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Cultural ecosystem services of beaver-modified landscapes in Britain

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ABSTRACT

Beaver (*Castor fiber*) translocations are accelerating across Britain as part of nature restoration efforts. While research on beaver effects on ecosystem services in Britain has progressed, our understanding of cultural ecosystem services of beaver-modified landscapes remains limited. We used a standardised questionnaire with 166 respondents across six beaver-modified landscapes in Scotland and England to understand cultural ecosystem services and disservices provided to landscape visitors. Our findings demonstrate that beaver-modified landscapes provide significant cultural ecosystem services to visitors. Respondents were drawn to beaver landscapes for recreation, educational opportunities, landscape aesthetics, inspiration and social relations. Positive aesthetic perceptions and positive emotions were significantly higher among women than men, environmental NGO members than non-members and respondents on guided beaver tours than those visiting independently. We recommend that beaver management strategies support access to these cultural values through accessible infrastructure, educational opportunities, benefit-sharing mechanisms and connections to health and wellbeing initiatives, while recognising that realising cultural benefits also requires addressing disbenefits that arise locally and accommodating plural, sometimes competing, values, as essential aspects of socially just nature conservation.

KEY POLICY HIGHLIGHTS

- We recommend that beaver advisory groups and governance bodies overseeing beaver strategy implementation systematically integrate socio-cultural value assessments, so that non-material values are recognised alongside material costs and benefits.
- We suggest continuing to develop local benefit-sharing mechanisms that allow communities bearing the costs of managing beaver modifications (e.g. dam or burrowing) to access associated benefits, such as ecotourism revenue sharing or nature credits/ green finance schemes.
- We recommend that beaver licensing processes incorporate consideration of positive immaterial values alongside expected (negative) impacts from beaver translocations.
- Translocation projects should consider investing in accessible infrastructure and educational provision, for example, trails with interpretation boards, and printed or online information materials.
- We show that beaver landscapes generate cultural landscape values and have the potential to deliver well-being benefits. We suggest that healthcare systems consider beaver landscapes as candidates for green/blue social prescribing.

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1. Introduction

Human impacts on ecosystems through land use change, urban development and climate change have been identified as the primary drivers of global biodiversity loss (Wilting et al. 2017; Davis et al. 2018), with the UK being reported as one of the most nature-depleted countries on Earth (Burns et al. 2023). To address this biodiversity loss, species reintroductions[1] and translocations[2] are an important conservation measure (IUCN, & SSC 2013; Seddon and Redford 2025).

In Britain, Eurasian beavers (*Castor fiber*) have become a popular keystone species for reintroduction and translocation due to their role as 'ecosystem engineers' (Nummi and Pöysä 1997; Wright et al. 2002), a term referring to beavers' ability to modify ecosystems to meet their ecological needs, resulting in considerable hydrological, ecological, and geomorphological changes (Brazier et al. 2021; Geris et al. 2022), with significant biodiversity benefits (Law et al. 2016). Alongside their positive contribution to biodiversity and ecosystem services, wetlands, such as those created by beavers, can also provide a range of cultural ecosystem services (CES), or 'non-material benefits people gain from an ecosystem' (MA 2005, 40) which can include wildlife viewing, outdoor

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education or aesthetic appreciation (Wood et al. 2024). However, there is limited published literature on perceptions of beaver-modified landscapes and their provision of CES (Auster et al., 2020a, 2021; Ulicsni et al. 2020). As beavers increasingly expand into culturally layered rural and urban landscapes in Britain, their transformative effects on these environments can influence intangible cultural values. Beaver wetlands, may, for instance, alter people's aesthetic experience of landscapes (Wartmann and Lorimer 2024), or change people's sense of place and place identity (Carter et al. 2007). Despite intangible values being crucial to understand and manage accelerating beaver translocations across Britain (Forestry and Land Scotland 2025; Natural England 2025), such intangible values are considered methodologically challenging to study, with typically fewer studies addressing these intangible cultural values compared to more tangible ecosystem services (Chan et al. 2012; Milcu et al. 2013).

Our study addresses this gap by providing empirical evidence of people's perception of CES in beaver-modified landscapes in Scotland and England, where beaver conservation translocations have been taking place and new translocations are being planned (IUCN/CPSG 2022; Otway and Pouget 2025). We collected empirical data using standardised questionnaires conducted face-to-face with 166 people visiting beaver-modified landscapes. In the following, we now briefly introduce existing literature on the CES framework, on beaver landscapes and CES, as well as the policy background around beaver translocations in Scotland and England.

1.1. Cultural ecosystems framework

We used the MA (2005) cultural ecosystem services (CES) framework for this study, as it is well recognised across practitioners and policy stakeholders in the UK, compared to more recent and more holistic conceptual frameworks such as the IPBES' 'Nature's contributions to people' (Díaz et al. 2015, 2018). Methodologically, the CES framework isolates non-material benefits into a category with multiple services, and creates space for allowing us to consider multiple intangible CES independently from the more environmental and physical ecosystem services, thus aiding comparison across sites and different groups of people. In contrast, the Nature's Contributions to People (NCP) framework adopts a more cross-cutting, pluralist approach across service categories (Hill et al. 2021), which can be a strength for more holistic assessments, but would be a challenge for a more detailed study solely on intangible values such as the one we present here. While plural valuation approaches better capture the diversity and incommensurability of values people hold (Isacs et al. 2023), they are not well-suited to explore and compare specific cultural service categories such as aesthetics or sense of place, which is the focus of this study. While we focus on the Ecosystem Services framework for this study, we see CES and Nature's Contributions to people as complementary, rather than competing lenses, with previous research also indicating that these frameworks have some conceptual overlaps (Kadykalo et al. 2019).

Furthermore, in addition to the positively connotated 'cultural ecosystem services', we follow the notion of 'ecosystem disservices', where the function of an ecosystem is instead perceived as negative for human-wellbeing (Lyytimäki and Sipilä 2009; Hirons et al. 2016; Blanco et al. 2019). An example of a cultural ecosystem disservice would be negative aesthetics some people may associate with flooded areas, felled trees or a sense of loss associated with a familiar, previously managed landscape.

In this study we focus on two CES, namely landscape aesthetics and sense of place, alongside human–nature connectedness (Mayer and Frantz 2004), a psychological construct that assesses an individual's feelings of being connected to nature (Martin et al. 2020; Lengieza and Aviste 2025). Beaver activity visibly alters vegetation structure and hydrology, including water levels, and is therefore likely to shape aesthetic perceptions (Brazier et al. 2021; Wartmann and Lorimer 2024). Beaver reintroduction also changes the character and possible management of familiar landscapes, which can alter people's sense of place and place identity (Carter et al. 2007; Devine-Wright 2009). While we also assess visitation and overall perception of beaver wetlands, as well as emotions related to beaver landscapes, we mainly focus on aesthetics and sense of place constructs, because they are most directly related to the physical changes, and associated perceptual shifts, that beaver modification brings to a landscape, but remain comparatively under-researched in reintroduction contexts relative to more tangible or provisioning services, despite their relevance to social acceptance of ongoing beaver translocations (Forestry and Land Scotland 2025; Natural England 2025). Human–nature connectedness is closely linked to how people experience and value both aesthetics and sense of place and is itself associated with pro-environmental behaviour and well-being (Barragan-Jason et al. 2023). We therefore include it as a complementary lens on how encounters with beaver-modified landscapes shape people's broader connectedness to nature, alongside our focus on CES.

1.2. Cultural ecosystem services of beavers and beaver landscapes

Much of the research on beavers has focussed on ecological effects of beavers on landscapes (Law

et al. 2017; Fairfax and Westbrook 2024; Hooker et al. 2024; Wilson et al. 2024). However, early beaver reintroductions were often motivated by cultural reasons. For example, Sweden reintroduced beavers in the 20th century to restore something 'lost' from the Swedish landscape (Jørgensen 2019). While human coexistence with beavers and beaver-modified landscapes likely relies on cultural acceptance, the cultural importance of beaver landscapes remains underresearched. Without understanding these cultural dimensions, conservation efforts risk generating conflict or missing opportunities to build support among communities who assign different values to beaver-modified landscapes. Although some literature addresses human-beaver relationships in Britain (Auster et al., 2020b; Gandy and Watts 2021; Jones and Jones 2023), less research examines the beaver-modified landscapes themselves and their associated CES. The centuries-long absence of beaver landscapes from Britain (Rosell and Campbell-Palmer 2022) likely contributes to this gap in knowledge. As no prior study has comprehensively reviewed CES across beaver landscapes, we provide an overview in Table 1 before focusing our own empirical contribution.

