BEES & HEATWAVES

2025

A GUIDE TO SUPPORT BEES IN A WARMING WORLD

INTRODUCTION

Almost 90% of wild flowering plants across the globe rely, at least in part, on animals to move pollen between flowers. These plants are vital for healthy ecosystems: they provide food, shelter, and essential resources for countless other species.

Pollinators are also key to our food supply. Over 75% of the world's main food crops depend on animal pollination to produce good yields and high-quality fruit. In fact, pollinator-dependent crops make up about 35% of global crop production by volume, showing just how important these animals are for humans too.

Beyond food and ecosystem health, pollinators enrich our lives in other meaningful ways. By supporting the growth of wild plants, they help shape the natural landscapes we value. These environments don't just support biodiversity; they also inspire art, music, literature, religion, and even technological innovation. In this way, pollinators make a profound contribution to human wellbeing and culture, far beyond their ecological roles.

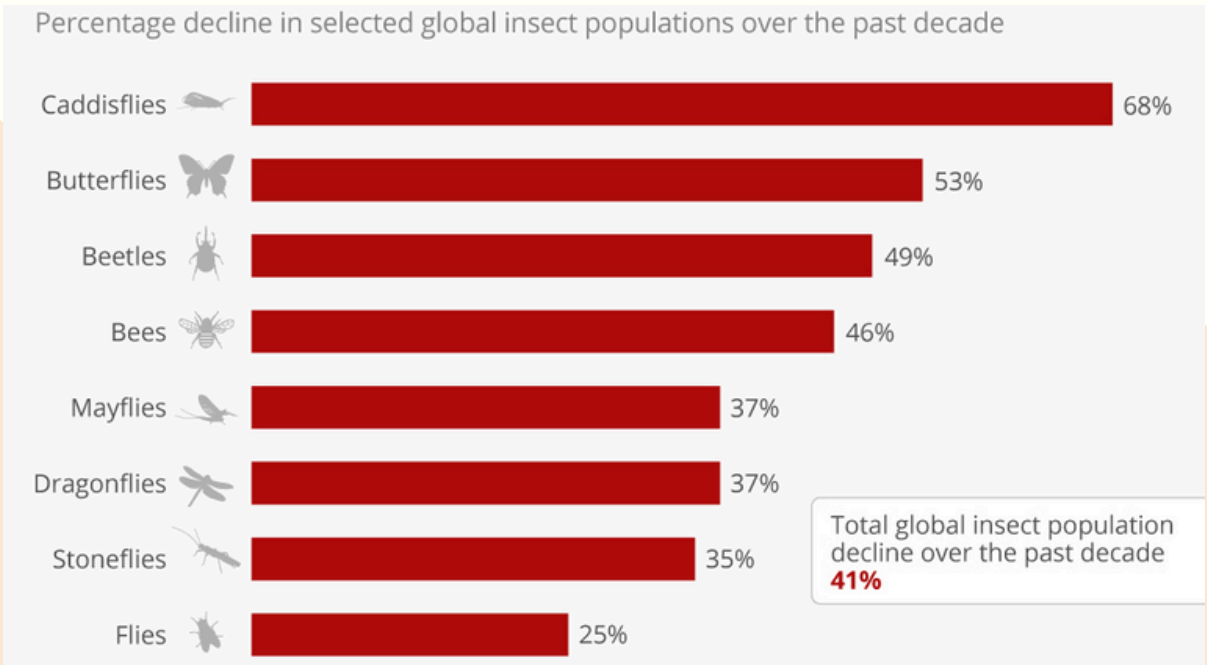
Common carder bee (*Bombus pascuorum*) on *Calibrachoa*. © Sam James.

Pollinators include a wide variety of animals, including insects, bats, birds, primates, marsupials, rodents, and reptiles. However, the vast majority of pollinators are **insects**. These include bees, flies, butterflies, moths, wasps, beetles, and thrips, all of which play a vital role in the pollination of many important crops such as apples, cacao, avocados, beans, peppers, tomatoes, and berries.

