Tiny Forest

Monitoring Report 2021

March 2022

tinyforest
earthwatch
EUROPE

OVERVIEW

Super powerful citizen scientists:
Monitoring the Tiny Forest network across the UK

In June 2021 Earthwatch Europe, together with community members, schools, businesses and local authorities, started the first year of Tiny Forest monitoring across the UK.

Thanks to the time of volunteers dedicated to monitoring each Tiny Forest, we now have the first insights into the benefits to the environment and biodiversity that a Tiny Forest can provide in its early stages.

This report provides a summary of the data that has been collected so far for our Tiny Forest core research topics: carbon capture, flood management, cooling effect of trees and biodiversity.

We will continue to monitor each Tiny Forest with Tree Keepers and volunteers through the seasons to have an all-year-round understanding of the cycles and changes in a Tiny Forest. Thanks to the newly launched Tiny Forest Portal, people will now be able to monitor their Tiny Forest more easily and independently. Join us!

The Tiny Forest Research Team, Earthwatch Europe

Autumn colours at Swindon Tiny Forest monitoring event. Photo taken late September 2021. (Credit: Macarena L. Cárdenas)

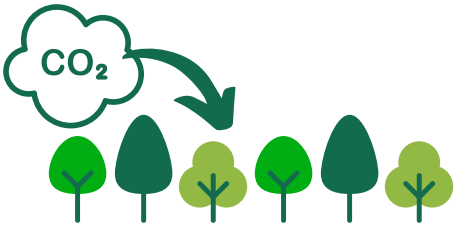
CITIZEN SCIENTISTS REVEAL THE ENVIRONMENTAL VALUE OF TINY FORESTS

Tiny Forest citizen science is a powerful tool for social engagement and scientific data gathering. Here is a summary of what we have learned so far

774

VOLUNTEERS TRAINED AS CITIZEN SCIENTISTS

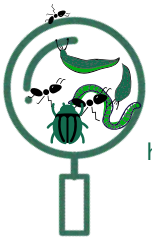
People from a wide range of ages and backgrounds came to monitor the Tiny Forest network carried out in 25 Science Days between June and November 2021



290 Kg

OF CO_2 STORED

in total within the 17 monitored Tiny Forests, where most have gone through one growing season



HIGH SOIL BIODIVERSITY

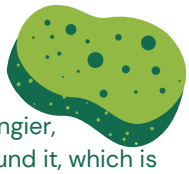
Soil diversity is key for tree health. Tiny Forests have rich biodiversity, including slugs, centipedes, earthworms and ants. Tiny Forest soil is alive!

1,442

Surveys with environmental data in total were submitted by citizen scientists!

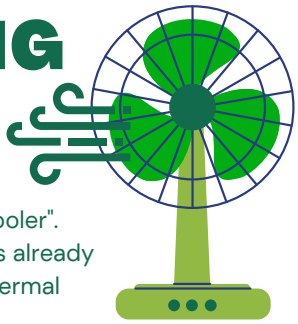
2.7 TIMES SOFTER SOIL

The soil of the Tiny Forest network is less compacted, spongier, than the soil around it, which is related to its higher capacity of infiltrating water and preventing flooding.



COOLING

62.5% of citizen scientists thought that outside the Tiny Forest it needed to be "much cooler". Each young Tiny Forest is already making a difference in thermal comfort.



POSITIVE FEEDBACK

60.2% of participants rated the Science days experience as **FANTASTIC**, 32.6% of participants said it was **REALLY GOOD**, and 2% that it was **OKAY**

TINY FORESTS ARE OF SIGNIFICANT POSITIVE VALUE FOR THE ENVIRONMENT AND PEOPLE

WHAT TINY FORESTS WERE MONITORED IN 2021?

Jane, Tree Keeper, measuring infiltration (Credit: Macarena L. Cárdenas)

Location	Science days dates
Foxwell Drive, Oxford	07.06.2021 & 06.07.2021
Trym Valley, Bristol	23.06.2021
Avenue End, Glasgow	19.10.2021 & 22.10.2021
Queensmead, Leicester	09.06.2021 & 10.06.2021
Oak Street, Wolverhampton	14.07.2021 & 30.09.2021
Perry Common, Birmingham	15.07.2021 & 04.11.2021
Hammersmith Park, Hamm & Fulham	29.06.2021 & 29.09.21
East Wichel Park, Swindon	22.06.2021 & 05.10.2021
Saltersgate School, Doncaster	01.07.2021 & 07.10.2021
Brickpond, Barnsley	30.06.2021
Meadow Lane, Oxford	10.07.2021
East Lancing Recreation Ground, Lancing	28.07.2021
South Park, Redbridge	30.06.2021
Eton Close, Witney	25.07.2021
Hautlieu School, Jersey	20.09.2021 & 25.09.2021
Speen (x2 Tiny Forests)	10.11.2021

