spatial variability in impact that could occur if beavers returned to being widespread both within the NP and the wider Spey catchment.

Combined with other components of feasibility work being undertaken, these model results will provide a geospatial basis for informing future impacts (both positive and negative) that the reintroduction of beavers could bring. Used strategically it is hoped that such data products can help maximise the benefits and minimise the conflicts associated with beaver.

Whilst useful, as with any model output, there are limitations and uncertainties (see Appendix 2 for use caveats) which need to be considered. These model results were ground-truthed during field visits to combine model outputs with expert interpretation to reach a conclusion on the suitability of the site will for beaver. Field based assessment will also consider the potential for beavers to bring positive impacts as well as the potential for management issues to arise and potential solutions to these.

Aspen Mapping

CNP have identified interactions between beaver and aspen (*Populus* spp.) as a potential concern flagged by other conservation groups and so have provided maps of known areas of aspen across CNP section of the Spey catchment. Aspen is a preferred forage species for beavers (Fryxell and Doucet 1993, Nolet et al. 1994) and especially if there is low availability of food nearby beavers will travel further from the water course to obtain this. Where it grows close to suitable water bodies it would most likely have the potential to be impacted. Studies have reported that beavers typically only fell aspen in leaf (Doucet et al. 1994, Wilsson 1971). It is critical to note that aspen readily suckers in response to beaver foraging, which increases its productivity, and beavers will often then forage on regrowth. Deer and livestock will preferentially feed on broadleaf new growth, so providing grazing pressure is not intensive new growth aspen will get away. The greater concern with beaver and aspen overlap, is beaver felling of mature trees and related impacts on associated bryophyte, lichen and invertebrate communities.

If particular trees, or more likely stands of mature aspen, are flagged as of interest, tree protection management approaches are readily available. To understand where known Aspen stands may have the potential to be impacted by beaver, a 10 m buffer was applied to all Aspen points and Polygons. These data points represent small, discrete groups of aspen <0.04 ha (20 x 20 m) in extent, plus individual aspen trees. The polygons are larger stands/areas of aspen-rich woodland ≥ 0.04 ha in extent.

From Figure 8 and 9 below it is evident that a large proportion of recorded Aspen areas exist within areas considered potential beaver habitat within the Spey. Out of 533 polygons of larger Aspen stands, 340 (or 64 %) fall within beaver habitat. For smaller stands represented by point data, 229 of 575 points (40 %) fall within beaver habitat. It is critical to note that this is a generous overestimation of overlap with beaver habitat assuming a maximum foraging range of 100 m from water courses, far greater than that which typically occurs. This analysis is presented as a first step in identifying known aspen stands that may overlap with beaver activity; however, local management and monitoring work is likely to be required to assess the ongoing conservation importance and any associated risks.

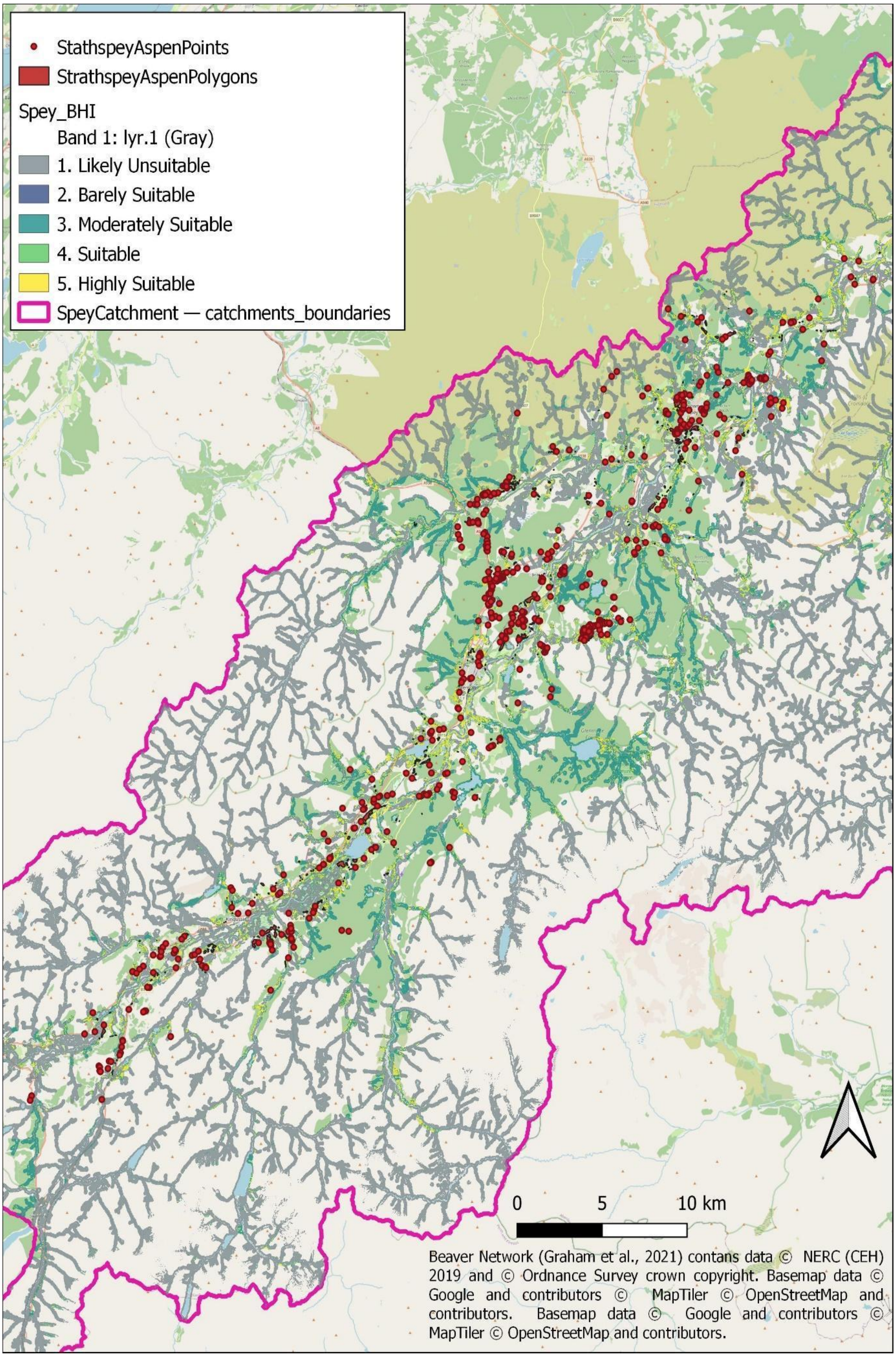

Figure 4. Aspen polygons and points mapped on top of beaver habitat for the Spey catchment. Points are enlarged to facilitate visualisation.

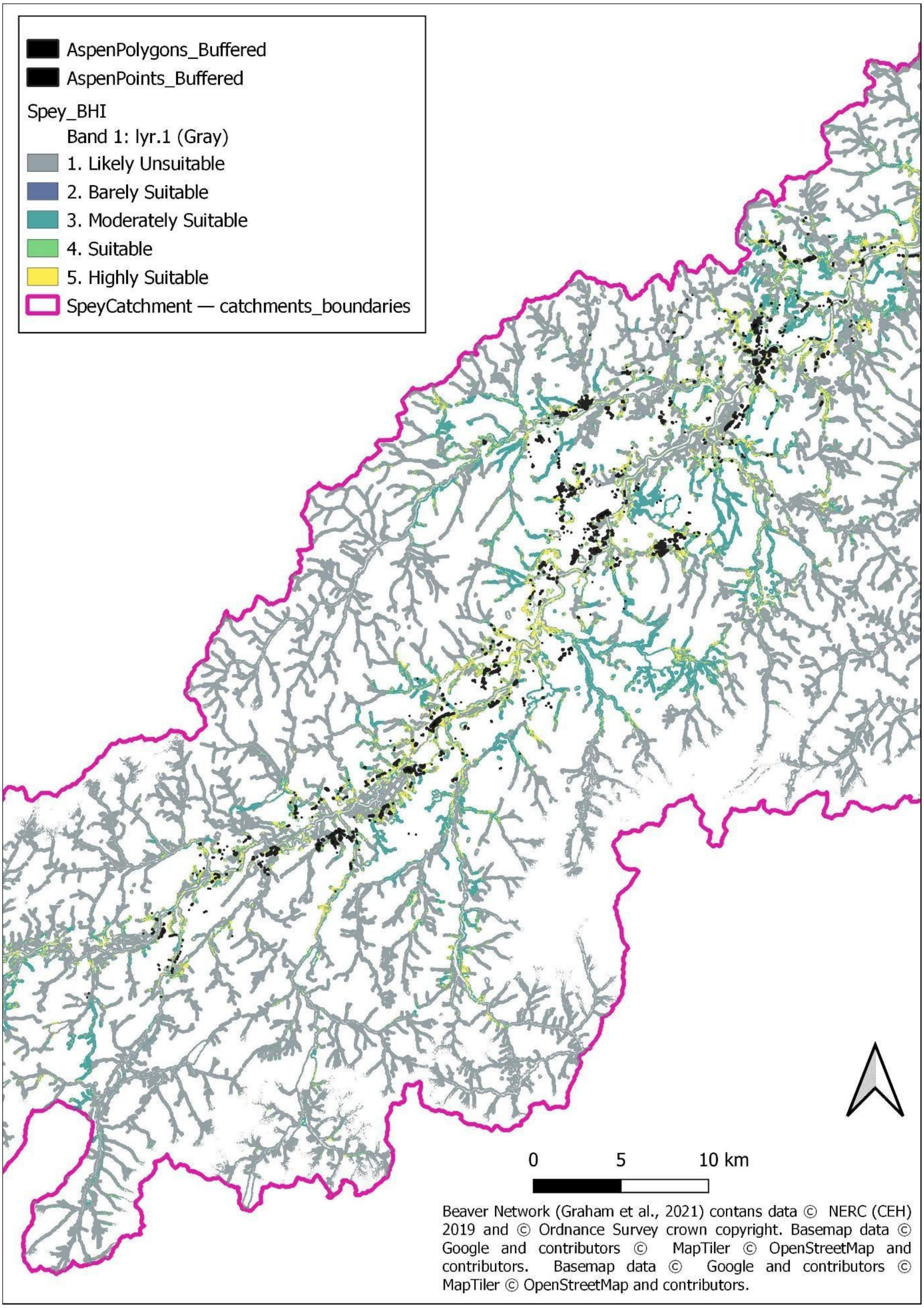

Figure 5. Buffered polygons of Aspen points and polygons overlayed with beaver habitat layers to calculate percentage overlap.

Beavers and Fish in the Spey

CNP have also identified interactions between beaver and salmonids as a potential concern. To support this feasibility project, locations of salmon and trout sampling points have been provided by CNP and the Spey Fishery Board. The sampling points provided are mapped in Figure 10, along with average density data in Figure 11 and 12. Figure 13 and 14 overlay current fish sampling points onto the beaver habitat and dam capacity layers. It is critical to note that the mapped data for fish only pertains to these datasets and additional fish data hosted by different organisations may be available. For further information on the trout and salmon data shown it is recommended contacting the Spey Fishery board.

The key benefits of beaver activity for salmonids that are commonly cited include increased habitat heterogeneity (Hägglund and Sjöberg, 1999; Smith and Mather, 2013) and quality (Pollock et al., 2003). In particular, ponds created upstream of beaver dams provide juvenile overwintering and rearing habitat (Cunjak, 1996; Needham et al., 2021), and can be a critical refuge for larger fish (Hägglund and Sjöberg, 1999; Needham et al., 2021). The beneficial response from a fisheries perspective is usually quantified in terms of increased fish abundance (Hägglund and Sjöberg, 1999; Jakober et al.,1998; Needham et al., 2021), condition and growth (Sigourney et al., 2006; but see Rabe, 1970, and Johnson et al., 1992; Needham et al., 2021), and overall productivity (Mitchell & Cunjak, 2007; Nickelson et al., 1992; Pollock et al., 2004). Conversely, the principal negative consequence of beaver activity often cited is the potential for dams to impede or delay salmonid migration, particularly for upstream moving adults during their migration to the spawning grounds (Lokteff et al., 2013; Rupp, 1955; Taylor et al., 2010). Furthermore, dams may reduce the availability of suitable spawning habitat in impounded areas, where there may be insufficient flow velocity to purge the gravels, which salmonids use for spawning and egg incubation, of the fine sediments deposited (Knudsen, 1962; Taylor et al., 2010). Malison and Halley (2020), however, found that beaver dams did not block the movement of juvenile salmonids or their ability to use upstream habitats and suggest that it is unlikely that dams negatively impact the juvenile stage of salmon or trout populations. Kemp et al. (2012) reviewed 108 studies of beaver and fish. Dams were cited as “barriers to fish movement” in 43% of papers and was the most common adverse effect discussed. However, these negative effects were speculative at best in that 78% of the studies did not support this claim with data. Further work is required to establish actual impacts of beaver dams on fish passage, but by cross referencing the BDC models with valuable salmonid habitat will help identify key areas of concern and alleviate possible impacts.

As described above, it is likely there will only be significant concerns where priority spawning grounds overlap with areas where beavers are present and there are suitable conditions for dam building. Therefore, along the main reaches of the Spey there is likely to be little concern due to there being no likelihood of damming, however, on some spawning grounds there is likely to be greater concern and need for monitoring and potential mitigation if deemed necessary. As an example of the monitoring points provided 90 out of the 181 monitoring points (49.7 %) have a high (frequent or pervasive) capacity for damming if beavers were present.

Many of the monitoring points provided do fall on reaches with beaver dam capacity, meaning if beavers were present in these reaches, they may provide a monitoring opportunity or a management concern. However, with only 181 monitoring points provided it is statistically unlikely that (at least in the short term) beavers would dam directly in the vicinity of these sampling points. Therefore, to provide opportunities to increase understanding between the impacts of beaver and fish supplementary monitoring targeted at beaver release site locations could be beneficial.

N.B. It is highly likely, as shown in the research literature for a number of sites studies (summarised in Kemp et al., (2012), that beaver activity, principally damming, will create new spawning grounds for salmonids, as cleaner and well oxygenated gravel beds are maintained. It is also possible that small areas upstream of dams accumulate sediment and potentially deteriorate in terms of quality for spawning. Thus, the balance between creation of new spawning grounds and potential negative impacts upon existing spawning grounds should be monitored. Overall, at the catchment scale, it is most likely that spawning habitat will extend and improve, as beavers establish and that salmonid population health and abundance will follow suit.

