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Trade-offs between the natural environment and recreational infrastructure: A case study about peatlands under different management scenarios

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ABSTRACT

The importance of peatlands for conservation and provision of public services has been well evidenced in the last years, especially in relation to their contribution to the net zero carbon emission agenda. However, little is known about the importance of recreation relative to conservation and their trade-offs. In this paper we address this knowledge gap by exploring the trade-offs between natural properties of peatlands and recreational infrastructures for different categories of recreationists (walkers, cyclists, anglers, and birdwatchers) of an open heather moors and peatlands landscape. We do so building on a series of management scenarios formulated through participatory methods and applying choice experiment related to an Area of Outstanding Natural Beauty and UNESCO Global Geopark in the UK. Results show a high degree of heterogeneity in landscape preferences across different user groups. Recreationists had a higher appreciation for semi-natural habitats compared to pristine or restored peatland (e.g., land rewetting). Walkers and cyclists were more sensitive to changes in the availability of recreational facilities than to environmental quality, while anglers' and birdwatchers' preferences were more aligned with values promoted by restoration policies. Overall, our results point to a potential value conflict between benefits generated by conservation and the benefits valued most by some groups of recreationists. To maximise success conflicts like the one revealed here need to be considered in strategies that provide a central role for peatlands in net zero climate mitigation strategies.

1. Introduction

Land use provides a dynamic link between human activity and the natural environment, driving environmental change, which in turn may constrain the delivery of services to society from land (Lobley and Winter, 2009). Land use policy seeks to manage benefits for different groups within society, or ecosystem services, by balancing competing interests (Randolph, 2004) as exemplified by the management of

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peatlands, whose strategies have changed consistently over time owing to a change in the importance attributed to peatlands for human uses (Reed et al., 2009a). If in the past, peatlands were mainly considered a source of food and materials (McDermott, 2007; Van de Noort and O'Sullivan, 2007), and a site for forestry and agriculture (Johnston and Soulsby, 2000; Rawlins and Morris, 2010; Van de Noort and O'Sullivan, 2007), more recently, they have started to be considered for the provision of public goods such as climate change mitigation, biodiversity, water quality (Martin-Ortega et al., 2014a) and flood regulation (Reed et al., 2009a, 2013a), but also of recreational and cultural services such as sense of place (Maltby, 2010). As such, peatlands restoration has started to feature prominently in international agendas as part of net zero and biodiversity conservation strategies (Bradfer-Lawrence et al., 2021) and initiatives for their conservation and restoration have started to emerge in the UK (e.g., the UK Petland Programme and the Nature Value Programme Peatland Tipping Points[1]) to protect an ecosystem that holds in absolute terms the highest level of carbon (Anderson et al., 2009).

The UK based research has started to provide evidence on the ecosystem services and associated benefits to support policies to restore peatlands to various level of ecological condition (Evans et al., 2014; Glenk et al., 2014; Glenk and Marting-Ortega, 2018) and to make an impact on UK policy. The Committee on Climate Change (CCC, 2020) concluded that restoring at least 50% of upland peat and 25% of lowland peat would reduce peatland emissions by 5 MtCO2e by 2050, contributing substantially towards the UK's net-zero emissions target. Subsequent recommendations from this national body and England's Natural Capital Committee (2020) included important public investment in peatland restoration alongside private investment via the Peatland Code, a voluntary certification standard for UK peatland projects wishing to market the climate benefits of peatland restoration (Reed et al., 2013a; Bonn et al., 2014).

Under these initiatives trade-offs between uses can emerge. The literature has started exploring if and how marketed economic benefits such as livestock grazing, game or timber production may occur at the expense of the capacity of the less tangible goods such as regulating services, e.g. carbon storage and flood control (Bonn et al., 2010; Evans et al., 2014). Some attention has been paid to the impacts of restoration on biodiversity (D'Astous et al., 2013) and intangible cultural values (Faccioli et al., 2020), but little is known about the importance of recreation relative to conservation and their trade-offs. Owing to the possible multiple trade-offs between values in peatland management, this paper explores some of trade-offs between services provision in UK peatlands, considering whether and how recreation benefits can be achieved without compromising the value of other benefits from these landscapes under different management scenarios, with special focus on conservation. This paper aims to fill this gap analysing the preferences of recreationists (walkers, cyclists, anglers and birdwatchers), using an open heather moors and peatlands landscape.

After reviewing the recreational benefits provided by peatlands, the paper describes a choice experiment (CE) that was used to assess the utility of natural properties of peatlands and recreational facilities eliciting the willingness to pay for different recreationists (walkers, cyclists, anglers and wildlife watchers) and the benefits received from recreation under a range of land management scenarios developed through a participatory baseline condition mapping and scenario development approach. Results provide relevant information to discuss important implications for decision-making relating to the values expressed by different groups of recreationalists, and their potential conflicts with regard to nature conservation and climate mitigation policy.

[1] A list of international initiatives is reported by IUCN at https://www.iucn-uk-peatlandprogramme.org/about-us/global-peatland-initiatives

2. Evidence of recreational services, preferences and valuation of benefits provided by peatland

To facilitate the comprehension of the context in which we operate, we present some studies (not a systematic review) carried out in the last 30 years that suggest a certain activism in the exploration of recreational values for peatlands but reveal a gap in terms of trade-off analysis with other utilitarian and relational and intrinsic values. Wichmann et al. (2016) highlighted two studies carried out in Italy in the early 2000 s on the value of recreational services that focused on picnicking, walking and wildlife watching whose value, assessed by contingent valuation method (CVM), ranges from \$400 to \$2,000 ha^{-1} yr^{-1}. An estimate of \$400 ha^{-1} yr^{-1}, which included also recreational fishing, assessed by net factor income, was reported for The Netherlands (Wichmann et al., 2016).

Most of the peer-reviewed papers consulted propose the theme of recreational services under the scenario of conserving the peatland. For instance, conservation value of peatland in the Flow Country (Scotland), assessed by CVM, is preferred to converting it to block tree plantations (Barbier et al., 1997), especially by visitors who stated a higher willingness to pay (WTP) than locals (£24.95/household vs £12.5/household). Similar estimates were provided by Bullock et al. (2012) who reported a WTP of £ 51 per person yr^{-1} for a National policy of Peatland Protection in Ireland [this is equivalent to nearly £ 39 yr^{-1} in 1997 GBP currency after removing inflation, making this estimate comparable with the one proposed by Barbier et al. (1997)]. CVM was also used to analyse the recreational dimension of different peatland landscapes in the North York Moors National Park, UK (White and Lovett, 1999). The authors found that both heather moorland and semi-natural broadleaved woodland were highly valued by visitors, with moorland primarily appreciated for recreation and woodland for nature conservation.

More recently, valuation studies in peatland landscapes have been carried out through choice experiment. Tinch et al. (2014) explored the effect of location and timing on elicited values associated with landscape and footpath network change of the Peak District National Park (England). In all scenarios proposed there was no preferences for a different intensity of farmland in the landscapes analysed compared to the status quo. The only attribute characterised by a significant change was the footpath network (preference for an improvement was elicited). In addition, the authors found differences between off-site and in situ elicited preferences. For the answers provided in situ, the variance of the coefficients increased relevantly, showing that people observing the landscape features described in the choice cards experienced a higher degree of difficulty in choosing the preferred alternatives.

We found only a single study related to the North Pennines AONB (Black et al., 2010) which showed that visitors' values for landscape and biodiversity are important in preference formation, with appreciation for a mosaic landscape in blanket bog and the associated increases in rare and threatened birds and mammals. However, the study does not provide evidence on the impacts of such values on recreation.

Other recent studies, well aligned to the goal of our research, have analysed trade-offs between peatland attributes using choice experiments. Martin-Ortega et al. (2017), for instance, have investigated the public's views and values of peatland restoration in Scotland using as attributes the landscape quality [bad (eroded soil), intermediate (grass dominated) and good (boggy dominated)], the capacity to store carbon and to provide water regulation services (organic carbon removal). The authors found that the public's perception of peatland restoration was predominantly positive, providing annual benefits that range from £ 127 ha^{-1} to £ 414 ha^{-1}, depending on the degree of improvement and the location where restoration takes place. Although recreational services were not reported as an attribute of the choice task, it was mentioned by the interviewees as one of the reasons for supporting restoration, along with climate change mitigation, opportunities to improve the rural economy and responsibility for future generations, and a sense of Scottish identity. The importance of recreation, enhanced by the presence of facilities such as gravelled paths, resting places and information boards, along with timber and peat production, protection and restoration, was investigated for the Finnish peatlands in a choice experiment by Tolvanen et al. (2013). The authors found trade-offs between users: the production-oriented class preferred an increase in timber and peat production areas, while environmentalists showed a high preference toward the cessation of peat production and increase in peatland restoration, even if the enhancement in recreational attribute (gravelled paths, resting places, information boards) was not a significant attribute of the econometric model. Conversely, facilities seemed to enhance recreational aspects of landscape in forest (Christie et al., 2007) and mountain areas (Scarpa and Thiene, 2005). Heterogeneous preferences between users show that specialist users attain higher values from improvement in facilities than general users, but, in both studies, environmental aspects are not considered a driver that influences behavioural choices.