Beyond beavers, other keystone species and ecosystem engineers have been shown to generate comparable cultural values. Atlantic salmon (*Salmo salar*) are recognised as a source of aesthetic and educational value in France, Germany, Sweden and Norway (Kochalski et al. 2022). Reintroduced European bison (*Bison bonasus*) boosted ecotourism around Romania's Bison Valley Reserve Rezervația Valea Zimbrilor (Joshi et al. 2026). The Marsican brown bear (*Ursus arctos marsicanus*[3]) provides both promotional and symbolic value and fosters emotional attachment among visitors to the Italian national parks it inhabits (Folmer et al. 2013; Tattoni et al. 2024). Alpine ibex (*Capra ibex*) and golden eagle (*Aquila chrysaetos*) have similarly been argued to constitute CES through cultural symbolism (Schirpke et al. 2018). Across these cases, cultural value appears linked to a species' visibility, symbolic value, and capacity to visibly transform its habitat. Though, similar to beavers, systematic, comparative evidence using CES, NCP or plural-values framings studies remains scarce.

Consequently, limited evidence on CES means they are still too often not appropriately considered in decision-making (Cabana et al. 2020), posing challenges for incorporating these services into policy-making and landscape management practices (Kosanic and Petzold 2020). While we have adopted CES rather than a more pluralist framework for methodological reasons (Section 1.1), robust evidence on specific CES remains a necessary building block for value-pluralistic decision-making that ecosystem governance increasingly requires, which recognises multiple, often conflicting, forms of value that cannot be reduced to a single common metric such as monetary value (Isacs et al. 2023). We argue that CES evidence is therefore essential to informing value pluralism in restoration efforts, including species reintroduction and translocation (Glikman et al. 2022; Allgood et al. 2025; Brewitt 2025). This study provides empirical evidence on CES of beaver-modified landscapes, addressing this gap directly. In the next section, we briefly discuss policy context and recent British policy changes around beaver translocations before introducing our methodology.

1.3. Policy context

Our research is based in a British policy context, where beaver protection and management is devolved to the nations: England, Scotland and Wales. Scotland's Beaver Strategy 2022–2045 (IUCN/CPSG 2022) is steering efforts to expand beaver populations alongside appropriate management and mitigation strategies, with focus also on how people can benefit from the presence of beavers. In England, as of February 2025, the Government announced commitment to the licensed release of beavers into the wild, marking a policy change (Natural England 2025). Previously, beavers in England were required to be enclosed, with exceptions made for some already wild populations (Natural England 2025). We excluded Wales from our study, as there are only some small populations of beavers in enclosures (Collins and Halliwell 2023). However, the Welsh Government has declared their support for the managed reintroduction of beavers into Wales (Irranca-Davies 2024). Despite being at different stages of reintroduction among the countries in Britain, there is a policy push from all to encompass beavers into future nature recovery plans.

2. Methodology

We used one standardised questionnaire with 166 respondents across six beaver landscapes in Scotland and England to understand visitor's perceptions of the landscape. Questions aimed to assess the cultural ecosystem services and disservices of beaver-modified landscapes.

This research was granted ethical approval by The Physical Sciences and Engineering Ethics Board at the University of Aberdeen (approval number *1357139*). Within our approval, we considered data protection by ensuring respondents remained anonymous by not collecting personal information. Respondents were also made aware of their voluntarty consent and right to withdraw from the questionnaire process at any point.

Table 1. Existing literature on cultural ecosystem services of beavers and beaver landscapes.

Cultural Ecosystem Service:	Existing Literature:
Recreation	Recreational services from beaver landscapes include wildlife watching in England (Auster et al. 2020a); birdwatching and canoeing across the Northern Hemisphere (Thompson et al. 2021); and fishing in Romania (Ulicsni et al. 2020). However, it was reported beaver landscapes can also negatively impact recreation by blocking recreational trails in some areas in Canada (Yarmey and Hood 2020).
Education	Educational services were reported from The Scottish Beaver Trial, hosting educational tours and school trips (Moran and Lewis 2014). However, educational aspects are otherwise rarely reported (Ulicsni et al. 2020).
Landscape aesthetics	Landscape aesthetics present challenges, as beaver-modified landscapes differ aesthetically from traditional anthropogenic landscapes that have become normalised and accepted in the beaver's absence (Prior 2023). European studies have shown beaver landscapes can be perceived as messy, and problematic for semi-traditional land use systems that value 'tidiness' (Ulicsni et al. 2020; Wartmann and Lorimer 2024). For example, Canadian residents thought that beavers 'created mess' and 'caused trouble in the streams' (Yarmey and Hood 2020). In Scotland, Johnson et al. (2023) found locals were concerned about beavers 'damaging trees'. However, views were polarised, with some locals acknowledging the 'rewilded' aesthetic that beavers can create. Ultimately, less attention has focussed on potentially positive aesthetics associated with beaver landscapes.
Cultural heritage	Cultural heritage can be negatively impacted when beavers expand into anthropogenic landscapes through physical modifications, including increased floodplains, and the creation of multi-thread channel systems (Larsen et al. 2021). Scotland's Strategic Environmental Assessment recognised potential interference with historic sites while also acknowledging cultural value that communities place on beaver reintroduction (Moran and Lewis 2014; The Scottish Government 2017). Thus further supported by the concerns of residents expressed within NatureScot's report over potential changes to their existing cultural landscape and heritage resulting from beaver reintroduction (Johnson et al. 2023).
Social relations	Social relations can suffer positively and negatively. Illegal beaver releases in Tayside, East Scotland created conflict between stakeholders (Coz and Young 2020), and NatureScot's report revealed residents were concerned that opposing views within the community could cause conflict (Johnson et al. 2023). However, beaver landscapes could theoretically enhance social relations through conservation activities that improve social interactions and mental health (Gandy and Watts 2021).
Spiritual & religious	Spiritual & religious values can have historical and contemporary significance, particularly for indigenous First Nations in North America who regarded beavers as mythic beings central to cosmogenetic stories of the origins of the world (Rosell and Campbell-Palmer 2022). Among indigenous European Saami, beavers often took the place of fish proscribed for ritual consumption, as offerings at sacred places and as the preferred food of mythical creatures such as the stone-coated *Stallo* giants (Salmi et al. 2018). Similar spiritual and religious values seem to be missing for central and Western Europe, although in the 19th century the American beaver was praised for its innate engineering abilities playing a prominent role in debates about social evolution (Morgan 1868; Kropotkin 1902).
Inspiration	Inspiration surrounding beavers is embedded in folklore across cultures. Indigenous peoples of North America have passed down stories inspired by beavers and their way of life through generations, for example, Ojibwe peoples of North America's *When Beaver Was Very Great* (Dunn 1995), and the Salish peoples of Montana's *Beaver Steals Fire* (Confederated Salish and Kootenai Tribes 2005). Beavers and their landscapes have inspired various plays, documentaries, and even computer games, such as *Timberborn (Mechanistry 2025)*, where players use wooden machinery, dams, and water physics *(Gabrielaitis et al. 2024)*.
Sense of place	Sense of place, although methodologically challenging to assess due to its intangibility (Wartmann and Purves 2018), represents complex connections between people and environments (Tuan 1977). Beaver ecosystem engineering may negatively impact sense of place through creating unfamiliar landscapes (Gandy and Watts 2021), yet some European cultures restored beavers precisely to address lost sense of place (Jørgensen 2019).
Knowledge systems and cultural diversity	Knowledge systems and cultural diversity as CES (MA 2005) of beaver-modified landscapes have not been identified in academic beaver literature, presumably requiring longer time periods to develop for measurement within this research framework. However, outwith academic sources, traditional ecological knowledge can exist within communities, but is unlikely to be documented academically (Huntington 2000; Sherry and Myers 2002). For example, in North America, traditional ecological knowledge on beavers is held by indigenous communities which they can use for beaver management (Moller et al. 2004).