Among these, bees stand out as the most effective pollinators. They are especially well adapted for transferring pollen, making them essential for the reproduction of many wild plants and for the productivity of a wide range of crops around the world.

CLIMATE CHANGE AND POLLINATORS

Climate change is one of the biggest challenges of our time. It's not just about the planet getting warmer over the years, but also about the increase in extreme weather events, like heatwaves, which are becoming more frequent, intense, and longer-lasting. These rapid shifts in temperature can be especially tough on insects. Insects are highly sensitive to temperature, and many of them, like bees, play a crucial role in keeping ecosystems healthy and food growing.



Percentage decline in selected global insect populations over the past decade, based on data from Sánchez-Bayo & Wyckhuys (2019). Image source: Statista.

Heatwaves, defined as short periods of unusually high temperatures, can be more dangerous to insects than slow, steady warming. That's because they strike fast and hard, giving little time for animals to adjust. For bees, this kind of stress can affect both their behaviour and survival.

To cope, many insects reduce their activity. Bees may stop foraging during the hottest parts of the day, which means they bring back less food to the colony. This can slow down growth, affect their young, and even impact the survival of the entire nest. Over time, these behavioural shifts can also reduce pollination, putting plants and food production at risk. But not all species can respond the same way; some are more vulnerable than others.

That's why understanding how different bees behave during heatwaves is so important. And that's what **Bees & Heatwaves** was created to explore.

THE **BEES & HEATWAVES** PROJECT

We launched **Bees & Heatwaves** to understand how bees respond to real heatwaves and which plants they visit during hot weather. Most research requires artificial heat to simulate heatwave conditions, as natural heatwaves are harder to study – but that's where the efforts of citizen scientists come in.

Looking Back: What We Did and Why

Before moving on to the plant guide, here's a quick reminder of what **Bees & Heatwaves** is all about.

Together, we set out to understand how bees respond to hot weather and which plants help them cope. With climate change making heatwaves more frequent and intense, this kind of information is more important than ever to help protect bees and the ecosystems they support.

Honey bee on water hyssop (*Bacopa*). © Sam James

In **2023**, we asked participants to observe bee activity before, during, and after a heatwave. In **2024**, we shifted to weekly observations, so we could track patterns across a range of temperatures – not just the extremes. In both years, participants helped us learn if bee activity changes during hot weather, how many bees they observe visiting their flower patch at different temperatures during the day, and which plants they turn to for food and shelter.

And thanks to these amazing contributions, we now have created a practical guide to help support pollinators and build climate-resilient green spaces.

