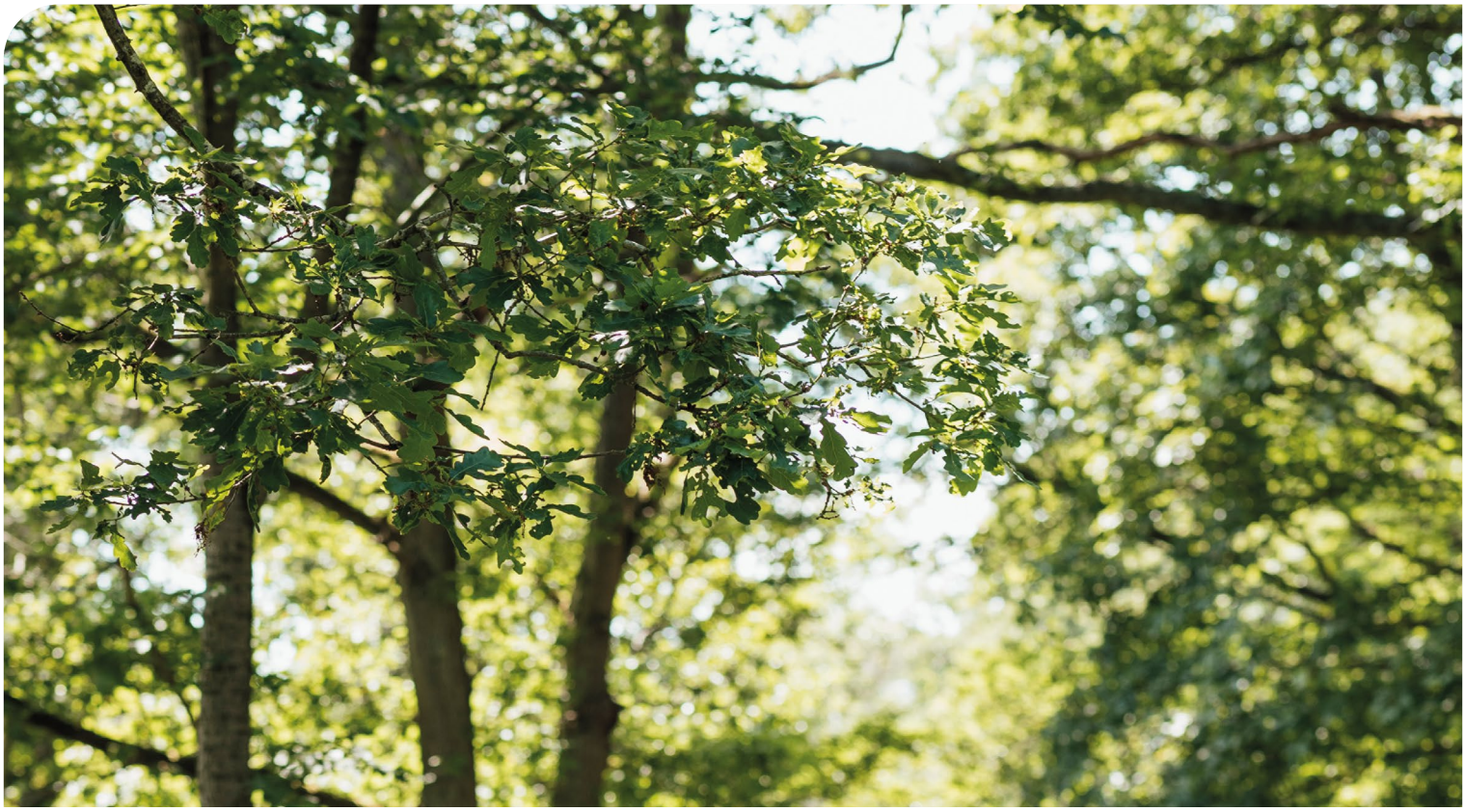
Forest Research



Valuing the mental health benefits of woodlands

Research Report

Forest Research

Valuing the mental health benefits of woodlands

Research Report

Vadim Saraev, Liz O'Brien, Gregory Valatin
and Matthew Bursnell

Forest Research: Edinburgh

© Crown Copyright 2021

You may re-use this information (not including logos or material identified as being the copyright of a third party) free of charge in any format or medium, under the terms of the Open Government Licence.
To view this licence, visit: www.nationalarchives.gov.uk/doc/open-government-licence/version/3/ or write to the Information Policy Team at: The National Archives, Kew, London TW9 4DU or psi@nationalarchives.gsi.gov.uk.

This publication is also available on our website at: www.forestresearch.gov.uk/publications

First published by Forest Research in 2021.

ISBN: 978-1-83915-014-2

Saraev, V., O'Brien, L., Valatin, G. and Bursnell, M. (2021).
Valuing the mental health benefits of woodlands.
Research Report.
Forest Research, Edinburgh i-iv + 1-32pp.

Keywords: natural capital; forest visits; depression; anxiety; trees; stress; economic; monetary.

Enquiries relating to this publication should be addressed to:

Forest Research
Silvan House
231 Corstorphine Road
Edinburgh EH12 7AT
+44 (0)300 067 5000
publications@forestresearch.gov.uk

Acknowledgements

We would like to thank many people who helped with this research, especially our critical friend, Dr Tim Taylor, a Senior Lecturer in Environmental and Public Health Economics, European Centre for Environment and Human Health at the University of Exeter Medical School, who provided many useful references and advice. His input was extremely useful and included helping identify material to review and refining searches. He also helped source information required in deriving monetary estimates and suggesting how approaches could be refined. We would also like to thank Danielle Standish and other members of the study steering group for their helpful comments and suggestions.

Forest Research

Forest Research is Great Britain's principal organisation for forestry and tree-related research and is internationally renowned for the provision of evidence and scientific services in support of sustainable forestry. The work of Forest Research informs the development and delivery of UK Government and devolved administration policies for sustainable management and protection of trees, woods and forests. For more information visit: **www.forestresearch.gov.uk**

Forest Research will consider all requests to make the content of its publications available in alternative formats. Please send any such requests to publications@forestresearch.gov.uk.

Contents

Executive summary

During the coronavirus disease 2019 (COVID-19) pandemic, the prevalence of mental distress has increased. Access to trees, woods, forests and other natural environments including urban greenspace has become even more important for individuals to support and maintain their well-being. This Research Report is the first attempt to estimate the mental health benefits associated with the UK's woodlands using an avoided costs approach, by valuing woodland through the reduced prevalence of mental illness.

The annual mental health benefits associated with visits to the UK's woodlands are estimated to be £185 million (at 2020 prices). Country-level values based on population size (rounded to the nearest million) are £141 million for England, £26 million for Scotland, £13 million for Wales and £6 million for Northern Ireland. The values are based on evidence of the reduced incidence of depression and anxiety as a result of regular visits to nature. We draw upon evidence regarding the number of regular visitors to woodlands, and the prevalence of mental health conditions in the general population, to estimate the numbers of cases of depression and anxiety that may be reduced. The avoided costs are based upon the average annual costs to society of living with depression or anxiety. These comprise costs associated with treatment, including visits to GPs, drug prescriptions, inpatient care and social services. They also include employment-related costs based on estimates of the number of working days lost due to mental health issues.

We also explore other approaches to valuing the mental health benefits of woodlands, including the impact of regular physical exercise on the incidence of mental health conditions. Proximity-based measures are also examined, based upon associations between greater residential greenspace and lower mental ill health, as well as between higher street tree density and reduced antidepressant prescriptions. Valuation based on the evidence of regular visits to natural environments (visits to nature) and reduced incidence of depression and anxiety is the most robust of the four pathways examined.

Visit- and proximity-based values can be added, provided that they do not overlap. Adding the value estimated for street trees to that for woodlands is considered feasible. The aggregate value is estimated to be £202 million (at 2020 prices). At country level (rounded to the nearest million), these values are £155 million for England, £27 million for Scotland, £13 million for Wales and £6 million for Northern Ireland. By comparison, the 2020 Office for National Statistics (ONS) Woodland natural capital accounts (NCAs) report a value for recreation (from 2017) of £516 million at 2018 prices, equivalent to £557 million at 2020 prices. However, there is greater uncertainty associated with the aggregate value than with that based on regular visits to woodlands alone.

Natural capital values are also estimated drawing upon population projections for the UK. The value over 100 years (from 2020) is estimated to be just over £11 billion for the mental health benefits of visits to woodlands. The aggregate value for woodlands and street trees of mental health benefits is estimated at just over £12 billion. Values can also be presented per visit. For example, with 475 million visits to the UK's woodlands estimated in the latest (2017) Woodland NCAs (ONS, 2020b), a UK average for visits to nature would be equivalent to a value of £0.39 per visit.

The limitations of the approach include the assumptions made when estimating the numbers of visitors to woodlands who have mental health conditions. Also, there is a lack of UK-based longitudinal research on how mental health is improved by regular visits to nature. The reported values are likely to be underestimates because both are based upon conservative estimates of the costs of mental health issues, while the number of regular woodland visitors is based upon year-round visiting habits. For example, mental health benefits for people who visit woodlands during the summer, but not during winter, are not currently accounted for using this approach. Mental health benefits received by those who would not have developed a specific mental health condition are not accounted for. Akin to the invisible part of an iceberg below the water, these mental health benefits of woodlands may potentially be substantially larger than those quantified using an avoided cost approach.

The focus on avoided costs helps expand the potential coverage of Woodland NCAs in a way that minimises the risk of double counting with other benefits such as recreation, amenity or physical health. Furthermore, based on visits to nature, the main pathway could potentially also be used in wider NCAs to value the mental health benefits of visits to other types of natural environments. Further research exploring links between improvements in mental health or reductions in mental distress and visits to the UK's woodlands would significantly improve the evidence base and provide more robust estimates.

Introduction

This is phase 2 of a study to estimate the value of the mental health benefits of woodlands (Figure 1). Phase 1 was the Scoping Study on Valuing Mental Health Benefits of Forests (Saraev *et al*., 2020), and phase 2 builds on its recommendations. This project is ground-breaking as national-scale estimates of the value of mental health benefits of woodlands have not previously been published for the UK.

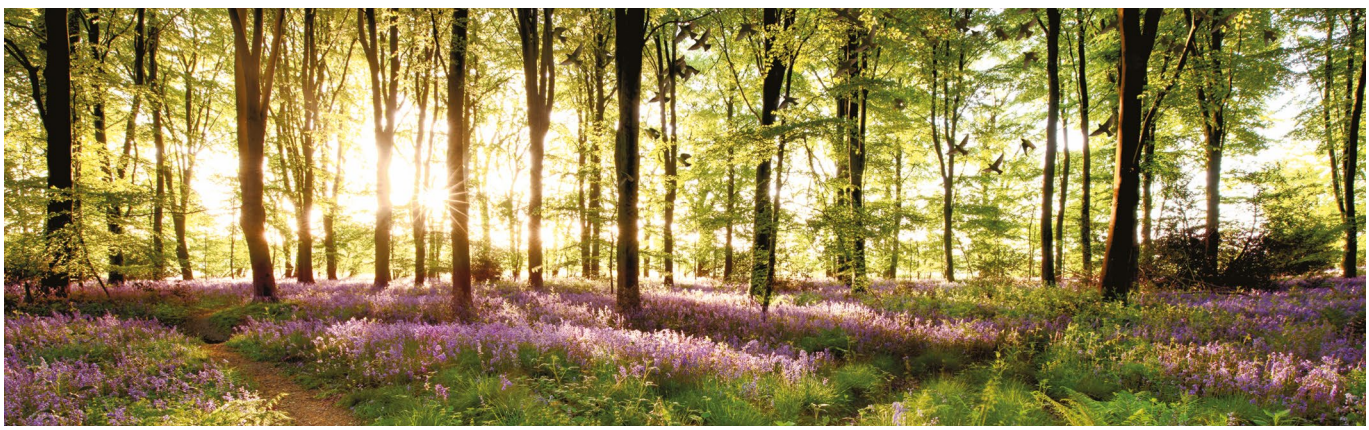
There is a lack of evidence on the economic value of woodlands—broadly defined by the ONS (2020b, p. 13) as 'tree-covered areas that include plantation forests, more natural forested areas, and lower density or smaller stands of trees'—in improving mental health. The scoping study completed in 2020 and subsequent workshop concluded that a first step would be to derive estimates of the direct benefits associated with reducing costs to the NHS. This approach to valuing mental health benefits has the advantage of minimising potential double counting, which could occur if a different approach was adopted. For example, the use of quality-adjusted life years (QALYs) is a popular way of valuing improvements in physical health, but it cannot account separately for improvements in mental health. There is also some debate about the effectiveness of using QALYs to adequately reflect improvements in mental health (Johnson *et al*., 2016). A well-being or life satisfaction valuation approach can be effective at capturing a broad range of benefits associated with improvements in mental health (Fujiwara and Dolan, 2014). However, the inclusiveness of a well-being or life satisfaction valuation makes it unsuitable for aggregating estimated values with pre-existing estimates for other cultural ecosystem services such as recreation. It is also difficult to separate out values for mental health benefits from those associated with improvements in physical health.

Aims

The project's aims are to:

- Detail and summarise quantitative evidence of the impacts of woodlands and other greenspace, including tree cover, on the prevention and cure of different types of mental illnesses for different population segments of the UK. Then to consider how this evidence can be used and up-scaled in combination with avoided cost data to derive national-level natural capital value estimates of the mental health benefits of woodlands.
- Investigate and compile information for the UK on avoided costs for the prevention and cure of different types of mental illness impacts using different measurement systems (e.g. NHS cost savings, working days lost), for which evidence concerning mental illness impacts has been identified.
- Derive estimates of the magnitude of natural capital values for the mental health benefits provided by woodlands based upon up-scaling and by combining existing evidence on mental illness impacts and avoided costs. (If insufficient evidence exists for impacts specifically concerning woodlands, the evidence for the mental health benefits of greenspace or nature can be used for valuing the benefits of woodlands).
- Provide recommendations on deriving more robust estimates through strengthening the evidence base and refining approaches.