2.1. Site selection

We selected six beaver-modified sites across Scotland and England (Figure 1) including both wild and enclosed populations using pragmatic criteria (Robertson and Sibley 2018), including site accessibility, geographic distribution and visitor access opportunities. For wild beaver populations, sites needed clear views of the landscape and beaver activity (such as felled trees) along public accessible walking routes. For enclosed populations, site selection was constrained by limited public accessibility, as most beaver enclosures are not publicly viewable due to past regulatory requirements (in England) mandating enclosure of beaver populations (Figure 2). Enclosed sites were restricted to organised 'beaver tours', which were therefore selected based on tour availability. This pragmatic approach ensured our sample captured visitor experiences across different beaver management contexts while working within access limitations.

2.2. Respondent sampling

We conducted a 10–15-minute face-to-face standardised questionnaire (Supplementary Materials 1) with respondents due to the established popularity of questionnaire-based assessments of CES in a non-monetary research context, for example within community level research (Plieninger et al. 2013; Cheng et al. 2019). Questionnaires combined open and closed-ended questions to understand CES provided to landscape visitors, with length kept short to increase response and minimise disruption for respondents during their visits (Bhattacherjee 2012).

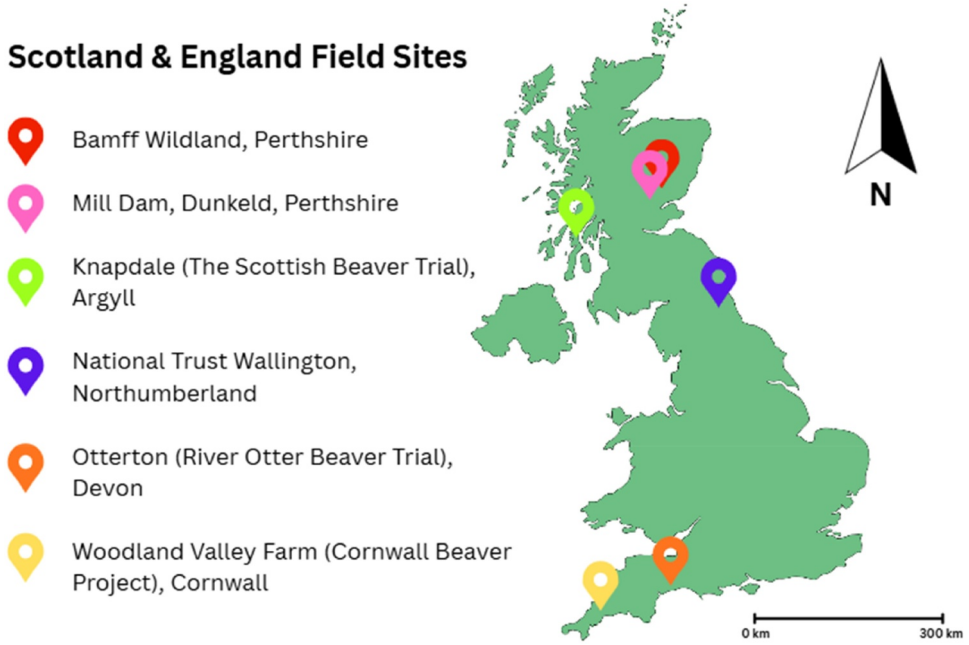


Figure 1. Map of Scottish and English field sites (image produced using Canva, 2025).

We employed convenience sampling due to the absence of knowledge of what would constitute the sampling universe of all site visitors. We recruited respondents in the field based on their availability and willingness, without following a probabilistic pattern (Galloway 2005). While this approach has representativeness limitations, it is commonly used in CES research conducted with visitors due to its pragmatic advantages, such as use within research where resources for more strategic sampling may be limited (Graves et al. 2017; Wartmann and Mackaness 2020). Given budgetary constraints, we targeted 30 respondents per site, a sample size comparable to previous cross-site CES research and deemed suitable for statistical analysis (Wartmann and Purves 2018; Field 2024), aiming for a total of 180 responses. Data collection primarily occurred during July and August 2024, with one site sampled in both July and September due to small visitor numbers. Time spent at each site varied between 3 and 7 days, and we ensured comparable weather conditions across data collection periods (Table 2).

2.3. Questionnaire development

We collected information on respondents' self-reported estimated visitation frequency during spring/summer and fall/winter periods, visiting companions and visitation motivations. Demographic data included age, gender, education level and environmental organization membership. Education level was collected using the categories primary school; secondary school; further education (e.g. college); and higher education (e.g. university), but then reclassified into two categories for analysis: primary through further education, and higher education.

Given that beaver-modified landscapes are potentially aesthetically challenging (Ulicsni et al. 2020; Prior 2023), we wanted to assess landscape aesthetics in a British context and understand whether people positively or negatively perceived beaver landscape features as 'messy'. We employed a Free Listing exercise commonly used in linguistics and anthropology to get an overview of terms associated with a specific concept (Sutrop 2001) or landscape (Wartmann et al. 2015) as the opening question, asking respondents *'How would you describe this landscape to me?'* to capture their immediate perceptions of the landscape and assess cognitive salience of landscape features that were mentioned (Wartmann et al. 2015). Respondents were aware that beavers inhabited the landscape and were aware of present landscape modifications such as dams, felled trees, gnaw marks, gnawed stumps, and deadwood. But for this exercise, the respondent was being asked about the entire landscape, not focussing exclusively on beaver-related landscape features. This method allowed us to understand which landscape features were saliently perceived and arrive at a bottom-up characterisation of the beaver landscape without imposing researchers' categorisations (Wartmann et al. 2018).

To analyse the Free Listing data, we calculated cognitive salience index ($S = F/(N^*mP)$) using Excel to identify top salient words. This index combines frequency and mean position parameters to determine word salience in lists, with values ranging from 0 to 1, where terms closer to 1 indicate higher salience (Sutrop 2001). We



Figure 2. Sampled beaver landscapes (photo credit: S. Webb). Photos show a range of beaver modifications which a visitor can expect from a beaver inhabited landscape such as deadwood, felled trees, gnawed tree stumps, dams and gnaw marks on trees. For example, beaver felled trees can be seen in the photos for Mill Dam, Woodland Valley Farm and Otterton. A beaver-built dam can be seen in the photo for Wallington. Gnawed tree stumps can be seen in the photo for Knapdale and Mill Dam. An old gnaw mark can be seen in the photo for Otterton, and deadwood is present in all photos.

excluded blank responses and unusable entries (responses that contained no landscape descriptors, such as comments about weather). We asked respondents what they liked and disliked about the landscape to understand whether specific landscape features were viewed positively or negatively. We analysed these responses using inductive thematic analysis (Terry et al. 2017), employing a 'bottom-up' approach without predefined themes due to limited existing literature on perceptions of beaver-modified landscapes. Structured coding was used to refine identified themes and ensure consistency in theme assignment (Terry et al. 2017).

Table 2. Overview of sampled beaver-modified landscape sites, their characteristics and sampling effort.

Field site	Site co-ordinates	Wild/ enclosed	Ecological characteristics	Sampled	No. of days	Weather conditions during sampling
Bamff Wildland	56.6472303, −3.2646913	Wild	Former agricultural area, with beavers creating several dams along a stream	July & Sept (2024)	6	Mostly clear skies and sunshine
Knapdale	56.0495786, −5.5571883	Wild, Beaver tour	Predominantly mixed forestry, with beavers damming a pre-existing lake	July (2024)	3	A mix of overcast cloud, sunny intervals and light rain
Mill Dam	56.5973964, −3.5796706	Wild	Predominantly mixed, upland forestry, with beavers damming a pre-existing lake	July (2024)	3	Clear skies and sunshine
Woodland Valley Farm	50.3203487, −4.9335721	Enclosed, Beaver tour	Mixed woodland, working farm, pre-existing watercourse within enclosure which beavers have dammed	August (2024)	7	Mostly clear skies and sunshine, some light rain
Otterton	50.6530826, −3.3058286	Wild	Recreational walkway alongside the River Otter, surrounding agricultural farmland	August (2024)	2	Clear skies and sunshine
Wallington	55.1948138, −1.9599779	Enclosed, Beaver tour	Mixed foresty, agricultural farmland, beavers introduced onto local burn.	August (2024)	3	Sunny intervals and light rain

2.3.1. Aesthetics and sense of place related to landscape

We included two sets of statements using 5-point Likert scales (Likert 1932) ranging from strongly disagree (1) to strongly agree (5). The first set captured respondents' aesthetic perceptions of the landscape, including statements such as *'this landscape is beautiful'* and *'this landscape is ugly'*. The second set of statements focused on respondents' emotions and sense of place related to the landscape, including statements such as '*this landscape makes me feel happy*' and '*this landscape makes me feel sad*'.