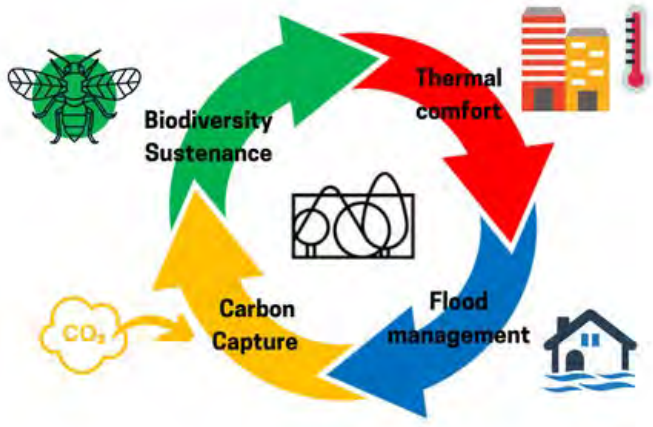
This map shows the location of all the Tiny Forests planted up to March 2021 (total 17), all were monitored by members of the local community, school pupils and their teachers, local partners and Earthwatch scientists.

THE IMPORTANCE OF DATA

Collecting data on the characteristics of the Tiny Forests and their immediate surroundings is key to understanding their potential benefits - for the environment and for people. Monitoring each Tiny Forest allows us to:

- Quantify and describe their benefits, i.e. how good Tiny Forests are for supporting our wellbeing and the environment,
- Build knowledge on the best practices to plant, support, and engage with Tiny Forests,
- Raise awareness and support interaction with nature where we need it the most, in our cities.

The practice of monitoring Tiny Forests through citizen science goes beyond the collection of data. Citizen science allows people to connect with nature, learn, acquire new skills, and create knowledge about our natural environment. Research shows that citizen science facilitates the creation of stronger links between people and the environment, encouraging sustainable action towards nature.



Carbon capture, biodiversity, flood management, and the cooling effect of trees, providing thermal comfort, are the four main topics of research that we are exploring with the data collected through the monitoring.

These four areas are strongly connected with one another, where the health and development of the Tiny Forests play an important role.

WHAT ARE WE MONITORING AND WHY?

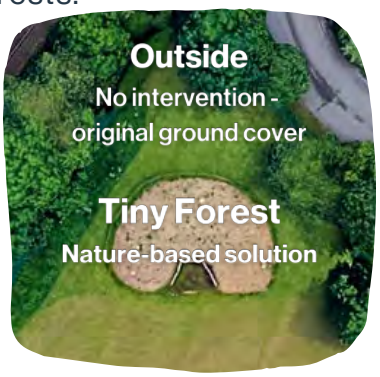
A pupil from Jersey is getting ready for biodiversity monitoring (Credit: Megan Evans)

DATA GATHERED

With 25 monitoring events carried out on 17 Tiny Forests and 774 volunteers trained as citizen scientists, we now have the first insights into the characteristics of Tiny Forests.

At least one monitoring event was carried out by volunteers at each of the Tiny Forests planted by Earthwatch Europe to date.

At each site, the Tiny Forest itself was compared to the surrounding land (typically amenity grassland) to help us understand the impact of the forest.



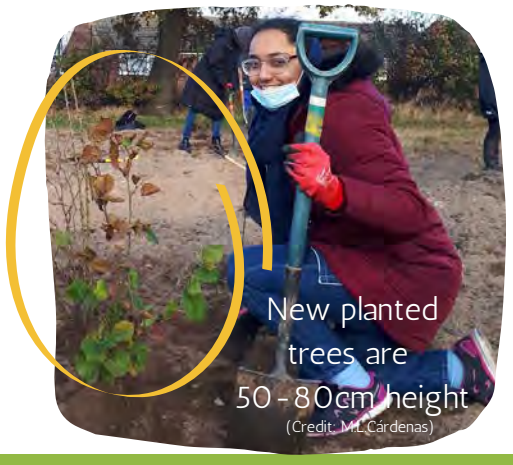
Here we highlight some initial results from the data gathered in this first year:

Carbon Capture and Storage

Trees capture and store atmospheric carbon to produce biomass. They store carbon in their trunk, roots and leaves. In fact, approximately half of the dry weight of a tree is carbon. This means that trees can help us to reduce the effects of climate change.

We trained volunteers to collect data to estimate carbon stored in Tiny Forest trees. The methods included measuring the diameter of the tree trunks and heights of a subset of trees for each one of the 17 Tiny Forests.