Figure 1 Connecting with nature can help to improve our mental health and sense of well-being.



Methodology

Forest Research worked closely with the project manager and steering group to establish the priorities for the review work.

In addition to more in-depth consideration of the evidence regarding the impacts of woodlands and other greenspace on mental health in the UK from the valuation studies reviewed in the phase 1 study (Saraev *et al.*, 2020), a wider review of literature was undertaken. The choice of terms for the literature search was guided by team members' specialist knowledge and developed in consultation with Dr Tim Taylor. Findings from other countries are included in the review, but literature published in English is the main focus. The Scopus database was used for the main searches. Scopus is currently the largest abstract and citation database of peer-reviewed literature, including scientific journals, books and conference proceedings. The search focused on publications from 2015 to early 2021. It was supplemented with Google Scholar searches for grey literature.

Additional literature was sourced through review papers as they were encountered, along with papers already known to the researchers. Appendix 1 describes the search strategy in greater detail.

Impacts on mental health: pathways

This section summarises evidence from the literature on the impact of woodlands and other greenspace on mental health, focusing on methods that can be used to convert these benefits into values representing financial assets (i.e. monetisation). These approaches, or pathways, differ based on how they quantify the change in mental health (i.e. response) as a result of exposure to nature, greenspace, woodlands or trees (i.e. dose). This relationship is typically described as the dose-response function (Shanahan *et al.*, 2016). A full list of the relevant evidence can be found in Appendix 1.

Visits to nature

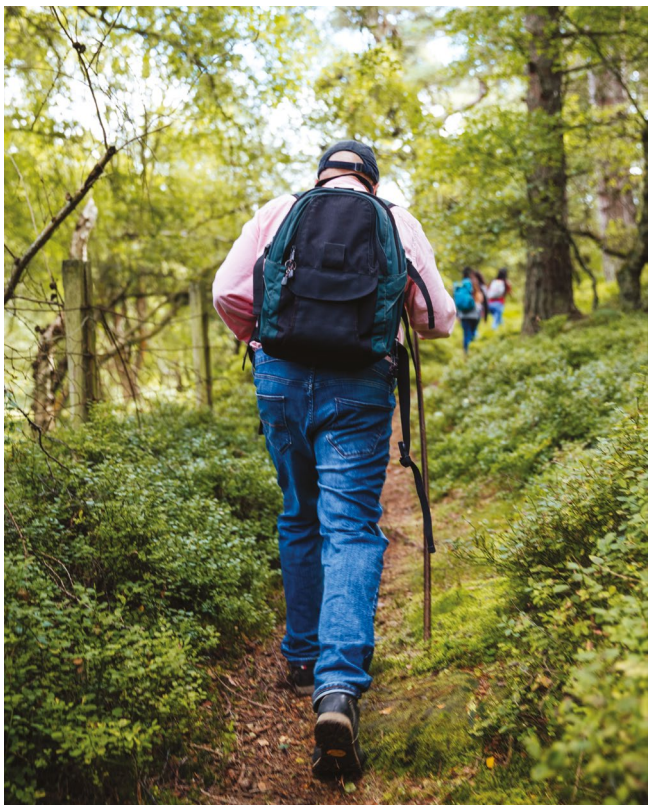
This pathway concerns research on improvements in mental health as a result of regular visits to nature or greenspace (Figure 2).

One of the main mechanisms driving the relationship is likely to be increased physical exercise (Mitchell, 2013), although natural environments are also increasingly recognised for their more restorative benefits, such as the growth of forest bathing (Kotera, Richardson and Sheffield, 2020). Forest bathing relates to the practice of mindfulness in woodlands, often during walks, and is sometimes accompanied by low-intensity activities such as breathing yoga. Forest bathing is explored later as a pathway for valuing mental health (see the Forest bathing/therapy section on page 5).

A leading example of the visits to nature research is found in Shanahan *et al.* (2016), who developed a dose-response framework to examine associations between the duration, frequency and intensity of exposure to nature with benefits in mental health. Exploring how greenspace visits among 1538 individuals in Brisbane, Australia, affected scores on the Depression, Anxiety and Stress Scales (DASS), the authors reported that visits to outdoor greenspace of 30 minutes or more during the course of a week could reduce the population prevalence of depression by 7%.

Similar dose-response work has been conducted in the UK, most notably by White *et al.* (2019), who reported that spending 120 minutes or longer in nature per week significantly increased the likelihood of high subjective

Figure 2 The benefits of woodland visits are now well recognised.



well-being (odds ratio (OR) = 1.23). Researchers have also explored these dose-response associations at international level across 18 countries, finding that an increased frequency of visits was negatively correlated with the incidence of mental distress (White *et al.*, 2021).

For the purposes of this Research Report, although it is more relevant to the UK, White *et al.*'s 2019 measure of subjective well-being is too broad a definition to explore the direct costs associated with mental health. The associations reported through White *et al.* (2021) are based on international averages for the frequency of visits to greenspace. The UK is ranked among the lowest countries for typical visit frequency, as well as for connection to nature, suggesting that these findings would not be representative for the UK. Australia, however, was ranked in a similar position as the UK for both typical visit frequency to greenspace and nature connection. Because of these considerations, findings from the Australian-based Shanahan *et al.* (2016) study are taken to represent this pathway.

Physical exercise

This pathway relates to the benefits associated with increased exercise and mental health improvements. There is significant research in this area (Mikkelsen *et al.*, 2017), although there is notably less work in understanding dose response, that is, how exercise can quantitatively affect the likelihood of developing mental health conditions (MHCs).

An example of where estimates using this quantitative relationship have been attempted can be found through the MOVES tool. MOVES was developed by Sport England to explore how incidence of disease rates are reduced at different levels of physical exercise (Sport England, 2016). The tool also includes estimates for risk reduction in depression (Woodcock *et al.*, 2009).

Using the tool to simulate physical exercise performed during visits to the outdoors, a reduction in the incidence of depression can be observed. Walking is taken to be the physical activity that is representative of all visits to woodlands (Figure 3). The average reduction in depression is simulated across all age groups (≥16 years) taking walking exercise each week. To reflect the numbers of visitors who visit woodlands several times per week, as well as those who only visit several times a month, average reductions in the incidence of depression are calculated for walking for one hour on three days each week, and also for walking for one hour each week. Typical walking

Figure 3 Walking in nature can help to reduce depression.

speed is modelled at the average value (between slow and brisk). The starting level is assumed to be 'low', representing approximately 60 minutes of moderate intensity exercise per week, as nationally only 63.3% of adults meet exercise guidelines of 150 minutes (DCMS, 2020).

Using this methodology, the average reduction in incidence of depression for UK adults from walking two hours a week is 0.67%.

Antidepressants and street trees

This pathway relates to research on the association between the presence of street trees or greenspace and antidepressant prescriptions.

Four studies were identified, three of which reported a negative association between antidepressant prescription rates and increased density of street trees or greenspace. Helbich *et al.* (2018) explored this association across the population of the Netherlands and found a positive association with antidepressant prescriptions and areas with a relatively low proportion of greenspace (<28%). A strong negative effect was also observed for areas with a large proportion of greenspace (>79%). Marselle *et al.* (2020) examined the association across 9751 residents

Figure 4 Tree-lined streets help to encourage active travel, enhancing mental health and other benefits.

of Leipzig, Germany, and reported that people living in homes with a greater density of street trees within 100 m were less likely to be prescribed antidepressants (log OR = −0.09) (Figure 4). Analysing data from London, Taylor *et al.* (2015) reported similar findings, with a decrease of 1.18 prescriptions per thousand population per unit increase in street trees per kilometre of street.

Conversely, international research across 18 countries found no associations between residential exposure to greenspace and depression/anxiety medication (White *et al.*, 2021). However, it is difficult to draw conclusions for the UK from this study, as its results suggested high inter-country variability.

Because of its UK focus and scalable quantitative association, the study conducted by Taylor *et al.* (2015) is taken as the leading example for this pathway.

Proportion of greenspace

This pathway was identified from the results in phase 1 of the research project (Saraev *et al.*, 2020). Two prominent examples of valuing the direct impacts on mental health from greenspace were identified. Both examples adopted the same methodology to explore the mental health value of local greenspace for NCAs but focused on different urban areas. These studies were undertaken for London (Vivid Economics, 2017) and Manchester (Dickie *et al.*, 2018).

Both examples based their calculations on a study conducted by White *et al.* (2013), which compared differences in the mental health of individuals associated with living in urban areas containing different densities of greenspace. Data were taken from the longitudinal British Household Panel Survey of individuals who had moved to a new house. Mental health was measured using the General Health Questionnaire (GHQ)-12 scale, which is typically used to indicate the presence of depression and anxiety. The study was able to control for a range of factors that also strongly affect an individual's mental health, including (but not limited to) employment status, existing health status, income and education. The study reported that a one standard deviation increase in the percentage of greenspace (equivalent to an area with 81% compared with 48% greenspace) in a lower super output area (LSOA) leads to a 0.14 reduction in GHQ-12 scores.

In order to estimate a value for the associated mental health benefits:

1. The dose-response relationship from White *et al.* (2013), describing the point change in GHQ-12 in association with local greenspace, is used with data on the proportion of greenspace in local areas to give estimates of average percentage improvements in mental health across local areas. A key part of this involves assuming a linear relationship between the percentage of available greenspace and mental health.

2. The economic value is estimated based upon NHS spending costs on mental health.

   For London's accounts (Vivid Economics, 2017), costs are based upon England-wide estimates for mental health-related spending costs from the Centre for Mental Health (2010). These include estimates of health and social care spending, covering services provided by the NHS and local authorities. They are scaled to costs per person and aggregated to the relevant population size for London LSOAs.

   For Manchester's NCAs (Dickie *et al.*, 2018), costs are taken from estimates of mental health-related spending in Greater Manchester.

   To calculate changes in costs, the estimates of percentage improvements in mental health due to greenspace are used to imply the same percentage reductions in costs.

London's greenspaces were estimated to deliver £370 million per year in avoided mental health costs (Vivid Economics, 2017) (Figure 5). Manchester's greenspaces were estimated to deliver £264 million per year in avoided mental health costs (Dickie *et al.*, 2018). Other approaches to valuing mental health in relation to woodlands and greenspace from the first phase of the research project can be found in Appendix 2. The other approaches discussed in Appendix 2 are not considered here, due to issues relating to double counting and the feasibility of data collection.

Figure 5 Trees are important components of urban greenspaces.

For the purposes of this report, the research reported by Vivid Economics (2017) is used to represent the proportion of greenspace pathway, because of its more conservative estimates of the benefits per person compared with those recorded for Manchester.

Forest bathing/therapy

Another pathway concerns research regarding the effects of forest therapy and other woodland-based interventions on individuals with poor mental health.

A variety of woodland-based interventions, including group activities performed in woodland settings, have also been found to be cost-effective in the improvement of mental health (Greenspace Scotland, 2011; CJC Consulting, 2016). Qualitative analysis of these types of programmes also tends to highlight a wide range of important well-being benefits for participants (O'Brien, 2018). The mechanisms that drive this relationship can be much broader than the woodland setting itself, with aspects such as the activities that people perform and group socialisation being important components. Thus, attributing their entire benefit to woodlands may be misleading.

Forest bathing is consistently found to be beneficial in the alleviation of anxiety (Kotera, Richardson and Sheffield, 2020) and can be similarly beneficial for the alleviation of stress (Antonelli, Barbieri and Donelli, 2019). Recently, the first controlled trial of forest bathing was performed in the UK, demonstrating an increase in heart rate variability as well as improvements in positive emotions, nature connection and compassion (McEwan *et al.*, 2021). However, the definition of forest bathing can be very broad and difficult to define precisely. Forest bathing is often recognised as more involved than simply walking in nature (Kotera, Richardson and Sheffield, 2020), but there is no standardised approach as to what constitutes a forest bathing session (Figure 6). The diverse forms that forest bathing takes can pose difficulties when considering how to scale up findings.

Forest therapy, taken as medical professionals leading therapeutic programmes such as cognitive behaviour therapy in a woodland environment, has a narrower definition, and this is easier to conceptualise when scaling up the mental health benefits from these types of programmes. Rosa *et al.* (2021) conducted a meta-analysis

Figure 6 Forest bathing, or taking in the forest atmosphere, is a physiological and psychological exercise that emerged in Japan as 'Shinrin-yoku' (literally 'forest bath') in the 1980s.

to explore the effects of forest therapy on depression in randomised controlled trials (RCTs) that used remission data (n = 51). Participants in the woodland groups were 17 times as likely to achieve remission compared with those who received only traditional outpatient treatment in the form of being prescribed antidepressants (risk ratio (RR) = 17.02). Compared with the same treatments performed in a hospital setting, participants in the woodland group were still twice as likely to achieve remission (RR = 1.97).

Although these findings are promising, it is difficult to estimate the current aggregate benefits of forest therapy because of a lack of data on participation and how widespread these programmes are in the UK. Compared with the number of individuals that regularly visit woodlands, this pathway is likely to contribute only a small proportion of the overall mental health value of woodlands due to the limited numbers of participants and interventions. It is important to note that almost all the research on forest therapy and bathing to date has been undertaken in East Asia, primarily Japan and South Korea.

Because of current difficulties in estimating the aggregate benefits, this pathway has not been used for the monetisation of mental health benefits of woodlands in this study, but may present an opportunity for future research.

Pathways summary

Table 1 provides a summary of the research behind the five defined pathways discussed above. The four of these that could be quantified are used to produce estimates of the mental health benefits of woodlands in the following sections.

Costing mental health

A consistent theme encountered is the lack of empirical research quantifying mental health outcomes that are directly monetisable. Exceptions to this are studies exploring the association between antidepressant prescriptions and street trees, where the prices of antidepressants can be directly observed, and forest therapy research, where treatment costs can be calculated.

