Forest Research

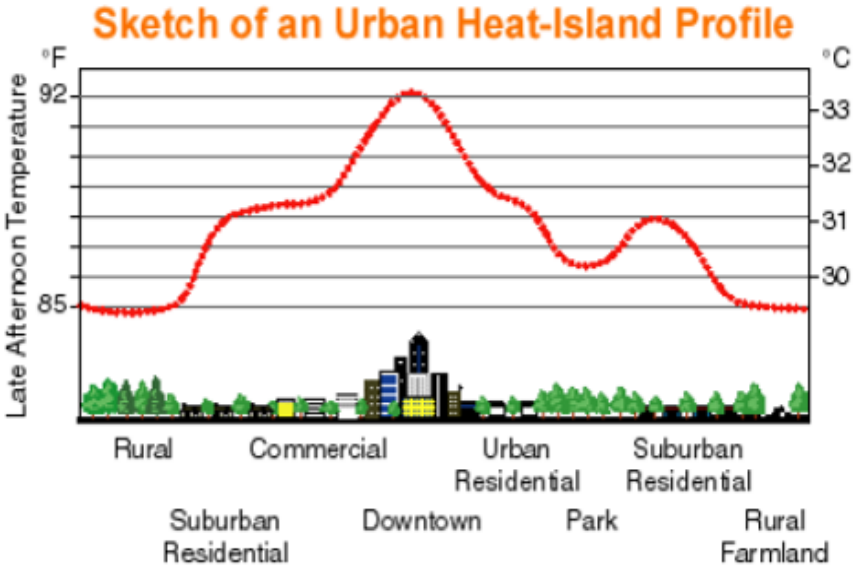
# The role green infrastructure plays in mitigating the Urban Heat Island effect

Dr Madalena Vaz Monteiro
Land Regeneration and Urban Greenspace Research Group
Centre for Sustainable Forestry and Climate Change
Forest Research, Farnham, Surrey

# The Urban Heat Island (UHI)

Average temperature is higher in cities than in surrounding countryside

Figure 1.




GLA (2006) London's urban heat island: A summary for decision makers

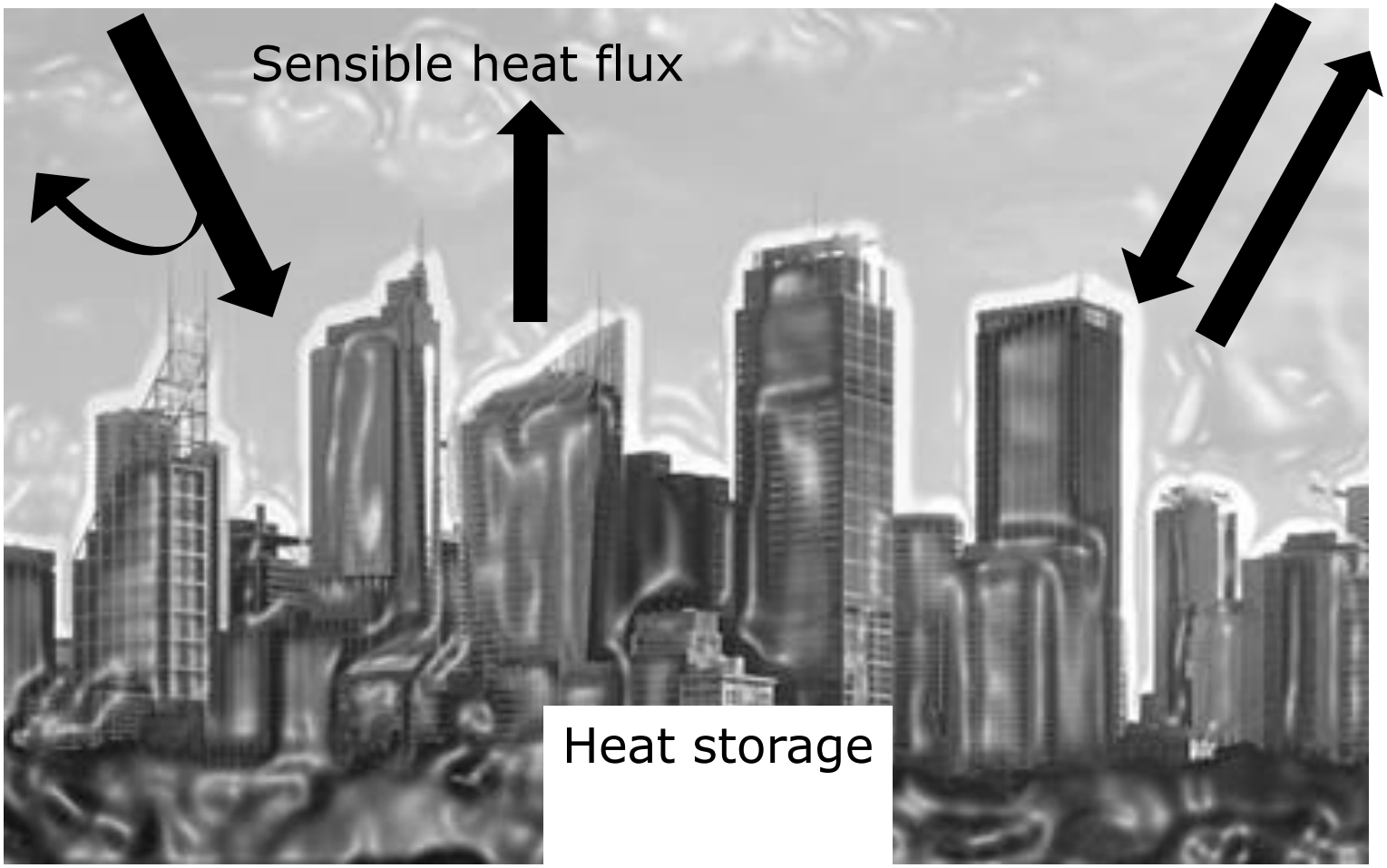
# Introduction (cont.)