2.3.2. Connectedness to nature, previous beaver encounters and beaver-related knowledge

We measured nature connectedness as a potentially important explanatory variable using the shortened Nature Relatedness (NR-6) scale (Nisbet and Zelenski 2013). This validated six-item instrument measures emotional and physical connections to nature using a five-point Likert scale from strongly disagree (1) to strongly agree (5), providing a reliable yet concise alternative to the full Nature Relatedness scale (Salazar et al. 2020).

To assess respondents' prior beaver experience and knowledge, we asked whether they had previously seen a beaver (in the wild, in an enclosure/zoo, or not at all) and tested their knowledge of beaver diet through a multiple-choice question, where correct answers for what beaver ate were 'tree bark', 'grass', 'leaves' and incorrect answers were 'fish' and 'insects'. We calculated the knowledge scale ranging from 0 correct answers to 5 correct answers. We created a variable on whether respondents visited on a beaver tour (study sites: Knapdale, Woodland Valley Farm, Wallington) or independently (study sites: Bamff Wildland, Otterton, Mill Dam).

2.4. Data analysis

Statistical analyses were conducted using SPSS Statistics v. 29 (IBM SPSS Statistics for Windows 2022). We used descriptive statistics to analyse visitation patterns, Likert-scale responses on aesthetics and emotions, and beaver encounter data. Principal Component Analysis with Varimax rotation was applied to statements about aesthetics for dimension reduction, retaining factors with eigenvalues ≥ 1. Principal component analysis is a dimensionality reduction technique used to transform numerous correlated variables into a smaller set of uncorrelated principal components (Sanguansat 2012). We used this analysis method to condense our multiple Likert scale statements on aesthetics and emotions into components that we analysed against respondent variables. The same dimension reduction approach was used for statements relating to emotions. Given

non-normal data distribution, we used non-parametric tests, using Mann–Whitney U tests for two-group comparisons (e.g. environmental organisation membership) and Kruskal–Wallis tests for multiple groups (e.g. study sites, age groups), with $\alpha = 0.05$. Spearman's rho correlation assessed relationships between continuous variables (Field 2024). These statistical comparisons were used to identify whether responses to visitation motivations, aesthetic and emotional statements, and beaver knowledge questions differed significantly across respondents grouped according to gender, age, study sites or membership of an environmental NGO.

3. Results

3.1. Respondent demographics and landscape visitation

During July and August 2024, we collected 166 in-situ questionnaires from visitors across six beaver-modified landscapes (Table 3). The sample included 88 females and 76 males. The sample was skewed toward older visitors, with nearly half (49.4%, $n = 83$) aged 55 or above, including 25.3% ($n = 42$) over 65 years and 24.7% ($n = 41$) between 55 and 64 years. Middle-aged respondents (35–54 years) comprised 30.2% ($n = 50$), while younger adults were underrepresented with 12.0% ($n = 20$) aged 25–34 years and 6.6% ($n = 11$) aged 18–24 years. Educational attainment amongst respondents was high, with 69.9% ($n = 116$) having higher education qualifications, while 18.1% ($n = 30$) had further education and 7.8% ($n = 13$) had secondary education. Environmental organisation membership was relatively balanced, with 47% ($n = 77$) members and 53% ($n = 87$) non-members.

Most respondents were infrequent visitors, with over 50% never visiting the beaver landscape in spring/summer and over 60% never visited in fall/winter. During visits, respondents typically spent 1–2 hours in the landscape during both seasons. Most visitors came with family or friends (62.1%, $n = 100$), while 8.7% ($n = 14$) visited alone, 24.2% ($n = 39$) visited both alone and with others.

Across all study sites, walking/hiking and enjoying views/scenery were the most popular visitation reasons, with less popular reasons including spiritual/religious purposes, and social gathering (Figure 3). Environmental organisation members were significantly more likely to visit for walking/hiking than non-members (members: 77, non-members: 85. Mann–Whitney U: $Z = -4.485$, $p < .001$), wildlife watching (members: 77, non-members: 85, Mann–Whitney U: $Z = -2.735$, $p = .006$), and learning about nature (members: 77, non-members: 85, Mann–Whitney U: $Z = -2.338$, $p = .019$).

When analysing the most popular visitation reasons for each site, recreation and ecotourism emerged as the dominant overall CES stated as the visitation reason, with wildlife watching and walking/hiking being the primary activities (Table 4).

Table 3. Number of survey respondents per study site and gender.

Study site	N	Female	Male
Bamff Wildland	24	13	11
Knapdale	32	20	12
Mill Dam	33	12	21
Woodland Valley Farm	27	15	12
Otterton	34	21	11
Wallington	16	7	9

3.2. Beaver encounters and knowledge about beavers

Out of the total responses to the question ($n = 163$), 37% ($n = 62$) of respondents had seen a beaver in the wild, 26% ($n = 43$) of respondents had seen a beaver in an enclosure or zoo, 6% ($n = 10$) of respondents had seen beavers in both the wild and in an enclosure or zoo and 29% ($n = 48$) of respondents had never seen a beaver.

Scores on the beaver knowledge scale, regarding beaver diet, ranged from 0 correct answers to 5 correct answers (mean: 3.17 ± 1.46, $n = 163$). There was no significant difference in beaver knowledge between men (mean: 3.24 ± 1.39, $n = 75$) and women (mean: 3.06 ± 1.52, $n = 87$, Mann–Whitney U: $Z = -0.679$, $p = 0.497$), between lower formal education (mean: 3.14 ± 1.24, $n = 42$) or higher levels of formal education (mean: 3.19 ± 1.54, $n = 115$ Mann–Whitney U, $Z = -0.555$, $p = 0.579$), but members of environmental organisations had significantly higher beaver knowledge scores (mean: 3.63 ± 1.34, $n = 75$) than non-members (mean: 2.72 ± 1.44, $n = 87$, Mann–Whitney U, $Z = -4.078$, $p < 0.001$). Beaver knowledge was significantly positively correlated with connectedness to nature (Spearman's rho = 0.277, $p < 0.001$), meaning that people who felt more connected to nature held more factually correct knowledge about beaver diets.

While 73.6% of respondents ($n = 120$) correctly answered that a beaver's diet included tree bark, 22% ($n = 37$) of respondents incorrectly answered that beavers ate fish. Level of education did not influence this percentage (Mann–Whitney U, $Z = -.395$, $p = .693$). However, respondents who were not members of an environmental organisation were more likely to believe that beavers ate fish ($n = 87$) than respondents who were members of an environmental organisation ($n = 75$, Mann–Whitney U, $Z = -3.416$, $p = <.001$).