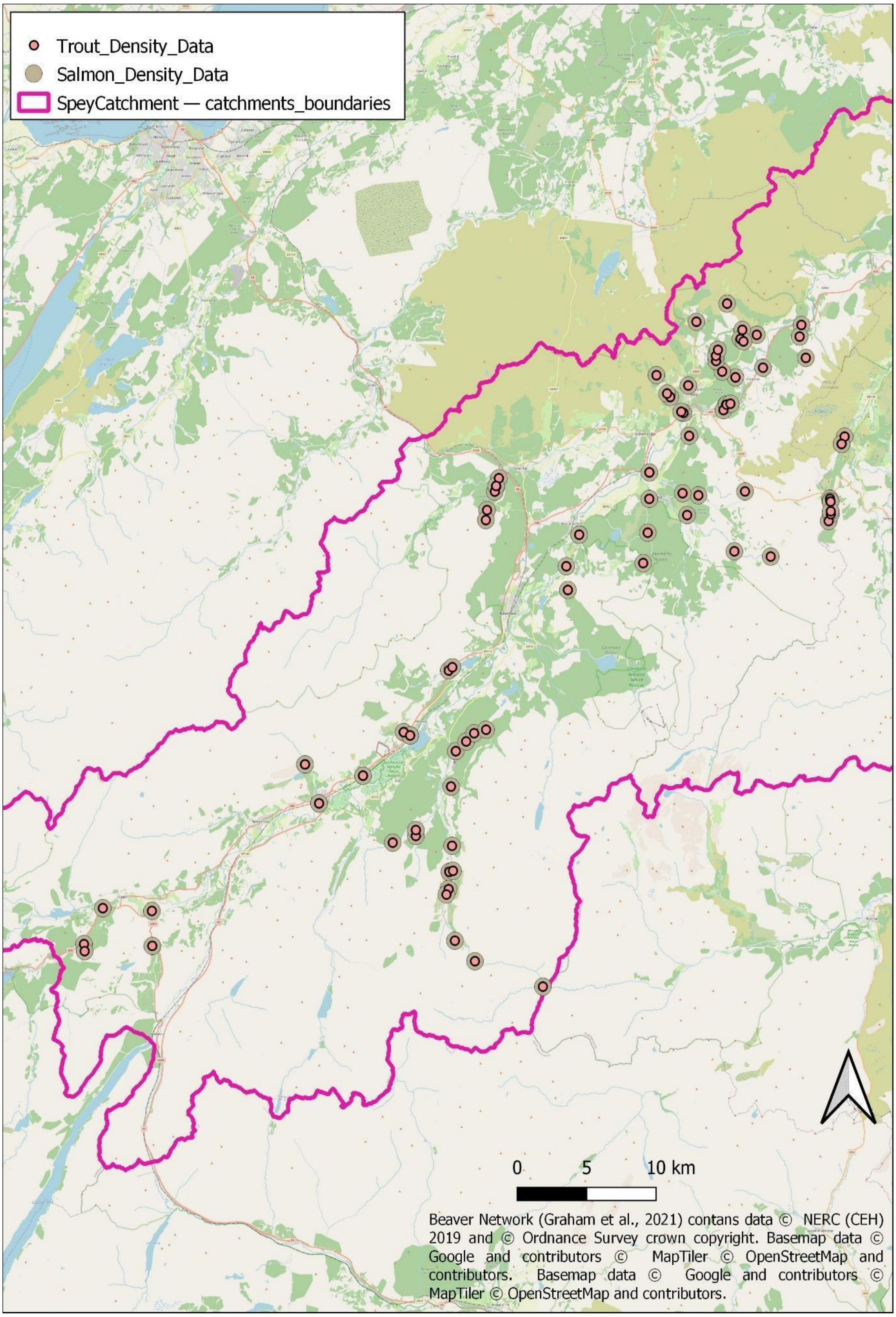

Figure 6. Points in Spey where trout and salmon data is recorded.

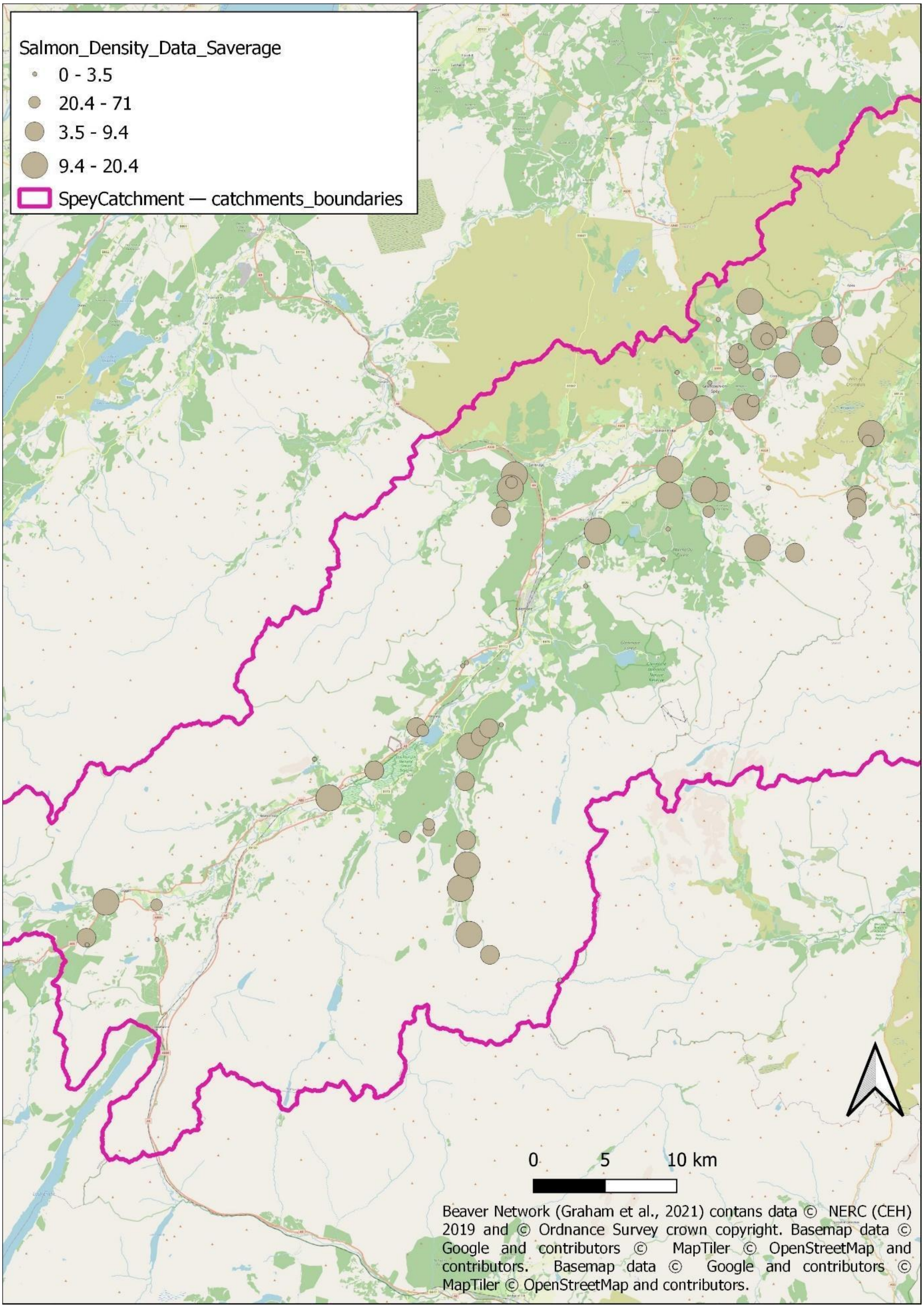

Figure 7. Salmon density average at provided monitoring points.

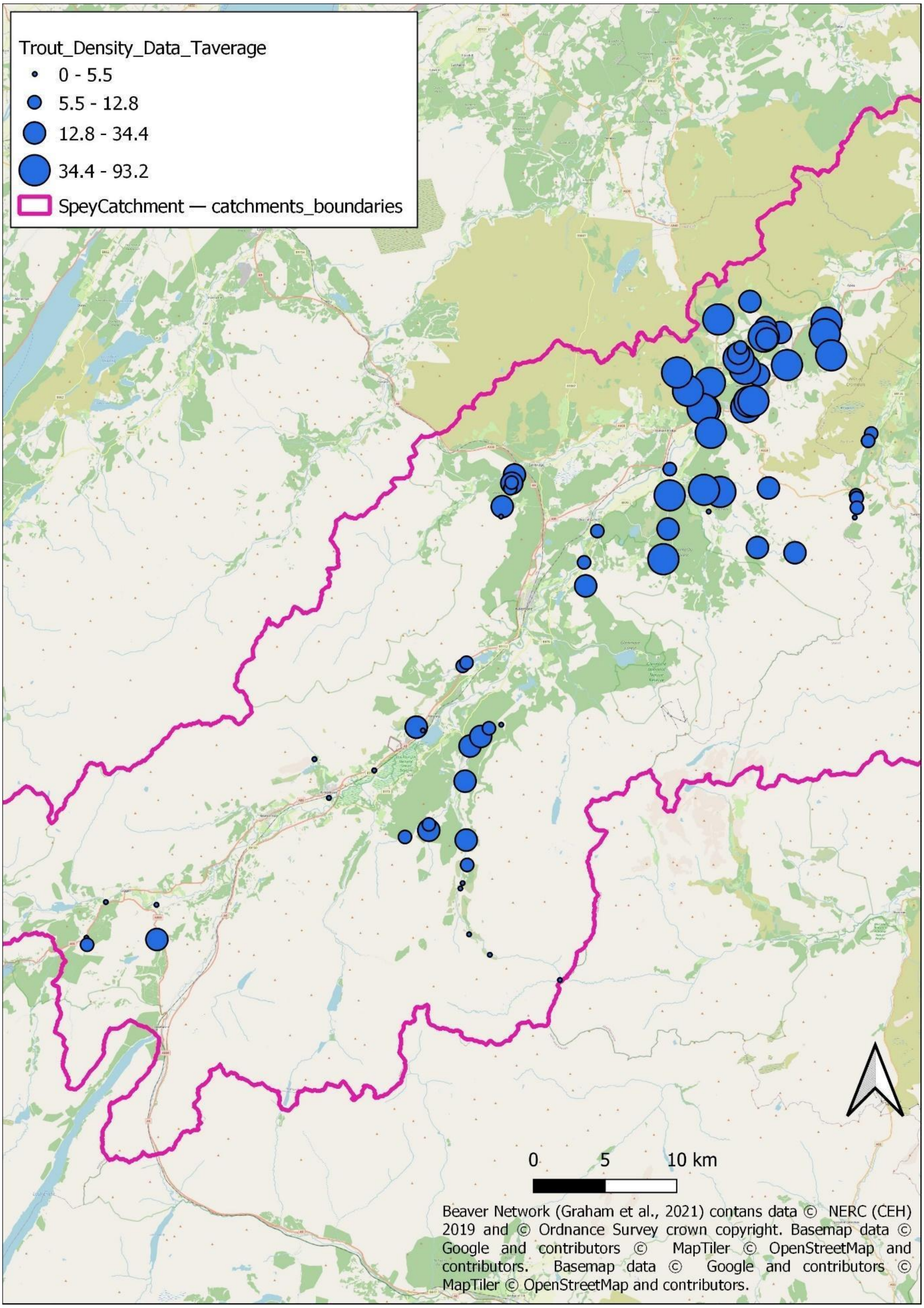

Figure 8. trout density average at provided monitoring points.

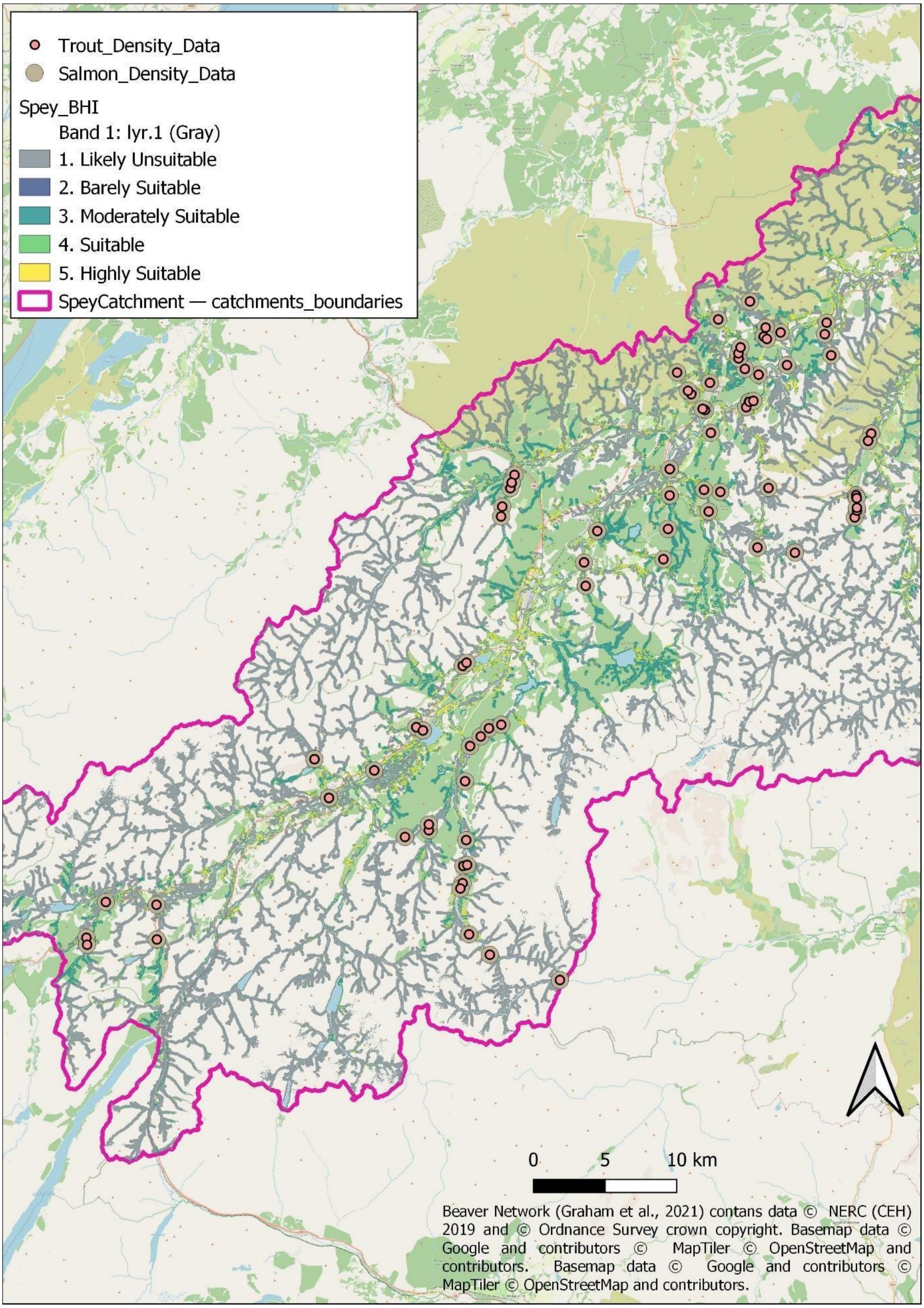

Figure 9. location of sampling points overlayed onto beaver habitat.

