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RESEARCH ARTICLE

Exploring the social and cultural values of trees and woodlands in England: A new composite measure

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Abstract

1. Existing research on the social and cultural (S&C) values of treescapes tends to be limited in scope, for example to recreation, aesthetic or health values, and much is primarily qualitative, which provides rich detail but does not lend itself easily to incorporation into decision-making. Having a way to quantify the range of S&C values associated with treescapes is important if decision-makers are to effectively take these into account. This issue is particularly important currently with ambitious plans to increase tree cover alongside growing threats to treescapes from climate change and tree pests and diseases.
2. This paper outlines the development of a new composite measure to quantify the S&C values associated with treescapes. The development of the measure resulted in a set of 19 statements across six categories of S&C value.
3. We present results from using the measure in a survey with a representative sample of 5000 people across England together with the results of a factor analysis, which suggests a way to simplify the measure into five statements.
4. We examine the measure through the lens of relational values and suggest that a majority of the values in our measure are relational.
5. *Policy implications*. The composite measure can be used by decision-makers looking to develop their evidence base regarding the value of treescapes in their area, or for exploring the impact of tree pests and diseases. It has already been used by more than one local authority in England. While data collection was limited to England, we suggest that the measure is applicable across a wider range of countries.

KEYWORDS
social and cultural, tree pests and diseases, trees and woodlands, values, values

1 | INTRODUCTION

There is currently a strong focus in the UK on increasing tree and woodland cover to contribute to targets for net zero carbon (UK Government, 2021), with a recognition that many other benefits could be realised, such as improved health and well-being for local communities (Davies et al., 2017). The scale of the planned landscape change has the potential to significantly impact the social and cultural (S&C) values people hold for trees and woodlands. For example, new woodlands with public access can provide a wide range of well-being benefits particularly to those who visit them (Forest Research, 2021), and trees in other locations provide aesthetic, cultural and symbolic value (Davies et al., 2017). The S&C values people associate with trees cannot be easily captured through ecological or monetary assessments. They are often relational values such as those around identity formation, learning, inspiration, physical and psychological experiences, and spiritual significance, developed through the deep-seated, mutually influencing relationships people have with trees and woodlands.

1.1 | Treescape values and the importance of S&C values

A large body of research has already explored the relationships people have with treescapes[1] and the values and benefits they provide, whether they are accessing and undertaking activities in woodlands or green spaces with trees (O'Brien & Morris, 2014; Saraev et al., 2021), or whether they are engaging with them through other means, such as visually, virtually or through livelihood activities (Marušáková & Sallmannshofer, 2019). Studies have also explored and identified these values with indigenous communities (Angarita-Baéz et al., 2017; Plumb et al., 2012; Sangha et al., 2019), urban dwellers (Li et al., 2019), national park visitors (Považan et al., 2015; Sumner & Lockwood, 2020), rural communities (Lee et al., 2020; Nassl & Löffer, 2019), forest owners and managers (Aukema et al., 2011) and city park visitors (Arnberger et al., 2020; Rudl et al., 2019).

Evidence suggests that the S&C values of treescapes are important and wide ranging, including landscape aesthetics, recreation, health, spiritual, place and identity. The aesthetic value for treescapes has been highlighted by Lim et al. (2015). O'Brien and Forster (2023), in an evaluation of the Active Forests Programme, found that one of the ways in which people valued being recreationally active in a forest environment was because of the beauty and variety of those landscapes. The health and well-being benefits of treescapes have also been highlighted in many studies (Beute et al., 2020; Tyrväinen et al., 2019), although further research is needed to understand more about the characteristics of treescapes that have the most impact on health. Spiritual, symbolic and sensory values related to forests have been identified as being important to a diverse range of people (Church et al., 2014; Cloke & Jones, 2002; Kenter et al., 2014; O'Brien et al., 2012, 2014). Research has also shown that the ways and reasons people value treescapes can change over the life course. For example, children value woods as places to play and build dens (Lovell & Roe, 2009; Milligan & Bingley, 2007), teenagers may do so as places for adventurous activities (Ward Thompson et al., 2010), parents with children value them as places for family activities that can bring the family together and tire out the children to improve their sleep (O'Brien & Morris, 2014), while some older people value opportunities for exercise and appreciation of nature. Furthermore, people can intrinsically value treescapes whether or not they visit or engage with them (Pounds, 2021). Many studies exploring S&C values focus on specific treescapes whether that is a particular woodland, trees in an urban context (Ambrose-Oji et al., 2021), or surveys about treescapes in general. Studies focussed on specific woodlands or treescapes offer greater detail of what is important and of value to people, whereas studies focussed on a national level concerning treescapes in general provide important overviews with less detail (Forest Research, 2021). However, much of the existing literature on S&C values is primarily qualitative, which provides rich detail but does not lend itself easily to incorporation into decision-making.

1.2 | S&C values and tree pests and diseases

There are an increasing number of threats facing treescapes including from a variety of existing and novel pests and diseases (P&Ds), perhaps most notably ash dieback (*Hymenoscyphus fraxineus*), which is expected to impact a large percentage of ash trees in the UK (Spence et al., 2020). There is limited evidence of what impact tree P&Ds might have on the S&C values people hold for treescapes. For example, the P&D might result in tree loss or tree damage or may involve a variety of management and control measures aimed at reducing spread, such as tree felling or chemical applications, which could affect people's S&C values (Porth et al., 2015). A small number of studies exploring the impact of P&Ds on S&C values have identified impacts on health (Donovan et al., 2013), on aesthetic values via reductions in property values (Aukema et al., 2011), on quality of life (Flint, 2006), and on cultural values associated with cultural practices such as basket weaving (Ranco et al., 2012). Further research is needed in this area as the number of P&Ds affecting treescapes increases.

1.3 | Actioning S&C values for decision-making

Several instruments have been developed to measure the values people have for different types of landscape. For example, Tarrant et al. (2003) created a 12-point scale to measure the importance of forests to the American people and Kendal et al. (2015) designed a tool to measure people's valued attributes of landscapes, suggesting that focussing on valued attributes was more tangible and less abstract than exploring values in general. However, these instruments do not focus specifically on S&C values, and there is currently no comprehensive method to capture the full range of S&C values

[1]We use the term treescapes throughout to capture trees within different landscape contexts from street trees to trees in parklands, to trees in woodlands and forests.

associated with treescapes in a way that fits easily within existing decision-making at a local or national level, which tends to be based primarily on monetary evidence. Understanding why treescapes matter to people is important for treescapes management and when considering the expansion and creation of more treescapes. We have created a composite measure that does this, testing it through a survey of 5000 people in England. The creation of the measure is part of a larger body of work within the context of an increase in tree P&Ds, exploring how S&C values for treescapes might be impacted by these threats and the control measures they entail. In this paper, we focus primarily on the development of the measure but touch briefly on the impact of tree P&Ds on S&C values to illustrate one application of the measure.