Table 1 Summary of the mental health research used within pathways.

Pathway	Description
Visits to nature	Shanahan *et al.* (2016) reported that visits to outdoor greenspace of 30 minutes or more per week are associated with a reduction in the prevalence of depression in the population of 7%.
Physical exercise	Findings from the MOVES tool developed by Sport England (2016) suggest that, on average, adults in the UK can reduce their incidence of depression by 0.67% by walking two hours per week.
Antidepressants and street trees	Taylor *et al.* (2015) reported a decrease of 1.18 prescriptions per thousand population per unit increase in trees per kilometre of street in London.
Proportion of greenspace	White *et al.* (2013) found improvements in mental health in areas with a greater proportion of greenspace. Vivid Economics (2017) adopted these findings, and applied estimates of avoided mental health spending in London, to estimate a mental health value of greenspace in London of £370 million.
Forest bathing/therapy	Not quantified due to lack of data.

A range of antidepressants, with varying prices, can be used to treat depression and anxiety. A summary from Viavattene and Priest (2020) presents drug costs per patient per year, ranging from £9.36 to £7820. A mid-value estimate of these NHS drug costs is £23 per patient per year (at 2017 prices). Drugs to treat severe depression are typically those with higher costs, with the £23 figure more closely reflecting costs associated with moderate and mild depression and anxiety. However, these costs still only represent a fraction of the overall direct costs associated with living with a MHC.

A more comprehensive approach to applying the direct costs of mental health is by using research that has observed changes in the incidence of specific MHCs, and that has then produced estimates on the wider costs associated with those individual MHCs.

A report from the Environment Agency, exploring approaches to monetise the mental health costs of flooding, demonstrates how this methodology can be applied by creating cost profiles associated with different MHCs (Viavattene and Priest, 2020). These costs are based on treatment, social care and NHS-related costs, as well as employment-related costs from increased numbers of sick days. Appendix 3 contains further information on evidence relating to the costs of mental health.

Treatment-based costs

A study from McCrone *et al.* (2008) explores the costs of mental health care in England for various MHCs. Data were taken from the Adult Psychiatric Morbidity Survey (APMS) and national datasets, concerning the costs associated with a range of treatments with varying access to services, in order to produce weighted annual treatment costs. Services include visits to GPs, prescribed drugs, inpatient care, supported accommodation and social services, as well as contact with a range of professionals and other costs. The costs allow for the fact that most individuals with these conditions have low costs due to the relatively minor nature of the treatment generally involved. The report gives the following estimates:

- The average annual treatment cost associated with depression is £2085 per person (at 2007 prices).
- The average annual treatment cost associated with anxiety is £1104 per person (at 2007 prices).

The report presents figures associated with a range of other MHCs. For the purposes of this Research Report, depression and anxiety are most relevant as they are the most widespread MHCs, and are also the MHCs that most of the research exploring the mental health impacts of the environment are focused on.

Employment-based costs

The latest figure for the average number of annual working days lost due to sickness and injury in the UK is 4.4 days (ONS, 2018). The latest figure for the number of annual working days lost from individuals self-declaring reasons of stress, depression or anxiety is 21.6 days (Health and Safety Executive, 2020). We estimate the excess average annual working days lost from individuals with depression or anxiety to be 17.2 days (i.e. the difference between the two).

Viavattene and Priest (2020) take estimates on excess lost working days and calculate annual costs based on the assumption of a 7.6-hour working day at the national living wage. A less conservative approach could adopt the median hourly wage for an adult working full time, rather than the national living wage. We favour the more conservative approach of using the national living wage, as individuals with MHCs in the UK are typically from lower income households (Mental Health Foundation, 2016). Calculations for this follow in the next section.

Other approaches to explore employment-based costs include examining economic inactivity due to MHCs (McCrone *et al.*, 2008), although these figures are larger and are more likely to overlap with calculations for excess working days lost. There is also complexity when attributing reasons for economic inactivity, as there are often multiple factors that can contribute in addition to the presence of MHCs. Excess working days lost is a more conservative and robust approach with higher confidence, and as such it is the preferred approach to incorporate employment-based costs, although it may underestimate the true value.

Cost profiles

For the purposes of this study annual depression and anxiety-related cost estimates are derived as follows.

Treatment costs are taken from McCrone *et al.* (2008) and adjusted to 2020 prices using the UK Government's gross domestic product deflator (GDP) series (HM Treasury, 2021).

Prices are also adjusted based on the percentage of individuals with depression and anxiety that actually seek and receive treatment for their MHCs. According to

the latest APMS (McManus *et al.*, 2016), only 48.2% of individuals receive treatment for anxiety and 59.4% for depression. On this basis:

- Average annual costs for treatment per person are estimated at £1640 for depression and £705 for anxiety (at 2020 prices).

To estimate costs associated with excess working days lost, the national living wage for an adult in 2020 is used (£8.72 per hour).

We multiply the national living wage per hour by 7.6 for an estimate of the value of a lost day (£66.27). Multiplied by excess working days lost for depression and anxiety, this gives the following estimate:

- Average annual employment-related costs of £1140 for depression or anxiety (at 2020 prices).

We also highlight £25 (adjusted to 2020 prices) as a value that we noted above for the median annual cost of anxiety- and depression-related drugs. This can be applied as a very conservative cost when uncertainty is especially high.

The overlap between MHCs is well documented, and this has implications when considering how to combine costs for both depression and anxiety. Data from the APMS 2007 explored the co-occurrence of multiple MHCs, summarised by Viavattene and Priest (2020). It was reported that 25.6% of respondents with probable diagnoses of depression and anxiety had both conditions, although this was based on a relatively small number of respondents (n = 519), and estimates are not available in the 2014 APMS dataset.

- When combining both anxiety- and depression-related costs, a simple approach is adopted, whereby the final cost figure is multiplied by 0.744.

Beyond depression and anxiety diagnoses, an additional 7.8% of the population have a common mental health disorder that is not otherwise specified (CMD-NOS) (McManus *et al.*, 2016). A CMD typically comprises a mixture of lower level depression and anxiety, for which a smaller percentage of individuals typically seek treatment (27.2%). The mean revised Clinical Interview Schedule (CIS-R) score, used to measure symptom severity, for people with CMD-NOS was 16.2, compared with 26.8 for depression.

We provide a very approximate indicative estimate of the costs associated with CMD-NOS based upon the average annual treatment costs of depression and anxiety, weighted by the percentage of individuals that seek treatment (27.2%).

- This gives an annual per person estimate for the cost of treatment of CMD-NOS of £574 (at 2020 prices).

To estimate employment costs utilising findings from CIS-R and treatment-seeking data, we assume excess working days lost from CMD-NOS as 50% of the average number of working days lost from individuals with anxiety and depression.

- The value of annual excess working days lost due to CMD-NOS is therefore estimated at £570 (at 2020 prices).

Results

Four pathways are presented in considering how to scale up avoided mental health costs to provide approximate indicative estimates of the annual value of the mental health benefits of the UK's woodlands.

Visits to nature

Shanahan *et al.* (2016) reported that visits to outdoor greenspace of 30 minutes or more per week could reduce the prevalence of depression in the population by 7%. This percentage is applied to the annual estimates of depression-related costs, to estimate avoided costs.

To estimate the prevalence of depression, the authors explored reductions in DASS scores, a scale which can also measure anxiety- and stress-related disorders. We extrapolate the findings of this research by assuming that visits also lead to a 7% reduction in anxiety-related costs as well as CMD-NOS-related costs.

We assume that the findings of reductions in MHC prevalence from visits to the outdoors apply equally to visits to woodlands as to other outdoor visits.

Data from the latest Public Opinion of Forestry (POF) survey are collected at country level regarding the proportion of adults that access woodlands at least once a year. These proportions are 63% in England, 84% in Scotland, 84% in Wales and 77% in Northern Ireland. Questions are also asked regarding the proportion of respondents that regularly visit woodlands at least several times a month (Forest Research, 2019). These proportions are 37% in England, 51% in Scotland and 37% in Northern Ireland. This question is not asked in the POF survey for Wales, although we can estimate this based on data from Northern Ireland and Scotland due to similarities concerning the proportions of adults that access woodlands at least once a year. This gives an estimate of 44% for Wales.

For the purpose of deriving preliminary rough indicative estimates of the impacts of woodlands, we assume that (i) visits made at least several times a month are equivalent to visits of at least 30 minutes per week; and (ii) people visiting woodlands are representative of the general population in terms of susceptibility and (other factors being equal) incidence of MHCs.

We make these assumptions on the basis that over 50% of visits to the outdoors in England are typically longer than one hour (Natural England, 2020a) and as such it is likely that visits made several times per month would exceed visits of 30 minutes per week in total minutes. Data are not available on visiting habits to woodlands made by people with specific MHCs, although data from the POF survey reveals that more than 90% of respondents during the past 10 years have consistently agreed that woodlands are important in helping them relax and de-stress (Forest Research, 2019). Given their importance for mental health benefits, we assume that these visiting habits among individuals with MHCs are at least equivalent to those for the general population.

Data on the total number of adults across the UK are taken from the 2019 ONS mid-year estimates (ONS, 2020a). Data concerning adults living with depression (3.3%), anxiety (5.9%) or CMD-NOS (7.8%) are taken from the APMS (McManus *et al.*, 2016).

Based upon the above data, we can estimate the numbers of adults that regularly visit woodlands across each country with these MHCs, assuming an even representation of MHCs across each country.

These estimates are multiplied by 0.07 to give the reductions in prevalence of the three MHCs as a result of regular visits. These are then multiplied by the associated avoided treatment and working day losses. When applying the costs for working day losses, only the average working population is used (adults aged 16–64 years), rather than the total adult population. To account for co-occurrence of the three MHCs, the resulting estimate is multiplied by 0.744.

The final figure, representing the annual mental health value of the UK's woodlands via avoided anxiety-, depression- and CMD-NOS-related costs, is £185 million (at 2020 prices). At country level and rounded to the nearest million, this is distributed as £141 million for England, £26 million for Scotland, £13 million for Wales and £6 million for Northern Ireland.

Advantages and limitations

The visits to nature pathway focuses on the value associated with woodlands using estimated visit data from the POF survey, and is similar to the methodology for recreational value in Woodland NCAs (ONS, 2020b). The pathway is not as limited by issues concerning locally specific variables associated with proximity-based methodologies. Scaling is performed using estimates of UK-wide visit data and is therefore more reliable than London-based population scaling approaches. The pathway can also be readily repeated and updated as annual visiting habits change.

The limitations and assumptions associated with this pathway are detailed in Table 2.

Physical exercise

Findings from the MOVES tool developed by Sport England (2016) suggest that, on average, adults in the UK can reduce their incidence of depression by 0.67% by walking two hours a week. The same pathway for scaling is adopted as for the visits to nature pathway, using depression, anxiety and CMD-NOS costs and the proportion of adults across the UK that regularly visit woodlands. We assume that the activity taking place during these visits would, at a minimum, be walking.

The final estimate for the associated annual mental health benefits of the UK's woodlands for reduction of anxiety-, depression- and CMD-NOS-related costs due to increased exercise is £18 million (at 2020 prices). Disaggregating this value based on woodland-visiting habits and the population size of the different countries gives a value for England of £14 million, £2 million for Scotland, £1 million for Wales and £500 000 for Northern Ireland (rounded to the nearest million, or hundred thousand if lower than £1 million).

Advantages and limitations

The physical exercise pathway represents a conservative estimate for the value of woodlands. Exercise is a well-recognised pathway to improve mental health, where changes in the incidence of MHCs can be directly observed as a result of increased exercise. The approach adopted to scale these findings has similar advantages to the visits to nature pathway. The physical exercise pathway has notable limitations (Table 3).

Table 2 Limitations of the visits to nature approach.

Limitation	Likely impact on valuation estimate
Mental health impact methodology	
Study by Shanahan *et al.* (2016) uses a self-report online survey to measure mental health, which can be affected by a variety of factors. Longitudinal methodology can control for these variables far more effectively.	Uncertainty
Study by Shanahan *et al.* (2016) is based in Australia. Findings may not be wholly representative for residents in the UK.	Uncertainty
Rather than observing mental health changes in a directly monetisable outcome, changes are observed on a mental health scale. Scores on the scale are converted to binary scores (likely depression or unlikely depression) to explore and estimate changes in the prevalence of depression.	Uncertainty
Some people with MHCs may actively choose to seek out woodlands and other natural environments for their calming effects (White *et al.*, 2021). This would imply that visitors to woodlands may be more likely to have MHCs than the general population average. As our estimate for the number of woodland visitors with MHCs is based on average MHC incidence across the population, our calculations may underestimate benefits.	Underestimate
Costing/scaling methodology	
Findings from Shanahan *et al.* (2016) on depression are applied equally to anxiety and CMD-NOS.	Uncertainty
Findings from Shanahan *et al.* (2016) on visits to greenspace are applied equally to visits to woodlands.	Uncertainty
A range of assumptions are made to estimate the numbers of regular visitors to woodlands with MHCs, including visit frequency and visiting habits for those with MHCs.	Uncertainty
The extent to which co-occurrence interacts across depression, anxiety and CMD-NOS is not well understood.	Uncertainty
Estimates are scaled based on the proportion of people that make several visits to woodlands a month all year round. The majority of visits to woodlands take place during summer (Forest Research, 2019). For people with variable visiting habits during a typical year, values will not be representative.	Underestimate

Abbreviations: CMD-NOS, common mental health disorder not otherwise specified; MHC, mental health condition.

Table 3 Limitations of the physical exercise approach.