## Nice and warm, so why the fuss…

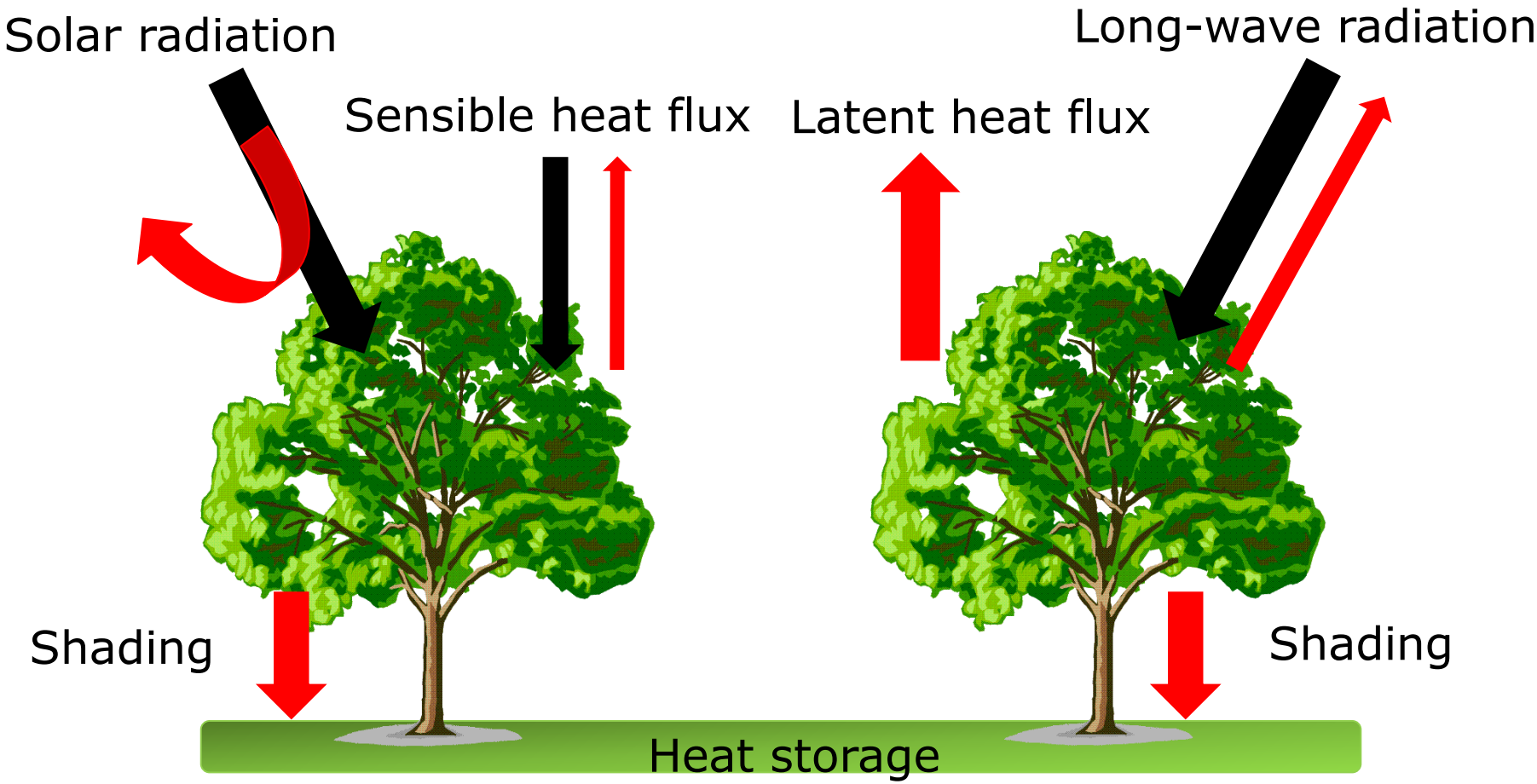
- UHI intensity in London can be as much as 10.5°C
- There is a direct and significant impact of heat on human health…
  - ~ 1,100 heat-related deaths and 100,000 hospital patient-days per year in the UK
  - …plus more deaths per heat wave (e.g. heat wave of 2003 - more than 2,000 extra deaths in England and Wales)