The focus on S&C values is an important topic because these values are not as prominent in decision-making, and major studies exploring the values of treescapes have often focussed on specific aspects of S&C values such as recreation, landscape aesthetics or, more recently, health and well-being (Saraev et al., 2021). These S&C values are sometimes considered in decision-making particularly when they are monetised. The types of value most likely to be monetised are recreation and landscape aesthetics through approaches such as the travel cost method or willingness-to-pay studies (Binner et al., 2017), with newer studies focussing on physical and mental health (e.g., Saraev et al., 2021). However, S&C values such as spiritual values and those associated with memories and creative inspiration connected to treescapes are less likely to be taken into account if they are not monetised or quantified. Qualitative evidence can provide rich detail of the S&C values that different groups of people hold for treescapes. This type of evidence can be seen as more difficult for decision-makers to take into account as the values are not reduced to a metric or monetary value that can then be compared, combined, or traded off with, for example, ecological or economic values (Bryce et al., 2016). However, Lewin and Glenton (2018) suggest that new methods and frameworks are being used to package different types of evidence in qualitative research to inform, for example, health policies and World Health Organization guidance.

Few studies have focussed on trying to integrate a range of S&C values of treescapes into a measure that could be used in future research and the results used in decision-making through, for example, natural capital assessments, local authority tree strategies, or in broader government strategies on tree health resilience (Defra, 2018). Our research has sought to address this problem through the development and testing of a composite measure that combines the more recognised S&C values with others that may be less noted. Our measure aims to capture the range of S&C values associated with treescapes. The measure and the results of our survey could be used in several ways, for example, to:

- highlight the range of S&C values of treescapes and any differences by demographics or geographic areas;
- take account of these values in the valuation of ecosystem services e.g. by referencing them in strategies or policies or including them in natural capital accounts;
- account for these values in decision making concerning the management and conservation of treescapes, the expansion and creation of new treescapes, and the impacts of tree P&Ds and relevant management and mitigation measures on those values;
- be used in future research such as surveys or workshops that seek to identify or explore the significance of the S&C values of treescapes to people or investigate any changes to these values over time.

The research questions we sought to address were as follows:

1. What values and value categories are there in the literature that demonstrate the S&C values of treescapes? How do these relate to current value theory?
2. How could these be developed into a quantitative measure of S&C values that could be used to better understand the value of treescapes?
3. How might this evidence be used in decision making particularly in relation to tree P&D impacts?

2 | THEORETICAL CONTEXT

In this section, we outline how we understand S&C values and situate this within relevant approaches. We focus on the concept of relational values, arguing that it offers a lens through which to consider our measure and survey results, and then briefly discuss our theoretical approach to developing the measure.

2.1 | Conceptualising S&C values

We have taken a broad approach to S&C values, intentionally not setting out a specific definition. The terms 'social values' and 'cultural values' are contested and rarely well-defined within the literature (Hall et al., 2020) and S&C values are experienced differently across groups and communities. Broadly speaking, cultural values are linked to sets of beliefs and practices upheld as being important within a society. These can be manifested through oral traditions, sense of identity, connections to place, spiritual connections and symbolic meanings. Social values may overlap with cultural values and are those held communally by groups or communities within society. Within the environmental sphere, S&C values are often linked to aspects such as landscape aesthetics, nature connections, recreation and biodiversity (da Rocha et al., 2017; Hall et al., 2020; O'Brien et al., 2017; O'Brien & Morris, 2014). Some research uses related terms, such as 'benefits' or 'services', and we included these as search terms in our evidence review; however, we have chosen in this paper to use the term values throughout.

Nonetheless, some limits were required on what is included or excluded within S&C values as people can value things about treescapes, which are outwith the social or cultural sphere such as trees' role in the reduction of flooding or the urban heat island effect.

Rather than explicitly exclude aspects of value, our approach has been to navigate this consideration through ongoing dialogue and debate within the project team and with our key stakeholders. This led us to include a nature/wildlife category that focusses on the personal value of wildlife to individuals rather than on the intrinsic value of wildlife. The lack of a clear definition has often encouraged productive debate.

Approaches and frameworks for the consideration of values abound. In the past two decades, the cultural ecosystems services approach, first set out in the Millennium Ecosystem Assessment (World Resources Institute, 2003) and built on in the UK National Ecosystem Assessment and related follow-on projects (UK National Ecosystem Assessment, 2011, 2014), has provided a stronger focus on the non-material benefits, including S&C values, which can be derived from different ecosystems. Fish et al. (2016) made a distinction between ecosystems services and practices and the cultural benefits that people gain from these. This dovetails with the concept of relational values which we turn to now.

2.2 | Relational values theory

The concept of relational values has become increasingly important in recent years after being included in the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (Pascual et al., 2017), and more recently in the IPBES values framework (Pascual et al., 2023) The IPBES framework seeks to establish values of nature on multiple levels, from world views and knowledge systems, to broad values, to specific values which can be identified through value indicators. Across these levels of values sit four frames, which set out values in terms of human–nature relationships: living from (instrumental use values), living in (nature as a setting for human lives), living with (nature supporting other than human beings) and living as (nature as a part of oneself and oneself as a part of nature) (ibid). Relational values sit within the IPBES typology's 'specific values' layer and can help us better understand why nature or specific ecosystems matter to people and offer a lens through which to examine our composite measure and survey results. It is a framing which is intentionally both interdisciplinary and which has real-world application (Chan et al., 2016, 2018). What is more, relational values offer a 'pluralistic approach' which 'captures the variety of ways people express why they value what they call nature' (Himes & Muraca, 2018, p. 2).

