The ‘performance gap’ – what does the global literature say?

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Trees & Design Action Group

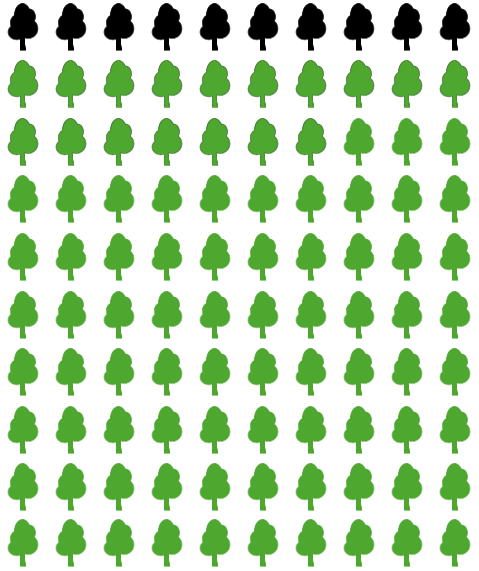
CARMINE
Climate-Resilient Development Pathways in Metropolitan Regions of Europe

UNIVERSITY OF BIRMINGHAM | BIFOR Birmingham Institute of Forest Research

Birmingham TreePeople

The quest …

- Birmingham TreePeople citizen science-led street tree monitoring project (2020 - to date)
- 50 trained citizen-scientists
- Monitored ~4,000 street trees planted between 2015 - 2020 (measurements and observations of the trees and the growing environment)
- Are our findings "normal“ what can we do with them?



Just some of the wonderful citizen scientists who have been collecting data on street tree establishment in Birmingham

Birmingham City Council

Birmingham TreePeople

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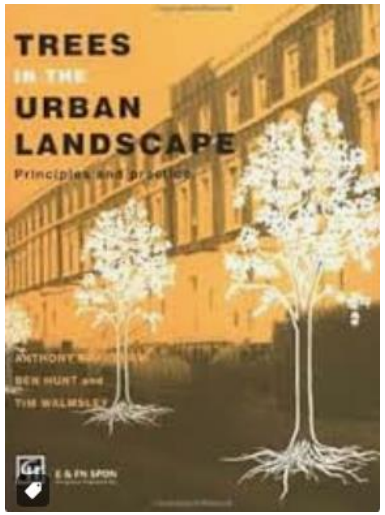
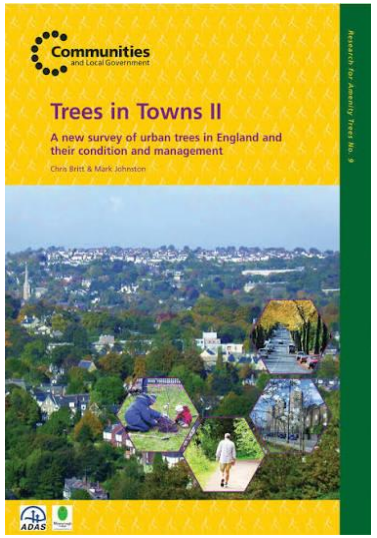
National literature



77% survival – first 3 years

Gilbertson and Bradshaw study (1985)

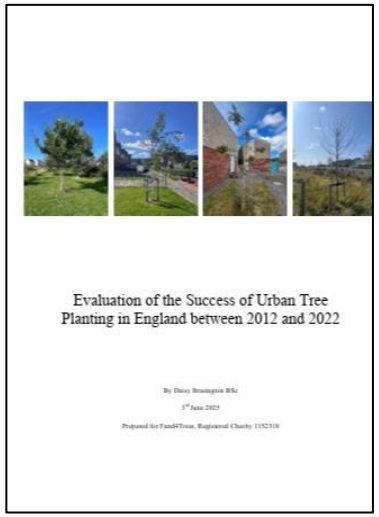


77% survival – first 5 years (street trees)

Trees in Towns II (2008)

50 –80% survival – tree inventory

Walker and Sparrow (2023) ARBmagazine



79% survival – 42% in a good condition

Brasington, D. / Fund4Trees (2025)