Multiple cooling mechanisms offered by greenspaces can significant impact on surrounding urban temperatures

# Introduction (cont.)



# Introduction (cont.)



# Case studies

## In 2011

- Aim: Determine the extent to which a large greenspace reduces UHI
- Air temperatures measured in one of central London's large greenspaces and also in an adjacent street

Doick, K. J., Peace, A. and Hutchings, T. R. (2014). The role of one large greenspace in mitigating London's nocturnal urban heat island. *Science of the Total Environment* 493: 662–671

## In 2012

- Aim: Define the relationship between cooling extent and the size of greenspace
- Air temperatures measured in and around eight London greenspaces, with areas ranging from 0.2 to 12.1 ha

Vaz Monteiro, M., Doick, K. J., Handley, P. and Peace, A. (2016). The impact of greenspace size on the extent of local nocturnal air temperature cooling in London. *Urban Forestry & Urban Greening* 16: 160–169

# Modelling the extent of cooling

At night when UHI is more developed and when air temperatures are less variable

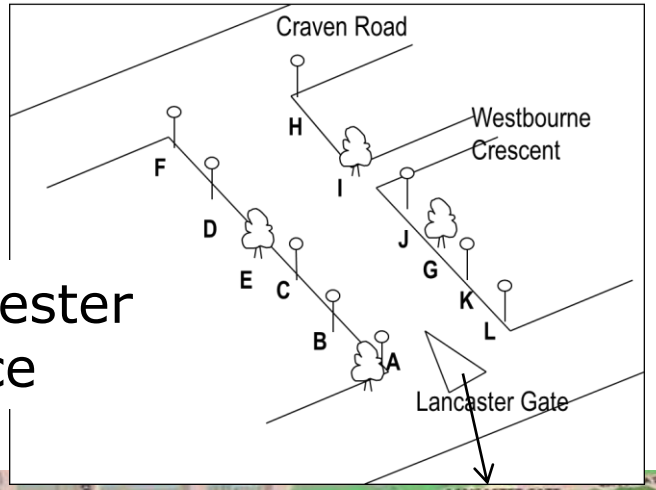
$$UHI\ intensity = T_{sensor} - T_{wisley}$$

$$t_i = a + b\ r^{distance_i} + e_i$$

- $t_i$ - estimated UHI intensity at sensor i located at distance$_i$ from each greenspace
- $a$ - maximum estimated UHI intensity
- $b$ - maximum cooling provided by the greenspace
- $r$ - estimated rate of increased temperature as one moves away from the greenspace
- $e_i$ - error in the estimate

# Study area 2011

Key:
Trees: A, E, G, I
Lamp posts: B, C, D, F, H, J, K, L
Intersections: A, F, H, L