The idea of relational values has been most prominently outlined by Chan et al. (2018), with a burgeoning body of work building on this article. Relational values are 'preferences, principles, and virtues about human-nature relationships' (Chan et al., 2018, p. A1) focussed on deep-seated relationships people have with nature. For a value to be relational, there must be a specific object (Chan et al., 2018) and it is the *relationship* that is the source of value. As Mattijssen et al. (2020, p. 403) write, 'the value of the relationship between a person and a tree … is not found in either the person or tree, but in the connection between the two'. Following from this point is the fact that these relationships are reciprocal—embedded within them is the potential for each party (human and nature) to impact the other (Mattijssen et al., 2020).

Relational values can be distinguished from instrumental and intrinsic values (respectively, what nature can do for people and the value of nature in and of itself). However, value types can overlap, and something can simultaneously have instrumental, intrinsic and relational value. For example, foraging for mushrooms in a woodland could be a means to an end (the production of a particular culinary dish), but it could also be part of a close relationship between a person and the woodland which has a strong focus on responsibility and ideas of stewardship, therefore ensuring that an area is not over harvested. Relational values differ from instrumental values both because it is the relationship itself which is important, rather than the end, but also because the thing being valued is not substitutable, that is a person could not get the same value from something else (Chan et al., 2018). We will return in the discussion to consider our identified S&C values in light of these aspects.

Some studies have sought to explicitly explore the relational values associated with treescapes; however, none of these have been in a UK context and each has focussed more on identifying or elaborating on values than on measuring them. Through an evidence review focussing on sub-Saharan Africa, Ihemezie et al. (2021) consider a series of motivational goals for forest ecosystem conservation within three value orientations: anthropocentric, relational and biocentric. They identified a series of cultural, social and management forest values and examined the potential impact of these values on conservation attitudes and behaviours. Yuliani et al. (2022) use relational values as a lens through which to explore how people in Indonesia relate to forests with the aim of understanding participation in social forestry programmes. Marquina et al. (2022) found that inviting people in Vermont to write letters to trees revealed that many expressed relational values through their writing. Shishany et al. (2022) used eight questions relating to relational value within a survey of 200 people in Jordan to explore how demographics and attitudes affect relational values relating to forest Protected Areas. It is worth noting that many other studies are relevant here; however, they may not have used the term relational values explicitly.

2.3 | A composite measure of S&C value

There is an inherent tension between demonstrating and measuring the breadth of S&C values associated with treescapes and distilling these into a single-number index. Proponents of the latter suggest single numbers can more effectively capture the attention of both the media and policy makers, while 'non-aggregators' advocate stopping at an 'appropriate set of indicators' (Sharpe, 2004, p. 9). Furthermore, single-number composite indices can support decision-makers, enable easy comparison and facilitate communication; however, they may also result in simplistic policy conclusions and can hide the decisions and values embedded in the construction of the index (OECD/European Union/EC-JRC, 2008, pp. 13–14).

While we agree that single numbers can have an attractive power, we want to ensure the diversity of S&C values are represented in our measure. We have taken a flexible and exploratory approach, focussed on defining a comprehensive set of statements which cover the range of S&C values associated with treescapes and then looking at ways in which we might reduce these to fewer variables where this might be needed.

3 | METHODOLOGY

We used a series of steps to select a set of value statements that capture the range of S&C values associated with treescapes. Drawing on a rapid evidence review, we identified and agreed upon a set of six categories of S&C value, based on those most often addressed by the reviewed publications (Hall et al., 2020). We then drew and further refined statements from the literature relating to each of these categories, before rationalising these statements into a smaller set for testing. The project has benefited from a project advisory group, comprising stakeholders from government bodies (Forestry Commission, Environment Agency, Natural England) and academia (Universities of Bangor and Gloucestershire), and a separate steering group, including policymakers, social scientists and economists. The steering group provided overall strategic direction so that the research could feed into tree health policy, while the project advisory group commented in greater detail on all aspects of the project and contributed their knowledge and expertise.

3.1 | Rapid evidence review

We conducted a database search of Scopus using agreed keywords. We screened results for publications in English, publication date between 2010 and 2020, topical relevance to trees, woods, or forests, and those that captured elements of S&C values such as 'cultural ecosystem', 'benefit', 'service', 'well-being', and 'social' or 'cultural value'. The search strings were as follows:

(Forest* OR Tree* OR Wood*) AND ("Cultural ecosystem" OR Benefit OR Service OR Well-being OR (Social OR cultural AND value)) AND (Impact OR Metric OR Indicator OR Assess* OR Evaluat* OR "Cost benefit" OR "Multi-criteria analysis" OR Deliberative).

(Forest* OR Tree* OR Wood*) AND ("Cultural ecosystem" OR Benefit OR Service OR Well-being OR (Social OR cultural AND value)) AND (Pest OR Disease OR Defoliat* OR Death OR Mortality OR Dieback OR Bleeding OR Canker).

The first search string focussed on capturing evidence of S&C values, while the second included terms related to P&Ds instead of those related to measurement. After reviewing titles and abstracts, we identified 188 relevant publications (see data sources list after the references), of which 160 directly addressed the S&C values of treescapes or included consideration of treescapes alongside other ecosystems. Nine publications focused on how P&Ds might impact people's values. The identified publications cut across contexts in terms of geography, protected area status, land use type, scale, urban–rural locations, tree species, and management. Fifty-two studies focus on Europe, 24 on Asia and 20 on North America.

3.2 | Defining categories of S&C value

A count of value-related terms within the article abstracts identified 54 mentioned at least twice. Through affinity mapping, we rationalised these terms into 11 categories, of which six had at least 20 mentions (recreation, aesthetics and landscape, health and well-being, nature/wildlife, place and community, and spiritual/emotional). We elected to omit 'recreation' as this generally related to the activities people undertake in woods or nature rather than their values. Alternatively, it was used in the literature as a catch-all category for a range of values or for development of a single monetary value. We added a sixth category, learning, following discussion and debate with the project advisory group who noted its importance in a range of studies focused on Forest School, skills development, and the passing of knowledge across generations (Cudworth & Lumber, 2021; O'Brien, 2005; Tabbush, 2010).

3.3 | Selecting statements

Having selected six categories of S&C value, we drew from the literature relevant statements used within empirical studies to capture these values. Refining this long list involved ensuring that each aspect of the value categories was captured and that all statements were individual-focussed, that is, to be answered by an individual on what is of value to them personally. Candidate statements were assessed by members of the project team against the criteria of generalisability (i.e., whether the statement would work when thinking about the value of treescapes at both the national and local levels), relevance to the given category, and simplicity. We discussed the draft list of statements with our project advisory group and steering group. This process resulted in a final set of 19 statements which we standardised by fitting them to the question 'I value trees, woods and forests because…' (Table 1). The references in Table 1 helped us to develop and refine our S&C value statements.