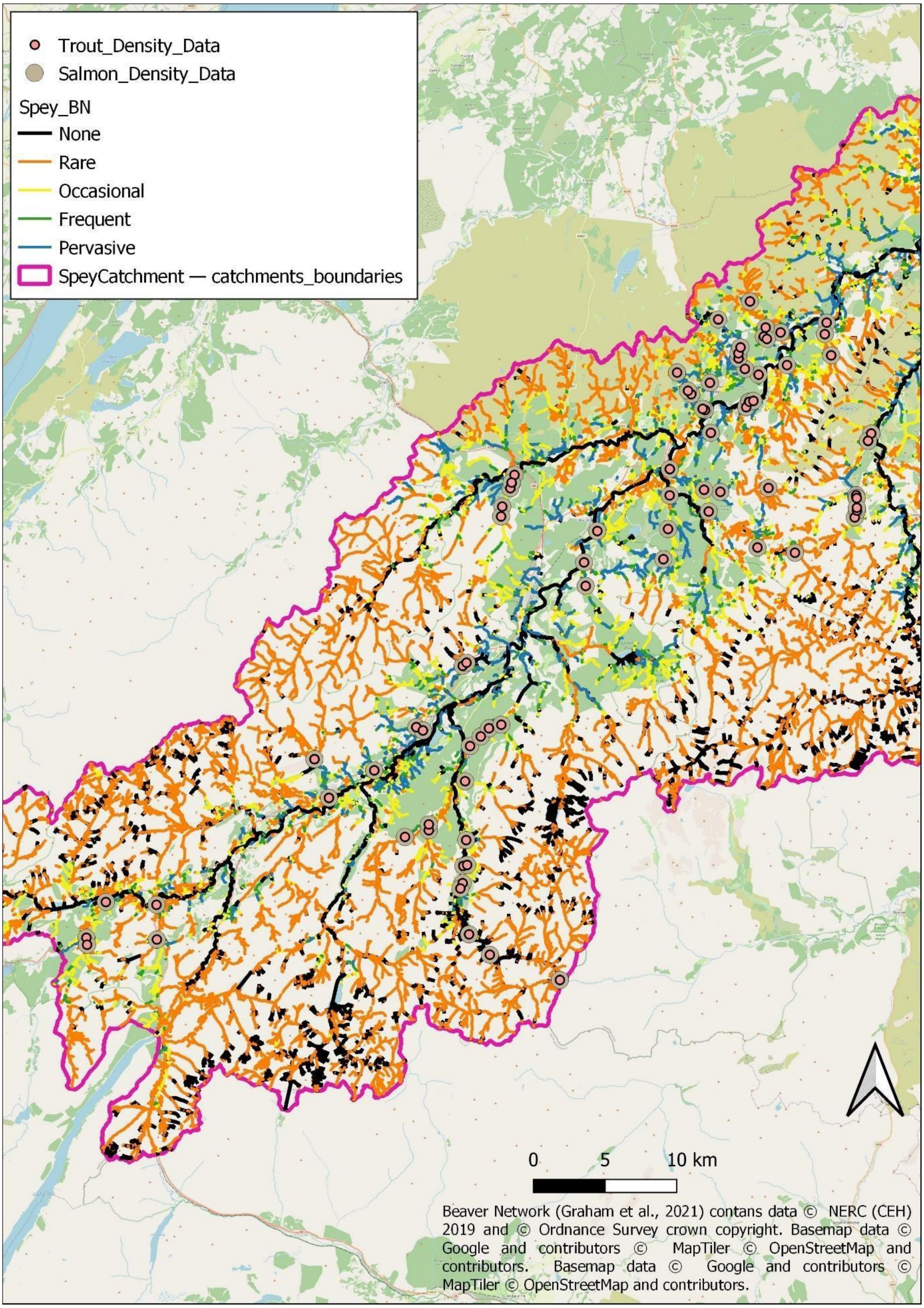

Figure 10. Location of fish sampling points overlayed onto beaver dam capacity river network layer.

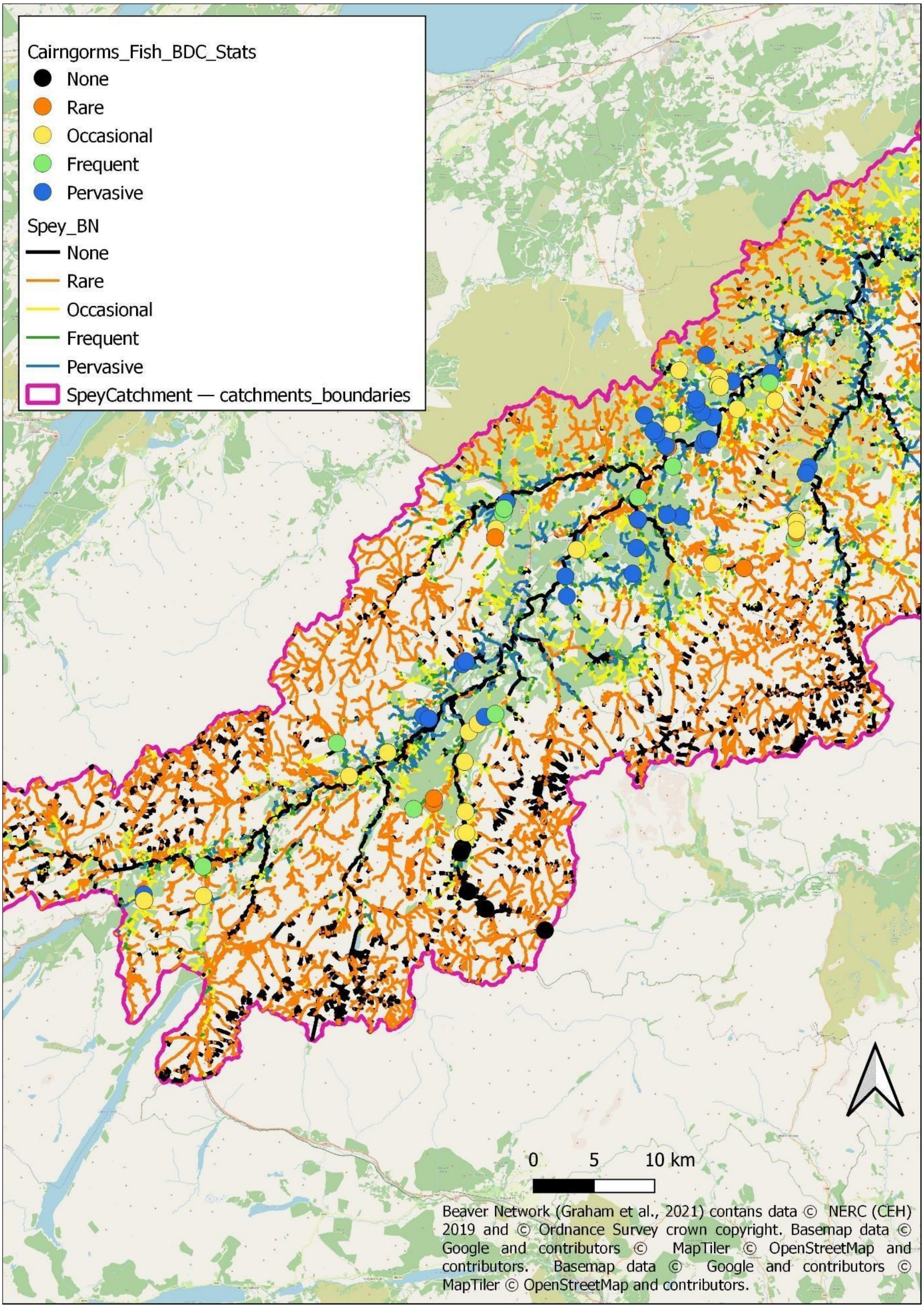

Figure 11. BDC classification for reach where each fish monitoring point exists. I.e. for each fish survey point provided by Spey Fisheries board the location has been matched with the corresponding river reach and the BDC model dam capacity classification has been extracted. This may give an indication that if beavers are present in these reaches where in time fish monitoring points may have the potential to be dammed.

Potential Release Site Assessments

Modelling outputs and site visits were made for each of the sites discussed below. Each site visit assessed and ground-truthed various site features. Methods for identifying the suitability and key habitat characteristics for beavers (both species) have been widely studied and published (including Allen 1983; Bergman et al., 2018; Dittbrenner et al., 2018; Halley et al., 2009; Hood, 2020; Macdonald et al.,1997). The main features considered included;

- The initial composition and structure of the vegetation within 30 m of the water's edge
- The distribution and abundance of palatable riparian trees
- The character of the riparian edge habitat
- The hydrology of the water bodies available to the beavers, including flow speeds, level stability and shoreline features
- Water management and where beavers may cause conflict i.e., flood banks/low-lying farmland/agricultural drainage.
- Topography – gradient of land, substrate type, valley shape
- Associated land-use – disturbance and land-management practices, infrastructure, water use

At each site an assessment of what beaver activities would be likely (e.g. damming or burrowing) over time and if these have a potential conflict concern were also assessed. All site survey work was undertaken in late March - early May, and involved speaking to CNP staff and local landowners associated with these sites as far as possible.

The following maps present model outputs for key sites that project partner engagement and feasibility visits have identified as being of potential interest for release. Please note no final decision has been made to release beaver at any of these sites.

In addition to model outputs, the Park Authority have provided fish (Salmon and Trout only) density monitoring points alongside mapped areas of known Aspen. For these data points represent small, discrete groups of aspen <0.04 ha (20 x 20 m) in extent, plus individual aspen trees. The polygons are larger stands/areas of aspen-rich woodland ≥ 0.04 ha in extent. These data points where near to particular sites of interest are included in maps for reference. To note these maps should be treated as displaying general data as a useful discussion starting point and further ground monitoring and refinement would be recommended going forward.

Site Mapping Summaries:

Insh Marshes

Overall extensive areas of suitable and highly suitable habitat around the site perimeter and more patchy vegetation within the marshes themselves which beavers will utilise. No dam capacity on the main River Spey as too large (especially when in spate), but extensive ditch and drainage systems that would support damming in some locations. Aspen presence around the reserve perimeter, but little mapped within the site itself or in the riparian zone of the main river.

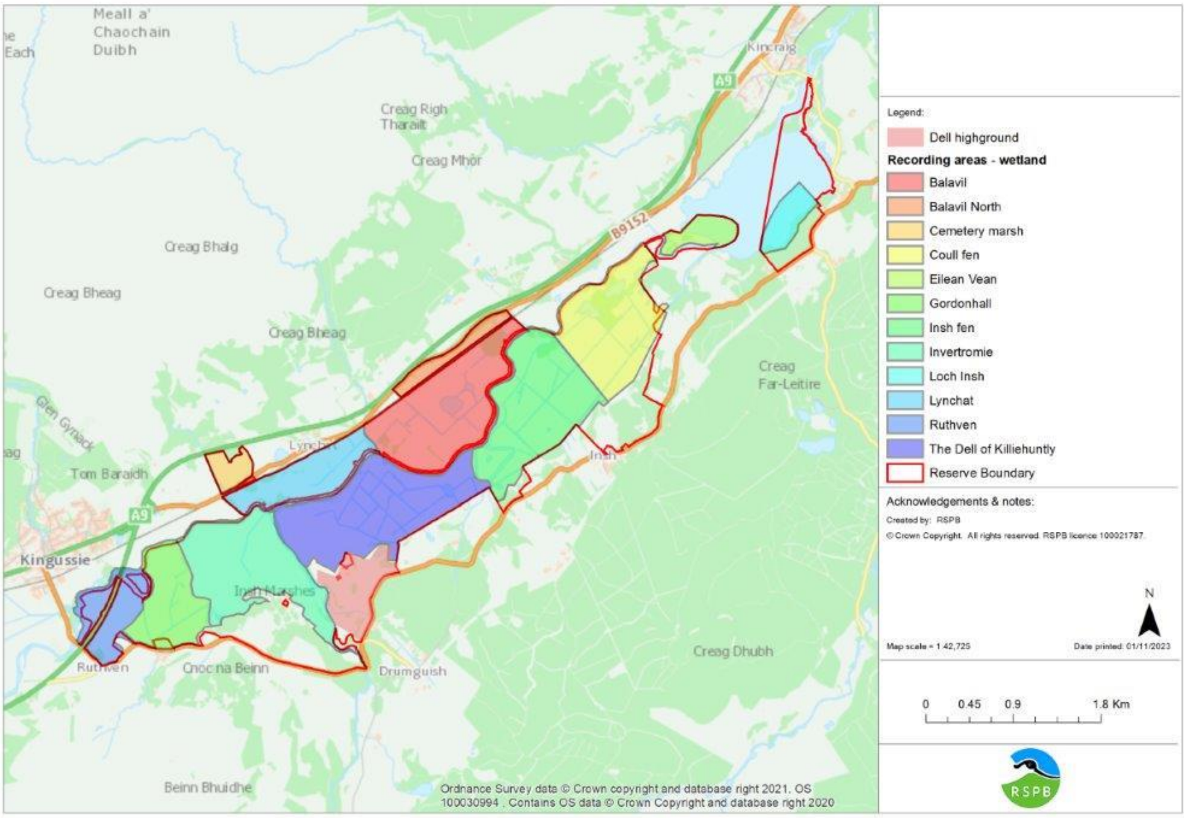

Figure 12. RSPB Insh Marsh Reserve with recording area names mapped.

