Nature in Cities

By earthwatch EUROPE

Tiny Forest Monitoring Report 2024

Bloomberg Tiny Forest (c) Lateral North

Contents

Tiny Forest brings the benefits of woodland to the heart of cities.

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Thank you to all the Tiny Forest Tree Keepers, citizen scientists, and unsung heroes, who made this report possible.

Key findings

In 2024, Earthwatch Europe ran 48 monitoring and engagement events, training 2091 citizen scientists across the UK. Thanks to our citizen scientists we have found…

Biodiversity:

Tiny Forests consistently support a diverse composition of ground dweller and pollinator morphotypes, and provide homes to less commonly observed urban species such as newts, solitary bees and slow worms.

Flood mitigation:

Infiltration rates inside Tiny Forests are on average **32% faster** compared to the surrounding area; thanks, in part to the **38% lower soil compaction** inside a Tiny Forest compared to outside.

Soil excavation depth:

Trees in forests where soil was prepped to 1m are **twice the height** of those only prepped to 0.5m by the end of their 4th year of growth.

Carbon storage:

Tiny Forests store **exponentially more carbon** as they age. Tiny Forests are sequestering 18,847 kg of above ground carbon, equating to 69.17 tonnes of CO2e (carbon dioxide equivalent).

Thermal comfort:

People feel more thermally comfortable in forests as they age. Tiny Forests have smaller temperature swings between day and night compared to outside of forests: during the day, air temperatures are up to **3°C cooler** inside two-year-old forests, and **6°C cooler** inside three-year-old forests, but at night temperatures are about **2°C warmer** inside the forests.

Social benefits:

Participating in Tiny Forest events significantly benefitted participants self-reported feelings of connection to nature

An introduction to Tiny Forest

Tiny Forest uses the Miyawaki tree planting method to bring the benefits of nature into the heart of our urban spaces. Through citizen science monitoring and community engagement we aim to understand how these pockets of urban woodland function to provide benefits to people and nature.

No space for nature

Around 1 in 3 people in England don't have access to nature-rich spaces near their homes, with some of the most deprived areas having no natural green space[1]. Green spaces can help bind communities together, reduce loneliness, and mitigate negative effects of air pollution, heat and flooding. Access to nature is associated with better health and wellbeing outcomes; but UK citizens measure lowest for their connection to nature out of fourteen European nations[2]. The UK also ranks worst out of these nations for biodiversity; the variety of all living things and their interactions. Less biodiverse ecosystems are less resilient to challenges such as climate change, pests and diseases. Therefore, the persistent decline in UK biodiversity, across all habitat types, is highly concerning[3].

Land use change, often leading to the destruction and fragmentation of natural forests and grasslands, is the biggest direct driver of biodiversity loss[4]. The loss of trees has further environmental impacts. Trees play a critical role in carbon absorbing and storing carbon dioxide, flood control, and creating comfortable microclimates. With 84% of the UK living in towns and cities[5] – where nature connection is often lacking, biodiversity is depleted, and climate adaption is paramount – planting trees in urban environments has never been more important.

Ecosystem Services

Urban trees provide several **ecosystem services** - benefits that humans derive from natural ecosystems - that enhance environmental, social and economic well-being. They moderate **urban temperatures** through shade and evapotranspiration, **manage stormwater** by intercepting rainfall, reducing runoff, and preventing soil erosion, and **improve air quality** by filtering pollutants and producing oxygen. They **support biodiversity** by offering habitats for birds, insects, and other wildlife, even in densely populated areas, and **improve human health** by reducing stress, enhancing mental well-being, and encouraging physical activity in green spaces.

The Miyawaki Method

Tiny Forest is a large-scale, long-term ecological experiment. It uses the Miyawaki method of tree planting to rapidly create small pockets of diverse, native woodland. We engage local communities in monitoring the provision of four ecosystem services: **biodiversity support, carbon storage, flood mitigation,** and **thermal comfort**. The results are used to guide design and implementation of the forests to maximise the benefits for people and nature.

Tiny Forest is an application of the Miyawaki tree-planting method which differs significantly from traditional tree planting in its focus on creating dense, biodiverse, and self-sustaining forests in a short time. Developed by Japanese botanist Miyawaki Akira[6], the method emphasizes planting native species in close proximity, mimicking natural forest ecosystems. Unlike traditional planting, which often involves canopy level species planted 1-2m apart in evenly spaced rows, the Miyawaki method uses a mix of species, from all four canopy layers to promote layered vegetation. Furthermore, the Miyawaki method prioritises preparation of soil prior to planting, recognising the importance of healthy soils to tree growth.

There is evidence that trees planted using the Miyawaki method grow much faster and have higher survival rates than those planted following traditional methods[7]. Supported by Earthwatch engagement activities, Miyawaki forests can also inspire local communities, facilitating their involvement and fostering environmental awareness and ownership of local green spaces. Importantly, the method is known to be effective for rapidly creating forest cover on land that has previously been used for other purposes, as urban land so often has been. As such, it presents an ideal opportunity to improve tree cover in urban areas.

Tiny Forests, Big Impact

Together with citizen scientists, **Earthwatch has planted one of the largest networks of small Miyawaki forests outside of Japan** and engages people to monitor the benefits of those forests through citizen science: the active involvement of non-scientists in scientific research. **Earthwatch Europe believes in the power of data for change**. We are collecting data across the network of 242 Tiny Forests, working with citizen scientists and researchers to deepen our understanding of the Miyawaki method and its impacts. We hope to gather valuable insights into the benefits of this afforestation technique, while also identifying potential challenges. This collaborative, community-focused approach allows us to refine our practice, identifying the best implementation methods for maximum socio-environmental benefits. Sharing those results with researchers, local communities and urban professionals around the world helps us to create greener, more pleasant urban environments for generations to come.

The Benefits of Tiny Forests

Ecosystem Service 1 - Biodiversity

Our research questions:
How do Tiny Forests contribute to urban biodiversity? How do forest features (such as age, tree species, and soil) affect invertebrate communities over time? Does the surrounding greenspace affect species recorded in the Tiny Forest?

In 2024, our citizen scientists carried out

- 89 ground dweller surveys across 68 forests
- 158 pollinator surveys across 63 forests
- 72 butterfly surveys across 53 forests
- An incredible 6,527 minutes of biodiversity monitoring!

Biodiversity is essential for many ecological processes, including pollination, soil enrichment, and nutrient cycling, all of which contribute to the resilience and productivity of the forest ecosystem. Insects are the predominant providers of these ecosystem services in the UK, and act as excellent indicators of ecosystem health. In 2024, Tiny Forest citizen scientists spent **over 100 hours** assessing the communities of ground-dwelling and pollinating invertebrates living in Tiny Forests.

Monitoring invertebrates isn't an easy task; 64% of all UK species are invertebrates and identification to species-level often requires a microscope. As such, two of our biodiversity surveys (ground dwellers and pollinators) look at **morphotypes**; groups of organisms with similar appearances. Butterfly surveys are used to look at species level diversity of one group of pollinators, as these are easier to identify by eye.

Ground Dwellers

Ground dwellers, such as earthworms, ants and beetles, play a pivotal role in maintaining soil health. By breaking down dead plant material, they accelerate the decomposition process, releasing nutrients that are readily absorbed by tree roots. This nutrient recycling not only nourishes the trees but also enhances soil fertility and reduces the compaction in the soil, improving the soil's water infiltration potential.

Ground-dwelling organisms often take shelter under rocks or large pieces of wood making lifting such objects a perfect door to the world below our feet. To standardise measurements, 40x40cm stone biodiversity tiles are laid on the forest floor inside each Tiny Forest, allowing recording of the forest's soil community.

Our data suggest that **as Tiny Forests age, the number of different ground-dwelling morphotypes increases** (Figure 1).

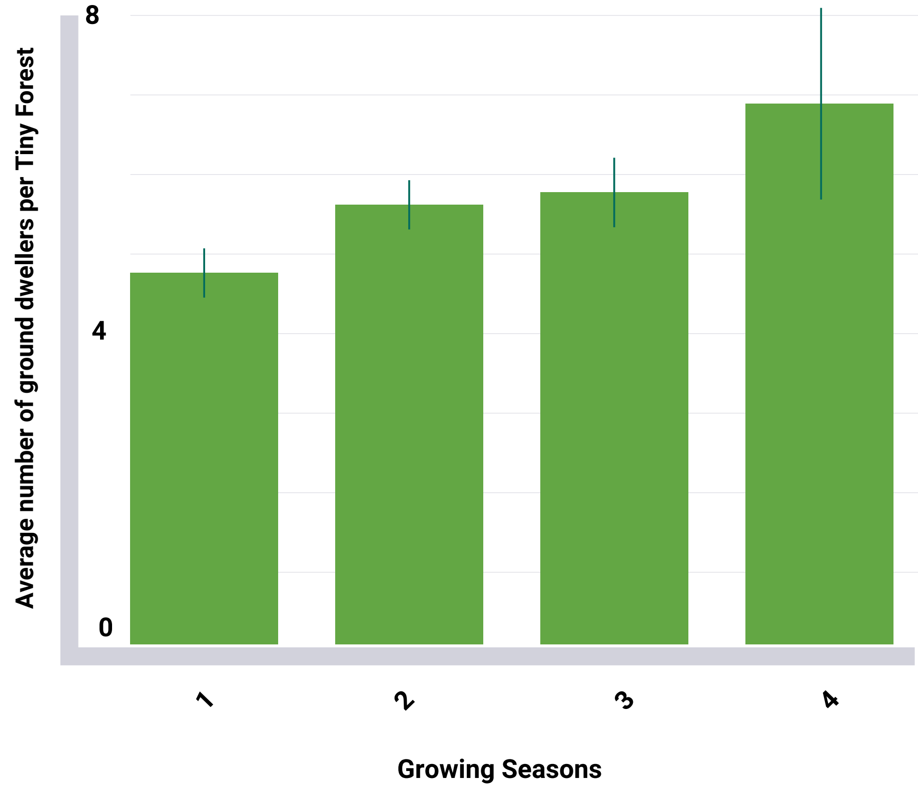


Figure 1. The average number of ground dweller morphotypes seen in Tiny Forests as they age.

Whilst these differences are not **statistically significant**, the increase between growing seasons 1 and 2 has been consistently observed in Tiny Forests and appears robust[8,9]. The increase in morphotypes between growing seasons 3 and 4 could be because some morphotypes take longer to reach their nearest Tiny Forest; but we need more data to be certain.

What do we mean by statistically significant?

"Statistically significant" means that a result from a study is unlikely to have occurred by chance, and that there is a real effect or relationship between variables being studied; in this case, the age of a Tiny Forest and the number of ground-dwellers.

(c) Earthwatch Europe

As Tiny Forests age, the number of different morphotypes is expected to plateau as species occupy the available habitat making it difficult for new species to move in. Currently, it is not possible to determine when this plateau is occurring as we need more data over future growing seasons. What is clear is that the diversity of ground dwellers does **not regress below the initial levels recorded at the start of their establishment.**

Our data also show that **as Tiny Forests age, the relative abundance of ground dwellers change.** The most abundant morphotype observed in Tiny Forests of all ages are ants (Figure 2a). This is because ants live in societies where thousands of female workers look after the queen and her offspring, and work collectively to ensure the colony thrives.