3.4 | Survey

We developed a survey that included the S&C values statements, but also covered questions on the use and frequency of use of woodlands and activities undertaken in woods (see Supporting Information for the survey questions). We provided information on the front page of the survey outlining its purpose and providing information on how we would protect respondents' data following the Data Protection Act 2018. We then outlined that if respondents clicked the next

TABLE 1 Selected 19 statements to access social and cultural value.

High-level categories	Social and cultural values statement all statements begin: 'I value trees, woods and forests because…'
Well-being (Bagstad et al., 2016; Pounds, 2021)	They contribute to my physical wellbeing
	They are good for my mental wellbeing
	They provide a peaceful refuge for me
Nature/wildlife (Bagstad et al., 2016; Bryce et al., 2016)	Of their importance for wildlife
	I like being part of a landscape which is also home to wildlife
	Being among them makes me feel more connected to nature
Place community (Baumeister et al., 2020; Gould et al., 2014; Riechers et al., 2021; Smith, 2018)	They connect me to memories of my past
	They provide places to spend time with my friends and family
	They provide places for my community to come together
	They provide me with places for fun and enjoyment
Spiritual (O'Brien et al., 2014; Pounds, 2021; Smith, 2018)	Being among them makes me feel part of something bigger than myself
	They make me feel creative and inspired
	Being among them I feel a sense of freedom
	Old and ancient trees are especially attractive to me
Learning (Pounds, 2021; Smith, 2018)	They can help me learn more about nature
	They are part of our cultural and historic landscape
Aesthetics and landscape (Bagstad et al., 2016; Bryce et al., 2016; O'Brien et al., 2014)	They stimulate my senses
	They make me notice the changing seasons
	I feel touched by their beauty

button on the survey they were giving their consent to participate in it. The survey comprised 23 questions (including demographic questions) and was conducted online, taking 15–20 min to complete. We asked respondents to score the S&C values statements from 0 to 100, choosing this scale to allow for more granular differences to be picked up given the large sample size. The statements were presented twice for consideration in relation to treescapes at a national level and at a local level to explore whether there would be a difference between these two geographic scales in terms of people's values. We wanted to account for the fact that valuing treescapes at a national level might include people valuing treescapes they never or rarely visited and that valuing treescapes at a local level might include those they engage with frequently or not. We also included a survey question asking whether there were any categories of value that had not been mentioned or identified. Other questions within the survey asked participants to score the importance of trees in different places and to rank the importance of the six high-level categories of value from our review (Table 1) by distributing 100 points across these categories. These two questions are not part of the composite measure, so are not discussed further in this paper.

We also asked respondents to rate on a scale of 0–100 the impact on their S&C values of a P&D infestation if it became an issue in the woodlands they visited (with 0 meaning 'no impact at all' and 100 meaning 'a great deal of impact'). We provided four potential impact scenarios: woodland closure, large-scale loss of trees, a gradual or slow decline of trees in the wood, and loss of a small number of trees that were replaced with different species.

The survey was piloted qualitatively with 30 people to check comprehensibility and then further with a non-representative sample of 249 people for statistical purposes to allow for testing of the factor analysis approach and exploring the descriptive statistics. The full survey ran in August and September 2022 through an online panel achieving a sample of 5000 people across England, representative across age, gender, and the nine International Territorial Level regions of England. Online survey panels are databases of respondents who agree to complete surveys and a variety of organisations such as market research companies have developed their own online panels. Respondents will be paid for completing a survey. We contracted a company with a large-scale online panel that could ensure provision of a representative sample of the population in England. There are limitations associated with online panels, for example, they may exclude people who are offline, and respondents have to opt in to complete surveys. To minimise the risk, the survey company used a range of recruitment methods such as emails, social media and e-newsletters. Our research followed Forest Research's Society and Environment Research Group Code of Ethics (Ambrose-Oji et al., 2020).

Table 2 shows a breakdown of the sample.

3.5 | Analysis

We applied an exploratory factor analysis approach to determine whether the 19 statements of the composite measure could be reduced to a smaller number of latent factors, and thus how the different statements loaded onto those factors. All analysis was conducted in R (version 4.1.0, R Core Team, 2021), with data cleaning and manipulation conducted using R package 'dplyr' (Wickham et al., 2020).

For the factor analysis, we treated the 0–100 scores as continuous (Robitzsch, 2020) and ensured the suitability of the data with a set of initial checks. The Kaiser–Meyer–Olkin test of sampling adequacy (Kaiser, 1970) resulted in an overall value of measure of sampling

TABLE 2 Demographic data for the 5000 England population sample. Representative by region, age and gender.

Region		Age		Gender	
East Midlands	9%	18–24	15%	Female	51%
East of England	11%	25–34	17%	Male	48%
London	14%	35–44	16%	Non-binary/ alternative ID	1%
North East	5%	45–54	17%	N/A	0.1%
North West	14%	55–64	14%		
South East	17%	65+	21%		
South West	11%				
West Midlands	11%				
Yorkshire and the Humber	10%				

adequacy (MSA) = 0.98 (and individual MSA values all above 0.9), confirming that the sum of partial correlations is not large relative to the overall sum of correlations (i.e., there are no collinearity issues), and therefore, factor analysis of the variables under consideration should yield distinct and reliable factors. The Bartlett's test of sphericity (Bartlett, 1951) provided results $\chi^2(171) = 1572.75$, $p < 0.001$, therefore we can confirm at the pre-specified 5% significance level that the correlation matrices are not identity matrices, i.e., there is enough correlation in the data (at least between some variables) to lead to meaningful factors. In addition, the determinant of the matrix of variables was found to be positive, which further confirmed the suitability of the data set for factor analysis. We used the fa.parallel function (Revelle, 2020) to determine the number of factors for both the local and national data scores, with the appropriate factor analysis applied using 'equamax' rotation and regression scores (R Core Team, 2021). Loadings were squared to determine communality, and a threshold value of 0.3 (equivalent to a loading of ~0.55) used as a cut-off for a good factor (Comrey & Lee, 1992). Scores for the relevant factors were outputted, named appropriately, and used for the construction of composite variables and as predictors in statistical modelling, both described below.

