Forest Research

Social and Cultural Values of Trees, Woods and Forests at Risk from Tree Pests and Diseases

Rapid Review

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Executive Summary

- As part of the Defra Future Proofing Plant Health programme, Forest Research, Stockholm Environment Institute at the University of York and Fera worked on a project during 2020/21 to investigate the social and cultural values of trees, woods and forests that are at risk from tree pests and diseases. This review forms part of that project.
- There are many frameworks for understanding how to categorise and classify social and cultural values. While the Ecosystem Services approach is widely used and may represent a useful starting point for understanding likely categories of cultural ecosystem services, it takes an instrumental, utilitarian approach to how people obtain benefit from ecosystems. Other frameworks, for example, the Cultural Values model, and that developed as part of the UK National Ecosystem Assessment (UKNEA) follow on project aim to understand more broadly how people relate to the 'natural' environment and attach meaning to it based on form, environmental spaces, activities, cultural practices and relationships.
- There are also ongoing debates about definitions of services, benefits and values. For this review the term 'values' is used throughout, with the recognition that some of the different categories of value referred to might be considered to be services or benefits by some authors.
- For this rapid review, an online database search using key words and structured search strings provided a collection of 188 publications relevant to this study. Of these, 160 related specifically to trees, woods or forests or included consideration of forests alongside other ecosystems.
- The studies cut across contexts, in terms of geography, protected area status, land use type, scale, urban – rural locations, tree species, and management. The continent where the largest number of studies were conducted was Europe, with 52 studies, followed by Asia (24 studies) and the USA and North America (20 studies).
- Social and cultural values are experienced differently by different groups of people and communities. The studies identified in this review address understandings of value from across many types of stakeholders including: Indigenous communities, forest owners, woodland managers, national park visitors, urban dwellers, city park visitors, experts and key forest stakeholders, social media users, the general public and rural forest communities.

- The value types most often addressed or identified by the studies were recreation, aesthetic, heritage, spiritual, landscape, health and place. There are existing estimates of the monetary value of forests and trees in terms of recreation and landscape aesthetics. For other value types there is little or no monetary valuation data available, and there is a need to develop the means to incorporate other units of measurement (that might be qualitative and narrative) into overall value estimates.
- Nine studies were found that have looked specifically at the impact of tree pests and diseases on social, cultural, economic and health values. The studies considered the social and cultural values of tourists, visitors, residential homeowners, forest managers and traditional communities, and others. There was a range of pests and diseases considered, including emerald ash borer, other bark beetles and phytophthora ramorum. The majority were studies from the USA with a couple in Europe. The nine studies considered the impact of tree pests and diseases on physical health, property prices, visitor perceptions of landscape, community perceptions and emotional experiences of local forest environments, among others.
- Central to this study is the need to understand how to capture and measure social and cultural values and value types. Given the breadth of 'types' of social and cultural values, a range of approaches are likely to be needed, some quantitative, others qualitative. The broader collection of reviewed studies utilised approaches that can be classified into five main methodological categories, namely: Monetary valuation; Geographic Information Systems (GIS) including Public Participatory Geographic Information Systems (PPGIS), and use of spatial data; Social media data extraction; Deliberative approaches; and Multi-Criteria Decision Analysis (MCDA). Three additional categories were identified, not of approach per se, but sources and tools that could be of use for capturing and measuring social and cultural values. These are: Ecosystem service data modelling tools; Longitudinal studies; Validated scales and metrics.
- The project team conclude that there are important evidence gaps that need to be filled:
    - While this review has begun to elucidate a better understanding of social and cultural values of trees, woods and forests at risk from tree pests and diseases, there remain gaps in the evidence.
    - There are varying definitions of social and cultural values and it would be beneficial for future work to develop a broad consensus for a

pragmatic characterisation of these values as they relate to trees and woods.

- There is very limited literature on how the attempts to manage a pest or disease outbreak at different scales and at different points of an outbreak, impact on social and cultural values. It is important to understand whether management interventions might have a greater impact on social and cultural values than letting a pest or disease take its course.
- There would be value in reviewing the literature on land use change (loss of or damage to trees) from other causes, such as deforestation due to wildfire, felling, development, agriculture and others, and how this impacts social and cultural values.
- There would be value in reviewing the literature on impacts of invasive species (and invasive species management) on social and cultural values.
- It is timely to consider the opportunities available through the use of innovative approaches to understand social and cultural values. These may include the use of social media data extraction (e.g. Flickr and other similar platforms), and other digital data such as from route trackers, fitness apps, wearable smart electronic devices, and so on. This is an area that warrants future investigation.
- Future work should consider compiling data monitoring sheets of existing data sources that could be utilised to monitor change in social values due to a pest or disease outbreak. This might include the previously mentioned longitudinal studies.

1. Introduction and methods

Introduction

In UK tree and plant health policy there are two related vehicles for understanding which pests and diseases pose the greatest level of current and future threat. These are the Plant Health Risk Register and Pest Risk Analyses. Both require consideration of social values at risk (alongside environmental and economic values at risk). Given the challenges of (a) defining social values and (b) capturing and measuring social values, they are generally undervalued, and hence the impact of pests and diseases on social values is under-estimated.

This project aims to provide long overdue improvements to the understanding of the social and cultural values associated with trees, woods and forests that are likely to be at risk from any tree pest or disease outbreak. Boyd *et al.* (2013) provided a diagrammatic representation of the potential impact of pests and diseases on ecosystem services, over time, assuming interventions are applied (Figure 1).

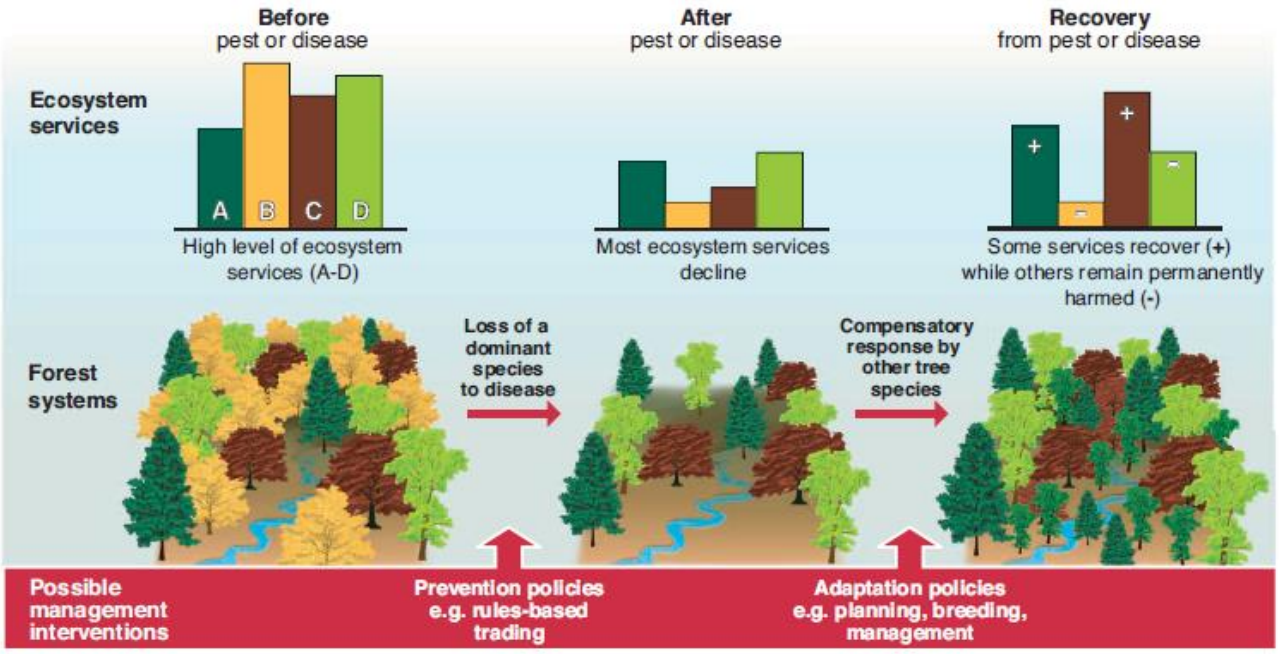

Figure 1 Diagram to show how tree pest or disease may impact ecosystem services over time (Source: Boyd *et al.*, 2013).

This rapid review aims to clarify social and cultural values across different scales, locations and contexts, including urban, peri-urban and rural, local, regional and national, protected areas, commercial and amenity forests and woodlands, and others. Further, there is an attempt to gain a more thorough understanding of methods and approaches for identifying, capturing, measuring and valuing social and cultural values, and how those methods and approaches map onto the different value categories and types[1].

[1] In an attempt to keep the main body of the report to within a strict page limit the report authors have placed various sections in appendices. Readers are referred to the Index for details of where to locate the different parts of the study.

The focus in this rapid review is on the categories of social and cultural value that were found through the literature search[2] (section 2 of this report), in different contexts (appendix 2). Particular focus has been placed on those papers that were found that had looked specifically at how tree pests and diseases had impacted on social and cultural values (section 3). While such studies were limited they are key to the topic of this project. There is an additional short section on the social and cultural values of trees outside of woods (section 4). Consideration is given to the methods that had been applied by researchers to uncover and capture social and cultural values (appendix 3). Section 5 briefly considers how management and mitigation measures implemented to deal with a tree pest or disease outbreak may itself impact on social and cultural values.

2. What are the social and cultural values associated with trees, woods and forests?

The literature searches resulted in 188 relevant studies. Key word counts of the social and cultural values referred to in the 188 abstracts illustrate the range of values studied and identified and reveals categories that span the list of CES included in the previous section (Table 1). Most commonly referred to are recreation, aesthetic, heritage, spiritual, landscape, health and place. Of the 188 relevant studies 160 directly addressed social and cultural values of trees, woods or forests, or trees or forests were included alongside other ecosystems (the remainder relate to other ecosystem types).

[2] See appendix one for details of the steps taken to carry out the review.

Table 1 Key word counts of value categories referred to in the abstracts (mentioned more than once)

Word	Count	Similar words	Word	Count	Similar words
Recreation	44	recreational	Wellbeing	3	
Aesthetic	28	aesthetics	Activities	2	activity
Heritage	14		Ancestral	2	
Spiritual	12	spirituality	Attachment	2	
Landscape	11	landscapes	Beauty	2	
Health	10		Connection	2	connections
Place	9	places	Culture	2	
Biodiversity	7		Economic	2	economically
Education	7	educational	Emotional	2	emotions
Nature	7	natural, naturalness	Enjoyment	2	
Tourism	7		Existence	2	
Identity	6		Intrinsic	2	
Life	6		Maintenance	2	
Community	5	communities	Outdoor	2	
Inspiration	5	inspirational	Property	2	
Sense	5		Protection	2	
Mental	4		Relaxation	2	
Physical	4		Restoration	2	restorative
Quality	4		Satisfaction	2	
Appreciation	3		Scenic	2	
Ecotourism	3		Sensory	2	
Local	3		Sports	2	
Personal	3		Subsistence	2	
Practices	3		Therapeutic	2	
Relationship	3	relationships	Understand	2	understanding
Religious	3		Use	2	
Sustainability	3	sustainable, sustaining	Wood	2	

Through a process of affinity mapping the values categories in Table 1 have been categorised under the broad headline categories shown in the left-hand column of Table 2. So, while "recreation" was mentioned in 44 abstracts, other narrower categories including "relaxation", "sport" and "activities" were also mentioned and are clustered with recreation, giving a total of 55 total mentions of a value type connected to recreation. The final right-hand column data are presented as a pie chart in Figure 2.