Further investigation of recreational experience in Scottish peatlands explored people's preferences under different uses, revealing multiple and ambivalent views of peatlands as *"bleak wastelands; beautiful, wild nature and cultural landscape"* (Byg et al., 2017). Although rational thinking would suggest that degraded peatland conditions might negatively affect recreational experience, as reported by the UK peatland strategy (2018–2040), preferences elicited in a workshop by Martin-Ortega et al. (2014b) showed that recreational uses, such as cycling or walking, could be carried out under non-optimal environmental conditions (including in degraded peatlands). The latter perspective shows how preferences for peatland uses and management strategies may be highly heterogeneous and generally the findings of the literature seem to suggest that recreational attitude can be enhanced in areas or landscapes characterized by higher infrastructures and facilities. This justifies the approach chosen in our research that seeks to verify trade-offs between conservation and recreational values and to contribute to the resolution of conflicts that could diminish the central role for the UK peatlands in net zero climate mitigation strategies.

3. Methodology

3.1. The study area

The area chosen for this research is the North Pennines AONB, a landscape of moorland and broad uplands dales in the North of England in the UK, extending from the Yorkshire Dales National Park to the Tyne Valley, just south of Hadrian's Wall (Fig. 1). The area is a UNESCO global geo-park with abundance of peat soil, providing 30% of England's upland heathland and 27% of its blanket bog. It is also rich in biodiversity hosting over 20,000 breeding pairs of wading birds. The area offers natural and historical attractions and possibilities for several recreational activities such as walking, cycling, horse riding, birdwatching, climbing, fishing and kayaking.[2] Information on the number and origin of recreationists was not publicly available at the time the survey was carried out (summer 2018).

3.2. Participatory management scenario building

Following best environmental social sciences practice, this research builds up from a participatory stance to inform the research design (Martin-Ortega et al., 2017). We performed a stakeholder analysis (Reed et al., 2009b) and gathered in May 2017 stakeholders operating in the North Pennines AONB in a workshop to develop socio-economic and biophysical dynamics of peatlands under different scenarios through a participatory process. The workshop was attended by 25 people representing agriculture, estate management, conservation, peatland restoration contractors, water companies with peatland catchments, peatland policy teams from relevant government agencies and members of the peatland research community.

During the North Pennines workshop, a participatory mapping exercise was initially carried out to familiarise participants with variables used subsequently in the scenarios analysis. This enabled participants to discuss and define each variable, considering how it related to peatlands in the study area, ensuring similar levels of understanding among all participants and enabling them to discuss the scenarios in greater depth in relation to the study site. Maps are not presented here, but images of the mapping process can be seen in Fig. 2. The mapping exercise provided fine-grained understanding of peatland condition necessary to elicit as willingness to pay benefits associated with changes in condition in each of the analysed scenarios, described at Section 4.1.1. The participating stakeholders mapped the landscape features related to water (e.g. natural pools, pools in ditch drains, brown water colour), peat (e.g. bare peat, gullies or blocked drains), vegetation (e.g. presence of Sphagnum mosses, Molinia grass or heather) and livestock and wild animals (e.g. sheep, grouse, deer, waders, birds of prey and frogs, lizards or newts) on a map for all the areas of interest and knowledge, classifying the abundance of each characteristic using a scale of 0 (absent or rare), + (occasional), + + (frequent), and + + + (common).

After the mapping approach, stakeholders discussed on land use scenarios relevant to peatlands, that were preliminary identified by literature review, and described how each scenario might play out in their study area. The discussion occurred in small groups who contributed to the information provided by others through rotational small group analysis and plenary discussion. After the workshop, the scenarios were written up and requested to be commented by the workshop stakeholders and the project's stakeholder advisory panel consisting of 14 high-level representatives of government, devolved administrations, agencies, land management, conservation and utilities. The research team, finally, reviewed and finalised the scenarios providing a detailed answers to stakeholders if the suggestions they proposed collided with evidence from the literature.

3.3. Choice experiment

A choice experiment, a type of stated preferences approach, where respondents are asked to choose between different alternatives characterised by a number of more or less desirable characteristics (Birol et al., 2006), was implemented to elicit values expressed for different conservation and recreational attributes as willingness to pay (WTP) by several categories of recreationists (walkers, cyclists, anglers and birdwatchers) that commonly attend the North Pennines AONB, via a face-to-face survey. WTP is a monetary measure of welfare that can be derived from stated preferences data on respondents' preferences for alternatives in hypothetical scenarios or contingent market (Hanemann, 1994; Arrow et al., 1993). In the choice experiment, respondents are asked to consider several alternatives, using multiple attributes, typically including a monetary cost to allow WTP estimation. A status quo is often added that is offered to respondents at no extra cost (Sanchez et al., 2016). WTP is estimated as the marginal rate of substitution between non-monetary and the cost attribute.

The choice experiment was designed to explore the importance of several attributes of the outdoor experience of these recreationists, considering both attributes of the peatlands, such as characteristics of the landscape, and recreational facilities such as the presence of infrastructures facilitating recreation such as gravel path or the presence of sign path.

The selection of the attributes was decided by the research team based on consolidated experience of working in the peatland context, and knowledge of the North Pennines AONB, geography and characteristics of that landscape (Martin-Ortega et al., 2014a, 2014b; 2017; Faccioli et al., 2018, 2020). We decided to include in the choice experiment attributes and levels related to landscape types, biodiversity

[2] Information got from the pocket guide 2014/2015 Explore the North Pennines.

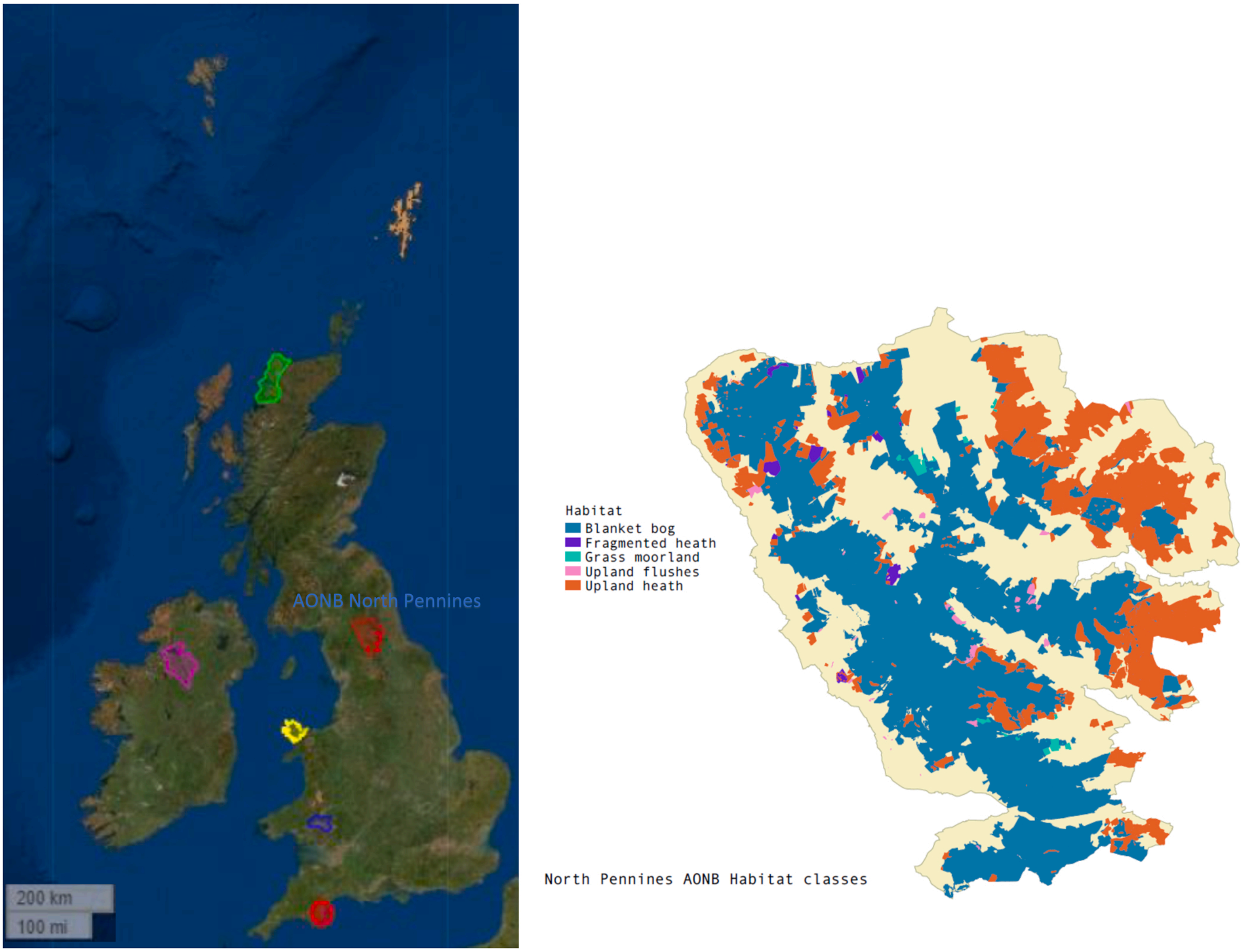


Fig. 1. Left: Map of UK Geoparks, showing the location of North Pennines AONB; Right: peatland habitat classes showing blanket bog as the most common habitat type.
Left: (Unesco Global Geoparks); Right: (authors' elaboration).