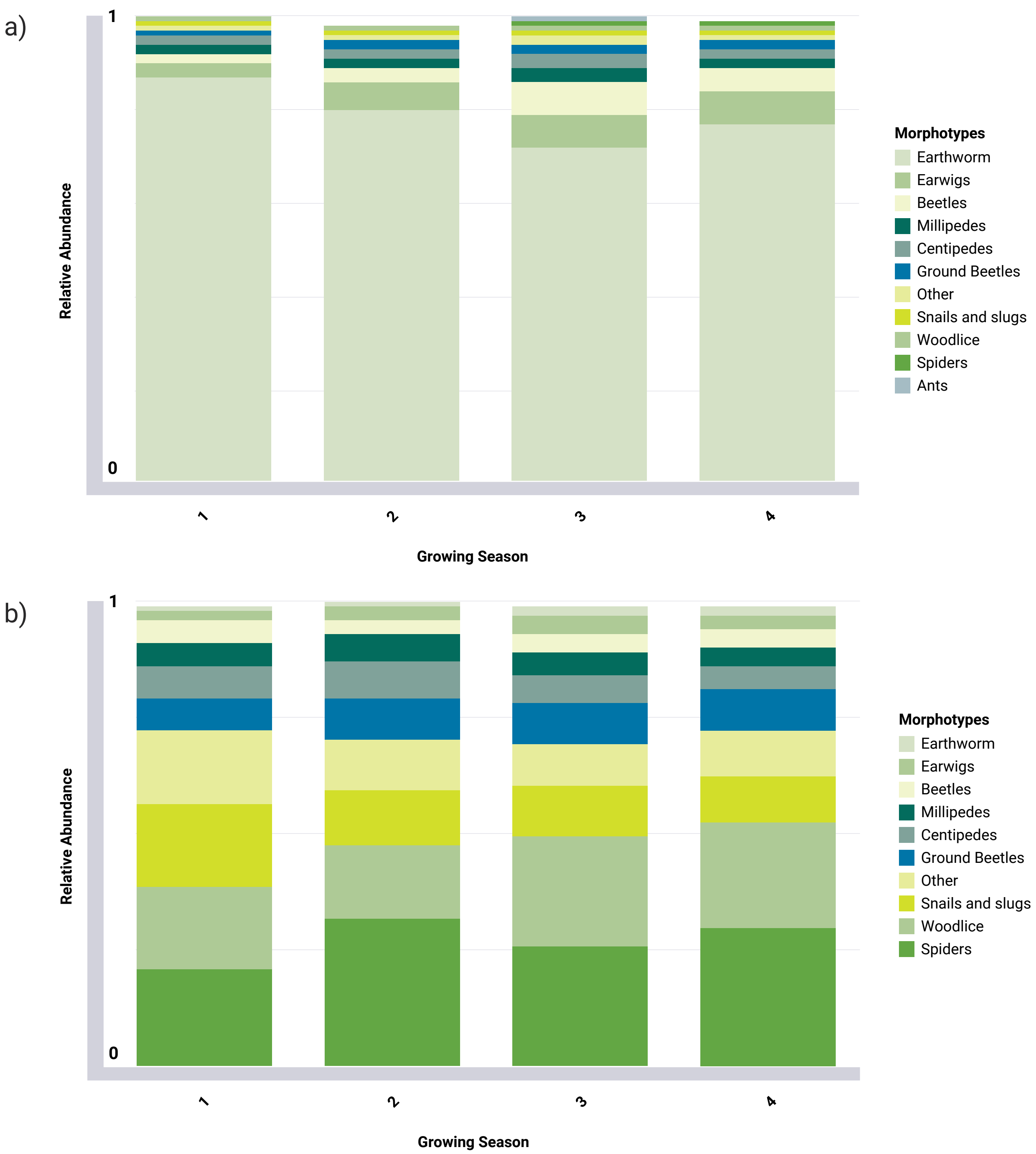


Figure 2. Relative abundance of ground dweller morphotypes as forests age a) including ants, b) with ants removed.

With ants removed, differences in other ground dweller communities become clearer (Figure 2b). The relative abundance of ground dweller morphotypes is more even in forests in their first growing season. **As forests age, snails and slugs and woodlice become the most common morphotypes** - comprising around 50% of the organisms observed - suggesting their activity may be linked to moisture and plant growth. Earthworms also become more abundant, whilst the abundance of other morphotypes stays relatively consistent.

Ants, centipedes, ground beetles, earthworms, other morphotypes, snails and slugs, spiders, and woodlice are regularly observed in at least half of the Tiny Forests surveyed, at all ages (Figure 3) suggesting these morphotypes are a relatively stable component of the Tiny Forest decomposer community.

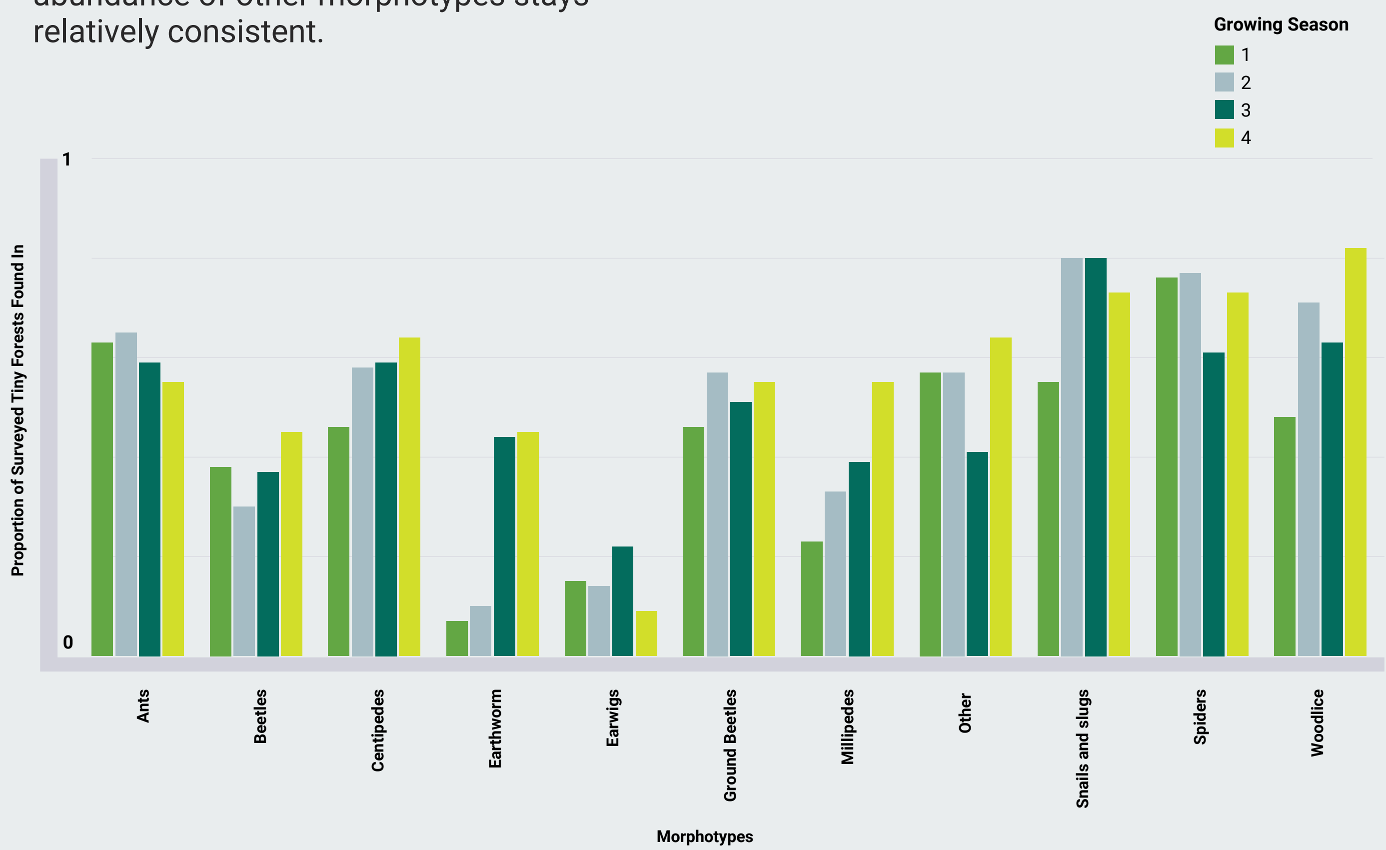


Figure 3. Proportion of total Tiny Forests surveyed that each morphotype is seen in, by forest age.

There does, however, seem to be quite a lot of variation in how regularly different morphotypes are seen in Tiny Forests across growing seasons. This could be driven by seasonal variations affecting population sizes of those morphotypes or an effect of sampling biases as there are fewer older forests and so sample sizes are lower. As the dataset grows, we'll be able to start analysing this and asking further questions, such as, do ground dweller communities vary with soil type?

Other types of ground dwellers spotted in Tiny Forests in 2024!

- 8 Solitary Bees
- 6 Newts
- 3 Frogs
- 3 Wasps
- 3 Rodents
- 2 Toads
- 1 Slow Worm

Biodiversity Research Spotlight

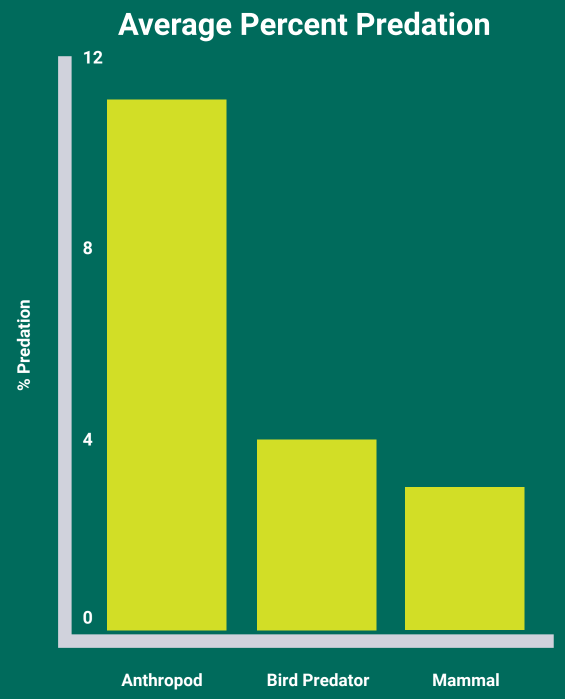
Yvonne Tran, Undergraduate Research Assistant, Royal Holloway University

Yvonne Tran, a BSc student from UCL working with Professor Julia Koricheva of Royal Holloway University investigated Tiny Forest biodiversity by seeing which species attempted to eat plasticine caterpillars. They also assessed levels of herbivory by looking at the leaves of trees and for galls. Turns out Tiny Forests are full of hungry, hungry critters.

Plasticine caterpillars were mostly predated upon by arthropods who leave light etchings, dots, or scrapes from their mandibles. Around 4% of caterpillars were predated on by birds, and 1% by mammals. Evidence of leaf chewing was relatively evenly distributed across all the Tiny Forest sites sampled. Of the other types of herbivory, leaf mining – eating leaves while living inside them - was the most observed, primarily on birch trees.

There was no clear relationship between herbivory and predation across Tiny Forests, suggesting that multiple variables are affecting the dynamic.

Herbivore-predator relationships are key to healthy ecosystem functioning: too many herbivores and vegetation health suffers, too many predators and herbivore populations decrease and the predators starve. We are looking grow this pilot project and collect more data to further assess this relationship in Tiny Forests.



Biodiversity Research Spotlight

Beth Taylor, PhD candidate, University of Warwick

Beth Taylor began her multidisciplinary PhD in January 2025, looking at the impact of urban Tiny Forests establishment on soil characteristics, microbial communities, nutrient cycling, and people. She will be completing her PhD part-time whilst continuing to work at Coventry Council.

Using soil samples that have been collected at 40 Tiny Forests across the West Midlands, Beth will investigate the factors which affect microbial communities in Tiny Forests, how they form over time, and affect nutrient cycling. Furthermore, she'll be looking at methods to improve community connection at these Tiny Forest sites. As an urban planning professional, Beth is ideally placed to translate the results of her PhD into real-world impact.

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Crab Apple			■	■	■							
Blackthorn			■	■								
Broom				■	■	■						
Wild Cherry			■	■	■							
Guelder Rose					■	■	■					
Hawthorn				■	■	■						
Hazel	■	■	■									
Heather							■	■	■			
Holly					■	■	■					
Small-leaved Lime						■	■					
Rowan					■	■						

Figure 4. Flowering time of insect-pollinated species in The Delph Tiny Forest, The Wirral.

Pollinators

In the UK, approximately 80% of all plants are pollinated by around 1500 insect species[10]. Climate change is affecting where and when pollinators are found. Spring and summer species have started to emerge earlier, autumn species emerge later, and many stay active in the environment longer[11]. This extends the period over which pollinators require resources: food, nesting sites, and water. **Diverse forest habitats, like Miyawaki forests, can provide nectar resources for pollinators throughout the year** (Figure 4).

To ensure our citizen-science data has the biggest possible impact, we've adapted the Pollinator Monitoring Scheme's Flower Insect-Timed count and Butterfly Conservation's Big Butterfly Count to understand how Tiny Forests are used by pollinators. Adapting surveys used by other organisations increases the usefulness of the data, allowing researchers to combine datasets and improve conservation strategies.

Our data show that as **Tiny Forests age, the average number of pollinator morphotypes observed stays constant** (Figure 5), with an average of 5 morphotypes being spotted in a Tiny Forest. This might seem strange as immature trees do not produce nectar or pollen, however, the reason lies in the soil preparation of a Tiny Forest. Soil preparation can support a proliferation of herbaceous plants whose seeds are already present in the soil. As the canopy closes, generally in years 3 and 4, the floor of the forest becomes shaded and the number of herbaceous plants decreases. The floral resources provided by the forest will then primarily be provided by the trees, way up in the forest canopy.