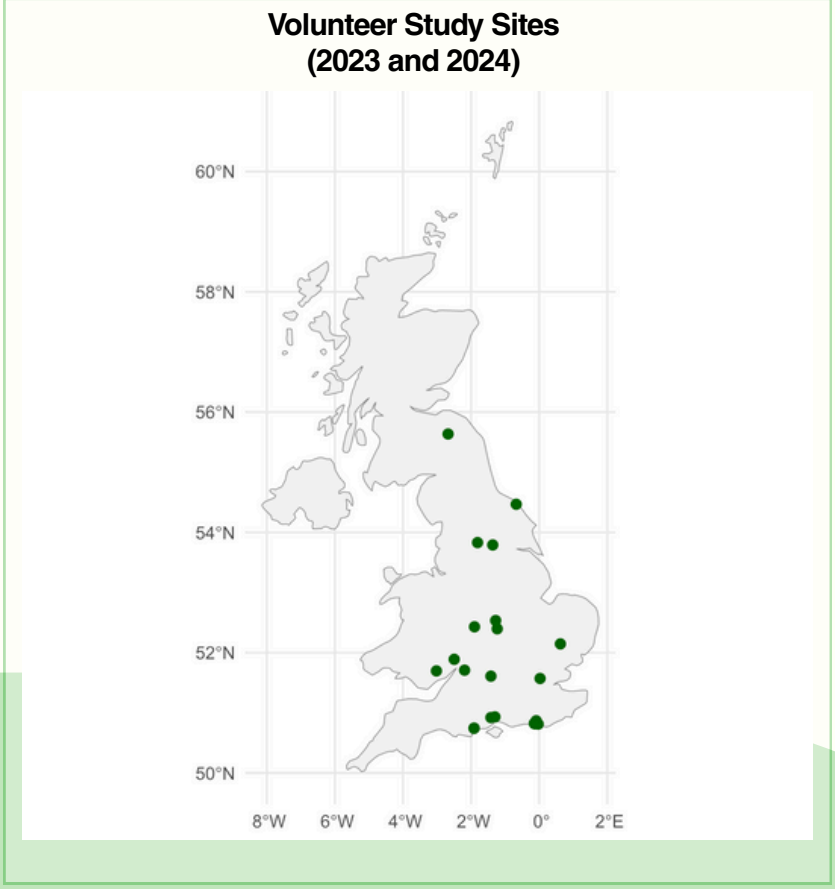
PLANT GUIDE

SUPPORTING BEES DURING HOT WEATHER

As temperatures rise, pollinators like bees face increasing challenges finding food and staying cool. Some flowering plants not only provide essential nectar and pollen, but also tolerate hot conditions, offering critical support during heatwaves. This section highlights bee-attractive plants that perform well in warm weather, helping to choose the best options to support pollinators when they need it most.

To create this guide, we grouped plants by genus, as not all participants were able to record the full species name. This still allows us to highlight the main plant groups most frequently visited by bees during hot weather. For each plant, we've included information such as which types of bees (bumblebees, honey bees, and/or solitary bees) visited most often and the temperature range in which those visits occurred. While this guide focuses on plants that support bees during high temperatures, we also collected valuable data on cooler conditions, which we look forward to sharing soon.

The data behind this guide come from over 2,500 observations recorded across the UK. The study sites include locations such as Southampton, Whitby, Hedge End, Earlston, Poole, Rugby, Brighton, Leicester Forest East, Wantage, Stroud, Leytonstone, Ross-on-Wye, Shipley, Bury St Edmunds, Garforth, Pontypool (Wales), and Birmingham.



> 2,500
observations of bees

> 25
study sites

PLANT GUIDE

SUPPORTING BEES DURING HOT WEATHER

Abelia is a hardy, heat-tolerant shrub that provides valuable floral resources for bees. Its long blooming period, often extending from late spring through autumn, offers a consistent source of nectar and pollen. The small, tubular flowers are particularly attractive to a variety of pollinators, including honeybees and bumblebees, making it a reliable food source during heatwaves when foraging options can become limited.

***Abelia* x *grandiflora* (Glossy Abelia)** produces nectar- and pollen-rich flowers that are highly attractive to bees.

Borage provides an abundant amount of nectar and pollen. It thrives in full sun and well-drained soil, making it an excellent choice for garden spaces looking to support pollinators.

Its long flowering season also provides a reliable food source during warmer months, helping to support bees during times of peak activity.

Dahlias are among the top flowers visited by bees in our observations, making them an excellent choice for pollinator-friendly gardens. Many dahlias, especially open-flowered types, provide abundant nectar and pollen throughout the summer and into autumn. Their long-lasting blooms offer resources during periods of hot weather.

Open-flowered dahlias, such as **'Bishop of York'**, **'Bishop's Children'**, and '**Bishop of Auckland'**, are great options to attract bees and other pollinators.