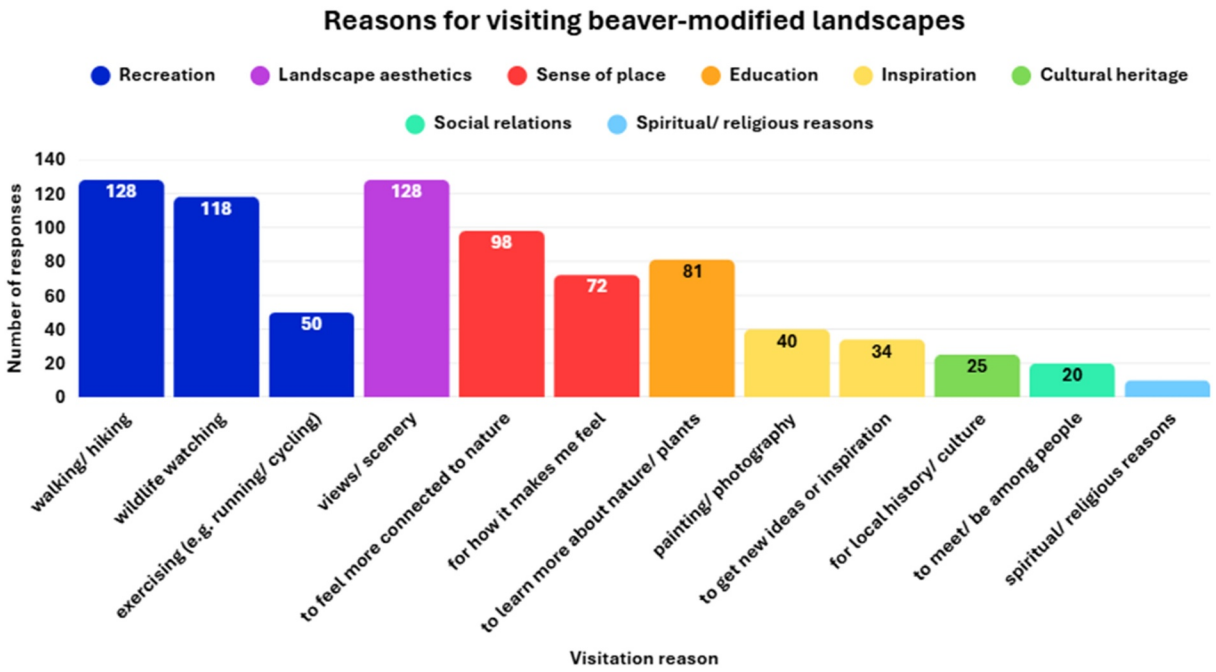


Figure 3. Histogram of landscape visitation reasons for all study sites, colour-coded into cultural ecosystem service categories (MA 2005, Image made using Canva, 2025).

Table 4. Most popular CES stated as visitation reasons for each study site.

Study site	Primary CES	Visitation reason(s):	N (responses)	N (total)
Bamff	Recreation and Ecotourism	Wildlife watching	23	24
Knapdale	Recreation and Ecotourism	Walking/ hiking	29	32
Mill Dam	Recreation and Ecotourism	Walking/ hiking	30	33
Woodland Valley farm	Recreation and Ecotourism Landscape Aesthetics	Wildlife watching Views/ scenery	23	27
Otterton	Recreation and Ecotourism	Walking/ hiking	33	34
Wallington	Recreation and Ecotourism	Wildlife watching	12	16
Total			150	166

3.3. Respondents describing beaver landscapes

Free listing analysis revealed predominantly positive landscape perceptions (Table 5). 'Beautiful' was the most salient word for three of four landscapes with wild beaver populations, while Bamff was described as 'complex'. Landscapes with enclosed populations were described as 'natural' (Woodland Valley Farm) and 'rugged' (Wallington). Overall, the most cognitively salient words were 'natural' (S = 0.115), 'Beautiful' (S = 0.112) and 'peaceful' (S = 0.098).

Thematic analysis of aspects respondents liked (n = 162 responses) revealed six main themes (Table 6). 'Biodiversity benefits' was the theme most frequently mentioned (43%, n = 69), followed by 'aesthetics and features' (33%, n = 56). Notably, 12 respondents specifically appreciated 'messy natures', expressing a view of disorder and randomness as positive.

Disliked aspects (Table 7) were mentioned less frequently (n = 65 responses from 166 surveys), with many respondents stating 'nothing' or leaving blank responses. 'Environmental damage' was the primary concern (31%, n = 20), focusing on tree damage and potential impacts on fish movement. 'Obstruction to human processes' (18%, n = 12) included concerns about agricultural impacts and restrictions on activities like dog walking. Interestingly, 'desire for more' (18%, n = 12) reflected respondents wanting more beavers and beaver landscapes rather than expressing genuine dislikes.

Table 5. Free listing results on most salient terms associated with beaver-modified landscapes per study site (N = number of usable free listing responses).

Study site	N	Top 3 cognitively salient words	Salience scores
Bamff	23	complex, wild, wet	0.130, 0.116, 0.112
Knapdale	31	beautiful, woodland, peaceful	0.176, 0.115, 0.107
Mill Dam	32	beautiful, natural, peaceful	0.223, 0.154, 0.112
Woodland Valley Farm	27	natural, peaceful, wet	0.185, 0.178, 0.111
Otterton	33	beautiful, natural, peaceful	0.205, 0.138, 0.104
Wallington	15	rugged, wooded, water	0.120, 0.071, 0.060

Table 6. Emerging themes of what respondents like about beaver landscapes.

Theme	Key aspects	Example quotes	N
Biodiversity benefits	Increased wildlife, habitat provision, ecological restoration	*'[I like] … the plethora of wildlife that returned and the ecological interactions that have been rapidly restored' (Knapdale)* *'[I like] … their capacity to create habitat for so many other species' (Bamff)*	69
Aesthetics and features	Positive landscape aesthetics, specific features (water, trees, deadwood)	*'[I like] … pools of still water, channels, and standing deadwood' (Wallington)*	56
Natural landscapes and nature-based solutions	Natural processes, natural solutions to environmental problems	*'I like the fact the beavers live as they would naturally, that they make it their home' (Otterton)*	27
Beaver activity/ modifications	Evidence of beavers, dams, lodges, landscape changes	*'I like that you can see the dams/ bitemarks etc. It feels like a little adventure walk to go through there and look for signs of them [beavers]' (Woodland Valley Farm)*	23
Lost landscapes	Restoring missing species and historical landscapes	*'It's a view across history, something we haven't seen in the UK for more an 400 years' (Knapdale)*	17
Messy Natures	Appreciation for disorder, randomness, and untidiness	*'I like that the landscape is completely wild – there is no order or uniformity' (Woodland Valley Farm)*	12

Table 7. Emerging themes about what respondents dislike about beaver landscapes.

Theme	Key aspects	Example quotes	N
Environmental damage	Potential damage to trees/ ponds, dams obstructing fish movement	*'[I dislike the] … destruction of certain areas, I planted trees in this area which have now been damaged by the beavers' (Mill Dam)*	20
Obstruction to human processes	Obstruction to paths/ damage or loss of agricultural land/ disruption to landowners/ restrictions due to beaver presence	*'[I dislike] … signs which tell me to keep my dog out the water [because of beaver presence], my dog loves water – and the introduction of beavers to sites restricts her from exercise and fun!' (Otterton)*	12
Desire for more	Desire for more opportunities to see and experience beavers, desire to have unenclosed beavers	*'[I dislike] … the fact they are still in enclosures/ man-made fences' (Wallington)*	12

Table 8. Mean, standard deviation, and N of Likert scale statements (Likert scale values: 1 – strongly disagree; 5 – strongly agree).

This landscape …	Mean	SD ±	N
… is beautiful	4.68	0.71	164
… is tranquil	4.64	0.72	162
… makes this area into something special	4.56	0.71	163
… is inspiring	4.49	0.79	164
… fills me with joy	4.39	0.81	163
… is buzzing with life	4.33	0.83	161
… is magical	4.13	0.97	163
… is messy	2.47	1.449	160
… is smelly	1.42	0.89	161
… is ugly	1.19	0.60	161
… is boring	1.16	0.56	161

3.4. Positive and negative landscape aesthetics associated with beaver-modified landscapes

Landscape aesthetics were overwhelmingly viewed positively. Over 75% ($n = 127$) of respondents strongly agreed that beaver-modified landscapes were beautiful, while over 85% ($n = 142$) strongly disagreed they were ugly. Respondents agreed with landscapes being *tranquil, inspiring, magical* and *buzzing with life*. Opinion was divided on whether landscapes were *messy*, with mixed agreement and disagreement (Table 8).

Principal component analysis of aesthetic responses with Eigenvalues > 1 produced a clear two-factor solution. Positive aesthetic categories (*beautiful, inspiring, magical, tranquil, something special and buzzing with life*) loaded strongly on one factor, while negative categories (*messy, smelly, ugly* and *boring*) loaded strongly onto a second factor (for details of factor analysis see Supplementary materials 2).