Table 2 Categories of social and cultural values addressed by the reviewed studies.

Broad category	Narrow category (based on our own assignment to broad categories)	T
Recreation (44)	Practices (3), Relaxation (2), Sport (2), Activities (2), Outdoor (2)	55
Aesthetics (28), Landscape (11)	Quality (4), Appreciation (3), Beauty (2), Scenic (2)	50
Health (10)	Life (6), Mental (4), Physical (4), Wellbeing (3), Restoration/Restorative (2), Therapeutic (2)	31
Nature (7)	Biodiversity (7), Sustainability (3), Existence (2), Intrinsic (2), Maintenance (2), Protection (2)	25
Place (9)	Identity (6), Sense (5), Attachment (2)	22
Spiritual (12)	Inspiration (5), Religious (3)	20
Heritage (14)	Culture (2), Ancestral (2)	18
Economic (2)	Tourism (7), Ecotourism (3), Property (2), Subsistence (2)	16
Community (5)	Relationship (3), Local (3), Connection (2)	13
Personal (3)	Enjoyment (2), Satisfaction (2), Emotional (2), Sensory (2)	11
Education (7)	Understanding (2)	9

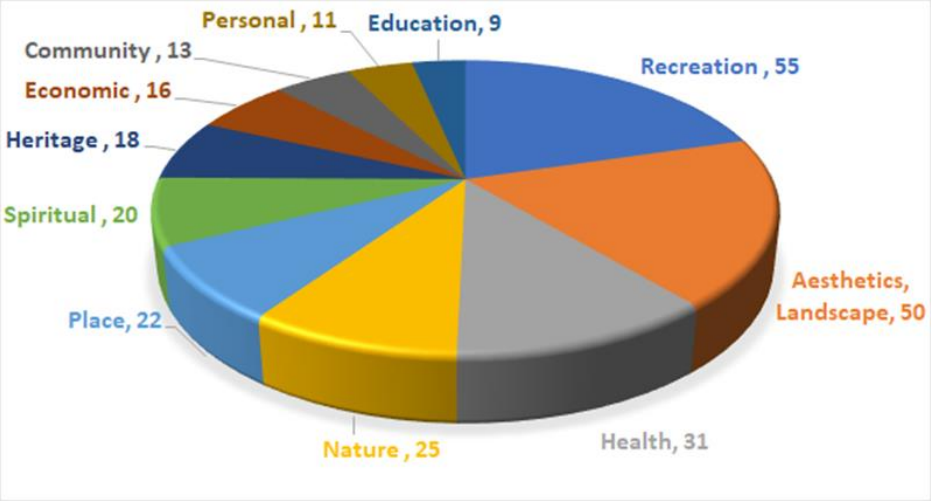

Figure 2 Value categories mentioned in the study abstracts.

3. How are social and cultural benefits and values of trees, woods and forests impacted by tree pests and diseases?

Nine studies were found that have explicitly considered how social, cultural, health and economic values have been impacted by tree pests and diseases. The pests and diseases considered are emerald ash borer (EAB) in the USA, spruce bark beetle in Alaska and the Rocky Mountains, wood borers, sap feeders and foliage feeders in the USA, Phytophthora ramorum and Phytophthora kernoviae in England and Wales, EAB in Austria, and the Hemlock wooly adelgid in USA. Contexts covered by these studies include city street trees, National Park forest areas, woodlands, forests, and urban areas.

Given that different people and communities will hold social and cultural values specific to themselves and their context, it is important to consider whose values are likely to be impacted before considering how those values might be impacted. Across these nine studies, the stakeholder groups studied were:

- Householders
- City residents
- Public
- Forest communities
- Forest stakeholders – forest managers and landowners, inc. municipal forest managers
- Native North American Indian communities (basket makers)
- National Park visitors
- University faculty members
- Visitors to city parks.

As the people and communities impacted are different, so too are the values types that they experience. Hence, it is important to consider what values were impacted for the different groups. The social and cultural value types addressed by the studies are:

- Aesthetic and emotional responses and appreciation,
- Emotions (grief and sadness, worry and anxiety),
- Quality of life,
- Community cohesion,
- Neighbourhood crime,
- Privacy (screening and windbreaks),
- Native communities traditional crafts,
- Physical health (specifically cardio-vascular and lower respiratory diseases),
- Non-use values (altruistic and bequest values, option values),
- Tourism, recreational opportunities, trail access,
- Landscape preferences,
- Residential property values (a proxy for aesthetic, amenity values),
- Local economy.

Depending on the population to be studied, the context in which they exist, and the types of values they experience, different methodologies will be required to capture those values and value change. Thus, it is necessary to ask how were values captured by the studies under review. The approaches used to investigate the impacts arising from tree pests and diseases are:

- Hedonic pricing method,
- Regression models,
- Economic modelling,
- Contingent valuation (willingness to pay survey),

- Image based choice experiment,
- GIS (census data and crime data mapping),
- On-site questionnaires,
- Mail surveys,
- Interviews,
- Stakeholder engagement through stakeholder groups.

The nine studies are summarised in Table 3. Broadly speaking, the more quantitative approaches are used to discover specific value types defined by the study. More qualitative, deliberative approaches allow an exploration of values impacted by pests or diseases, from the perspective of those impacted. Likely, any exercise seeking to understand the social and cultural values impacted by tree pests and diseases would need to utilise a range of different approaches.

Table 3 Studies considering how tree pests & diseases have impacted on social and cultural values

Approach used	Pest or disease	Location	Stakeholder group	Value types considered	Ref
Economic modelling	Three types of tree pests: wood borers, sap feeders and foliage feeders (e.g. gypsy moth)	USA	Government, householders and forest owners	Economic impacts inc residential property values	Aukema *et al.*, 2011
Regression models	Emerald ash borer	15 US states	General residential population	County-level mortality related to cardiovascular and lower respiratory diseases	Donovan *et al.*, 2013
Natural experimental approach using crime data and mapping data of ash tree loss	Emerald ash borer	Cincinnati, Ohio	General residential population	Related to quality of life / neighbourhood safety: Changes in levels of crime	Kondo *et al.*, 2017
Hedonic property value analysis	Emerald ash borer	Milwaukee, Wisconsin	Urban residential home owners	Residential property values	Li *et al.*, 2019

Approach used	Pest or disease	Location	Stakeholder group	Value types considered	Ref
Contingent valuation survey (WTP study)	Phytophthora ramorum and Phytophthora kernoviae	Heritage gardens, heathland and woodland in England and Wales	General population	Non-use values: altruistic and bequest values, option values	Drake & Jones, 2017
An image-based discrete choice experiment - on-site questionnaires	Emerald ash borer-impacted forest scenarios	Vienna, Austria and Minneapolis, USA	Visitors	Landscape preferences	Arnberger *et al.*, 2020
An on-site questionnaire	Bark beetle	Rocky Mountain National Park, Colorado	Visitors	Aesthetics, landscape quality, vitality and health.	Sumner & Lockwood, 2020
Interviews and mail surveys	Spruce beetle	Six Alaskan communities	Residents and key informants	Aesthetic loss, privacy loss, grief and sadness, worry and anxiety. Impacts on tourism, trail access, and property values.	Flint, 2006
Stakeholder engagement	Two forest pests of hemlock and ash.	Maine, USA	Range of forest stakeholders inc. Indian communities	Property values and revenue from recreational opportunities (e.g., hunting, hiking, camping, fishing). Native traditional & cultural arts (woven brown ash baskets)	Ranco *et al.*, 2012

Aukema *et al.* (2011) modelled the economic impacts to government, householders and forest owners of three types of tree pests, namely, borers, sap feeders and foliage feeders in the USA. Borers were found to have the highest damage costs overall. However, foliage feeders caused the greatest loss in residential property

values. Their example foliage feeder was the gypsy moth. This study may be useful as the impact on property values relates to the aesthetics of street trees, which is one aspect of the social value of urban treescapes.

Authors in the USA tested whether a major change to the natural environment—the loss of 100 million ash trees to the emerald ash borer —influenced mortality related to cardiovascular and lower respiratory diseases (Donovan *et al.* 2013). Regression models were used to estimate the relationship between emerald ash borer presence and county-level mortality from 1990 to 2007 in 15 U.S. states, while controlling for a wide range of demographic covariates. The study found an increase in mortality related to cardiovascular and lower-respiratory-tract illness in counties infested with the emerald ash borer. Results suggest that loss of trees to the emerald ash borer increased mortality related to cardiovascular and lower-respiratory-tract illness.

Kondo *et al.* (2017) investigated the association between the emerald ash borer (EAB) and crime in Cincinnati, Ohio. They used a natural experimental approach and compared data for 11 categories of crime in census block groups infested with EAB with crime in block groups not infested with EAB, for the period between 2005 and 2014. EAB infestation was significantly and positively associated with relative increases in crime in all but four crime categories. The loss of each additional tree was associated with a significant increase in theft, breaking and entering, and property crime incidents and in simple assaults, felony assaults and violent crimes at EAB-infected block groups compared to in non-EAB infected block groups. Results suggest that invasive tree pests may be associated with social costs that need considering when managing invasive species.

To better understand the economic cost of EAB in urban settings, Li *et al.* (2019) conducted a hedonic property value analysis to evaluate the impact of ash tree damages due to EAB infestation on housing sales prices. The study was conducted in Milwaukee, Wisconsin. Results revealed that the EAB outbreak had a negative

impact on home values for properties located in close proximity to ash trees in the urban forest. The value premium attributed to ash trees throughout the study area (northern 10 zip codes in Milwaukee) was dramatically reduced after the arrival of EAB. Authors concluded that not only the tree condition, but also the treatment and replacement procedures could impact property sale values, as they could potentially change the expectation of property values.

The impact of Phytophthora ramorum and Phytophthora kernoviae on heritage gardens, heathland and woodland in England and Wales was considered in a paper by Drake & Jones (2017). The authors used a contingent valuation survey to assess the non-use values at risk from an uncontrolled spread of these diseases in England and Wales. Survey respondents were asked their WTP to avoid an uncontrolled spread of P. ramorum and P. kernoviae. As part of the survey respondents were shown images of healthy and diseased plants and trees. The non-use values that are at risk from P. ramorum and P. kernoviae spread are estimated at £202m per year for woodland. These non-use values may be altruistic and bequest values, with the former being a desire for others to have access to uninfected habitats, and the latter being a desire that future generations should have access to the uninfected habitats. Non-use values may also be option values so that they themselves maintain the option of using the habitats at some point in the future.