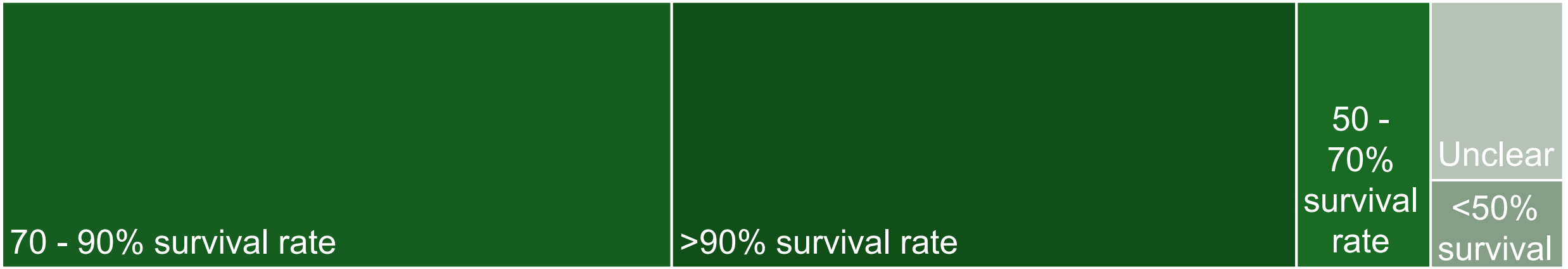
61% of trees on new development sites visited missing or dead.

Literature review

- **Hilbert et al.** (2019) Urban Tree Mortality – studies back to 1970s only 57 studies!
- **Sousa-Silva et al.** (2023) Keys to better planning and integrating urban tree planting initiatives
- Studies between 2003 – 2025.
- Focus on studies completing monitoring in first 12 years, young feathered/standard sized trees, >30 trees in study.
- Aim was to collate the challenges facing trees, explore study designs and results, understand barriers to monitoring trees, and make recommendations for future studies.

Results

- High percentage of studies from USA
- Over half of studies monitored trees in the establishment phase
- Street trees / open areas parks / tree giveaways
- Mix of data monitors including citizen scientists and students
- Binary data (alive/dead) vs categorical data ‘good, fair, poor, dead’
- Tree species information almost always included
- Rarely do studies consider belowground variables
- Rarely do studies include climate data in analysis
- Last decade increase in studies including socioeconomic data



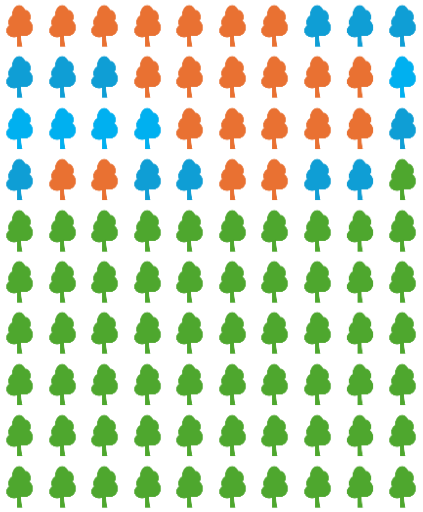
Variation in reporting

Mix of ways to report field monitoring results

Cumulative survival / mortality

Simple annual survival / mortality
61% trees alive 39% dead over 10 years
Annual mortality = 39% ÷ 10 = 3.9% - not recommended use ecological annual mortality instead

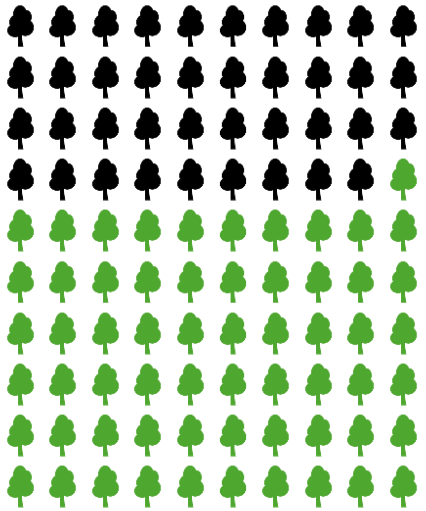
Breakdown of establishment and post-establishment phase. For example, Hilbert et al. (2019) 93.4% survival rate (6.6% mortality) in the establishment phase, followed by 97% survival thereafter.