Limitation	Likely impact on valuation estimate
Mental health impact methodology	
There are limited quantitative data on reduced incidence of MHCs through exercise. Data used to calculate these changes in the MOVES tool may not be wholly accurate.	Significant uncertainty
Widespread intensive activities performed in woodlands such as running or cycling are not represented, which, solely through exercise, would generate significantly greater mental health benefits than walking through physical exercise alone.	Underestimate
Costing/scaling methodology	
A range of assumptions are made to estimate the numbers of regular visitors to woodlands with MHCs, including visit frequency and visiting habits for those with MHCs.	Uncertainty
Existing activity levels for regular woodlands visitors cannot be factored in.	Uncertainty
The extent to which co-occurrence interacts across depression, anxiety and CMD-NOS is not well understood.	Uncertainty
Findings are only scaled based on the proportion of people that make several visits to woodlands a week all year round. The majority of visits to woodlands are conducted during summer (Forest Research, 2019). For people with variable visiting habits during a typical year, values are not represented.	Underestimate
The approach to estimate the prevalence of weekly visits to woodlands of 120 minutes in length is likely to be conservative, as values are not captured for those who exceed this threshold, whereby the benefits may be expected to be greater.	Underestimate

Abbreviations: CMD-NOS, common mental health disorder not otherwise specified; MHC, mental health condition.

Antidepressants and street trees

Taylor *et al.* (2015) report a decrease of 1.18 prescriptions per thousand population per unit increase in trees per kilometre of street. Multiplying by the average trees/km in London (40.2, as given in Taylor *et al.*, 2015) and the population of London in thousands (8908), gives a figure of 422 560 antidepressant prescriptions avoided in London. Data from Public Health England report that 51% of antidepressant prescriptions are received for three months or less (Public Health England, 2020). Based upon this, for the purposes of deriving approximate estimates of mental health-related costs, we make the assumption that four antidepressant prescriptions are equivalent to one year's worth of average antidepressant drug costs.

A significant feature of this pathway is that the relationship reported in Taylor *et al*. (2015) is only marginally significant and that the relationship is likely driven by a limited number of data points. There are likely significant factors contributing to this relationship that were not measured in the research. Due to these limitations, we adopt a conservative approach when deriving initial indicative estimates based upon the median annual cost of annual drug prices alone, rather than the wider costs of MHCs.

Based purely upon a median estimate of annual NHS prescription costs for antidepressants of £25 per patient (adjusted to 2020 prices), the annual NHS saving arising from the presence of street trees is estimated at £2.68 million for London (at 2020 prices). Extrapolating this to the UK based on population differences and multiplying this figure by 7.55, we attain an annual value of £20.3 million. This is further adjusted based on the urban population of the UK, as the research from Taylor *et al.* (2015) is London-based and may not be representative of rural areas. Data on the urban: rural population ratio of the UK is collected at country level for England (Defra, 2020), Scotland (National Records of Scotland, 2020), Wales (Welsh Government, 2015) and Northern Ireland (Northern Ireland Statistics and Research Agency, 2020). This gives £16 million as the value of UK urban street trees through avoided antidepressant costs. At country level, these values are £14 million for England, £1 million for Scotland, £600 000 for Wales and £400 000 for Northern Ireland (rounded to the nearest million, or hundred thousand if lower than £1 million).

For comparative purposes, if the average annual anxiety- and depression-related costs developed in the Cost profiles section (page 7), were adopted rather than solely drug prices, then using the same methodology, the UK figure would be £1.5 billion at 2020 prices. At country level, the values would be £1.3 billion for England, £110 million for Scotland, £53 million for Wales and £33 million for Northern Ireland.

Advantages and limitations

The antidepressants and street trees pathway's main advantage is that antidepressants can be taken as a direct indicator of the presence of a MHC (depression or anxiety), rather than having to estimate the presence of a MHC from a scale. Antidepressants can act as a reliable and conservative indicator for the prevalence of MHCs and their associated costs. There are, however, significant limitations and uncertainties with this pathway (Table 4). It should be noted that this pathway only relates to woodlands under a broad definition encompassing all greenspaces where trees are a prominent feature – including street trees. This may be regarded as a limitation.

Proportion of greenspace

This pathway considers the proportion of greenspace approach. This is based upon the approach adopted by Vivid Economics (2017).

Rather than using the costs we develop in the Cost profiles section (page 7), we adopt the costs used for London by Vivid Economics (2017), as these are already intrinsically linked to the proportion of greenspace.

The £370 million figure for London, from estimates of mental health spending costs in 2010 (Centre for Mental Health, 2010), is multiplied by 7.55 to extrapolate to the UK based on population differences between London and the rest of the UK. This gives a figure of £2.79 billion, representing the total mental health benefit of greenspace in terms of avoided mental health-related costs.

It is difficult to directly apportion a value to the UK's woodlands due to the lack of studies on the influence of woodlands on mental health compared with greenspace more generally, or datasets on the use and proximity of different types of greenspace in the UK. However, for the purposes of this study, a crude assumption is adopted based on average visit data over 10 years from the Monitor of Engagement with the Natural Environment (MENE) survey. Of visits to greenspace over the past 10 years (to playing fields, countryside, country parks, farmland, mountains/hills, urban parks and woodland), 14.1% of these were made to woodlands (Natural England, 2020a).

Taking the figure for the value of UK greenspace and multiplying by the proportion of visits to greenspace that are to woodlands gives £394 million at 2010 prices. Similar to the antidepressants and street trees approach, this value can be modified based on the urban population of the UK. Estimates can also be adjusted to 2020 prices. This gives a final value for the UK of £394 million as the annual value of woodlands (based on the proportion of all greenspace visits) through avoided mental health spending costs. This value can also be disaggregated by country, based on urban populations. This gives values for England of £342 million, £29 million for Scotland, £14 million for Wales and £9 million for Northern Ireland (rounded to the nearest million).

Table 4 Limitations of the antidepressants and street trees approach.

Limitation	Likely impact on valuation estimate
Mental health impact methodology	
The relationship between antidepressants and street trees is only marginally significant and is based on a few data points in Taylor *et al*. (2015). There are potential unmeasured factors that influence this relationship, including population density and neighbourhood quality measures such as reduced vandalism and traffic.	Significant overestimate
It is very difficult to control for all locally specific variables with a proximity-based approach.	Uncertainty
The relationship between presence of street trees and mental health is assumed to be linear.	Uncertainty
The association may not be wholly representative, as people with MHCs may actively choose to live in areas with a greater density of street trees or greenspace as part of self-treatment (White *et al.*, 2021).	Uncertainty
Costing/scaling methodology	
Scaling value to the UK is performed crudely. Findings in London may not be representative of the rest of the UK.	Uncertainty
Using prescription costs only is likely to be an underestimate of the total costs avoided from street trees.	Underestimate

Abbreviation: MHC, mental health condition.

Advantages and limitations

The main advantages of the proportion of greenspace approach to valuing mental health benefits relate to adoption of the White *et al.* (2013) methodology in analysing the mental health impact. The latter study analysed changes in the mental health of individuals associated with the percentage of nearby greenspace within a longitudinal dataset, with the ability to control for a wide number of variables. There are limited examples of longitudinal analysis in the UK exploring the relationship between greenspace and changes in mental health.

Table 5 summarises some of the limitations of this approach. Limitations are considered in terms of applicability for the aims of this project as well as limitations within the methodologies themselves, and the impact on final valuation estimates is also considered.

Valuation summary

Table 6 summarises the limitations discussed for each pathway by ranking each pathway for confidence relative to the others across different criteria. Table 7 summarises values across different valuation pathways at country and UK level.

Finally, we also present some indicative estimates of the natural capital asset value of mental health benefits due to woodland and trees (Appendix 4). These are the first of this kind for the UK and its constituent countries and may be a first step towards including mental health benefit values in national natural capital accounting. The estimate for asset value through the visits to nature pathway is just over £11 billion. The aggregate estimate for the visits to nature and antidepressants and street trees pathways is just over £12 billion.

Table 5 Limitations of the proportion of greenspace approach.

Limitation	Likely impact on valuation estimate
Mental health impact methodology	
Not focused on woodlands. Greenspace is used as an inclusive term for a variety of environments. Excluding private gardens from the calculations halved the estimated benefit of mental health.	Overestimate
Not all potential explanatory variables can be controlled for, and thus causality cannot be assumed. Furthermore, the mechanisms through which benefits are delivered (e.g. increased usage and increased physical activity, non-use and visual amenity benefits) are not fully understood.	Uncertainty
It is very difficult to control for all locally specific variables with a proximity-based approach.	Uncertainty
The relationship between the amount of available greenspace and mental health is assumed to be linear.	Uncertainty
The association may not be wholly representative, as people with MHCs may actively choose to live in areas with a greater density of street trees or greenspace as part of self-treatment (White *et al.*, 2021).	Uncertainty
Costing/scaling methodology	
Costs are inclusive of all mental health spending costs. Changes in GHQ-12 are mostly linked to minor psychiatric disorders (i.e. depression and anxiety).	Overestimate
Changes in GHQ-12 due to greenspace are assumed to act evenly across the population. In practice, individuals with mental health problems (to whom the assumed costs apply) may react differently to greenspace than the general population.	Uncertainty
Costs are not necessarily directly linked to changes in mental health. Rather than observing changes in a directly monetisable outcome, changes are observed on a mental health scale. A simple approach is adopted, where percentage change across the scale is taken as percentage change in costs.	Uncertainty
Scaling value to the UK is performed crudely. Findings in London may not be representative of the rest of the UK.	Uncertainty
Value for woodlands is taken as the proportion of visits to greenspace that are typically to woodlands, instead of the actual coverage of woodland across greenspace.	Significant uncertainty
Costs do not take into account employment-based losses through inactivity or excess sick days.	Underestimate

Abbreviations: GHQ, General Health Questionnaire; MHC, mental health condition.

Table 6 Confidence of pathways to value the UK's woodlands through direct mental health costs.

Pathway	Mental health impact confidence	Costing/ scaling confidence	Relevance for mental health benefit in the UK's woodlands	Ease of measurement and repeatability	Overall rank
Visits to nature	1	1	1	1	1
Physical exercise	2	2	2	1	2
Antidepressants and street trees	3	3	3	3	3
Proportion of greenspace	4	4	4	4	4

Note: the pathways are ranked relative to each other (1 = best, 4 = worst).

Table 7 Summary of estimated values of mental health benefits of the UK's trees and woodlands in terms of avoided costs using different pathways.

Pathway	Value description	England	Scotland	Wales	Northern Ireland	UK	Overall rank
Visits to nature	Annual value of woodlands: avoided anxiety-, depression- and CMD-NOS-related costs.	141	26	13	6	185	1
Physical exercise	Annual value of woodlands: avoided anxiety-, depression- and CMD-NOS-related costs due to increased exercise.	14	3	1	0.5	18	2
Antidepressants and street trees	Annual value of urban street trees: avoided costs of drug prescriptions.	14	1	0.6	0.4	16	3
Proportion of greenspace	Annual value of woodlands (based on proportion of all greenspace visits): avoided mental health expenditure.	342	29	14	9	394	4

Abbreviation: CMD-NOS, common mental health disorder not otherwise specified.

Note: figures in the country columns are £ million at 2020 prices, rounded to the nearest million or hundred thousand if less than £1 million.

Discussion

The figures presented in the results summary are of an equivalent order of magnitude to estimates for similar ecosystem services. For comparison, recreational visits to woodlands from the UK's Woodland NCAs were valued at £516 million for 2017 (at 2018 prices) (ONS, 2020b), equivalent to £557 million at 2020 prices. Research has also explored the physical health benefits from visits to nature associated with increased regular exercise, converting activity levels into increased QALYs, which can be readily monetised. An estimate for the annual value of visits made to England's natural environments is given as £2.18 billion, assuming a conservative QALY value of £20000 (White *et al.*, 2016), equivalent to £2.46 billion at 2020 prices. The value of mental health benefits associated with woodland visits is equivalent to approximately 7.5% of this figure for physical health benefits from all visits to nature (at 2020 prices).

Representing the value of woodlands through avoided mental health costs comes at an important time societally. Mental health spending in England has risen from £11.0 billion in 2015–6 to a planned £14.0 billion in 2020–1 (NHS England, 2021), reflecting both an increase in the importance of tackling mental health as a problem as well as the growing burden of mental health issues across society.

In light of the COVID-19 pandemic, the population prevalence of clinically significant levels of mental distress has risen significantly (Pierce *et al.*, 2020). Access to woodlands and nature has emerged as an important outlet for individuals to support and maintain their well-being (O'Brien and Forster, 2020). Of the pathways that we present, those that are scaled up based on the proportion of individuals that regularly access woodlands have the capacity to account for these changes through annual updates to reflect visit patterns.

Limitations around costing mental health

During our review, evidence on the costs of mental health or costs associated with individual MHCs was scarce. The most relevant source we identified to use for treatment costs was over a decade old and may not be wholly reflective of the current landscape of mental health in the UK today. For example, there may be significant numbers of people that seek treatment for MHCs privately, through mental health programmes through their employers or through charities, which are not captured through our costs. It is also likely that the true number of excess working days lost because of MHCs will be underestimated, due to the prevailing cultural stigma of people not wanting to disclose mental health issues as a reason for missing work. Given these issues, the costs that we use are likely to be an underestimate of the true scale of MHC costs.

Employment-related costs of MHCs can be updated annually with the latest figures on working days lost and in line with increases in wages. Updates on treatment-related costs of MHCs require further research.

Limitations and areas for improvement in the pathways

The figure presented through the visits to nature pathway is ranked as the most reliable with the fewest large assumptions required for the methodology itself; the closest relevance to the project aims; and the best pathway for ease of measurement and repeatability. The value is also likely an underestimate, given that the value through this pathway is estimated based only on regular visitors to woodlands throughout an entire year. The pathway has long-term monitoring potential, using data on visits to woodlands, and represents a woodland-specific mental health value.