Interviews and mail surveys administered to residents in six Alaskan communities revealed differences in perception of biophysical, social, and economic impacts that resulted from changing forest conditions related to the spruce beetle outbreak (Flint 2006). In some communities, the loss of a living spruce (Picea spp.) forest profoundly affected quality of life, and led to community conflict, increased risk perception of future impacts, and economic challenges. Based on key informant interviews, the impacts described by respondents included aesthetic and emotional issues; economic impacts; community cohesion issues; and problems of inconvenience and safety, all of which could be described as impacts on social and cultural values (the findings are included in igure 3).

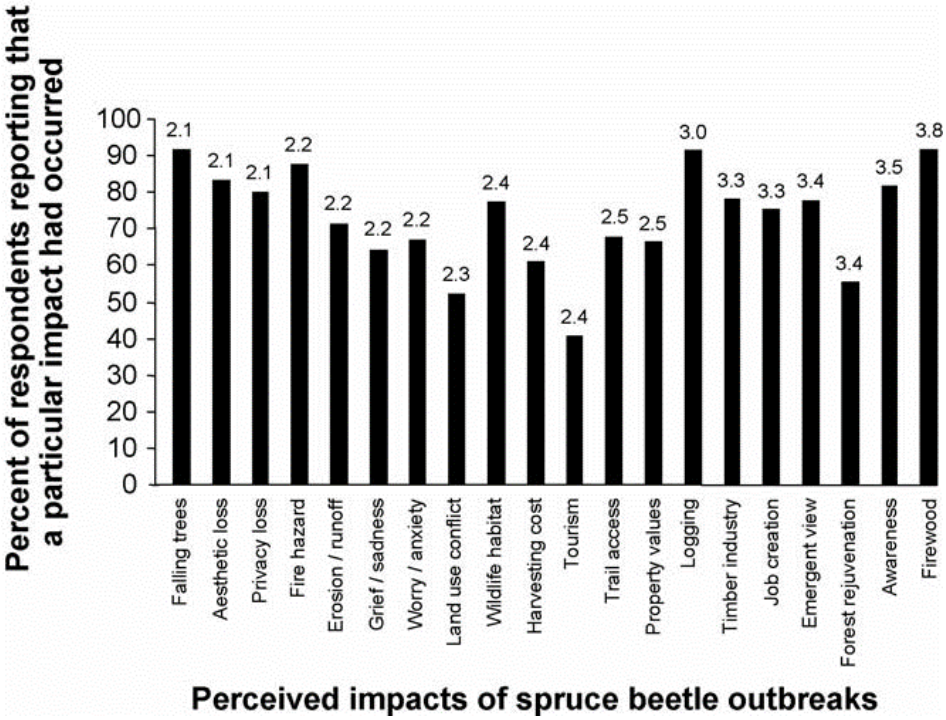

Figure 3 Percentage of residents among six communities on the Kenai Peninsula, Alaska in 2004 reporting spruce beetle impacts on different biophysical and socioeconomic attributes (n = 1056). Numbers over bars indicate the average degree that residents perceived

The figure shows that a wide range of negative social impacts arose from the spruce bark beetle in Alaskan communities. These included: aesthetic loss, privacy loss, grief and sadness, worry and anxiety. There were also negative impacts on tourism, trail access, and property values.

Ranco *et al.* (2012) conducted a study in Maine to consider the impact of two forest pests. The study sought to understand the socio-cultural impacts of a pest already present and a pest not yet present.

Work with stakeholders of hemlock forests revealed that socio-economic concerns about the loss of hemlock are driven by how an individual or organisation values the resource. Stakeholder values were categorised as ecological, recreational, aesthetic, educational, and/or economic. The hemlock stands in Maine were said to possess a unique aesthetic value, and while hemlock is not of significant value to

the lumber industry, it can be important to local economies. The authors reported that economic loss could be the result of a decrease in property values and lost revenue from recreational opportunities (e.g., hunting, hiking, camping, fishing). They also reported that one of the oldest arts traditions in North America is the native woven brown ash baskets which are a critical cultural and economic resource to Maine's Indian communities. This cultural, social, and economic significance of brown ash to Maine Indians means that it is thought of as a cultural keystone species wherein its removal would radically change the social, cultural, and physical health of the tribal nations in Maine.

An exploration of how bark beetle-caused forest changes were perceived and understood by visitors at Rocky mountain National Park, Colorado, was carried out by Sumner and Lockwood (reported in 2020). They utilised the aesthetic model of scientific cognitivism to design a visitor study and visitors were asked to complete an onsite questionnaire. Results shows that visitors perceived the forest as beautiful, inspiring, and interesting. Non-native species were primarily seen as having negative impacts on the forest. The visitors at RMNP rated the forest highly with regard to beauty despite the prevalence of dead lodgepole pines visible from the questionnaire location and along the roadway. Authors concluded that the visitors may have been incorporating into their perception of the infested forests a larger framework including the mountainous topography, experiences with wildlife, and appreciation of a non-urban setting. Overall, visitors did not interpret the dying and dead individual beetle-afflicted trees as a dying forest but viewed the whole forest as alive and well. Overall, visitors continued to regard the park positively (e.g., beautiful, interesting, satisfying) despite observed bark beetle disturbance. Visitors also perceived the forest as alive and healthy despite evidence of tree mortality and awareness of bark beetle activity.

There is considerable interest in European countries in the potential impact that EAB might have in the European context, should it be introduced. Arnberger *et al.* (2020) investigated the potential impact on urban park visitors of EAB damaged

ash trees. They were particularly interested in landscape preferences and used a hypothetical image-based choice experiment to investigate this. What they found was that visitors were more concerned about issues such as visitor numbers and background viewscapes in the urban forest images than they were about EAB impacted ash trees. To some extent this echoes the Sumner and Lockwood findings that visitors experience and enjoy a wider landscape that is not necessarily diminished by individual infested trees.

4. Social and cultural values of trees outside of woods

Recognising that tree pests and diseases may impact single, individual trees, that is, trees outside of woodlands, this section reviews papers that have considered the social and cultural values attached to such trees.

Doda (2019) considers the cultural importance of sacred trees, with a focus on yellowwood trees in Ethiopia. He focused on the local explanations for the importance of the trees and found that the continued existence of the trees depended on the resilience of ancestral tree-based rituals. Thus, the trees existed within an ancestral value system that helped to ensure its conservation. Other aspects of social and cultural value of these trees was found to be functional through providing shade, shelter, resting and recreational space for households. The trees also provided important links to community, through providing space for discussions and debates, and links to the past and ancestors by acting as burial sites and grave markers.

In the UK it is widely noted that the oak tree is the most iconic of native broadleaf trees. This was confirmed in work carried out in London in 2018-19 with regard to OPM (Marzano *et al.*, 2020). Findings from interviews confirmed that oak is highly valued for many reasons including its historical importance, aesthetics, landscape

and because it was felt to symbolise Britain and British cultural heritage. The longevity of oak trees was considered particularly important. Where oak trees are relatively scarce, such as in urban areas, on streets and in gardens such values may be even more significant.

In 2011, household surveys were conducted in six locations in Puerto Rico to evaluate residents' attitudes toward residential and neighbourhood trees (Olivero-Lora *et al.*, 2020). Among other things, the authors asked residents about the benefits provided by residential and neighbourhood trees. The benefits identified by residents included 16 that the authors classified as cultural benefits. These included aesthetic value, spiritual, recreation, privacy, relaxation, family tradition, tranquillity, comfort, bird song, neighbour interaction and neighbourhood well-being.

There is interest in understanding how social and cultural values might differ according to age and size of trees. As seen above very old and large iconic trees such as oak trees in London can be considered to have extremely high cultural importance. However, small, young trees have also been found to have cultural significance in urban settings (Rudl *et al.*, 2019). In this study many of the trees found to be important were planted as memorial trees for influential people in the study city (Prague) or as symbols of national identity. Other commemorative trees were planted as symbols of peace or the millennium. This idea of memorial or commemorative trees having cultural, social, historical, symbolic or political importance is not unique to this location.

Vaz *et al.* (2018) considered the differences in the cultural values of non-native trees as opposed to native trees. They found that the differences were not straightforward with some cultural values being higher where the trees were non-native. For example, they concluded that non-native trees increased recreation and ecotourism services in some instances. They also found that non-native trees in

some contexts decreased aesthetic values, increased what they called cultural heritage services, but had no effect on inspiration values. Overall, their study would suggest that there is no consistent distinction between social and cultural values based on native versus non-native trees.

5. How could mitigation measures or pest and disease management impact social and cultural values?

As noted above it is possible that mitigation and management measures themselves could impact social and cultural values of trees, woods and forests, aside from the direct impact of tree pests and diseases. Taking the Asian Longhorn Beetle as a case study, Porth and Dandy (2015) considered, not the direct impact of a tree pest on social values, but the felling programme that was implemented to prevent the beetle becoming more widely established. Residents expressed despair and sadness at losing hundreds of trees. People also lost windbreaks and privacy - the seclusion previously provided by trees was therefore another important loss. People experienced interference with their future plans for their land. Previously the trees had provided noise insulation from the traffic and this was lost due to the tree felling. The felling also impacted on local bird species; one resident reported that she used to enjoy seeing a local population of woodpeckers but they moved on when their habitat was destroyed. There were also concerns about negative impacts on property values because of the change in aesthetics locally. Overall, this study revealed a wide range of impacts on social and cultural values of the management activities designed to prevent the pest problem.

In another example, some of the forests in New Zealand, near Auckland for example, are being closed due to Kauri Dieback (KD). The aim is to protect the trees from people spreading the disease. However, such closures lead to a loss of

connection to important cultural sites for Maori and of recreational opportunities for a wide range of people. Fences to restrict access have been damaged and broken by those frustrated with the restrictions. However, closure of parts of forests has started a dialogue about KD, tree health and tree protection as illustrated by the 'Into Darkness: standing up to kauri dieback' video (https://www.youtube.com/watch?v=oeTJzfVlDhk)

This is an area that warrants additional investigation with regard to, for example, Oak processionary moth (OPM) nest disposal by operators in full chemical hazard suits, chemical injections to tree trunks for EAB, restrictions on movement (of goods or people in the countryside), and aerial spraying for OPM. These are all potential management and mitigation measures that may be detrimental to social and cultural values.

6. Conclusions

1: Social and Cultural Value categories

The collection of studies revealed that the social and cultural values categories mentioned most frequently were: recreation, aesthetic, heritage, spiritual, landscape, health and place.

Consensus is needed on which are the priority values for further work on social and cultural values at risk from tree pests and diseases.

2: Impacts of pests and diseases on social and cultural value

A small number of studies were found through the review that have explicitly considered how social, cultural, health and economic values have been impacted by tree pests and diseases.

The social and cultural value types that are addressed by these studies are: residential property values (a proxy for aesthetic, amenity values), visitor aesthetic and emotional responses and appreciation, 11 categories of crime, physical health (specifically cardio vascular and lower respiratory diseases), aesthetic, privacy (screening and windbreaks), emotions (grief and sadness, worry and anxiety), tourism, trail access, property values, non-use values (altruistic and bequest values, option values), native communities arts traditions, recreational opportunities, and local economy.