Pupils collecting carbon storage data at Queensmead Playing Field Tiny Forest, Leicester (Credit: Megan Evans)

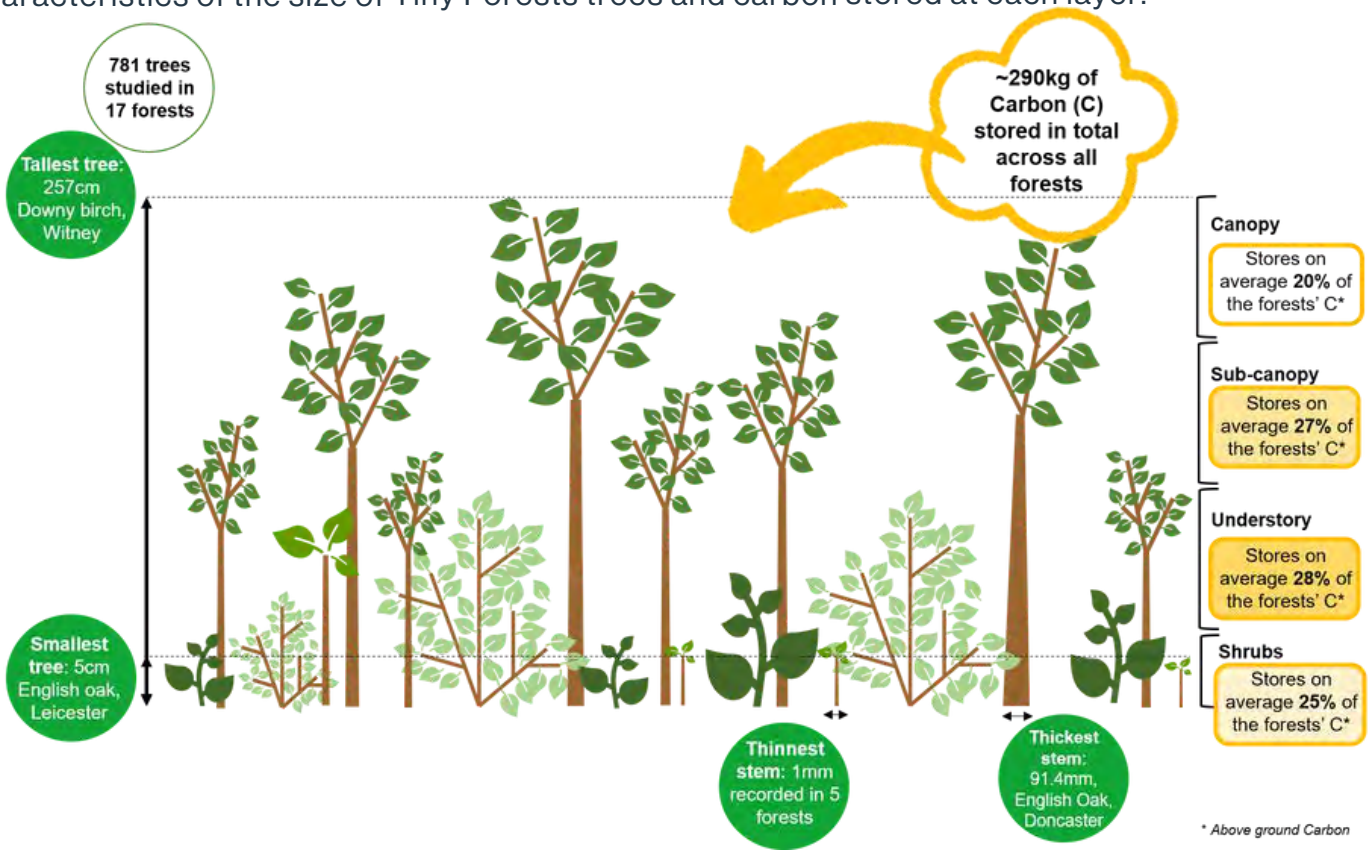


We study a subset of around 100 trees carefully selected and tagged to be representative of each forest's tree species and structure.

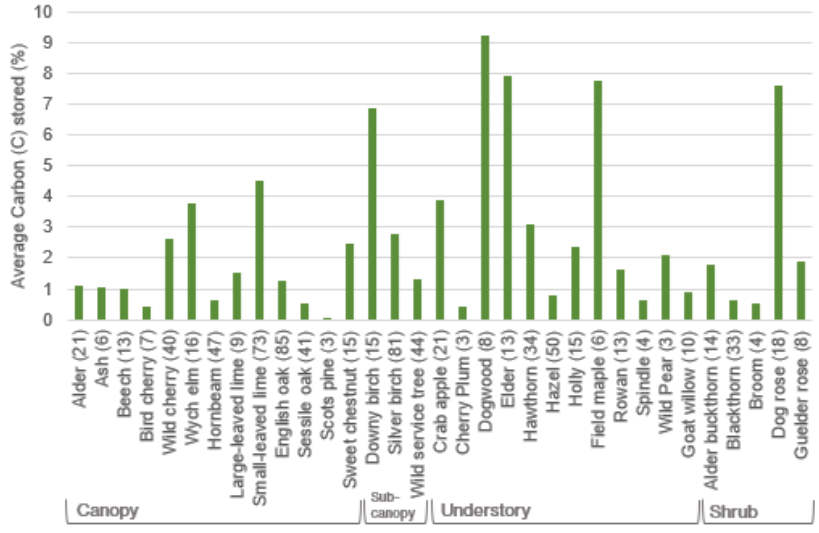
Tiny Forests are planted based on the tree canopy distributions you would find in mature forests. Therefore, you will find canopy, sub-canopy, understory, and shrub species within it. Each group grows at a different speed and therefore stores carbon at a different rate.

