Embedding nature recovery in the Levelling-up and Regeneration Bill

Agile Initiative Research Brief

By Alison Smith, Caitlin Hafferty, and Prof Nathalie Seddon (The Agile Initiative and the Nature-based Solutions Initiative, University of Oxford). 10 February 2023

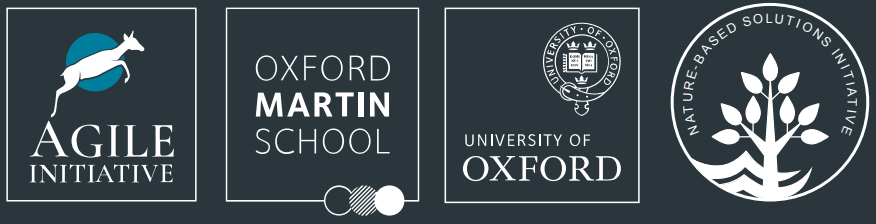

Table of contents

Summary

There is strong scientific evidence that natural green space plays a vital role in supporting human health and wellbeing while delivering many economic benefits. However, not everyone has access to nature-rich spaces and the UK's most deprived communities tend to have less green space. The evidence presented here shows the importance of providing more accessible nature-rich green spaces that benefit everyone, as a core part of levelling-up and regeneration.

The Levelling-up and Regeneration Bill currently neglects the important role of natural green space for boosting local economies, improving human health and wellbeing, tackling social inequalities, contributing to community cohesion and pride of place, and providing climate resilience. It also threatens to weaken nature protection and thus undermines government targets for Net Zero and Nature Recovery.

There are opportunities to redress this omission and strengthen the Bill so that it delivers lasting benefits for communities and the economy, and contributes to delivering the wider government agenda on climate and nature.

Firs Farm Wetlands, Enfield, were restored by de-culverting a hidden river. They now protect 100 houses from flooding, filter out pollution from surface water runoff, and provide beautiful natural spaces for local people. Photo: SUSDRAIN

Summary of recommendations to strengthen the Levelling-up and Regeneration Bill

The Bill needs to explicitly recognise the role of nature in supporting human health, climate resilience and the economy.

Net Zero and Nature Recovery clauses should be added to ensure that new developments are consistent with the government's goals.

A health, wellbeing and community cohesion clause should be added, with a new duty on local authorities to address existing inequalities in access to green space.

The new Environmental Outcome Reports must be strengthened so that they are stronger than, not weaker than, the current level of protection for habitats and wildlife.

The proposed National Development Management policies need to set a strong and consistent national approach for protecting existing natural assets (habitats, species, water and air quality), a minimum standard for access to natural green spaces, and criteria for building in new high quality climate-resilient green and blue infrastructure to new development. This could be based on the new Green Infrastructure Standards being developed as part of the government commitments in the 25 Year Environment Plan.

The Infrastructure Levy and developer contributions proposals should state that these should contribute to nature recovery and net zero alongside wider social objectives.

Introduction

The Levelling-up and Regeneration Bill sets an ambitious new framework for planning and development, but it fails to recognise the strong links between nature recovery, levelling-up, and other government goals (Box 1). A joined-up approach is needed, embedding nature recovery into the levelling-up and regeneration agenda in order to deliver multiple benefits for people, nature and the economy, while making sure that these benefits are equitably distributed. This policy brief compiles evidence from the academic literature to demonstrate the vital role that nature can play in securing health, wellbeing and socio-economic benefits for the deprived communities targeted by the levelling-up programme. It also identifies opportunities for embedding nature into the Bill.

Box 1: Problems with the current Levelling-up and Regeneration Bill

It neglects the value of nature for improving and sustaining human physical and mental health and community cohesion, boosting local economies, delivering climate resilience and addressing socio-economic inequalities.

It weakens environmental protection, replacing the comprehensive system of Environmental Impact Assessments and Strategic Environmental Assessments with undefined 'environmental outcome reports' to be specified by the Secretary of State. There is no guarantee that these will maintain the same level of protection as the current system, or provide the stronger protection needed to halt the ongoing loss of nature-rich green spaces to development.

It undermines the Government's Net Zero and Nature Recovery policies by failing to protect and restore nature. This risks the loss of wildlife habitats and the release of large amounts of carbon stored in soils and vegetation.

Evidence of the health and economic benefits of nature-rich green space

Well-designed and equitably delivered nature-rich green spaces improve health and wellbeing while delivering economic benefits. This can occur through multiple pathways (Figure 1).

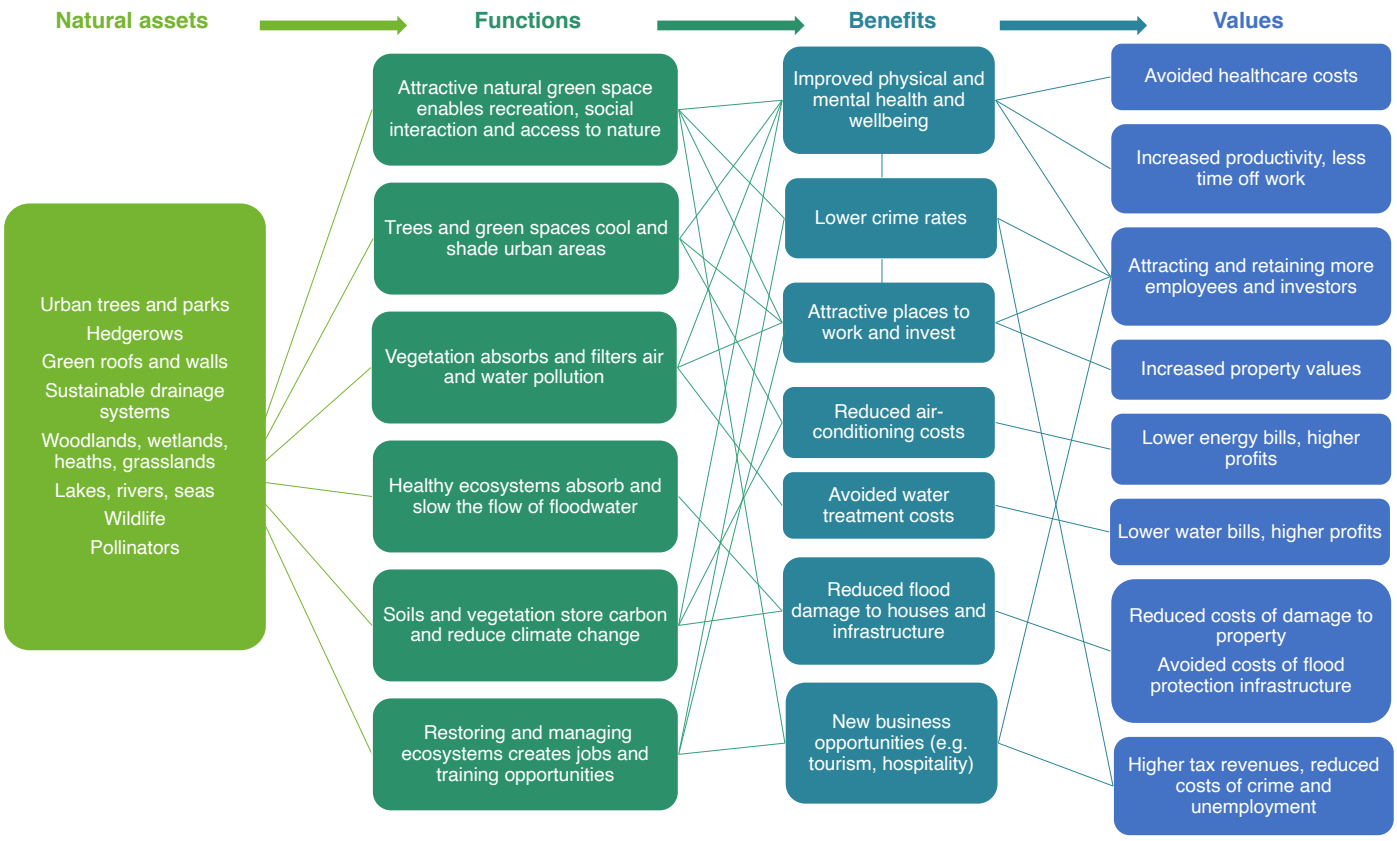

Figure 1: How natural green space improves health, communities and the economy

Health and wellbeing outcomes of natural green space

There is now substantial evidence that nature-rich and accessible green spaces deliver significant benefits for human health and wellbeing. This occurs through several pathways:

1. **Recreation:** Green spaces provide pleasant places for recreation and encourage physical activity, leading to physical and mental health benefits.
2. **Interaction with nature**: Being in green spaces and interacting with nature can reduce stress and improve mood, also leading to physical and mental health benefits.
3. **Social interaction and cohesive communities**. Green spaces can encourage integration and community cohesion, with benefits for mental health and wellbeing, combatting loneliness and isolation, reduced crime, encouraging pro-environmental behaviours, and fostering pride of place.
4. **Microbiome regulation**: There is evidence that the human immune system can benefit from (or requires) exposure to the natural microbiota found in soils, vegetation and air.
5. **Air quality.** Trees and other vegetation absorb air pollution, reducing the incidence of asthma, cardiovascular disease and lung cancer.
6. **Cooling and shading.** Green spaces, especially trees, can help to cool the air and provide shade, reducing heat stress during hot weather.
7. **Noise regulation.** Trees can also act as a noise barrier, reducing stress and improving health, especially by improving sleep at night.