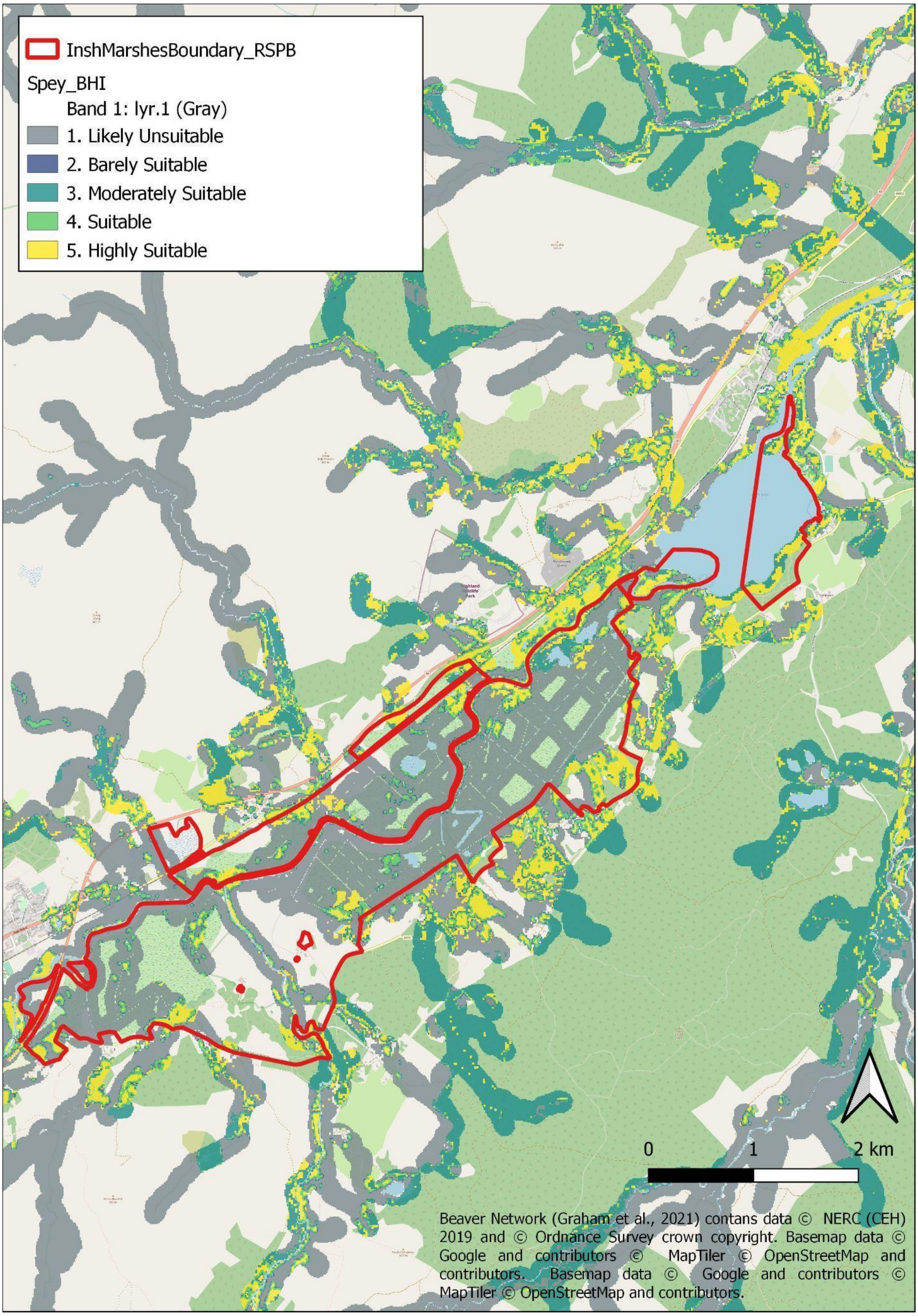

Figure 13. Beaver habitat mapping for Insh Marshes and surrounding area. Note the most suitable habitat throughout the marshes is generally situated along the outer fringes of the floodplain, especially associated with the lower gradient inflow sections, ox-bows and off-channel lochans and along the main river stem. However, it is also worth adding that some unsuitable areas may contain herbaceous summer forage potential. The mid- to upper inflows all typically constitute low suitability habitat. Beavers may explore and forage in these areas at a time when population density is high and/or during periods of extreme flooding when they seek refuge.

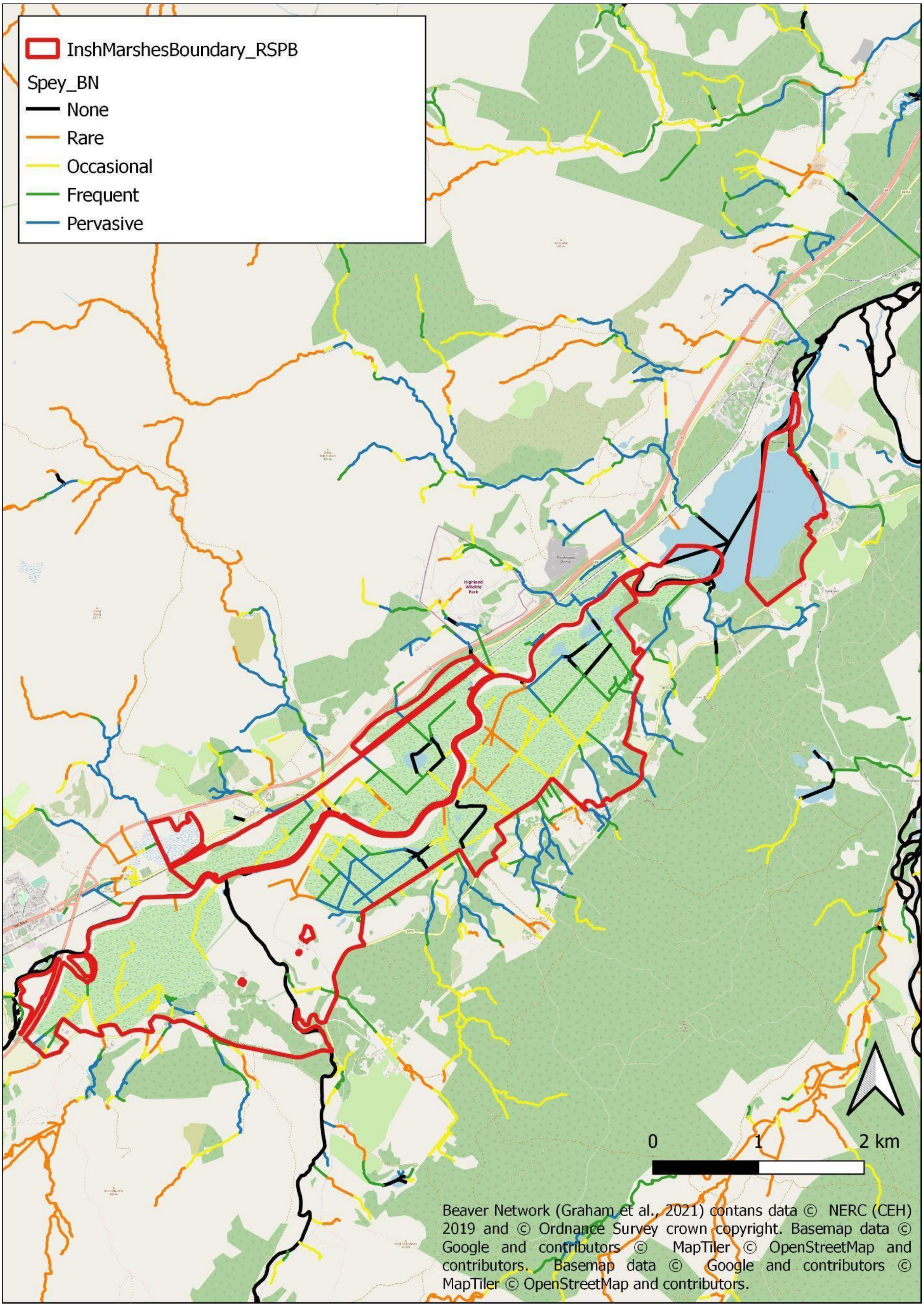

Figure 14. Beaver dam capacity mapping for Inch Marshes and surrounding area. Note much of the Insh Marshes and associated inflows are unlikely to be dammable, being either spatey inflows, the main river (too deep and wide) or deeper drains through the marshes.

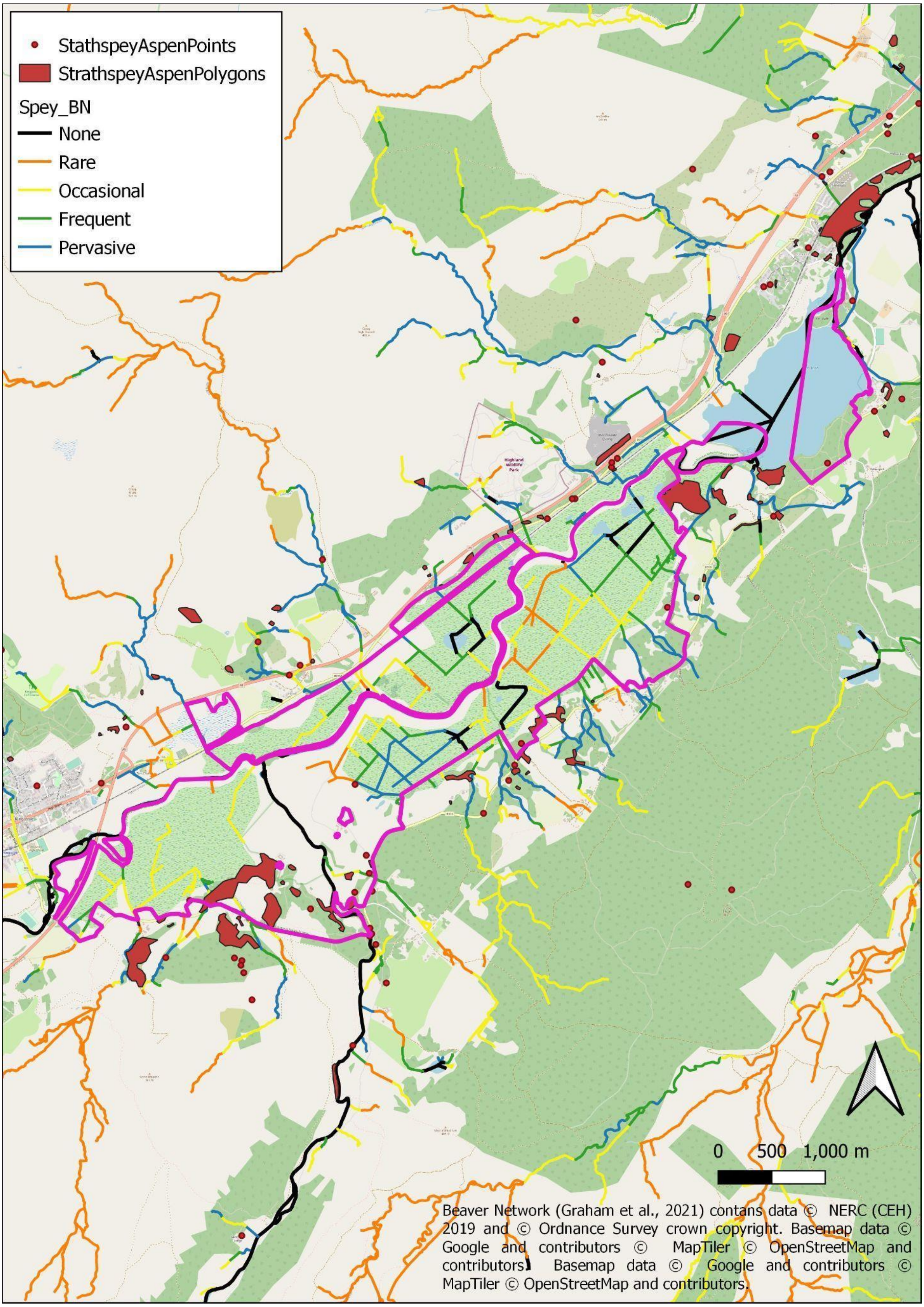

Figure 15. Beaver dam capacity mapping alongside known areas of Aspen as per Stathspey Aspen datasets provided to this project by CNP.