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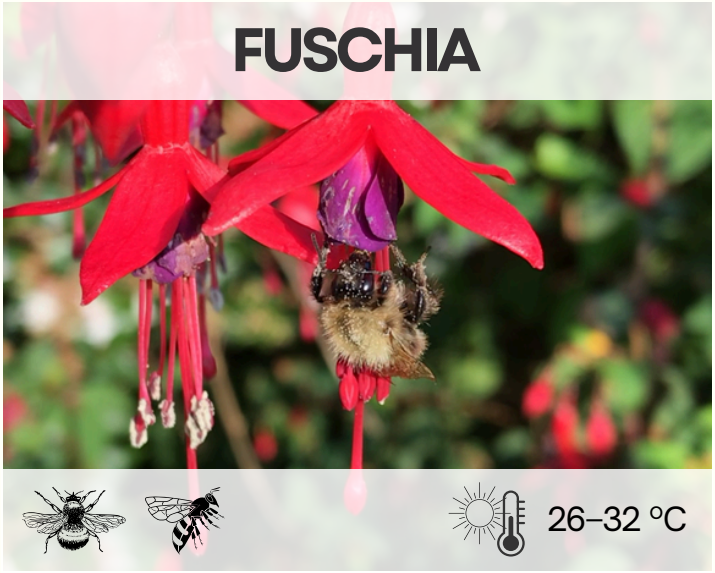
Globe thistle (*Echinops*) is a highly attractive plant for bees, with our results showing frequent visits even during hot weather. Its spherical, spiky blue or purple flower heads are rich in nectar and bloom in mid to late summer – just when many other flowers start to fade. Drought-tolerant and low-maintenance, globe thistle is an excellent choice for supporting pollinators in high-temperature conditions.

***Echinops ritro* (Veitch's Blue)** is an easily grown perennial that is loved by many pollinators, including bees and butterflies!

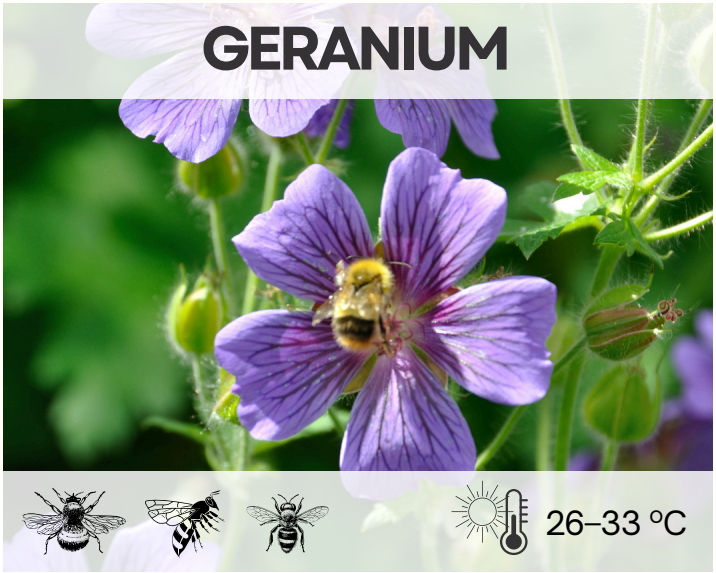
Fuchsia is a popular garden plant that can also support bees, especially in cooler, shaded spots during hot weather. Fuchsias can bloom from summer into autumn, helping to extend the availability of floral resources when other plants may have finished flowering.

Fuchsia '**Lady Boothby**' and '**Mrs Popple**' have single flowers that bloom throughout summer, offering vibrant colour and valuable nectar for pollinators in gardens. Both RHS Award of Garden Merit winners!



Geraniums are a popular choice for pollinator-friendly gardens, offering easy access to nectar with their open flowers. They provide a steady food source during warmer months. As perennials, they thrive in sunny or partially shaded spots, making them a great choice for adding colour while supporting pollinators.

***Geranium pratense* 'Mrs Kendall Clark' (Meadow Cranesbill)** and ***Geranium sanguineum* (Bloody Cranesbill)** are excellent choices for attracting bees and other insect pollinators.



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SUPPORTING BEES DURING HOT WEATHER

Hibiscus is a striking plant with large, open flowers that can support bees, especially in warm weather. While not all varieties are equally attractive, bees often visit hibiscus primarily for its abundant pollen rather than nectar. Most garden hibiscus species are perennials –like hardy hibiscus, which returns each year– but tropical varieties are often grown as annuals in cooler climates.

Hibiscus syriacus **(Rose of Sharon)** and ***Hibiscus moscheutos*** **(Hardy Hibiscus)** provide valuable nectar and plenty of pollen for bees and other pollinators during hot weather.