Given the dearth of research focused on the social and cultural values impacted by tree pests and diseases more work is needed in this area.

3: Methods for capturing value and measuring change

Given the diversity of value types any attempt to understand and capture the change in social and cultural values brought about by tree pests and diseases will need to utilise a combination of qualitative (deliberative) methods and quantitative (and possibly monetary valuation) methods. Mapping and the use of social media data offer opportunities for innovative and place-based investigation.

Future work should aim to identify how best to capture social and cultural values that cannot be monetised in such a way that they can be incorporated into decision and policy making.

4: Future research

This review has revealed a number of additional areas where further research would be of value:

- Pre-existing datasets and data sources could be of use for monitoring change in social / cultural values. More work is needed to establish what data are available and how they could be applied.

- Other land use change (deforestation/tree loss, for example due to felling, wildfires, development, agriculture) has been shown to impact social and cultural benefits and values – there would be value in reviewing this literature.
- The literature on values relating to invasive species and their management could provide some relevant lessons to be learnt and should be reviewed.
- More research is needed on the impact on social and cultural values of the management and mitigation measures that might be implemented in the management of tree pests and diseases.

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Appendix A. Methods

The project team drew up key word terms for use in an online database search (Boxes A1 & A2 below). These resulted in the search strings shown beneath the boxes. Searches were conducted using the terms below in Scopus during June 2020. Results were restricted to hits from 2010 onwards and English language only.

Box A1 Search terms one: Used for review of how to capture and measure social values

Term 1	Term 2	Term 3
Forest*	Cultural ecosystem	Impact
Tree*	Benefit	Metric
Wood*	Service	Indicator
	Social or cultural value	Assessment
	Well-being	Evaluation
		Cost benefit
		Multi-criteria analysis
		Deliberative

Box A2 Search terms two: Used for review of how pests and diseases might impact values

Term 1	Term 2	Term 3
Forest*	Cultural ecosystem	Pest
Tree*	Benefit	Disease
Wood*	Service	Defoliation
	Social or cultural value	Death
	Well-being	Dieback
		Bleeding
		Canker

(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)

An initial review of titles and then abstracts left a collection of 188 publications considered to be relevant.

Additional targeted searches were carried out, for example, to search for studies that had considered social and cultural values associated with hedgerows and wood pasture. Further, the review team made additional suggestions based on their extensive combined experience of working in this area.

Appendix B. Services, benefits and values: Definitions and frameworks

The terms social values and cultural values are both contested, and not clearly defined in the studies reviewed. Broadly speaking, cultural values are linked to sets of beliefs, traditions, customs, and practices upheld as being important within a society. These can be manifested through rituals/festivals, oral traditions, sense of identity/place, spiritual connections, and symbolic meanings. Social values are those held by groups/ communities within society often linked in the environmental sphere to aspects such as recreation, landscape aesthetics, nature connections and biodiversity. The two 'types' of value are often context-specific.

There are also ongoing debates about the definitions and differences between services, benefits and values. This review uses the term values throughout, whilst being aware that some schools of thought may consider some the value categories described in this report to be services or benefits.

There are numerous (sometimes conflicting) schools of thought regarding frameworks for understanding the benefits that humans obtain from ecosystems, and, as noted above, the use of the terms services, benefits and value. Here consideration is given to a number of these frameworks.

Below is a figure from The Economics of Ecosystems and Biodiversity (TEEB) programme of ecosystem study which represents the 'cascade' linear model of how value is derived from ecosystems via the services provided and the benefits obtained (Figure A1). In this review the 'biophysical structure' box would contain trees, woods and forests' and the interest is on how pests and diseases exert pressure on those structures, causing changes that cascade through to (negative) impacts on value. The 'ecosystem service' box in the model would contain the category of cultural ecosystem services; the 'benefit' box would contain the various well-being benefits that people obtain from the cultural ecosystem services; and the 'value' box is the central interest in this report.

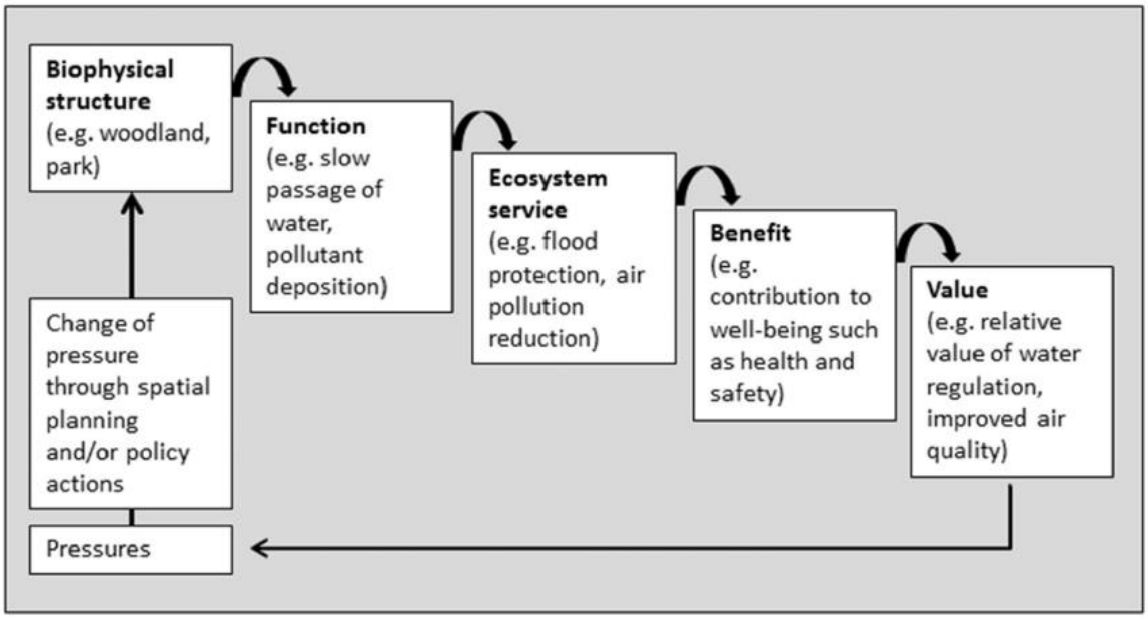

Figure A1: The cascade model framework for ecosystem valuation (from TEEB, 2010; Potschin & Haines-Young, 2011)

Given that this review is concerned with social and cultural values, the Cultural Values Model (Stephenson, 2008) can be informative here. It posits that there are three fundamental components of landscape: forms, practices and processes, and relationships (Figure A2).

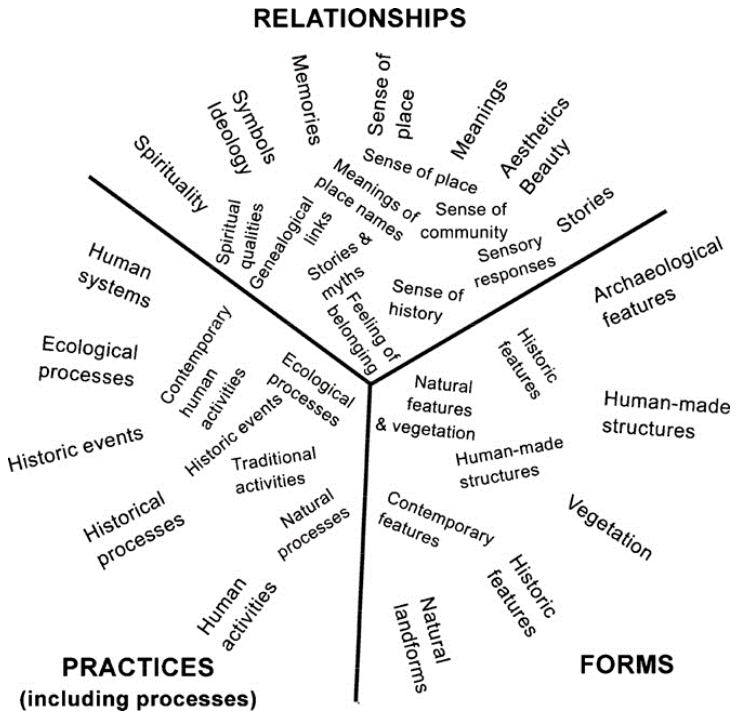

Figure A2 The three interacting components of landscape in the cultural values model (Stephenson, 2008)

The cultural values model is reflected in another framework, devised by Fish *et al.* (2016) which posits that cultural ecosystem benefits are derived through cultural practices being experienced in environmental spaces (Figure A3). This was developed as part of the UKNEA FO (Church *et al.*, 2014). Their framework outlines how the realisation of cultural ecosystem services involve interactions between environmental spaces (place) and cultural practices (activities) and that in turn these generate benefits which contribute to human well-being. Thus environmental places and activities interact to provide experiences that contribute to well-being, mental and physical health, and provide opportunities for developing skills and capabilities. The social and cultural value categories included in Church *et al.*'s framework are represented by three categories of cultural ecosystem benefits (dimensions of human well-being), namely identities, experiences and capabilities. The examples they provide in the framework are belonging, sense of place, rootedness, spirituality, tranquillity, inspiration, escape, discovery, knowledge, health, dexterity and judgement.

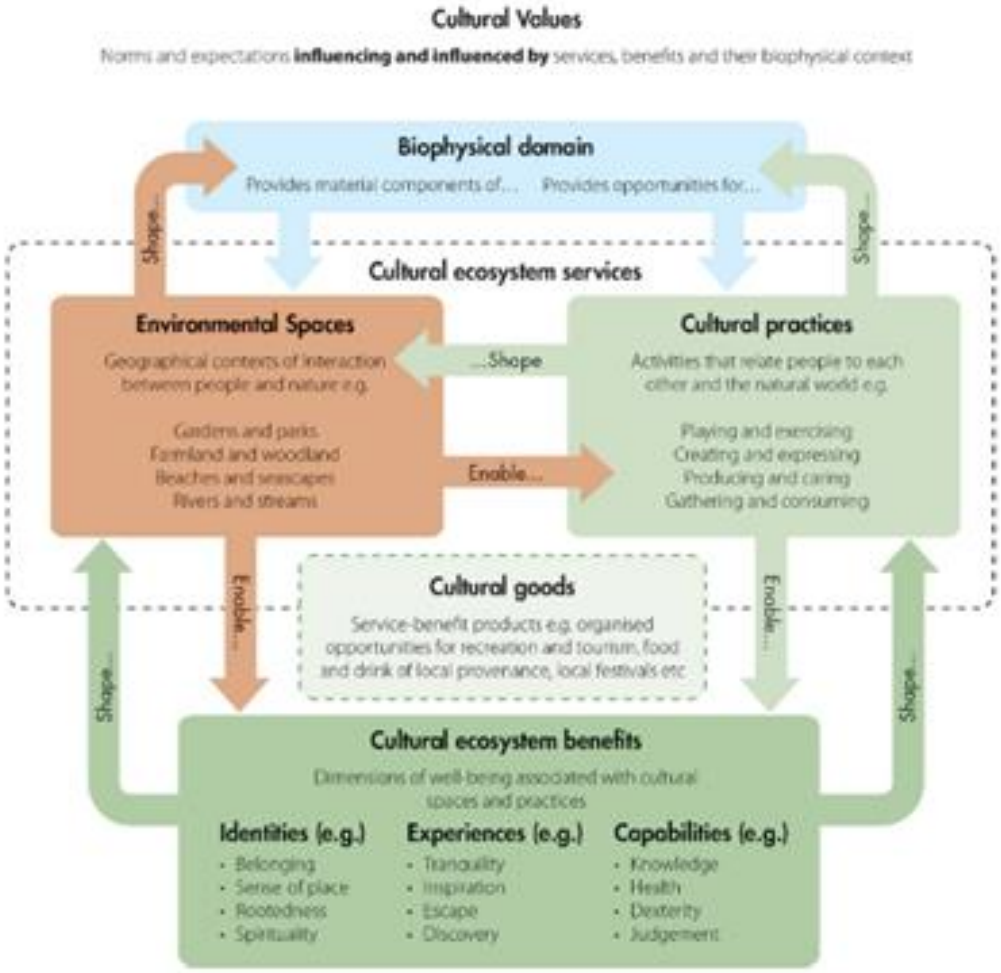

Figure A3 Cultural ecosystems framework (Source: Fish, Church, Winter 2016)