Our data also show **the relative abundance of pollinator morphotypes is similar across Tiny Forests of all ages** (Figure 6). This might be because pollinator communities are being sampled at similar flower species at Tiny Forests of all ages, or that factors other than forest age – such as the surrounding landscape - are the primary drivers of pollinator community composition.

The most abundant morphotype, regardless of forest age, is "Other flies", accounting for 27% of all organisms observed. Bees (bumblebees, honey bees, and solitary bees) account for around 20% of the observed pollinators, and butterflies 4%.

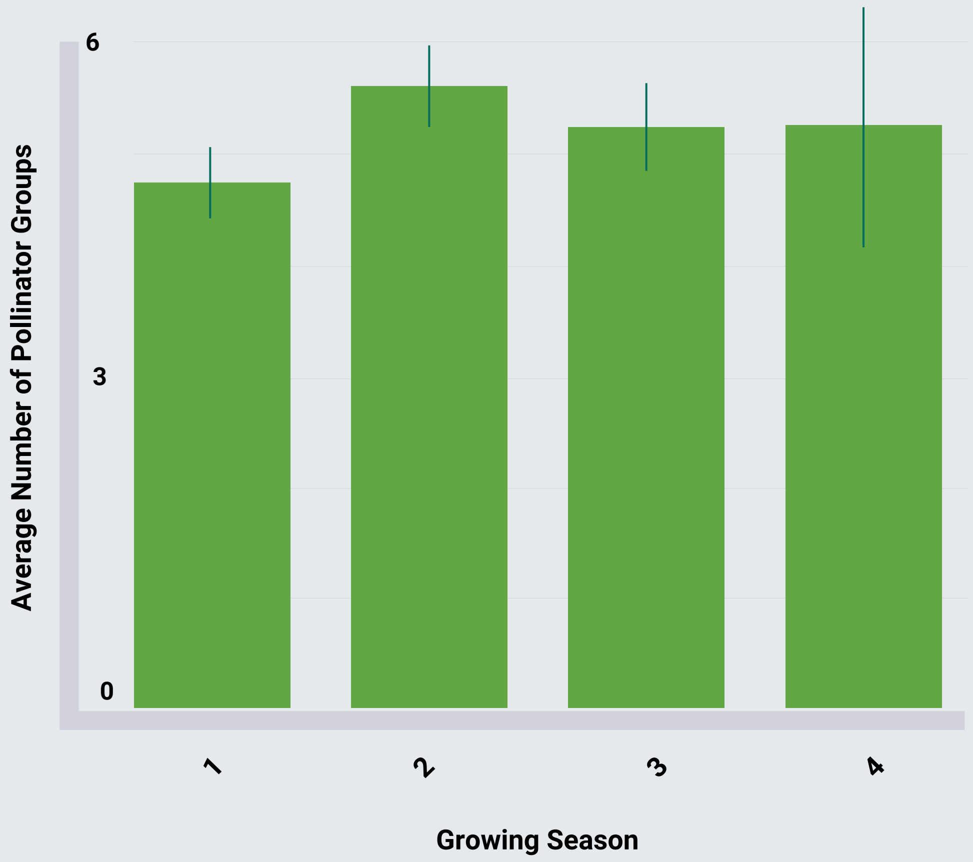


Figure 5. Average number of pollinator morphotypes observed interacting with flower heads in Tiny Forests as they age.

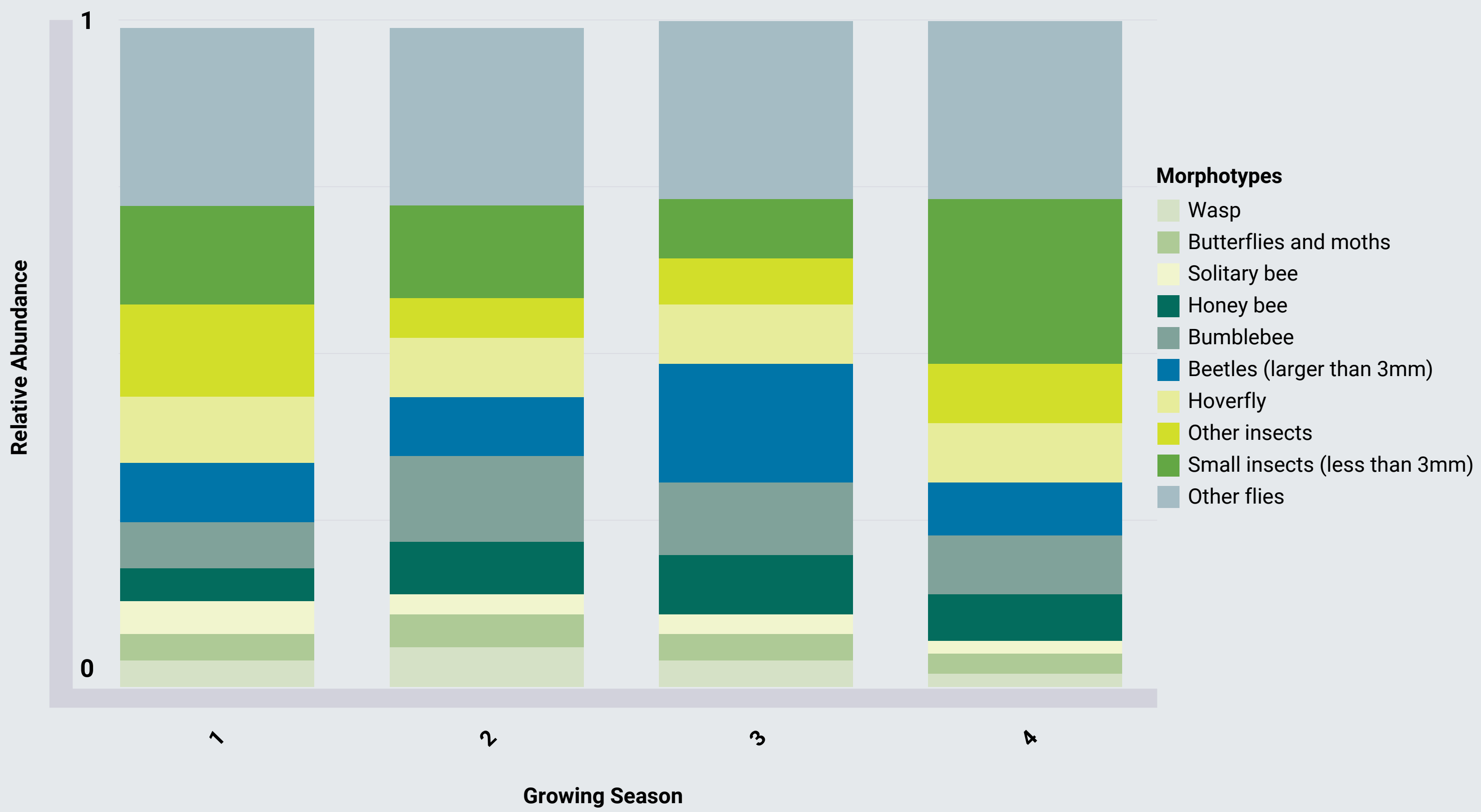


Figure 6. Relative pollinator morphotype abundance as forests age.

Other flies are also the most commonly observed pollinator morphotype, recorded in over 80% of forests regardless of growing season. Butterflies and moths, solitary bees, honey bees and wasps were consistently observed in the lowest number of forests (Figure 7).

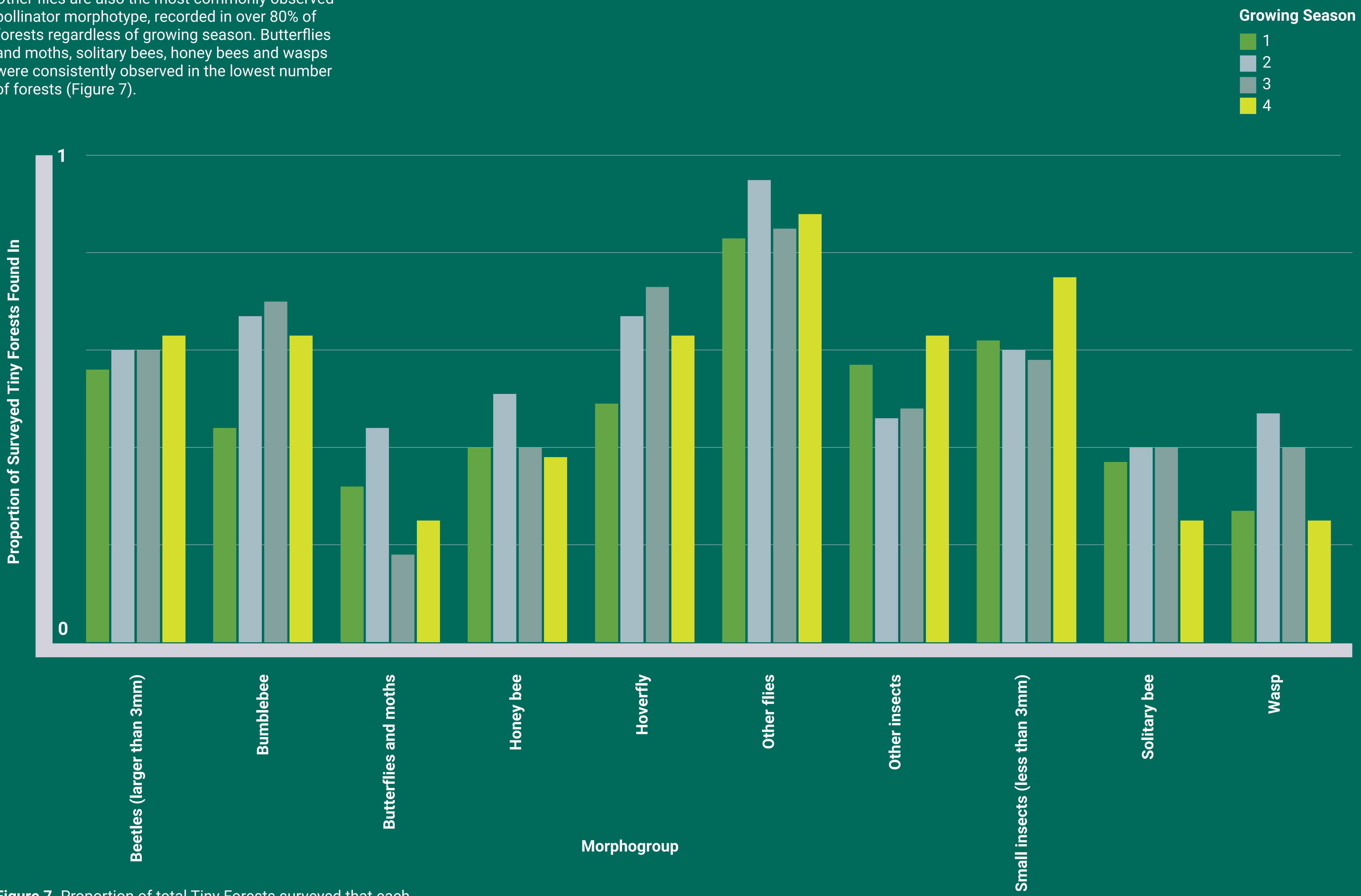


Figure 7. Proportion of total Tiny Forests surveyed that each morphotype is seen in, by forest age.

Butterfly Counts

Whilst looking at morphotypes provides a high-level overview of animal communities, the breadth of those groups hides within it a wealth of information that can only be answered at the species level, such as: are the species observed using Tiny Forests predicted by the surrounding area - or features of the Tiny Forest itself - and does this change over time?

Butterflies are excellent for examining such changes; however, butterfly species emerge at different times of year, and their abundances vary year-on-year. All of this means that comparing butterfly numbers between years is tricky, especially where sampling happens at different times in the season.

Compiling data from multiple years, we find no significant difference in the number of butterfly species observed in Tiny Forests over time (Figure 8).