100 – 7 = 93
93 – 6 = 87
87 – 6 = 81
81 – 5 = 76
76 – 5 = 71
71 – 2 = 69
69 – 2 = 67
67 – 2 = 65
65 – 2 = 63
63 – 2 = 61

$$m = \left(\frac{number\ trees\ died/removed}{number\ of\ planted\ trees}\right) x100$$

m = mortality



61% cumulative survival
39% mortality rate over 10 years

$$EAM = 1 - \left(\frac{Number\ trees\ survived}{Number\ of\ trees\ alive\ at\ last\ monitoring}\right)^{1/t}$$

EAM = ecological annual mortality
t = time; number of years between monitoring

Annual (ecological) survival 95.2% / mortality 4.8%

Establishment phase

Most often taken as the first 5 years after planting.

Characteristics of the Tree

- Species hardiness and taxonomy and transplant stress
- Quality of nursery stock including fine root structure, girdling roots, grafting
- Supply chains and capacity to provide diverse stock and stock of suitable provenance
- At-planting size of tree

Management and Institutions

- Quality of tree specification (planting plans)
- Skill of planting actors e.g. trees planted too deep
- Levels of care and stewardship e.g. mechanical damage from grass cutting machinery, tree support and protection systems incorrectly installed or not removed in good time and incorrect pruning
- Insufficient irrigation
- Out of season planting

Surrounding Growing Conditions

- Urban form e.g. street canyons resulting in shade and reduced sunlight hours / wind effects
- Landuse type, e.g. residential / commercial
- Land use intensity
- Nearby construction and utilities
- Traffic levels and car parking pressures
- Size of planting area and rooting space
- Soil sealing and plant-available water
- Soil quality e.g. nutrient limitation, compaction, waterlogging, presence of de-icing salts and heavy metals
- Browsing and burrowing animals

Human Community

- Community size
- Community trust
- Vandalism and vehicle strikes

Broader Environmental Context

- Changing weather patterns e.g. late / early frosts
- Urban Heat Island effects
- Extreme weather e.g. storms, heavy rainfall, sunscald
- Pest and disease outbreaks
- Air pollution

Barriers to monitoring tree establishment

- Uncomfortable truths
- Baseline data availability
- Difficult to draw conclusions
- Difficult to understand belowground constraints and soil
- Time – long-term monitoring and time to complete monitoring

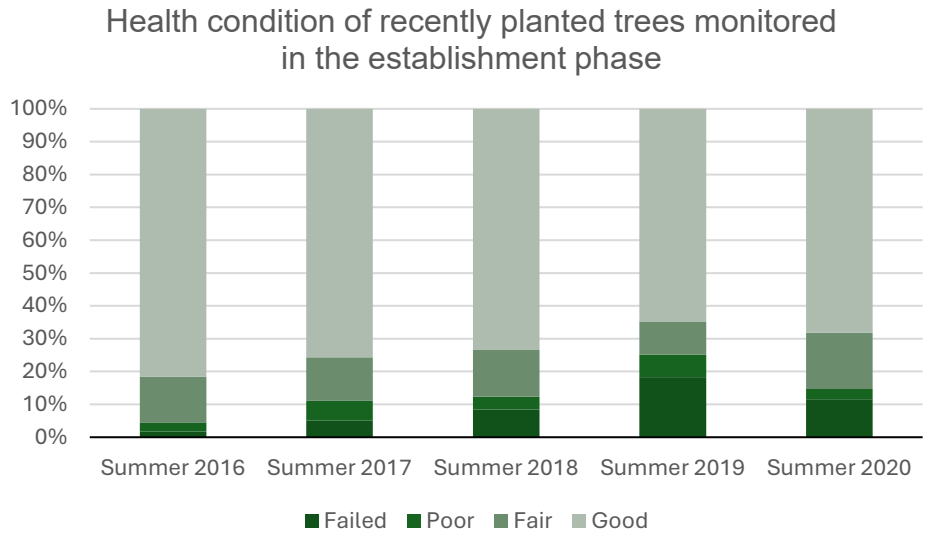
Why is monitoring important?