Evidence of these benefits has been synthesised in a rapid evidence review for Natural England by the University of Exeter.[1] This found that people who live in greener neighbourhoods tend to be happier, healthier and live longer lives than those who live in less green places, with the benefits being even greater for more disadvantaged communities.

To illustrate the wide range of health benefits delivered by nature, Table 1 summarises some of the key evidence. It is based on a 2017 review by Frumkin et al.,[2] updated and extended to include additional categories and more recent references.[3] The table is illustrative, not comprehensive, and new evidence is constantly emerging. The sources listed include both primary studies and systematic reviews.

Health and wellbeing benefits	References
Improved mental health and wellbeing	
Reduced stress	4, 5, 6, 7, 8, 9, 10, 11, 12, 13
Better sleep	4, 6, 14, 15, 16, 17, 18
Reduced depression	6, 7, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30
Reduced anxiety	6, 7, 20, 25, 27, 31, 32, 33
Greater happiness, wellbeing, life satisfaction	6, 30, 34, 35, 36, 37, 38, 39,
Improved concentration and memory; restoration from mental fatigue	15, 40 (children)
Reduced ADHD symptoms	15, 41, 42, 43, 44, 45, 46
Reduced aggression, less crime	47, 48, 49, 50, 51, 52
Reduced schizophrenia	53
Increased social connectedness and prosocial behaviour	5, 7*, 15, 54, 55, 56, 57, 58, 59, 60*,61, 62 *Benefits delivered via social prescribing programmes
Improved physical health	
Improved cardiovascular health	10, 21, 63, 117, 119, 64 (older people)
Improved congestive heart failure	65
Lower blood pressure	10, 66, 67, 68, 69
Reduced obesity	55, 70, 71, 72, 73, 74, 75
Reduced diabetes	10, 76, 77, 78, 79
Better eyesight	80, 81, 82
Improved pain control	Acute pain: 83, 84. Chronic pain: 85, 86
Improved immune function	34, 85, 87, 88, 89, 90, 91*, 92*, 93* *via exposure to beneficial microbes
Asthma and/or allergies (includes both improvements and exacerbations)	Improvements: 10, 94, 95 Mixed or inconclusive: 96, 97 Exacerbations: 55, 98, 99
Improved general health	
Improved general health	9, 78, 100, 101, 102, 103, 104, 105, 106
Reduced mortality	10, 64, 107, 108, 109, 110, 111, 117, 112, 113
Improved birth outcomes	34, 72, 114
Improved child development	40, 115, 116
Greater benefits for more socio-economically deprived groups	25, 26, 78, 100, 102, 118

Table 1: Illustrative evidence on the multiple health benefits of contact with nature, updated and extended based on Frumkin et al. (2017)

Benefits from recreation and interaction with nature

Several large medical studies have found that living close to green space is associated with a lower risk of heart attacks and strokes.[117] This is linked to the ability of natural green spaces to relieve stress,[118] decrease air pollution, encourage physical activity and boost social interactions.[119] Loss of nature has been shown to have detrimental impacts on health.[120]

Spending time in natural environments such as woodlands, parks and gardens reduces stress and depression, restores attention fatigue, increases self-reported positive emotions and improves self-esteem, mood, and perceived mental and physical health.[34] There is now a scientific consensus that experiencing nature is associated with benefits for mental health and psychological wellbeing, including through positive social interactions, improved cognitive function, memory, concentration and creativity, improved sleep, and better school performance in children, as well as protecting from the risk of developing anxiety disorders or ADHD.[15,121] According to the latest People and Nature Survey for England,[122] 94% of adults who had visited a green and natural space in the previous 14 days agreed that spending time outdoors was good for their physical health, 92% agreed it was also good for their mental health, 82% agreed that being in nature made them very happy, and six in ten agreed that they felt part of nature.

Access to natural environments also tends to encourage outdoor exercise, with benefits for physical health such as reduced risk of obesity and type 2 diabetes. For example, a systematic review found 90 studies supporting the conclusion that living near an attractive natural environment can motivate physical activity, and that policy interventions should therefore enable access to and maintenance of the natural environment.[72,123]

94% of adults who had visited a green and natural space in the previous 14 days agreed that spending time outdoors was good for their physical health.

Emerging evidence suggests that biodiversity could boost the immune system and reduce allergies through exposure to natural microbes found in soil and vegetation.[91, 92,93] It is also thought that green spaces can help to reduce pain, including in chronic conditions, via exposure to natural chemicals produced by plants (phytoncides), negative air ions, and sunlight, as well as by encouraging social interaction and physical activity.[86]

Green space can be particularly beneficial to elderly people. A systematic review found 22 studies showing that urban environments with more green cover were associated with reduced risk of cardiovascular disease and all-cause mortality in older people.[64]

A study of 132 pairs of twins in Belgium found that children growing up close to green spaces had a lower blood pressure as adults.

Natural environments are also important for healthy development in children and teenagers, and can lead to lifelong benefits. Birth weight of babies tends to be higher in greener urban areas.[34] A study in Denmark showed that people living in areas with the lowest amount of green space had a 1.5x higher risk of developing schizophrenia, but children living in greener areas had a lower risk of developing schizophrenia in later life.[53] A study of 132 pairs of twins in Belgium found that children growing up close to green spaces had a lower blood pressure as adults.[66]

Sustainable drainage systems can be designed to provide attractive green and blue spaces for people, as well as preventing flooding, improving water quality and supporting biodiversity. Photo: SUSDRAIN

Benefits for more integrated and cohesive communities

Nature plays an important role in bringing people together, strengthening social capital, driving integration and community cohesion. Beneficial outcomes can include shared norms and values between people, more positive and friendly relationships, feelings of being accepted and belonging, increased sense of place, and bringing people together from different backgrounds.[57,124,125] This is particularly important for urban areas which have become more diverse, with people with different migration backgrounds, cultures and lifestyles living together. In addition to associated health and wellbeing benefits,[124] urban green spaces also provide many opportunities for residents to meet and interact with other people, contributing to a sense of belonging to the community/neighbourhood that they live in and developing friendships between culturally diverse groups.[124,126]

> More green space and tree cover is associated with less aggressive behaviour and fewer crimes.

Numerous studies have showed green space is linked with increased social contact. Studies have found an association between green local spaces and perceived social cohesion at the neighbourhood scale, and an even stronger association for higher quantity and quality of green space.[127] For example, one study in the USA found that the presence of trees and grass on common spaces (e.g., local parks) was positively associated with informal social contact between neighbours.[128] The relationship between green space and health has also been shown to be strongly mediated by social cohesion.[56] However, local green spaces must be of high quality and well maintained, with attractive recreational facilities, to realise their full potential in developing community cohesion.[57]

Evidence suggests that green spaces and social cohesion are positively linked to people's sense of safety. More cohesive and connected communities typically have lower crime rates, which can contribute to people feeling safer in their local area.[129,130] More green space is linked to fewer crimes, with one study showing that residents who have more trees and grass around buildings displayed less aggressive behaviour due to spending more time outdoors and monitoring nature.[50] Other studies showed crime levels decreased by an average of 1.2% for every 1% increase in tree canopy cover,[51] and that areas of a US city with more nature had less crime.[50]

Social cohesion also improves happiness, work performance, environmental concern and pro-environmental behaviours. The evidence increasingly suggests that close-knit communities promote a sense of happiness and general well-being,[129] with knock-on benefits including a reduced use of solitary media to escape daily life (e.g. browsing the internet and social media),[131] which can in turn have benefits for workplace behaviour and better work performance.[132] Research has also shown that when people live in more cohesive societies with increased access to green space, they are more likely to contribute with environmentally friendly behaviours such as recycling, making diet changes, using energy efficiently, and volunteering.[133,134,135]

It is essential to ensure that any benefits – including for community cohesion, health and wellbeing, and local economic growth – are equitably shared and distributed, so that green spaces that include one group of people do not exclude others.[136] To achieve this, it is important for decision-makers to actively engage communities in the planning and management of green spaces. For example, strategies can be targeted at encouraging people to engage in nature-related, collaborative activities at the local community level (e.g., spending time in local parks and gardens, environmental stewardship, and volunteering) to increase residents' daily nature experiences and the associated benefits for improving community cohesion and wellbeing.[124,137,138]

Mature urban trees store carbon, soak up floodwater, provide shade on hot days and contribute to local character and a sense of place.
Photo: Alison Smith

Benefits from reduced exposure to air pollution, heat and noise

Urban green features (especially trees) can also help to trap air pollution,[79] reduce the urban heat island[139] and reduce perceived noise from traffic[140] (Box 2). These multiple benefits can all reinforce each other, leading to synergies for health.[141]

> Trees and hedgerows can filter and absorb pollution, especially if positioned as barriers.