3.4.1. Positive aesthetic factor

The positive aesthetic factor scored highly across all respondents (mean = 4.49 ± 0.59, $n = 164$). Environmental organisation members showed significantly higher positive aesthetic associations (mean: 4.60 ± 0.60, $n = 77$) than non-members (mean: 4.38 ± 0.56, $n = 85$; Mann–Whitney U: Z = −3.524, $p < 0.001$). Female respondents also rated positive aesthetics significantly higher (mean: 4.57 ± 0.56, $n = 86$) than males (mean: 4.39 ± 0.61, $n = 76$; Mann–Whitney U: Z = −2.937, $p = 0.003$). Respondents who visited on an organised 'beaver tour' rated the positive aesthetics significantly higher (mean: 4.55 ± 0.63, $n = 75$) than respondents who visited independently (mean: 4.44 ± 0.55, $n = 89$, Mann–Whitney U: Z = −2.00, $p = 0.45$). A strong positive correlation existed between aesthetic appreciation and nature connectedness (Spearman's rho = 0.386, $p < 0.001$, $n = 160$), as well as with beaver knowledge (Spearman's rho = 0.261, $p < 0.001$, $n = 161$). No significant differences emerged among study sites (Kruskal–Wallis H = 9.059, df = 5, $p = 0.107$), education

levels (Mann–Whitney U: Z = −1.456, $p = 0.145$) or age groups (Kruskal–Wallis H = 10.543, df = 5, $p = 0.061$).

3.4.2. Negative aesthetic factor

Negative aesthetic associations were consistently low across respondents (mean = 1.58 ± 0.70, $n = 160$), with no significant differences between environmental organisation members (mean: 1.60 ± 0.72, $n = 76$) and non-members (mean: 1.57 ± 0.69, $n = 84$, Mann–Whitney U: Z = −0.625, $p = 0.532$) or between higher formal education levels (mean: 1.62 ± 0.74, $n = 116$) and lower (mean: 1.44 ± 0.59, $n = 40$, Mann–Whitney U: Z = −1.254, $p = 0.210$). However, significant differences among study sites emerged (Kruskal–Wallis H = 16.785, df = 5, $p = 0.005$), with Woodland Valley Farm showing the highest negative ratings (mean: 1.90 ± 0.86, $n = 27$) and Mill Dam the lowest (mean: 1.34 ± 0.50, $n = 32$). Age groups also differed significantly (Kruskal–Wallis H = 14.364, df = 5, $p = 0.013$), with respondents aged 35–44 years showing the most negative perceptions (mean: 2.05 ± 0.95, $n = 22$) and those 65+ showing the least negative (mean: 1.33 ± 0.39, $n = 38$). There was no difference in negative perceptions between people on a beaver tour or not (Mann–Whitney U: Z = −2.841, $p = 0.150$). No correlation existed between negative aesthetics and nature connectedness (Spearman's rho = −0.065, $p = 0.414$, $n = 159$) or beaver knowledge (Spearman's rho = 0.110, $p = 0.166$, $n = 160$).

3.5. Sense of place and emotions

Emotional responses were also highly positive. For example, 69% ($n = 115$) of respondents strongly agreed that beaver landscapes made them feel happy, and 89% ($n = 148$) strongly disagreed they felt angry. Beaver-modified landscapes generated strong agreement with statements about feelings of peace and hope for nature restoration.

The principal component analysis of responses related to emotional statements produced a clear two-factor solution, with positive emotions (*happy, joy, at peace, hopeful we can restore nature*, and *impressed*) loading strongly on one factor, and negative emotions (*sad* and *angry*) loading onto a second factor (for details of principal component analysis, see Supplementary Materials 2).

3.5.1. Positive emotions factor

Respondents expressed strong positive emotions toward beaver landscapes overall (mean = 4.51 ± 0.62, $n = 164$). Several demographic patterns emerged in emotional responses. Women reported significantly higher positive emotions (4.62 ± 0.57, $n = 86$) than men (4.38 ± 0.65, $n = 76$; Mann–Whitney U: Z = −3.131, $p = 0.002$), and environmental organisation members showed stronger positive emotional responses (4.61 ± 0.60, $n = 77$) than non-members (4.41 ± 0.62, $n = 85$; Mann–Whitney U: Z = −2.366, $p = 0.018$). Positive emotions were significantly higher for respondents visiting on a beaver tour (mean: 4.61 ± 0.63, $n = 75$) than for those visiting independently (mean: 4.43 ± 0.60, $n = 89$, Mann–Whitney U: Z = −2.841, $p = 0.004$). However, positive emotions did not vary significantly by education level (Mann–Whitney U: Z = −0.758, $p = 0.449$), age group (Kruskal–Wallis H = 4.994, df = 5, $p = 0.417$) or study site (Kruskal–Wallis H = 10.976, df = 5, $p = 0.052$). Nature connectedness showed a strong positive correlation with positive emotions (Spearman's rho = 0.457, $p < 0.001$, $n = 160$) and with beaver knowledge (Spearman's rho = 0.257, $p = 0.001$, $n = 161$).

3.5.2. Negative emotions

Negative emotions toward beaver landscapes were consistently low across all respondents (mean = 1.13 ± 0.43, $n = 163$). Environmental organisation members reported significantly lower negative emotions (1.07 ± 0.38, $n = 76$) than non-members (1.19 ± 0.47, $n = 85$; Mann–Whitney U: Z = −2.242, $p = 0.025$). No other demographic differences emerged, with negative emotions showing no significant variation by education level (Mann–Whitney U: Z = −0.378, $p = 0.706$), gender (Mann–Whitney U: Z = −0.817, $p = 0.414$), age group (Kruskal–Wallis H = 5.695, df = 5, $p = 0.337$), or study site (Kruskal–Wallis H = 2.122, df = 5, $p = 0.832$). There was no difference in negative emotions whether respondents visited on a beaver tour or not (Mann–Whitney U: −0.153, $p = 0.878$). Nature connectedness showed no correlation with negative emotions (Spearman's rho = −0.081, $p = 0.307$, $n = 159$) or with beaver knowledge (Spearman's rho = −0.052, $p = 0.513$, $n = 160$).

4. Discussion

This study provides an empirical assessment of CES derived from beaver-modified landscapes by visitors in Scotland and England. Our findings reveal that these landscapes generate predominantly positive cultural values across multiple dimensions including recreation, aesthetics, education and emotional connection among visitors to beaver sites. However, the emergence of cultural heritage as simultaneously a service and disservice points to deeper tensions within conservation translocations of species and the ecological transformations they bring.

4.1. Recreation and ecotourism

Recreation and ecotourism emerged as dominant services, with wildlife watching and walking/hiking attracting visitors across all sites, supporting predictions about the growth potential of beaver tourism in

Britain (Auster et al., 2020a). However, our data extends beyond specialised ecotourism to reveal broader recreational values that go beyond specific beaver-viewing activities. Even at sites where beaver sightings were unlikely, visitors valued the landscapes for their inherent qualities, including water features (wetlands, dams and canals), deadwood, varied vegetation structure that beaver activities create.

These findings are consistent with findings of previous studies highlighting the recreational benefits of species reintroductions, such as the case of elk (*Cervus canadensis*) in Tennessee, USA for increased hunting opportunities (Chapagain and Poudyal 2020) and the white stork (*Ciconia ciconia*) reintroduction in England for potential to create ecotourism opportunities similar to those linked to 'stork villages' in Europe (Czajkowski et al. 2014; White et al. 2023).

The strong correlation between environmental organisation membership and nature-based recreation suggests that existing conservation networks serve as important conduits for beaver landscape appreciation. This has practical implications: conservation organisations may be key allies in building broader public support for beaver restoration, particularly through organised visits and educational programming. However, this also raises questions about how to engage publics beyond those already familiar with beavers. This is a critical challenge as beavers expand into landscapes where residents have not actively chosen to engage with beaver-modified environments (Johnson et al. 2023).

Importantly, site accessibility fundamentally shaped how cultural services were accessed and experienced. Wild beaver populations at accessible locations like Mill Dam naturally facilitated recreational walking where beaver signs became part of the broader landscape experience, while enclosed sites relied on organised tours centralising the beaver as the primary attraction. This distinction matters for management: as beaver populations expand and become less novel, we will begin to see a shift from beavers as an attraction to beavers existing in a more prevalent setting, which may represent a maturation of human-beaver coexistence in Britain (Auster et al. 2026). Scotland's Beaver Strategy (IUCN/CPSG 2022) recognises this potential, identifying scope for recreational and tourism opportunities, which our findings substantiate. As England and Wales develop their own strategic approach following recent policy changes (Irranca-Davies 2024; Natural England 2025), understanding these multifunctional values will be crucial.