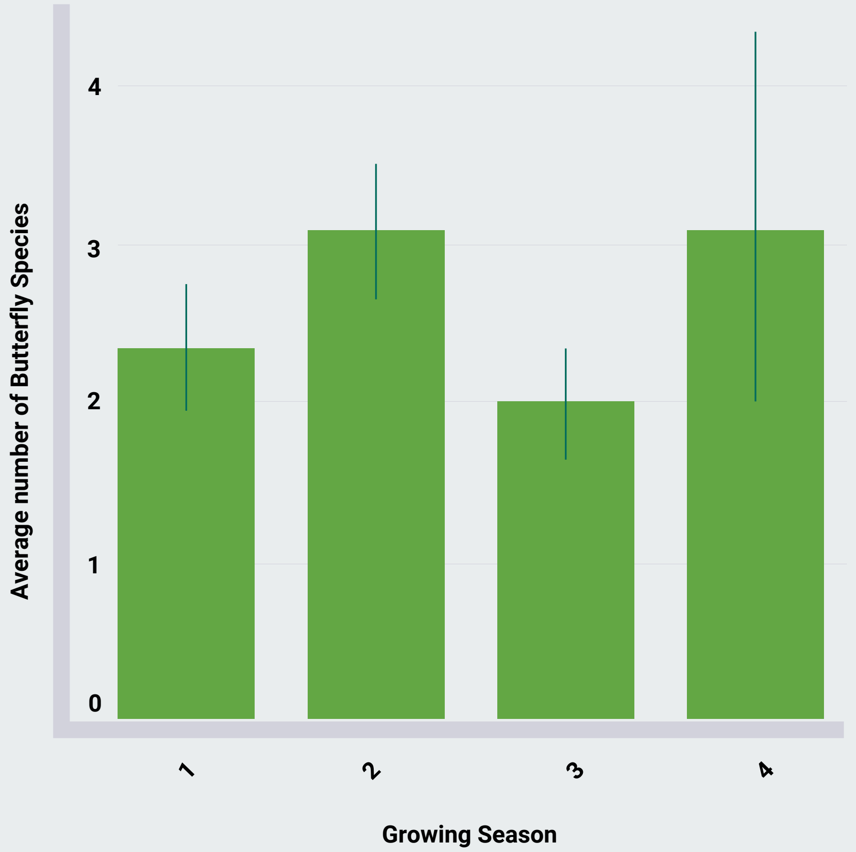


Figure 8. Average number of butterfly species per Tiny Forest as forests age

Nor do we observe a difference in the average number of species observed per hour in Tiny Forests as they age (Figure 9) – consistently averaging 1.6 butterfly species per hour. Growing season four is likely to be an outlier as only six Tiny Forests have been monitored for butterfly diversity in their 4th growing season.

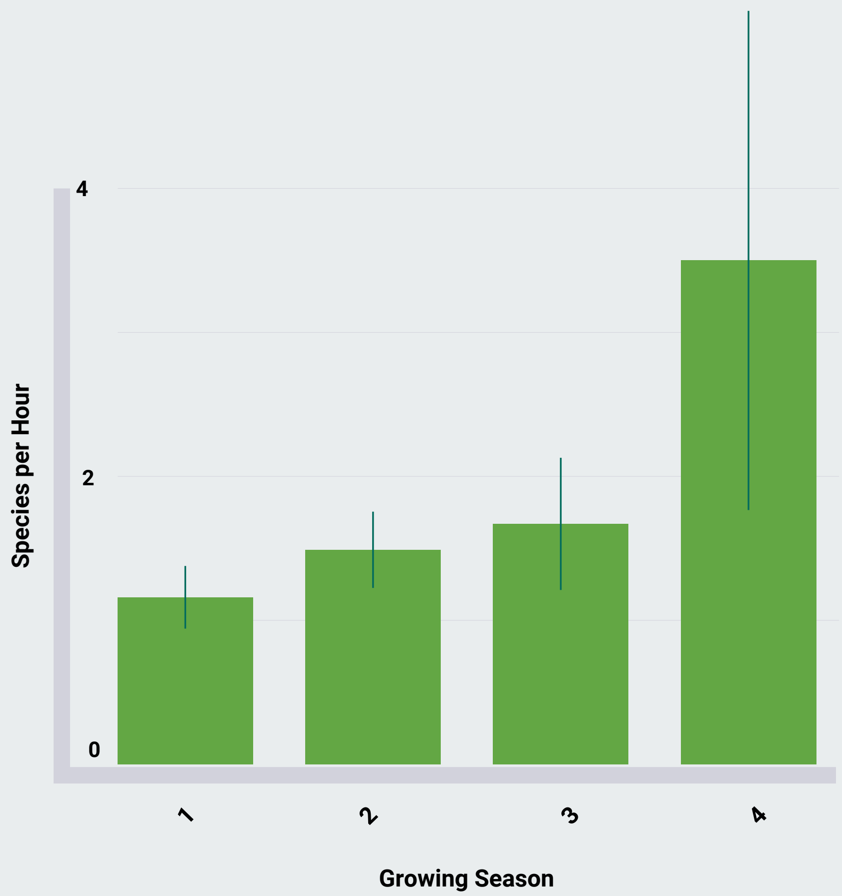


Figure 9. Average number of butterfly species observed per hour in Tiny Forests as they age

In 2024, the most commonly observed butterfly species were 'Large white' and 'Small white', observed in 23% and 19% of surveyed forests, consistent with 2023 monitoring results. Whilst large and small white butterflies are commonly occurring species in the UK, finding the same result between years is surprising, as 2024 is known to have been a bad year for butterflies across the UK[12], and long-term trends point to widespread declines [13].

Looking at other key woodland species in the UK, orange-tips - one of the earliest butterfly species to emerge - were observed in 6% of surveyed forests; speckled wood -one of the few species whose numbers have increased in recent decades - was seen in 11% of surveyed forests; and the comma - easy to identify from a distance thanks to the ragged-edge of its wings - was spotted in 2% of surveyed forests.

Biodiversity Research Spotlight

Julian Flowers

Julian wrote a data analysis code - https://github.com/julianflowers/tiny-forest - to analyse Tiny Forest biodiversity data and biodiversity determinants data (number of tree species, tree growth rate) as well as data from publicly available sources (surrounding biodiversity obtained from National Biodiversity Atlas)

He found that Tiny Forests pollinator and ground dweller diversity increased with Tiny Forest age and tree height, suggesting that older Tiny Forests are more biodiverse than younger Tiny Forests. Conversely, butterfly species richness was more influenced by extrinsic variables and predicted by the butterfly species already observed nearby.

Taken together, our data shows that Tiny Forests are providing valuable habitat for a diverse community of urban organisms. These organisms provide essential ecosystem services including nutrient cycling and pollination. They are munching on leaves and being predated upon, supporting species across trophic levels. Indeed, it seems that Tiny Forests are becoming mini urban communities.

(c) Earthwatch Europe

Ecosystem Service 2 - Flood Mitigation

Our research questions:
How do Tiny Forests affect flood management compared to the surrounding area? What is the potential capacity of Tiny Forests to store water by changes to soil quality and improving permeability as the forests grow?

In 2024, citizen scientists carried out

176 colour compaction and texture surveys and 166 infiltration rate surveys across 56 Tiny Forests

Urban flooding is an escalating global challenge driven by rapid urbanisation, climate change, and inadequate drainage systems. Key contributors include extensive impermeable surfaces, reduced vegetation cover, compacted and degraded soils, and increasingly intense and unpredictable rainfall events due to climate change. Urban trees play a critical role mitigating flooding by enhancing infiltration rates and improving soil health. Vegetation, particularly dense tree cover, increases the soil's capacity to absorb and retain water. Over time, tree roots improve soil structure, fertility, and aeration, further promoting water infiltration and storage. These natural processes reduce surface runoff, lower the risk of flash floods, and support groundwater replenishment.

Dedicated citizen scientists and volunteers got their hands dirty assessing whether or not Tiny Forests can provide flood mitigation benefits by measuring the colour, compaction, texture, and infiltration rate of the soil in the middle, edge, and outside Tiny Forests.

Across forests of all ages, **infiltration rates inside Tiny Forests are 32% faster compared to the surrounding area** (Figure 10), confirming the strong effect Tiny Forests can have improving infiltration rates.

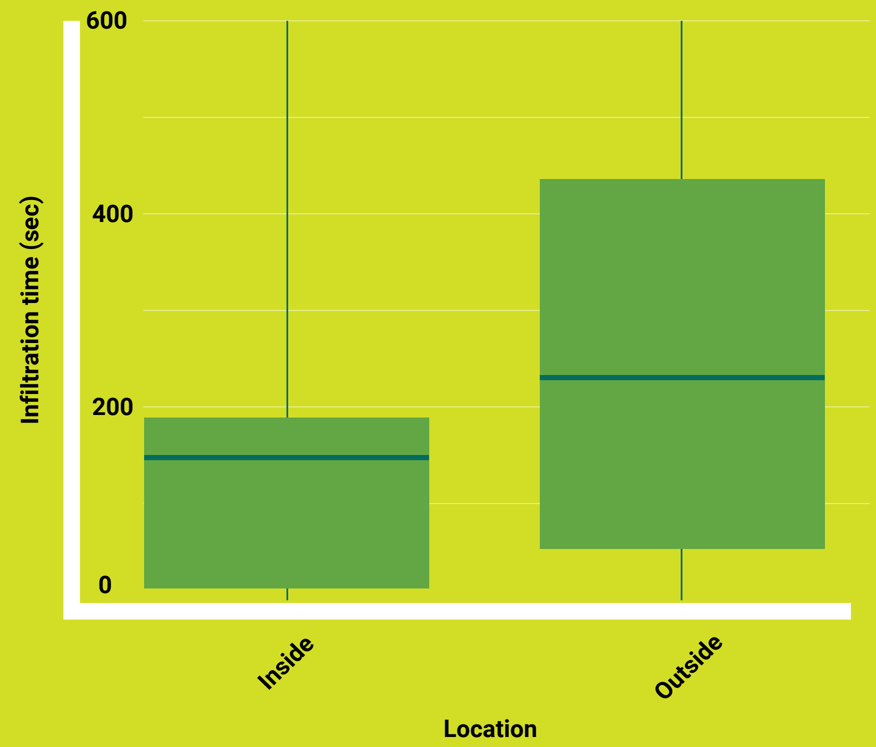


Figure 10. Infiltration rates inside and outside of a Tiny Forest

Across growing seasions, infiltration rates inside Tiny Forests are faster than outside Tiny Forests with the exception of growing season 2. **Infiltration rates may also be improving as Tiny Forests age** (Figure 11).

In their first monitoring season, Tiny Forests show an average 38% faster infiltration rate than surrounding areas, although this is attributed to our soil preparation method and the addition of soil supplement. **In their third season, Tiny Forest infiltration rates are 56.7% faster than in surrounding areas**, likely due to the increased need for water by the growing trees. This difference is reduced to 33.9% in growing season 4 but sample sizes are low, so this finding requires further investigation.

School children in Bloomberg Tiny Forest at Ladywell Fields, Lewisham (c) Navy Studios

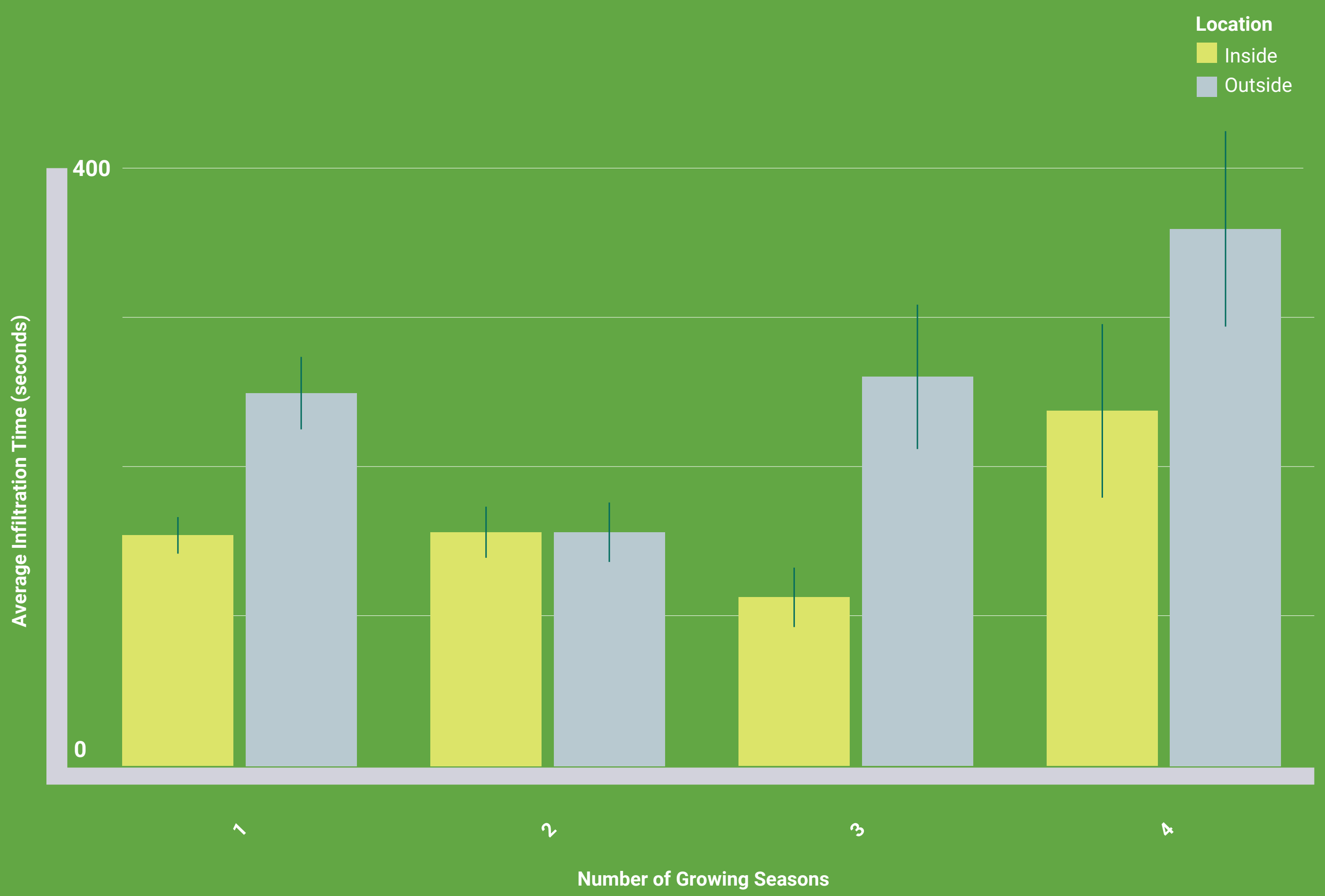


Figure 11. Infiltration rates inside and outside Tiny Forests over growing season