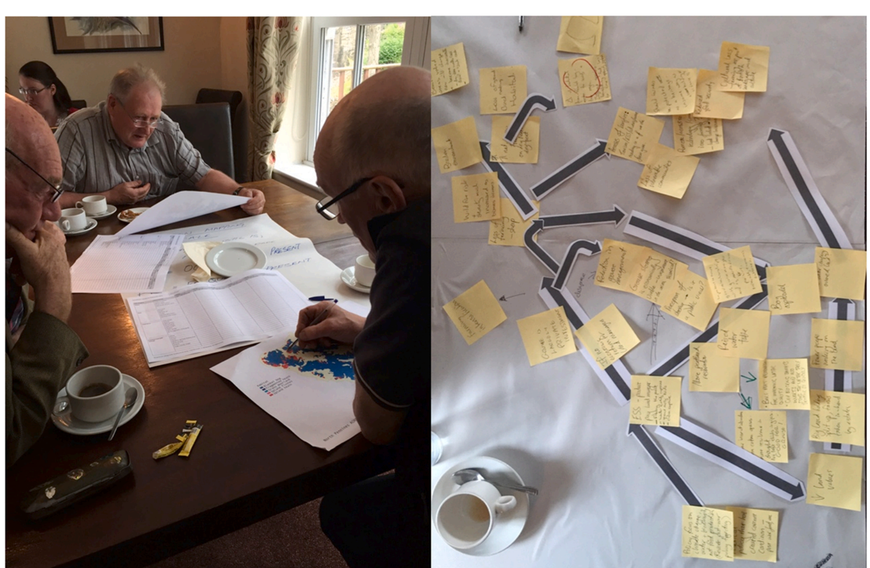


Fig. 2. Workshop participants describing the condition of peatlands (left) and participatory scenario development (right).

and water quality as proposed by Martin-Ortega et al. (2017), and, in addition to that, we explored the preferences for recreational facilities as described by the local guides of the North Pennines AONB to address trade-offs between natural features and recreational facilities available in the peatlands. All attributes are categorical (Table 1) except for the monetary attribute and are described in detail in the Section 3.4.

3.4. Survey questionnaire and choice experiment design

Participants were given background information on the study purpose and policy context, focussing on the likely changes in the natural characteristics of peatlands, recreational facilities and management of the North Pennies AONB. The survey, available in Supplementary Material 1, was divided in three sections: the first part was about the respondents' background, and contained the main reasons for visiting the North Pennies AONB, the recreational activities carried out on site and visitation rates. Further questions addressed the modality of mobility, if the recreationists travelled in groups and their size, and if they were day or overnight visitors. Place of origin, information on travel distance, main mode of transport, total cost sustained and information about the number of days spent on site were also recorded. Some questions explored the importance of undertaking recreation in the North Pennines AONB and the significance of landscape in choosing the location where to do recreation. No information was requested about preferred day or moment of recreation during the week, therefore no difference in WTP was estimated between those preferring recreation during weekdays or weekend.

The second section presents the choice experiment. Attributes used to prepare choice cards for the choice experiment were presented to recreationists as pictograms, as shown in Supplementary Material 2, and are listed in the Table 1. The attributes refer to natural features of peatlands, chosen from previous research carried out by Martin-Ortega et al. (2017), from which pictograms for landscape attributes were also derived, and to the most common facilities available to recreationists in the North Pennines AONB. They were selected with the goal of investigating trade-offs with peatland properties when choosing the place where to carry out the preferred recreational activity.

Five attributes were selected for the choice design (landscape, wildlife abundance, water quality, recreational facilities, and cost). The attribute *landscape* has 4 levels (eroded, dominated by heather, dominated by grass, dominated by mossy bog); the attribute *wildlife abundance* has 3 levels (very limited presence of wading birds, limited presence of wading birds, noticeable presence of wading birds); the attribute *water quality* has two levels (low water quality, high water quality); the attribute *recreational facilities* has 4 levels (no facilities; car parks and toilets; car parks toilets and sign post; and car park, toilets, sign post and paved or gravel path). For those who described themselves as anglers the facilities were different (no facilities; car park and toilets; car parks toilets and equipment rental; car park, toilets, equipment rental and fishing lessons). The detailed description of the attributes is provided in Table 1. Finally, the monetary attribute is related to the distance travelled to the place of the interview plus an additional distance of 10, 20, 50 and 100 miles as an additional hypothetical cost to enjoy the peatlands attributes depicted by the choice card.

A full factorial design was not feasible. Therefore, we opted for a fractional factorial design. Building on previous experience in running onsite survey, to avoid participant fatigue and poorly considered responses from the respondents, we opted for a design that contains 24 choice cards grouped in six blocks, each block containing four choice cards, and each card presenting two hypothetical recreational options and a status quo (opt out) option (stay at home, where we assume that baseline conditions for the peatland are eroded land, with limited wildlife abundance, poor water quality and no recreational facilities). Participants completed one randomly chosen block (i.e., four cards). Choice cards were prepared in Ngene version 1.1.1 (ChoiceMetrics) according to a D-efficient design that minimises the information matrix of the multinomial logit model (Campbell, 2007), with the results of the pilot test as priors. A choice card example is presented in Fig. 3. The design was constrained for potentially counterintuitive combinations, such as a boggy area with low water quality. For other scenarios, the combination of attributes is more flexible. For instance, a peatland dominated by grass or heather, according to the human pressure received by agriculture, grazing or game activities, can be characterised by a high or low water quality, or different levels of biodiversity abundance according to the type of land use management that can externally force certain levels of attributes to deviate from an expected outcome.

Following Christie et al. (2007) and Jobstvogt et al. (2014), we asked participants to allocate up to five recreational opportunities, to be taken over a period of 12 months, between two hypothetical sites and the 'stay at home' option. Data analysis was carried using Nlogit version 5.0 (Econometrics Software). By including the travel distance, we were able to estimate the monetary value of a trip and disentangle the utility (in monetary units) of each single attribute composing the recreational experience. We used a factor of 0.13 GBP per mile to convert distance in miles to monetary unit.[3] Additional costs of car maintenance, insurance, expenses incurred on the way and value of time were not considered. Thus, this travel cost can be considered a lower bound proxy for the value of travelling as proposed by Jobstvogt et al. (2014).

A follow up multiple choice question was proposed to exclude from the analysis those respondents who replied randomly, based their choice according only to one or limited number of attributes and avoided trading-off money against the non-monetary attributes. Finally, the last section of the questionnaire is about socio-demographic questions investigating age class, gender, level of education and household income.

3.5. Sample selection and pilot test

More than 300 recreationists were interviewed face-to-face in seven different locations of the North Pennines AONB (Bowlees visitor centre, Cow Green Reservoir, Middleton in Teesdale, Selset Reservoir, Ouston Fell, Upper Teesdale, Wellhope Moore) in Summer 2018 (first two weeks of September) during both weekdays and weekends.

The interviewers selected random groups of visitors passing near the place chosen for the interview (strategic points close to the visitor centre, at gates of the park, etc.) and asked for their willingness to participate to the questionnaire survey. If anyone in the group replied in a positive way, the interview was conducted. Only one member of the group was interviewed to avoid multicollinearity between respondents of the same group who might have similar taste, because of similar origin, or social and cultural background. If none of the members of the group expressed desire to participate to the survey, the interviewer waited until a new single person or group passed by.

The final survey was preceded by a pilot survey conducted in August 2018 with 60 participants (only walkers) in one location, to test the choice experiment. Each person was facing four choice sets reported in one of the six blocks. A conditional logit model and a mixed logit model were used to analyse the data. Coefficients of both models were statistically significant but negative for mossy bog landscape, while non-significant for the heather peatland. The remaining coefficients were all significant. As expected, the monetary attribute was significant and negative. Priors from the mixed logit were used to run the final design. A problem encountered during the pilot test was that respondents (49%) showed that they could not make any trade-off between non-monetary and monetary attributes. This problem was addressed in the final survey by reminding the respondent to carefully consider the distance (and then the implied cost) when making their preferred choice. The number

[3] This is the estimated average cost in 2018 for a less than 1.4 litre petrol and diesel vehicle covering 10,000 miles per year. https://www.gov.uk/government/publications/advisory-fuel-rates/how-advisory-fuel-rates-are-calculated

Table 1
List of the attributes of the choice experiments.

Attribute	Level 1	Level 2	Level 3	Level 4
Vegetation and landscape	Moorland dominated by mossy bogs, with visible surface water	Moorland dominated by rough grasses	Moorland dominated by heather	Moorland dominated by areas of bare and eroding peat *(baseline)*
Wildlife	Very limited, almost unnoticeable presence of wading birds *(baseline)*	Limited, difficult to notice presence of wading birds, such as curlew, dunlin, golden plover and short-eared owls	Noticeable presence of wading birds, such as curlew, dunlin, golden plover and short-eared owls	
Water quality	DOC < 20 mg/l (good quality water with light brown colour)	DOC > 60 mg/l (poor quality water with dark brown colour) *(baseline)*		
Facilities (for walking, birdwatching, cycling	No facilities *(baseline)*	Car parks and toilets	Car parks and toilets, sign posted trails	Car parks and toilets, sign posted trails and paved or gravel paths
Facilities (only for fishing)	No facilities *(baseline)*	Car parks and toilets	Car parks and toilets and equipment rental	Car parks and toilets, equipment rental and optional instruction lessons available (at additional cost)

of people who were not able to make this trade-off in the final test was reduced compared to the pilot test. From the multiple choice test following the choice experiment, only 20% of the final sample was discarded for the final analysis because not able to show trade-offs between non-monetary and monetary attributes or made random choices during the choice experiment.