Trees and hedgerows can filter and absorb pollution,[142] especially if positioned as barriers (e.g. between homes or schools and busy roads),[143] although the degree of removal cannot be a substitute for reducing pollution at source.[107] There can be some risks of adverse impacts, such as if lines of trees trap traffic pollution in street canyons, or if trees cause pollen allergies, but these can be mitigated by careful design and species selection.[143] Some trees produce volatile organic compounds (VOCs) that combine with the nitrogen oxides found in traffic pollution to form harmful ground-level ozone and fine particles. This can be tackled by reducing traffic pollution and selecting tree species that produce lower levels of VOCs.[143,144] Also, exposure to the diverse microbes in biodiverse natural spaces is thought to reduce the likelihood of developing allergies.[95]

Box 2: Benefits of green infrastructure for air quality, cooling and noise reduction

Parks can have 9% lower concentrations of particle pollution (PM10) 50m inside the boundary.

Street trees can reduce nitrogen oxide concentrations by 1-21%. They can reduce surface temperatures by 11°C and air temperatures by 3°C.

Hedges can provide a 15-61% reduction in air pollution concentrations immediately behind the hedge.

Green roofs can reduce rainfall runoff by 63% to 75% and reduce indoor temperatures by 2°C.

Green walls can reduce particle (PM10) concentrations in a street canyon by 22-50% at street level, reduce noise levels by 50%, and reduce indoor air temperatures by 4.8°C in hot weather.

Source: all figures are average values from the IGNITION project evidence review[145]

Importance of the quality and biodiversity of green space

Quality of green space is important, as well as quantity. Higher quality green spaces attract more use and therefore deliver more benefits. For example, a survey of 2594 mothers in Bradford between 2012 and 2015 found that satisfaction with the quality of nearby green space (and therefore greater usage) was associated with fewer behavioural difficulties and greater prosocial behaviour for south Asian children.[146]

Quality also increases the benefits delivered by each usage of green space. Important factors typically include obvious qualities such as safety and cleanliness (i.e. no litter or vandalism), but there is also mounting evidence that more biodiverse and natural green space provides greater benefits. For example, a systematic global review (including seven studies from the UK) found evidence that greater biodiversity (e.g. the number of bird or plant species in an area) leads to higher self-reported outcomes for health and wellbeing.[34] Similarly, in California, urban areas with greater tree diversity were associated with a lower mortality rate for heart disease and stroke from 2014 to 2019.[147] In Singapore, people who visited more diverse types of natural spaces (e.g. wild nature, parks and beaches) had higher life satisfaction.[148]

Wildlife-rich areas with semi-natural habitats that support native species are likely to have far greater benefits than sterile green spaces, because encounters with wildlife are an important aspect of delivering wellbeing benefits. For example, a study by Exeter University showed how chance wildlife encounters during daily life can lift moods, alleviate depression, and stimulate social interaction.[149]

Greater biodiversity (e.g. the number of bird or plant species in an area) leads to higher self-reported outcomes for health and wellbeing.

Biodiversity tends to be far higher in long-established habitats than in newly created areas, so it is important to protect existing ecosystems. For example, investigators in Belgium found that people living in areas with larger, older trees purchased less medication for cardiovascular disease and mood disorders. This is thought to be because large trees are more effective at reducing environmental stressors like urban heat, air pollution, and noise than smaller trees, as well as being more attractive and providing a greater sense of place.[21]

Role of nature in living with COVID-19

Nature plays an important part in COVID-19 recovery and future resilience. Evidence is growing that access to nature also helped people to cope physically and mentally with the stress of the COVID-19 pandemic. A global review found strong evidence that increased exposure to nature during the first two years of the pandemic was related to improved health and wellbeing. This came from reduced depression, stress, loneliness, and anxiety, better sleep and increased physical activity, and more happiness and life satisfaction.

Access to nature may have prevented further mental and physical health deterioration on a large scale.[6] A study of mothers of young children in the Netherlands found that living close to green space helped to buffer against stress during the pandemic.[150] In the U.S, an online survey found that individuals with strong perceived nature deprivation under COVID-19 had lower wellbeing.[151]

The People and Nature Survey has revealed that nearly half of adults in England reported spending more time outdoors during the pandemic than before, with four in ten stating that nature and wildlife were more important than ever for their wellbeing.[152] For many people, increased engagement with nature during the coronavirus pandemic allowed them to find new ways to connect with nature. 68% of people said they were taking more time to notice and engage with everyday nature, 33% of adults reported visiting local green and natural spaces more often since coronavirus restrictions were put in place, and 40% said that this had been even more important to their wellbeing.[153]

There is growing evidence that restoring nature close to where people live can boost resilience to COVID-19. As well as the general benefits of green spaces for physical and mental health described above, there is also emerging evidence that volatile compounds emitted by plants (phytoncides) can enhance the activity of natural killer cells (lymphocytes) that underpin the immune system, and exposure to beneficial microbiota in the environment can boost the immune system and reduce stress.[154] For example, a type of bacteria found in biodiverse soils has been shown to reduce anxiety in mice.[155] Finally, trees and other vegetation reduce air pollution, which increases COVID-19 mortality.

Economic outcomes of natural green space

Protecting and restoring natural green spaces brings multiple benefits for national and local economies.

1. **Business investment.** Attractive green space helps to improve the image of an area, create a sense of place, and encourage investment by businesses.

2. **Staff recruitment and retention.** High quality staff are more likely to gravitate towards (and stay in) jobs in areas with a range of attractive green spaces nearby.

3. **New business opportunities** can be created, such as in tourism and hospitality.

4. **Direct employment**. Jobs can be created directly in maintaining and improving green spaces.

5. **Reduced healthcare costs.** The health benefits of green spaces can reduce the burden on national and local health and social care budgets. Parks in England provide at least £6.6bn per year in health and environmental benefits, returning £7 to £10 for every £1 spent.[169] If everyone in England had access to good quality green space, there could be savings of £2.1bn per year for the NHS.[170] Similarly, an analysis of five million people in the USA found lower healthcare costs in greener areas.[156] In Plymouth, it is estimated that visits to green spaces provide health benefits worth £22 per visit, adding up to £150 million per year.[157]

6. **Labour productivity.** Access to nature can improve productivity, reduce absence from work due to sickness, and reduce antisocial behaviour.[158]

7. **Property values.** Property in areas with more natural green space can have a higher value. One study indicates a 1% increase in house prices for a 1% increase in green space within a ward, higher house prices close to nature reserves, and 17% higher house prices in National Parks.[159]

8. **Lower crime rates** can be found in areas with more green space, leading to savings for victims of crime as well as a reduced burden on the police and criminal justice systems.

9. **Flood protection.** Well-designed green infrastructure including Sustainable Drainage Schemes (SuDS) can reduce surface water flooding and associated damage to homes and property, as well as reducing the costs for hard drainage and flood defences.

10. **Water treatment costs** can be reduced by using nature-based solutions such as habitat restoration, buffer strips and SuDS to reduce soil erosion and water pollution.

11. **Energy cost savings.** Green infrastructure such as green roofs and walls, parks and street trees can provide cooling and shading, reducing the need for costly air conditioning and thus saving money on energy bills.

Habitat restoration creates more employment per £1 invested than many other sectors usually targeted for economic recovery, such as fossil fuel energy projects.[160] Investing in nature recovery creates both low-skilled and high-skilled jobs, making this a flexible response to economic downturn.[161] One study showed that investing in nature recovery and urban green infrastructure could create over 16,000 jobs in the 20% of constituencies likely to face the most significant employment challenges post-COVID.[162] In addition to direct jobs in restoring nature, attractive nature-rich areas support tourism and outdoor recreation businesses. For example, nature-based tourism generates £1.4 billion a year and 39,000 full-time equivalent jobs in Scotland.[163] The Knepp Estate, which pioneered rewilding of unproductive farmland, has an annual turnover of around £800,000 from nature tourism, with a 22% profit margin.

Economic benefits also arise from the environmental benefits of investing in nature. Every £1 invested yields an estimated return of £4.62 for peatland restoration, £2.79 for woodland and £1.31 for saltmarsh, from carbon sequestration, recreation and (for woodland) air quality benefits alone, without considering other benefits such as flood and erosion protection.[164] As NbS often have large up-front costs, from buying the equipment, materials and services needed to create or restore ecosystems, they also create growth in the wider economy (via high multiplier effects) and generate high gross value added (GVA).[160]

Box 3: Economic benefits of green infrastructure

Parks can increase nearby property prices by 9%. Higher levels of greenness are associated with a 56% decrease in violent crimes and a 48% decrease in property crimes.

Street trees can increase property prices by 4.5% and land prices by 6-15%. Customers spend 10-50% more and use restaurants 40% more in shopping streets with high quality tree canopy cover. One study showed that business occupancy rates increased by 38% following investment in planting trees.

Views of nature or indoor green infrastructure can lead to an 18% reduction in staff turnover, 10% reduction in sick leave and 15% increase in worker productivity.

Green roofs can cut energy use for air conditioning by 16% in hot weather, and cut energy use for heating by 4%, saving typically 7% of total energy use for the space directly below the roof.

Green walls can cut energy use for air conditioning by 13-23% in hot weather, and cut energy use for heating by 1.2-6.3%, saving typically 8-15% of total building energy use.

Sustainable drainage systems can reduce surface water runoff by up to 100% if well-designed, and can remove up to 79% of nitrate pollution and 85% of phosphate pollution.