Soil Health

Soil colour, texture and compaction are assessed in Tiny Forests as they give an indication of changing soil health. Healthy soil not only supports healthy trees, it also tends to be softer, allowing for faster infiltration.

Compact soils have had the air stamped out of them. This reduces infiltration rate, and - if compaction reaches more than 1.6 kg/cm2 - slows root growth. Soil compaction is on average **38% lower inside Tiny Forests than outside** (Figure 12). Growing season does not affect compaction as our Tiny Forests are still young; and although the edges of the forests may be more compact than the center of forests, this difference is not significant.

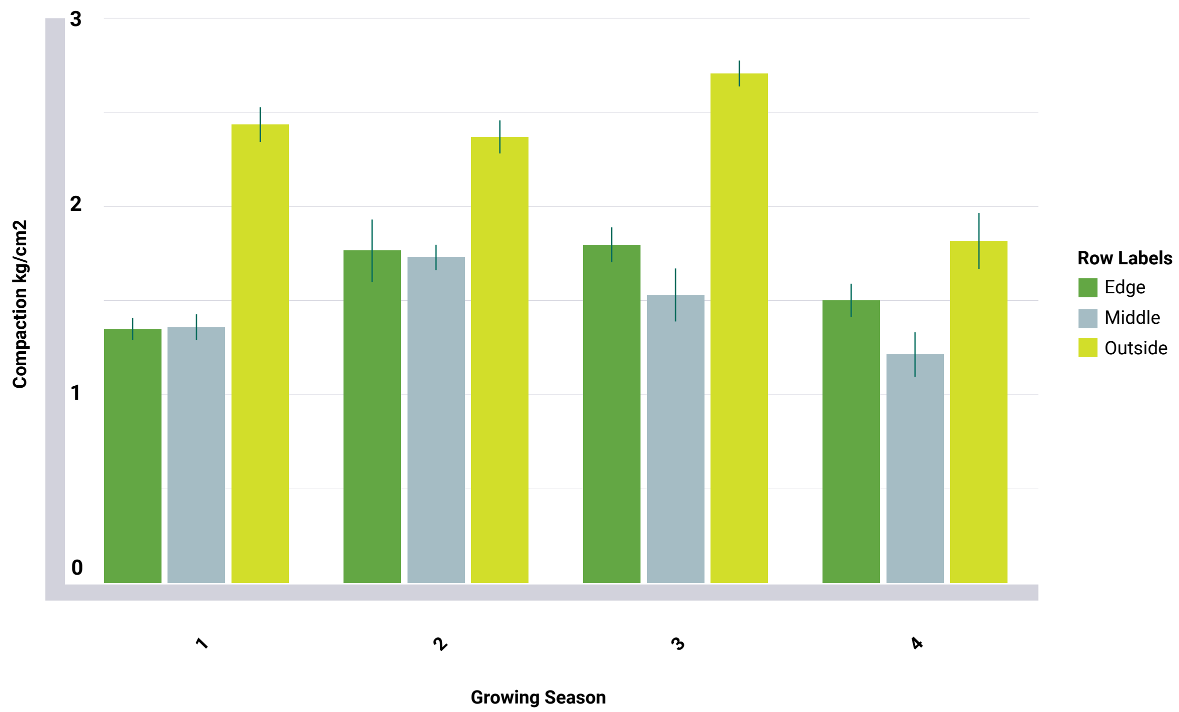


Figure 12. Average soil compaction in and outside of Tiny Forests by growing season

Soil texture describes the proportion of sand, silt and clay-sized particles, which can influence how water is absorbed, retained, and drained. Coarse soils, such as sand, allow for fast water infiltration but may not retain water which can cause flooding from surface runoff in heavy rain events. Fine textured soils, such as clay, have smaller tightly packed particles which absorb water more slowly but can cause runoff when saturated. Loamy soils, a balance of sand, silt, and clay particles, are ideal for managing floods as they combine good infiltration and water retention. **This year the most common soil texture sampled was Clay loam**, which made up 17.5% of all soil sampled this year.

Soil colour tells us about the amount of organic matter in the soil, the darker the colour the higher the concentration of organic matter, providing a rich supply of nutrients to the trees and plants in the forest. As expected, **soil colour is similar inside and outside of Tiny Forests**, with variation likely due to the natural variation in soils, addition of nutrients prior to planting or mixing with lower layers.

How Does Excavation Depth Affect Tree Growth and Biodiversity?

The Miyawaki method often involves extensive soil preparation compared to most other planting methods. Wherever soil is compact and lacking nutrients, the Miyawaki method instructs digging down to **one metre deep** and mixing in appropriate soil supplements.

We are often asked what happens if you don't dig that deep? Our data show that soil preparation significantly impacts tree growth: by the fourth growing season **trees in soil prepped to 1m are twice as tall as trees planted in soil prepped to 0.5m.**

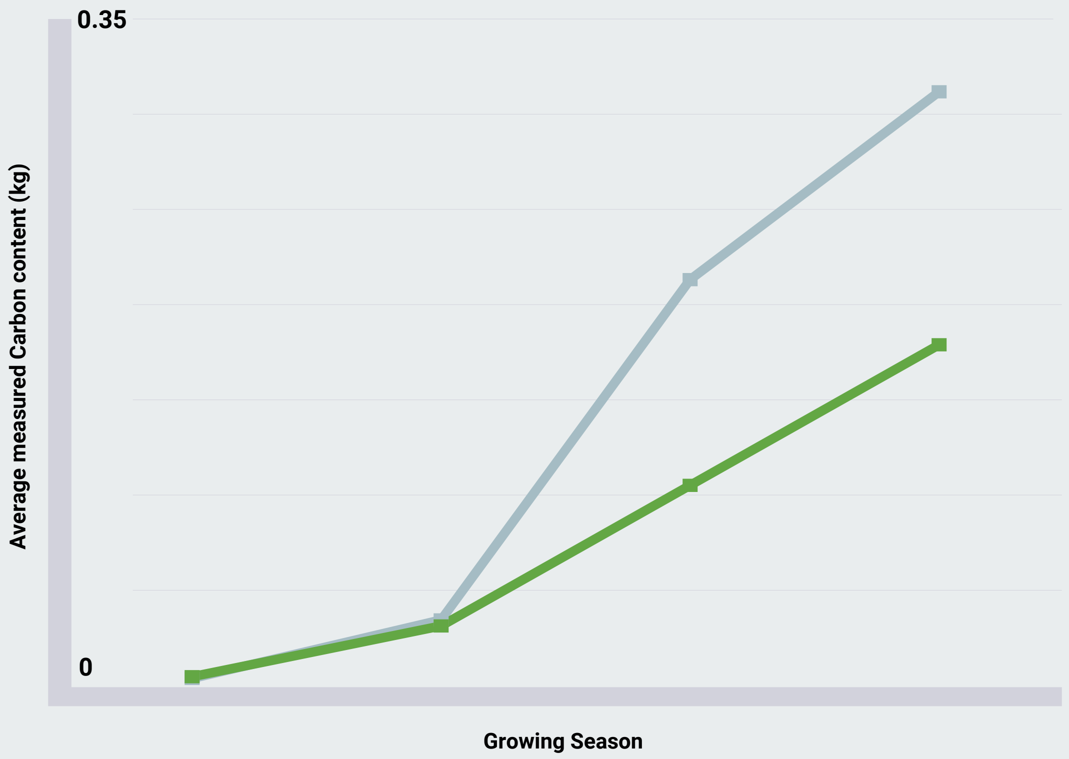


Figure 13. Tree growth rate in Tiny Forests prepped to 0.5m and 1m

In contrast, soil preparation does not impact ground-dweller or pollinator biodiversity up to growing season four (Figure 14). However, it will be interesting to see if this relationship is affected by the differences in tree height over time.

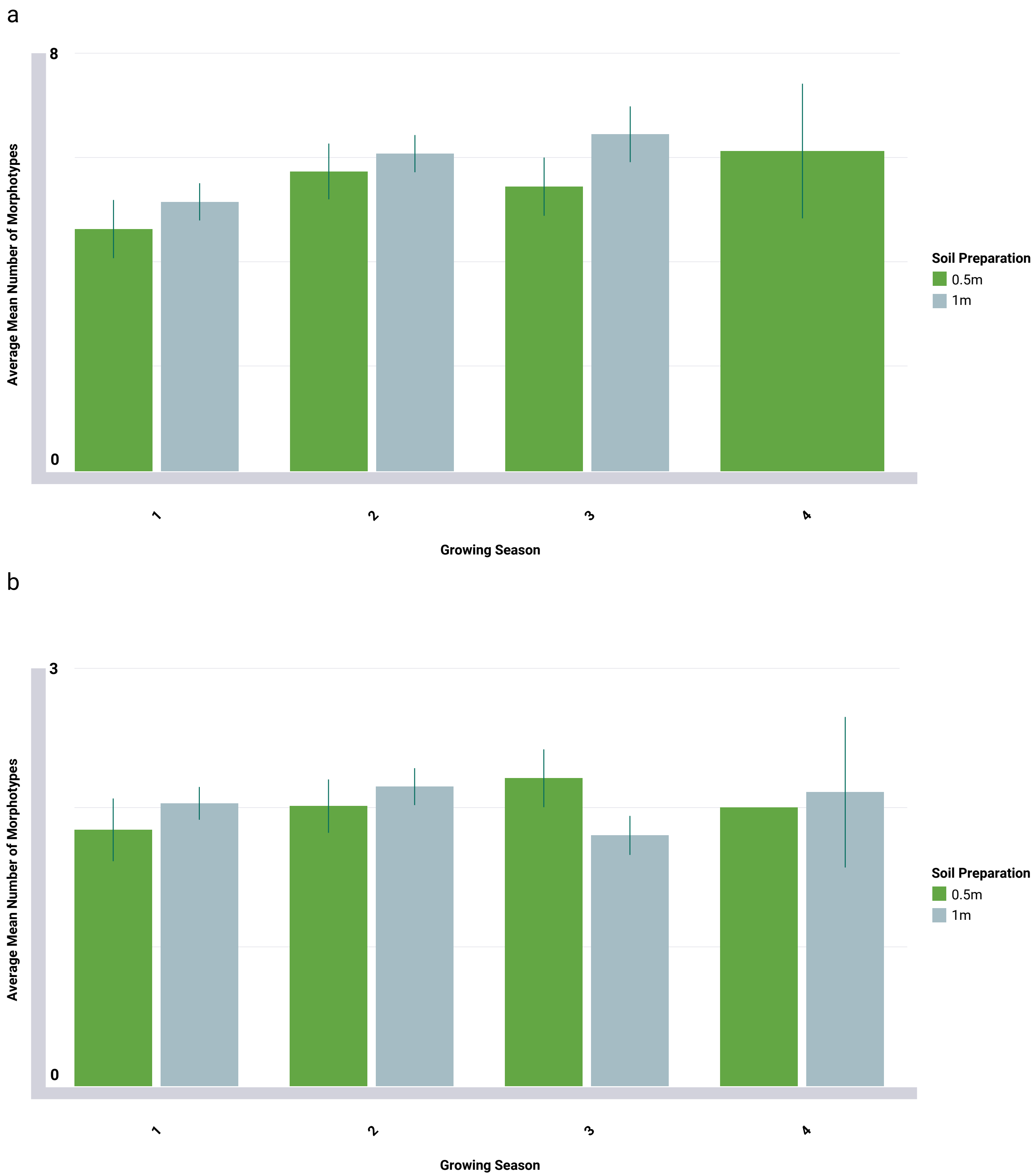


Figure 14. Ground dweller (a) and pollinator (b) numbers in Tiny Forests prepped to 0.5m and 1m

Bloomberg Tiny Forest birdview (c) Lateral North

Ecosystem Service 3 – Tree Growth and Carbon Storage

Our research questions:
How do Tiny Forests grow and store carbon? How does tree growth and carbon storage vary across the Tiny Forest network annually?