HIBISCUS

26–27 °C

Lavender is a classic pollinator-friendly plant, and in our observations, it attracted a high number of bumblebee and honey bee visits, especially during hot, dry conditions. Its small, tubular flowers are rich in nectar and bloom over a long period in summer, making it a reliable food source.

Lavandula angustifolia **(English Lavender)** is particularly well-suited to pollinators. Cultivars such as **'Hidcote'** and **'Munstead'** are excellent choices for gardens, offering long flowering periods and strong nectar rewards.

LAVENDER (*Lavandula*)

27–31 °C

Scabious is a bee magnet! Its open, nectar-rich flowers make it easy for bees to access food, even in high temperatures. Scabious blooms over a long period –from early summer into autumn– and is especially valuable during heatwaves. Depending on the variety, it can be an annual or a perennial, and it thrives in sunny spots with well-drained soil.

Scabiosa atropurpurea **(Sweet Scabious)** is an excellent choice to support bees and other pollinators such as butterflies and hoverflies, thanks to its nectar-rich, long-lasting summer blooms.

SCABIOUS (*Scabiosa*)

26–31 °C

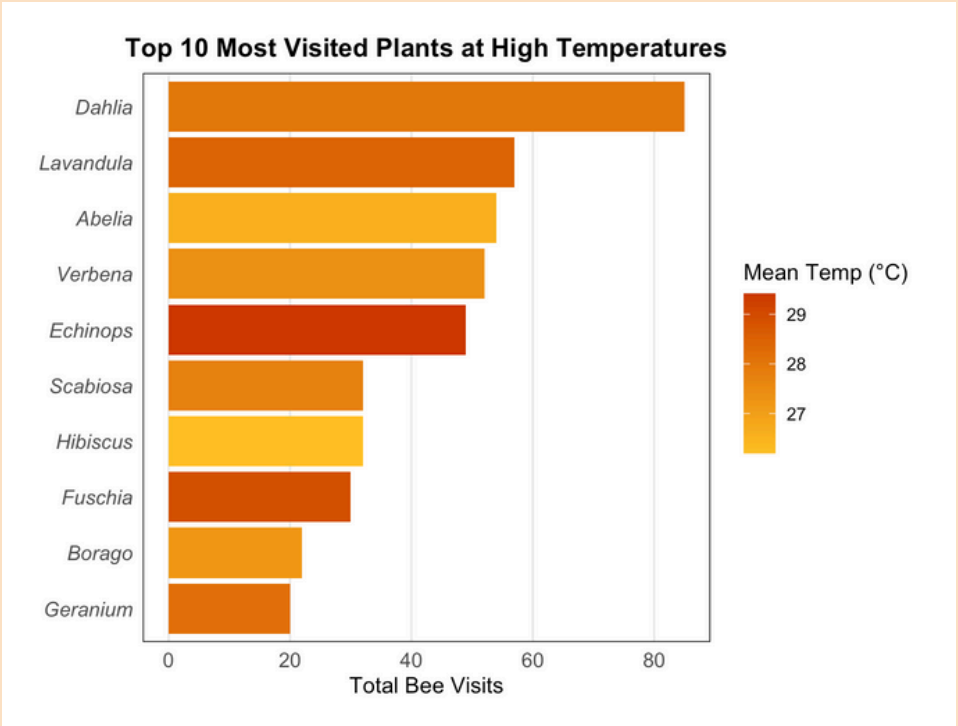
PLANT GUIDE

SUPPORTING BEES DURING HOT WEATHER

Verbena is a great nectar provider for bees, especially during long, dry summers. Its tall stems and clusters of small purple flowers make it easy for bees to access, and it keeps blooming well into autumn. It thrives in sunny, open spots and, while technically a short-lived perennial, it's often grown as an annual in cooler climates. Even a few plants can draw in loads of pollinators!

Verbena bonariensis **(Purple Top Vervain)** and ***Verbena officinalis*** **(Common Vervain)** are loved by pollinators!