Source: all figures are average values from the IGNITION project evidence review[145]

Inequalities in access to green space

Disadvantaged groups and people living in socio-economically deprived areas benefit more from access to green space, and health inequalities between different socio-economic groups tend to be lower in greener urban areas.[1,10,112] For example, greenspaces help women in low-income groups in the UK to cope with stress,[146] including during the COVID-19 lockdown.[165]

> In England: 26% of adults surveyed in March 2022 said that they had not spent any time in green and natural spaces in the previous 14 days.

One in three people in England do not live near a local green space. Access to green space can be assessed using the Accessible Natural Greenspace Standards, which set criteria for the size of green spaces that should be accessible at certain distances from people's homes. The three most local standards are for a doorstep green space of at least 0.5ha within 200m, a local natural green space of at least 2ha within 300m, and a neighbourhood natural green space of at least 10ha within 1km (a 15 minute walk). However, one in three people in England do not live within any of these zones.

Only 3% of the most disadvantaged people have access to local green space. In the 200 most disadvantaged urban Lower Super Output Areas (those with the lowest levels of accessible green space combined with the highest levels of deprivation), only 3% of people have access to green space within a 15-minute walk zone.[166]. The People and Nature Survey for England has revealed that the transformative benefits of nature are not felt by everyone equally and that deprived communities have less access to green space. Spending time outside in nature is not always easy for people in England: 26% of adults surveyed in March 2022 said that they had not spent any time in green and natural spaces in the previous 14 days.[152]**.** For people from lower income households (income less than £15,000) this increased to 37%, suggesting that existing inequalities persist in accessing nature. Almost 40% of people from black, Asian and minority ethnic backgrounds live in the areas of England that have the least green space, compared to 14% of white people.[171]

Creating new green infrastructure as part of regeneration can play a key role in addressing these striking inequalities. However, this must be carefully designed in partnership with local communities and other key stakeholders to avoid problems associated with 'green gentrification', where improving green spaces increases house prices and thus leads to social exclusion.[1]

Opportunities to strengthen the Levelling-up and Regeneration Bill

There are major opportunities to strengthen the Levelling-up and Regeneration Bill by ensuring that future development protects existing natural assets, restores degraded ecosystems and creates new urban green infrastructure. There is overwhelming evidence that this will improve public physical and mental health and wellbeing, boost resilience to future outbreaks of disease such as COVID-19 (reducing the social cost of healthcare), improve resilience to future climate threats such as floods, droughts and heatwaves, and deliver a wide range of economic benefits. This will help to redress existing inequalities in health and access to nature faced by the communities targeted by the Bill. For example, 40% of the areas with the lowest green space provision are in Levelling-up target areas.[172] Specific opportunities to strengthen the Bill and address its current omissions are listed below.

- **The Bill needs to explicitly recognise the role of nature in supporting human health and cohesive communities, climate resilience and the economy**, and ensure that national and local planning policies, assessment processes and individual planning decisions put nature recovery and protection of existing natural assets at the heart of the planning system.

- **A Net Zero clause should be added**, to ensure that all new developments are consistent with the government's Net Zero goals.

- **Nature recovery clauses should be added,** to ensure the delivery of the government's commitment to protect 30% of land for nature, to establish a **new designation to safeguard land for nature's recovery**, and to address the contribution development makes to freshwater pollution through **nutrient negativity** measures.

- **A health, wellbeing and community cohesion clause should be added**, with a new duty on local authorities to address existing inequalities in health and access to green space and equal distribution of benefits, including ensuring that communities are served by active travel networks of footpaths and cycleways.

- **The new Environmental Outcome Reports must be strengthened** so that they provide a minimum level of protection at least equivalent to the existing system, including Strategic Environmental Assessments, Environmental Impact Assessments, the Habitats Regulations Assessment process, Species protection, cultural heritage and landscape protections. These protections should be explicitly retained in the Bill, and not subject only to the decisions of the Secretary of State.

- **The proposed National Development Management policies** need to set a strong and consistent national approach for protecting existing natural assets (habitats, species, water and air quality), a minimum standard for access to natural green spaces, and criteria for building in new high quality climate-resilient green and blue infrastructure to new development. This could be based on the new Green Infrastructure Standards being developed as part of the government commitments in the 25 Year Environment Plan.

- **The Infrastructure Levy and developer contributions** proposals should state that these should contribute to nature recovery and net zero alongside wider social objectives.

This flood retention pond was designed in partnership with the local community, so that it provided attractive green spaces for relaxing and playing.
Photo: SUSDRAIN

Case study 1: The Mersey Forest

The Mersey Forest is one of 13 Community Forests which were created in England during the 1990s. Over the last 25 years, the Mersey Forest Partnership has planted over 9 million trees to create a network of local woodlands across 500 square miles of Cheshire and Merseyside. More recently, the Mersey Forest has joined with three other community forests (Manchester City of Trees, the White Rose Forest and the Humber Forest) to create the Northern Forest, spanning from coast to coast across the whole width of northern England.

The Mersey Forest works with local communities to regenerate ex-industrial areas by improving health, the economy and social cohesion. This delivers economic benefits by improving the image of derelict urban areas, attracting investment, skilled workers and tourists to the are and increasing land and property values. For example, in St. Helens, development of a community woodland on a former colliery site added £15 million to property values. So far, the Forest has secured £31 million of investment and demonstrates exceptional value for money, with a return of £8 for every £1 invested.

The Natural Economy Northwest project has compiled evidence of 11 ways in which the Mersey Forest's green infrastructure has added value to the region's economy:

1. **Economic growth and investment.** Businesses attract and retain more motivated staff in greener settings.
2. **Land and property values.** Views of natural landscapes can add up to 18% to property values.
3. **Labour productivity.** Green spaces near workplaces reduce sickness absence, increasing productivity.
4. **Tourism.** Rural tourism supports 37,500 jobs in the North West.
5. **Products from the land.** 40,000 people work in agriculture in the North West.
6. **Health and well being.** Green infrastructure reduces pollution which leads to asthma and heart disease.
7. **Recreation and leisure.** Footpaths, cycle paths and bridleways enable healthy, low-cost recreation.
8. **Quality of place.** Community-owned green spaces can create jobs and local pride.
9. **Land and biodiversity.** Green infrastructure provides vital habitats and jobs managing the land.
10. **Flood alleviation and management.** Urban green spaces reduce pressure on drainage and flood defences.
11. **Climate change adaptation and mitigation.** Green infrastructure can counter soaring summer temperatures in cities.

Social benefits are maximised by a strong focus on engagement with local people and businesses, to meet the needs of the local community and avoid problems of ‘green gentrification’, where property in greened areas passes to wealthy owners. For example, the Wirral Waters project is successfully regenerating a deprived dockland area by starting with a £1.2M investment in green infrastructure, known as ‘Setting the Scene for Growth’. Trees, wildflowers and raingardens were planted along footpaths, roads and cycleways to link the docklands with local communities, a new pocket park was created, and an old landfill site was transformed into a nature reserve. This improved the image of the area, which is attracting new development including a college of further education, offices creating hundreds of new jobs, and high quality affordable homes. Greening this inner city area provides a healthy, calming environment with physical and mental health benefits for the students, residents and workers.

The Natural Economy Northwest project has compiled evidence of 11 ways in which the Mersey Forest’s green infrastructure has added value to the region's economy.
Photo: Chris Fry

Case study 2: Plymouth's Natural Grid and Community Forest

Plymouth has severe health inequalities, with life expectancy in the most deprived areas near the waterfront being seven years lower than in the more affluent areas just a few miles away. The Natural Grid project is enhancing habitats and improving access to 390ha of land. It has generated 22 new jobs including apprenticeships for young people, and accredited learning opportunities for 96 people. Nature engagement weeks in deprived areas have connected 1000 people with nature and provided learning and employment opportunities, including working with local schools to create green learning centres and plant wildflower meadows.[167]

Funding has now been secured for a much larger Community Forest that will create 1,900 hectares of ecologically resilient community woodland, street trees, woodland corridors and hedgerows, including through rewilding and natural regeneration. It will be steered by a Youth Panel, and focused on skills development and job creation for young people. The new forests are expected to deliver 350 jobs and over £7 million of benefits per year, from increased property value, physical and mental health benefits, carbon sequestration and pollution removal.[168]

School children planting trees as part of a Mersey Forest project.
Photo: McCoy Wynne

About the Authors

Alison Smith

Alison is a Senior Research Associate at the Environmental Change Institute and the Nature-based Solutions Initiative (NbSI), University of Oxford.

Caitlin Hafferty

Caitlin is a Postdoctoral Researcher at the Environmental Change Institute and the NbSI, University of Oxford.

Prof Nathalie Seddon

Nathalie is Professor of Biodiversity and Director of the NbSI, University of Oxford.

This policy brief was funded by the Agile Initiative at the Oxford Martin School and the Nature-based Solutions Initiative. The Agile Initiative has been established with £10 million from the Natural Environment Research Council (NERC) [grant number NE/W004976/1] to revolutionise the delivery of world-class, high-impact interdisciplinary research to support evidence-based policymaking on environmental issues. It brings together outstanding researchers from the University of Oxford with external partners, and industry and community stakeholders to address time-critical questions of importance for policymakers.