We tested two different ways to explain the full composite measure by means of a sub-set of statements. These tests aimed to inform a potential reduction in the statements required in future assessments if time and resources were limited. First, we tested whether the four relevant factors together with the statement on learning about nature were a representative sub-set of statements. We did so by assessing the correlations of the 19 individual statements' scores with the scores resulting from the 0–100 rescaling of the sum of each factor's scores multiplied by their explained variance and the weighted individual statement on learning about nature. Second, we tested whether the statement with the highest communality per factor could represent the other statements in that factor by assessing the correlations of the 19 individual statements' scores with the scores resulting from the 0 to 100 rescaling of the sum of each highest communality statement's scores multiplied by the corresponding factor's explained variance and the weighted individual statement on learning about nature.

For the statistical modelling of factor scores, each factor was taken in turn (i.e., a single factor score per respondent) and linear regression used to determine potential associations with key demographic factors: age, sex, ethnicity, household income, employment status, urban/rural location and the absence or presence of more than one adult, under tens, and 11–18 year olds. Model assumptions were assessed via residual inspection and estimated marginal means (Lenth, 2022) calculated where the coefficient of determination R^2 exceeded 0.01 and F test p values were <0.01 (Fox & Weisberg, 2019).

4 | RESULTS

Below, we outline the results for the 19 S&C values statements for treescapes at the local and national levels, briefly note some results specific to S&C values in relation to tree P&Ds, and then present the outcomes from the exploratory factor analysis. The focus of this paper was on the development of the composite measure and therefore it does not report results from all the questions asked in the survey.

4.1 | S&C values scores

Table 3 shows the median scores (plus inter-quartile ranges, in brackets) for the local, national and national-minus-local scores (per individual) for each statement. The overall median value across all the statements was 70. There were no statistically significant differences between responses at the local and national levels. Across both levels, the lowest median is 57, showing that many people were positive about all the statements.

Focussing on treescapes at the local level, the importance for wildlife statement scored highest, with a median of 80. The lowest scoring statements were 'they provide places for the community to come together', 'they make me feel creative and inspired' (both with a median of 57) and 'they connect me to memories of the past' (median 58). Regarding the national level, the picture is similar, with the importance for wildlife scoring highest (median 80),

TABLE 3 Scores per statement (median (lower quartile; upper quartile)) for local, national, and national-minus-local scores (per individual).

Statement	Local score	National score	Difference
Of their importance for wildlife	80 (58; 98)	80 (57; 98)	1 (−5; 9)
They are good for my mental wellbeing	75 (53; 94)	75 (54; 94)	1 (−5; 9)
They make me notice the changing seasons	75 (54; 94)	74 (54; 92)	1 (−5; 12)
Being among them makes me feel more connected to nature	74 (53; 91)	74 (53; 92)	0 (−7; 7)
I like being a part of a landscape which is also home to wildlife	74 (53; 92)	73 (52; 90)	0 (−7; 6)
They are part of our cultural and historic landscape	74 (52; 92)	73 (52; 91)	0 (−6; 9)
Being among them I feel a sense of freedom	71 (51; 88)	72 (52; 89)	0 (−5; 8)
They contribute to my physical wellbeing	71 (51; 89)	70 (51; 87)	0 (−5; 7)
They provide a peaceful refuge for me	71 (51; 89)	70 (50; 89)	0 (−5; 5)
I feel touched by their beauty	70 (51; 88)	70 (50; 87)	0 (−5; 7)
Old and ancient trees are especially attractive to me	69 (48; 88)	69 (50; 86)	0 (−8; 4)
They provide places to spend time with my friends and family	68 (48; 85)	69 (50; 86)	0 (−5; 8)
They stimulate my senses	68 (50; 85)	68 (49; 85)	0 (−6; 8)
They provide me with places for fun and enjoyment	67 (49; 84)	67 (49; 84)	0 (−7; 5)
They can help me learn more about nature	66 (49; 83)	67 (49; 84)	0 (−6; 5)
Being among them makes me feel part of something bigger than myself	65 (47; 84)	66 (49; 83)	0 (−9; 6)
They connect me with memories from my past	58 (38; 79)	62 (45; 80)	0 (−7; 7)
They make me feel creative and inspired	57 (40; 77)	61 (43; 79)	0 (−7; 7)
They provide places for the community to come together	57 (40; 76)	60 (39; 80)	0 (−7; 7)
Average (median)	70 (52; 85)	70 (52; 85)	0 (−2; 3)

and the three lowest scoring statements being the same, albeit with different median values. Although there are small differences in some of the scores between the national and local statements, we can keep the same order of statements in terms of their importance at both levels. In terms of the five top scoring statements all but one (mental wellbeing) focus on wildlife and connections to nature.