In total, the Tiny Forests studied (x17) have ~290kg of Carbon stored in them over the first growing season. Establishing this baseline value for the carbon stored at young Tiny Forests is a basic requirement for future calculation of the amount of carbon they can capture each year.

The results show that the understory layer of the Tiny Forests is storing more carbon on average (these individuals were the biggest on average). The diagram below shows the results for the main characteristics of the size of Tiny Forests trees and carbon stored at each layer.



Carbon stored by Tiny Forest to date (values for each parameter are an average of the data coming from all the Tiny Forests). Tiny Forests are composed of layers: Canopy, sub-canopy, understory and shrubs.
Carbon storage was calculated by estimating the average dry weight of monitored trees, assuming that there was no difference between species. The final calculation was the extrapolation from this subset of individuals per species.



This figure shows the relative average C stored per species (number studied in brackets) and forest layer across all Tiny Forests planted. Four species, Black poplar, Grey willow, Gorse and Wayfaring tree omitted from graph as only two individuals were sampled in each case.

As most of our Tiny Forests were planted less than a year ago, the results represent how much carbon is stored at this early stage including while they were growing at the tree nursery.

We expect the capacity to capture carbon to increase quickly for at least the first 5 years.

We can also already see differences in growth amongst the different trees layers of Tiny Forests, just like a natural woodland does!

Biodiversity

We are running biodiversity surveys to evaluate the abundance and diversity of invertebrates visiting our Tiny Forests. We are focusing on pollinators and ground-dwelling invertebrates as a fundamental component of forest food chains and representing a variety of functions of woodland ecosystems.

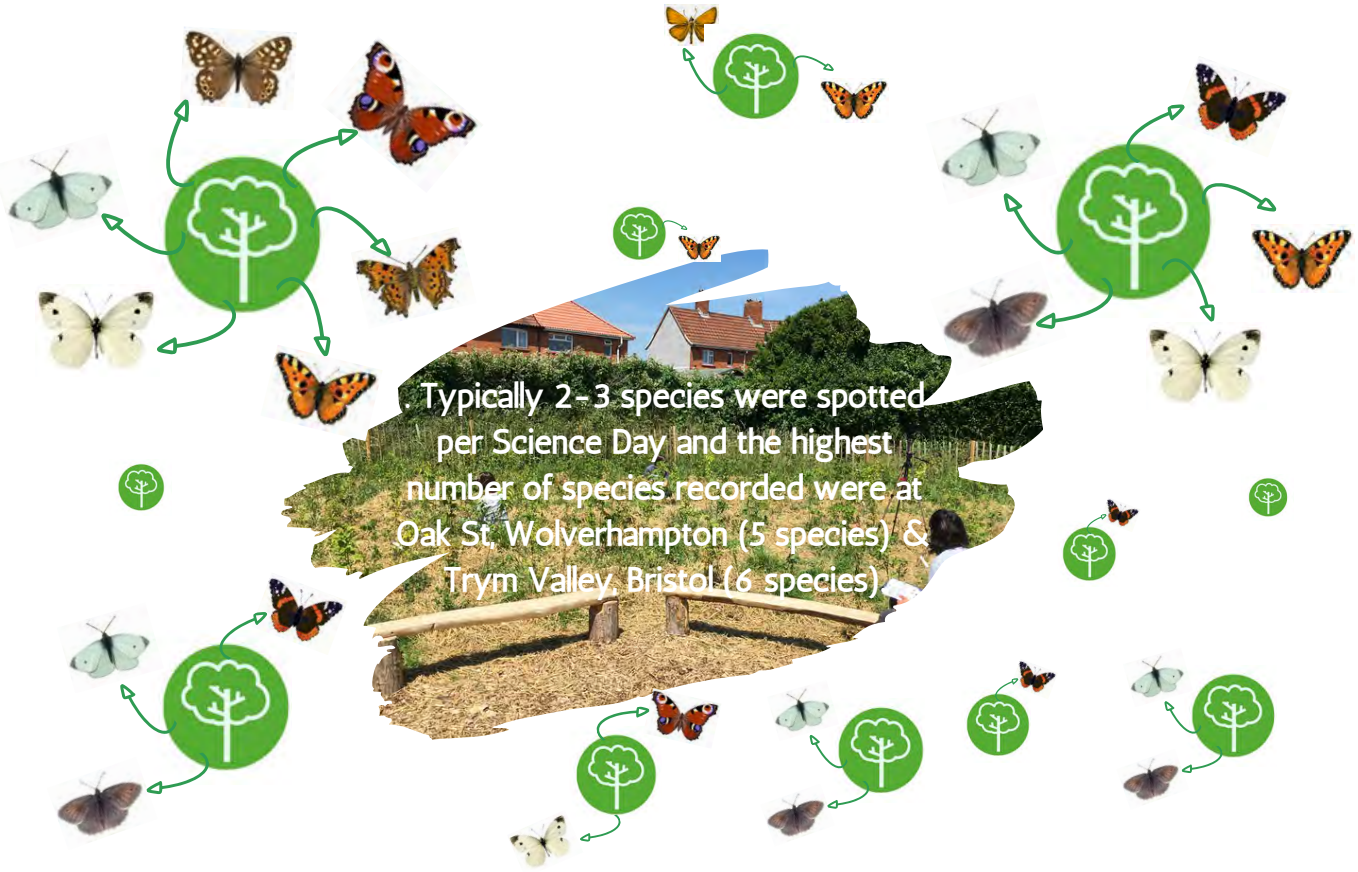
Citizen scientists undertaking a butterfly count survey (Credit: Megan Evans)