AGILE INITIATIVE

OXFORD MARTIN SCHOOL

UNIVERSITY OF OXFORD

NATURE-BASED SOLUTIONS INITIATIVE

References

1 Lovell, R., White, M.P., Wheeler, B., Taylor, T., Elliott, L. (2020) A rapid scoping review of health and wellbeing evidence for the Green Infrastructure Standards. European Centre for Environment and Human Health, University of Exeter Medical School. For: Natural England, Department for the Environment, Food and Rural Affairs, Public Health England, and Ministry for Housing, Communities and Local Government, England.

2 Frumkin et al. (2017). Nature Contact and Human Health: A Research Agenda. *Environmental Health Perspectives 125*(7) 075001.

3 Additional references for health outcomes were gathered by searching Web of Science for systematic reviews using the search string Title = ("natur* or biodiverse* or green*) AND (health* or disease* or wellbeing or mortality or illness or cardiovascular). This retrieved 295 results (December 2022). We scanned the list for papers with quantitative evidence on the links between nature and health, but this was not done in a systematic or comprehensive way.

4 Berto, R. (2014). The Role of Nature in Coping with Psycho-Physiological Stress: A Literature Review on Restorativeness. *Behavioral Sciences* 4(4), 394–409.

5 Fan, Y., Das, K. V., & Chen, Q. (2011). Neighborhood green, social support, physical activity, and stress: Assessing the cumulative impact. *Health & Place*, *17*(6), 1202–1211.

6 Labib, S. M., Browning, M. H. E. M., Rigolon, A., Helbich, M., & James, P. (2022). Nature's contributions in coping with a pandemic in the 21st century: A narrative review of evidence during COVID-19. *Science of The Total Environment*, *833*, 155095.

7 Maund, P. R., Irvine, K. N., Reeves, J., Strong, E., Cromie, R., Dallimer, M., & Davies, Z. G. (2019). Wetlands for Wellbeing: Piloting a Nature-Based Health Intervention for the Management of Anxiety and Depression. *International Journal of Environmental Research and Public Health*, *16*(22), 4413.

8 Nielsen TS, Hansen KB. (2007). Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators. *Health Place*13(4):839–850.

9 Stigsdotter UK, Ekholm O, Schipperijn J, Toftager M, Kamper-Jørgensen F, Randrup TB. (2010). Health promoting outdoor environments - associations between green space, and health, health-related quality of life and stress based on a Danish national representative survey. *Scand J Public Health* 38(4):411–417.

10 Twohig-Bennett, C. & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental Research*, *166*, 628–637.

11 van den Berg A, Custers M. (2011). Gardening promotes neuroendocrine and affective restoration from stress. *J Health Psychol* 16(1):3–11.

12 van den Berg AE, Maas J, Verheij RA, Groenewegen PP. (2010). Green space as a buffer between stressful life events and health. *Soc Sci Med* 70(8):1203–1210.

13 Ward Thompson C, Aspinall P, Roe J, Robertson L, Miller D. (2016). Mitigating stress and supporting health in deprived urban communities: The importance of green space and the social environment. *Int J Environ Res Public Health* 13(4):440.

14 Astell-Burt T, Feng X, Kolt GS. (2013). Does access to neighbourhood green space promote a healthy duration of sleep? Novel findings from a cross-sectional study of 259 319 Australians. *BMJ Open* 3(8):e003094.

15 Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., de Vries, S., Flanders, J., ... Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. *Science Advances*, *5*(7), eaax0903.

16 Grigsby-Toussaint DS, Turi KN, Krupa M, Williams NJ, Pandi-Perumal SR, Jean-Louis G. (2015) Sleep insufficiency ad the natural environment: Results from the US Behavioral Risk Factor Surveillance System Survey. *Prev Med* 78:78–84.

17 Morita E, Imai M, Okawa M, Miyaura T, Miyazaki S. (2011) A before and after comparison of the effects of forest walking on the sleep of a community-based sample of people with sleep complaints. *Biopsychosoc Med* 5:13.

18 Shin, J. C., Parab, K. V., An, R., & Grigsby-Toussaint, D. S. (2020). Greenspace exposure and sleep: A systematic review. *Environmental Research 182*, 109081.

19 Astell-Burt T, Mitchell R, Hartig T. (2014a). The association between green space and mental health varies across the lifecourse. A longitudinal study. *J Epidemiol Community Health* 68:578–583.

20 Beyer KMM, Kaltenbach A, Szabo A, Bogar S, Nieto FJ, Malecki KM. (2014) Exposure to neighborhood green space and mental health: Evidence from the survey of the health of Wisconsin. *Int J Environ Res Public Health* 11(3):3453–3472

21 Chi D, Aerts R, Van Nieuwenhuyse A, Bauwelinck M, Demoury C, Plusquin M, et al. (2022). Residential exposure to urban trees and medication sales for mood disorders and cardiovascular disease in Brussels, Belgium: an ecological study. *Environmental Health Perspectives* 130(5):57003.

22 Cohen-Cline H, Turkheimer E, Duncan GE. (2015) Access to green space, physical activity and mental health: a twin study. *J Epidemiol Community Health* 69(6):523–529.

23 Gascon M, Triguero-Mas M, Martinez D, Dadvand P, Forns J, Plasencia A, et al. (2015). Mental health benefits of long-term exposure to residential green and blue spaces: a systematic review. *Int J Environ Res Public Health* 12(4):4354–4379.

24 Kim W, Lim SK, Chung EJ, Woo JM. (2009) The effect of cognitive behavior therapy-based psychotherapy applied in a forest environment on physiological changes and remission of major depressive disorder. *Psychiatry Investig* 6(4):245–254

25 Maas J, Verheij RA, de Vries S, Spreeuwenberg P, Schellevis FG, Groenewegen PP. (2009b) Morbidity is related to a green living environment. *J Epidemiol Community Health* 63(12):967–973

26 McEachan RR, Prady SL, Smith G, Fairley L, Cabieses B, Gidlow C, et al. (2016) The association between green space and depressive symptoms in pregnant women: Moderating roles of socioeconomic status and physical activity. *J Epidemiol Community Health* 70(3):253–259.

27 Nutsford D, Pearson AL, Kingham S. (2013) An ecological study investigating the association between access to urban green space and mental health. *Public Health* 127(11):1005–1011.

28 Sturm R, Cohen D. (2014) Proximity to urban parks and mental health. *J Ment Health Policy Econ* 17(1):19–24.

29 Taylor MS, Wheeler BW, White MP, Economou T, Osborne NJ. (2015) Research note: urban street tree density and antidepressant prescription rates—a cross-sectional study in London, UK. *Landscape and Urban Planning* 136:174–179.

30 White, M. P., Alcock, I., Wheeler, B. W., & 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), 920–928.

31 Bratman GN, Daily GC, Levy BJ, Gross JJ. (2015a) The benefits of nature experience: improved affect and cognition. *Landsc Urban Plan* 138:41–50.

32 Song C, Joung D, Ikei H, Igarashi M, Aga M, Park BJ, et al. (2013) Physiological and psychological effects of walking on young males in urban parks in winter. *J Physiol Anthropol* 32:18.

33 Song C, Ikei H, Igarashi M, Takagaki M, Miyazaki Y. (2015) Physiological and psychological effects of a walk in urban parks in fall. *Int J Environ Res Public Health* 12(11):14216–14228.

34 Aerts, R., Honnay, O., & Van Nieuwenhuyse, A. (2018). Biodiversity and human health: Mechanisms and evidence of the positive health effects of diversity in nature and green spaces. *British Medical Bulletin*, *127*(1), 5–22.

35 Ambrey CL. (2016) An investigation into the synergistic wellbeing benefits of greenspace and physical activity: moving beyond the mean. *Urb Forestry Urb Greening* 19:7–12.

36 Fleming CM, Manning M, Ambrey CL. (2016) Crime, greenspace and life satisfaction: An evaluation of the New Zealand experience. *Landsc Urban Plan* 149:1–10.

37 Larson LR, Jennings V, Cloutier SA. (2016) Public parks and wellbeing in urban areas of the United States. *PLoS One* 11(4):e0153211.

38 MacKerron G, Mourato S. (2013) Happiness is greater in natural environments. *Global Environmental Change* 23(5):992–1000.

39 Van Herzele A, de Vries S. (2012) Linking green space to health: A comparative study of two urban neighbourhoods in Ghent, Belgium. *Popul Environ* 34(2):171–193.

40 Mason, L., Ronconi, A., Scrimin, S., & Pazzaglia, F. (2022). Short-Term Exposure to Nature and Benefits for Students' Cognitive Performance: A Review. *Educational Psychology Review*, *34*(2), 609–647.

41 Amoly E, Dadvand P, Forns J, Lopez-Vicente M, Basagana X, Julvez J, et al. (2014) Green and blue spaces and behavioral development in Barcelona schoolchildren: The BREATHE project. *Environ Health Perspect* 122(12):1351–1358.

42 Faber Taylor A, Kuo F, Sullivan W. (2001) Coping with ADD: the surprising connection to green play settings. *Environ Behav* 33(1):54–77.

43 Faber Taylor A, Kuo F. (2009) Children with attention deficits concentrate better after walk in the park. *J Atten Disord* 12(5):402–409.

44 Faber Taylor A, Kuo FEM. (2011) Could exposure to everyday green spaces help treat ADHD? Evidence from children's play settings. *Appl Psychol Health Well Being* 3(3):281–303.