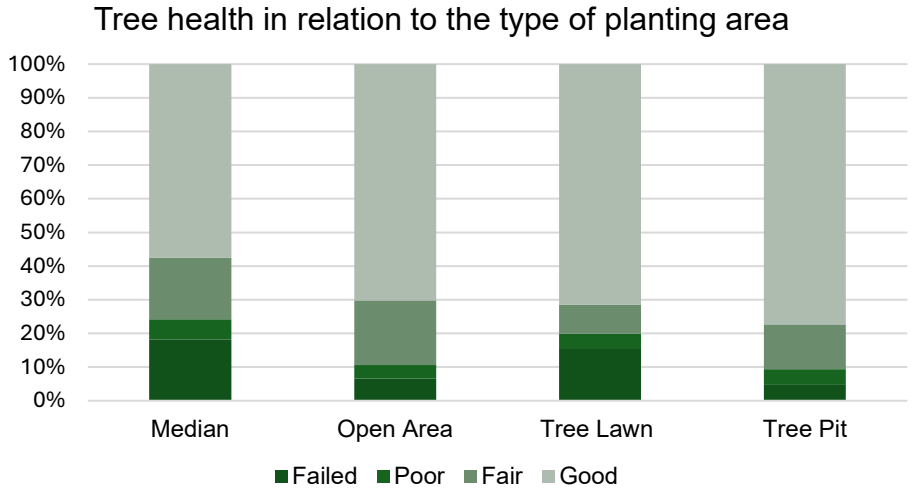
- Monitoring and evaluation like with all things improves practice and can help target human resources
- Urban forest modelling - growth and climate adaptation
- Understand the economic impacts “greenwasting”
- Citizen science opportunity – ripple effect
- Future will include smart technologies

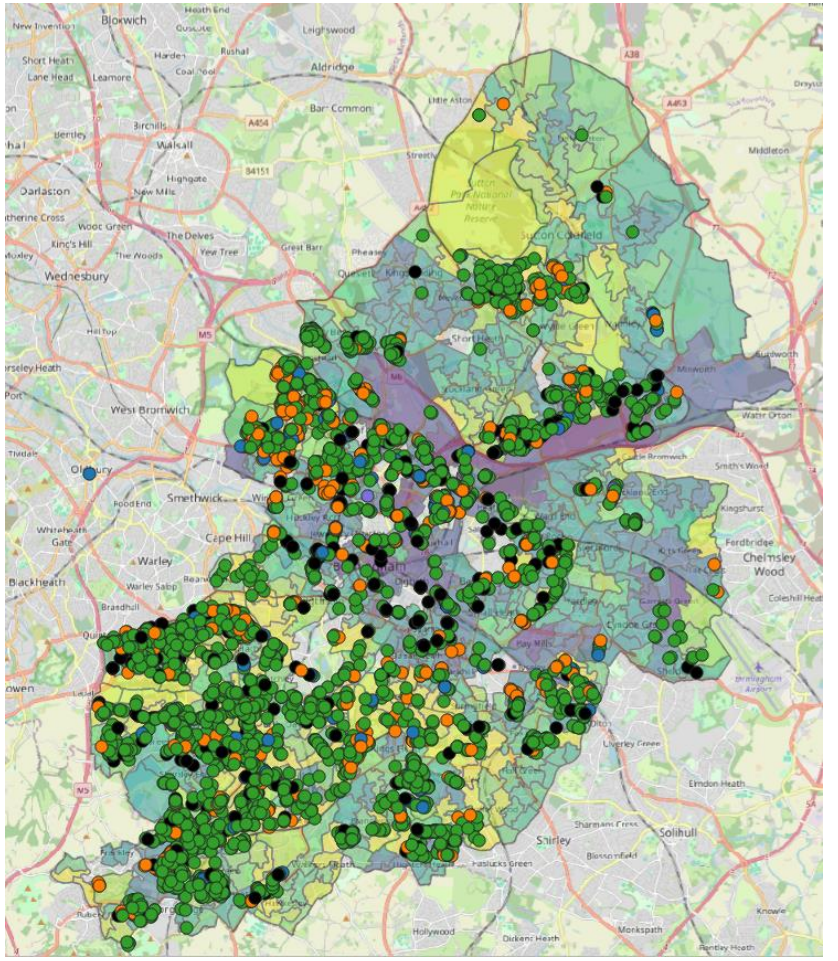
Analysing data from monitoring

- Correlation-based patterns
- Regression models ranking
- Multivariate approaches / conditional inference tree
- More difficult when trees are all planted in different years (climate)
- Spatial data layer