At the end of the pilot test, we asked respondents to state if any difficulties and fatigue were experienced. Given little concern among respondents, we considered that four choice cards could provide enough information to run the model (Martino et al., 2022) and concluded that no conceptual changes were necessary to produce the final survey questionnaire.

3.6. Analysis - Choice experiment

Choice experiment responses were analysed based on random utility theory (McFadden, 1974). In this model, utility is decomposed in a deterministic part (v) that is assumed to be a linear function of the attributes of the environmental good, and a random component (ε) that is not observable.

$$U_{ij} = v_{ij} + \epsilon_{ij} \quad (1)$$

$$v_{ij} = \beta_1 + \beta_2 x_{ij2} + \ldots + \beta_m x_{ijm} \quad (2)$$

where j is the kth choice made by individual i, x is a vector of attributes (environmental, recreational and related to the respondent) and β are the coefficients associated to these attributes. If the error component (ε) is assumed to be independently and identically Gumbel distributed (iid), the probability under the multinomial (MNL) logit model of the individual i to choosing the alternative j from a set of k alternatives can be estimated by:

$$\pi(ij) = \frac{exp^{vij}}{\sum_{k \epsilon C} exp^{vik}} \quad (3)$$

To calculate this probability, we used the mixed logit (MXL) model that has the advantage to overcome the limit of Independence Irrelevant Alternatives (IIA) assumption (the ratio of any two outcome probabilities is independent of any other outcomes' probabilities) suffered by the MNL model, and to capture the random preference variation among individuals. The choice probability in the MXL model cannot be calculated exactly because it involves an integral which does not have closed form (Eq. 4).

$$P_{ij} = \int \pi(ij) f(\beta|\theta)\, d\beta \quad (4)$$

$f(\beta|\theta)$ is the density function of βs with θ referring to a vector of parameters of that density function (mean and variance). We assumed βs as normally distributed, except for the cost attribute, which was fixed. In Eq. 4, the mixed logit probabilities are the weighted average of the standard multinomial logit probabilities (Eq. 3) with the weights determined by the density function $f(\beta|\theta)$. .

The marginal willingness to pay (WTP) of each level was estimated as the negative ratio of non-monetary (*nm*) and monetary (*m*) beta coefficients (Eq. 5) with error of the mean calculated by Delta method.

$$WTP = - \frac{\beta_{nm}}{\beta_m} \quad (5)$$

We used Eq. 4 to calculate the probability of making a recreational choice as driven by environmental attributes of the peatland under different management scenarios (or policy views) (see Sections 4.1.1 and 4.1.2) for different localities compared to the current state (or baseline), as proposed in Table 3. Finally, changes in welfare (monetary benefits) from the baseline were assessed using the logsum approach (Eq. 6) (Hynes et al., 2013) as a measure of compensating surplus (*CS*) (Karlström, 1998, 2001).

$$(CS) = -\frac{1}{\beta_m}\left(ln\sum_i e^{vij^1} - ln\sum_i e^{vij^0}\right) \quad (6)$$

where β_m is the marginal utility of income provided by the MXL model and v the utility for individual i and alternative j measured under two policy scenarios: policy 1 refers to one of the alternative policy scenarios, while policy 0 is the status quo or baseline (see Table 3). Coefficients provided by the MXL model are multiplied by the categorical value that each attribute takes under the different scenarios (1 if the level is present, 0 if absent) to calculate the deterministic part of utility v. Travel distance is simulated assuming a log-normal distribution from a population of 5000 individuals. In the valuation of *CS*, recreational facilities were kept constant at the baseline level to explore the welfare change arising only from environmental attributes. Valuation is provided for different locations (Teesdale, Upper Teesdale, Forest in Teesdale, Bowlees, and Ninebanks – see Table 3).

4. Results

4.1. Results from the workshops

From the debate that occurred in the workshop, not necessarily representing a consensus of opinion among group participants, four scenarios were developed: *1) Maximise production; 2) Market collapse; 3) Public money for public benefits; 4) Sustaining agricultural communities*. A synthesis of the four scenarios and environmental and management consequences is presented in Table 2, integrating evidence from

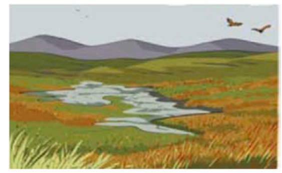
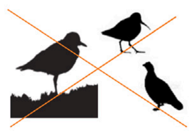
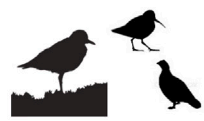
	Activity A	Activity B	Stay at home (levels at the baseline and no cost)
Vegetation and landscape	Moorland dominated by heather 	Moorland dominated by mossy bogs, with visible surface water 	
Wildlife	Very limited, almost unnoticeable presence of wading birds 	Limited, difficult to notice presence of wading birds, such as curlew, dunlin, golden plover and short-eared owls 	
Water quality	Poor quality water with dark brown colour 	Good quality water with light brown colour 	
Facilities	Car parks and toilets, sign posted trails and paved or gravelled paths 	No facilities	
Travel distance within local region	10 miles (one way) more than current trip	20 miles (one way) more than current trip	
Number of opportunities out of 5:			

Fig. 3. Example of a choice card.

previous studies of UK uplands with workshop outputs (Reed et al., 2009a, 2013a).

The first scenario depicts a future in which markets are able to sustain farming under a limited regulatory burden and a more intensive management. Conversely, the second scenario explores the possibility that markets are not able to sustain farming, leading to a significant reduction in the intensity of management and land abandonment. The third scenario focuses on managing peatlands by optimizing, in exchange for payments, public benefits such as climate mitigation and water quality. Finally, the fourth scenario adopts the same “public money for public benefits” policy as the previous scenario and focuses on the economic and social sustainability dimension of farming by sustaining rural communities through projects in which farmers, rural businesses, local organisations, public authorities and individuals from different sectors come together to form local action groups.

4.2. Shift in landscape regimes under different policy views

This section describes the likely transitions from the status quo (baseline or current environmental conditions agreed with local stakeholders) to expected environmental conditions (reported in Table 3) under the management scenarios proposed in Table 2. These transitions are results of integration of literature, considerations matured during the workshops and judgement of the research team.

Under scenario 1, characterised by high levels of provisioning services, we expect mainly land to be managed for agriculture, sheep grazing and grouse shooting. Grass dominated peatland is expected under more intense grazing, and it is common to see grass dominating on

Table 2
Comparison of four policy views or scenarios showing the expected environmental and management consequences of each policy for different peatland attributes.

	Scenario 1: Maximise production	Scenario 2: Market collapse	Scenario 3: Public money for public benefits	Scenario 4: Sustaining agricultural communities
Peat and hydrology	More runoff and erosion caused by drained land and ditches unblocked to favour agriculture and sheep grazing	Drainage ditches left unblocked and unmanaged leading to creation of gullies. In places, ditches revegetate	Drainage ditches progressively blocked and eroded areas revegetated, leading to shallower water tables and peat maintained or restored	
Wildlife	Expected reduction in insects associated with wetter habitats. Increase in sheep density also leads to more disturbance and trampling of nests.	Species requiring short vegetation may be negatively affected because of abandoned land. Species associated with tall grass or woodier habitat may benefit	Appropriate management of grazing, cutting or burning may lead to increase in ground nesting birds and specialist plants and insects in bog	
Carbon emission	Expected increase in carbon emissions due to intensive use of land	Similar to current levels, but higher in years where there are Wildfires	Appropriate land use management and rewetting in some areas decrease greenhouse gas emissions	
Water quality	Expected more dissolved organic carbon in water and risk of eutrophication	No significant change in water quality	Reduced erosion and water table retention diminishes dissolved and particulate organic carbon and improves water quality	
Communities	Farming communities retained	Farming communities decline, although many grouse moor operations continue	Consolidation of land-holdings and jobs associated with peatland management supported by public money paid to generate public benefits	Community is sustained, small scale farming is not lost, and jobs associated with peat-land management increased

one side of a fence line where sheep grazing is intensive contrasting with the other where it is not (e.g. Anderson and Yalden, 1981; Usher and Thompson, 1988). Shifts from bog to grassland and from heather to grassland are modelled according to this evidence. Conversely, in situations characterised by reduced grazing activity, Pakeman et al. (2003) and Pakeman and Nolan (2009) provided strong evidence that heather is favoured over grass. However, this is not accepted by other authors who found weak evidence that under reduced sheep grazing vegetation community changes to dwarf shrub (Gardner et al., 2002; Critchley et al., 2008; Welch, 1998). Additional evidence is provided by Rawes and Hobbs (1979) who showed that light sheep grazing (0.01–0.05 LU ha-1 yr-1) does not reduce heather cover on blanket bog. Welch et al. (2005) and Britton et al. (2005) reported that blanket bogs grazed at low-level conserve a vital community of bob mosses and lichens. According to this evidence, blanket bogs under scenario 2 are assumed to retain their ecological state, while a shift to short shrub is foreseen under scenario 3, characterised by an appropriate grazing regime that focuses on optimizing public benefits in return for reduced but continued public support. Moreover, heather dominated bogs are considered to retain their properties under scenario 3 and likely to be replaced by grass dominated bog under scenario 2.