45 Markevych I, Tiesler CMT, Fuertes E, Romanos M, Dadvand P, Nieuwenhuijsen MJ, et al. (2014b). Access to urban green spaces and behavioural problems in children: results from the GINIplus and LISAplus studies. *Environ Int* 71:29–35.

46 van den Berg AE, van den Berg CG. (2011) A comparison of children with ADHD in a natural and built setting. *Child Care Health Dev* 37(3):430–439.

47 Bogar S, Beyer KM. (2016) Green space, violence, and crime. *Trauma Violence Abuse* 17(2):160–171.

48 Branas CC, Cheney RA, MacDonald JM, Tam VW, Jackson TD, Ten Have TR. (2011) A difference-in-differences analysis of health, safety, and greening vacant urban space. *Am J Epidemiol* 174(11):1296–1306.

49 Kondo, M. C., Fluehr, J. M., McKeon, T., & Branas, C. C. (2018). Urban Green Space and Its Impact on Human Health. *International Journal of Environmental Research and Public Health*, *15*(3), 445.

50 Kuo FE, Sullivan WC. (2001a). Environment and crime in the inner city: does vegetation reduce crime? *Environ Behav* 33(3):343–367.

51 Troy A, Morgan Grove J, O'Neil-Dunne J. (2012) The relationship between tree canopy and crime rates across an urban–rural gradient in the greater Baltimore region. *Landsc Urban Plan* 106(3):262–270.

52 Younan D, Tuvblad C, Li L, Wu J, Lurmann F, Franklin M, et al. (2016) Environmental determinants of aggression in adolescents: Role of urban neighborhood greenspace. *J Am Acad Child Adolesc Psychiatry* 55(7):591–601.

53 Engemann, K., Pedersen, C. B., Arge, L., Tsirogiannis, C., Mortensen, P. B., & Svenning, J.-C. (2018). Childhood exposure to green space – A novel risk-decreasing mechanism for schizophrenia? *Schizophrenia Research*, *199*, 142–148.

54 Broyles ST, Mowen AJ, Theall KP, Gustat J, Rung AL. (2011) Integrating social capital into a park-use and active-living framework. *Am J Prev Med* 40(5):522–529.

55 Dadvand P, Villanueva CM, Font-Ribera L, Martinez D, Basagana X, Belmonte J, et al. (2014a). Risks and benefits of green spaces for children: a cross-sectional study of associations with sedentary behavior, obesity, asthma, and allergy. *Environ Health Perspect* 122(12):1329–1335.

56 de Vries S, van Dillen SM, Groenewegen PP, Spreeuwenberg P. (2013) Streetscape greenery and health: Stress, social cohesion and physical activity as mediators. *Soc Sci Med* 94:26–33.

57 Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and Health. *Annual Review of Public Health*, *35*(1), 207–228.

58 Holtan MT, Dieterlen SL, Sullivan WC. (2015) Social life under cover: tree canopy and social capital in Baltimore, Maryland. Environment and Behavior 47(5):502–525.

59 Home R, Hunziker M, Bauer N. (2012) Psychosocial outcomes as motivations for visiting nearby urban green spaces. *Leis Sci* 34(4):350–365.

60 Leavell, M. A., Leiferman, J. A., Gascon, M., Braddick, F., Gonzalez, J. C., & Litt, J. S. (2019). Nature-Based Social Prescribing in Urban Settings to Improve Social Connectedness and Mental Well-being: A Review. *Current Environmental Health Reports*, *6*(4), 297–308.

61 Piff PK, Dietze P, Feinberg M, Stancato DM, Keltner D. (2015) Awe, the small self, and prosocial behavior. *J Pers Soc Psychol* 108(6):883–899.

62 Sullivan WC, Kuo FE, DePooter SF. (2004) The fruit of urban nature: vital neighborhood spaces. *Environ Behav* 36(5):678–700.

63 Dalton, A. M., & Jones, A. P. (2020). Residential neighbourhood greenspace is associated with reduced risk of cardiovascular disease: A prospective cohort study. *PloS One*, *15*(1), e0226524.

64 Yuan, Y., Huang, F., Lin, F., Zhu, P., & Zhu, P. (2021). Green space exposure on mortality and cardiovascular outcomes in older adults: A systematic review and meta-analysis of observational studies. *Aging Clinical and Experimental Research*, *33*(7), 1783–1797.

65 Mao G, Cao Y, Wang B, Wang S, Chen Z, Wang J, et al. (2017) The salutary influence of forest bathing on elderly patients with chronic heart failure. *Int J Environ Res Public Health* 14(4):368.

66 Bijnens, E. M., Nawrot, T. S., Loos, R. J., Gielen, M., Vlietinck, R., Derom, C., & Zeegers, M. P. (2017). Blood pressure in young adulthood and residential greenness in the early-life environment of twins. *Environmental Health*, *16*(1), 53.

67 Duncan M, Clarke N, Birch S, Tallis J, Hankey J, Bryant E, et al. (2014) The effect of green exercise on blood pressure, heart rate and mood state in primary school children. *Int J Environ Res Public Healt*h 11(4):3678–3688.

68 Markevych I, Thiering E, Fuertes E, Sugiri D, Berdel D, Koletzko S, et al. (2014a) A cross-sectional analysis of the effects of residential greenness on blood pressure in 10-year old children: results from the GINIplus and LISAplus studies. *BMC Public Health* 14:477.

69 Shanahan DF, Franco L, Lin BB, Gaston KJ, Fuller RA. (2016). The benefits of natural environments for physical activity. *Sports Med* 46(7):989–995 .

70 Bell JF, Wilson JS, Liu GC. (2008). Neighborhood greenness and 2-year changes in body mass index of children and youth. *Am J Prev Med* 35(6):547–553.

71 Cleland V, Crawford D, Baur LA, Hume C, Timperio A, Salmon J. (2008) A prospective examination of children's time spent outdoors, objectively measured physical activity and overweight. *Int J ObesRelat Metab Disord* 32:1685–1693.

72 James, P., Banay, R. F., Hart, J. E., & Laden, F. (2015). A Review of the Health Benefits of Greenness. *Current Epidemiology Report*, *2*(2) 131–142.

73 Lachowycz K, Jones AP. (2011) Greenspace and obesity: A systematic review of the evidence. *Obes Rev* 12(5):e183–e189.

74 Sanders T, Feng X, Fahey PP, Lonsdale C, Astell-Burt T. (2015) Greener neighbourhoods, slimmer children? Evidence from 4423 participants aged 6 to 13 years in the Longitudinal Study of Australian Children. Int J Obes (Lond) 39(8):1224–1229.

75 Stark JH, Neckerman K, Lovasi GS, Quinn J, Weiss CC, Bader MDM, et al. (2014) The impact of neighborhood park access and quality on body mass index among adults in New York City. Prev Med 64:63–68.

76 Astell-Burt T, Feng X, Kolt GS. (2014b). Is neighborhood green space associated with a lower risk of type 2 diabetes? Evidence from 267,072 Australians. *Diabetes Care* 37:197–201.

77 Bodicoat DH, O'Donovan G, Dalton AM, Gray LJ, Yates T, Edwardson C, et al. (2014). The association between neighbourhood greenspace and type 2 diabetes in a large cross-sectional study. *BMJ Open* 4:e006076.

78 Brown SC, Lombard J, Wang K, Byrne MM, Toro M, Plater-Zyberk E, et al. (2016) Neighborhood greenness and chronic health conditions in medicare beneficiaries. Am J Prev Med51(1):78–89.

79 Thiering E, Markevych I, Bruske I, Fuertes E, Kratzsch J, Sugiri D, et al. (2016) Associations of residential long-term air pollution exposures and satellite-derived greenness with insulin resistance in German adolescents. *Environ Health Perspect* 124(8):1291–1298.

80 French AN, Ashby RS, Morgan IG, Rose KA. (2013) Time outdoors and the prevention of myopia. *Exp Eye Res* 114:58–68.

81 Guggenheim JA, Northstone K, McMahon G, Ness AR, Deere K, Mattocks C, et al. (2012). Time outdoors and physical activity as predictors of incident myopia in childhood: A prospective cohort study. *Invest Ophthalmol Vis Sci* 53(6):2856–2865.

82 He M, Xiang F, Zeng Y, Mai J, Chen Q, Zhang J, et al. (2015). Effect of time spent outdoors at school on the development of myopia among children in China: A randomized clinical trial. *JAMA* 314(11):1142–1148 .

83 Diette GB, Lechtzin N, Haponik E, Devrotes A, Rubin HR. (2003) Distraction therapy with nature sights and sounds reduces pain during flexible bronchoscopy. *Chest* 123(3):941–948.

84 Lechtzin N, Busse AM, Smith MT, Grossman S, Nesbit S, Diette GB. (2010) A randomized trial of nature scenery and sounds versus urban scenery and sounds to reduce pain in adults undergoing bone marrow aspirate and biopsy. J Altern Complement Med 16(9):965–97

85 Han J-W, Choi H, Jeon Y-H, Yoon C-H, Woo J-M, Kim W. (2016). The effects of forest therapy on coping with chronic widespread pain: Physiological and psychological differences between participants in a forest therapy program and a control group. *Int J Environ Res Public Health* 13(3):255.