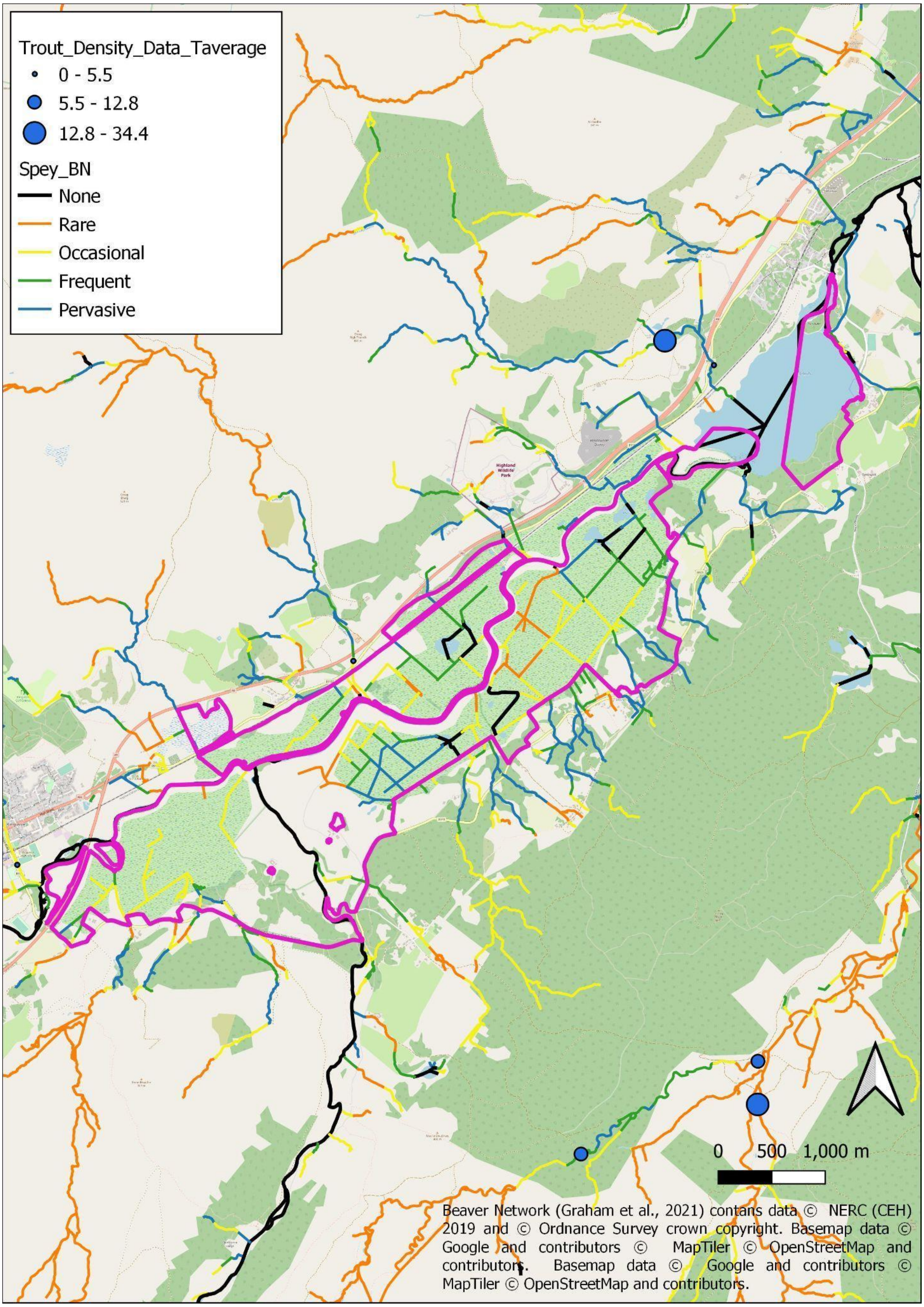

Figure 16. Location of trout monitoring data provided to CNP by the Spey Fishery Board for Inch Marshes and surrounding area. Data mapped by trout average density. Note the salmon and trout sampling points on a watercourse whose damming capacity is pervasive, in the south, the salmon and trout sampling points are on watercourses with rare damming.

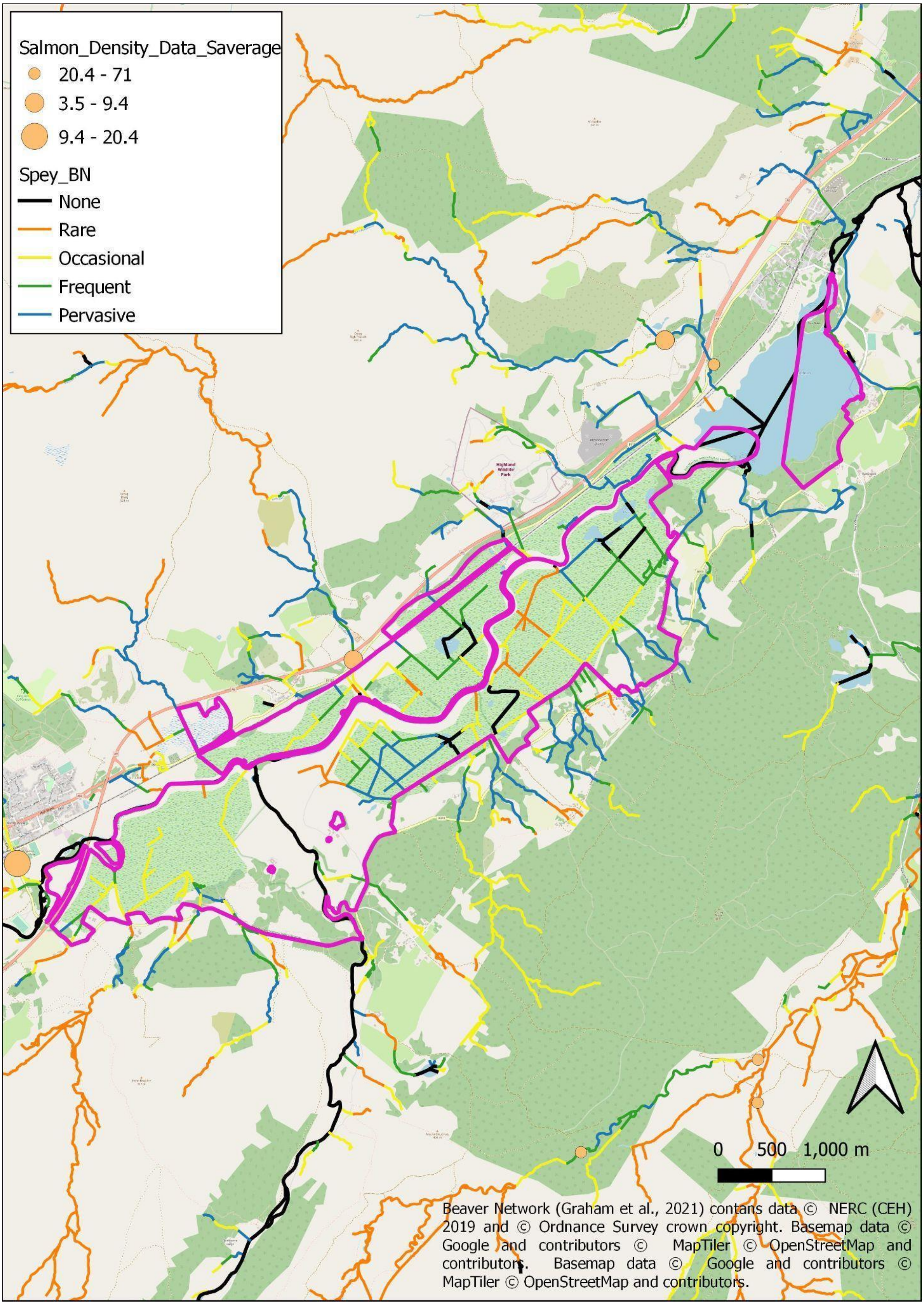

Figure 17. Location of trout monitoring data provided to CNP by the Spey Fishery Board for Insh Marshes and surrounding area. Data mapped by trout average density. Note the salmon and trout sampling points on a watercourse whose damming capacity is pervasive, in the south, the salmon and trout sampling points are on watercourses with rare damming.

Various points across the Insh Marshes reserve were assessed in collaboration with RSPB staff, especially to discuss potential sources of conflict, likely beaver behaviours and practicalities of any release.

Several points at [redacted], [redacted] and [redacted], [redacted] were assessed and most of these included highly suitable wet woodland and would be colonised by beavers from the river Spey in time, they were all [redacted] Particular sensitivities of beaver damming on the [redacted] were discussed. Though theoretically beavers may be able to dam this burn at low water levels, the likelihood of this should be highlighted as very low. [redacted]. Given all these factors the motivation for beaver damming this stretch should be considered as very low.

Figures Redacted

Figures 18-20. [redacted], very stony with little attractive vegetation. Theoretically dammable given stream width but highly unlikely beavers would be motivated to dam and physically difficult to ever maintain.

[redacted]

[redacted] area is a priority area for scrub removal given it is a [redacted]. The [redacted] area itself has little tree presence but could offer attractive summer foraging. The area is lined by extensive patches of broadleaf, including aspen stands on hills nearby. It is likely as beaver population levels increase, this area would be colonised by dispersing animals, beavers on the wider marsh are also likely to retreat to this floodplain fringing woodland areas during floods. This area was discounted as a release site due to sensitivity of [redacted] and perception of impacts on aspen stands. However, it would be highly likely in time and any growing population density that beaver would naturally recolonise this area, especially as beavers could be pushed into closer proximity during floods. Sensitive mature aspen stands and lichen assemblage of conservation value are generally quite far back and uphill of the floodplain, though of significant distance to both any proposed release sites and extent of higher flood levels, proactive monitoring and consideration of beaver deterrent fencing should field signs approach this area would be recommended. Planting a buffer of willow could also be used in targeted areas to reduce motivation to forage on more valuable areas of woodland. A stock fence is currently present along much of the fringing woodland. It was noted that the dimensions would not prevent beaver access, with some concerns that a risk may be posed to smaller animals becoming stuck.

Figure Redacted

Figure 21. Insh Marshes overview [redacted]. This area is fringed by higher banks and expansive broadleaf assemblage including aspen and is likely to become attractive as population density increases and/or during periods of expansive flooding of the Spey.

Figures Redacted

Figures 22 and 23. Insh Marshes , noting vegetation diversity likely rich summer feeding for beavers and expansive fringing broadleaf woodland likely to become more accessible and attractive during peak floods. Mature aspen stands are present but generally set well-back from floodplain, though beavers could display selective foraging in time. Reactive management plans including fencing and sacrificial willow planting would be prudent strategies.

Onsite discussions with CNP and RSPB staff have highlighted a monitoring schedule within such sensitive areas will be critical, with an agreed flowchart of mitigation steps dependent on what activities occur.

Burns within such woodlands are typically steep and rocky, so therefore would be difficult for beavers to maintain dams, would be a lot of effort for beavers to maintain dams / deep water here. Monitoring efforts should focus round the burns.

[redacted]

This [redacted] is well vegetated with extensive broadleaf and wet woodland, it is connected to the river Spey through a long range of wooded ditches fringing the marsh. These ditches appear to be deep, therefore damming is less likely, but beavers are likely to increase open water in this area through canal digging and potential damming of smaller burns. Banks are readily burrowable. Overall, this would be a highly suitable release site and likely to be fairly self-contained. Beaver activity could be viewed and has the potential to increase the diversity, complexity and ecological interest in this area. [redacted]. The main potential issue would be if beavers utilised the nearby [redacted] of [redacted]. Further discussion and investigation to determine if beaver activity could impact on water levels around [redacted] tree foraging.

Figure Redacted

Figure 24. [redacted].

Figures Redacted

Figures 25 and 26. [redacted] is also well wooded and supported with diverse understory vegetation. Damming along these water courses is highly unlikely given depth of water, however an adjoining burn to the right could readily be dammed and may have some impacts on [redacted]. Dams in this burn could be mitigated.

Figure Redacted

Figure 27. One of the main drains running through RSPB Insh Marshes, such habitat scores low for suitability and damming capacity unlikely due to depth. Beavers would readily utilise such ditches for access to more attractive habitat and foraging resources and for wider catchment dispersal, considered positive for genetic flow.

[redacted]

The lower section of the [redacted] was assessed. In general, this is a well-wooded water course, but very rocky and shallow, with periods of high energy spates. Though some sections appear on modelling which are theoretically dammable, in reality the likelihood of beaver maintaining dams is unlikely and would be seasonally flushed out. The shoreline is very rocky and in general seems unattractive to beaver colonisation and not considered as a suitable release site. At high population density, dispersing individuals may explore and utilise this area in seeking any suitable habitat upstream. In general, this would be considered as a low conflict area.

[redacted] and wet woodland area

This is a pool- ditch system dominated by mixed age willow. Deer impacts are evident, and a revision of deer management is suggested but willow is getting away in inaccessible areas. Damming and burrowing would not be any issue here and RSPB would welcome an increased complexity generated by beaver activity. The [redacted] though beavers would readily use the wider area and have access to forage and shelter creation opportunities without concern. The river is very accessible and immediately provides good stretches of highly suitable habitat.

Figures Redacted

Figures 28-31. Wet woodland associated with the [redacted] and [redacted], offering highly suitable habitat and shelter opportunities. Banks are highly suitable to burrow and shelter construction. This area does regularly see annual flooding events though beavers would be very able to be mobile with water levels and seek shelter and foraging opportunities on higher fringing banks and woodland.

Figures Redacted

Figures 32 and 33. [redacted] offers very attractive habitat and it could be likely any released beavers reside in this area and forage in the fen behind. [redacted] is accessible, with willow dominated tree coverage and deep friable banks for easy shelter construction.

[redacted]

This area of the Insh marshes offers an area of [redacted] on the reserve. The majority of the shoreline is supported by stretches of highly suitable habitat, including large sections of wet willow fen. Emergent and aquatic vegetation is also high in this area especially offering plenty of summer foraging opportunities. Given the bank profile gradient, burrowing for shelter opportunities may be limited, however lodge construction would be entirely possible. Beaver activities may also see extensive canal networks being constructed should beaver reside in this area. Highly suitable and attractive habitat is present in significant sections on the main River Spey below. Proximity to and being linked by extensive willow woodland, makes this very accessible but also likely that any beaver released onto the [redacted] are likely to concentrate activities in this area and less likely to be attracted to woodland associated with [redacted] This has been flagged for mature woodland, aspen, bryophyte and lichen interests, but this [redacted] so not likely to be vulnerable to beaver foraging with any impacts most likely concentrated in the less steep perimeter area of the site. On site discussions with CNPA, Beaver Trust and RSPB staff have determined that a long-term monitoring programme for any beaver impacts would be possible in this area which would trigger a reactive implementation of a mitigation strategy.

Figures Redacted

Figures 34 and 35. Looking into [redacted] areas from [redacted]. Stock fencing is constructed from posts and horizontal wire only and entirely passable for beavers.

Figure Redacted

Figure 36. Proximity of loch to River Spey [redacted] fringes to the right. Beavers highly likely to access both feeding resources and may be initially attracted to this river section, though a [redacted] release is recommended.

Figure Redacted

Figure 37. River Spey below – low conflict area with good sections of high quality habitat.

[redacted] is surrounded with a wide margin of wet woodland. Associated reed beds, aquatic and semi-aquatic vegetation appear extensive and diverse, lined with broadleaf and would provide extensive foraging opportunities year-round. The shoreline has multiple bays and complexities and though generally low in gradient, shelter building opportunities would not be an issue. Water levels appear fairly stable but if floods occur beavers would have fringing shoreline to move into without restrictions. Mapping demonstrates an excellent expanse of highly suitable habitat both around the loch and the neighbouring riparian zone of the main channel. High modelled dam capacity on both inflow and outflow, but main the Spey are too large to be dammed. Any damming would serve to increase wetland habitat and complexity of this site, with additional biodiversity benefits highly likely. Surrounding marsh/grassland could readily contain a network of beaver dug canals, again increasing site complexity and areas of open water. No mapped Aspen stands in the riparian zone of either [redacted] or immediate riparian zone of Spey. No fish density data sampling points provided. In general, the potential for conflict at this site appears low with surrounding land-use deciduous woodland with some tracks which are all located away from the [redacted] itself, therefore it seems unlikely burrowing, damming or tree felling are likely to be an issue.