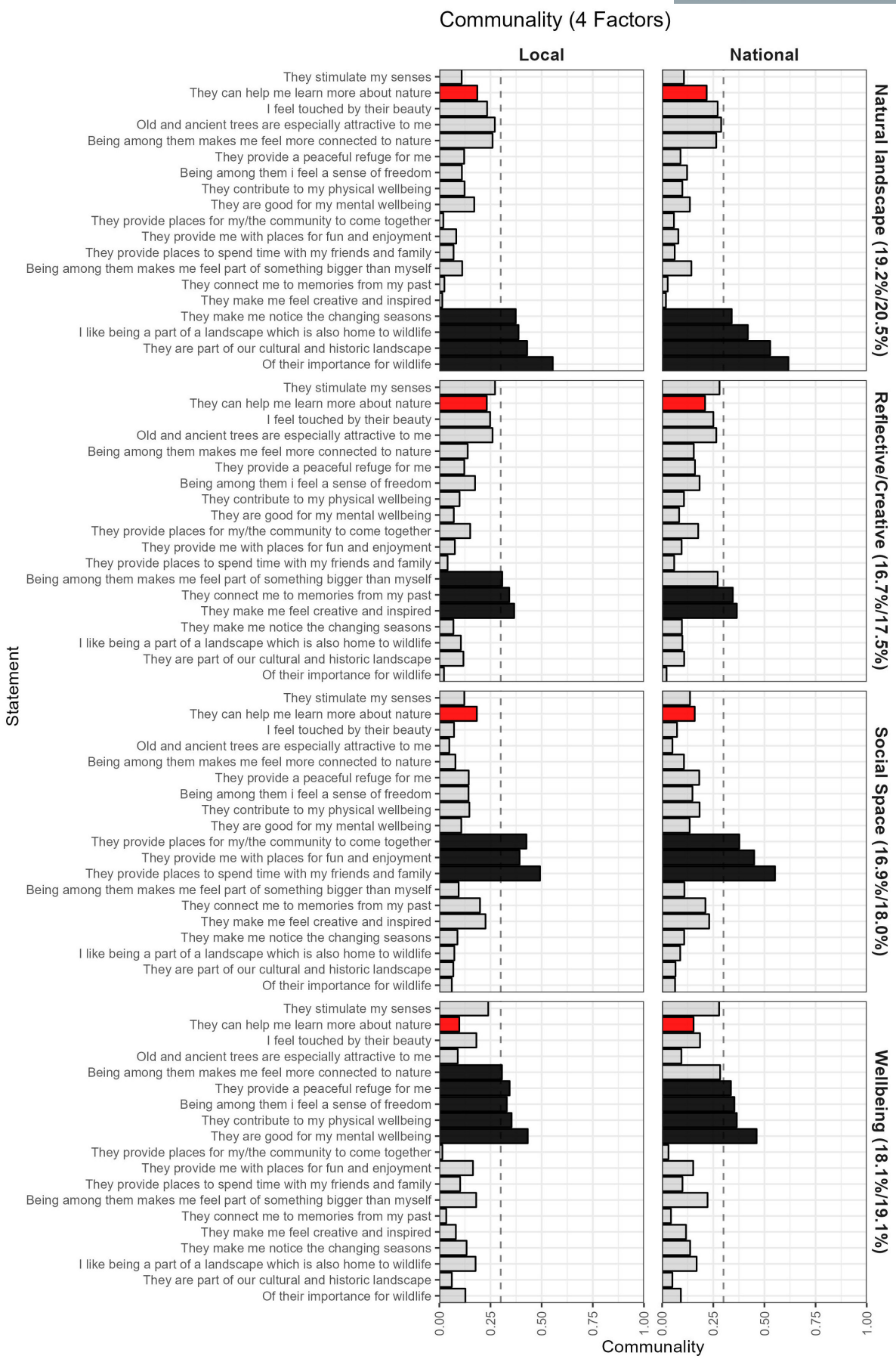
4.2 | Factor analysis

The exploratory factor analysis highlighted four key aspects of S&C values, with 15 of the 19 statements loading strongly (communality >0.3) onto one of the four factors. We interpreted and labelled these four factors as: Nature and landscape, Reflective and creative, Social space, and Well-being. These four factors explained 71% of the variance for the local statements and 75% for the national statements. Figure 1 shows the communalities for each factor applied to each statement. The statements that loaded well onto each factor are highlighted in black. Of the statements that did not load onto any of the four factors, three were moderately represented by at least one of the four factors. However, the statement related to learning ('they can help me learn more about nature') was poorly represented by the four factors (communality <0.25 for all factors, highlighted in red).

There were some statistically significant differences by demographics across the factors. For example, older age groups were associated with higher scores for the Nature and landscape ($F_{5,4479}=33.2$, $p<0.0001$, $R^2=0.028$), Social space ($F_{5,4479}=15.5$, $p<0.0001$, $R^2=0.016$), and Reflective and creative factors ($F_{5,4479}=15.2$, $p<0.0001$, $R^2=0.016$). People with children were associated with lower scores in the Nature and landscape factor.

Using the scores of the four factors plus the learning statement, weighted by variance explained and 1/19 respectively, correlated well (all ~0.7 or higher, 12/19 0.8 or higher, Spearman's rho) with the individual statements, indicating that the composite measure is a good correlate with the S&C values of treescapes. Similarly, replacing the factor scores with the most correlated statement within each factor and applying the same weighting also correlated well with all statements (all ~0.7 or higher, 11/19 0.8 or higher, Spearman's rho). This indicates that a reduced list of five statements could provide a reasonable approximation for the S&C values of treescapes in a truncated questionnaire design (Table 4).

FIGURE 1 Exploratory factor analysis showing the four factors (panel rows) by local and national (panel columns) statements. Bars represent communalities (loadings^2), with the dashed vertical line representing the threshold for a good explanatory factor (0.3). Bar fill indicates how well statements are explained by factors: red bars show poor explanation across all four factors; black bars show good explanation within factor.



4.3 | Impact of a pest or disease on S&C values

Regarding the impact of a P&D infestation on people's S&C values (Figure 2), large-scale loss of trees was of most concern (median 69), followed by a gradual slow decline of trees in the wood (median 63) and woodland closure (median 62). The loss of a small number of trees that are then replaced was of less concern (median 51). (This is linked to question 14 in the survey—see Supporting Information.)

5 | DISCUSSION

Our discussion focusses on whether the S&C values we cover are relational, how our composite measure might be applied, the potential impact of P&Ds on these values, and the future use and development of the measure, as well as outlining some of its limitations.

TABLE 4 Five statements of social and cultural (S&C) values that can be used in future studies if time and resources do not allow all 19 statements to be used.

Factor categories	S&C value statements
Natural landscape	Of their importance for wildlife
Well-being	They are good for my mental wellbeing
Social space	They provide places to spend time with friends and family
Reflective and creative	They make me feel creative and inspired
Learning	They can help me learn more about nature

5.1 | Are values from our research relational?

The values gathered from the literature are to some extent a function of the methods that were used in the studies, and it is likely that values that are less well understood are less likely to be articulated clearly in the literature. The IPBES framework, too, postdates the references used in this study. However, on the surface, our 19 S&C value statements would appear to be relational. We applied four tests to consider whether they are, as outlined in the theoretical context section. First, do they have an object? It seems clear they do—the treescape. Second, is the relationship reciprocal—that is, do both parties (human and treescape) have the potential to impact the other? This also seems to be the case for our value statements. Third, is it the relationship itself that is of value? Again, we would argue that this is the case for many of our statements. However, some statements, for example 'of their importance for wildlife' and the statements relating to treescapes providing places 'to spend time with my friends and family', 'for my community to come together', and 'for fun and enjoyment' indicate instrumental rather than relational values. Finally, is the object of value substitutable? This is less straightforward. Mattijssen et al. (2020) explain that 'In the same way that cherished friends or loved ones cannot be replaced by another equivalent other with similar characteristics, so too the landscapes and species with which we bond are not easily replaced by something "just like it."' (Mattijssen