Butterflies:

Butterflies are important pollinators and indicators of environmental health. Their activity is highly dependent on the weather and time of year. Surveys were only conducted when conditions were suitable (dry, sunny, and low wind).

Species recorded are shown in the table below:

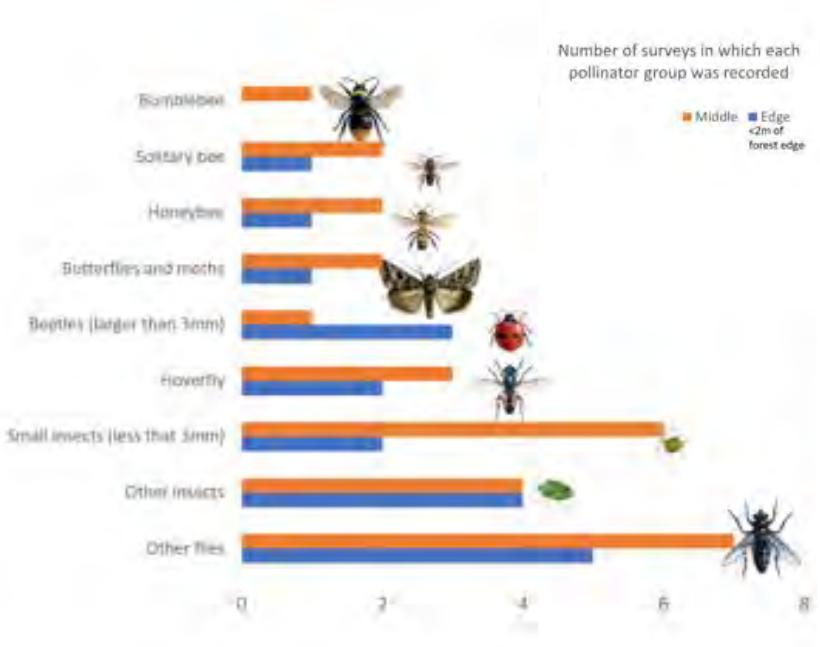
	Species	Scientific Name	Number of Tiny Forests
	Small White	*Pieris rapae*	6
	Red Admiral	*Vanessa atalanta*	4
	Meadow Brown	*Maniola jurtina*	4
	Small Tortoiseshell	*Aglais urticae*	4
	Large White	*Pieris brassicae*	3
	Peacock	*Aglais io*	2
	Speckled Wood	*Pararge aegeria*	1
	Comma	*Polygonia c-album*	1
	Skipper species		1



All species recorded are relatively common and widespread species in the UK found in a range of habitats including urban gardens and parks. Some species such as Comma and Speckled wood butterflies are found associated with woodlands and wilder habitats in our urban greenspaces. Small Tortoiseshell are declining in the UK so wild areas like a Tiny Forest will provide them with an important habitat.

Pollinators

Everyone was surprised to see how many pollinators were already visiting the young Tiny Forests. Nine types of different pollinators were spotted at the monitored Tiny Forests.