Surveys, minutes:

There were 2,326 tree growth surveys in 2024 at 79 Tiny Forests.

Carbon moves naturally through our ecosystems. During photosynthesis, plants absorb CO_2 from the atmosphere, combining it with water and sunlight to create sugar, which they use to build their structure. This process locks carbon into the plant's tissues. Over time, other natural processes, like respiration, release that carbon back into the air as CO_2. However, human activity has disrupted this natural cycle. Burning massive amounts of carbon-rich coal, oil, and gas—fossil fuels that have been stored safely underground for millions of years—has added an excess of CO_2 to the atmosphere, driving climate change.

To tackle this challenge, we're exploring ways to use natural cycles to draw carbon out of the atmosphere and store it safely. To estimate the carbon in our trees, we use the **Allometric Equation** (Box 1). We rely on this method because it's well-established and trusted, although it does have some limitations, such as only focusing on carbon stored above ground—in the trunk, branches, and leaves—without accounting for the carbon in the roots or soil. This means we might be underestimating the total carbon stored in our tiny forests. However, we're confident that our estimates represent a **reliable minimum**—it's unlikely there is any less carbon stored than what we've measured.

$$C = 0.0577 \cdot D^2 \cdot H \cdot 0.25$$

In this equation, **C** is the carbon in the stem of the tree; **0.0577** is a constant in the allometric equation; **D** is the diameter of the trunk of the tree, in cm, squared; **H** is the height of the tree in metres; and 0.25 is to account for the conversion from green weight to dry weight.

Box 1. The Allometric Equation to describe tree mass and Carbon content.

Tree Height

The tallest tree measured across our Tiny Forests is a goat willow (*Salix caprea*) at Tychwood, Witney, standing at 7 meters tall. For a 5-year-old willow, that's impressive—just shy of the height of a third-story window. You might expect goat willow to be a **canopy** species but it belongs to the **understory layer**, reaching a maximum height of about 12 meters. Research predicts that understory and sub-canopy species will grow fastest at first, competing for light whilst canopy species invest in deep roots initially before growing rapidly up and through the sub-canopy.

Pioneer species are also expected to grow quickly. Pioneer species are the first plants to colonise disturbed or barren environments. They grow rapidly, tolerate harsh conditions, and modify the environment, allowing slower-growing, long-lived species to establish later. To date, most of the tallest trees in Tiny Forests are pioneer species[8,9,14] (Table 1).

Species	Pioneer	Forest	Growing Season	Height (cm)
Goat willow	Yes	Tychwood, Witney	5	700
Downy birch	Yes	Tychwood, Witney	5	653
Silver birch	Yes	Tychwood, Witney	5	611
Goat Willow	Yes	Tychwood, Witney	5	608
Silver birch	Yes	Tychwood, Witney	5	603
Goat willow	Yes	Tychwood, Witney	5	540
Silver birch	Yes	Grenada Dove, Bloxwich Community Orchard	3	502
Aspen	Yes	Canja Pheasant, Barr Beacon Nature Reserve	3	500
Silver birch	Yes	Holt Drive, Charnwood	4	457
Aspen	Yes	Guernsey Lily, Swannies Field	3	430

Table 1. The 10 tallest trees measured in Tiny Forests are all pioneers.

Blythe Hill TF Planting Day (c) Earthwatch

As predicted, while we certainly have some giants - especially in the understory layer - the other trees are catching up fast (Figure 15).

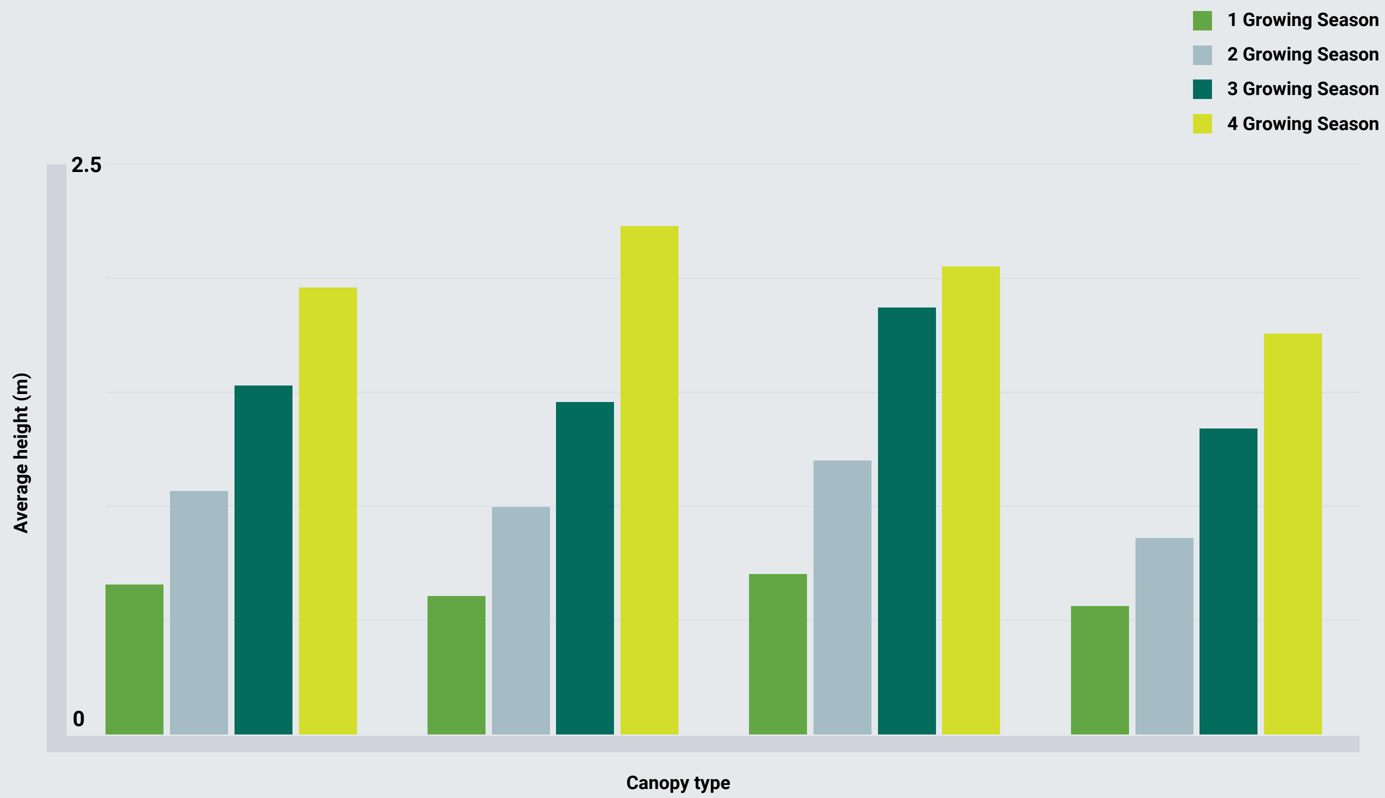


Table 15. The average height of Tiny Forests canopies in 2024.

We can use the height and girth of trees to estimate the carbon stored in each Tiny Forest, based on its age, as shown in Figure 16. **Our data show Tiny Forests store exponentially more carbon as they age**, at least up until growing season 4, with four-year-old forests storing 141.3kg of carbon on average, compared to 3-year-old Tiny Forests which store 87.5kg.

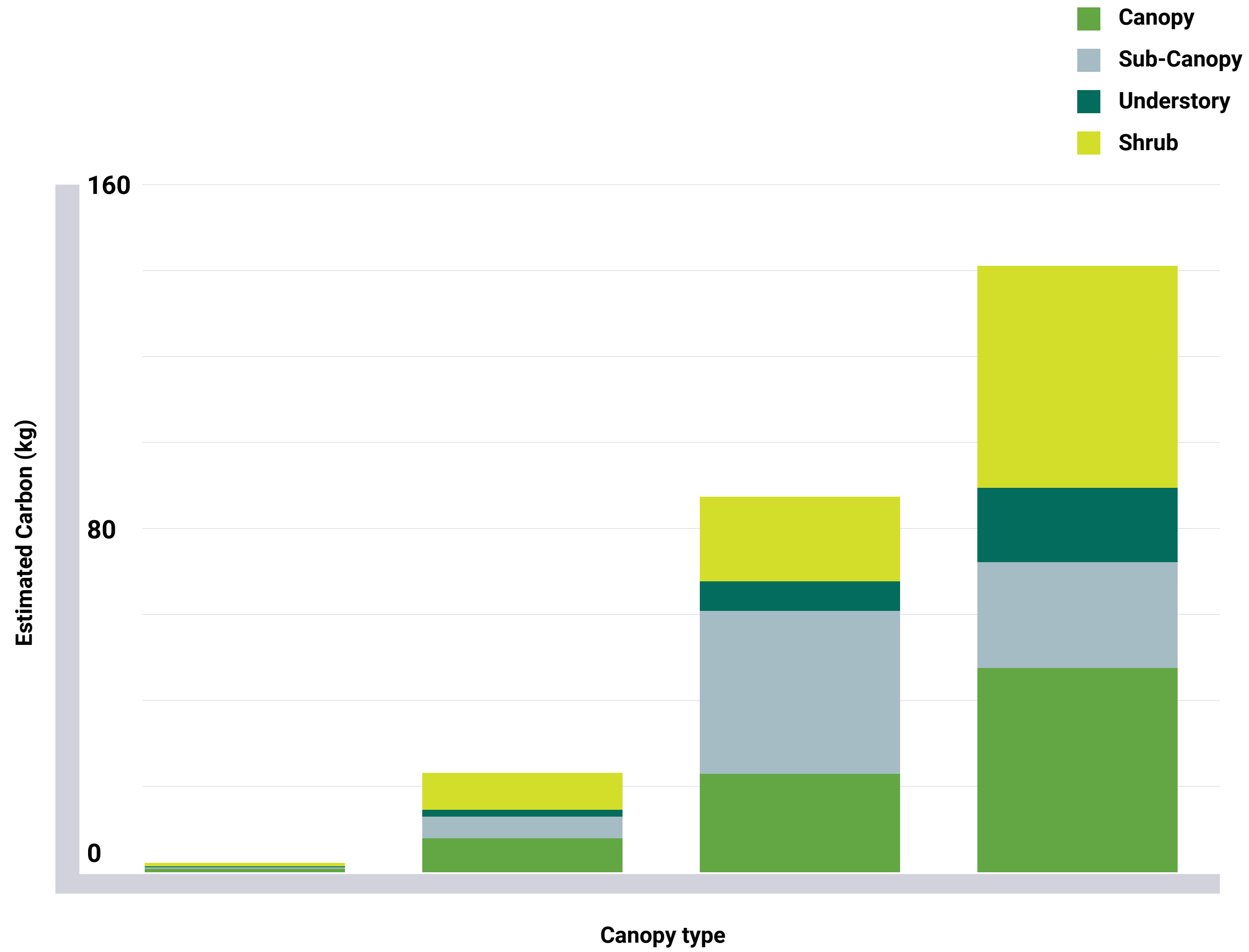


Figure 16. Estimated Carbon (kg) in an average tiny forest, according to the age of that tiny forest (measured in number of growing seasons).

By adding up the carbon stored across all our Tiny Forests of a given age, we estimate that **Tiny Forests are sequestering 18,847 kg of above ground carbon, equating to 69.17 tonnes of CO_2e (carbon dioxide equivalent)**. This is a significant increase from 2,400 kg/8.81 tonnes of CO_2e in 2022 and 4,600 kg/16.89 tonnes of CO_2e in 2023. This increase is due to both the number of Tiny Forests being planted, and their increased carbon-capture through ageing.