To scale up this pathway, a key data requirement is estimating the number of regular visitors to woodlands that meet the required threshold of exposure (>30 minutes/week). Currently, only the POF survey asks questions specific enough to perform these estimations. A limitation of the POF survey is that its sample size is relatively small compared with other national level environmental surveys (Forest Research, 2019). In 2019, the POF survey in England covered 1800 respondents, the one in Wales 1000 and the one in Northern Ireland 1000. In Scotland, 1000 respondents participated in 2017, in the latest POF survey undertaken there. The POF survey is conducted separately across the UK countries, each with its own slightly different version. The latest edition of the POF was released in July 2021, after analysis in this research was finalised.

By comparison, the People and Nature Survey (PANS) England aims to sample up to 25000 adults during 2020–1 (Natural England, 2020b), and when it was running, the MENE survey sampled at least 45000 adults every year over 10 years (Natural England, 2020a). In both of these larger surveys, it is more difficult to understand visitor behaviour specifically in relation to engagement with woodlands. Total annual visits to woodlands can be estimated through questions posed in these surveys, but understanding the number of individuals that visit woodlands at different frequencies is not possible.

At a sample size of only 1000, the ability to perform valid statistical analysis across frequency of visits may be reduced, although this ability improves at sample sizes of 2500 and 5000 (Saraev *et al.*, 2021). An improvement to the visits to nature pathway could be made with an increase to the sample size of the POF survey so that it is more representative across the UK's constituent countries, or by additional questions being added to the PANS to help understand visit frequency to specific natural environments and woodlands in particular.

Another improvement would be developing longitudinal, UK-based research that explores changes in mental health or the prevalence of MHCs in relation to visits to woodlands or the natural environment. This would improve upon the current cross-sectional research, with an ability to robustly explore the confounding effects of variables that complicate dose-response relationships (Dzhambov *et al.*, 2020), as well as making the research that underpins this pathway UK-specific. Other improvements could include development of a more reliable estimate for individuals with MHCs making regular visits to woodlands. Currently, this is taken as a proportion of population-wide MHC estimates and does not account for potential differences in the visiting habits of people with MHCs.

Another important limitation to note is the fact that people with MHCs may actively choose to seek out these places for the calming effects they have (White *et al.*, 2021), which may underestimate the overall magnitude of benefit that visits to woodlands can deliver for people's mental health.

Use of a mental health scale for evaluating mental distress can mitigate this effect more than a measure such as antidepressant medication, because a mental health scale can provide a more up-to-date snapshot of an individual's mental health. This effect can be observed in findings from White *et al.* (2021), where depression medication was marginally negatively associated with an increased visit frequency to greenspace, while anxiety medication was positively associated.

For performing future work around visits to nature and mental health in the UK, there are longitudinal datasets that have regularly collected data related to anxiety (Natural England, 2020a), and the prevalence of self-reported MHCs (Scottish Government, 2020) in relation to visits to nature. However, using the prevalence of MHCs may underestimate the overall association for the reasons stated above. Other secondary datasets in this area include the Welsh Secure Anonymised Information Linkage (SAIL) databank, which could also be explored to link residential proximity to woodlands to improvements in mental health.

The MOVES tool used to calculate the reduced risk of depression in the physical exercise pathway is effective at presenting the well-researched areas of health benefits from exercise, such as reduced incidence of type 2 diabetes, heart disease and stroke. However, the reduced risk of depression from exercise is less well researched. The dose-response function for exercise and depression used in MOVES is based on data from a longitudinal research study on male Harvard graduates from 1962 to 1988 (Paffenbarger, Lee and Leung, 1994); note that, as well as the study not being representative of the UK population, it took place at a time when mild to moderate cases of depression were not as well recognised as they are now. The authors acknowledge that modelling changes in depression are based on limited point estimates and that this could be an underestimate (Sport England, 2016).

This dose-response relationship could be significantly improved in the future, with research that does not need to be specific to engagement with the environment. In practice, physical exercise could provide a direct and robust link when exploring changes in the incidence of MHCs. The pathway does not rely on estimation of the likely presence or absence of MHCs through self-reported mental health scales in the same way that the visits to nature pathway does.

The pathway is conservative in estimating the physical activity performed during visits to woodlands. Because of the lack of available data on activities performed in woodlands in conjunction with visit frequency, only mental health benefits of walking as a form of physical exercise are estimated. Gathering more detailed data across national level environmental surveys on active visits to the natural environment and woodlands is an area that could usefully

be improved in monitoring and valuing the health benefits of environmental visits. The key requirements to enable this are the incorporation of questions related to the intensity, frequency and duration of the activities performed (Moseley *et al.*, 2018). With this type of information, the benefits of physical and mental health could be calculated simultaneously with the same data.

A limitation of this pathway remains, however, in that it cannot capture mental health benefits delivered through non-exercise-specific channels and as such would underestimate the overall benefit. These non-exercise mental health benefits are known to be substantial (Kotera, Richardson and Sheffield, 2020; McEwan *et al.*, 2021).

The proximity-based figures, from the proportion of greenspace, and antidepressants and street trees pathways, are scaled more crudely than the visit-based measures, as the research used was London-centric. These pathways also have a greater level of overall uncertainty associated with them, with the influence of locally felt variables being substantial and difficult to control for (Taylor *et al.*, 2015), and uncertainty regarding the extent to which factors such as increased visits to nature may affect the relationship (White *et al.*, 2021). High uncertainty in the antidepressants and street trees pathway justifies the use of drug costs alone rather than the full costs of MHCs, to avoid distorting confidence in other pathways and reducing the clarity of our findings. While the approach focused upon is likely to underestimate the value of the mental health benefits, for sensitivity analysis, the effect of adopting a full costs approach instead is reported in the antidepressants and street trees results section.

To improve these pathways, further research could be undertaken across more representative parts of the UK, rather than just London. There have been more recent cross-sectional studies that have examined greenspace and mental health in the UK and internationally (Sarkar, Webster and Gallacher, 2018; White *et al.*, 2021), but White *et al.* (2013) remains the leading example using longitudinal methodology. Findings from White *et al.* (2013) could be applied across multiple UK cities and a different costing methodology could be applied to the one adopted in Vivid Economics (2017), although the limitation of its strong greenspace focus rather than trees or woodland would remain.

The methodology adopted by Taylor *et al.* (2015) used in the antidepressants and street trees pathway could be similarly applied across multiple areas in the UK to be more representative when scaling. A requirement for this would be collecting data on street tree prevalence, which are typically collected on a council-by-council basis, requiring access to be requested individually. In addition, there may be discrepancies and inaccuracies in how data are collected across different councils. There are, however, advances being made in remote sensing to develop spatial datasets on tree canopy cover across the UK, such as with the i-Tree Canopy tool (i-Tree, 2021). In the future, exploring street tree data in association with indicators of MHCs, such as antidepressant prescription prevalence, or even other indicators such as the prevalence of therapies, could be performed effectively with a national street tree dataset.

Aggregating estimates across different pathways

There is scope to consider the extent to which estimated values from proximity-based pathways can be complementary to those from visit-based approaches. Whereas visit-based approaches can be conceptualised as capturing primarily direct use values, proximity-based approaches are more likely to also capture some non-use values of woodlands. It is possible that individuals who live in an area with a greater density of street trees might also make more frequent visits to woodlands than the average person, as their choice of where to live reflects a greater appreciation of such greenspaces. Alternatively, they may make fewer woodland visits because they consider there is less need, as there are more street trees where they live, which to some extent substitute for such visits. Were it the case that such individuals tended to be more regular visitors to woodlands, estimating the 'full' mental health benefit from both of these separate pathways by aggregating benefits from each as suggested in this report could overestimate the overall value. Recent research suggests that there may be a link between these two pathways (White *et al.*, 2021), although it is difficult to say definitively how much these approaches may overlap without longitudinal research.

As the values estimated using the antidepressants and street trees pathway are calculated with a conservative cost methodology, it is more justifiable to combine them with values from the visits to nature pathway to give an overall estimate for the mental health value from trees and woodlands.

Recommendations

The value of £185 million (at 2020 prices) from the visits to nature pathway represents a conservative initial estimate for the annual value of the UK's woodlands through avoided mental health-related costs. Given the current state of evidence on the mental health benefits from woodlands and the natural environment, there is greater confidence in this estimate than in those from the other pathways for valuing the mental health benefits of woodlands. At country level and rounded to the nearest million, these values would be £141 million for England, £26 million for Scotland, £13 million for Wales and £6 million for Northern Ireland.

Natural capital values for this pathway, adjusted for population projections, are estimated at just over £11 billion for the mental health benefits of visits to woodlands (100 years, from 2020). Values can also be presented per visit. For example, with 475 million visits to the UK's woodlands estimated in the latest (2017) Woodland NCAs (ONS, 2020b), the UK average for the visits to nature pathway would be equivalent to a value of £0.39 per visit.

There may be scope to consider an aggregate estimate of the mental health benefits of both woodlands and street trees. The use of a conservative cost methodology with the antidepressants and street trees pathway increases its applicability for these purposes. The aggregate value would be £202 million at 2020 prices, representing both the annual value of the UK's woodlands for reducing mental health-related costs as well as the annual value of the UK's street trees for reducing antidepressant prescriptions. At country level and rounded to the nearest million, these values would be £155 million for England, £27 million for Scotland, £13 million for Wales and £6 million for Northern Ireland. The aggregate natural capital value for woodlands and street trees in terms of mental health benefits, adjusted for population projections, is estimated at just over £12 billion (100 years, from 2020).

The visits to nature pathway alone has the highest confidence, although the aggregate estimate could be used, depending on the context and requirements. The focus on avoided costs helps to expand the potential coverage of Woodland NCAs in a way that minimises the risks of double counting with existing values for other ecosystem services, such as that for recreation. This pathway could also be used to value mental health benefits to other types of natural environments in broader NCAs, if the steps outlined in this report were followed using annual estimates of visits to other greenspaces.

Valuing the mental health benefits of visits represents an important step towards ensuring that NCAs are more representative of the range of cultural ecosystem services delivered by woodlands and other natural environments. The values are expected to be useful for policymakers in developing strategies for greenspace interventions and making a case for allocating resources.

Areas for future research

- To strengthen the visits to nature pathway with UK-centred research, the association between visits to nature and the prevalence of anxiety could be explored using data from the Monitor of Engagement with the Natural Environment or People and Nature surveys. This could adopt a similar approach to that used in looking at life satisfaction (White *et al.*, 2019).
- More in-depth research exploring the long-term effects of exercise on the likelihood of developing mental health issues would strengthen the evidence base for the physical exercise pathway.
- Further analysis on woodlands and mental health could be performed using secondary data sources such as the Welsh SAIL databank, linking residential exposure to woodlands to improvements in mental health.
- The effects of forest bathing/therapy on mental health could be explored with a longitudinal study in the UK to quantify relationships between these interventions and improved mental health outcomes. Data on their prevalence would also need to be collected for this pathway to be used.
- The effects on mental health of different woodland types (e.g. conifers, broadleaves or mixed) and tree species (e.g. those emitting particular types and levels of volatile organic compounds) could be explored in 'controlled' environments that minimise the influence of potential confounding factors.
- Synergistic or other effects on mental health of other types of natural environments including bluespaces (e.g. streams and waterfalls) could also be explored in 'controlled' environments that minimise the influence of potentially confounding factors.
- The research underpinning the antidepressants and street trees pathway (Taylor *et al.*, 2015) could be repeated across multiple UK cities and towns to explore how this association varies nationally. This relationship could also be explored more broadly, extending beyond prescriptions to other costs (e.g. therapies).

References

ALCOCK, I., WHITE, M.P., WHEELER, B.W., FLEMING, L.E. and DEPLEDGE, M.H. (2014). Longitudinal effects on mental health of moving to greener and less green urban areas. *Environmental Science and Technology* 48(2), 1247–55.

ANTONELLI, M., BARBIERI, G. and DONELLI, D. (2019). Effects of forest bathing (shinrin-yoku) on levels of cortisol as a stress biomarker: a systematic review and meta-analysis. *International Journal of Biometeorology* 63, 1117–34.

ASTELL-BURT, T. and FENG, X. (2019). Association of urban green space with mental health and general health among adults in Australia. *JAMA Network Open* 2(7), e198209.

BEYER, K.M.M., KALTENBACH, A., SZABO, A., BOGAR, S., JAVIER NIETO, F. and MALECKI, K.M. (2014). Exposure to neighborhood green space and mental health: Evidence from the survey of the health of Wisconsin. *International Journal of Environmental Research and Public Health* 11(3), 3453–72.

BRAGG, R., WOOD, C. and BARTON, J. (2013). *Ecominds: Effects on Mental Wellbeing*. Mind, London.

BUCKLEY, R., BROUGH, P., HAGUE, L., CHAUVENET, A., FLEMING, C., ROCHE, E., SOFIJA, E. and HARRIS, N. (2019). Economic value of protected areas via visitor mental health. *Nature Communications* 10(1), 5005.

CENTRE FOR MENTAL HEALTH (2010). *The economic and social costs of mental health problems in 2009/10*. Centre for Mental Health, London.

CJC CONSULTING (2016). *Branching Out Economic Study Extension.* Final Report to Forestry Commission Scotland. CJC Consulting, Oxford.

COHEN-CLINE, H., TURKHEIMER, E. and DUNCAN, G.E. (2015). Access to green space, physical activity and mental health: A twin study. *Journal of Epidemiology and Community Health* 69, 523–9.

CURTIS, L.A. and BURNS, A. (2019). *Unit Costs of Health and Social Care 2019*. PSSRU, University of Kent, Canterbury.

DCMS (2020). *Physical activity*. [Internet], Department for Digital, Culture, Media and Sport, UK Government, London [www.ethnicity-facts-figures.service.gov.uk/health/diet-and-exercise/physical-activity/latest]. Accessed July 2021.

DE BRITO, J.N., POPE, Z.C., MITCHELL, N.R., SCHNEIDER, I.E., LARSON, J.M., HORTON, T.H. and PEREIRA, M.A. (2019). Changes in psychological and cognitive outcomes after green versus suburban walking: A pilot crossover study. *International Journal of Environmental Research and Public Health* 16(16), 2894.