Figure Redacted

Figure 38. Beaver habitat mapping for [redacted] and surrounding area.

Figure Redacted

Figure 39. Beaver dam capacity mapping for [redacted] and surrounding area.

Figure Redacted

Figure 40. Beaver dam capacity mapping alongside known areas of Aspen and fish monitoring points for [redacted] and surrounding area.

Figure Redacted

Figure 41. Overview of [redacted] with complex shoreline including multiple bays, good broadleaf coverage and extensive wetland with patches of wet woodland.

Figure Redacted

Figure 42. [redacted] typical riparian vegetation, providing rich summer foraging in particular and likely to see extensive canal digging.

Figures Redacted

Figures 43 and 44. Extensive wet woodland associated with this area, providing highly suitable habitat as well as connectivity with the wider catchment.

[redacted]

[redacted] is a [redacted] and relatively enclosed [redacted], predominately surrounded by very suitable habitat of wet woodland, developed understory and reed-beds and connected to the larger [redacted]. Conifer stands are present but set back from the [redacted], bar a smaller stand located near the [redacted] ([redacted]) has been recently planted here which should be monitored for any beaver interest. This [redacted] seems less used recreationally wise. Mapping shows expansive areas of excellent habitat availability both around [redacted] (and the neighbouring [redacted]). No Aspen stands mapped on banks of [redacted], but some on [redacted] and in the wider vicinity. The banks are generally low profile but could sustain burrowing and digging activities, therefore readily form shelter constructions and canals to increase shoreline complexity. Surrounding land use is deciduous woodland and the neighbouring [redacted], which all offer high quality and connecting habitat. Mapping shows small inflow and outflow streams to be bordered by good habitat and have a high dam capacity. No fish density data for [redacted] but some on streams connecting to [redacted].

Figure Redacted

Figure 45. Beaver habitat mapping for [redacted] *and surrounding area.*

Figure Redacted

Figure 46. Beaver dam capacity mapping for [redacted] *and surrounding area.*

Figure Redacted

Figure 47. Beaver dam capacity mapping alongside known areas of Aspen and fish monitoring points for [redacted] *and surrounding area.*

Figures Redacted

Figures 48 and 49. Main [redacted] *with deep fringes of broadleaf and conifer behind, birch dominated. Understory is fairly well developed. Shoreline though generally uncomplicated and rocky, with section of low gradient reedbeds, do have multiple crevices that could form shelter foundations.*

[redacted]

This is a [redacted] but with deep stands of broadleaf tree coverage and a rich understorey of semi-emergent and aquatic vegetation. [redacted] during the summer months is especially noted (as the tubers from this plant can be a food resource for beavers in the winter). Modelling and site visit reveals extensive highly suitable habitat on south-east side of [redacted], less extensive on north-west side but decent vegetation coverage in the immediate vicinity of bank that would undoubtedly support long-term beaver colonisation. Both connecting [redacted] show a high dam capacity, with connectivity to other water bodies and opportunities to increase wetland habitat within the surrounding woodland. Surrounding topography, described as ‘hummocky’, with numerous existing small pools with steep banks scattered throughout the woodland. Therefore, beaver damming could create numerous, dynamic wetland features and tiered dam systems in time, integrated with patchy tree felling to open the existing canopy. Most activity would occur on the main [redacted], which is presumed to have little potential conflict. Considerations should be given if certain potential beaver activities, such as damming of the [redacted] would impound water which could impact on forest tracks for example. This area is popular with walkers, and of important recreational value to the [redacted], therefore resident beavers here could provide an important focal point for wildlife and education engagement opportunities. A high demand for beaver watching persists throughout Britain, so any accessible sites with infrastructure, including car parking, such as this site, remain popular. Diversification into products for sale, guided walks along with student placement opportunities would all seem plausible. No mapped Aspen or fish data provided, therefore impacts appear very limited, though this is a [redacted] Proactive communications with the fishing sector would seem sensible, as there may be concerns with increased trees falling onto shoreline margin (though this can also be considered a positive impact for casting).

Figure Redacted

Figure 50. Beaver habitat mapping for [redacted] *and surrounding area.*

Figure Redacted

Figure 51. Beaver dam capacity mapping for [redacted] and the surrounding area.

Figures Redacted

Figures 52-54. Main [redacted] with expansive fringes of broadleaf, birch dominated. Understory is fairly well developed, and [redacted] Shoreline though generally uncomplicated and rocky, with section of low gradient reed – beds, do have multiple crevices that could form shelter foundations.

[redacted]

This [redacted] shows large areas of highly suitable habitat. This availability of high quality habitat extends to the neighbouring [redacted] and continues downstream to the [redacted]. The [redacted] itself would provide a high-quality release site with potential to retain beavers, though colonisation (including future offspring dispersal) of wider surrounding area would be highly likely. This site would immediately provide good food resources and shelter construction opportunities. Beaver canal construction activities could be possible, resulting in increased wetland complexity with likely biodiversity benefits. An established territory would be likely to utilise suitable habitat on the [redacted], whilst residing on [redacted], especially during periods of high flow on the river below. Surrounding land-use is wet woodland with some rough grazing, beaver occupation is unlikely to have land-management impacts. No Aspen is mapped in the riparian zone [redacted] or river network in this area. No fish data density points provided.

Figures Redacted

Figure 55. Beaver habitat mapping for [redacted] – focusing on [redacted]

Figure Redacted

Figures 56 and 57. Main water body lined by broadleaf and extensive semi-emergent vegetation. Banks are earthen and could be easily manipulated.

Though not immediately neighbouring this site, in the future any dispersing beavers may colonise the [redacted] close by. The [redacted] represent good habitat in themselves but are also surrounded by highly suitable and therefore attractive habitat. The main [redacted] and [redacted] would be the immediate dispersal routes and could provide resident opportunities for beavers, though are too large to be dammed, but several smaller water courses entering [redacted] in addition to numerous smaller channels running through woodland neighbouring the [redacted] all show a high dam capacity with highly suitable woodland. Even if beavers initially resided and utilised these areas, should they colonise these areas it would be likely at some stage that beavers utilise the [redacted], especially to seek areas of deeper and more stable water. The banks are also highly suitable for shelter construction. The majority of the banks are immediately lined with mown grass paths to facilitate recreational use, with trees set back a few metres – but all providing highly suitable forage within forage range. Though beavers may not reside here long-term, dispersers may remain and/or territorial animals utilise for forage. Theoretically and with planning, deterrent fencing could be utilised along the riverside margin with dual otter/ beaver function.

Figures Redacted

Figures 58 – 60. [redacted] Stable water levels, immediate forage opportunities and banks suitable for shelter construction. Burrowing into banks to either construct burrows or creating canals, could result in adjacent ponds being connected and/or unwanted burrow collapse. Further consideration of risk of any beaver burrowing, *[redacted]. Tree felling into [redacted].*

Figures Redacted

Figures 61 and 62. [redacted], some are shallow and lack vegetation so are highly unlikely to be attractive to beavers, others could be utilised. Water levels [redacted] which are highly likely damming points for beavers to maintain and increase water levels.

[redacted] with predominant conifer coverage, development of understorey vegetation and patches of broadleaf scrub in very limited patches. Site visit supported habitat modelling in that [redacted] had very little high quality beaver forage and generally low suitability. It would be feasible that in time, and with higher population density, that dispersing individuals find these lochs and set up residence, though they are unlikely to be immediately attractive or support large numbers of animals. Any land management supporting broadleaf regeneration would favour beavers and encourage colonisation, but this is deemed unsuitable as a release site at this point of initial restoration proposal. Small aspen stands are present within easy forage range and given these sit amongst moderately suitable habitat are likely to be utilised by beavers. This should encourage aspen sucking and spread, though if mature trees are located here with any important bryophyte, lichen and invertebrate assemblages then consideration of exclusion fencing would be suggested.

[redacted] in particular, is [redacted] and has [redacted]. Therefore, this could be an area to engage visitors in relation to beaver information and wider project restoration aims. It seems unlikely that beavers would display pervasive damming activity across this site but one point of reasonable monitoring would be the [redacted], which is highly dammable and lined with high quality forage. It could be entirely plausible in time that beavers may colonise this area from the [redacted] below. The main potential issue may be impounded water from dams along this outflow may impact the main access track to the car park, requiring dam mitigation. Given potential impact on infrastructure this could be a straightforward management and it seems this would readily fall into licensable mitigation on dam features which would offer a great opportunity to demonstrate and interpret mitigation measures, showing how beavers and infrastructure can co-exist.

Figures Redacted

Figures 63-66. Typical shoreline and tree coverage around [redacted]. Many parts are well worn by visitors with little opportunity for regen, deer grazing pressure may also be an issue. Away from these areas understory is typical upland/ moor with some regenerating deciduous.

Figures Redacted

Figures 67 and 68. Typical shoreline and tree coverage around [redacted]. [redacted] is much quieter, with more reed bed and semi-emergent plants, though conifer is generally to the shoreline, with few regenerating broadleaf patches.

Figure Redacted

Figure 69. Beaver dam capacity mapping alongside known areas of Aspen for [redacted] Note only the two small stands immediately along the loch shorelines are likely to be of any concern. These areas could be monitored should beaver naturally

recolonise this loch and reactive mitigation implemented. Given stand size, deterrent fencing around the whole stand would be recommended if of concern.

Figure Redacted

Figure 70. Beaver habitat mapping alongside known areas of Aspen for [redacted]

[redacted] deciduous trees, with some regen of mainly birch though grazing pressure may be a concern. Grass, some reeds and bracken represent most of the understorey vegetation. Semi-emergent and aquatic vegetation were not immediately obvious, wave action likely. Overall providing moderately suitable forage. Banks are generally friable and would be suitable for shelter construction though in general most of the banks are quite exposed with fewer complications and bays. No aspen or fish records were highlighted for this loch. Damming capacity and likelihood from both the modelling and site visits suggests the outflow and access route to the main river are highly likely to be dammed in time should beavers take up residence. This area, including the main river comprises high quality and attractive habitat. Given the proximity to the road, dependent on specific location, some dams may require mitigation to ensure road is not impacted. This would be an area to include on a regular monitoring approach. The inflow, the [redacted], is highly manipulated but typically deep and linear with no attractive vegetation associated with it, and therefore highly unlikely to be dammed in its current state. This area could however provide a key opportunity for naturalisation with planting, re-meandering and peat development, if beavers could be encouraged to utilise and dam this area in the future. [redacted], it is likely beavers will naturally colonise this area should surrounding populations grow. Especially during periods of flooding and spate.

Figure Redacted

Figure 71. View of southern [redacted] *including the* [redacted] *burn (inflow).*

Figure Redacted

Figures 72 and 73. Northern shore of Loch [redacted] *with patches of broadleaf, especially birch, but majority conifer. Understorey vegetation is quite developed with grass and heath. Outflow,* [redacted]*, is highly dammable and culverted under road.*

Figure Redacted

Figure 74. Beaver dam capacity mapping alongside known areas of Aspen for Loch [redacted]

Figure Redacted

Figure 75. Beaver habitat mapping alongside known areas of Aspen for Loch [redacted]*.*

Uath Lochans

These series of four lochans are managed by Forestry and Land Scotland. It would be likely that beavers could build suitable shelter in the banks, most likely associated with bank crevices. Burrowing unlikely to be extensive so lodge building on bank tops would be more likely. Though mixed woodland is present, riparian trees are conifer dominated with only small patches of suitable broadleaf including limited willow and birch regen. Given conifer coverage the understorey vegetation is generally poor and limited to grasses and heath assemblages. There are small areas of reeds and semi-emergent vegetation which would provide summer forage. Compared to other sites only patchy areas of good habitat surrounding the lochans and habitat also appears to be much sparser on the nearby River Feshie, when compared to the reaches of the Spey and Druie at other sites considered. Moving downstream on the Feshie towards the Spey habitat improves so may support dispersing beaver but doesn't show the immediate high suitability of other sites. Main channel is too large for damming, but smaller connecting channels to Uath Lochans would most likely support damming. No Aspen areas mapped around Uath Lochans and no fish density data although there are points upstream and downstream on the River Feshie.

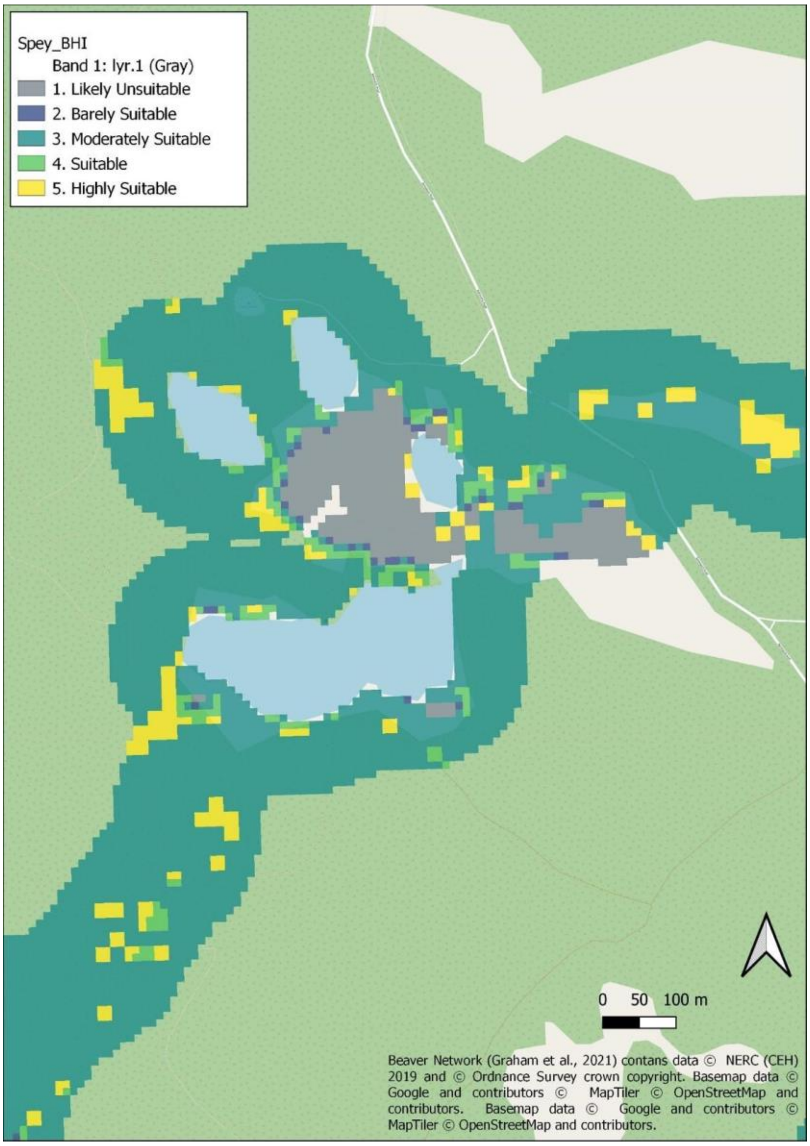

Figure 76. Beaver habitat mapping for Uath Lochans and surrounding area noting majority of area deemed moderately suitable.