Carbon to carbon dioxide equivalent

To convert carbon (C) to carbon dioxide equivalent CO_2e), we multiply the amount of carbon by 3.67. The atomic weight of carbon is 12, the atomic weight of CO_2 is 44, and 44/12 is 3.67.

Ecosystem Service 4 - Thermal Comfort

Our research questions:
Do Tiny Forests have a cooling effect? Do local microclimate conditions differ within the Tiny Forest compared to urban surroundings, and how do people perceive these differences in terms of thermal comfort? What kind of effect does thermal comfort have on human health and wellbeing?

Surveys, minutes:

There were 387 surveys of thermal comfort in 2024, across 55 tiny forests. The most intensely studied forest was Knowlegates Farm in Derbyshire, with 39 reported surveys of their Miyawaki forest.

Urban areas in the UK often experience higher temperatures than the countryside, a phenomenon known as the urban heat island (UHI) effect. This happens because materials like concrete and asphalt absorb and retain heat, while the lack of green spaces reduces natural cooling. Trees and urban forests are nature's air conditioners and can significantly help to cool our towns and cities. Their leaves release water into the air through a process called transpiration, which cools the surrounding area. Shade from trees can also lower temperatures on streets and buildings, reducing the need for air conditioning.

Thermal comfort is less about the absolute temperature and more about how people feel in the environment. **As Tiny Forests age, people report feeling more comfortable inside them**; with 55% of participants rating four-year-old forests as being slightly to very comfortably (Figure 17).

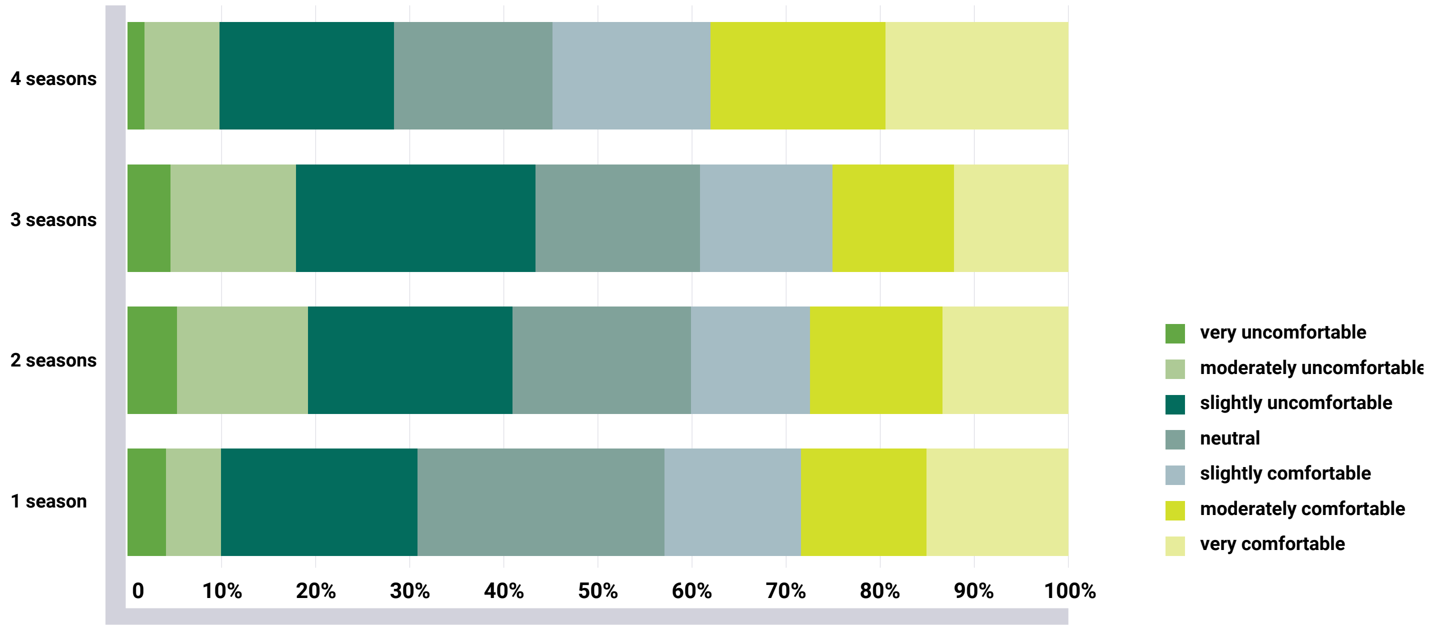


Figure 17. People report feeling more comfortable inside older Tiny Forests.

Equating this to actual temperature, people seem to be most comfortable around 22°C, reporting that they would not want to be any warmer or cooler at this temperature (Figure 18).

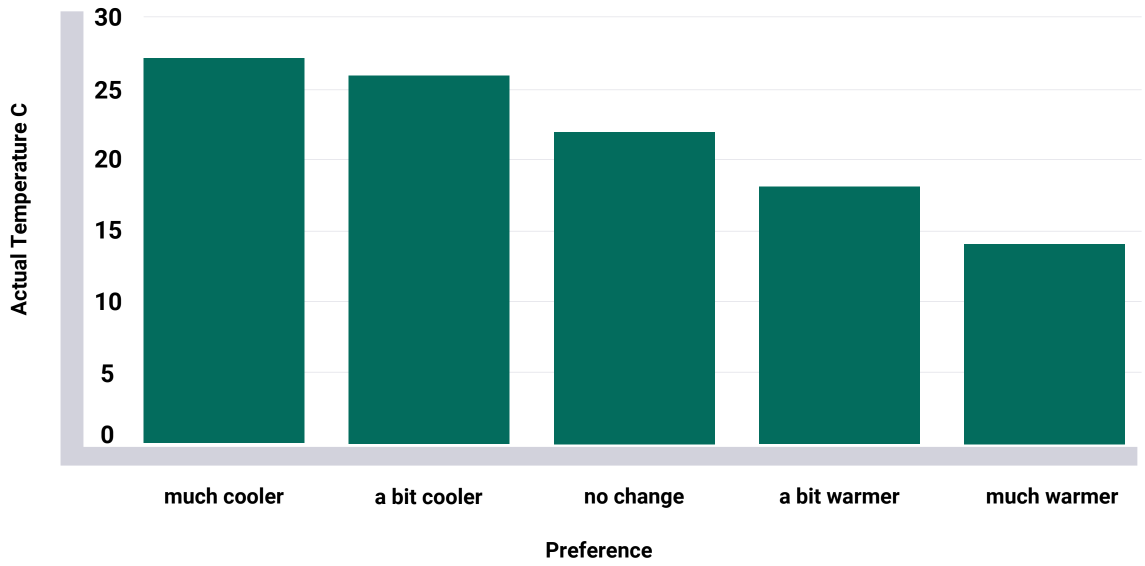


Figure 18. Reported preferences at varying temperatures within Tiny Forests

Thermal Comfort Research Spotlight

Jessica Sherlock, King's College London Environmental Science for Sustainability

Jessica monitored four Tiny Forests in West London over 13 days using low-cost sensors for air temperature, humidity, air pressure, ground temperature, and light levels inside and outside the forests. During the day, air temperatures were up to **3°C cooler** inside two-year-old forests, and **6°C cooler** inside three-year-old forests, compared to areas outside the forest. At night, however, temperatures were about **2°C warmer** inside the forests. The forests also had slower morning warming rates and smaller temperature swings between day and night. Ground temperatures inside were up to **1.3°C cooler** than outside. Humidity, light levels, and air pressure showed minor or no significant differences.

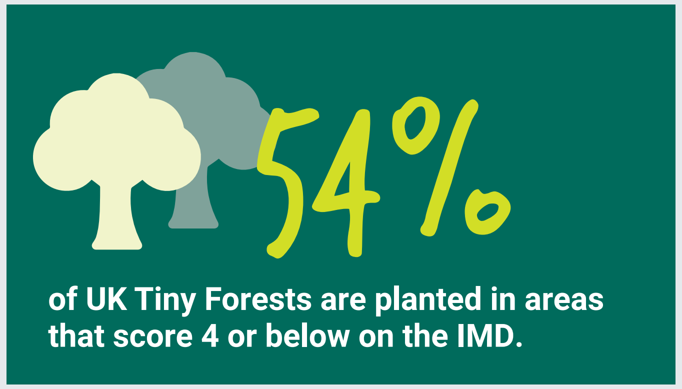
Thermal Comfort Research Spotlight

Rasheed Akinleye Hammed, PhD Candidate University of Manchester

Rasheed carried out his MSc research with Tiny Forest a few years back and loved it so much he developed a PhD with Earthwatch and Manchester University to use remote sensing, Light Detection and Ranging (LiDAR) - a remote sensing method used to examine the surface of the Earth - and citizen science data to assess the structural diversity of Tiny Forests and model the effect on thermal comfort. Rasheed's research will provide valuable information on the structural complexity of Miyawaki forests and how extrinsic and intrinsic factors affect ecosystem service provision by urban nature-based solutions.

Southall Recreation Ground TF Planting (c) Earthwatch

Blythe Hill TF Planting Day (c) Earthwatch




Blythe Hill TF Planting Day (c) Earthwatch

Ecosystem Service 5 - Social Benefits

Our research questions:
What is the social reach of Tiny Forest? How can planting, monitoring and engagement activities be designed to foster nature connectedness? Does improvements in nature connectedness lead to more pro-environmental behaviour?

Lack of access to greenspace in the UK predominately affects people living in deprived areas, minority ethnic groups, and younger people[15]. Earthwatch Europe is helping to address this inequality by planting high quality green space in urban areas across the UK, and engaging people in connecting with those spaces through implementation, environmental monitoring and community events.

Across the UK, the **Index of Multiple Deprivation** can be used as an indicator of areas experiencing inequality in greenspace provisioning and access. The IMD ranks every small area in England from 1 (most deprived) to 32,844 (least deprived). To date, over **54% of UK Tiny Forests are planted in areas that score 4 or below on the IMD.**

Being in and interacting with nature improves our mental and physical well-being, as well as how we relate to and feel about nature - our **nature connectedness** – and, therefore our attitudes and behaviours towards it. Concerningly, nature-connectedness in the UK seems to be particularly low. The UK ranked 59th out of 65 countries on the Connectedness to Nature Scale, and 31st out of 65 countries on the Nature Exposure Scale, which measures how people interact with nature.

In 2024, Earthwatch Europe ran 48 monitoring and engagement events, training 2091 citizen scientists across the UK. This builds upon the already active group of Tree Keepers who care for and monitor their local Tiny Forests. Data were collected at 108 Tiny Forests spanning the UK from Dundee to the Channel Islands, Dublin to Newbury Park, London (Figure 19).

Our data show that **participating in Tiny Forest events significantly benefitted participants self-reported feelings of connection to nature**, on average moving from D to E on the inclusion of nature in self-scale (Figure 20).

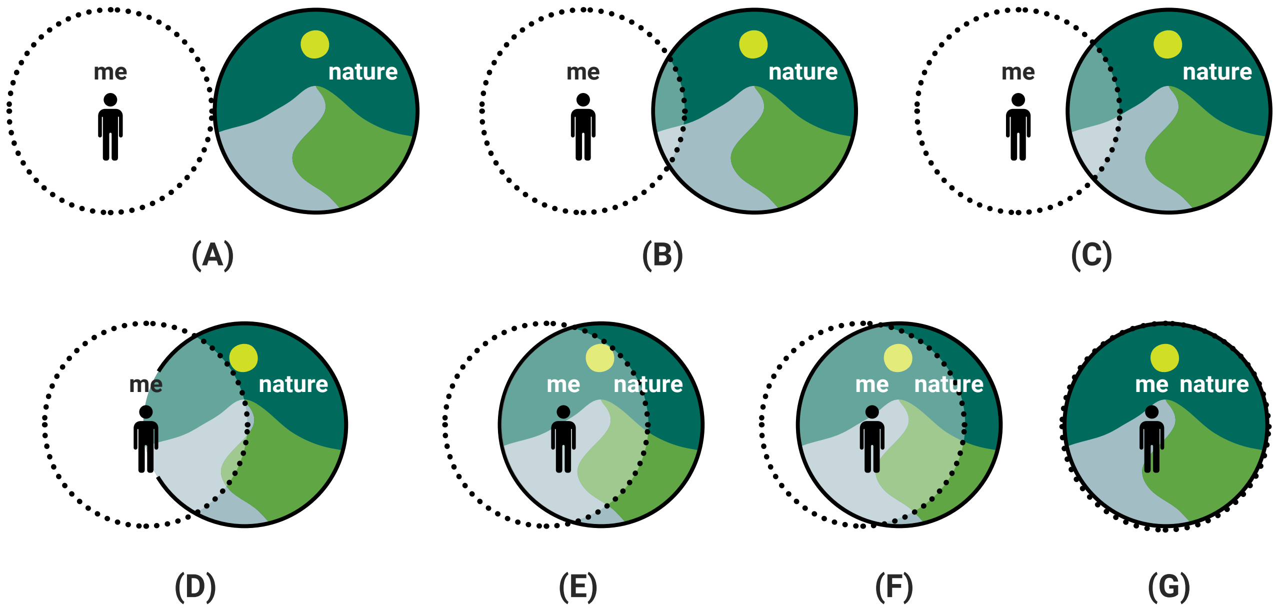


Figure 20. Inclusion of nature in self-scale

EW Tiny Forest planting (c) Lateral North

Overall, we find evidence that Tiny Forests are providing important ecosystem services, that when combined with other nature-based solutions to create cities with diverse, connected and self-regulating green spaces, can ensure that the impacts of climate change are less harshly felt.