O = open space
G = grass
T = tree

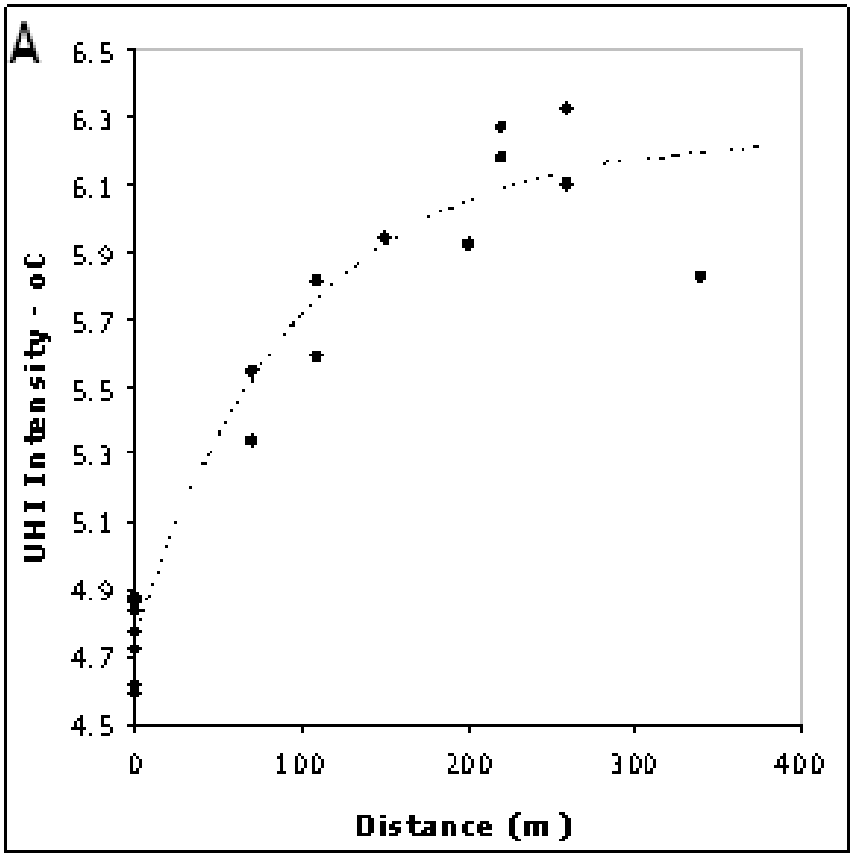

https://www.royalparks.org.uk/about-us/publications

# Comparison of urban heat island intensity

- Max and Min's are the largest and smallest hourly UHI values observed in a month
- Mean values are for the month

| Location | Urban heat island intensity (°C) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | August | | | September | | | October | | |
| | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min |
| Kensington gardens | 6.6 | 1.4 | -3.4 | 7.5 | 1.5 | -2.1 | 8.6 | 1.5 | -2.3 |
| Gloucester terrace | 7.5 | 1.8 | -3.6 | 9.1 | 2.0 | -2.2 | 10.5 | 2.1 | -2.2 |