These plants provide valuable nectar and pollen resources, supporting a diverse range of bee species, including bumblebees, honeybees, and solitary bees. By incorporating these bee-friendly plants, we hope people can create a thriving environment for pollinators, especially during warmer months when food sources are crucial. The following figure highlights the top 10 plants that are most visited by bees in our observations.



Top 10 plant species visited by bees during high-temperature periods. Bars represent the total number of bee visits recorded per plant species, with colors indicating the average temperature (°C) at which visits occurred. Plants are ordered by total bee visits, with the most visited at the top. This information can help identify key floral resources that support pollinators under heat stress conditions.

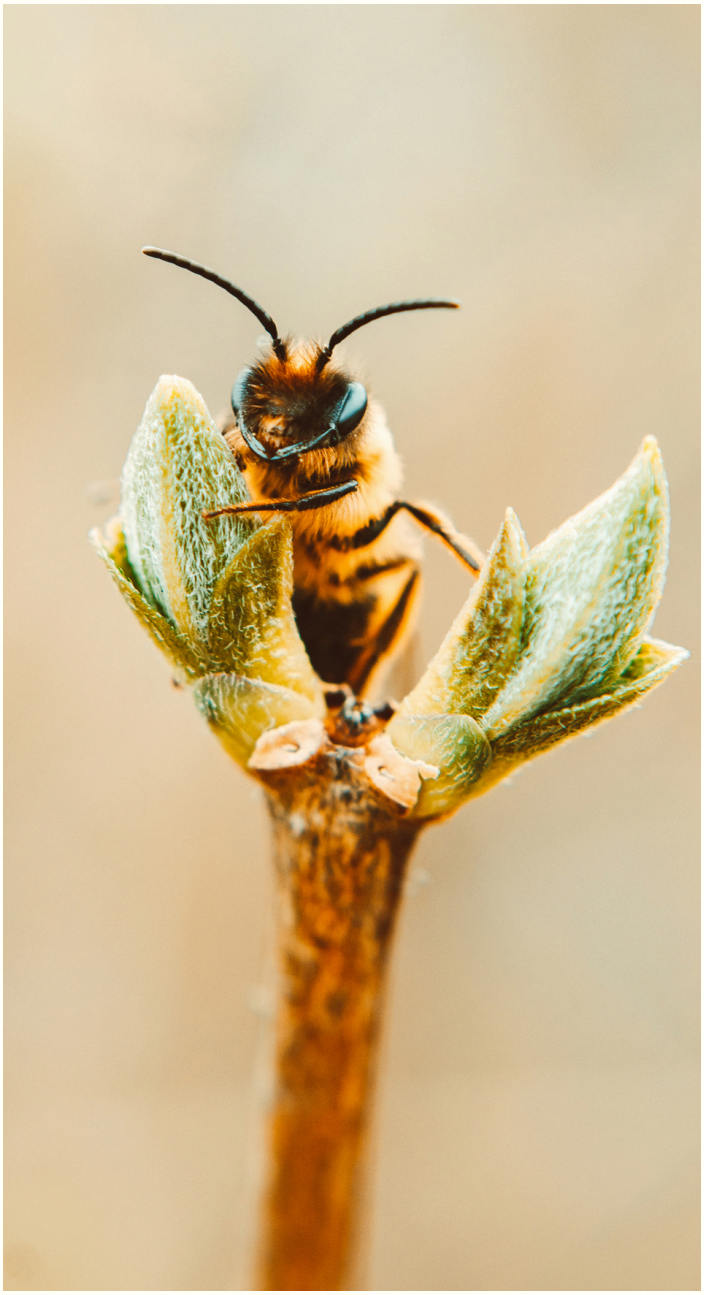
Bumblebees Honeybees Solitary bees

CONCLUSIONS AND FUTURE **RESEARCH**

The Bees & Heatwaves project was created to understand how bees respond to natural heatwaves, and just as importantly, which plants continue to support them during hot weather. While many scientific studies take place in controlled lab settings, this project captured the behaviour of bees in natural conditions thanks to the help of citizen scientists across the UK.