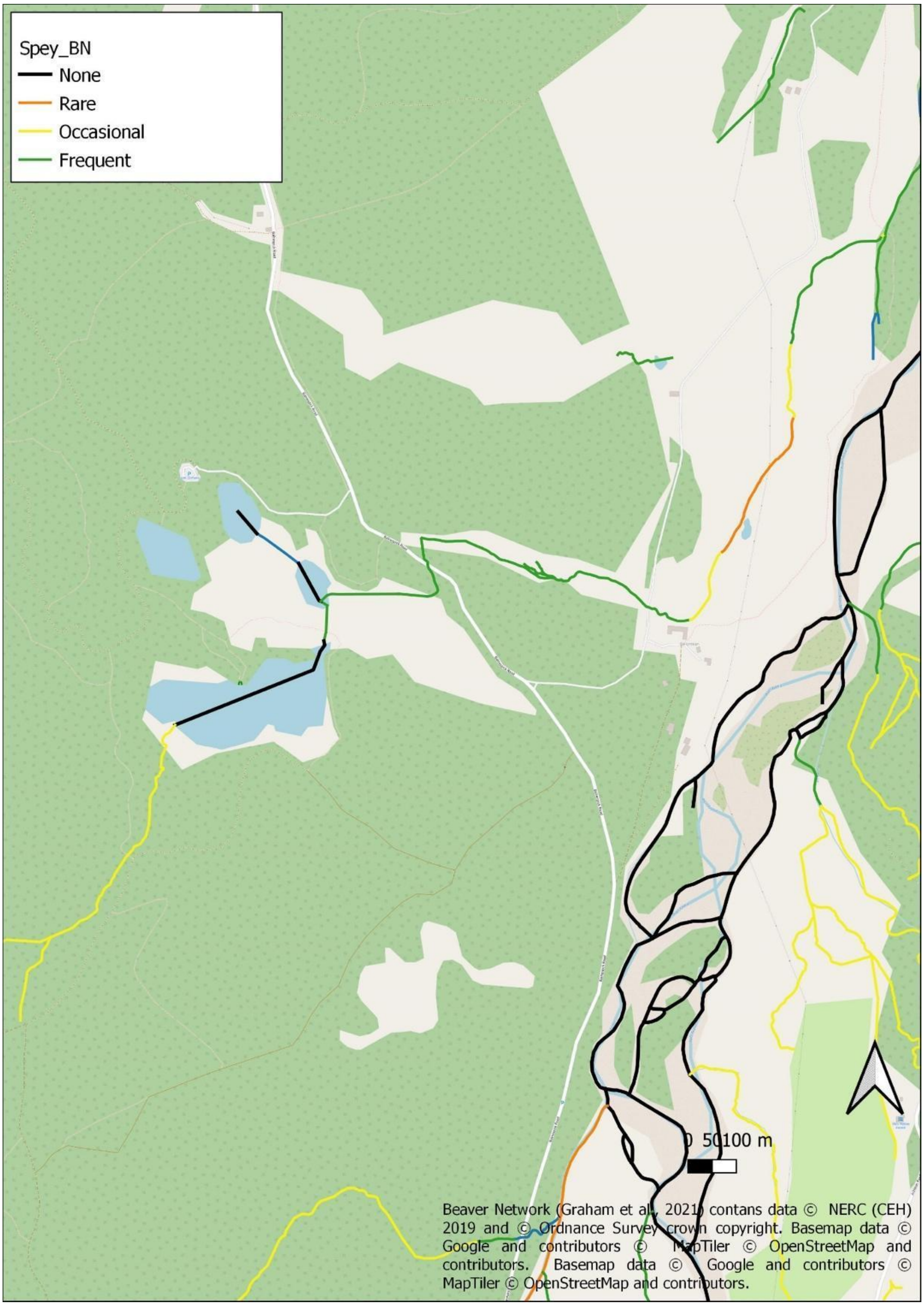

Figure 77. Beaver dam capacity mapping for Uath Lochans and surrounding area, noting few of the water courses are suitable for damming.

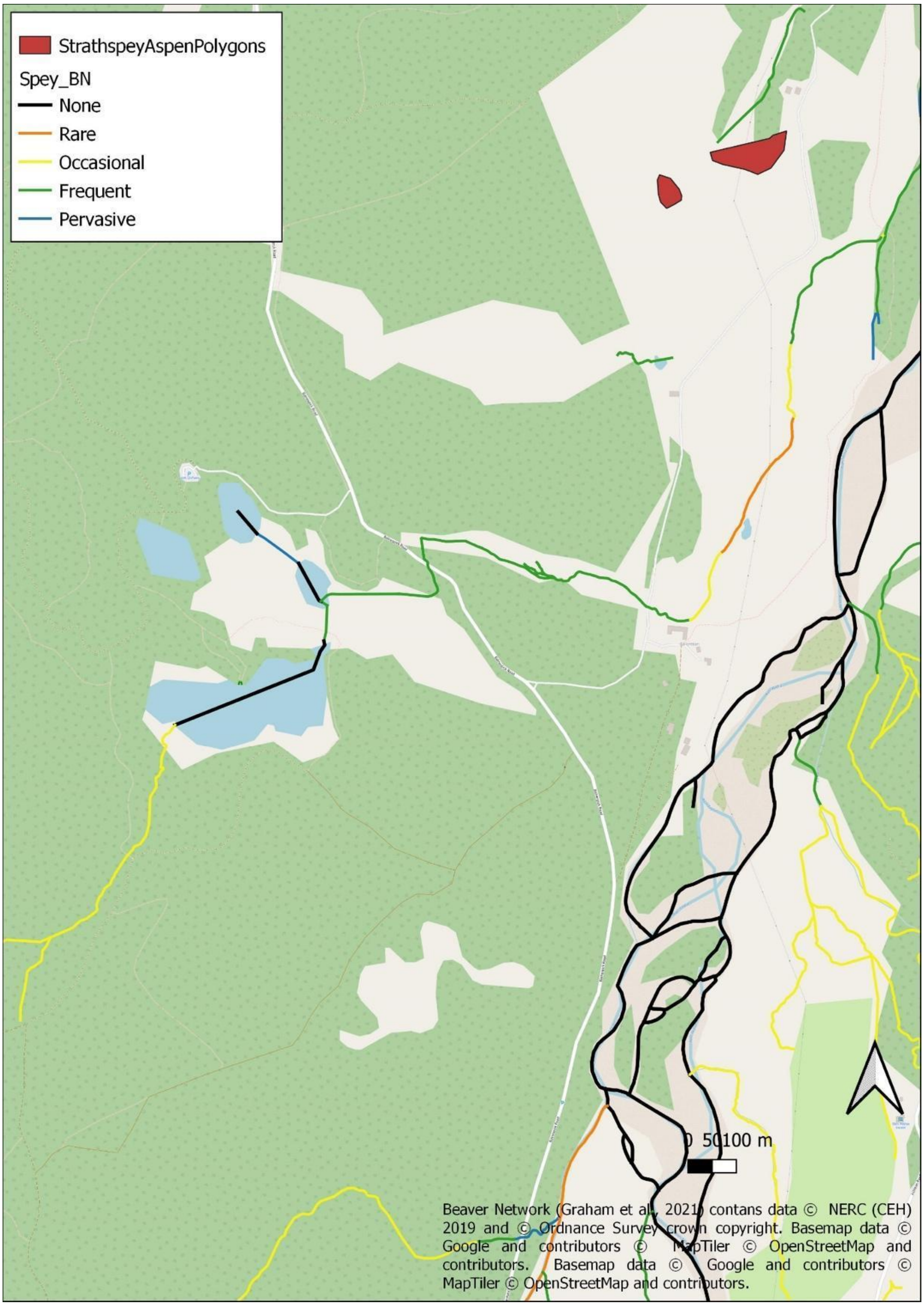

Figure 78. Beaver dam capacity mapping and known areas of Aspen for Uath Lochans and surrounding area.


Figures 79 and 80. Typical banks and vegetation across the Uath Lochans. Damming in reed areas could extend wetland area here and if broadleaf regen was encouraged these could be viable release sites in the future.


Figures 81 and 82. Reed fringing around sections of the lochans could provide summer forage and potential canal construction beaver reacted activity into surrounding wetland areas, to open up these sections and increase complexity and biodiversity.

 

Figures 83 and 84. Supported by the habitat modelling outputs, the majority of the shoreline across all the lochans generally provides low suitability for beavers, with small, fragmented patches of suitable habitat which may support a released pair initially though could prove unlikely for a long-term, breeding territory. This is mainly related to dominant conifer coverage and more limited diverse understory vegetation. Opening up some shoreline via conifer felling and even broadleaf planting would confidently increase the suitability of this area.

Encouraging broadleaf regeneration through conifer clearance (suggested felling conifers into water and leaving in place) and/or planting in these areas would significantly improve their suitability for future beaver colonisation. Though conflicts would be deemed low, some consideration of water levels rises if outflows dammed and any potential impacts on existing boardwalks, paths and dragonfly breeding areas.

[redacted]

[redacted] There is significant broadleaf riparian vegetation, hence modelling displays large areas of highly suitable habitat though understorey is generally poor. The banks are predominantly gravel and sand in composition. This loch was deemed unsuitable for beaver release based on significant water level drops regular exposing low gradient stony banks making shelter construction challenging; food resources distances fluctuating; likely degree of human disturbance especially during establishment; and a lack of connectivity with other potential release sites.

Figures Redacted

Figure 91 -93. Good tree coverage but the whole loch dominated with low gradient, stony banks and lack of tree cover making shelter construction challenging. Little understory vegetation present. Loch is also very popular for recreation across the whole loch.

Figure Redacted

Figure 94. Beaver dam capacity mapping alongside known areas of Aspen [redacted] *Note this area is not recommended as a release site and is fairly isolated for natural colonisation being generally very unconnected. Should beavers ever naturally colonise (note significant population density and pressure would need to be reached in the immediate surrounding area.*

Figure Redacted

Figure 95. Beaver habitat mapping alongside known areas of Aspen for [redacted].

[redacted]

This site was [redacted]. [redacted] keen to understand what impacts and opportunities this could present, especially to promote ecotourism and wildlife watching. The site represents a number of [redacted], with a diverse range of aquatic and semi-aquatic vegetation, lined with predominantly willow regeneration and in turn surrounded by diverse planted native woodland. Current management [redacted]. Part of this outflow is piped in parts so could present perfect damming opportunities, with the whole outflow being highly dammable. [redacted], there would be little perceived impacts and could generate dynamic wetland recovery.

[redacted] and this section offers highly suitable beaver habitat. There would be a strong chance beavers present on the wider Spey could be attracted to this area. This section of the Spey is deeper and slower moving, with deep banks which would be highly suitable for burrow and lodge construction. Mixed woodland with a diverse understorey is also present. This area could present beaver watching and [redacted] opportunities with relatively little impact on beavers.

Should a release beaver pair/family reside [redacted] a range of activities would be expected which may require further consideration of potential impacts and mitigation. For example, trees felled into the ponds are not likely to be an issue and would serve to increase habitat complexity and biodiversity. Some felled trees could block current access routes and may require some level of site staff management to clear and keep access open. Beavers would readily construct burrows and most likely further connect [redacted]. This may not be an issue, though risk of burrow collapse along current access routes would need consideration, though could be resolved by re-routing. Beavers would undoubtedly dam [redacted], especially outflow pipes to both connect [redacted] and increase area of impounded water, impacts on [redacted] could be an issue. A large [redacted] so conversations to see if beaver felling would generate issues should be had.

Figures Redacted

Figures 96 and 99. [redacted] represent high quality habitat which could be used and further modified by beavers to create an active territory. Vegetation is diverse and includes surrounding planted native woodland. Banks are highly suitable for burrow construction.

Figure Redacted

Figure 100. [redacted] River area here is also high quality habitat and would seem attractive to beavers on the wider system having a good depth of riparian woodland, slower and deeper areas of water and highly favourable banks for shelter construction.

Figure Redacted

Figure 101. Beaver habitat mapping for the [redacted] and surrounding area noting majority of area deemed highly suitable with good levels of connectivity.

Figure Redacted

Figure 102. Beaver dam capacity mapping alongside published salmon density records. Noting high damming capacity along [redacted] main outflow, with few other expected damming issues in the wider area.

Figure Redacted

Figure 103. Beaver dam capacity mapping alongside published trout density records.

Figure Redacted

Figure 104. Beaver dam capacity mapping alongside known areas of Aspen. Noting a large amount of Aspen is present throughout this area, [redacted] potential impacts in these areas should be further investigated to see if they would be of significant concern.

[redacted]

This [redacted] woodland of approximately [redacted] hectares is predominantly native pinewoods, known for recreation and wildlife engagement opportunities. Within are numerous irregular landforms creating a series of habitats including woodland, dry health, bog, reed-bed, small lochans and burns. There are a series of recreational paths throughout the woods, including the [redacted] therefore public access is key. Given the importance of this woodland to the [redacted], a supported beaver release could be an important local engagement tool, providing many social opportunities. The long-term management plan is also to gradually move from a pine plantation to the promotion of a range of native plants and animals, which beaver activities would serve to promote habitat and biodiversity objectives.

Figures Redacted

Figures 105 and 106. Typical burn and pinewood habitat throughout the woods, including varying landforms and dense sphagnum dominated understorey vegetation layer. Water courses viewed were all readily dammable, with many opportunities to create multiple new ponds.

Figures Redacted

Figures 107 and 108. The main area of focus on the site visit was a large lochan that has become encroached with reed-bed, this area had the most willow. Small outflows could be readily dammed to impound water in the lochan and create open water again.