DEFRA (2020). *Rural population and migration statistics*. Department for Environment, Food and Rural Affairs, UK Government, London.

DICKIE, I., BOSHOFF, J., GIANFERRARA, E., PORTER, J. and OZDEMIROGLU, E. (2018). *Natural Capital Account for Greater Manchester*. Economics for the Environment Consultancy, London.

DZHAMBOV, A.M., BROWNING, M.H.E.M., MARKEVYCH, I., HARTIG, T. and LERCHER, P. (2020). Analytical approaches to testing pathways linking greenspace to health: A scoping review of the empirical literature. *Environmental Research* 186, 109613.

FIELDS IN TRUST (2018). *Revaluing Parks and Green Spaces: Measuring their economic and wellbeing value to individuals*. Fields in Trust, London.

FOREST RESEARCH (2019). *Public Opinion of Forestry*. Forest Research, Edinburgh.

FUJIWARA, D. and DOLAN, P. (2014). *Valuing mental health: how a subjective wellbeing approach can show just how much it matters*. UK Council for Psychotherapy, London.

GREENSPACE SCOTLAND (2011). *Social Return on Investment of urban nature sites: Woods for Health on Kinnoull Hill Perth*. Greenspace Scotland, Stirling.

HEALTH AND SAFETY EXECUTIVE (2020). *Working days lost in Great Britain*. Health and Safety Executive, London.

HELBICH, M., KLEIN, N., ROBERTS, H., HAGEDOORN, P. and GROENEWEGEN, P.P. (2018). More green space is related to less antidepressant prescription rates in the Netherlands: A Bayesian geoadditive quantile regression approach. *Environmental Research* 166, 290–7.

HM TREASURY (2008). *Intergenerational wealth transfers and social discounting*. Supplementary Green Book guidance. HM Treasury, London.

HM TREASURY (2018). *The Green Book*. Central Government Guidance on Appraisal and Evaluation. HM Treasury, London.

HM TREASURY (2021). *GDP deflators at market prices, and money GDP*. HM Treasury, London.

I-TREE (2021). *i-Tree Canopy*. [Internet], United States Department of Agriculture, Washington [www.itreetools.org]. Accessed July 2021.

JOHNSON, R., JENKINSON, D., STINTON, C., TAYLOR-PHILLIPS, S., MADAN, J., STEWART-BROWN, S. and CLARKE, A. (2016). Where's WALY?: A proof of concept study of the 'wellbeing adjusted life year' using secondary analysis of cross-sectional survey data. *Health and Quality of Life Outcomes* 14, 126.

KOSELKA, E.P.D., WEIDNER, L.C., MINASOV, A., BERMAN, M.G., LEONARD, W.R., SANTOSO, M.V., DE BRITO, J.N., POPE, Z.C., PEREIRA, M.A. and HORTON, T.H. (2019). Walking green: Developing an evidence base for nature prescriptions. *International Journal of Environmental Research and Public Health* 16(22), 4338.

KOTERA, Y., RICHARDSON, M. and SHEFFIELD, D. (2020). Effects of shinrin-yoku (forest bathing) and nature therapy on mental health: a systematic review and meta-analysis. [Internet], *International Journal of Mental Health and Addiction* [https://doi.org/10.1007/s11469-020-00363-4].

LAYARD, R., CLARK, D., KNAPP, M. and MAYRAZ, G. (2007). Cost-benefit analysis of psychological therapy. *National Institute Economic Review* 202, 90–8.

MARSELLE, M.R., BOWLER, D.E., WATZEMA, J., EICHENBERG, D., KIRSTEN, T. and BONN, A. (2020). Urban street tree biodiversity and antidepressant prescriptions. *Scientific Reports* 10, 22445.

MCCRONE, P., DHANASIRI, S., PATEL, A., KNAPP, M. and LAWTON-SMITH, S. (2008). *Paying the Price: The cost of mental health care in England to 2026*. Kings Fund, London.

MCEWAN, K., GILES, D., CLARKE, F.J., KOTERA, Y., EVANS, G., TEREBENINA, O., MINOU, L., TEELING, C., BASRAN, J., WOOD, W. and WEIL, D. (2021). A pragmatic controlled trial of forest bathing compared with compassionate mind training in the UK: Impacts on self-reported wellbeing and heart rate variability. *Sustainability* 13(3), 1380.

MCMANUS, S., BEBBINGTON, P., JENKINS, R. and BRUGHA, T. (eds) (2016). *Mental health and wellbeing in England.* Adult Psychiatric Morbidity Survey 2014. Office for National Statistics, Surrey.

MENTAL HEALTH FOUNDATION (2016). *Mental health statistics: poverty*. [Internet], Mental Health Foundation, London [www.mentalhealth.org.uk/statistics/mental-health-statistics-poverty]. Accessed July 2021.

MIKKELSEN, K., STOJANOVSKA, L., POLENAKOVIC, M., BOSEVSKI, M. and APOSTOLOPOULOS, V. (2017). Exercise and mental health. *Maturitas* 106, 48–56.

MITCHELL, R. (2013). Is physical activity in natural environments better for mental health than physical activity in other environments? *Social Science and Medicine* 91, 130–4.

MOSELEY, D., CONNOLLY, T., SING, L. and WATTS, K. (2018). Developing an indicator for the physical health benefits of recreation in woodlands. *Ecosystem Services* 31, 420–32.

NATIONAL RECORDS OF SCOTLAND (2020). *Population Estimates by Urban Rural Classification (2011 Data Zone based)*. National Records of Scotland, Edinburgh.

NATURAL ENGLAND (2020a). *Monitor of Engagement with the Natural Environment (MENE)*. Natural England, Worcester.

NATURAL ENGLAND (2020b). *The People and Nature Survey*. Natural England, Worcester.

NHS England (2021). *NHS Mental Health Dashboard.* [Internet], NHS England, London [www.england.nhs.uk/mental-health/taskforce/imp/mh-dashboard/]. Accessed July 2021.

NHS Improvement (2018). *Reference costs 2017/18: highlights, analysis and introduction to the data*. NHS Improvement, London.

NORTHERN IRELAND STATISTICS AND RESEARCH AGENCY (2020). *2019 Mid Year Population Estimates for Northern Ireland*. Northern Ireland Statistics and Research Agency, Belfast.

NOALL, J. (2018). *Forests, health and inequalities in Scotland: a longitudinal approach*. PhD Thesis. University of Edinburgh, Edinburgh.

O'BRIEN, L. (2018). Engaging with and shaping nature: A nature-based intervention for those with mental health and behavioural problems at the Westonbirt Arboretum in England. *International Journal of Environmental Research and Public Health* 15(10), 2214.

O'BRIEN, L. and FORSTER, J. (2020). *Engagement with nature and Covid-19 restrictions.* Qualitative analysis 2020. Forest Research, Surrey.

ONS (2018). *Sickness absence in the UK labour market: 2018*. Office for National Statistics, London.

ONS (2020a). *Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid-2019*. Office for National Statistics, London.

ONS (2020b). *Woodland natural capital accounts, UK: 2020*. Office for National Statistics, London.

ONS (2020c). *Woodland natural capital accounts methodology guide, UK: 2020*. Office for National Statistics, London.

PAFFENBARGER, R.S., LEE, I.-M. and LEUNG, R. (1994). Physical activity and personal characteristics associated with depression and suicide in American college men. *Acta Psychiatrica Scandinavica* 377, 16–22.

PIERCE, M., HOPE, H., FORD, T., HATCH, S., HOTOPF, M., JOHN, A., KONTOPANTELIS, E., WEBB, R., WESSELY, S., MCMANUS, S. and ABEL, K.M. (2020). Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. *The Lancet Psychiatry* 7(10), 883–92.

PUBLIC HEALTH ENGLAND (2020). *Prescribed medicines review: summary*. Public Health England, London.

ROSA, C.D., LARSON, L.R., COLLADO, S. and PROFICE, C.C. (2021). Forest therapy can prevent and treat depression: Evidence from meta-analyses. *Urban Forestry and Urban Greening* 57, 126943.

SARAEV, V., O'BRIEN, L., VALATIN, G., ATKINSON, M. and BURSNELL, M. (2020). *Scoping Study on Valuing Mental Health Benefits of Forests*. Forest Research, Edinburgh.

SARAEV, V., O'BRIEN, L., VALATIN, G., FORSTER, J., BURSNELL, M. and COOK, M. (2021). *Health and Well-Being Benefits of Visits to Scotland's Forests.* Forest Research, Edinburgh.

SARKAR, C., WEBSTER, C. and GALLACHER, J. (2018). Residential greenness and prevalence of major depressive disorders: a cross-sectional, observational, associational study of 94 879 adult UK Biobank participants. *The Lancet Planetary Health* 2(4), 162–73.

SCOTTISH GOVERNMENT (2020). *Scottish Household Survey: Key findings 2019*. Scottish Government, Edinburgh.

SHANAHAN, D.F., BUSH, R., GASTON, K.J., LIN, B.B., DEAN, J., BARBER, E. and FULLER, R.A. (2016). Health benefits from nature experiences depend on dose. *Scientific Reports* 6, 28551.

SPORT ENGLAND (2016). *MOVES.* [Internet], Sport England, London [sportengland.org/how-we-can-help/measuring-impact?section=moves]. Accessed July 2021.

TAYLOR, M.S., WHEELER, B.W., WHITE, M.P., ECONOMOU, T. and OSBORNE, N.J. (2015). Research note: Urban street tree density and antidepressant prescription rates–A cross-sectional study in London, UK. *Landscape and Urban Planning* 136, 174–9.

VIAVATTENE, C. and PRIEST, S. (2020). *A method for monetising the mental health costs of flooding*. Flood and Coastal Erosion Risk Management Research and Development Programme, Bristol.

VIVID ECONOMICS (2017). *Natural capital accounts for public green space in London: Methodology document*. Vivid Economics, London.

WEIMANN, H., RYLANDER, L., ALBIN, M., SKÄKÄRBÄCK, E., GRAHN, P., ÖSTERGREN, P.O. and BJÖRK, J. (2015). Effects of changing exposure to neighbourhood greenness on general and mental health: A longitudinal study. *Health and Place* 33, 48–56.

WELSH GOVERNMENT (2015). *Best fit of Lower Super Output Areas to built up areas: 2011*. Welsh Government, Cardiff.

WHITE, M.P., ALCOCK, I., GRELLIER, J., WHEELER, B.W., HARTIG, T., WARBER, S.L., BONE, A., DEPLEDGE, M.H. and FLEMING, L.E. (2019). Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific Reports* 9, 7730.

WHITE, M.P., ALCOCK, I., WHEELER, B.W. and DEPLEDGE, M.H. (2013). Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. *Psychological Science* 24(6), 920–8.

WHITE, M.P., ELLIOTT, L.R., GRELLIER, J., ECONOMOU, T., BELL, S., BRATMAN, G.N., CIRACH, M., GASCON, M., LIMA, M.L., LÕHMUS, M., NIEUWENHUIJSEN, M., OJALA, A., ROIKO, A., SCHULTZ, P.W., VAN DEN BOSCH, M. and FLEMING, L.E. (2021). Associations between green/blue spaces and mental health across 18 countries. *Scientific Reports* 11, 8903.

WHITE, M.P., ELLIOTT, L.R., TAYLOR, T., WHEELER, B.W., SPENCER, A., BONE, A., DEPLEDGE, M.H. and FLEMING, L.E. (2016). Recreational physical activity in natural environments and implications for health: A population based cross-sectional study in England. *Preventive Medicine* 91, 383–8.

WOODCOCK, J., EDWARDS, P., TONNE, C., ARMSTRONG, B.G., ASHIRU, O., BANISTER, D., BEEVERS, S., CHALABI, Z., CHOWDHURY, Z., COHEN, A., FRANCO, O.H., HAINES, A., HICKMAN, R., LINDSAY, G., MITTAL, I., MOHAN, D., TIWARI, G., WOODWARD, A. and ROBERTS, I. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. *The Lancet* 374(9705), 5–11.

WU, Y.T., PRINA, A.M., JONES, A., MATTHEWS, F.E. and BRAYNE, C. (2015). Older people, the natural environment and common mental disorders: Cross-sectional results from the Cognitive Function and Ageing Study. *BMJ Open* 5(9), e007936.

Appendix 1: Literature: methodology and impacts on mental health

Searches were performed to capture academic literature exploring the direct impacts of woodlands or greenspace on mental health. Scopus was the chosen database for searching, and includes more than 95% of Medline publications. Searches focused on English language papers and only those published from 2011 to 2020 were included. Table A1.1 summarises the search terms used and their combinations. Within each column, similar terms were combined with a logical Boolean OR operator and terms across columns were combined with AND operators. The string yielded 771 results.

In addition to academic searches, literature was also sourced through contact with steering group members and knowledge gained from the previous phase of the research project (Saraev *et al*., 2020). A 'snowballing' approach was adopted, collecting relevant references cited within literature as they were encountered.

Impacts on mental health

Table A1.2 provides a summary of quantitative evidence on the impact of woodlands and other greenspace on the treatment and improvements in an individual's mental health.

For inclusion in Table A1.2, papers must provide:

- A direct focus on mental health or a MHC (not well-being).
- A focus on woodlands or a broader focus on greenspace.
- A longitudinal cohort or a large (>1000) cross-sectional sample.

Meta-analyses and quantitative literature reviews were also included, in which case the constituent papers that were analysed in the reviews were not separately included.

Table A1.1 Scopus search string.

Location	Mental health condition	Direct impact
forest* OR woodland* OR parks OR park OR 'green space*' OR greenspace*	'mental health' OR anxiety OR schizophren* OR psychosis OR depression OR ptsd OR ocd OR bipolar	cost* OR saving* OR productivity OR absen* OR 'working day*' OR treatment OR prescription* OR 'GP visit*' OR 'admission*' OR antidepressant* OR antipsychotic* OR ritalin OR self-harm OR 'self harm'

Table A1.2 Impact of woodlands and other greenspace on mental health.