# Results 2011

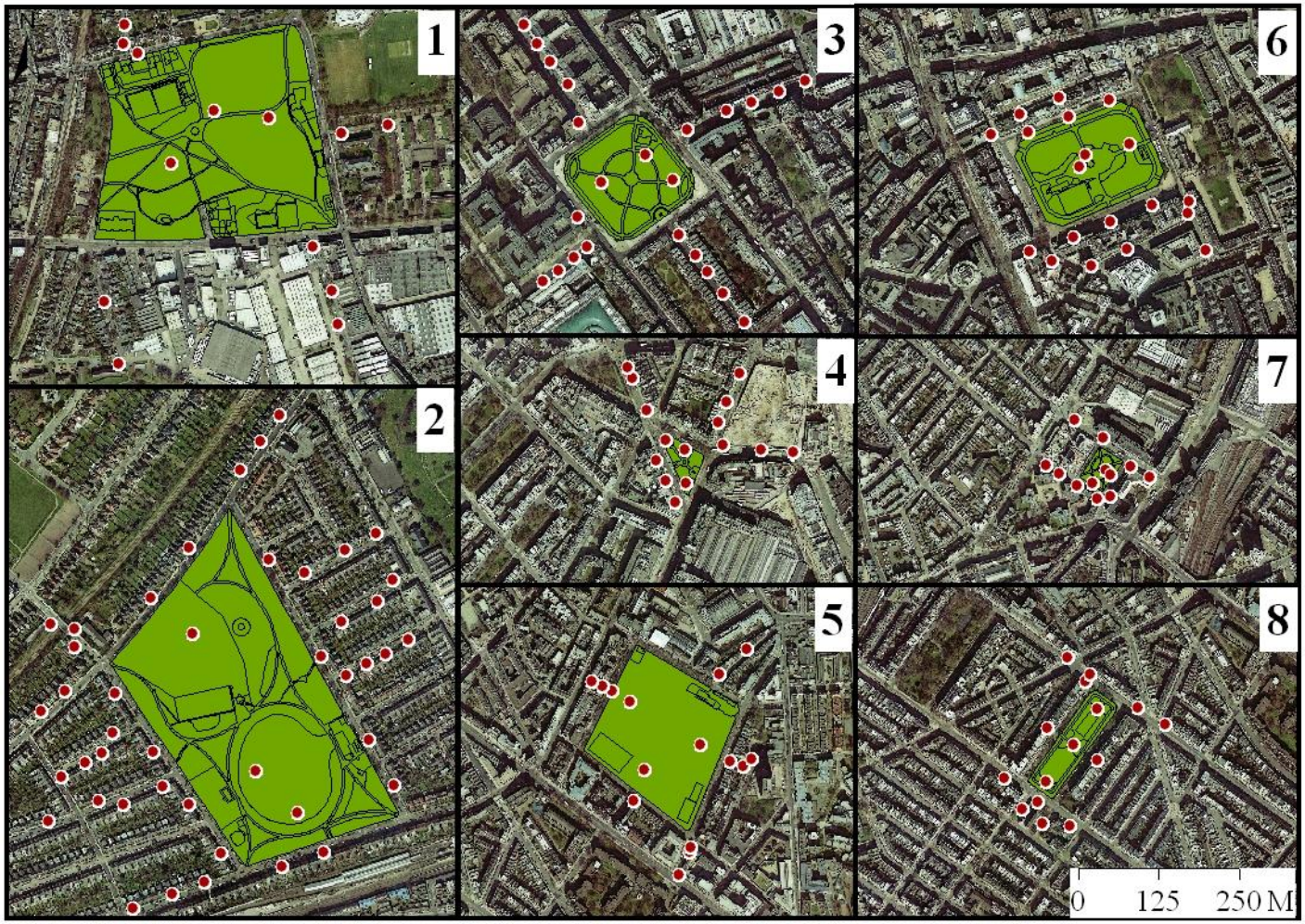



Relationship between urban heat island intensity and increased distance from Kensington Gardens on 9 August

Park cooled the transect when cooling was most needed, on warm calm nights

Cooling of up to 4°C over 440 m distance from the park was observed on single nights

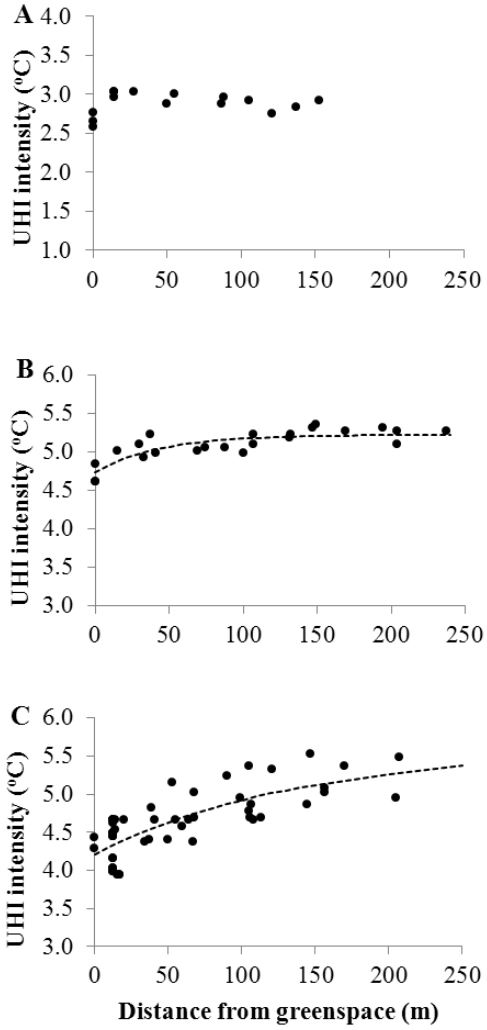
# Study areas 2012




Key: 1. Acton Park, 2. Queen's Park, 3. Russell Square, 4. Grosvenor Gardens, 5. Vincent Square, 6. Lincoln's Inn Fields, 7. Ebury Square Gardens and 8. Warwick Square (© Crown copyright and database right [2015] Ordnance Survey [100021242])