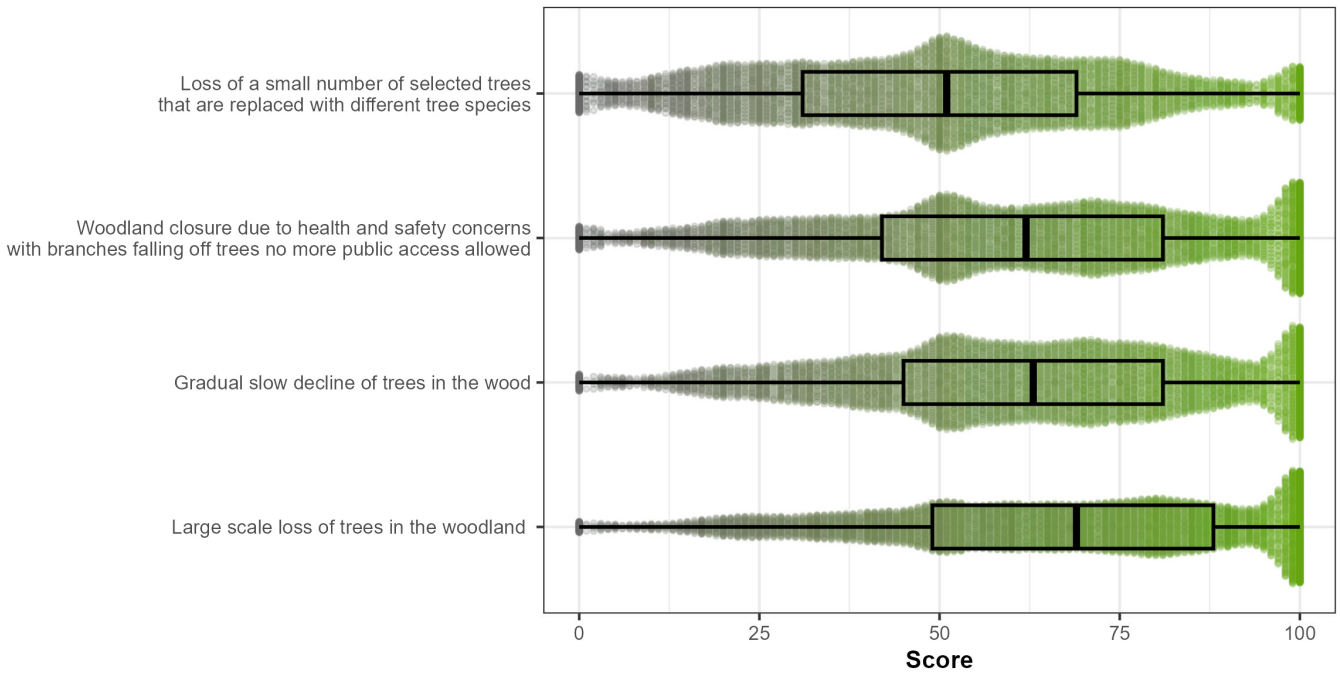


FIGURE 2 Impact on social and cultural values of a pest and disease infestation in the woodland respondents visit. Data points show individual respondent scores. Boxplots show median, lower and upper quartiles and range.

et al., 2020, p. 403). Given the similarity in scores within our survey between local and national treescapes, it is questionable to what extent these values measure relationships with *specific* treescapes. Nonetheless, it is the case that survey respondents scored the statements with specific regard to treescapes, rather than nature more broadly. We would therefore contend that these values *can* be considered non-substitutional because they can only come from treescapes.

Our suggestion is that people may at first hold relational values for treescapes that they connect and engage with specifically; however, they then might recognise that many different treescapes could, if given time, come to hold similar meanings for them and therefore they can value them in more general abstract terms. So, if parents value their local woods for family activities, they may associate woods more widely as providing a similar value. This still allows for specific treescapes to hold particular importance for people. Hall et al. (2019) in reporting on the tributes people submitted for the Forestry Commission centenary celebration found that emotional and sensory tributes were most prominent, with people giving specific examples of treescapes that were of greater value because of the relationship they had with them. These tributes were sometimes linked to a specific tree but at other times people talked about trees in general highlighting that it is not always one individual tree or wood that provides value, rather many treescapes could be important to people. However, these could be non-substitutable, that is, treescapes might not easily be replaced by another habitat or something other than nature. Mattijssen et al. (2020) suggest people bond with a specific landscape and not an abstraction, but we might argue that people can build relationships with other treescapes that they have not previously engaged with. The open questions in our survey highlight some of these relationships whereby connecting and engaging with treescapes provided solace and refuge for those with, or caring for people with, health conditions (Hall & O'Brien, 2023).

5.2 | Application of the composite measure

Given the prospect of significant changes to treescapes in the coming years within the context of the widespread impact of ash dieback, the prospect of other tree P&Ds, and the strong focus on increasing tree cover in England (UK Government, 2021), it will be valuable to repeat our survey in future years to explore any changes in S&C values. Furthermore, although our survey ran only in England, there is little reason to think the composite measure could not be useful more broadly—at a minimum within the rest of the UK and Ireland. However, our evidence review included international research and our 19 statements were drawn from research in multiple countries.

Nonetheless, our primary aim in developing the measure was to be of value in real-world contexts. As set out in the introduction, the focus of the work was to take account of S&C values in relation to tree P&Ds. In addition, we have identified an opportunity for the measure to be used by local authorities (i.e., local government).

5.3 | Impact of tree P&Ds on S&C values

This research was developed within a project with a specific focus on how decision-makers might take better account of S&C values within the context of assigning resources for the management of tree P&Ds. Our survey findings demonstrate the strength and range of S&C values associated with treescapes, highlighting the potential value at risk from tree P&Ds and the control or mitigation measures they might require. The results indicate that tree P&Ds have the potential to strongly impact the S&C values associated with treescapes. This finding is consistent with existing evidence which has found that tree P&Ds can negatively impact property values (Aukema et al., 2011), mortality related to cardiovascular and lower respiratory diseases (Donovan et al., 2013), crime statistics (Kondo et al., 2017), quality of life (Flint, 2006) and aesthetics (Arnberger et al., 2020; Sumner & Lockwood, 2020). It is also noted in the literature that mitigation and management measures to control or eradicate a tree P&D could also impact the S&C values people hold for treescapes. Porth et al. (2015) explored the felling programme implemented to eradicate the Asian Longhorn Beetle in southern England. Residents expressed despair and sadness at losing hundreds of trees, and noted that many of the trees provided windbreaks, privacy, and contributed to noise reduction. The study found a wide range of impacts on people's S&C values from the management actions undertaken to prevent the pest problem. This is an area that warrants additional research, as identified by Hall et al. (2020).