Effect of grazing on birds are also studied. In general, there is a contrast between short vegetation, resulting from high grazing levels, which increases access for foraging birds (e.g., Whittingham and Evans, 2004; Whittingham and Devereux, 2008) and longer vegetation, often associated with low (or no) grazing animals, which acts as a higher quality habitat for both vertebrate and invertebrate prey of birds (e.g. Garratt et al., 2011; Garratt et al., 2012). Another trade-off occurs for nesting birds, with some species, e.g., golden plover, preferring to nest in areas with a good field of view (such as provided in areas with shorter vegetation) whilst others, e.g., red grouse, prefer areas of dense heather in which to conceal their nests and sit tight when a predator approaches (Whittingham et al., 2002).

Whilst high grazing intensity may negatively affect the abundance of foliar invertebrates (e.g., Dennis et al., 2008) as well as in some cases the bird populations themselves (e.g. Jenkins and Watson, 2001), overall the evidence suggests that management regimes which create mosaics of vegetation communities and structures are likely to support the greatest abundance and diversity of invertebrates (Buchanan et al., 2006). As a result, areas of unenclosed upland habitats with a heterogeneous mix of sward heights tend to support the greatest diversity and abundance of upland species (Pearce-Higgins and Grant, 2006). In addition to the impacts of grazing, there are strong associations between invertebrate abundance and wetness (Buchanan et al., 2006) which mean that drainage to increase agricultural productivity can have a significant negative impact on invertebrate densities (Carroll et al., 2011) and increase the vulnerability of upland bird populations to climate change (Pearce-Higgins et al., 2010). Probably the strongest determinant of upland bird abundance at present is associated with predation pressure (e.g., Buchanan et al., 2017). As a result of these combined pressures, for the purpose of the contingent behaviour, we assumed that increased agricultural activity and grazing pressure (under scenario 1) reduce the overall abundance of wading birds through reductions in vegetation heterogeneity, drainage and increasing rates of predation, while scenario 3, characterized by revegetation, rewetting and moderate intensities in agricultural practices, provides a transition to higher level of birds' abundance.

There is less evidence on water quality. At low stock density, grazing alone appears to have little effect on water quality (Worrall et al., 2007), while at higher densities, grazing may cause soil erosion that in turn negatively affects water quality. Agricultural practices can have a direct effect because of the perceived need to deepen water tables with the aim of increasing productivity (Wilson et al., 2011). Here we assume that good water quality at the baseline can be retained under scenario 2 and 3, while bad water quality can be improved only towards a transition to scenario 3.

4.3. Descriptive statistics

The total number of respondents questioned in the final survey was 301. Eighty of them, self-reported as walkers, 76 as cyclists, 76 as anglers and 69 as birdwatchers. Considering the whole sample, 25% undertook recreational activities every week, 17% every month and 12% 2–3 times a week. Similar patterns were recorded for the single recreational categories as shown in the Table 4.

These recreationists were mainly overnight visitors (67%) from the UK, spending on average three to four nights in the area. To reach the AONB, they travelled an average distance of 84 miles from their place of residence, preferring their own car as a method of transport (94%). The

Table 3
Transitions in levels of environmental attributes for each scenario from the baseline for different localities used in the analysis of welfare measures.

Teesdale	*Baseline/ Status quo*	*Scenario1 Max _Production*	*Scenario2 Market_Collapse*	*Scenario3 Public Money*	*Scenario4 Sustaining Agric. Community*
Landscape	Heather	Grass/eroded land	Grass	Heather/Bog	Same As Scenario3
Wildlife Abundance	Medium	Low	Medium	High	Same As Scenario3
Water Quality	Poor	Poor	Poor	Good	Same As Scenario3
Bowlees VC/Ninebanks	*Baseline*	*Scenario1 Max _Production*	*Scenario2 Market_Collapse*	*Scenario3 Public Money*	*Scenario4_Sustaining Agric. Community*
Landscape	Grass	Grass/eroded land	Grass	Heather/Bog	Same As Scenario 3
Wildlife Abundance	High	Low	Medium	High	Same As Scenario 3
Water Quality	Good	Poor	Good	Good	Same As Scenario 3
Forest In Teesdale	*Baseline*	*Scenario1 Max _Production*	*Scenario2 Market_Collapse*	*Scenario3 Public Money*	*Scenario4_Sustaining Agric. Community*
Landscape	Bog	Grass/eroded land	Bog	Heather/Bog	*Same As Scenario 3*
Wildlife Abundance	High	Low	High	High	Same As Scenario 3
Water Quality	Good	Poor	Good	Good	Same As Scenario 3
Upper Teesdale	*Baseline*	*Scenario1 Max _Production*	*Scenario2 Market_Collapse*	*Scenario3 Public Money*	*Scenario4_Sustaining Agric. Community*
Landscape	Grass	Grass/eroded land	Grass	Heather/Bog	Same As Scenario 3
Wildlife Abundance	High	Low	Medium	High	Same As Scenario 3
Water Quality	Poor	Poor	Poor	Good	Same As Scenario 3

Table 4
Frequency (0–1) of recreation in the AONB in the last 12 months.

	walking	cycling	Fishing	Birdwatching
Daily	0.08	0.07	0.07	–
2–3 times a week	0.14	0.12	0.12	0.13
every week	0.24	0.21	0.21	0.21
every 2 weeks	0.08	0.08	0.08	0.08
every month	0.24	0.16	0.16	0.17
every 2 months	0.06	0.07	0.07	0.13
4–5 times per year	0.04	0.13	0.13	0.14
2–3 times per year	0.06	0.13	0.13	0.13
Annually	0.08	0.04	0.04	0.03
Total	1.00	1.00	1.00	1.00

sample consisted predominantly of men (62%) and was characterised by a high level of education (70% possessed a higher education qualification). Household income was not stated by 45% of the sample; the remaining declared income between GBP 20–35k (12%), GBP 35–50k (16%), GBP 50–80k (14%) and above GBP 80k (9%). This sample was not representative of the UK population, the latter being characterised by a lower frequency of people with high-level of education (42% in 2017 according to the Office of National Statistics),[4] and income in the categories 20–40k and 40–60k hold by 62% of the population.[5]

When questioned about the importance of recreational activity in the North Pennines AONB in undertaking the trip, 72% of the sample said it was essential and 25% said it was very important. Among recreationists, there are differences in the answers provided, with the majority of anglers, cyclists and birdwatchers considering their activity essential for their visit, while only 40% of walkers provided the same response (Table 5). The reply from the walkers can be justified considering that the peatland was not essential for many of the walkers interviewed because they could carry out this activity elsewhere. Thus, we can deduce that walkers are in a position to give more consideration to the recreational activity than the characteristics of the place where the action is carried out.

Table 5
Importance (in frequency) of recreational activity for undertaking the trip to the North Pennines AONB.

	walking	Fishing	Cycling	Bird-watching
somewhat important	0.04	–	–	–
important	0.04	0.01	0.01	0.01
very important	0.51	0.03	0.18	0.24
essential	0.41	0.96	0.80	0.75
total	1.00	1.00	1.00	1.00

It is also interesting to note that when asked about the importance of landscape in choosing the locality of recreation (Table 6), only 57% of the sample considered it was essential, although for birdwatchers, landscape plays a more important role than for the other recreationists. These figures might suggest that the choice of a specific locality in the AONB is influenced by its ability to generate or facilitate recreational values along with the appreciation for the landscape.

4.4. *Choice experiment*

The total number of responses was 1204[6] (301 interviews). However, some observations were removed from the econometric analysis: we used 94% of the sample (only those travelling by car) and removed those who replied randomly and were not able to trade-off environmental attributes against travel distance (20%). This led to this subset of data being used in the analysis: 204 observations for walkers (51 interviews), 228 for cyclists (57 interviews), 236 for anglers (59 interviews) and 244

Table 6
Importance (in frequency) of landscape for undertaking the trip to the North Pennines AONB.

	walking	Fishing	Cycling	Bird-watching
somewhat important	0.03	0.01	0.01	–
important	0.05	0.10	0.04	0.01
very important	0.30	0.39	0.39	0.37
essential	0.63	0.50	0.55	0.61
total	1.00	1.00	1.00	1.00

[4] ONS – steady increase in the number of graduates in the UK over the past decade. Available at https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/graduatesintheuklabourmarket/2017#steady-increase-in-the-number-of-graduates-in-the-uk-over-the-past-decade. Page visited on 30th September 2019.

[5] ONS – number of households by gross income band in the UK, financial year ending 2017 – available at https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/adhocs/008926numberofhouseholdsbygrossincomebandintheukfinancialyearending2017. Page visited on 30th September 2019.

[6] Each person provided three responses per choice card for a total of 4 choice cards.

for birdwatchers (61 interviews).