Our findings revealed that some plants were consistently visited by bumblebees, honey bees, and solitary bees, even during the hottest parts of the day and during heatwaves. These plants play a crucial role in supporting pollinators when they need resources to cope with the stress of unsuitable environmental conditions. Identifying these plant species is essential to help support pollinators as summers grow hotter.

This guide brings together the most frequently visited and reliable plant species observed during the project, so you can make informed choices when planning your garden, balcony, allotment, or community space. Whether working with a large plot or a window box, choosing the right plants can make a real difference.



Going forward, through the Bees & Heatwaves project, we will continue to collect data to build a better understanding of how plant-pollinator interactions change during extreme weather. With ongoing support from volunteers, we hope to expand our plant list, identify any changes in bee behaviour during extreme weather events, track long-term patterns, and empower more people to create pollinator-friendly spaces.

We’re incredibly grateful to everyone who joined the project and we hope you'll take part again next year! In the meantime, feel free to share this guide with others who care about pollinators and want to make their gardens more resilient.

IN THE **SPOTLIGHT**

Bombus Review - Spring 2025

Your latest issue of *Bombus Review* is here! As the days grow longer and nature bursts into bloom, it's the perfect time to step outside, enjoy the buzz of the season, and catch up on the latest in bumblebee research.

Bombus Review remains dedicated to making research work for conservation by bringing the scientific evidence to people who make a difference.

This edition features a wonderful line-up of researchers sharing the insights they have learned:

- Can plucking bumblebee hair samples provide a less invasive alternative for DNA sampling?
- Is bee knowledge a barrier to urban bumblebee conservation?
- Can our gardens provide vital refuges for farmland bumblebees?
- In an ever changing climate, how do bees respond to heatwaves?

Bees and heatwaves: investigating bees' responses to heatwaves using citizen science

Sepúlveda, Y. (2024) PhD thesis: *Pollinators in a warming world: the impact of heatwaves on the physiology and behaviour of bees* *Open access*

Provided by Dr Yanet Sepúlveda (University of Sussex)

Summary
Extreme temperatures, even for short periods, can have direct negative effects on insects, including bees. Some species adjust their behaviour in response, such as shifting their foraging activity to cooler times of the day. While this might seem beneficial, these changes can disrupt pollination services and, in turn, affect entire ecosystems. To investigate this, we launched *Bees & Heatwaves*, part of The Buzz Club citizen science project. In 2023 and 2024, volunteers across the UK recorded local bee activity at different times of the day and before, during, and after a heatwave.

Participants observed a 2m square flower patch during morning, afternoon and evening hours, once per week from June to August. We used the UK Met Office definition of a heatwave: a period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold. The threshold varies by area of the UK and may be 25, 26, 27 or 28ºC. Participants recorded the total number of bees observed during a five-minute interval, together with the time, temperature (ºC) and type of bee observed. Participants also recorded plant species – including those highly visited at temperatures of 21-32ºC – and bee behaviour, selecting from: collecting pollen, feeding on nectar, flying, or resting.

Figure 1. Common carder bumblebee *(Bombus pascuorum)* on *Agastache*. © Sam James

A cooler than average summer in 2024 meant that only one participant was able to record data during heatwave conditions that year. However, data from 2023 (16 study sites, comprising 15 across England and one in the Scottish Borders) revealed a clear pattern: temperature (ranging from 11 to 32°C) had a significant, non-linear effect on bee activity at the sites surveyed. Initially, the number of bees observed by participants increased with rising temperatures, but as the ambient temperature (recorded at the time of observation) climbed beyond 21.5°C, the number declined. This pattern was consistent across honeybees, bumblebees and solitary bees. This could be because bees, especially bumblebees, may reduce or cease flight to avoid overheating, as their body temperature can exceed air temperature and can approach their thermal limits during flight.