4.2. Challenging assumptions about aesthetics of beaver landscapes

Perhaps most significantly, our findings on beaver landscape visitor perceptions can challenge the prevailing narrative that beaver-modified landscapes are aesthetically problematic (Ulicsni et al. 2020; Prior 2023). The overwhelming positive visitor responses, with 'beautiful' emerging as the most salient descriptor across multiple sites, suggest that visitors may be accepting of ecosystem engineering impacts on landscape aesthetics. This contrasts markedly with European studies documenting aesthetic concerns over 'messy' landscapes (Ulicsni et al. 2020) or mediated outrage at a garden exhibit that imitated a beaver landscape at the Chelsea horticultural show in the UK (Wartmann and Lorimer 2024). Critically, our data reveals emerging acceptance of 'messy natures' also when encountered 'in the wild', with some visitors explicitly valuing disorder and natural randomness present in beaver landscapes. This suggests a potential cultural shift in landscape aesthetics as perceived by visitors, moving away from tidiness preferences toward appreciation of ecological authenticity, at least for the self-selected sample who visited these landscapes in person. However, the divided opinions on 'messiness' indicate that even among those who specifically chose to visit beaver landscapes, aesthetic acceptance still varies among individuals.

The factor analysis revealing distinct positive and negative aesthetic dimensions, with positive aesthetics strongly correlated with nature connectedness, suggests that visitor aesthetic appreciation of beaver landscapes may be mediated by broader environmental values and ecological literacy (Gobster et al. 2007). This has important implications for how beaver restoration is communicated: framing beaver modifications within narratives of ecological restoration and natural processes may foster aesthetic acceptance, while focusing solely on physical changes (tree felling, flooding) without ecological context may trigger aesthetic rejection (Nassauer 1995).

4.3. Cultural heritage: restoration versus loss

Cultural heritage was evaluated simultaneously as both a service and disservice. Some visitors experienced beaver landscape modifications as environmental damage, including trees damaged, ponds altered, familiar landscapes changed, while others celebrated the restoration of 'lost' landscapes absent from Britain for centuries, viewing beaver-modified features as cultural heritage being restored rather than damaged.

The tension between traditional land use values, such as land management for agriculture and forestry, and ecological restoration goals mirrors broader debates about cultural landscape identity in nature recovery contexts (Drenthen 2018; Gammon 2019; Mikołajczak et al. 2022; Massenberg et al. 2023). Some visitors explicitly valued beaver

landscapes as 'natural solutions' to environmental problems, suggesting that ecological functionality may be increasingly viewed as culturally valuable. However, some visitors also expressed concerns over potential damages to agricultural land, as beavers can pose a risk to farm crops through consumption or through flooding agricultural land (Janiszewski and Hermanowska 2019; Coz and Young 2020; Mikulka et al. 2020; Holmes et al. 2024).

This paradox reflects deeper tensions between competing landscape narratives and cultural values. Centuries of anthropogenic landscape management have created cultural expectations about how British landscapes should look like (Matless 2016). Such expectations shape what is perceived as 'natural' or 'appropriate' (Prior and Brady 2017; Prior 2023; Wartmann and Lorimer 2024). However, beaver modifications can disrupt normalised aesthetics of anthropogenic landscapes, potentially threatening sense of place for those whose place attachment is rooted in traditional land-use practices such as farming and agriculture. The growing ecological awareness has fostered alternative narratives that value 'wildness' and ecological functionality (Gobster et al. 2007; Prior and Brady 2017; Clayton 2019) also in working landscapes.

Unlike many conservation interventions that broadly maintain existing landscape aesthetics, ecological restoration through beaver translocations can results in visible landscape changes (Law et al. 2016, 2017). Although recent examples in Scotland initially show very little visible changes following beaver translocations in the Cairngorms (Willet 2024), the ecosystem-engineering capabilities of beavers may force communities to confront questions about which historical baselines matter, whose landscape values count, and what role humans and non-humans should play in shaping British ecosystems.

Current beaver management frameworks do not directly address this cultural heritage complexity. Scotland's Beaver Strategy (IUCN/CPSG 2022) discusses social monitoring but lacks more specific guidance on how to accommodate competing cultural heritage values or integrate beavers into evolving British cultural identity. The framing of beavers as nature's 'engineers' and 'workers' (Woelfle-Erskine 2019; Welden 2023), while highlighting their ecological role, may actually hinder cultural integration by implying beavers are accountable to human goals rather than recognising beavers as autonomous community members with their own ecological and behavioural imperatives (Treves and Comino 2024). Future efforts should be made to integrate beavers and their landscape modifications into evolving British cultural heritage rather than treating them as external interventions into established cultural landscapes. This means developing new cultural narratives and practices that accommodate both ecological transformation and cultural continuity, which requires engagement with diverse stakeholders, particularly those most directly affected by landscape changes.

4.4. Education and inspiration: building cultural connections

We found that respondents who experienced beaver-modified landscapes through organised 'beaver tours' reported significantly higher positive perceptions and positive emotions. This relationship may be because of a self-selection of people who join a beaver tour (often at cost) who may be predisposed more positively to beavers and their effects on landscapes than the general population, previously reported before for support of white stork translocations in Britain (White et al. 2023). However, this nonetheless might be an indication of the importance of linking education with species translocations for public support (Parker 2008). The educational value of beaver landscapes extends beyond formal tours to encompass informal learning experiences that nearly half of the respondents in this study sought. This suggests that beaver-modified landscapes could serve as 'outdoor classrooms' that can build broader public understanding of ecosystem processes, supporting Gandy and Watts's (2021) notion that beavers may be a potential flagship species for generating wider interest in nature amongst children. In our study, the correlation between nature connectedness scores and inspiration-seeking behaviour among adults furthermore indicates that these landscapes may particularly resonate with environmentally engaged visitors. Moreover, the use of education programmes or outreach has the potential to improve human-beaver coexistence by teaching individuals about beaver history in British landscapes (Pooley et al. 2021; Holmes et al. 2024), which could be adopted by NGOs such as wildlife trusts, national parks or local site managers.

4.5. Sense of place and emotions related to beaver landscapes

The strongly positive emotional responses to beaver-modified landscapes with 69% of respondents strongly agreeing these landscapes made them feel happy, and high levels of feelings of 'peace' and 'hope' challenge suggestions that beaver presence diminishes sense of place (Gandy and Watts 2021). For many visitors, beaver modifications appear to enhance rather than diminish place attachment, creating emotional connections rooted in ecological richness, aesthetic appeal and hope for nature restoration.

This finding is particularly significant given that sense of place is often considered a challenging CES to assess (Chan et al. 2012; Fish et al. 2016; Wartmann and Purves 2018; Ryfield et al. 2019) while possibly being vulnerable to landscape change (Devine-Wright 2009). The positive emotions expressed by visitors suggest that sense of place impacts from beaver restoration are highly contextual. For visitors seeking wildlife, nature connection and ecological authenticity, beaver modifications may strengthen place attachment by making landscapes feel more 'alive' and ecologically functional. The strong correlation between nature connectedness and positive emotions supports this interpretation.

However, the negative experiences reported by frustrated dog walkers demonstrate that sense of place impacts are activity-dependent and individualised. When beaver modifications disrupt established practices and routines that form the basis of place attachment, emotional responses can turn negative and lead to political resistance against nature restoration (Fox et al. 2016). This suggests that sense of place benefits and disservices from beaver restoration will vary systematically across different user groups and activities. The correlation between positive emotions and nature connectedness raises important questions about whose emotional responses to beaver landscapes are currently captured and valued. Our sample of mostly recreational visitors likely overrepresents those with strong nature connections who are predisposed to positive emotional responses. Residents whose place attachments are rooted in different landscape values such as agricultural productivity, or residential amenity may experience very different emotional impacts as beaver populations establish and landscapes transform. We return to these sampling considerations alongside other methodological limitations below.