86 Stanhope, J., Breed, M. F., & Weinstein, P. (2020). Exposure to greenspaces could reduce the high global burden of pain. *Environmental Research*, *187*, 109641.

87 Li Q, Morimoto K, Kobayashi M, Inagaki H, Katsumata M, Hirata Y, et al. (2008a). A forest bathing trip increases human natural killer activity and expression of anti-cancer proteins in female subjects. *J Biol Regul Homeost Agents* 22(1):45–55.

88 Li Q, Morimoto K, Kobayashi M, Inagaki H, Katsumata M, Hirata Y, et al. (2008b). Visiting a forest, but not a city, increases human natural killer activity and expression of anti-cancer proteins. *Int J Immunopathol Pharmacol* 21(1):117–127.

89 Li Q, Kobayashi M, Inagaki H, Hirata Y, Li YJ, Hirata K, et al. (2010) A day trip to a forest park increases human natural killer activity and the expression of anti-cancer proteins in male subjects. *J Biol Regul Homeost Agents* 24(2):157–165.

90 Li Q, Kawada T. (2011) Effect of forest environments on human natural killer (NK) activity. I*nt J Immunopathol Pharmacol* 24(1suppl):39S–44S.

91 Liddicoat, C., Bi, P., Waycott, M., Glover, J., Lowe, A. J., & Weinstein, P. (2018). Landscape biodiversity correlates with respiratory health in Australia. *Journal of Environmental Management*, *206*, 113–122.

92 Rook, G. A. (2013). Regulation of the immune system by biodiversity from the natural environment: An ecosystem service essential to health. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(46), 18360–18367.

93 Ruokolainen, L., Fyhrquist, N., & Haahtela, T. (2016). The rich and the poor: Environmental biodiversity protecting from allergy. *Current Opinion in Allergy and Clinical Immunology 16*(5), 421.

94 Lovasi GS, Quinn JW, Neckerman KM, Perzanowski MS, Rundle A. (2008) Children living in areas with more street trees have lower prevalence of asthma. *J Epidemiol Community Health* 62(7):647–649.

95 Ruokolainen L, von Hertzen L, Fyhrquist N, Laatikainen T, Lehtomaki J, Auvinen P, et al. (2015). Green areas around homes reduce atopic sensitization in children. *Allergy* 70(2):195–202.

96 Fuertes E, Markevych I, von Berg A, Bauer CP, Berdel D, Koletzko S, et al. (2014) Greenness and allergies: evidence of differential associations in two areas in Germany. *J Epidemiol Community Health* 68:787–790.

97 Fuertes E, Markevych I, Bowatte G, Gruzieva O, Gehring U, Becker A, et al. (2016) Residential greenness is differentially associated with childhood allergic rhinitis and aeroallergen sensitization in seven birth cohorts. Allergy 71(10):1461–1471.

98 Andrusaityte S, Grazuleviciene R, Kudzyte J, Bernotiene A, Dedele A, Nieuwenhuijsen MJ. 2016. Associations between neighbourhood greenness and asthma in preschool children in Kaunas, Lithuania: a case–control study. BMJ Open6(4):e010341.

99 Lovasi GS, O'Neil-Dunne JP, Lu JW, Sheehan D, Perzanowski MS, Macfaden SW, et al. (2013) Urban tree canopy and asthma, wheeze, rhinitis, and allergic sensitization to tree pollen in a New York City birth cohort. *Environ Health Perspect* 121(4):494–500.

100 de Vries S, Verheij RA, Groenewegen PP, Spreeuwenberg P. (2003) Natural environments—healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environ Plann* A35(10):1717–1731.

101 Kardan O, Gozdyra P, Misic B, Moola F, Palmer LJ, Paus T, et al. (2015) Neighborhood greenspace and health in a large urban center. Sci Rep 5:11610.

102 Maas J, Verheij R, Groenewegen P, de Vries S, Spreeuwenberg P. (2006) Green space, urbanity, and health: how strong is the relation?. *J Epidemiol Community Health* 60(7):587–592.

103 Maas J, Verheij RA, de Vries S, Spreeuwenberg P, Schellevis FG, Groenewegen PP. (2009b). Morbidity is related to a green living environment. *J Epidemiol Community Health* 63(12):967–973.

104 Wheeler BW, Lovell R, Higgins SL, White MP, Alcock I, Osborne NJ, et al. (2015) Beyond greenspace: an ecological study of population general health and indicators of natural environment type and quality. *Int J Health Geogr* 14:17.

105 Ray H, Jakubec SL. (2014) Nature-based experiences and health of cancer survivors. *Complement Ther Clin Pract* 20(4):188–192.

106 Kim JH, Lee C, Sohn W. (2016) Urban natural environments, obesity, and health-related quality of life among Hispanic children living in inner-city neighborhoods. *Int J Environ Res Public Health* 13(1):E121.

107 Coutts C, Hahn M. (2015) Green infrastructure, ecosystem services, and human health. *Int J Environ Res Public Health* 12(8):9768–9798.

108 Hu Z, Liebens J, Rao KR. (2008) Linking stroke mortality with air pollution, income, and greenness in northwest florida: An ecological geographical study. *Int J Health Geogr* 7:20.

109 James P, Hart JE, Banay RF, Laden F. (2016) Exposure to greenness and mortality in a nationwide prospective cohort study of women. *Environ Health Perspect* 124(9): 1344–1352.

110 Rojas-Rueda, D., Nieuwenhuijsen, M. J., Gascon, M., Perez-Leon, D., & Mudu, P. (2019). Green spaces and mortality: A systematic review and meta-analysis of cohort studies. *The Lancet Planetary Health*, *3*(11), e469–e477.

111 Takano T, Nakamura K, Watanabe M. (2002). Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *J Epidemiol Community Health* 56(12):913–918.

112 van den Berg, M., Wendel-Vos, W., van Poppel, M., Kemper, H., van Mechelen, W., & Maas, J. (2015). Health benefits of green spaces in the living environment: A systematic review of epidemiological studies. *Urban Forestry & Urban Greening*, *14*(4), 806–816.

113 Villeneuve PJ, Jerrett M, G. Su J, Burnett RT, Chen H, Wheeler AJ, et al. (2012). A cohort study relating urban green space with mortality in Ontario, Canada. *Environ Res* 115:51–58.

114 Dzhambov AM, Dimitrova DD, Dimitrakova ED. (2014). Association between residential greenness and birth weight: Systematic review and meta-analysis. *Urb Forestry Urb Greening* 13(4):621–62.

115 Fjørtoft, I. (2001) The Natural Environment as a Playground for Children: The Impact of Outdoor Play Activities in Pre-Primary School Children. *Early Childhood Education Journal* 29, 111–117.

116 Kellert SR. (2005) Nature and childhood development. *Building for Life: Designing and Understanding the Human-Nature Connection.* Kellert SR, ed. Washington, DC:Island Press, 63–89.

117 Gascon M, Triguero-Mas M, Martínez D, Dadvand P, Rojas-Rueda D, Plasència A, et al. (2016). Residential green spaces and mortality: a systematic review. *Environ Int* 86:60–67.

118 Sudimac, S., Sale, V., & Kühn, S. (2022). How nature nurtures: Amygdala activity decreases as the result of a one-hour walk in nature. *Molecular Psychiatry 27*(11), 4446–4452.

119 Yeager, R. A. et al. (2020). Green environments and cardiovascular health. *Trends in Cardiovascular Medicine* 30(4) 241–246.

120 For example, in the USA, the spread of an invasive pest (the emerald ash borer) which killed 100 million trees from 1990 to 2007 was associated with increased deaths from cardiovascular and lower-respiratory diseases. Donovan, G. H., Butry, D. T., Michael, Y. L., Prestemon, J. P., Liebhold, A. M., Gatziolis, D., & Mao, M. Y. (2013). The Relationship Between Trees and Human Health: Evidence from the Spread of the Emerald Ash Borer. *American Journal of Preventive Medicine 44*(2), 139–145.

121 Thygesen, M., Engemann, K., Holst, G. J., Hansen, B., Geels, C., Brandt, J., … Dalsgaard, S. (2020). The Association between Residential Green Space in Childhood and Development of Attention Deficit Hyperactivity Disorder: A Population-Based Cohort Study. *Environmental Health Perspectives 128*(12), 127011.

122 https://www.gov.uk/government/collections/people-and-nature-survey-for-england

123 Calogiuri, G., & Chroni, S. (2014) The impact of the natural environment on the promotion of active living: An integrative systematic review. *BMC Public Health 14*(1), 873.

124 Jennings, V., & Bamkole, O. (2019). The Relationship between Social Cohesion and Urban Green Space: An Avenue for Health Promotion. International Journal of Environmental Research and Public Health, 16(3), 452.

125 Oh, R. R. Y., Zhang, Y., Nghiem, L. T. P., Chang, C., Tan, C. L. Y., Quazi, S. A., … Carrasco, R. L. (2022). Connection to nature and time spent in gardens predicts social cohesion. Urban Forestry & Urban Greening, 74, 127655.

126 Elands, B., Ambrose-Oji, B., Haase, A., & Peters, K. (2020). Urban realities of engaging with nature in Europe: Increasing diversity and consequences for wellbeing and social cohesion. In Urban Nature. Routledge.