# Results 2012

Modelling of cooling extent was statistically valid only on calm warm nights (≥ 10°C and wind speed ≤ 3 m/s)



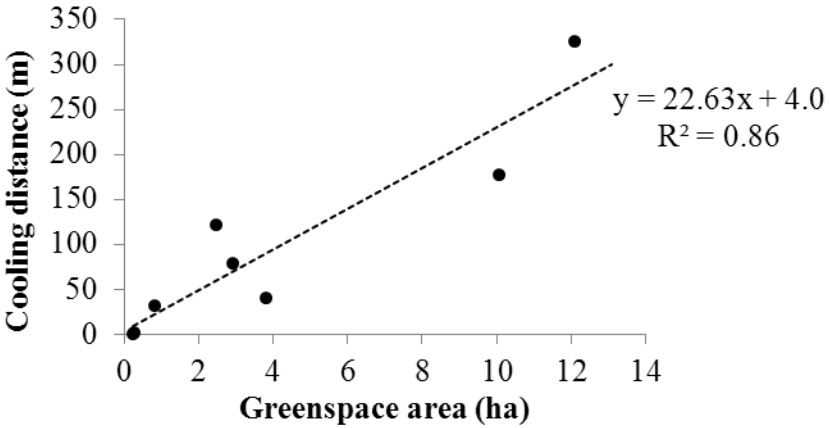

Very small greenspaces (area <0.5 ha) did not affect the air temperatures of their surrounding areas

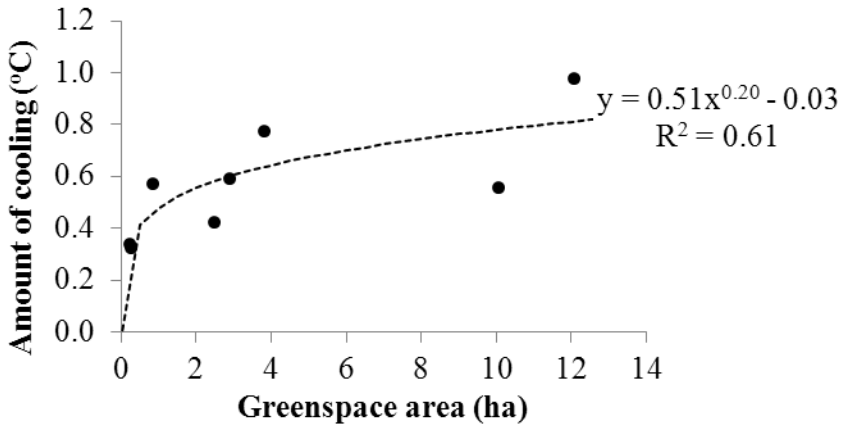
Small greenspaces (area 0.8 to 3.8 ha) cooled by an average of 0.4 to 0.8°C over approximately 30 to 120 m

Medium greenspaces (area 10.1 to 12.1 ha) cooled by an average of 0.6 to 1.0°C over approximately 180 to 330 m

A. very small greenspace (Grosvenor Gardens, 27 June)
B. small greenspace (Russell Square, 20 September)
C. medium greenspace (Queen's Park, 18 August)

# Results 2012




Cooling distance increased linearly with increasing area of greenspace but the relationship between area and the amount of cooling was non-linear

# Conclusions

- Urban dwellers experience warmer temperatures than people living in the countryside
- It is cooler close to a medium/large greenspace than [say] 300m away
- Cooling extent and intensity vary with greenspace size
- Impact of cooling by greenspaces is present when needed the most

# Acknowledgements

This work was funded by Forestry Commission

Contributions from:
Dr Kieron Doick
Phil Handley
Andrew Peace
Paul Taylor
Tony Hutchings

Collaboration from:
Royal Parks
Royal Borough of Kensington and Chelsea
City of Westminster
City of London Corporation
Ealing Council
London Borough of Camden
Victoria Business Improvement District
Sarah Syborn

# Thank you