As with butterflies, pollinating insects are most active in warm and dry weather. Pollinator timed counts were carried out in suitable conditions at six Tiny Forest Science Days in June, July and September 2021. In total 16 surveys were completed with the majority being done in three Tiny Forests (East Lancing (4), Trym Valley, Bristol (5) & Tychwood, Witney (4)).

Multiple surveys from the same location add extra value to the data as the overall results become more representative of pollinator groups present in the Tiny Forest.

Flies and small insects were recorded in the highest number of surveys but despite low numbers of flowers in the young Tiny Forests this year larger insects including bumblebees, hoverflies and solitary bees were also spotted.

From these initial surveys, the pollinators recorded did not show preference for the middle or edge of the Tiny Forest except for small insects which appeared in higher numbers in the middle of the forest while beetles were found to be more abundant at the edges. This is not surprising as the structure of the forest is quite uniform in the first year.

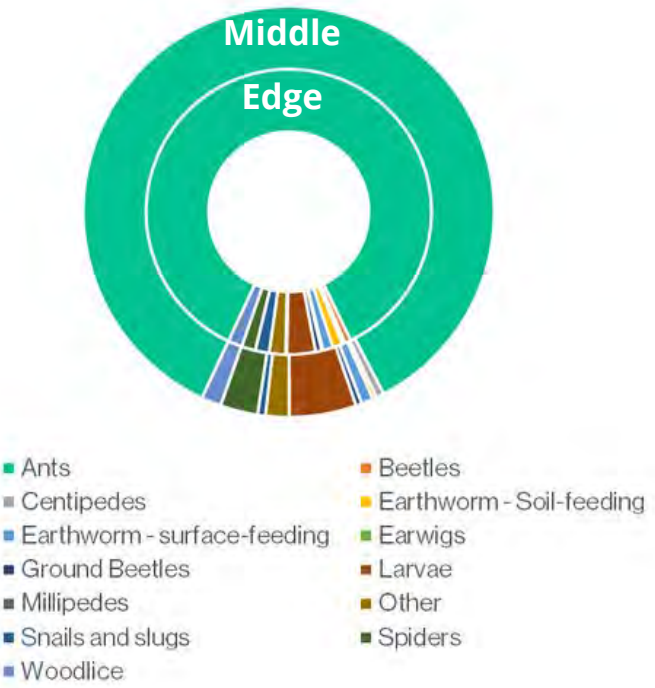
As the forest develops and the layers become more complex we expect to see differences in the species preferring different niches and tree species in the forest.

Ground dwellers

Nine different groups of ground dwellers, plus "other" non-identified invertebrates were found underneath the biodiversity tiles (see pie chart right). The most abundant groups were ants and beetles, while the most commonly found groups across all Tiny Forests were ants, earthworms, woodlice, and larvae.

Silvera,, member from Hammersmith and Fulham council, finds slug eggs under a tille

Pupils enjoyed seeing evidence of ants - ant trails and eggs



Pie chart representing the abundance of ground dwellers found under at the tiles of the middle and edge of the Tiny Forests

Many ground dwelling invertebrates perform important functions in recycling - helping break down dead wood and leaves, others are miniature predators. Soil invertebrates are one of the least studied so monitoring how these species groups change in number and diversity over time will indicate how Tiny Forests develop compared to established woodlands.

Flood management

Flooding is a common cause of concern, especially in urban environments, where impermeable surfaces cause problems from runoff. Nature-based solutions (like Tiny Forest) are increasingly being recognised as a sustainable way to combat flooding.

Below we explain and show the main methods used for assessing flood management and what we have found so far.

Infiltration

How quickly water goes through the soil has a direct impact on how much water accumulates on the surface. The capacity of soil to absorb water was determined by measuring how long a known volume of water takes to infiltrate within a pipe. The faster the water infiltrates, the less prone to flooding that soil is.

Infiltration set up: PVC ring located outside the Tiny Frest, ready for measuring

A total of 71 samples were collected for infiltration amongst all the studied Tiny Forests.
A total of 52 samples came from inside the Tiny Forests and 19 control samples from outside the Tiny Forests.
On average it was found that the water infiltrated quicker inside the Tiny Forest than outside (see below).

Average time for the water to infiltrate into the soil outside and inside the Tiny Forest

Results of the infiltration measurements

These preliminary results suggest that there is faster infiltration inside the Tiny Forest compared to soils outside which have not been modified. Results represent the differences in the soil characteristics, obtained thanks to the soil preparation protocol for Tiny Forests.

Soil moisture

Soil moisture is a direct factor of how well the soil can infiltrate and store water. The wetter the soil, the less capacity it has to infiltrate water. Soil moisture inside and outside the forest was categorized with a: "0" if dry, "1" if wet, "2" if there were puddles, and with a "3" if there was runoff at the same locations where infiltration was measured.