127 de Vries, S., Claßen, T., Eigenheer-Hug, S.-M., Korpela, K., Maas, J., Mitchell, R., & Schantz, P. (2011). Contributions of Natural Environments to Physical Activity. In K. Nilsson, M. Sangster, C. Gallis, T. Hartig, S. de Vries, K. Seeland, & J. Schipperijn (Eds.), Forests, Trees and Human Health (pp. 205–243). Dordrecht: Springer Netherlands.

128 Kuo FE, Sullivan WC, Coley RL, Brunson L. (1998). Fertile ground for community: inner-city neighborhood common spaces. Am. J. Community Psychol. 26:823–51.

129 Weinstein, N., Balmford, A., DeHaan, C. R., Gladwell, V., Bradbury, R. B., & Amano, T. (2015). Seeing Community for the Trees: The Links among Contact with Natural Environments, Community Cohesion, and Crime. *BioScience*, *65*(12), 1141–1153.

130 Raphael, D., Renwick, R., Brown, I., Steinmetz, B., Sehdev, H., & Phillips, S. (2001). Making the links between community structure and individual well-being: Community quality of life in Riverdale, Toronto, Canada. *Health & Place*, *7*(3), 179–196.

131 Bickham, D. S., & Rich, M. (2006). Is television viewing associated with social isolation? Roles of exposure time, viewing context, and violent content. *Archives of Pediatrics & Adolescent Medicine*, *160*(4), 387–392.

132 Voydanoff, P. (2001). Incorporating Community into Work and Family Research: A Review of Basic Relationships. *Human Relations*, *54*(12), 1609–1637.

133 Larson, L. R., Stedman, R. C., Cooper, C. B., & Decker, D. J. (2015). Understanding the multi-dimensional structure of pro-environmental behavior. *Journal of Environmental Psychology*, *43*, 112–124.

134 Barbaro, N., & Pickett, S. M. (2016). Mindfully green: Examining the effect of connectedness to nature on the relationship between mindfulness and engagement in pro-environmental behavior. *Personality and Individual Differences*, *93*, 137–142.

135 Roseland, M. (2000). Sustainable community development: Integrating environmental, economic, and social objectives. *Progress in Planning*, *54*(2), 73–132.

136 Jennings, V., Larson, L., & Yun, J. (2016). Advancing Sustainability through Urban Green Space: Cultural Ecosystem Services, Equity, and Social Determinants of Health. *International Journal of Environmental Research and Public Health*, *13*(2), 196.

137 Burls, A. (2007). People and green spaces: Promoting public health and mental well-being through ecotherapy. *Journal of Public Mental Health*, *6*(3), 24–39.

138 James, P., Tzoulas, K., Adams, M. D., Barber, A., Box, J., Breuste, J., … Ward Thompson, C. (2009). Towards an integrated understanding of green space in the European built environment. *Urban Forestry & Urban Greening*, *8*(2), 65–75.

139 Iungman, T., Cirach, M., Marando, F., Barboza, E. P., Khomenko, S., Masselot, P., … Nieuwenhuijsen, M. (2023). Cooling cities through urban green infrastructure: A health impact assessment of European cities. The Lancet.

140 Dzhambov & Dimitrova (2015). Green spaces and environmental noise perception. *Urban Forestry & Urban Greening 14*(4), 1000–1008.

141 van den Bosch & Nieuwenhuijsen (2017). No time to lose – Green the cities now. *Environment International*, *99*, 343–350.

142 Nowak, D.J.; Crane, D.E.; Stevens, J.C. (2006) Air pollution removal by urban trees and shrubs in the United States. *Urban For. Urban Green* 4, 115–123.

143 Hewitt CN, Ashworth K, MacKenzie AR. Using green infrastructure to improve urban air quality (GI4AQ). Ambio. 2020 Jan;49(1):62-73.

144 Donovan, R., Stewart, H., Owen, S. M., Mackenzie, R., & Hewitt, C. N. (2005). Development and application of an urban tree air quality score for photochemical pollution episodes using the Birmingham, United Kingdom, area as a case study. *Environmental Science and Technology*, 39(17), 6730-6738.

145 Morrison, R. and Hartley, S. (2020) IGNITION Nature-Based Solutions Evidence Base Headline Findings Report.

146 McEachan, R. R. C., Yang, T. C., Roberts, H., Pickett, K. E., Arseneau-Powell, D., Gidlow, C. J., … Nieuwenhuijsen, M. (2018). Availability, use of, and satisfaction with green space, and children's mental wellbeing at age 4 years in a multicultural, deprived, urban area: Results from the Born in Bradford cohort study. *The Lancet. Planetary Health*, *2*(6), e244–e254.

147 Giacinto, J. J., Fricker, G. A., Ritter, M., Yost, J., & Doremus, J. (2021). Urban forest biodiversity and cardiovascular disease: Potential health benefits from California's street trees. *PLoS ONE*, *16*(11), e0254973.

148 Chang, C., Oh, R. R. Y., Nghiem, T. P. L., Zhang, Y., Tan, C. L. Y., Lin, B. B., … Carrasco, L. R. (2020). Life satisfaction linked to the diversity of nature experiences and nature views from the window. *Landscape and Urban Planning*, *202*, 103874.

149 Bell et al. (2018). Everyday green space and experienced well-being: The significance of wildlife encounters. *Landscape Research*, *43*(1), 8–19.

150 Vos, S. et al. (2022). Residential green space is associated with a buffering effect on stress responses during the COVID-19 pandemic in mothers of young children, a prospective study. *Environmental Research*, *208*, 112603.

151 Tomasso, L. P. et al. (2021). The Relationship between Nature Deprivation and Individual Wellbeing across Urban Gradients under COVID-19. *International Journal of Environmental Research and Public Health*, *18*(4), 1511.

152 45% of adults in England reported spending more time outdoors during the pandemic than before, with 39% stating that nature and wildlife were more important than ever for their wellbeing. People and Nature Survey March 2022 Statistics.

153 People and Nature Survey March 2022 Statistics

154 Robinson, J. M., Aronson, J., Daniels, C. B., Goodwin, N., Liddicoat, C., Orlando, L., … Breed, M. F. (2022). Ecosystem restoration is integral to humanity's recovery from COVID-19. *The Lancet Planetary Health*, *6*(9), e769–e773.

155 Liddicoat, C., Sydnor, H., Cando-Dumancela, C., Dresken, R., Liu, J., Gellie, N. J. C., … Breed, M. F. (2020). Naturally-diverse airborne environmental microbial exposures modulate the gut microbiome and may provide anxiolytic benefits in mice. *Science of The Total Environment*, *701*, 134684.

156 Van Den Eeden et al. (2022). Association between residential green cover and direct healthcare costs in Northern California: An individual level analysis of 5 million persons. *Environment International*, *163*, 107174.

157 Analysis by Vivid Economics for Plymouth City Council using the Greenkeeper model

158 Buckley, R. C., & Brough, P. (2017). Economic Value of Parks via Human Mental Health: An Analytical Framework. *Frontiers in Ecology and Evolution*, *5*.

159 Gibbons, S., Mourato, S., & Resende, G. M. (2014). The Amenity Value of English Nature: A Hedonic Price Approach. *Environmental and Resource Economics*, *57*(2), 175–196.

160 BenDor, T., Lester, T. W., Livengood, A., Davis, A., & Yonavjak, L. (2015a). Estimating the Size and Impact of the Ecological Restoration Economy. PLOS ONE, 10(6), e0128339.

161 Chausson, A., Smith, A.C., Turner, B. and Seddon, N. (2022) Understanding the economic recovery potential of investing in biodiversity in the Global South. Nature-based Solutions Initiative, University of Oxford. Report to the NERC Programme on Synthesising Evidence in Economics of Biodiversity.

162 WPI Economics and Green Alliance (2021) Green Renewal – The Economics of Enhancing the Natural Environment.

163 McVittie, A., Bryce, R., Glass, J., Woolvin, A., Carver, S., Fisher, M., McMorran, R., & Sedee, C. (2017). A review of the social, economic and environmental benefits and constraints linked to wild land in Scotland. (Commissioned Report; No. 919). Scottish Natural Heritage.

164 Dicks, J., Dellacio, O. and Stenning, J. (2020) Economic costs and benefits of nature-based solutions to mitigate climate change. Report by Cambridge Econometrics for the RSPB.

165 Burnett, H., Olsen, J. R., Nicholls, N., & Mitchell, R. (2021). Change in time spent visiting and experiences of green space following restrictions on movement during the COVID-19 pandemic: A nationally representative cross-sectional study of UK adults. *BMJ Open*, *11*(3), e044067.

166 Natural England, Green Infrastructure Mapping Database and Analyses. Website accessed on 22/12/22.

167 https://www.plymouth.gov.uk/plymouth-natural-grid-project

168 https://www.plymouth.gov.uk/plymouth-and-south-devon-community-forest

169 Eftec (2019) Using natural capital accounting in the business case for parks. Eftec for The Parks Alliance, Parks Action Group and MHCLG.

170 Natural England (2009) An estimate of the economic and health value and cost effectiveness of the expanded WHI scheme 2009. Technical evidence note TIN055.

171 Friends of the Earth (2020) England's Green Space Gap.

172 Fields in Trust (2022) Green space index reveals importance of local parks for levelling up.