Birmingham Street Tree Monitoring

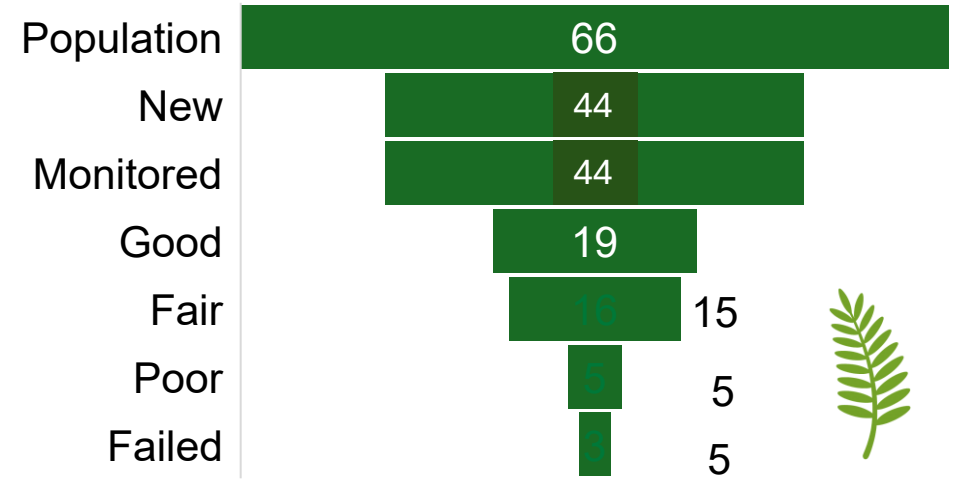




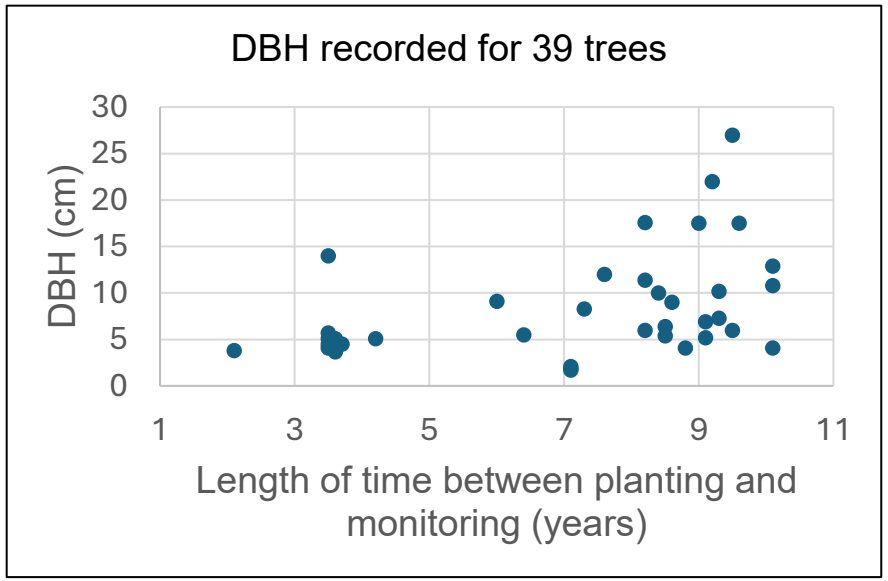


Each dot is a newly planted tree that has been monitored, plotted onto the Tree Equity map for Birmingham