A total of 71 surveys were completed for estimating soil moisture. Soil moisture was most commonly found to be "wet" (61%), with 34% samples found to be dry and 3% flooded soil. There was a very small difference in the moisture found between the inside and outside of the forest (see table on the right)

Tiny Forest	Outside
0.7	0.6

Average moisture score of samples inside and outside the Tiny Forest

The weather has a large influence on soil moisture, which can vary between monitoring dates. Nevertheless, the results suggest that the differences seen in infiltration between inside and outside the Tiny Forests may be more influenced by soil properties, such as compaction, than how wet the soil was during data collection. See the next section to understand why.

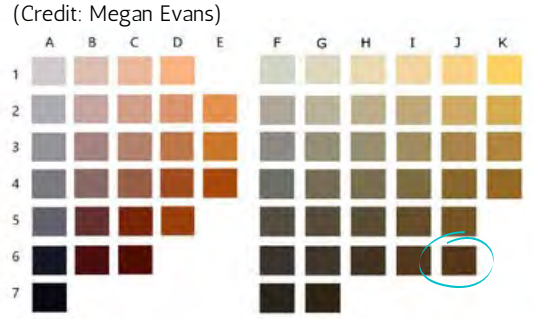
Soil colour and texture

Colour and texture are key properties of the soil. Colour indicates how much organic carbon is stored in the soil, which influences how permeable it is. Texture, on the other hand, indicates the size of the grains that make up the soil, where the larger the particle size, the more permeable it is. Both soil colour and texture are tested by manipulating the soil by hand.

A total of 86 samples of soil were studied for colour and texture from all the studied Tiny Forests. The most common soil colour found amongst them all was **J6** (see soil colour chart to the right-hand side).

The soil texture descriptions from 60 samples revealed that the soils inside the Tiny Forest were mostly predominated by clay (30%), silt (38%), and sand (27%) while the soils sampled as controls outside the Tiny Forest were predominated by loam (47%) (15 samples).

Pupils study soil texture at the Tiny Forest in Jersey (Credit: Megan Evans)



Soil colour chart. The darker the more organic the soil is.

Sandy soil

Silt soil

Clay soil

Loamy soil

Soil grain sizes, were sandy is the largest (0.05-2mm), followed by silt (0.002-0.05mm), and then clay (<0.002mm). Loam is a combination of clay (20%) with silt (80%) and sand (50%).

Note: all the soils studied have a combination of sand, clay, silt and loam, which have different grain sizes and give key properties to the soil. The diagram to the left illustrates soil grain sizes.

The results here are the baseline for our Tiny Forests. They show that their soils have a varied range of grain sizes, facilitating drainage and that their texture is in general different from the soil outside the forests following the soil preparation as part of the Tiny Forest planting protocol. We also found that soil is relatively dark inside the forest, suggesting rich organic content. We expect these properties to change and improve as the forests grow, towards better texture which will facilitate infiltration while becoming more organic as leaves fall from the trees and decompose.

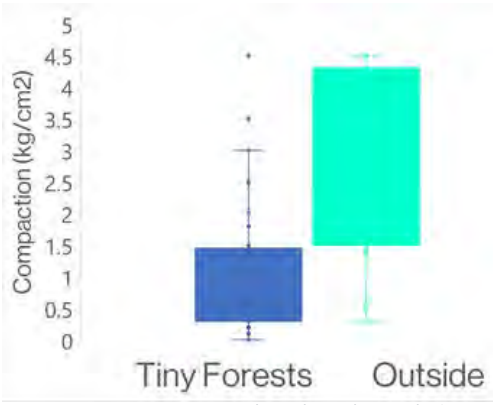
Soil compaction

A pupil reads soil compaction on the penetrometer from the Tiny Forest at Swindon. (Credit: Macarena L. Cárdenas)

Soil compaction determines how easily young trees can root, and how easily water can infiltrate through the soil and therefore prevent flooding.

Soil compaction was measured inside and outside the Tiny Forests using a pocket penetrometer, an instrument designed to determine how hard or compacted the soil is.

Overall, the soil within the Tiny Forests showed low compaction, while the compaction outside the Tiny Forest was more than twice as high (see graph to the right-hand side).



Compaction measured inside and outside (control) the Tiny Forests.

These preliminary results demonstrate the benefits of the method used for Tiny Forest planting, where the soil is prepared so the compaction is decreased to improve tree rooting and water infiltration.