Many of the studies identified through the review relied on or drew upon some variation of the ecosystem services (ES) framework, originally proposed in the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment (MA), 2003), for understanding categories of benefit and specific value types. This project is focused on social and cultural values which fall primarily into the Cultural Ecosystem Services (CES) category of an ES framework. For information, the MEA referred originally to the following categories of CESs.

- Spiritual and religious values
- Recreation and ecotourism
- Aesthetic values
- Inspiration

- Educational values
- Sense of place
- Cultural heritage values (MA, 2003, Summary, p5).

Appendix C. The contexts of the studies captured by the searches

The studies elicited through the review addressed a range of contexts and locations of trees, woods and forests, as well as some other landscape and ecosystem types (Table A1). (NB – numbers do not add up to 188 because some studies were reviews or were conceptual, developmental papers, and therefore not context specific). By far the most common type of context was forest, with 76 of the studies focused on this. However, within the forest category are multiple types of forest, reflecting differences in location, age, structure, ownership and management, as well as primary tree species. The sub-categories include near natural forest, temperate forest, high forest, mountain forest, tropical forest, rotational forest, national forest, agroforestry, experimental forest, family owned forest, state owned forest, oak forest, and spruce forest.

Table A1 The contexts of the reviewed studies

Number of papers	More detail
FORESTS: 76 studies were conducted in relation to a forest setting	**Types of forest setting** - near-natural forest, rotational forest, temperate forest, national forest, high forest, agroforestry, experimental forests, family owned forests, tropical forest, oak forest, mountain forest, state-owned forest, spruce forest
URBAN: 34 studies undertaken in urban areas	**Type of urban area** - peri-urban, sub-urban, urban greenspace, street trees, urban forest, and parks
WOODS: 9 papers focused on woods / woodlands	Used term woods, wood, woodland – all in Britain (except one)
TREES: 8 papers focused on trees specifically	**Tree specific studies** - tree species, native versus non-native trees, and height (age) of trees, and the values associated with those. Some of these are considered in more detail in the section on trees outside of woods.
COMMUNITY: 7 papers focused on community forests	Focused on community, community forests or forestry
NOT TWF: 34 studies not TWF focused	**Type of area** - marine, mountain areas, biosphere reserve, national park, or other more generic such as natural areas, countryside, tourist areas, landscapes. Note that some of these included trees or forests alongside other ecosystems or as part of broader landscapes.

A large number of the reviewed studies (52) were conducted in Europe. A further 24 were conducted in Asia, and 20 in USA and North America (Table A2).

Table A2 Regions where reviewed studies were conducted.

Region	N	Including:
Europe	**52**	UK, Germany, Italy, Spain, Portugal, Norway, Finland, Netherlands, Slovakia, Czech Republic, Lithuania, Austria, Latvia, Sweden, Estonia, Greece, Switzerland, Belgium, Hungary, Macedonia, Poland
Asia	**24**	China, Japan, Indonesia, Singapore, Korea, Kyrgystan, Nepal, Bhutan, Taiwan, Thailand
USA & North America	**20**	California, Hawaii, British Colombia, Ohio, Wisconsin, Oregon, Arizona, Alaska, Maine, Colorado, Wyoming, Georgia, Michigan, Indiana, Pennsylvania
Cental & South America	**9**	Colombia, Brazil, Patagonia, Chile, Puerto Rico, Honduras, Mexico, Argentina
Africa	**5**	South Africa, DRC, Rwanda, Ethiopia, Madagascar.
Middle East	**4**	Iran, Israel
Australia and New Zealand	**3**	

Social and cultural values are experienced differently by different groups of people and communities. The studies identified in this review address understandings of value from across many types of stakeholders including: Indigenous communities, forest owners, woodland managers, national park visitors, urban dwellers, city park visitors, experts and key forest stakeholders, social media users, the general public and rural forest communities.

Appendix D. How can social and cultural benefits and values be identified and measured?

The papers revealed a wide range of approaches and methodologies that had been applied to develop greater understanding of the social and cultural benefits and values that people obtain from ecosystems including trees, woods and forests. This section includes examples of studies found in the review, across different categories, as detailed below. These can be broadly classified under four categories:

- Monetary valuation;
- GIS/Spatial data including Public Participation GIS;
- Social media data capture;
- Deliberative methods and Multi-criteria Decision Analysis.

It is worth pointing out that these categories were not all separate from each other, that is, some studies use mixed methods from across categories. In addition to the studies reviewed following the formal online searches a further three categories are considered.

- Data driven online modelling tools Longitudinal studies
- Validated scales and metrics

Attempts have been made to illustrate how the approaches and methods used relate to value types captured and unit of measurement that is generated (Table A3). This work requires further development in subsequent phases of this project.

Table A3 Methodologies, types of value and units of measurement

Broad approaches / tools	Methods used	Value types captured	Unit of measurement
Monetary valuation	Travel cost Hedonic pricing Willingness to pay Cost benefit analysis Quality adjusted life years	Tourism / recreation Property values Landscape aesthetics Amenity Physical health	Monetary values
Deliberative approaches / Multi criteria decision analysis	Workshops / Focus groups Interviews Participatory Rural Appraisal Delphi technique Stakeholder engagement (groups)	Broad range – can be useful for investigating peoples' own understanding of value; prioritising across value types	Narrative Ranking Prioritised lists
GIS and Participatory GIS	Mapping / data layers	Broad range	Mapped / geolocated values and value change in line with other variables
Social media data extraction	Creation of image database combined with API data	Broad range – e.g. recreation, cultural, social connections, landscape	Geo-located values

A previous review (O'Brien *et al.*, 2017) found a similar broad range of approaches had been used for capturing cultural ecosystem services (Figure A4).

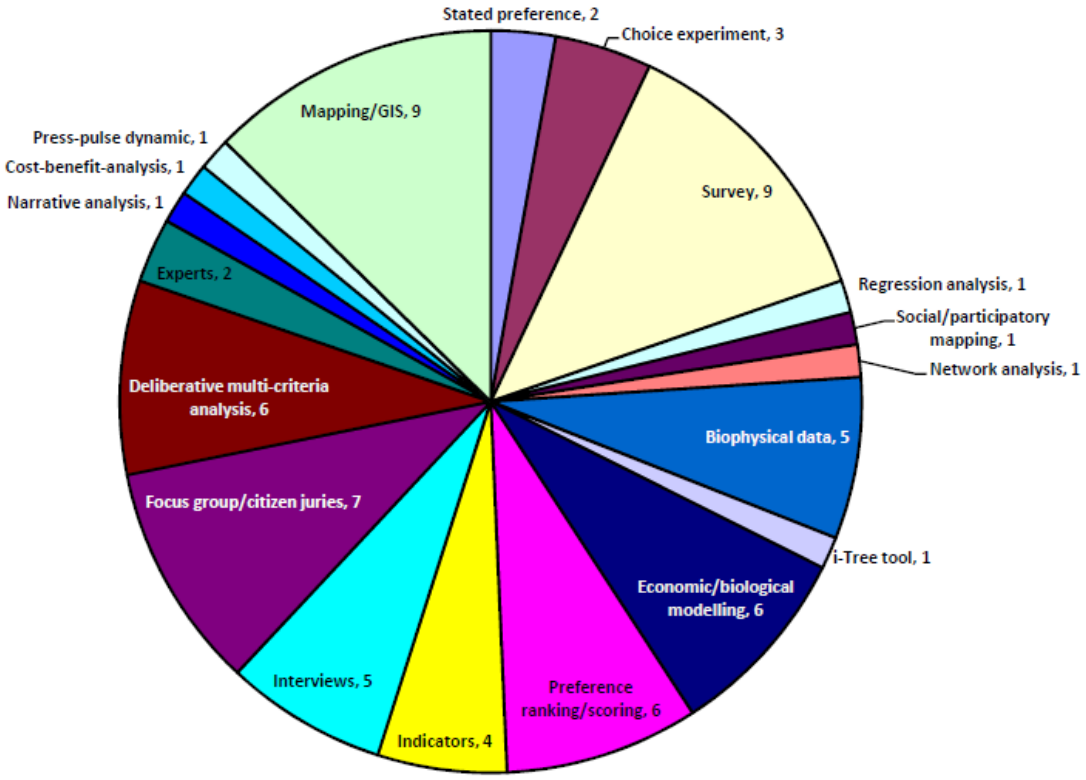

Figure A4 Range of methods used to capture CES (Source O'Brien *et al.*, 2017).

Monetary valuation

As social and cultural values are considered to be non-market benefits there is a range of monetary valuation methods that have been applied in order to derive economic values. These methods have provided monetary valuation data for a limited number of social and cultural values, particularly landscape aesthetics and recreational visits (Figure A5).