Metasequoia glyptostroboides – Dawn Redwood



Cumulative survivorship is 90.5%



Tree Characteristics

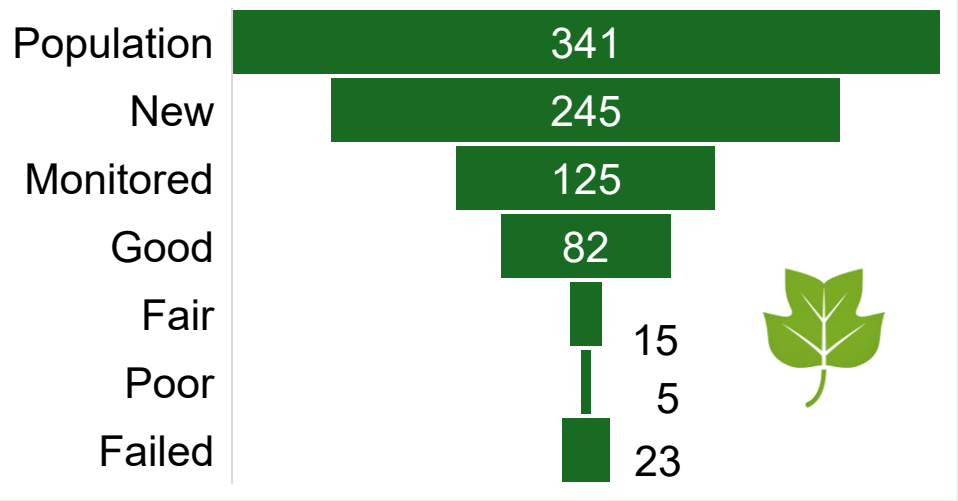
Drought tolerance: Moderate
Shade tolerance: Partially
Mature size: Massive
Nativeness: Non-native

Future climate suitability*: Low

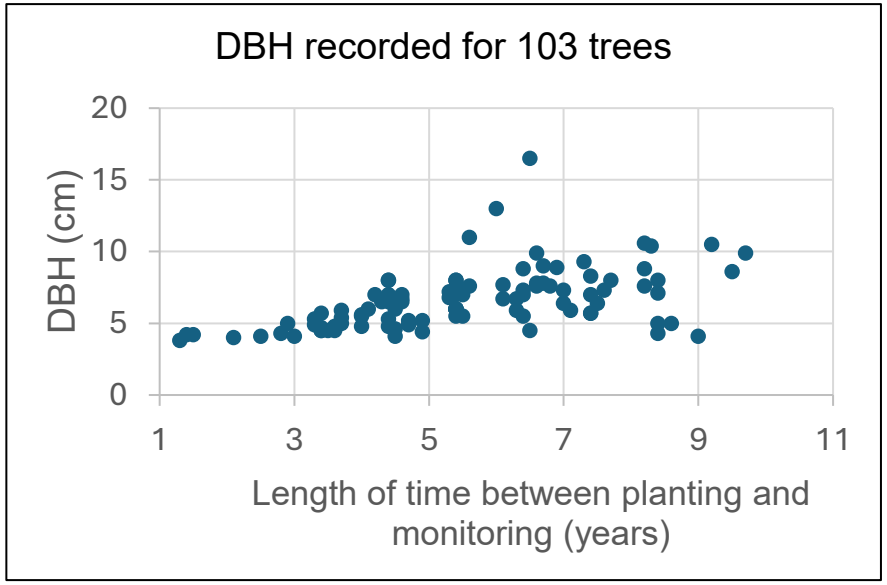
Planting area: Open areas and medians

Both trees planted in 2015

Liriodendron tulipifera - Tulip tree



Cumulative survivorship is 81.6%



Tree characteristics

Drought tolerance: Moderate
Shade tolerance: Partially
Mature size: Large
Nativeness: Non-native

Future climate suitability*: Vulnerable

Main Planting Areas: Tree lawns, medians, open areas and tree pits

Planted winter 2018

Google Street View

*Hirons, A. et al. (2025) Future climate suitability of London's public realm trees.

Thank you for your attention

Thanks to all involved in the street tree survey – special thanks to Simon, Tonia, Mac, Steve and an even bigger

thanks to Nina (Street Tree Survey Coordinator and Trainer) and of course to all the citizen scientists.

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