Thermal Comfort

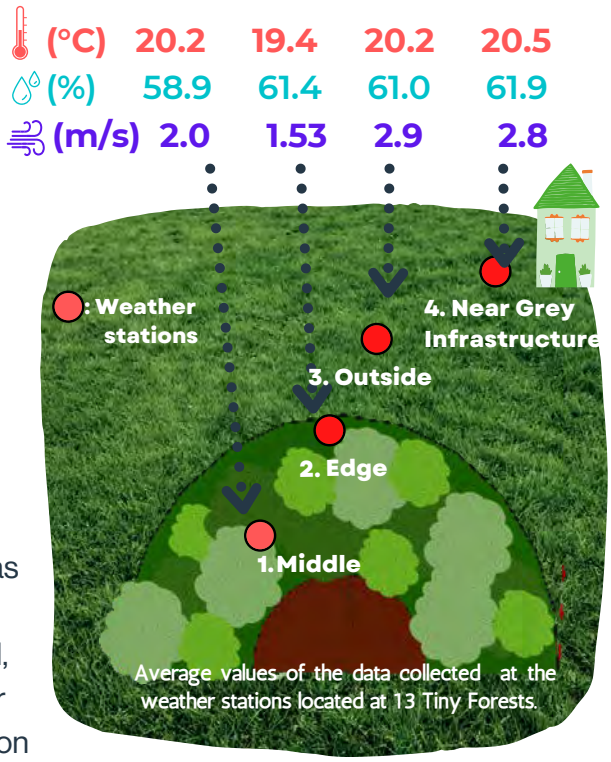
The term 'thermal comfort' describes a person's state of mind in terms of whether they feel too hot or too cold. Environmental factors, such as humidity and sources of heat, combined with personal factors (i.e. your clothing) and physical activity you may be doing, influence your 'thermal comfort'. We measured both empirical data for temperature, humidity, and wind speed, as well as how the weather was perceived by the citizen scientists, to describe thermal comfort inside and outside the Tiny Forests.

Weather station readings

A total of 13 Tiny Forests were studied for thermal comfort from where 247 data points of live data on temperature, humidity, and wind speed were collected from weather stations. Weather stations were located at the middle, edge, outside and near grey infrastructure (if available) (see diagram below).

The temperatures found at the time of data collection were an average of 20 degrees Celsius, wind speed of around 2 m/s, and humidity between 59 and 62 % (just like the average weather across most of the UK in June and July 2021!)

While temperature did not show large differences amongst the four locations of the weather stations, wind speed and humidity showed some difference, with the lowest values in the middle and edge of the forests.



Personal preference

Perception of the weather was collected at the same time as the weather at each station. People's perceptions of the weather varied within and outside the Tiny Forests. Overall, the results show that people preferred to have much cooler weather when they were outside the Tiny Forest (see Station #3 and 4 in the Table below).

A family does some thermal comfort readings at a near grey infrastructure weather station in the Tiny Forest in Witney (Credit: Macarena L. Cardenas)

	Weather Stations	1	2	3	4
People's preferences (*I'd rather be...*")	much warmer	30.77%	17.95%	28.21%	23.08%
	a bit warmer	28.83%	30.63%	22.52%	18.02%
	no change	30.19%	28.30%	24.53%	16.98%
	a bit cooler	44.12%	23.53%	17.65%	14.71%
	much cooler	25.0%	2.50%	37.50%	25.0%

People's perceptions of the weather varied at the different positions when they were inside the forests: average preference showed that some people preferred a bit cooler in the middle (Station #1) and others a bit warmer when on the edge (Station #2).

An interesting preliminary result is that while young Tiny Forests do not make a big difference in temperature, it seems to for wind speed. This is a key factor in thermal comfort that tends to make temperature sensation much higher.

YOUR FEEDBACK

"We loved the monitoring day!"
- Jess, Fever-Tree employee

"The Tiny Forest is so beautiful and I've learned so many new things today"
- Student, East Wichel Primary

"Many thanks for coming again. This is the third time I come (I have been in the planting and the two Science days), and I always enjoy it!"
- Cameron, Teacher

"The community monitoring day was ACE!!"
- Liane Holdsworth, Barnsley Council

BETTER UNDERSTADING OF TINY FORESTS

Thank you for coming to collect data with us! We are pleased to see that everyone is enjoying monitoring their Tiny Forests.

This report shows just the first insights of Tiny Forests. As we collect more and more data, these results will become clearer.

You can play an even bigger role as a volunteer in contributing to the scientific understanding of your Tiny Forest. The online surveys on the Tiny Forest portal make it easy to monitor them. Here are some ideas:

- Go with your family or friends to survey pollinators or butterflies in your Tiny Forest. It only takes 10-15 minutes.
- Ask your teacher to spend some time at your local Tiny Forest to collect ground dweller data.
- Organise a one or two-hour event on the weekend with your friends or community to measure the height and diameter of the trees to understand carbon capture.
- Email us at tinyforest@earthwatch.org.uk if you would like support in collecting data at your forest or if you are interested in becoming a Tree Keeper of your Tiny Forest.

Thank you for supporting Tiny Forest research!

WHAT HAPPENS NEXT?

Super tiny,
Super powerful

for more information visit
tinyforest.earthwatch.org.uk

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