4.6. Study limitations and further work

We chose a convenience sampling method due to resource limitations of conducting in-situ landscape perception studies with respondents and carefully chose a study design that represents a diversity of beaver landscapes (Emerson 2021). However, our convenience sampling method inherently captured visitors who actively chose to engage with beaver landscapes, likely creating substantial selection bias toward positive attitudes and nature-oriented values. Further, we sampled our field sites in summer due to resource and time constraints, which we recognise can cause a spatial bearing on aesthetics due to the possibility of vegetation covering signs of beaver activity/ restoration. Therefore, further signs of beaver activity may not have been visible to visitors in summer, which may have influenced their aesthetic and emotional attitudes towards the beaver-modified landscapes. However, whilst we recognise this possibility for bias, sampling our sites in summer, within the British school holidays, provided a higher likelihood of visitation to allow better chances of collecting our desired sample size. Interestingly, although we sampled sites in the British school holidays, a substantial proportion of visitors were from older age groups that were overrepresentated in our final sample. This overrepresentation of older respondents, alongside overrepresentation of environmental organisation members, and people with higher education further limits generalisability to broader publics. While we believe we adequately sampled the population that would likely visit beaver-modified landscapes recreationally, this is a specific subset of the people affected by beaver restoration. Most critically, our sample contains fewer of the voices most directly impacted by beaver landscape modifications: residents, farmers, landowners and adjacent communities who experience both services and disservices from beaver presence but would not 'visit' beaver landscapes as recreationists. These missing voices likely hold very different perspectives, particularly regarding cultural heritage, aesthetic values and practical disservices, as demonstrated in public engagement research (Johnson et al. 2023).

Despite the limitations of our sample, this study provides empirical evidence that there is a notable contrast between visitor appreciation documented in our study and documented conflicts between beavers and agricultural communities (Coz and Young 2020). While recreational visitors derive recreational, aesthetic, and emotional benefits from landscapes they encounter, residents who may not visit beaver landscapes recreationally must negotiate ongoing relationships with transformed landscapes that affect their livelihoods, property, and daily practices. CES and disservices experienced by these groups likely differ from those we documented.

Furthermore, our study captures a snapshot of early-stage restoration when beaver landscapes retain novelty value. Longitudinal research tracking how perceptions evolve as beaver populations establish and landscape transformations become normalised is essential for understanding the durability of CES and whether initial positive responses persist, strengthen or decline over time.

4.7. Implications for beaver management and policy-making

With beaver management increasingly focusing on human dimensions alongside ecology (Treves and Comino 2024), understanding CES is essential for informing future policy and management decisions. Building on our findings, we propose five actionable recommendations, each directed at specific actors

within current beaver management decision-making structures and policy.

(1) **Recognise and accommodate value pluralism**. Audience: the Scottish Beaver Advisory Group (SBAG) (NatureScot 2026b) and equivalent governance bodies overseeing beaver strategy implementation. Different groups hold legitimate but competing values regarding beaver landscapes; management frameworks must create space for these rather than privileging some (e.g. ecological restoration values) over others (e.g. agricultural productivity values) (Robinson 2011; Cortés-Capano et al. 2022). Specifically, we recommend that SBAG's annual progress reporting against Scotland's Beaver Strategy 2022–2045 indicators (IUCN/CPSG 2022) of success incorporate an explicit measure of social and cultural value recognition (e.g. the proportion of management decisions that document consideration of competing stakeholder values). Further, we recommend that, license applications consideration of stakeholder engagement in England go beyond outlining how applicants will work with stakeholders 'to avoid, manage, or mitigate the risks of negative outcomes' (DEFRA 2021) and also have to incorporate considerations of potential positive immaterial values. This would enhance value pluralism in reintroductions and conservation translocations guidance more generally.

(2) **Reframe beaver modifications in public communication**. Audience: conservation NGOs, site managers and communications teams at agencies such as NatureScot and Natural England. How beaver landscape changes are communicated matters. Framing modifications within e.g. nature-based solutions narratives may foster acceptance among broader audiences (Kusmanoff et al. 2020; Thomas-Walters et al. 2024). Specifically, we recommend that, e.g. public engagement materials developed as part of Natural England's Long-Term Management Plan for beavers could adopt a nature-based solutions or relational framing, with effectiveness measurable through visitor and community perception surveys at licensed release sites.

(3) **Invest in accessible infrastructure and educational opportunities**. Audience: licensed wild release project leads and site-level managers. We found positive perceptions and emotions related to beaver-modified landscapes were higher on guided beaver tours than independent visits. Strategic investment in guided walks, interpretive materials, and accessible trails can improve CES delivery while managing visitation impacts, as demonstrated by the Ealing Beaver Project's use of signage and public-awareness materials (Rutherford 2011; Turnbull et al. 2026). Specifically, we recommend that interpretive infrastructure and guided-access provision could be built into site management plans as a standard licensing requirement, with uptake tracked via Natural England's Beaver Considerations Assessment Toolkit (BCAT) (White and Smith 2026).

(4) **Build local benefit-sharing mechanisms**. Audience: institutions involved in the continued management of human-beaver coexistence. We suggest continuing to develop local benefit-sharing mechanisms that allow communities bearing the costs of managing beaver modifications (e.g. dam or burrowing) such as ecotourism revenue sharing, employment in beaver monitoring or nature finance schemes recognising contributions to biodiversity and water management goals (Simpson et al. 2021). Specifically, this could include potentially reviewing and extending England's existing Protection and Infrastructure grant (Rural Payments Agency 2026) (available since January 2026 to help manage the impacts of beaver behaviours), and Scotland's Beaver Mitigation Scheme (NatureScot 2024) to include revenue-sharing or livelihood-support elements for affected landowners. Thus building on SBAG's ongoing exploration of alternative funding mechanisms for the agricultural sector blending private green capital with Nature Restoration Funds to finance structural demonstration trials, such as floodbank realignment, while lowering agricultural costs through technology-driven solutions such as using drones to map and monitor burrowing activity in embankments (NatureScot 2026a). This approach seeks to shift the financial burden away from traditional state farming subsidies by creating long-term, incentive-based revenue streams for landowners sharing landscapes with beavers.

(5) **Connect beaver landscapes to green/blue social prescribing**. Audience: NHS integrated care systems and green social prescribing coordinators in England; NatureScot and Green Health Partnership coordinators in Scotland; delivery partners such as local Wildlife Trusts. The aesthetic, sense-of-place, and human–nature connectedness benefits documented in this study align closely with the aims of existing nature-based health interventions such as those of 'Green prescribing' (Howlett et al. 2025; NHS England 2026). Beaver-created

wetlands offer a distinctive setting for structured 'blue-green prescribing' activities similar to those already delivered by, e.g. The Mental Health Foundation's Blue Prescribing Project (Mental Health Foundation 2026) and for green social prescribing pathways operating through NHS integrated care systems in England and Green Health Prescriptions in Scotland. Beaver reintroduction sites could be assessed for inclusion as green/blue social prescribing venues by relevant integrated care system or Green Health Partnership coordinators, with uptake and participant wellbeing outcomes evaluated using existing green social prescribing evaluation frameworks.

5. Conclusion

Understanding cultural dimensions of beaver restoration is essential as Britain expands beaver populations following recent policy changes. Our findings demonstrate strong potential for positive CES among recreational visitors, challenging assumptions about aesthetic unacceptability while revealing complex negotiations around cultural heritage and landscape values. However, visitor perspectives represent only one dimension of the cultural impacts from beaver restoration. The critical research and management challenge lies in understanding and accommodating the diverse cultural values, lived experiences and legitimate concerns of all affected communities, particularly those whose voices are absent from our study but whose acceptance and engagement will ultimately determine the social sustainability of beaver restoration in Britain.

Notes

1. A species reintroduction is the movement and release of an organism inside its indigenous range from which it had previously disappeared (IUCN, & SSC 2013, 3).
2. A conservation translocation is the movement and release of an organism for the benefit of conservation, therefore aiming to improve conservation status of the focal species and/ or restoring natural ecosystem functions or processes (IUCN, & SSC 2013, 3).
3. Also known as: *Ursus arctos arctos*

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Author contributions

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