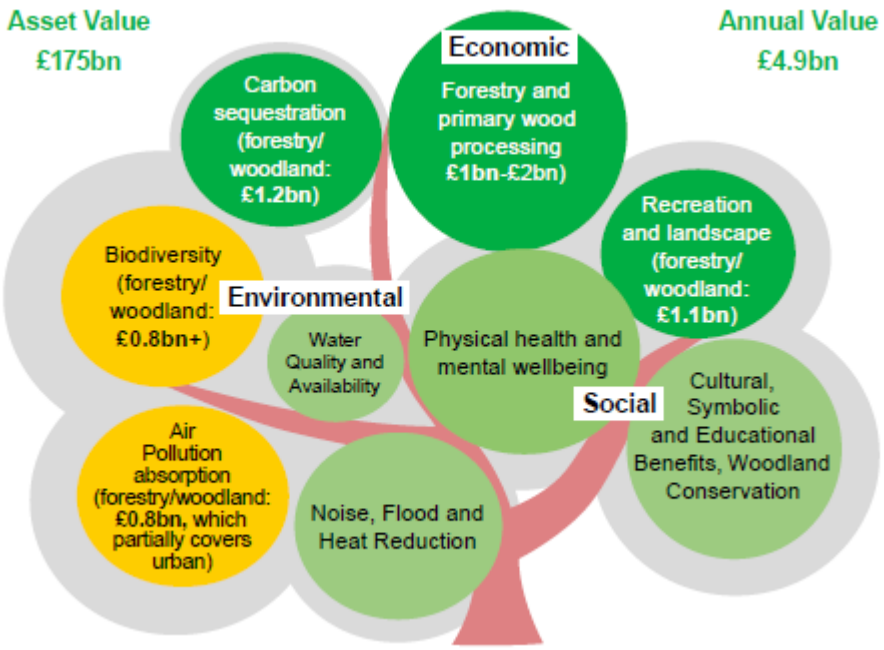

Figure A5 Summary of the Value that Forests and Trees Provide to Society (Source: Defra, 2018)

Commonly, the approaches applied encompass methods of eliciting people's values through either revealed or stated preference techniques (contingent valuation methods, the travel cost method, hedonic pricing, willingness to pay studies). This section also includes consideration of Qalys (Quality of adjusted life years), used in the health sector.

Commonly, the travel cost method has been applied to derive economic values for tourism and recreational visits to natural areas and greenspace by asking visitors how far they have travelled and (sometimes) how much they spend during their visit. One example of this approach was applied to the Low Tatras National Park in Slovakia, an area of forest ecosystems with mountain grasslands (Jaďuďová *et al.*, 2017). They concluded that the average cost of a journey for visitors (including the cost of food, accommodation, transport, entrance fees) was 168 EUR (2017).

Another approach for estimating the value of recreation in forest areas is the willingness to pay method. As an example, this was applied to a suburban forest in the Czech Republic through surveying the willingness of visitors to the area to pay

for the use of the recreational function of the forest (Hlaváčková *et al.*, 2016). This study asked what percentage of income tax visitors were willing to allocate to improve the recreational function of the area of interest to derive an economic value for recreation as an ecosystem benefit.

In the context of valuing social and cultural values of urban trees an often-applied method in many different parts of the world is the hedonic pricing method. This is generally applied to evaluate the effect of street trees (or sometimes access to local greenspace such as a park) to residential property values. Hence, the premium for homes located in more 'leafy' urban areas is considered to be a proxy for the aesthetic and amenity value of trees in the locale. The rapid review identified a number of such studies including an application in four cities in Florida which concluded that, on average, property value increased by $1586 per tree and $9348 per one-unit increase in Leaf Area Index (Escobedo *et al.*, 2015). Another study carried out in Seoul applied the hedonic price method to evaluate how a variable termed 'distance to park' impacted house prices (Park *et al.*, 2017).

As one aspect of a cost benefit analysis of converting a Norway spruce forest rotation to near natural beech forest, authors in Denmark included the recreation benefits of the conversion to estimate the contribution of near natural forest to human welfare (Amsalu *et al.*, 2014). They concluded that the economic value of use values of recreation (and groundwater benefits) outweighed the loss of timber on good soil conditions. The change in recreation benefit of converting a Norway spruce stand into beech forests was estimated by considering the influence of tree size on recreationists' preferences. The value was based on a choice experiment method to elicit Danes' WTP for Norway spruce and beech represented by different stand characteristics in a mature forest state. The respondents' preference for changing from the forest rotation with clear-felling, norway spruce trees and no deadwood trees into near natural beech forest with shelterwood, beech trees, and few deadwood trees scenario was estimated at € 172 per person per year, at 2012 prices.

When seeking to apply monetary values to non-market goods another example presented here of relevance to the present study is the use of Qalys (Quality Adjusted Life Years) for estimating the health benefits of access to natural environments, including woodland. By taking results from survey data (in this

example, the MENE (Monitor of Engagement with the Natural Environment) survey in England) and using the responses regarding amount of active exercise undertaken in the natural environment, it is possible to place a monetary value on that recreational exercise through the use of Qalys. In the example study derived from the searches for this rapid review (White *et al.*, 2016), authors assumed a value of £20,000 for a Qaly, where a Qaly is equivalent to one year lived in 'full' health. In practical terms the value is considered to be avoided health care costs. The annual value of the active visits to the natural environment were £2.18 billion from an estimated annual 109,164 Qalys.

Geographic Information Systems (GIS)

Use of GIS and spatial data

GIS and spatial data has been widely applied to map ecosystem services. Of interest in this rapid review is a study from the USA (Almeter *et al.*, 2018) that considered the value of new tree planting in urban areas. By mapping the benefits of 'walkability' (pedestrian accessibility) and protection of vulnerable populations using data layers from (for example) census data and roads data, they were able to demonstrate the 'best' locations for new tree planting, by ranking the (mapped) locations according to value of benefits.

Similarly, Cochran *et al.* (2019) derived a Community EcoHealth Index by using GIS data on residential population within 500-m walking distance of a park entrance, residential population with views of trees, greenery along low-speed (walkable) streets, and high-speed streets bordered by a tree buffer. Using the EnviroAtlas geospatial platform (in the USA) they were thereby able to assess the health value of urban trees.

In a very different context GIS was combined with semi-structured interviews with indigenous communities in the Colombian Amazon (Angarita-Baéz *et al.*, 2017). Community perceptions of the benefits of the local area connected to education and recreation, spiritual values and sense of place, were probed and mapped using PRA techniques. These were then combined with GIS to derive non-monetary, geo-located values for these ecosystem services.

GIS has also been applied to mapping ecosystem services without considering public or community perceptions of benefit from natural areas, by relying solely on landscape features. Using a US army training ground with 50% hardwood forest cover, Booth *et al.* (2017) sought to value aesthetics of natural landscapes by considering and mapping vista aesthetics and landscape aesthetics (the difference being distance away). These were modelled using landscape features. Aesthetics was thereby incorporated as an ES into an existing decision analysis support tool (EcoAIM) that uses geospatial analysis of land use/land cover (LU/LC) changes.

A mapping tool that has been applied to understand the benefits of urban areas is the i-Tree Street package (Widney *et al*., 2016; Wang et a, 2018). In these example studies in cities in the USA and China, on the ground tree surveys fed into monetary valuation of five benefit categories including property value benefits. As noted above, the value of urban trees has been found to be reflected in house prices in tree-lined streets because of the aesthetic and amenity values of these.

Public Participation GIS (PPGIS)

A sub-set of the GIS approaches is Public Participation GIS (PPGIS). This is an approach of growing interest in studies seeking to value ecosystem services, particularly cultural ecosystem services. By combining public preference data with local maps researchers have sought to derive values for different greenspaces in a variety of contexts. Examples include a National Forest in the USA (Bagstad *et al.*, 2016; Bagstad *et al.*, 2017) which sought to derive geo-located values for a range of categories including aesthetic, cultural, future, historic, intrinsic, learning, life-sustaining, recreation, spiritual, and therapeutic using the Social Values for Ecosystem Services tool. They produced social values maps using survey data from respondents who were asked to allocate 100 hypothetical dollars among 12 value types at mapped locations. Similarly, Brown *et al.* (2015) used a PPGIS web survey to ask participants to drag and drop markers onto mapped locations that they considered important for 14 ecosystem service values types, including recreation, scenic areas, culture/identity, income, undisturbed nature (naturalness), social activities, spiritual, therapeutic/health, and special places. This was combined with a land cover GIS layer with 22 land cover classes so that each mapped ecosystem service value had an associated land cover class.

A study in Stockholm looked at seven areas of Gothenburg, namely, suburban woodland, urban woodland, urban park, allotment area, infrastructural green space, urban park & woodland, residential area (Andersson-Sköld *et al.*, 2018) to consider social values of recreation, mental and physical health, aesthetic appreciation, and inspiration for culture, art and design. They gathered perceived values of these benefits from civil servants via a ranking exercise of ESs at a workshop, and the same from members of the public through face-to-face interviews using a questionnaire at six public places. These perceived values were combined with mapped ecological indicators, including canopy cover, leaf area density, and diversity and numbers of songbirds. Four categories of cultural value considered by the study - perceived wellbeing and health, aesthetic values, Recreation and ecotourism, and educational values - were rated 4 or above on an importance scale of 1-5 where 5 was very important. Face to face questionnaires were completed by 111 members of the public in public spaces in Gothenburg, Sweden.

Social media data capture

Social media is providing new opportunities for understanding the social and cultural values of trees, woods and forests, particularly the aesthetic and recreation benefits. There are now numerous studies that have used geotagged photographs and their corresponding text posted through platforms including Flickr and Panoramio to investigate the locations that are associated with high aesthetic value, recreation value, and also cultural heritage value, places for meeting and socialising, and that have spiritual value (see for example, Bernetti *et al.*, 2019; Oteros-Rozas *et al.*, 2018; Thiagarajah *et al.*, 2015; Van Berkel *et al.*, 2018). These studies take the photos and the Public Application Programming Interfaces (APIs) to compile datasets of georeferenced photo points. Studies have focused on forests and trees in Tuscany (Bernetti *et al.*, 2019), a range of rural and urban landscapes and ecosystems, including wood pastures across five European countries (Oteros-Rozas *et al.* 2018), coastal mangrove forests in Singapore (Thiagarajah *et al.*, 2015), and a coastal state in the USA (Van Berkel *et al.*, 2018). While aesthetic appeal, public enjoyment of outdoor activities, and sense of place were perhaps the most obvious values considered through these approaches, other value categories including the significance of places of spiritual connection, social connection and cultural importance were also evaluated using the social media data. Where text was available, for example the study by Bernetti *et al.* (2019), authors carried out content analysis looking for tags containing specific words and phrases including

wood, forest, tree and other related terms to focus the research on the value of trees, woods and forests.

Deliberative methods and participatory approaches[4]

This section includes a diversity of approaches: Delphi method, interviews, focus groups, workshops, and Participatory Rural Appraisal (PRA). A selection of studies that were identified through the online searches are briefly described to demonstrate how such approaches might be used to uncover the social and cultural values associated with trees, woods and forests. By using a Delphi approach it is possible to rank the relative importance of cultural ecosystem services alongside other ecosystem services (as applied by Barron *et al.*, 2016). These authors emailed a Delphi survey to international academics and local practitioners to obtain an indication of the importance of human health and well-being represented by physical access to nature and visual access to nature at urban forests in Vancouver. Using a standard likert scale these values were ranked alongside other ecosystem services. In section two of this review the Cultural Values model was referred to. This was utilised to analyse interview data collected in Germany and Austria in urban and remote rural areas (including some forests) (Bieling *et al.*, 2014). The authors assigned interview responses to the three categories from the Model of forms, practices or relationships (their results for the relationship category are presented in Figure A6). The relationship items correspond with types of value of interest to this project and are: Beauty, Naturalness/ nature, Tranquility, Place attachment/ feeling at home, Unspoiltness/ integrity, Recreation/ relaxation, Green, Diversity/ variedness, Good air, Space for doing and experiencing things. In their study the value types were ranked according to how many interviewees mentioned them. Interviews were carried out with residents, visitors and farmers, and they were asked 'how does the landscape here contribute to your wellbeing?". The use of interviews and this one open-ended question provided authors with the opportunity to derive a rich dataset of values and value types. This is in contrast to some of the other approaches already reviewed which often focus on only one or perhaps two categories of value (such as landscape aesthetics, recreation, property prices).