Table 7 presents the results from the mixed logit model for walkers, cyclists, anglers and birdwatchers. Walkers and cyclists have a positive alternative specific constant (ASC) showing the appreciation for the recreational activity option, compared to the baseline (stay at home). ASC for anglers is not estimated.[7] The Birdwatchers model proposes a negative ASC, showing that the stay-at-home option provides a higher utility than the alternative choices (A and B) if the level of the non-monetary attributes in the alternative options is not different by the status quo.[8] Thus, the decision of travelling can generate a better utility for birdwatchers only in those scenarios where the peatlands show improved environmental conditions compared to the baseline.

The limited observations and the potential correlations between categorical variables allow only for two attributes to be randomly modelled.[9] Considering the interest in observing the variability for landscape quality and recreational facilities, we opted for testing the heterogeneity of the highest levels of these attributes. Using two random parameters, stability in the coefficients is achieved from 500 Halton draws. Table 7 reports the coefficients estimated at 2000 Halton draws.

All the attributes are statistically significant, with the exclusion of cost for the birdwatchers. As expected from the priors of the pilot test, some attributes are characterised by a negative sign. For walkers and cyclists, this concerns the landscape attributes. Conversely, anglers show a positive attitude for landscape. As regards facilities, walkers show negative coefficients for the low and mid-levels, while the highest level (characterised by the presence of gravel path) is highly appreciated. Conversely, cyclists show preference for the low and mid-levels (presence of signposts) and gravel path are negatively valued.

Anglers, compared to the previous two groups of recreationists, have a better appreciation for landscape levels, with the exclusion of bog peatlands. Moreover, the possibility of obtaining facilities like renting fishing line or getting fishing lessons is not positively valued.

Birdwatchers do not receive positive utility from landscape characterised by bog and grass but are positively affected by heather (probably those sampled were more attracted by the typical fauna available in heather-dominated habitats). The coefficients for the medium and high level of birds' abundance are positive and the highest amongst the whole set of attributes, showing that this is the targeted attribute by this group of recreationists. The latter attribute is also appreciated by the other recreationists with the exclusion of cyclists. Recreational facilities are positively valued by walkers and cyclists but appear to be of reduced relevance for anglers and birdwatchers. Finally, birdwatchers show a positive reaction to the monetary attribute; this generates a counterintuitive interpretation from an economic perspective, showing that they have a non-decreasing utility at higher expenses. This is probably caused by misleading trade-offs between recreational and monetary attributes in the choice cards selection. We decided to report only the beta coefficients of the MXL model, being impossible to provide a meaningful analysis of the willingness to pay.

The coefficients reported in Table 7 highlight the trade-offs between environmental attributes and recreational facilities for walkers, cyclists and anglers. If walkers and cyclists seem to prefer recreational facilities to a pristine landscape, the opposite preference is shown by anglers. Birdwatchers have both a negative taste for the landscape and facilities levels proposed and seem to be mainly getting utility by wading bird abundance.

The analysis of the WTP is reported in Table 8 for walkers, cyclists and anglers, respectively. WTP reflects the sign of the beta coefficients reported in Table 7. For the walkers' category, the WTP estimated is negative for the majority of the levels, with the exclusions for bird abundance, water quality and the presence of gravel paths. The latter

Table 7
Mixed logit model for walkers, cyclists, anglers and birdwatchers. Coefficients, standard error (SE) and significance (asterisks) are reported. Positive ASC indicates preference for the option doing recreation. Bog and PTSG and PTRL are randomly distributed (2000 quasi random Halton draws are used). All the other variables are fixed.

	Walkers		Cyclists		Anglers		Birdwatchers	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
ASC	2.27039 * **	0.01151	0.79123 * **	0.01928	–	–	-0.09087 * **	0.01893
Bog	-2.15626 * **	0.00647	-7.04272 * **	0.01358	-0.67861 * **	0.02487	-0.44880 * **	0.02324
Grass	-0.29073 * **	0.00650	-0.21374 * **	0.01794	0.62435 * **	0.01719	-0.33063 * **	0.01736
Heather	-0.81255 * **	0.00665	-0.15602 * **	0.01513	0.84348 * **	0.02353	0.23459 * **	0.01676
Medium Birds abundance	0.82432 * **	0.00349	-0.24436 * **	0.01327	0.47518 * **	0.01642	0.16445 * **	0.01475
High Birds abundance	1.12559 * **	0.00740	-0.12203 * **	0.01077	0.20366 * **	0.01771	0.91814 * **	0.01790
Water	0.75170 * **	0.00310	0.02864 * **	0.01037	-0.21544 * **	0.02028	0.10078 * **	0.01482
P + T	-0.45563 * **	0.00769	0.81778 * **	0.00970	XXX	XXX	-0.64568 * **	0.01297
P + T + S	-0.33906 * **	0.00333	0.30304 * **	0.01181	XXX	XXX	-0.34043 * **	0.01262
P + T + S + G	1.46395 * **	0.00899	-0.49780 * **	0.01462	XXX	XXX	-1.24507 * **	0.02814
P + T	XXX	XXX	XXX	XXX	-0.35001 * **	0.01208	XXX	XXX
P + T + R	XXX	XXX	XXX	XXX	-0.10531 * **	0.02013	XXX	XXX
P + T + R + L	XXX	XXX	XXX	XXX	-2.33891 * **	0.05149	XXX	XXX
Cost	-0.02796 * **	.8887D-04	-0.07634 * **	0.00023	-0.01309 * **	0.00059	0.00017	0.00023
Std Dev Bog	4.86966 * **	0.00126	12.2146 * **	0.00420	5.63370 * **	0.02783	7.54801 * **	0.02846
Std Dev PTSG	5.95949 * **	0.00944	5.21692 * **	0.00216	XXX	XXX	8.71369 * **	0.06919
Std Dev PTRL	XXX	XXX	XXX	XXX	6.29514 * **	0.09610	XXX	XXX
Log Likelihood	-694.65186		-855.94203		-1016.45754		-939.72557	
Restricted log	-1120.58453		-1252.41801		-1296.36250		-1340.30699	
Pseudo R-square	0.3800987		0.3165684		0.2159157		0.2988729	

Note: * ** , ** , * == > Significance at 1%, 5%, 10% level Legend: P = Car parks; T = Toilets; S = Sign posted trails; G = Paved or graveled paths; R = renting fishing line; L = providing fishing lessons.

[7] Likelihood maximization algorithm does not converge to a general maximum when introducing the ASC.

[8] We can certainly say that being equal the characteristics of the peatlands between the options A, B and C (status quo), the additional cost that people should sustain when opting for A or B makes those options of limited interest compared to the status quo.

[9] Increasing the number of Halton draws stabilises the value of the beta coefficients only if a maximum of 2 random parameters are chosen. Selecting three or more random parameters it causes the impossibility of the likelihood maximization algorithm to converge to a general maximum. Only local maxima are found at different number of Halton draws (from 20 to 2000). In addition, the very high (above 80%) pseudo R2 reported at three or more random parameters shows that the model is generating correlations between the random attributes and overfitting the data, thus losing any predictive meaning.

Table 8
WTP of environmental and recreational attributes for walkers, cyclists and anglers.

Coefficient	Walkers	Cyclists	Anglers
Bog	-77.11 * ** (0.343)	-92.26 * ** (0.330)	-51.83 * ** (3.036)
Grass	-10.39 * ** (0.235)	-2.80 * ** (0.263)	47.69 * ** (2.453)
Heather	-29.06 * ** (0.246)	-2.04 * ** (0.197)	64.42 * ** (3.157)
Medium Bird	29.48 * ** (0.144)	-3.20 * ** (0.18)	36.29 * ** (1.856)
High Bird	40.25 * ** (0.283)	-1.59 * ** (0.143)	15.55 * ** (1.429)
Water	26.88 * ** (0.146)	0.375 * ** (0.135)	-16.45 * ** (1.611)
P + T	-16.29 * ** (0.283)	10.71 * ** (0.124)	XXX
P + T + S	-12.12 * ** (0.124)	3.96 * ** (0.152)	XXX
P + T + S + G	52.35 * ** (0.361)	-6.52 * ** (0.195)	XXX
P + T	XXX	XXX	-26.73 * ** (1.801)
P + T + R	XXX	XXX	-8.04 * ** (1.720)
P + T + R + L	XXX	XXX	-178.64 * ** (9.457)

Note: * ** , ** , * == > Significance at 1%, 5%, 10% level; Error of the mean is calculated by Delta method and is reported in bracket- Legend: P = Car parks; T = Toilets; S = Sign posted trails; G = Paved or gravelled paths; R = Renting fishing line; L = Taking fishing lessons

recreational facility is characterized by positive values that are of higher magnitude compared to the environmental attributes. Good water quality is also considered important to enhance walking experience, probably affected by the transparency of the water stream.

Cyclists show a similar pattern to that found for walkers, with stronger preference for recreational facilities than environmental attributes. All typologies of landscape provide a negative utility, probably because benefit is generated by the recreational experience rather than observing the landscape. Cyclists, compared to walkers are not increasing their utility by biodiversity abundance. In addition, water quality is significant but only slightly higher than zero, suggesting a limited importance to these user groups.