Figure Redacted

Figure 109. Beaver habitat suitability mapping for the woodland and surrounding area including River Spey. Noting the majority of the woodland area scores moderately suitable, with highly suitable habitat patchy and generally limited to the fringes of water courses.

Should this site be considered as a beaver release site, additional survey work/ information on presence and distribution of species of conservation value would be recommended, and are outside the scope of this report. Pre-release preparation work would be highly recommended most importantly the temporary damming of the outflows from the old lochan/ wetland area to ensure the creation of open water to act as a focal point for release and encourage site fidelity. Without which, beavers are highly unlikely to remain post-release. Temporary shelter provisions in terms of creation of brash piles would be encouraged. Continual monitoring programme of any damming activity that may impact the path network should be implemented.

Figure Redacted

Figure 110. Beaver dam capacity mapping alongside published salmon density records. Noting high damming capacity associated with the assessed site.

Figure Redacted

Figure 111. Beaver dam capacity mapping alongside published trout density records.

Figure Redacted

Figure 112. Beaver dam capacity mapping alongside known areas of Aspen which is general widely dispersed but existing in very small coverage.

[redacted]

[redacted] was visited at the owners request to discuss the potential of beavers either naturally colonising from releases on the Spey catchment and/or the suitability of the site for beaver release/ occupation. This [redacted]-hectare estate has a range of land use including commercial forestry, heather moorland, native [redacted]. The main hydrology includes [redacted], draining into the [redacted] catchment. [redacted] could be accessible from the [redacted] catchment via artificial ditches, and therefore accessible to [redacted] beavers in the future. The riparian banks throughout the estate are well wooded with native broadleaf, with the majority scoring highly suitable throughout. There is a broad range of tree and plant species and diverse undergrowth. Commercial forestry is set back from the water course. Initial colonising beavers are very likely to use the main loch for their main territory area. The shoreline is predominantly earthen so burrow and lodge construction is readily possible. Aquatic and semi-aquatic vegetation is also present throughout.

Figure Redacted

Figure 113. [redacted] – a long and narrow loch with extensive woodland coverage and aquatic vegetation provides highly suitable beaver habitat and would provide an ideal release site.

Figures Redacted

Figures 114 and 115. Downstream of [redacted] multiple burns such as the [redacted], eventually join the [redacted]. These are well wooded before the [redacted] [redacted] passes through more agricultural landscapes.

Figure Redacted

Figure 116. Beaver habitat suitability mapping demonstrates highly suitable beaver habitat is present throughout this upper catchment and tightly associated with the main river water courses. Noting there is fairly continuous highly suitable habitat connecting the [redacted] catchments.

Figure Redacted

Figure 117. Damming capacity is fairly limited within the [redacted] catchments, though could be fairly pervasive in the lower order water courses.

[redacted] could provide a highly suitable area to support one or two beaver families. Should beavers colonise the Spey and reach higher densities it is likely beavers would naturally jump catchments and be attracted to the high-quality habitat here, though this could take many years. Perhaps the most pressing assessment would be the potential capacity of beaver burrows to impact [redacted], which lays in very close proximity to the [redacted]. There are also limited parts of this [redacted] that run alongside some burns and parts of the [redacted] in which damming and burrowing may require impact monitoring.

Key recommended release sites, connectivity, and dispersal

Beavers are highly territorial and will actively defend their territory as a family unit against dispersing and neighbouring beavers (Nolet and Rosell, 1994). Territory size will vary according to habitat types. Smaller water bodies (such as lochans and ox-bow lakes typically contain one pair/ family unit, while beavers on riverine systems typically have more linear and potentially larger territories than those creating dam systems on smaller streams. Territory sizes can range from 1-7 km in bank length (average 3.7 km depending on habitat quality and surrounding population density (McClanahan et al. 2020). A pair/breeding pair with any dependent offspring would be released. As with any wild animal release, site fidelity, pair/family cohesion and success can vary.

It has been demonstrated that beavers typically first settle in the most suitable habitats, then as population numbers rise, they will utilise lower quality habitats, which may see more habitat modifications e.g. damming of smaller water courses to create deeper water for burrows and access to forage. In the Netherlands, where beavers were introduced into unoccupied habitat, it was found that animals released initially still had the largest and highest quality territories after 5 years, while those that were released later had smaller, poorer territories (Nolet and Rosell, 1994; Campbell et al., 2005). The sequence of arrival of pairs in unoccupied areas seems to play an important long-term role in determining the size of the territory (Campbell et al., 2005). Population growth in beavers follows similar patterns throughout their native range, with several phases. In newly established populations connectivity is key, growth is initially slow due to both breeding rates (beavers typically do not become sexually mature and disperse until ca. 2 years of age), and territories are usually sparsely distributed, therefore a lower probability of finding a mate. In release projects, if large (40+) numbers of animals are released in a connected landscape, migrating offspring will meet each other sooner and therefore population growth will be higher (Rosell and Campbell-Palmer, 2022). As dispersers may travel dozens of kilometres from their family territories, the process of population establishment creates a 'patchwork' pattern of beaver territories. As the number of territories grow, disperses have a better chance of finding a partner and with plenty of suitable habitat remaining, survival rates are typically high as resources are not lacking, this is the stage of more rapid growth. The length of time required for rapid population expansion varies depending on the characteristics of the river system and may take 15–20 years on larger river systems (Hartman, 1995). This is usually followed by population growth slowdown, the occupation of marginal habitat not capable of sustaining beavers permanently, survival rates fall as competition for more limited resources increase (Halley and Rosell 2002, Petrosyan et al. 2016). The highly territorial behaviour of beaver families has a regulatory effect on beaver populations.

The following sites are recommended as immediate potential release sites offering highly suitable habitat and space for dispersal and connectivity to promote population establishment (see figure 96) and geneflow. Each names site represents a point of release for one pair/ small family unit.

- [redacted]- RSPB Insh Marshes
- [redacted]– Wildland Ltd
- [redacted] - Rothiemurchus Estate
  [redacted]

The sites proposed have some physical containment but are all associated with the wider flood plain and beavers would have the capacity to disperse and exercise habitat selection throughout the wider catchment. Releasing animals together, in highly suitable habitats, immediately available food resources, with more stable water levels and banks enabling rapid shelter construction – are all known to increase changes of territory establishment around the release site. Given the expanse of the Spey catchment (>3000 km^2) if only a small number of animals are released over a large area it may result in failure to establish any viable population. Small populations are highly vulnerable to extinction and/or genetic diversity loss, which have been well documented in restoration and reintroduction projects globally (e.g. Frankham et al. 2010). Since any beavers being restored to the Spey catchment would be seeking to establish a new population, which is unlikely to benefit any natural migration from existing Scottish populations to the south, founder numbers, health and genetic diversity are key considerations for success of beaver reintroduction on Speyside.

Figure Redacted

Figure 96. Recommended priority release areas to establish multiple pairs/ families likely to show a level of release site fidelity but which are connected with highly suitable habitat to enable infilling and geneflow to promote a healthy founder population.

Conclusions and Next Steps

From both the modelling work and ground-truthing it is apparent that the majority of the main stem of the River Spey and inflow tributaries (particularly those in the flood plain) are highly suitable for beaver colonisation. Many of these channels are upland rivers and streams which fairly immediately become steep gradient, fast-flowing and are often rocky-banked. Beaver damming capacity is expected to be quite limited in this catchment, as beavers are unlikely to maintain dams in many of the running water courses as they are too wide and deep and/or too high energy during spate flows. Though beavers may utilise these channels in time this is only likely once population density is significant and main riverine territories are occupied. Therefore, a prediction of where beaver colonisation and occupations will concentrate immediately around the main river stem, accessible wooded lochs/lochans and any significant lower gradient tributaries.

Throughout the catchment, riparian vegetation is generally suitable with diverse broadleaf and understorey. Given the extent of regular flooding, there are good sections of vegetated floodplain, including lochans, wet woodland and ox-bows. However, there are significant sections which have little tree coverage and are typically grazed by livestock, and in which bank erosion is currently apparent. Though such areas are likely to be unattractive to beavers, especially in the early years of colonisation, burrowing and felling of mature trees into the water courses may be a perceived source of conflict in a limited number of locations. Encouraging such landowners to incorporate riparian planting (of coppicing species, especially willow), buffer strips and grazing management (deer control and livestock exclusions) would be recommended. Herbivore impact assessments have also been recommended across the catchment in the recent SEA. Overall, the Spey catchment provides plentiful habitat for an expanding and dynamic future beaver population, the majority of which would reside in close association with the main water courses.

Though main river releases have been very successfully employed in beaver restoration projects throughout Europe, it has been proposed that any releases should initially focus on semi-contained water bodies to promote establishment and connectivity, enable some level of post-release monitoring and encourage pairs/families to remain together. This report has identified several potential release sites offering suitable habitat, initially low damming capacity, expected lower management conflicts and which have a high level of connectivity. Note these sites are all connected to the main River Spey so are not proposed as retention sites, beavers can disperse freely and select high quality riverine habitat. Each site would require little if any pre-release preparation. These sites are owned and/or managed by different landowners or organisations and further conversations on specific site details are expected ahead of any application.

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Appendix 1. Datasets used

The source datasets analysed during the current study were made available from the following locations:

OS Mastermap Water Network Layer: https://www.ordnancesurvey.co.uk/business-and-government/products/os-mastermap-water-network.html

APGB DTM 5m: https://docs.wixstatic.com/ugd/66c69f_482b0b6f530f4463a02626c8b194e25d.pdf

National River Flow Archive: https://nrfa.ceh.ac.uk/data

OS VectorMap Local: https://www.ordnancesurvey.co.uk/business-and-government/products/vectormap-local.html

CEH Land Cover Map: https://doi.org/10.5285/bb15e200-9349-403c-bda9-b430093807c7

Copernicus TCD: https://land.copernicus.eu/pan-european/high-resolution-layers/forests/tree-cover-density/status-maps/2015

CEH Linear Woody Framework: https://www.ceh.ac.uk/services/woody-linear-features-framework

Appendix 2. Caveats for use

Beaver vegetation and habitat index

BHI provides a resource for quantifying beaver habitat suitability with national coverage. A high (5m) spatial resolution enables it to have the capacity to inform detailed local decision making.

Examples of BHI presented overlaid on satellite imagery reflect its ability to provide a highly useful classification of beaver habitat based upon a vegetation suitability ranking and access to water (including both river network and waterbodies such as ponds and lakes). However, it is critical to note that BHI is a model rather than an absolute reflection of reality and the below caveats should be considered when using the BHI model outputs.

- Output resolution only as a high as the spatial resolution of coarsest input dataset (5 m).
- Remote sensing/mapping vegetation/landuse datasets not to species level. However, beavers are generalists foraging and utilising a wide range of vegetation so this is an applicable approach. However, if more detailed information is required (i.e., protected plant species) supplementary local studies and data sets are recommended.
- Whilst broad categories have been used to classify beaver suitability it is important to highlight all classes from 2 (barely suitable) to 5 (highly suitable) are thought to contain suitable habitat that beavers being resourceful generalists could utilise.
- Each dataset essentially a snapshot in time. Areas of vegetation removal or land use change may degrade vegetation suitability whilst conversely replanting and conservation schemes may improve vegetation suitability. However, combination of datasets and methodology for ranking vegetation suitability minimise the risk of areas of suitable/unsuitable vegetation being missed currently.
- Some small channels i.e. agricultural ditches and ponds may be missing or outdated in dataset meaning beavers could access or exist in such areas but not be correctly classified by BHI model as falling within 100m of a water body.
- Most literature cites 50 m as maximum foraging range of beaver (i.e. Stringer et al., 2018) however, to incorporate uncertainty, site development (i.e. beavers damming or canal building allowing them to extend their foraging range) and due to reports of further foraging we have adopted 100 m as per Macfarlane et al., 2015. There are extreme reports of beavers moving up to 250m from channel (Macfarlane et al., 2015) but this is thought to be incredibly rare and not applicable to a general widely deployed habitat model.
- Summary statistics will reflect the above requirement for access to water, hence most if not all catchments will be dominated by areas not accessible to beaver. This does not mean they will not support healthy beaver populations.
- BHI focused on vegetation suitability and distance to channel/waterbody as a computationally effective model that can be deployed nationally. However, other local factors that will restrict access to water/vegetation particularly slope human infrastructure culverted/constrained sections walls/fences may locally limit beaver habitat suitability.

- Due to the above considerations, it is always recommended that if making important and detailed decisions at the local scale, supplementary site visits are undertaken.

Beaver dam Capacity Model

The BDC model estimates the capacity of river systems to support dams at the reach-scale (c.a. 150m). The model also highlights reaches that are more likely to be dammed by beaver and estimates the number of beaver dams that could occur for a catchment at population carrying capacity. As such, this highly detailed tool would provide understanding of where dams are most likely to occur and in what densities, supporting future work on the conflicts and opportunities that might accrue from beaver reintroduction. However, as with BHI, it is important to remember BDC is a model and for all critical decisions, particularly at the local scale, understanding from modelling results should be supplemented by site visits. The following caveats in-particular should be considered for interpretation of BDC results:

- BDC is heavily dependent on the input channel network. In some areas, flow pathways can be complex and not always accurately represented by even detailed river network GIS and mapping.
- BDC modelling is a snapshot in time and will not reflect any subsequent alterations to channel networks.
- It is important to note that the model assumes both reach and catchment population carrying capacity for beaver. Therefore, in reality the maximum number of dams indicated in a category class is unlikely to occur.
- Flow conditions display a high degree of temporal variability, short term fluctuations due to rainfall events patterns and seasonal trends will alter the suitability of a channel for damming. I.e. a channel classed as having a rare capacity for damming, might see this capacity increase during drought periods, but conversely reduce to none during the wet/winter season.
- Modelling does not consider the resilience of dams. It is likely that dams in small channels with a high BDC will be more resilient than those in a larger channel with a higher stream power. However, BDC does not quantify this.
- BDC does not consider the exact spatial distribution or configuration of dams, which is also likely to be heavily dependent on beaver population dynamics.
- BDC reflects the capacity of a given reach to support beaver dams (assuming catchment beaver population carrying capacity) rather than the actual number of dams that are likely to occur. In isolation, BDC cannot predict the likely number of dams in a catchment.
- Most operational catchment boundaries used for determination of BDC extent exclude coastal and tidal reaches. Whilst these are often not suitable for beaver damming anyway it is important to highlight their omission.