Reference	Study overview	Greenspace interaction	Population sample	MH component and metric/ indicator	Findings
Greenspace Scotland (2011)	Evaluation of woods for health pilot at Kinnoull Hill Woodland Park. The programme provided a range of outdoor activities in woodlands for vulnerable adults.	Intervention in woodlands	*n* = 7 Adults accessing MH support services in England	Depression (PHQ-9)	The intervention improved participant scores by 2.37 (8.78%) (scale movement indicative of moving from an average of moderate depression to minimal depression).
Rosa *et al.* (2021)	Research conducted an overview of SRs and meta-analyses of 13 primary studies to provide the most comprehensive summary of the effect of forest therapy on depression.	Forest therapy	*n* = 311 (from 13 primary studies for overall findings) *n* = 51 (from two RCTs including data on remission from depression) Adults in South Korea	Depression (multiple indicators)	From RCTs, participants in the forest groups were 17 times as likely to achieve remission compared with those who received only traditional outpatient treatment in the form of being prescribed antidepressants (RR 17.02). From RCTs, compared with the same therapy treatments performed in a hospital setting, participants in the forest group were still twice as likely to achieve remission (RR 1.97). We found no evidence that forest therapy was a less acceptable treatment than other alternatives.
Kotera, Richardson and Sheffield (2020)	This systematic review and meta-analysis examined the MH impacts of shinrin-yoku. Findings indicate that shinrin-yoku can be effective in reducing MH symptoms in the short term, particularly anxiety.	Forest visits (forest bathing)	*n* = 1449 (from 16 primary studies for pre-post scores of depression) *n* = 417 (from six RCTs exploring the effects of depression) Adults	Depression (multiple indicators)	There was a medium mean negative effect size for pre-post scores, 95% CI [−1.47, −0.60]), which was significant. There was a small mean negative effect size in depression in RCTs, 95% CI [−3.56, −1.52]), which was significant.
			n = 1371 (from 16 primary studies for pre-post scores of anxiety) *n* = 327 (from five RCTs exploring the effects of anxiety) Adults	Anxiety (multiple indicators)	There was a large mean negative effect size for pre-post scores measuring anxiety, 95% CI [−3.07, −0.58]), which was significant. There was a large mean negative effect size in RCTs, 95% CI [−21.91, 3.57]), which was not significant.
Antonelli, Barbieri and Donelli (2019)	To investigate the effects of forest bathing on levels of salivary or serum cortisol as a stress biomarker to understand whether forest bathing can reduce stress.	Forest visits (forest bathing)	Eight primary studies included	Stress (cortisol)	The main results of the meta-analysis showed that salivary cortisol levels were significantly lower in the forest groups compared with the urban groups both before (MD = −0.08 [95% CI −0.11 to −0.05] µg/dl; $p < 0.01$; I2 = 46%) and after intervention (MD = −0.05 [95% CI −0.06 to −0.04] µg/dl; $p < 0.01$; I2 = 88%). Overall, forest bathing can significantly influence cortisol levels over the short term in such a way as to reduce stress, and anticipated placebo effects can play an important role.

Table A1.2 Impact of woodlands and other greenspace on mental health (continued).

Reference	Study overview	Greenspace interaction	Population sample	MH component and metric/ indicator	Findings
Shanahan *et al.* (2016)	Used a nature dose framework to examine the associations between the duration, frequency and intensity of exposure to nature and health in an urban population.	Nature visits	*n* = 1538 Residents of Brisbane, Australia	Depression (DASS)	A dose-response analysis for depression suggest that visits to outdoor greenspace of ≥30 minutes during the course of a week could reduce the population prevalence of these illnesses by up to 7%.
de Brito *et al.* (2019)	Invested the effects of repeat walking sessions over three weeks within green environments and suburban environments.	Nature trail visits (featuring forest)	*n* = 24 Adults aged 35–59 years in Minneapolis, USA	Anxiety (STAI)	Nature trail walks reduced anxiety states by −2.5 points compared with baseline (4.12%). Suburban walks increased anxiety.
Koselka *et al.* (2019)	Compared before and after psychological effects of walks in nature, walks along roadsides and normal daily activities.	Forest visits	*n* = 38 Adults aged 18–35 years in Illinois, USA	Anxiety (STAI)	Forest walks reduced anxiety states by −3 points compared with baseline (5%). Roadside walks slightly reduced anxiety. Normal daily activities increased anxiety.
				Stress (PSS)	Forest walks reduced stress by −1.4 points compared with baseline (3.5%).
Mitchell (2013)	Examined MH benefits from physical activity in natural environments compared with other environments.	Forest visits (physical activity)	*n* = 1890 Adults in Scotland	Anxiety/ depression (GHQ-12)	Using woods/forest at least once a week for physical activity was associated with a lower risk (OR 0.557) of scoring high GHQ (≥4, defined as possible minor psychiatric morbidity). Once a week usage of pavements or streets (OR 0.905).
Wu *et al.* (2015)	Examined the association of exposure to natural environments and the odds of developing depression and anxiety in later life. Based on a 10-year population-based study of ageing.	Residential proximity to urban trees	*n* = 2424 Elderly people aged ≥74 years in the UK	Anxiety/ depression (geriatric mental scale examination)	Compared with the lowest quartile, living in the highest quartile of neighbourhood natural environment provision was associated with reduced odds of sub-threshold depression (OR 0.66), anxiety symptoms (OR 0.62) and their co-occurrence (OR 0.55) after adjusting for individual-level factors.
Noall (2018)	Linked personal data from the SLS to estimations of forest access and usage.	Residential proximity to accessible forest	*n* = 247 000 Adults in Scotland	MHCs (presence of MHCs)	For those whose forest access improved from 1991 to 2001, and who remained living within 150 m from the nearest forest, the likelihood of reporting a MHC in 2011 was 17% less likely than those living >500 m from the nearest forest.
Taylor *et al.* (2015)	The issue of street trees in the nature-health nexus was raised and secondary data sources were used to examine the association between the density of street trees (trees/km street) in London boroughs and rates of antidepressant prescribing.	Residential proximity to urban trees	Adults in London	Depression (antidepressant prescriptions)	An inverse association was found, with a decrease of 1.18 prescriptions per thousand population per unit increase in trees per km of street (95% credible interval 0.00, 2.45).

Table A1.2 Impact of woodlands and other greenspace on mental health (continued).

Reference	Study overview	Greenspace interaction	Population sample	MH component and metric/ indicator	Findings
Helbich *et al.* (2018)	To assess antidepressant prescription rates in relation to greenspace, and to analyse how the relationship varies non-linearly across different quantiles of antidepressant prescription rates.	Residential proximity to urban trees	Adults in the Netherlands	Depression (antidepressant prescriptions)	For areas with a low amount of greenspace (i.e. <28%), a positive association with antidepressant prescriptions was found, although the CIs are wide because of only a few observations in this value range. Beyond these values, the greenspace correlation turned out to have the expected negative association before levelling off. A strong negative effect appears for areas with a large proportion of greenspace (i.e. >79%).
Marselle *et al.* (2020)	Analysed the association of street tree density and species richness with antidepressant prescribing using longitudinal data.	Residential proximity to urban trees	*n* = 9751 Residents of Leipzig, Germany	Depression (antidepressant prescriptions)	Accounting for covariates, people living in homes with a greater density of street trees within 100 m were less likely to be prescribed antidepressants (OR −0.09).
Astell-Burt and Feng (2019)	Six-year longitudinal study exploring the association between residential proximity to greenspace and health outcomes.	Residential proximity to greenspace and tree canopy	*n* = 46 786 Residents of Australia who did not move address	Psychological distress (K10)	Exposure to tree canopy (comprising ≥30% of total greenspace) was associated with lower incidence of psychological distress (OR 0.69; 95% CI 0.54–0.88).
Cohen-Cline, Turkheimer and Duncan (2015)	Examined the association between access to greenspace and MH among adult twin pairs.	Residential proximity to greenspace	*n* = 4338 Adult twins in the USA	Depression (PHQ-2)	People who live in or around dense vegetation have a 0.44 lower depression score than those who live without any access to greenspace (4.89%).
Beyer *et al.* (2014)	Explored associations between neighbourhood tree canopy and MH health with a four-year longitudinal database.	Residential proximity to tree canopy	*n* = 2479 Adults in Wisconsin, USA	Anxiety (DASS)	A 25% increase in tree canopy coverage is associated with a decrease in the DASS anxiety score of 0.267 (1.11%).
				Depression (DASS)	A 25% increase in tree canopy coverage is associated with a decrease in the DASS depression score of 1.005 (2.39%).
White *et al.* (2013)	Used panel data to explore longitudinal effects on the relationship between urban greenspace and mental distress.	Residential proximity to greenspace	*n* = ~10 000 Adults in the UK	Anxiety/ depression (GHQ-12)	One standard deviation increase in density of greenspace (equivalent to an area with 48% compared with 81% greenspace) leads to a 0.14 reduction in GHQ-12 scores (1.17%).
Alcock *et al.* (2014)	Used panel data to explore longitudinal effects on the relationship between urban greenspace and mental distress.	Residential proximity to greenspace	*n* = 594 (moved to greener areas) *n* = 470 (moved to less green areas) Adults in the UK	Anxiety/ depression (GHQ-12)	Compared with pre-move MH scores, individuals who moved to greener areas (*n* = 594) had 0.369 better scores at one-year post-move (1.15%). Individuals who moved to less green areas (*n* = 470) had 0.123 worse scores at one-year post-move (0.38%).
Weimann *et al.* (2015)	Used panel data to explore longitudinal effects on the relation between urban greenspace and mental distress.	Residential proximity to greenspace	*n* = 9444 Adults in Sweden	Anxiety/ depression (GHQ-12)	Individuals exposed to more neighbourhood green qualities on average had slightly but statistically uncertain better scores in MH (OR 1.03). Inter-individual effects of moving and increasing greenness exposure showed marginally better results (OR 1.07).

Abbreviations: CI, confidence interval; DASS, Depression, Anxiety and Stress Scales; GHQ, General Health Questionnaire; I2, heterogenity test; K10, Kessler Psychological Distress Scale; MD, mean difference; MH, mental health; MHC, mental health condition; OR, odds ratio; p, probability; PHQ, Patient Health Questionnaire; PSS, Perceived Stress Scale; RCT, randomised controlled trial; RR, risk ratio; SLS, Scottish Longitudinal Study; SR, systematic review; STAI, State-Trait Anxiety Inventory.

Appendix 2: Literature: existing examples of directly valuing mental health

Table A2.1 explores examples of literature that have attempted to directly value mental health costs from interactions with woodlands and other greenspace, encountered from the previous phase of the review and findings from the latest literature search.

Table A2.1 Examples of direct mental health valuation from greenspace.

Reference	Greenspace interaction	Mental health impact methodology	Costing methodology	Summary
Vivid Economics (2017)	Residential proximity to greenspace.	Uses White *et al.* (2013) methodology (creates an association between greater greenspace density and improvements in GHQ-12) to give a percentage improvement in mental health, dependent on local greenspace density.	Calculates mental health costs in London by population weighting from estimates of total UK mental health-related costs (Centre for Mental Health, 2010).	Greenspace in London is estimated to deliver £370 million per year in avoided mental health costs.
Dickie *et al.* (2018)	Residential proximity to greenspace.	Uses White *et al.* (2013) methodology (creates an association between greater greenspace density and improvements in GHQ-12) to give a percentage improvement in mental health, dependent on local greenspace density.	Applies a percentage-based reduction from the estimated mental health spending in Greater Manchester (Dickie *et al.*, 2018).	Greenspace in Manchester is estimated to deliver £264 million per year in avoided mental health costs, via a percentage of mental health spending.
Fields in Trust (2018)	Visits to greenspace.	Being a regular greenspace user is associated with 4.2% greater likelihood of reporting good health. People who report good health are 25.4% less likely to visit their GP.	Estimates each GP visit has an average cost of £37.00.	Being a regular greenspace user is associated with a reduction of £3.16 in GP-related medical costs per person per year. Aggregate annual NHS cost savings across the UK for regular greenspace users is estimated at £111 million. Note: this approach is inclusive of GP costs for all health-related issues.
Bragg, Wood and Barton (2013)	Evaluation of the Ecominds scheme, a range of ecotherapy projects based around engagement with nature, including activities such as green exercise, nature arts and crafts and care farming; ~60% of the scheme was greenspace-based, the other 40% was based around agricultural and horticultural activities.	On average, participants experienced increases in WEMWBS scores of 17%.	Directly followed the cost savings associated with individuals who went through the Ecominds programme. Costs included reduced prescriptions, medical consultations and community nurse visits as well as reduced Jobseeker's and Disability Living allowance and increased tax and national insurance contributions.	For five directly observed Ecominds participants, average savings of £7082 were observed per participant. Scaling up for the 246 participants who found full-time work, total savings for the programme were estimated at £1.46 million.

Abbreviations: GHQ, General Health Questionnaire; WEMWBS, Warwick-Edinburgh Mental Well-Being Scale.

Further examples of literature have adopted similar approaches to valuing mental health, although they have adopted a valuation approach through QALYs rather than a costs-based approach. These include:

- Buckley *et al.* (2019): regular visitors to Australian national parks had 2.5% better Personal Well-being Index (PWI) scores compared with national averages. At an Australian QALY value of $200 000, regular park visitors are assumed to have better health, equivalent to $5000 per year.
- CJC Consulting (2016): mean QALY scores improved by 0.0227 per person completing the Branching Out course. At a NICE QALY value of £30 000, improvements were equivalent to £681 per person. With a 12-week programme costing £392.30 per user, the programme cost per QALY generated is £17 276.

Appendix 3: Literature: direct costs of mental health

The following tables explore methods of how mental health can be valued through a direct costs approach. Table A3.1 summarises evidence that has estimated the costs of treating various MHCs through mental health services.