[4] Note that many of the GIS approaches used deliberative methods and combined findings with mapping. Similarly, the social media data capture studies also combined data with deliberative methods (for example the study by Thiagarajah *et al.* (2015).

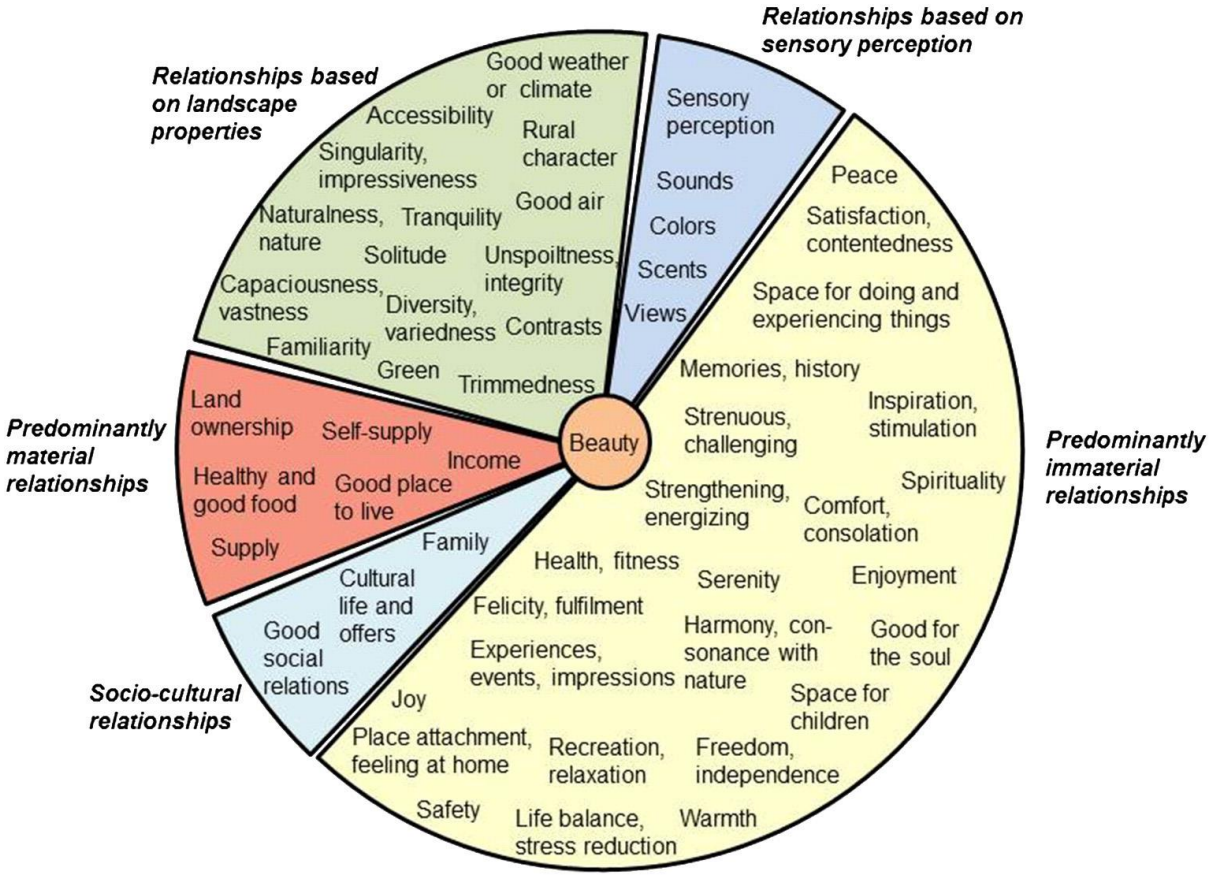

Figure A6 Overview of the items assigned to subcategories of the landscape values type 'relationships'. (from Bieling *et al.*, 2014)

Another study which utilised interviews to derive complex and rich understanding of the social and cultural values of trees, woods and forests is from South Africa (Cocks *et al.*, 2012). The study utilised group and individual interviews, 'walk-in-the-woods' interviews and participatory mapping exercises. By focusing on 'thicket biomes' important to local communities, villages and townships authors were able to develop understanding of the emotions, meanings and values associated with these places. The value 'types' that they uncovered included presence of ancestral spirits, sense of cultural identity, and nature-based religious beliefs, and emphasised a strong sense of interconnectedness with nature. Participants also expressed an enjoyment of being in nature that highlighted qualities such as silence, beauty and tranquillity, the opportunity to observe wild animals and a chance to escape the worries of home.

By combining participatory deliberative methods (community workshop and in-depth interviews), ecosystem service models, vegetation surveys, and document analysis, Bremer *et al.* (2018) were able to consider the impact of land use change on CESs. The context for the study was native forests and agroforestry in indigenous Hawaiian communities. In line with the purpose of the study which was to place an emphasis on an indigenous Hawaiian worldview the value categories that they uncovered were ʻIke' (knowledge), 'Mana' (spirituality), 'Pilina Kānaka' (social interactions), and 'Ola Mau' (physical and mental well-being). A quote from one of the participants summed up the relationship with the natural world "*When we describe ourselves as the child of the land, we have every obligation to the land that we do to our Tūtū* [grandparent]…". While the context of this particular study is very different to Great Britain the combination of approaches used to gather information about the values, and the fact that the study modelled change is relevant for this project, where the focus is on how degradation of trees, woods and forests by pests and diseases may impact social values.

Another informative study, again from a very different cultural perspective, is from Nepal where authors considered values of different user groups associated with community forestry and collaborative forestry (Acharya *et al.*, 2019). In focus groups the authors asked participants to prioritise different cultural services under the following value types: Bequest, Aesthetic, Existence, Recreation, Cultural heritage, Religious, Tourism, Educational, Amenity, Landscape, Hunting. Results are included here in Figure A7 which shows that bequest values, followed by aesthetic values and existence values were prioritised most highly across all groups.

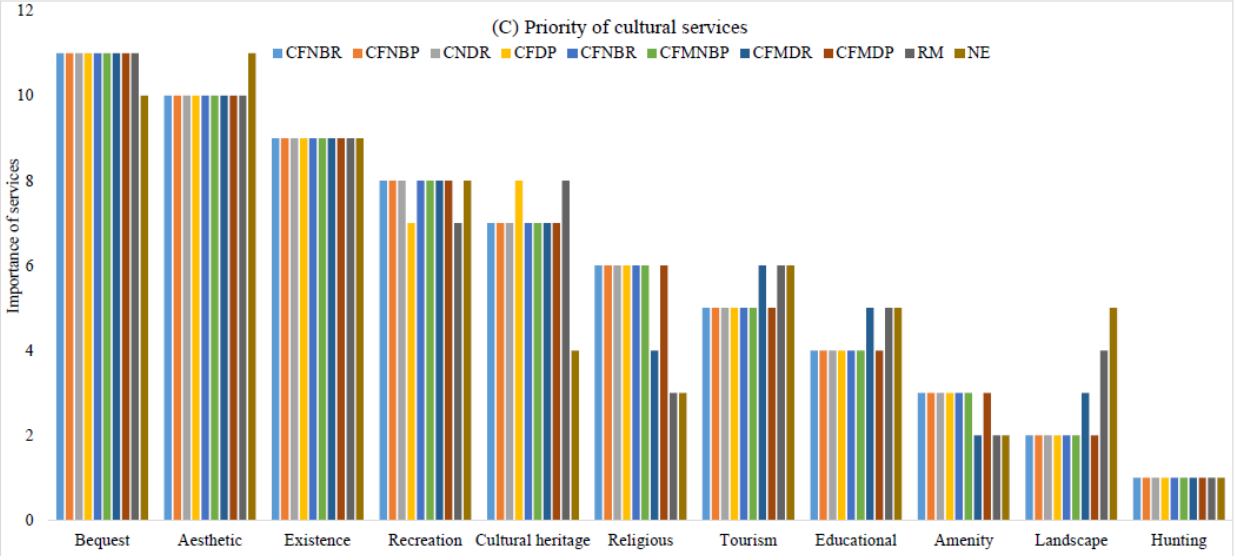

Figure A7 Prioritisation of different cultural services by different user groups (CFNBR = Community Forest Nearby Rich Users; CFNBP = Community Forest Nearby Poor Users; CFDR = Community Forest Distant Rich Users; CFDP= Community Forest Distant Poor Users; CFMNBR = Collaborative Forest Management Nearby Rich Users; CFMNBP = Collaborative Forest Management Nearby Poor Users; CFMDR = Collaborative Forest Management Distant Rich Users; CFMDP = Collaborative Forest Management Distant Poor Users; RM = Regional Managers; NE = National Experts) (note – their key above the chart contains some errors)

Another study where the context is more closely aligned with the needs of the current project was conducted in four peri-urban woodlands in England. The study utilised a range of data collection methods, in the form of in-situ woodland walks, focus group discussions and photo elicitation (O'Brien *et al.*, 2014). The aim was to uncover values associated with the peri-urban woodlands using qualitative data collection methods that left people free to express the values in their own terms. Responses were categorised into the value types of self-reported health and well-being; social connections; reflection and opportunity to connect with what matters to themselves; and mental restoration.

Focus groups were also used in a study regarding a forested national park in Israel (Orenstein *et al.*, 2015) where a technique known as 'immersive visualization theater' was trialled as a new tool for ecosystem assessment and landscape planning. The approach used a series of photographs projected onto a wraparound screen. Participants were asked (in writing and orally) to choose from among the

scenes where they would prefer to spend time, and then asked to explain their answers. This enabled an explanation of the values they associated with each of the images. Some relevant categories of value that were revealed through this study were peoples' memories and sensory responses to landscapes.

Participatory Rural Appraisal techniques have already been described in use in some of the reviewed studies. In another study local knowledge and perceptions were collected (Kandel *et al.*, 2018) using mapping methods that involved participatory rural appraisal tools, a household survey, and geospatial inputs to understand the linkages between human well-being and ecosystem services in three major ecosystems (including forests) in Bhutan. As perceived by the local community, six cultural services were revealed, namely, aesthetic beauty, nature worship, ecotourism, education, recreation, and spiritual enrichment. Again the use of a combination of more deliberative methods enabled the revelation of deep social and cultural values present in local forest ecosystems.