Finally, preferences for anglers seem very different from those elicited by the other recreationists, showing a positive WTP for landscape attributes, but negative or insignificant WTP for recreational facilities. Medium bird abundance seems to be preferred to high bird abundance. It is possible that some wading birds are perceived as potential fish predators by anglers (even though the ground-nesting wading bird species in these areas do not feed on fish). Alternatively, this result can be explained by the difficulty of birdwatchers in distinguishing the two levels of biodiversity abundance [because of the embedding effect one level of the attribute (medium abundance) is enclosed by the next higher level (greater abundance) (Carson and Cameron, 1995), causing the impossibility of clearly discriminating between the preferenecs of the two leveles]. Water quality is characterised by a negative WTP, contrarily to any expectation, suggesting that this parameter is not necessarily relevant to full a positive angling experience.

It is interesting to note that for all the three categories of recreationists the bog peatland shows the lowest WTP amongst the landscape levels.

4.5. Probability of recreation and welfare measures under different scenarios

Table 9 shows the probability of recreation at the baseline and under different scenarios for several localities. Because of the possibility of multiple effects in the management of peatlands under the policy scenarios proposed in Table 2, Scenario 1 is split into two sub-scenarios. The first (Scenario 1a) simulates a grass-dominated habitat, while the second (Scenario 1b) models degradation to bare peat. Scenario 3 is also split into two sub-scenarios. Scenario 3a models the behaviour of recreationists under heather-dominated habitat, while Scenario 3b under a bog (wet) habitat. Scenario 2 is simulating a grass dominated landscape in all localities with the exclusion of Forest-in-Teesdale where bog is modelled.

Walking is preferred to the stay-at-home option. Scenarios 2 and 3a, characterised by grass and heather-dominated landscape, respectively, document the most significant positive change from the baseline (see Table 3). While Scenario 3b, characterised by peatland restoration through rewetting, is the least appreciated. Similar considerations apply to cyclists under Scenario 3, although they seem to prefer the opt-out option, to stay at home. For these recreationists, the greatest transition from the baseline is recorded under Scenario 1b. Anglers have a behaviour that is similar to walkers with higher preferences for Scenarios 2 and 3a.

Table 10 reports the change in compensating surplus per trip for each recreationist from the baseline, under different scenarios and in several localities. In those cases where the probability of a scenario is lower than that at the baseline, the compensating surplus is negative. Welfare change is characterised for walkers by negative values in all scenarios and places, apart from Forest-in-Teesdale, where natural peatland, the least appreciated by walkers, is the current landscape. Thus, a transition to grass or heather in Forest-in-Teesdale provides a positive welfare change. As regards cyclists, welfare changes are not so different from zero in many simulations, in accordance with the low probability of recreation under each scenario. The highest negative WTPs for walkers are recorded for the transition to a boggy peatland. Conversely, the situation shown by anglers is much more diverse. Benefits achieved can be quite broad, ranging from negative to positive according to the level of the environmental attributes (landscape) modelled in each scenario. Overall, scenarios characterised by grass and heather landscape are the most valued, while negative welfare measures are recorded in the third scenario characterised by rewetted peat. Variability in benefits is also explained by a change in water quality and in wildlife abundance especially in those contexts where wildlife is expected to be more abundant, because characterised by less intense grazing/agricultural practices (as proposed in Scenario 2 and 3).

5. Discussion

5.1. Role of environmental attributes versus facilities in peatland recreation

We have applied a participatory scenario approach to develop and discuss with stakeholders the future management strategies in the North Pennines AONB and elicited under the same set of scenarios conservation and recreation values of different categories of recreationists with the goal of exploring trade-offs between environmental attributes and recreational facilities. We found that recreationists showed higher appreciation for semi-natural habitats versus pristine or restored peatlands, with walkers and cyclists more sensitive to changes in recreational facilities than environmental quality. Anglers and birdwatchers showed preferences more aligned with values promoted by conservation. These results suggest that there is not a common and strong preference for conservation if certain stakeholders are targeted (e.g. recreationists), although prior studies suggest a general positive attitude for peatland conservation strategies (Tolvanen et al., 2013), especially for those habitats located in wild areas and characterised by high peat concentration (Glenk and Marting-Ortega, 2018). However, the latter literature is not specifically targeting recreationists. When observing more specific literature addressing the preference of recreationists, findings, like those shown by our research, emphasise the importance of recreational facilities under different environmental contexts such as urban areas (Kabisch, 2015), agricultural landscapes (Reed et al., 2014;

Table 9
Probability of recreation and staying at home under different scenarios compared to the current state (or baseline) of the peatlands in several locations of the North Pennines AONB for walkers, cyclists and anglers (as depicted in Table 3). Scenarios 1 and 3 are split in two sub scenarios. Scenario 1a is simulating a grass-dominated habitat, while the second (Scenario 1b) is modelling degradation to bare land. Scenario 3a is modelling the behaviour of recreationists under heather-dominated habitat, while Scenario 3b under boggy-dominated habitat. Scenario 2 is simulating grass in all localities with the exclusion of Forest in Teesdale where bog is modelled.

probability of walking						
At Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.83	0.78	0.82	0.83	0.86	0.78
staying at home	0.17	0.22	0.18	0.17	0.14	0.22
At Bowlees	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.99	0.95	0.96	0.98	0.98	0.95
staying at home	0.01	0.05	0.04	0.02	0.02	0.05
At Forest in Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (bog)	scenario3a (heather)	scenario3b(bog)
doing recreation	0.78	0.78	0.82	0.78	0.93	0.78
staying at home	0.22	0.22	0.18	0.22	0.07	0.22
At Upper Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.98	0.95	0.96	0.96	0.97	0.95
staying at home	0.02	0.05	0.04	0.04	0.03	0.05
probability of cycling						
At Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.47	0.51	0.56	0.47	0.50	0.00
staying at home	0.53	0.49	0.44	0.53	0.50	1.00
At Bowlees	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.33	0.35	0.39	0.30	0.34	0.00
staying at home	0.67	0.65	0.61	0.70	0.66	1.00
At Forest in Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (bog)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.00	0.51	0.56	0.00	0.49	0.00
staying at home	1.00	0.49	0.44	1.00	0.51	1.00
At Upper Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.32	0.35	0.39	0.31	0.33	0.00
staying at home	0.68	0.65	0.61	0.69	0.67	1.00
probability of fishing						
Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.68	0.52	0.37	0.68	0.62	0.23
staying at home	0.32	0.48	0.63	0.32	0.38	0.77
Bowlees	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.52	0.52	0.37	0.63	0.57	0.23
staying at home	0.48	0.48	0.63	0.37	0.43	0.77
Forest in Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (bog)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.29	0.60	0.45	0.29	0.65	0.29
staying at home	0.71	0.40	0.55	0.71	0.35	0.71
Upper Teesdale	baseline	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass)	scenario3a (heather)	scenario3b (bog)
doing recreation	0.57	0.52	0.37	0.68	0.62	0.23
staying at home	0.43	0.48	0.63	0.32	0.38	0.77

van Berkel and Verburg, 2014), forest (Verlič et al., 2015), mountain ecosystems (Scarpa and Thiene, 2005) and protected areas (Schägner et al., 2016). More specifically, our results match with the findings provided by Christie et al. (2007) who showed that specialist recreationists visiting UK forests expressed enhanced recreational values when they were able to use outdoor facilities. Other specialist users, such as climbers, attained higher values in alpine landscapes with high quality facilities than general users (Scarpa and Thiene, 2005). Furthermore, Sonter et al. (2016), investigating nature-based recreation within conserved lands in Vermont, USA, also observed more visits in larger areas, with less forest cover, greater trail density and more opportunities for snow sports.

This research has also evidenced that some recreational facilities in the North Pennines AONB have a greater positive influence on recreational experiences than natural environmental attributes, supporting the public view and preferences elicited by Martin-Ortega et al. (2014b), who found that under conditions of land degradation some recreational activities might still be carried out and valued. For example, walking is still considered viable in degraded peatlands. Our results support this conclusion suggesting that the role of the natural landscape for walkers and cyclists is less relevant than recreational facilities.

Finally, our findings suggest that to appreciate how several aspects of a recreational experience influence different users, it is necessary to explore the perception people have under different peatland uses and, in more detail, understand people's recreational motivations in relation to nature. Stakeholders' views on the role of peatlands are variegated (Byg et al., 2017) and affected by personal link with biophysical characteristics, history, and cultural relationships with nature. If these ambivalent preferences count, predicting recreationists' attitudes towards a specific combination of recreational and environmental features or conditions becomes relevant to facilitate the inclusion of recreation in policy valuation.

5.2. Welfare changes under peatland management scenarios

Prior literature provides an evidence-base to explore the benefits of regenerating altered areas as a way to increase water quality (Martin-Ortega et al., 2014a) and achieve climate emissions control targets (Salomaa et al., 2018). More recent is the exploration in peatland policies [e.g., in Finland (Salomaa et al., 2018) and in the UK (IUCN, 2018)] of spatial planning and analysis of accessibility as a way to enhance recreation opportunities and other cultural services. In our study, we found that the altered areas can be relevant for enhancing recreationists benefits, suggesting that peatlands restoration to their natural condition to enhance the regulating services provided by rewetting (e.g., climate mitigation) (IUCN, 2018; Parry et al., 2014) may clash with the

Table 10
Compensating surplus in GBP for each recreationist per trip under different scenarios in several locations (standard deviation is in parenthesis). Simulation is based on a population of 5000 units for walkers, cyclists and anglers. Standard deviation is reported in bracket. Scenarios 1 and 3 are split in two sub scenarios. Scenario 1a is simulating a grass-dominated habitat, while Scenario 1b is modelling degradation to bare land. Scenario 3a is modelling the behaviour of recreationists under heather-dominated habitat, while Scenario 3b under boggy-dominated habitat. Scenario 2 is simulating grass in all localities with the exclusion of Forest in Teesdale, where bog is modelled.