5.4 | Use of the S&C values composite measure by local government

Our approach is novel as it explored S&C values at both a local and national level. Our findings show that local and national S&C values scores differed little and therefore are broadly applicable in both local and national contexts. It also shows that the S&C values of treescapes are highly rated by our representative sample of the English population at both levels and this has been further confirmed by work outlined below with a local authority in northwest England. Despite our survey showing little difference at the local and national levels, in terms of S&C values, it remains the case that specific treescapes may be valued more highly or be associated with particular S&C values (Hall & O'Brien, 2018; O'Brien, 2018). The recently published Trees and Woodland Strategy Toolkit for Local Authorities developed by the Tree Council, Forest Research, Fera Science, the Forestry Commission, and local authorities (Allan et al., 2022) emphasises the need for local tree strategies to be underpinned by evidence, which is likely to be locally specific. Local authorities may benefit from using our S&C values composite measure to understand

how residents value treescapes within their area as part of this evidence base. For example, local authorities could use the measure in a survey or in engagement or consultation activities with residents.

A local authority in the northwest of England has already used the composite measure within a survey with residents. As part of an i-Tree Eco project, the local authority surveyed 304 residents about local treescapes, using our measure at the local level. (For information on i-Tree Eco see i-Tree Eco—Forest Research). We used the opportunity to test our exploratory factor analysis results by using the new survey data to perform a confirmatory factor analysis exploring the fit of our four factors with the new data (Walker et al., 2023). We found there was good correlation with composite reliability of 0.8 or above and statement loadings were 0.7 or higher between the i-Tree Eco project survey results and our England-wide survey results. This demonstrates that the measure can be used independently or within a broader survey and/or in interdisciplinary research.

5.5 | Future development of the composite measure

As outlined earlier, approaches to measuring phenomena such as S&C values may tend towards wider coverage of factors (as we have done) or towards refining measures to few factors or even a single index. We have thought it important to cover a wide range of S&C values within our measure; however, we accept there will be times when parsimony of indicators is preferable. Therefore, we have used the factor analysis to explore the possibility and validity of using fewer statements to adequately represent the overall S&C values related to treescapes. As the four factors explain a high percentage of the variance and the statements in each factor are highly correlated, the highest-scoring statement from each factor could be used to represent all the statements in that factor. As noted in the results section, four of our 19 statements did not load onto any of the factors, however three of them did correlate reasonably with the four factors but not enough that they could be allocated to a single factor. However, the learning statement was poorly represented by any of the factors, suggesting that this would need to be treated independently in a reduced list of statements. This approach of using one statement for each of the four factors and adding the statement on learning would result in five statements, and we have tested this in our analysis. Therefore, the five statements could be used in shorter simpler surveys to quickly capture S&C values for example when there is a P&D outbreak. This would be a practical solution for those seeking to capture S&C values data on treescapes if time and funding did not allow all 19 statements to be used.

5.6 | Limitations of the composite measure

As outlined in the theoretical context section, S&C values are not always explicitly defined in the literature. There is a range of categories of value that are included under the auspices of S&C values. Although recreation was frequently mentioned within our rapid evidence review, we have not included it in the composite measure as it is often used in economic studies to identify a monetary value for the importance of treescapes to people and can or could include multiple aspects of value without clearly defining exactly what these are, or it focusses on valuing the recreational activity (Snowdon et al., 2017). Although there is potential to reduce the 19 S&C values statements to five if needed, as described above, if this original research is not referenced then those who use the measure or read about its results could lose sight of the fact that the five statements represent a much longer list of 19 statements that clearly highlight a broader range of the S&C values of treescapes.

While we have taken a considered and structured approach to developing the S&C values statements by drawing on existing evidence to develop our categories of value and the value statements, and incorporating discussions from our project advisory group and steering group, there are potentially aspects of S&C values that we have not included. However, the open comments in our survey, which allowed people to add anything they felt was missing, did not result in new S&C value categories. Instead, people outlined the importance of specific S&C categories of value to themselves that we had already included, or they talked about environmental or ecological values that do not fit with our focus on S&C values. Overall, we have taken a pragmatic approach which we have shown can be used by organisations such as local authorities when gathering evidence from local residents on how they value their local treescapes, which could be incorporated into their local tree strategies.

6 | CONCLUSION

In this study, we have developed a composite measure of the S&C values of treescapes, tested the measure and then run it in a survey with a representative sample of the England population. The composite measure brings to the fore aspects of S&C values that are often not captured, taken into account, or used in decision-making. This is due to them often being viewed as intangible, identified through qualitative research or via a focus on one aspect of S&C values such as health, or landscape aesthetics; which are often the focus in economic studies in relation to developing a monetary value. We specifically developed the S&C values measure to fill a gap in the current evidence base and provide quantitative data and a measure that can be used in full or in part in future processes including research, surveys, workshops, and when engaging with the public. Our work has already shown usability by being used in another project for a local authority in the northwest of England.

AUTHORS CONTRIBUTIONS

Liz O'Brien, Clare Hall, Alison Dyke, Glyn Jones, Jack Forster and Vadim Saraev conceived the ideas and designed the methodology; Liz O'Brien and Clare Hall organised and contracted the data collection; Jack Forster statistically analysed the date; Clare Hall analysed

the open question responses in the survey; and Liz O'Brien and Stephen McConnachie led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

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CONFLICT OF INTEREST STATEMENT

We declare that we have no conflict of interest related to this research.

DATA AVAILABILITY STATEMENT

These data are not being deposited at present. We did not gain consent from participants for this and there is a risk of identification. The resources required for us to gain consent and ensure compliance with data subjects rights under the Data Protection Act (HM Government, 2018) and General Data Protection Regulation are not reasonable or proportionate at this time. Due to this, the risk of disclosure and harm to those involved in the survey is high. We are working on a new approach to data deposit across our organisation concerning how best to manage the data including the identification of an appropriate archive potentially in future.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Appendix S1. Survey questionnaire.

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