Social Benefits Research Spotlight

Babette van Gerwen, PhD Candidate Royal Holloway University

Recent evidence suggests that citizen science can improve nature connectedness however, this is a developing field and Earthwatch are interested in further elucidating this relationship; exploring how different types of citizen science and other types of activities compare in their nature connectedness benefits, and how nature connectedness can be promoted during activities.

Babette started her PhD in the Social Purpose Centre for Doctoral Training at Royal Holloway in January 2025, focusing on citizen science as a tool for enhancing human-nature connectedness and pro-environmental behaviour. Babette has been working as a programme manager for sustainable accelerator programmes, as a garden ecotherapy worker and an artist and facilitator. Her practice focuses on nature connectedness and ecological engagement making her the perfect candidate for this PhD as she's passionate about exploring how people and communities relate to nature and investigating ways that help create stronger connections.

Social Benefits Research Spotlight

Molly Tucker, University of Oxford

Evidence suggests that Volatile Organic Compounds (VOCS) - chemicals produced by plants, fungi and bacteria that evaporate into the air – could be beneficial to peoples' wellbeing; however, our understanding of VOC profiles in urban green spaces is limited. In partnership with Professor Kathy Willis at the University of Oxford we've begun investigating whether the VOC profile of Tiny Forests positively affects human health and wellbeing.

As part of this pilot study, volunteers had their heart rate and salivary amylase levels measured, and self-completed a State-Trait Anxiety Inventory (which provide physiological and psychological indicators of stress and anxiety) both before and after spending twenty minutes in either (1) a Tiny Forest, (2) another open green space, or (3) an indoor space.

Preliminary results indicate that the VOC profile of Tiny Forests differs across plots; likely due to plant species and age. Based on the State-Trait Anxiety Inventory, Tiny Forests could have a positive impact on wellbeing; with participants reporting lower anxiety levels after spending twenty minutes in a Tiny Forest.

Black Mountain Primary Tiny Forest (c) Earthwatch Europe


Leicester Goodgym. The team at the Tiny Forest for their monitoring session during Tiny Forest Tree Survey Week in October.

The People Behind the Data

This report wouldn't be possible without the hard work of Tiny Forest Tree Keepers and citizen scientists. So far, around 8,000 people have collected data at Tiny Forests across the UK. Tree Keepers lead the charge, organising data collection events and looking after their local Tiny Forest. Here are a few of their stories.

GoodGym are a Great Community in Leicester

Sarah Horner & the Leicester based Tiny Forest x Good gym team, Holt Drive Tree Keeper & Goodgym Activator for Leicester

Where: Looking after the Holt Drive, Charnwood Tiny Forests, and visiting other Leicester-based Tiny Forests.

Sarah, along with her GoodGym friends and family, have been a vital part of maintaining and monitoring the Holt Drive Tiny Forest in Charnwood. The commitment doesn't stop there—Sarah and her team also visit and support other Leicester-based Tiny Forest sessions, including planting days, weeding and litter picks.

"Visiting the Tiny Forest always feels rewarding, especially watching the rapid growth of the trees. We can see how much the trees have grown just by comparing them to the height of our group members! During this year's Tree Survey Week we all revisited Holt Drive Tiny Forest, the last group visit was about 14 months ago during Paul and Gus' Tiny Tour. Back then, the trees were about half of Kim's height, now they're twice as tall as Kim! As a group, we worked together to measure 49 trees in just one hour. We all really enjoyed taking part in the Tiny Forest citizen science. Everyone got stuck in measuring, identifying trees and taking notes to report back to Tiny Forest HQ."

Sarah and her team are also helping the Tiny Forest science team trial new monitoring methods. At Holt Drive, they are trialing a transect-based method through their forest to monitor tree growth and mortality, replacing the usual tagging technique. This new method could help solve the challenge of "mysteriously vanishing tags" while simplifying data collection. The group's efforts and feedback during Tree Survey Week will be invaluable for refining these techniques. We hope to adopt this method more widely soon and update our protocols for next season—stay tuned!

What would you say to someone thinking of becoming a Tree Keeper?

"Join with a friend or family member, I have brought along my mum to help out, she really enjoyed it too and previously I have brought my two children to search for tree tags and they loved it."

Walsall Healthy Spaces

Emma, Walsall Healthy Spaces team and the Tree Warden Volunteer team

Where: Emma and her team are dedicated stewards of all nine Tiny Forests in Walsall.

"In most of the Tiny Forests, the trees are growing healthily, so I felt it was important to monitor them and visit each one in turn to ensure they continue to grow healthily so they are a valuable resource in the future. I feel collecting monitoring data helps contribute to the understanding of positive benefits Tiny Forest gives us. Even though it is fully expected - that a tree will grow - it's a thrill to see how much the tree has grown since your last measurements."

Emma has found that caring for her Tiny Forests is about more than just trees—it's about people and connections.

"One of the best parts has been to see the friendships that have formed among volunteers. I have made some amazing friends through this work, and it feels like I've known them far longer than I actually have. We've also involved children from local schools in our Tiny Forest sessions, and it's been so rewarding. I hope it may inspire a love of nature in them. Finding great crested newts under the biodiversity tiles is also very exciting - it doesn't matter how old you are! Generally, I've found spending the time outside so rewarding. The feel-good factor and how it positively impacts your outlook on life is amazing."

What would you say to someone thinking of becoming a Tree Keeper?

"Don't delay! Get involved. Any amount of time that you can spend in a Tiny Forest is really rewarding; from taking care of the trees and making sure they are growing healthily, to recording data and knowing that you are adding to the bank of national data. Spending time outside, surrounded by nature with like-minded people from your local community gives you such a feel-good factor that it's well-worth becoming a Tree Keeper."

"Spending time outside, surrounded by nature with like-minded people from your local community gives you such a feel-good factor that it's well-worth becoming a Tree Keeper."

EW & Walsall Healthy Spaces team. Emma and her partner Stuart at this year's Tree Keeper Social in Birmingham (top pic). A collage of photographs taken across a variety of events in the Walsall Tiny Forests taken by Emma and her team (collage).

"It's an easy and rewarding way to learn a lot more about nature and to get involved in nature stewardship."

Case Study: From Ecological Tragedy to Tiny Forest Success in Bromley

Millie, Sarah, and the Cator Park Friends group and Tree Keeper Team

Where: Cator Park Tiny Forest, Bromley, London

In June 2023, Bromley residents were devastated by the illegal felling of over 100 trees in Cator Park. In response, residents rallied, and the Friends of Cator Park launched a fundraising campaign to create a Tiny Forest, aiming to heal the park and provide lasting benefits. In just 42 days, 243 supporters raised funds to plant the Cator Park Tiny Forest—the only Tiny Forest in the Earthwatch Europe network to be fully funded by its community. Today, the Tiny Forest stands as both a symbol of hope and resilience and a testament to the community's determination to transform a tragedy into something positive and enduring.

A Growing Legacy

Since planting in 2023, the Friends of Cator Park group has taken an active role in monitoring and caring for their Tiny Forest.

"Carrying out the monitoring and data collection creates this ongoing relationship with the Tiny Forest. We can follow its growth and development and makes us pay more attention to the smaller changes. The data we collect really helps evidence our understanding that it's not just that trees are important locally, but how and why they're important beyond just their planting. I also feel like I'm contributing to my local area, which makes me feel more engaged and connected."

"I often see parents with young children enjoying the Tiny Forest. I think it might provide a helpful focal point for parents to introduce their children to nature, especially when the trees are no bigger than the children themselves."

What would you say to someone thinking of becoming a Tree Keeper?

"It's an easy and rewarding way to learn a lot more about nature and to get involved in nature stewardship. It's a great step to take if you feel worried about biodiversity and climate emergencies, but don't know how you can contribute. But it's also good if you simply like spending time outdoors in green spaces."

Tree Keeper Millie. Some of the team in their Tiny Forest for a monitoring session.

Bloomberg Tiny Forest (c) Lateral North

Where Do We Go From Here?

Restoring urban biodiversity and nature connection has never been more important. We believe that there are four key areas that Government and stakeholders need to address to create a national strategy for biodiverse cities of the future.

1. Embrace natural spaces and nature-based solutions

Nature-based Solutions address societal challenges through actions to protect, sustainably manage, and restore natural and modified ecosystems, benefiting people and nature at the same time. With 84% of the UK living in towns and cities – where nature connection is lacking, biodiversity is depleted, and climate adaption is paramount – the creation of more biodiverse green space in communal areas and the use of nature-based solutions in urban environments has never been more important. Earthwatch believes that urban developers need to plan for natural spaces and implement nature-based solutions across our cities – including tree-planting, wildflower meadows, wetlands and rain gardens, green roofs and living walls – and that these solutions should be at the forefront of urban policy towards climate mitigation and adaptation.

Southall Recreation Ground TF Planting (c) Earthwatch

2. Improve equal access to natural spaces

Around 1 in 3 people in the UK don't have access to nature-rich spaces near their homes, with fundamental disparities disproportionately affecting people from Black, Asian and minority ethnic backgrounds and those living on a lower income. The Environmental Improvement Plan16 contained a promise to "work across government to fulfil a new and ambitious commitment that everyone should live within 15 minutes' walk of a green or blue space". In support of this promise, Earthwatch believes that all people, regardless of background, should have equal access to natural spaces. Beyond the generation of green and blue spaces in established urban environments, and the consideration of natural spaces during urban development planning, we want to see the barriers to access addressed, in part through the engagement of communities.

3. Empower and engage communities

Access to nature is associated with better health and wellbeing outcomes, with green spaces helping to bind communities together and reduce loneliness. We believe communities should be empowered to assist in the planning, creation, maintenance and – where applicable - monitoring of natural spaces. We want to see communities supported to care for and enjoy their existing local green spaces. By engaging communities in the design and development of natural spaces in urban areas, we can better appreciate the cultural variation in how people want to spend time in these environments and foster a greater sense of nature connection. Nature connection is a psychological concept that describes the way we relate to, and experience, nature. It refers to the kind of relationship we develop with the natural world. We know that nature connectedness explains 30 times more pro-nature behaviour than knowledge-based environmental education and is the strongest predictor of ecological behaviour.

Tiny Forest planting in Southmere Park, Thamesmead (c) Richard Held

4. Facilitate outdoor learning

Despite 83% of 8–15-year-olds interviewed by Natural England in 2020 saying that being in nature made them very happy, fewer than 1 in 10 children regularly play in wild places, compared to 5 in 10 a generation ago17. Earthwatch believes teachers and educators should be equipped with the tools they need to take learning outside, inspiring their children and young people to build curiosity of the natural world, create solutions-focused thinking and build a foundation of strong scientific knowledge of the environment. We want to see education policy support the creation of quality green spaces in school grounds that educators and students can access and enjoy on a daily basis and support for teachers and pupils to embed nature-positive learning into the curriculum.

We couldn't do any of this without you.

A huge thank you to all partners and supporters of Tiny Forest. **www.earthwatch.org.uk/program/tiny-forest/**

Thank you to all of the amazing citizen scientists, volunteers, and Tree Keepers who have contributed to this research over the last four years. Some of our forests might seem tall, but they're still young and we have much more to learn from them. So please, do keep going out there and collecting data … the more the better.

For more information on how to get involved visit the Tiny Forest Website: **www.tinyforest.earthwatch.org.uk/get-involved**

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Volunteer planting a sapling in a Tiny Forest in Darlington Credit Jamie Haslam ROAM

Nature in Cities

By earthwatch EUROPE

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