Multi-Criteria Decision Analysis (MCDA)

Another broad category of approaches for gathering information about the social and cultural values of trees, woods and forests across the world, that was revealed through the online searches for this rapid review, is Multi-Criteria Decision Analysis. This generally involves the use of deliberative, participatory approaches to inform structured prioritisation exercises. The example reviewed here is from an urban forest area in northern Sweden (Nordström *et al.*, 2011). Place specific values were gathered from the perspective of four social groups: timber producers, reindeer herders, recreationists, and environmentalists. Stakeholder values were identified through interviews, and maps were used to capture place-specific spatial values. The place-specific spatial values were included in the creation of a map showing zones of different silvicultural management classes. The approach worked well for capturing place-specific values. Non-spatial values were formulated as criteria and used to build a hierarchy describing a forest planning scenario. By combining the spatial, place-based values with the non-spatial values the forest planning decision analysis was progressed.

A second similar example also involved collecting opinions from stakeholders about the services delivered by pine plantations, including cultural services (Derak &

Cortina, 2014). These were used to weight indicators and criteria to derive understanding of the importance of the pine forests for the delivery of different types of services, including aesthetic value. Both of these studies demonstrate the potential usefulness of MCDA to incorporate social and cultural values in complex decisions about woodland and forest management, that could be applied to management for tree health.

Other data sources and tools

Greenspace planning and decision-making tools

ORVal (https://www.exeter.ac.uk/leep/research/orval/)

The Outdoor Recreation Valuation tool (ORVal) is a web application developed by the Land, Environment, Economics and Policy (LEEP) Institute at the University of Exeter. The main use of Orval is to provide information, for example as part of a project appraisal, to help understand the benefits that could be provided by accessible greenspace. The ORVal tool is based on a recreational demand model built using data collected through the Monitor of Engagement with the Natural Environment (MENE) survey (see below). The model can provide estimates of visits to greenspace and derive monetary values for the recreational opportunities provided by those spaces. The potential usefulness of ORVal is through the ability to estimate how greenspace usage might change if the characteristics of a recreational greenspace changed. If, therefore, a local woodland was impacted by a tree pest or disease it would be possible to model the impact on the characteristics of the woodland and the associated loss of amenity value.

Greenkeeper (https://www.vivideconomics.com/greenkeeper/)

Similar to ORVal Greenkeeper is an online tool designed to support green infrastructure planning and development in UK cities. The tool uses data on visit patterns and site characteristics, combined with evidence of the social, economic and environmental benefits of green infrastructure. Greenkeeper uses health research and economic valuation methods to provide developers and planners with an understanding of the contribution that an urban park can make to health and wellbeing. Again, like ORVal, Greenkeeper could be of use in the present context as it can model how changes in urban green infrastructure might reduce or improve the amenity and other benefits provided by that infrastructure.

Time series surveys and questionnaires/Longitudinal studies

Consideration here is given to the use of longitudinal studies. While the use of questionnaires and surveys has already been noted in numerous of the reviewed studies mentioned in this review the following examples are included as they demonstrates the role of secondary data analysis using longitudinal questionnaire data. This is about how surveys can show changes in values over time but also how those datasets can be used and combined with other datasets to home in on specific issues e.g. the White paper on QALYs used the MENE data.

Monitor of Engagement with the Natural Environment

https://www.gov.uk/government/collections/monitor-of-engagement-with-the-natural-environment-survey-purpose-and-results

Since 2009, Natural England has delivered the annual Monitor of Engagement with the Natural Environment (MENE) survey. MENE focuses on the time people spend in the natural environment, in gardens and volunteering, as well as, pro-environmental behaviours such as recycling. The data provides understanding about how people use, enjoy and are motivated to protect the natural environment. Importantly, MENE has monitored changes over time in the use and enjoyment of the natural environment. If combined with data on treescape change due to a pest or disease outbreak it could help demonstrate how recreational values are impacted by the outbreak. Note that, in 2020 MENE was replaced by a new survey called 'People and Nature' which has moved to online data gathering with a reduction in sample size.

Public Opinion of Forestry Survey

https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/sources/public-opinion-of-forestry/

Another potential useful source of longitudinal data is The Public Opinion of Forestry (Forestry Commission/ Forest Research). Since 2009 this has provided consistent data on eight measures of woodland and forest importance (in a survey undertaken every 2 years). Of particular relevance would be the data on woodland recreation.

ONS / Defra Natural Capital Accounts – February 2020 update to Woodland Accounts

https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/woodlandnaturalcapitalaccountsuk/2020#regulating-ecosystem-services-quantity-and-value

Drawing on MENE data plus data from the Welsh Outdoor Recreation Survey and the Scottish People and Nature Survey, a recent Office of National Statistics publication demonstrates how the longitudinal data could be used. The publication includes a graph showing that visits to, and time spent in, woodland areas have gradually increased over time, from 2009 to 2017 (Figure A8). This can be considered to show a change in social values (recreation) over time.

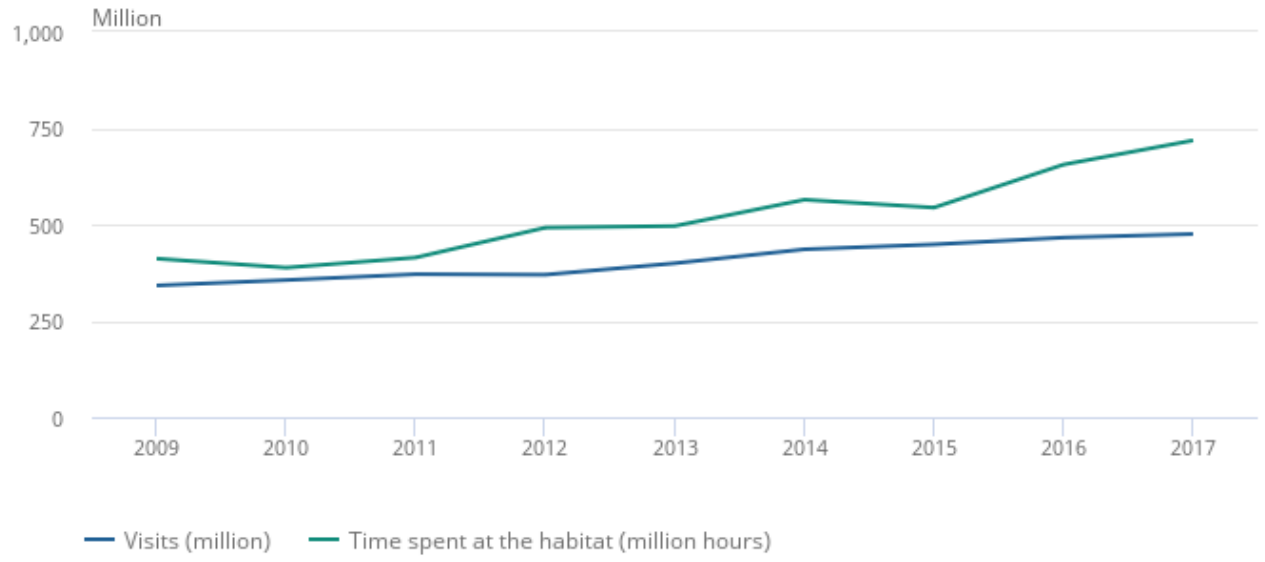

Figure A8 Number of visits and hours spent in woodlands, UK, 2009-2017

(Validated) Scales and Metrics

There are numerous validated scales and metrics that have been widely applied to 'measure' social values and in recent years there has been a particular focus on nature connectedness and physical and mental health. These scales and metrics offer standardised approaches that have been tried and tested across different group, countries and sometimes languages that can be used across a variety of studies so that comparisons can be made between studies and sometimes with national level results. These are briefly described below.

Nature connectedness metrics

Restall and Conrad (2015) review eighteen nature connectedness metrics that also include validated scales such as the Connectedness to Nature Scale (CTN), Perceived Restorativness Scale (PRS), New Ecological Paradigm (NEP), Inclusion of Nature in Self (INS), the Environment Identity Scale (EIS) and the Nature Relatedness scale (NRS). This field of research is grounded primarily in the discipline of psychology. Progress has been made in the development of nature connectedness metrics and research has identified strong convergent validity amongst the different measures. The review highlights that not many of the measures have been used spatially or involved stakeholders in their studies, other than via gathering data from them. The measures have been categorised in terms of whether the connection to nature is a 'cognitive representation' (i.e. place attachment), an 'affective affiliation' (i.e. emotional) or 'relationship commitment' (to nature). An assumption of some of the literature concerning people's connection to and dependence on nature is that it can be translated into actions to conserve and protect nature. While, more research is needed, recently Barbett *et al.* (2020) have created a validated Pro-Nature Conservation Behaviours scale (ProCoBS) to be used in exploring the assumption that being connected to nature can translate into action for nature. A Nature Connection Index (NCI) of 6 items has been used by Natural England in the 'Monitor of engagement with the natural environment' survey (Natural England, 2017).

Health metrics

The European Centre for Environment and Human Health carried out review work for the Valuing Nature Programme Coordination Team in 2019 (Cracknell *et al.* 2019). The review identified UK health metrics, i.e. measures of health determinants, states or outcomes, related to any aspect of health. Some of these metrics the report outlines can be used across different health states such as Quality Adjusted Life Years (QALY), Disability Adjusted Life Years and can be translated into an economic value. The report outlines that there are thousands of different health metrics so the researchers identified key nature health reviews to identify metrics that could be used to explore nature-health relationships. Over 270 metrics were identified as being used in the nature health field, and the report usefully identifies which key domains (physical/physiological, mental/psychological, social) and sub domains are covered by each metric. The report and associated tables of metrics and references do not suggest which metric should be used, rather the authors point towards how the natural capital community might identify

a theory of change to inform the choice of health metrics. There is also no indication of which metrics are most commonly used, however recent evaluations of interventions in nature have included the International Physical Activity Questionnaire (IPAQ), the Warwick Edinburgh Mental Wellbeing Scale (WEMWEBS) and short WEMWEBS (SWEMWEBS), Short Form (SF6, 12 or 36), the Office for National Statistics Personal Wellbeing Questions (ONS-4) (refs). These metrics have been validated through extensive trialling and testing of the metrics with different populations. Currently there is no specific consensus in the natural capital/environment field on the key metrics to use to explore the health benefits of nature. However, the health sector uses WEMWEBS, SF, and the ONS-4 is widely used in national statistics and therefore using metrics common to the health sector can be beneficial in illustrating how nature can contribute towards health and wellbeing. A recent review by Saraev *et al.* (2020) identified three major methodologies for valuing mental health: 1) QALYs, 2) wellbeing via the SWEMWBS or life satisfaction score, 3) avoided costs e.g. of medication, costs of mental health via productivity loss, costs to the NHS (Saraev *et al.* 2020). Howe *et al.* (2020) in targeted work for Forestry England on natural capital accounting recommended the use of QALYs to identify the social value of woodlands for wellbeing.

International physical activity questionnaire (IPAQ)

https://sites.google.com/site/theipaq/background

The International Physical Activity Questionnaires (IPAQ) is a survey instrument that can be used to obtain estimates of physical activity. It features a standardised set of questions, widely tested internationally.

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