Table A3.1 Mental health service-related costs.

Reference	Methodology summary	Costed element	Cost (£)
McCrone *et al.* (2008)	Estimates service costs based on direct health and social care costs. (2007 prices)	Per person cost for treatment of depression	2085
		Per person cost for treatment of anxiety	1104
		Per person cost for treatment of schizophrenia	10605
		Per person cost for treatment of bipolar disorder	1424
Layard *et al.* (2007)	Estimates average cost of cognitive behavioural therapy. (2007 prices)	Per person cost for standard course of 10 meetings for psychological therapy	750
Viavattene and Priest (2020)	Estimates therapy costs based on data from the Personal Social Services Research Unit. (2015–6 prices)	Per person cost for course of 12 meetings for behavioural activation therapy	185
		Course of 12 meetings for mindfulness-based cognitive therapy	168
	Presents a mid-value estimate of annual NHS drug costs. (2017 prices)	Per patient cost of antidepressants	23
NHS Improvement (2018)	Calculates cost of NHS mental health services. (2017–8 prices)	Total cost of mental health service spending in England	7.2 billion
Curtis and Burns (2019)	Provides figures for unit costs of health and social care in England. (2018–9 prices)	Mental health services cost per bed day	314
		Mental health services cost per assessment	314
Centre for Mental Health (2010)	Estimates the cost of services provided by England's NHS and local authorities for people with mental health problems. (2009–10 prices)	Total health and social care cost of mental health problems in England	21.3 billion

Note: some of these costs are inclusive of wider health issues.

Table A3.2 summarises evidence that has considered employment costs related to mental health conditions.

Table A3.2 Employment losses costs.

Reference	Methodology summary	Costed element	Cost (£)
McCrone *et al.* (2008)	Estimates lost employment costs due to unemployment and economic inactivity from those with a mental health condition. (2007 prices)	Per person cost for economic inactivity due to depression	7226
		Per person cost for economic inactivity due to anxiety	6850
		Per person cost for economic inactivity due to schizophrenia	19078
		Per person cost for economic inactivity due to bipolar disorder	24544
Viavattene and Priest (2020)	Estimates the cost of annual excess sick days from individuals with a mental health condition. Based on sick day data from Layard *et al.* (2007) and the national living wage for an adult in a 7.6-hour working day (£53.48). (2018 prices)	Per person cost for excess working days lost due to depression (19)	1016.12
		Per person cost for excess working days lost due to anxiety (9)	481.32
Centre for Mental Health (2010)	Estimates output losses based on sickness absence due to mental health in England. (2009–10 prices)	Total cost of lost output due to mental health sickness absence in England	30.3 billion

Appendix 4: Estimating mental health natural capital asset values

This appendix provides some estimates that indicate the natural capital value of mental health benefits attributable to woodland and trees. First, we briefly present the general approach to natural capital accounting, then the estimates.

The net present value (NPV) approach is recommended for valuing natural capital within the System of Environmental-Economic Accounting (SEEA). This approach involves valuing the natural capital stock based on annual ecosystem services flows.

The value of the annual ecosystem services flow is estimated by multiplying a physical measure of the benefit flow by a price. The price can be either an actual market price, or an estimated price for the ecosystem services in a hypothetical market.

To calculate the NPV, the stream of services that are expected to be generated over the life of the asset (forest, woodlands and trees) are estimated. The issues related to NPV calculation are:

- Annual values of the service flows provided in constant prices
- Pattern of expected future flows of values
- Time period over which the flows of values are expected
- Choice of discount rate.

NCA methodologies adopted by the ONS assume that ecosystem services flows and prices (and thus, the annual values) remain constant throughout the life of the asset, except where official projections are available (e.g. for carbon sequestration, recreation and air pollution). For recreation and air pollution, future projections use an average population growth rate and an assumed 2% increase in income per year (declining to a 1.5% increase after 30 years and a 1% increase after 75 years) (ONS, 2020c). A similar approach incorporating projected population growth would be appropriate for estimating the natural capital value of the mental health benefits that woodlands and trees provide. The expected ecosystem services values would be assumed to be the mean over the latest five years, up to and including the reference year in question. See the service value five-year average equation below:

$$SV_t = \frac{SV_{t-4} + SV_{t-3} + SV_{t-2} + SV_{t-1} + SV_t}{5}$$

In cases where five years of data are not available, the most recent available value is used.

In the current guidance, a 100-year asset life is applied to all renewable natural capital assets, including woodlands and trees.

The discount rates recommended are set out in the HM Treasury Green Book (HM Treasury, 2018). The standard discount rate recommended is 3.5% for the first 30 years, declining in a series of steps thereafter. The recommended discount rate for risk to health and life values is 1.5% for a long-time horizon of 30 years. This is because the 'wealth effect', or real per capita consumption growth element of the discount rate, is excluded. (Where long-term impacts involve very substantial or irreversible wealth transfers between generations, including irreversible changes to the natural environment, sensitivity analysis applying lower than standard discount rates is also recommended). Schedules of the standard and health discount rates (HM Treasury, 2008) are presented in Table A4.1.

Table A4.1 Declining long-term discount rates.

Year	Standard (%)	Health (%)
0–30	3.50	1.50
31–75	3.00	1.29
76–125	2.50	1.07
126–200	2.00	
201–300	1.50	
301+	1.00	

For all price adjustments the UK Government GDP deflator (www.gov.uk/government/collections/gdp-deflators-at-market-prices-and-money-gdp) for calendar year series should be used. Given that our analysis focuses on the health benefits of trees, the health declining discount rates in Table A4.1 are recommended.

The estimated annual reduced mental health-related costs due to existing UK woodlands and trees for the identified pathways (Table 1) are presented in Table A4.2.

Table A4.2 Estimated annual values.

Pathway	England	Scotland	Wales	Northern Ireland	UK
Visits to nature	141	26	13	6	185
Physical activity	14	2	1	0.5	18
Antidepressants (drug costs)	14	1	0.6	0.4	16
Proportion of greenspace	342	29	14	9	394

Note: figures are £ million at 2020 prices, rounded to the nearest million or hundred thousand if less than £1 million.

Table A4.3 Estimated natural capital asset values.

Pathway	England	Scotland	Wales	Northern Ireland	UK
Visits to nature	7671	1406	681	312	10070
Physical activity	734	135	65	30	964
Antidepressants (drug costs)	768	65	32	20	885
Proportion of greenspace	18593	1584	765	480	21422

Note: figures are £ million at 2020 prices.

Table A4.4 Estimated natural capital asset values with population growth.

Pathway	England	Scotland	Wales	Northern Ireland	UK
Visits to nature	8628	1406	695	320	11049
Physical activity	826	135	67	31	1058
Antidepressants (drug costs)	864	65	32	20	982
Proportion of greenspace	20914	1584	781	492	23771

Note: figures are £ million at 2020 prices, rounded to nearest million.

The visits to nature pathway is considered more reliable than the others (see the Valuation summary section on page 13 and the Discussion on page 15). The estimates show that our preferred pathway of visits to nature yields approximately £185 million per year. The proportion of greenspace pathway yields the highest estimated value of approximately £394 million per year.

These annual values yield estimated natural capital asset values (NPV over 100 years, not adjusted for population changes) (Table A4.3). An asset value of our preferred pathway visits to nature amounts to approximately £10 billion for the UK. The proportion of greenspace pathway yields the highest estimated asset value of approximately £21 billion.

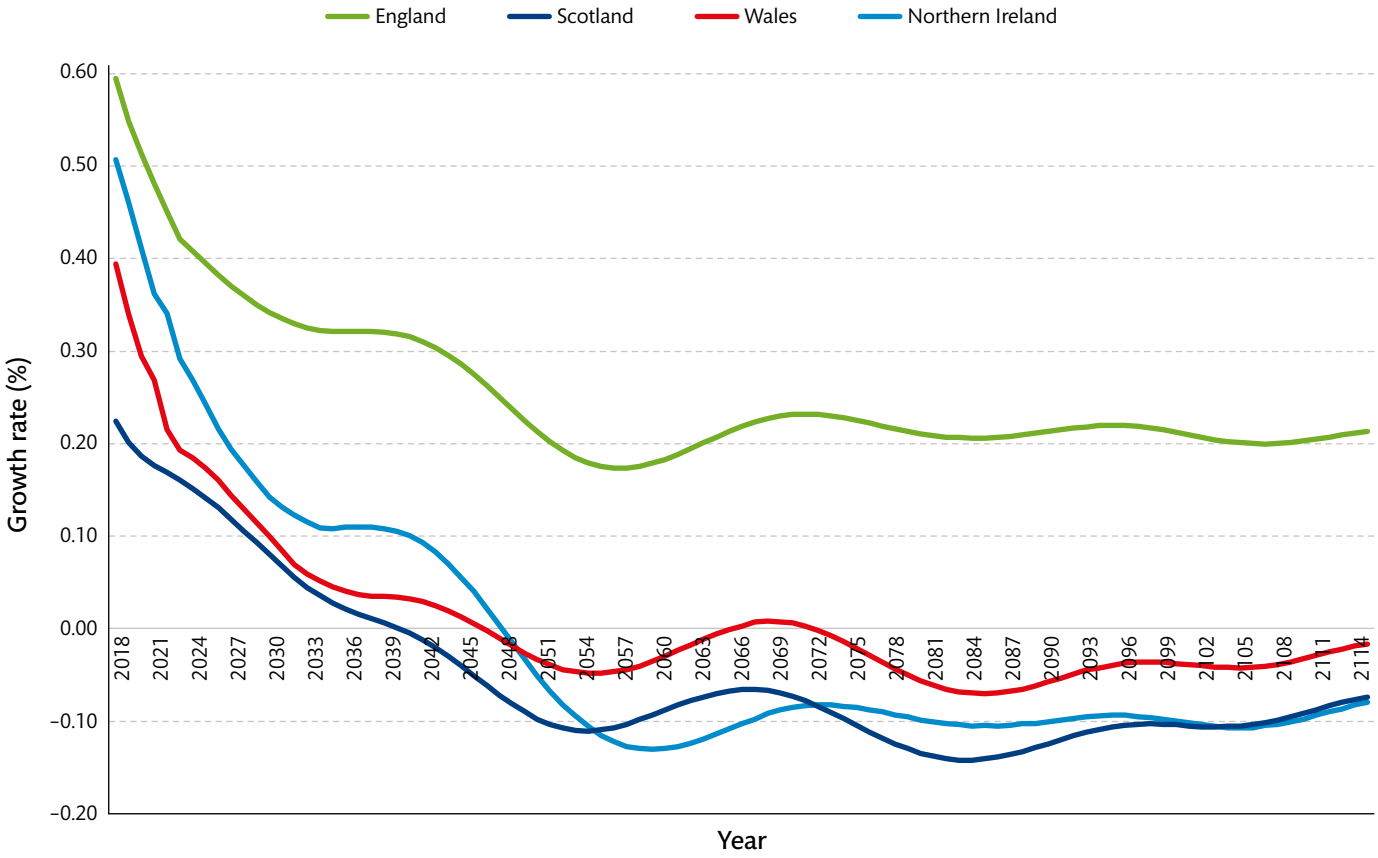
We consider that aggregating the estimates from the visits to nature pathway with the antidepressants and street trees pathway is feasible as it would not lead to significant double-counting issues. In this case the natural capital value of mental health benefits due to woodland and trees is estimated at approximately £11 billion.

In principle these values could increase further if population projections for the UK and its constituent countries for the next 100 years are taken into consideration. The growth rate for population projections for the UK (www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea11principalprojectionuksummary) over 2018–9 to 2117–8 is small but positive with an average value over 100 years of 0.22% per year. Note that various countries of the UK have different growth projections, with England showing the largest growth (Figure A4.1).

Using annual values as before (Table A4.2), but adjusting for population growth, yields estimated natural capital asset values (NPV over 100 years) (Table A4.4).

In this case, the estimate for asset value through the visits to nature pathway is approximately £11 billion. Aggregating the estimates from the visits to nature with the antidepressants and street trees pathway, the natural capital value of mental health benefits due to woodland and trees is estimated at £12 billion.

Figure A4.1 Projected population annual growth rates from 2018–9 to 2117–8.



Abbreviations

DASS	**Depression Anxiety Stress Scales**. A set of mental health scales based upon a questionnaire designed to measure depression, anxiety and stress symptoms.
GHQ-12	**General Health Questionnaire**. A questionnaire used to identify minor psychiatric disorders and psychological distress.
K10	**Kessler Psychological Distress Scale**. A mental health scale designed to measure anxiety and depression.
PHQ-2	**Patient Health Questionnaire**. A screening questionnaire for brief diagnoses of symptoms of major depression.
PHQ-9	**Patient Health Questionnaire**. A questionnaire aimed at measuring the severity of depression symptoms.
PSS	**Perceived Stress Scale**. A mental health scale used to measure the perception of stress.
QALY	**Quality-Adjusted Life Years**. A measure of the state of health of a person or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. One QALY is equal to one year of life in perfect health. The value of one QALY recommended for policy appraisal following Green Book guidance (HM Treasury, 2018) is currently £60 000.
STAI	**State-Trait Anxiety Inventory**. A psychological inventory used to measure anxiety and distinguish it from depressive syndromes.
WEMWBS	**Warwick-Edinburgh Mental Well-Being Scale**. A mental health scale used to measure feeling and functioning aspects of mental well-being.

FRRP034/LBD/WWW/DEC21

Access to woodlands is very important for individuals to support their mental health and well-being. However, these benefits have yet to be included in natural capital accounts at national level. This study is the first attempt to provide national estimates of the natural capital value of the mental health benefits provided by UK woodlands. Values are estimated using an avoided cost approach that avoids potential double counting with values for other types of benefits. It is based upon an association between regular visits to natural environments and a reduced prevalence of common mental illnesses, combined with societal costs of depression and anxiety, including lost working days and NHS costs.