Interestingly, the data showed that more bees were observed in the afternoon (13:00-15:00) than in the morning (7:00-9:00) or evening (18:00-20:00). However, since recorded temperatures peaked at only 32°C, it remains unclear whether bees would shift their foraging times more under more extreme heat conditions. Some of the data is still under analysis, with further insights expected to be made available soon.

Interestingly, during the heatwave, there was a slight increase in bee activity in the evening compared to both the morning and afternoon. While this difference wasn't statistically significant, it is possible that bees were adjusting their activity patterns in response to the higher temperatures. This observation provides a glimpse into how bees could potentially shift their behaviour during extreme heat, but more data would be needed to confirm this trend.

The data collected prior to, during and after the 2023 heatwave revealed a significant drop in the bee numbers observed during and after the event. However, the highest temperatures occurred in early September, coinciding with the natural seasonal decline of several bumblebee and solitary bee species. This raises an important question: was the drop in bee numbers due to heat stress, or was it simply the end of their life cycle? These uncertainties highlight the need for long-term citizen science projects to better understand how extreme heat events affect pollinator populations.

The study also identified plant species that were highly visited at higher temperatures (21-32°C), using data collected in 2023 and 2024 from a total of 28 study sites across England, Scottish Borders and south-east Wales. These included *Abelia*, *Dahlia*, *Lavandula* (lavender), and *Echinops* (globe thistle). Understanding which plants provide resources under heat stress, and tolerate other impacts of global warming (such as waterlogged soils in winter), can help guide conservation efforts and urban planting strategies.

Author's conclusions from a bumblebee conservation perspective
Understanding how bumblebees respond to extreme heat is crucial for their conservation, especially as climate change increases the frequency and intensity of heatwaves. Identifying climate-resilient plant species provides an opportunity to support bees by ensuring they have access to floral resources even in extreme conditions. However, long-term monitoring is needed to distinguish between natural seasonal declines and heat-related impacts. Citizen science plays a vital role in filling these knowledge gaps and empowering communities to take action – whether by creating bee-friendly habitats or contributing valuable data for future research. The results of this research will be made available as a guide to help the general public create resilient gardens that support pollinators under extreme temperatures.

Bumblebee Conservation Trust thoughts
Over the past decade the Trust has grown increasingly concerned about the effects of hot weather on bumblebees, particularly in southern England. It's hugely useful to see this kind of detailed breakdown of bumblebee behaviour during heatwaves and we'll use this to influence our own conservation work.

The author here comments on the value of long-term citizen-science recording schemes for gathering this kind of data – of course this is something that the Trust also does, via our BeeWalk monitoring scheme. The effect of weather – both hot and cold – on bumblebee numbers comes through very clearly, but is hugely variable between species because of timings and species preferences. There's a lot more work to be done!

ACKNOWLEDGEMENTS

Bees & Heatwaves Contributors

This project is the result of the collaboration, support, and contributions of colleagues and participants from across the UK. We are deeply grateful to all those who dedicated their time, expertise, and enthusiasm to Bees & Heatwaves.

Thanks to Prof. Dave Goulson, founder of The Buzz Club, for co-authoring this research and contributing his valuable insights throughout the development of the project. Thanks to Issy Sexton, whose feedback, support in promoting the project, and participation in our first round of data collection were greatly appreciated.

Steering Group

Thanks to all members of the Buzz Club Steering Group for the valuable feedback, including Dr. Beth Nicholls, Dr. Maria Clara Castellanos, Dr. Linda Birkin, Dr. Janine Griffiths-Lee, and Dr. Ellen Rotheray.

Special Thanks

To all the citizen scientists who joined the Bees & Heatwaves project in 2023 and 2024: your careful observations and dedication made this project possible. Whether this was your first time contributing to research or you're a long-time member of The Buzz Club, your involvement is incredibly appreciated!

Thank you to those who also submitted beautiful photos and to all of you who even identified different bee species – truly impressive work! I hope that you enjoyed the project and that stepping outside, even just once a week, brought a sense of calm and connection to the tiny creatures that visit our gardens; or as the biologist E.O. Wilson once said, "the little things that run the world."

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BEES & HEATWAVES 2025