Walking					
	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass/bog only Forest in Teesdale)	scenario3a (heather)	scenario3b (bog)
At Teesdale	-8.71 (1.15)	-0.35 (0.04)	–	9.11 (1.11)	- 8.38 (1.11)
At Bowlees	- 65.36 (4.34)	- 55.44 (3.55)	-28.98 (1.70)	-18.40 (1.04)	- 64.97 (4.30)
At Forest in Teesdale	-0.33 (0.05)	8.03 (1.07)	–	41.60 (4.72)	–
At Upper Teesdale	-39.90 (2.83)	-28.98 (2.03)	-28.58 (2.00)	-18.18 (1.23)	- 38.50 (2.79)
Cycling					
	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass/bog only Forest in Teesdale)	scenario3a (heather)	scenario3b(bog)
At Teesdale	1.21(0.51)	2.70 (1.11)	–	0.78 (0.33)	- 9.22 (4.45)
At Bowlees	0.41 (0.19)	1.44 (0.66)	-0.51 (0.24)	0.25 (0.12)	-5.52 (2.81)
At Forest in Teesdale	10.43 (4.95)	11.92 (5.55)	–	10.19 (4.85)	–
At Upper Teesdale	0.53 (0.25)	1.57 (0.72)	-0.27 (0.13)	-0.25 (0.12)	- 5.40 (2.75)
Fishing					
	scenario1a (grass)	scenario1b (eroded land)	scenario2 (grass/bog only Forest in Teesdale)	scenario3a (heather)	scenario3b(bog)
At Teesdale	-31.82 (4.61)	-52.93 (8.15)	–	-13.45 (1.85)	-68.50 (11.06)
At Bowlees	0.46 (0.07)	-20.64 (3.48)	21.51 (3.21)	9.07 (3.40)	-36.22 (6.40)
At Forest in Teesdale	44.69 (7.41)	19.56 (3.48)	–	54.59 (8.80)	–
At Upper Teesdale	-8.44 (1.31)	-29.55 (4.86)	23.38 (3.31)	9.92 (1.46)	- 45.12 (7.78)

preferences of some recreationists. The extent to which the most extreme conservation scenario is able to generate an overall negative impact depends on the balance between reduced recreational values and benefits that local communities and wider society can achieve by changes in regulating services such as climate change mitigation, water discharge control and nutrient and pollutant removal. The latter ecosystem services are recognised as the most valuable and dominate the policy debate around peatland protection (Bain et al., 2011; Bonn et al., 2014; Reed et al., 2013b, 2014). The recent and periodic failure of many UK landscapes to cope with extreme weather conditions (drought in summer, and heavy rain in winter) seems to suggest that managing land for enhancing regulating services is a priority. In light of recent UK conservation policies for peatland, it can be expected that many more hectares of private and public lands under the right economic incentives will be facing a shift from grass and heather-dominated vegetation to wetted peatlands to cope with the compelling climatic emergency.

5.3. Limits of the research design and analysis

The are some limits to our analysis that arise from the type of data collected, also influenced by the need to reduce the burden for respondents, and that must be considered in future research.

A limitation stays on the type of data we have collected that make impossible to run a latent class model (Greene and Hensher, 2003). We have interviewed people asking for frequencies or number of hypothetical recreational experiences in the landscapes to be shared between the three options proposed in the choice cards (and not to make a clear choice between those options, i.e., the binary model where only one option is made in the choice card). This gives the opportunity to process a more complete information (Christie et al., 2007; Jobstvogt et al., 2014). However, this typology of data does not give the opportunity to run a latent class model that could be used to confirm the result of our model based on a priori classification of the typology of recreationists. In future research, a different approach to data collection will be necessary to run a latent class model and account for possibilities for recreationalists to one day be a walker, but another day a cyclist or a birdwatcher.

Second, in our approach, we were careful in asking respondents after the choice experiment if they were able to trade-off between non-monetary and monetary attributes and consequently to exclude from the analysis those who stated negatively or replied randomly. However, we have not collected information on the single attributes that were not attended (non-attendance of attributes), or not considered in the formulation of the choice. This would have required after each choice cards an open-ended format question to record the attributes not considered by the respondents. To reduce the fatigue, limit time needed to complete the onsite survey and the risk to get poorly considered answers, we have decided to not collect this information that if recorded would have contributed to make a more robust analysis of the econometric coefficients (Carlsson et al., 2010; Balcombe et al., 2011).

A further note is on the choice experiment design. We have applied a limited number of restrictions just to avoid combinations of levels that could be perceived as illogical to the respondents (as detailed in the Section 3.3). It is possible that under certain real land management scenarios some of the combinations of levels proposed to the participants could be implausible. However, our goal was the analysis of preferences for environmental attributes referring to a hypothetical landscape that could be found in the North Pennines AONB, as explained to the respondents in the introduction of the choice experiment, without reference to the specific environmental context and land uses that the recreationists could find in the particular location where they were interviewed. More localised research could deal with more realistic scenarios with a reduced set of attributes and combination of levels to reflect the reality of the specific place under investigation.

There are other aspects that are not necessarily limits of this study but could be addressed in future research. Although our findings are supported by other studies undertaken in other landscapes, as indicated in the discussions at Section 5.1. and 5.2, we suggest exploring the effect of the properties of the North Pennines AONB elicited in this paper through an off-site analysis. We have seen in Tinch et al. (2014) that the in-situ experience of observing the landscape can cause a higher variation in the econometric coefficients compared to the case where an offsite analysis is carried out. In addition, Tinch et al. (2014) found that people interviewed in situ did not pay attention to the price attached to the alternatives but focus instead on the landscape characteristics they prefer. We found this result in our study only for the category of birdwatchers.

A final note is with regard to the assumptions of commensurability and substitutability of values that underpin choice experiments (Kenter et al., 2016; Isacs et al., 2022). It is important to recognise that all categories of peatland, from heather to rewetted bogs, may be associated with non-substitutable shared, relational and intrinsic values that may only be partially reflected in indicators of total economic value, including use and non-use values (Kenter et al., 2015; Anderson et al., 2022). Management may benefit from further participatory and qualitative research (Reed et al., 2020) to present a more complete understanding of peatland values, which could help identify further value conflicts, improve legitimacy, and reduce the risk of policy backlashes (Kenter et al., 2014).

6. Conclusions

The literature reported at Section 2 has shown little attention to potential trade-offs between environmental attributes necessary for the provision of regulating services and the value of recreational activities in peatlands. We addressed this gap by considering environmental and recreational attributes of peatlands and their level of preference for four categories of recreationists (walkers, cyclists, anglers and birdwatchers). We did so under different management scenarios emerged from a participatory process that had the capacity to enhance the relevance of scenarios to stakeholders by incorporating and building on their preferences.

Results have shown prevalence of infrastructure over natural attributes for walkers and cyclists, and of natural attributes for anglers. If considered, these results introduce more complexities in policymakers' choices in deciding on conservation strategies. In addition, we found preferences are highly heterogeneous and that some recreational values are unaffected by degraded peatlands. Conversely, deterioration of preferences for outdoor activities may emerge under certain management practices, such as rewetting, that are required to restore ecosystem function processes. At smaller scale, this may generate conflicts in the choice of the most beneficial management policy for degraded peatlands that are valued highly by walkers and cyclists, although for large-scale restoration projects the global benefits arising from conservation are likely to outweigh the disutility accrued to recreationists if considered commensurable in monetary terms.

Our results suggest decisionmakers and policymakers should consider the possibility that some land use decisions that are being driven by the net zero policy agenda may come with trade-offs for recreationists. For these strategies to be successful across a broad range of considerations, however, they cannot be seen as generating winners and losers. It is important therefore that policymakers consider these potential conflicts between net zero targets and the delivery of other ecosystem services, and wherever possible identifying synergies or making use of spatial planning to maximise different (suitable to the context) options in different places (e.g., Manning et al., 2018). For instance, it could be sensible to manage peatlands to target the provision of regulating services (e.g. climate change mitigation, water quality improvement and flood risk management) through the restoration of degraded peatlands by domestic voluntary carbon markets such as the Peatland Code (Reed et al., 2017; 2022) or a combination of public and private funding (Reed et al., 2014; 2022), whilst targeting public funding for the creation of new recreational access routes (e.g. via board walks over rewetted bogs) in peatlands close to large conurbations that experience high levels of recreational use (e.g. the Peak District National Park). Alternatively, areas may be zoned for recreational use versus restoration for other ecosystem services, with restoration targeting less heavily used sites. This approach is supported by the results of this study that shows how recreational aspects such as walking or cycling can be carried out with a certain satisfaction even in more degraded landscape, where there is an adequate level of recreational facilities. Peatland restoration management may also consider opportunities for value formation and change with recreationalists, where e.g., through in situ education (e.g., interpretation boards), opportunities for participation in management, and other forms of engagement and awareness raising, the benefits and motivations for rewetting and other conservation measures are presented, to provide a counterweight for the potential disutility of restoration approaches such as rewetting.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2022.106401.

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