Supplementary Information S2

Table S2. Justifications used to support the necessary conditions identified in Table 2 of the main manuscript.

Benefits to Achieve and Drawbacks to Avoid	**Necessary Conditions**																										
	Consistent water supply for healthy growth[1]	Tree's access to light maintained	Low stress from soil pollution	Low stress from air pollution	Root growth not substantially impeded	A tree is still present	Tree is large or mature	People are present nearby	Tree is visually accessible to public	Tree is maintained for amenity[2]	Large-scale tree-cover across urban area	Tree is maintained for wildlife[3]	Surrounding area built to high density	Tree is physically accessible to public	Tree not in a street canyon with busy road	Tree does not overhang road or pavement	High canopy[4]	Tree blocks solar access to building	No artificial lighting	Tree is part of a densely-vegetated barrier[5]	No persistent noise	Tree is connected to a broader tree network	Species is native	Species is low VOC emitter	Lateral root spread not excessive	Tree is growing in a pervious surface	Species is evergreen
Provide feeding resource for native birds/bats	? [a]	? [a]	? [a]	? [a]	? [a]	√	√	! [b]		! [c]	√	√	! [d]	! [b]	√				√		√	√	√ [e]			? [f]	
Cool buildings (shade)	√	√	√	√	√	√	√								! [g]			√									? [h]
Reduce heating requirements during cold weather	√	√	√	√	√	√	√						! [j]				! [k]	! [m]		√							√
Attenuate noise throughout the year	√	√	√	√	√	√	√			! [n]							! [k]			√						? [o]	√ [p]
Reduce net CO_2 emissions	√	√	√	√	√	√	√			! [q]	√ [r]															?	
Reduce stormwater runoff rate/volume	√	√	√	√	√	√	? [s]				√															√	? [t]
Summertime cooling	? [u]	√	√	√	√	√	√				√				! [g]	! [g]		√ [m]									
Reduce exposure to air pollutants (NO_2, O_3, PM)	√ [w]	√	√	√	√	√	√	√		?	? [x]				√ [y]									√			? [p]
Reduce psychological stress	√	√	√	√	√	√	? [z]	√	√					?			√ [aa]										
Decrease perceptions of overcrowding	√	√	√	√	√	√	? [z]	√	√			! [bb]	√		! [cc]	! [cc]											
Create desirable environments for recreation	√	√	√	√	√	√	? [z]	√	√	√		! [bb]		√			√					√			√		
Improve urban aesthetics	√	√	√	√	√	√	? [z]	√	√	√		! [bb]													√		
Increase property values	√	√	√	√	√	√	? [z]	√	? [dd]	√		! [bb]															
Reduce crime	√	√	√	√	√	√	! [ee]	√	√	√	√	! [bb]					√		! [ff]	! [ff]							
Increase economic investment within surrounding area	√	√	√	√	√	√		√	√	√	√	! [bb]							!		! [gg]						

Table S2. *Cont.*

Benefits to Achieve and Drawbacks to Avoid	**Necessary Conditions**																										
	Consistent water supply for healthy growth[1]	Tree's access to light maintained	Low stress from soil pollution	Low stress from air pollution	Root growth not substantially impeded	A tree is still present	Tree is large or mature	People are present nearby	Tree is visually accessible to public	Tree is maintained for amenity[2]	Large-scale tree-cover across urban area	Tree is maintained for wildlife[3]	Surrounding area built to high density	Tree is physically accessible to public	Tree not in a street canyon with busy road	Tree does not overhang road or pavement	High canopy[4]	Tree blocks solar access to building	No artificial lighting	Tree is part of a densely-vegetated barrier[5]	No persistent noise	Tree is connected to a broader tree network	Species is native	Species is low VOC emitter	Lateral root spread not excessive	Tree is growing in a pervious surface	Species is evergreen
Stabilise cuttings/embankments						√ hh	√ hh							! jj													
Avoid root interference with built infrastructure & paved surfaces [6]	√ kk	! mm	! mm	! mm	!	!	!				!		!					!				!			√		
Avoid shrink-swell damage to buildings & infrastructure [6]	√ kk	! mm	! mm	! mm		!	!				!		!													√	
Avoid public hazard due to leaf/fruit fall [6]	√ nn	!	!	!	!	!	!			? oo	!	!		!		? oo											
Avoid injury/damage due to branch/tree fall [6]	√	√	√	√	√	!	!			√	!	!	!	!		√	!										

KEY: √ = Condition is typically necessary for delivering intended benefit; ? = Condition may be necessary in some contexts; ! = Potential conflict between condition and a particular benefit; **Notes:** [1] May be some limited water stress in hot periods; [2] Tree pruned, leaf litter removed, pests controlled; [3] Dead wood retained, complimentary habitats protected; [4] Does not impede ground-level visibility; [5] Defined here as an optically opaque barrier; [6] Key drawbacks to avoid; **Justification:** [a] Good tree health is not necessarily a requirement for ecological benefits, as dead wood can provide a variety of valuable habitats. [1,2]; [b] Human disturbance may be significant for some species [3–5]; [c] High levels of management can limit feeding opportunities for wildlife. e.g., Heavy pruning, pesticide use, removal of dead wood [2]; [d] Presence of some bat and bird species is negatively correlated with surrounding built density e.g., [6]; [e] Tree species that have been present the longest in Britain tend to have high insect species richness [7]. Non-natives support few insect species; [f] A vegetated area beneath the tree increases habitats for invertebrates; [g] Shading of built and paved surfaces is important as they re-radiate solar radiation effectively. Avoiding planting in street canyons eliminates many shading opportunities; [h] Only necessary when year-round cooling is required, rather than summer cooling alone; [j] Windbreak effect greatest in low-density suburban-type areas. Trees are unlikely to provide significant windbreak in high-density areas; [k] High canopies may only provide a limited barrier effect; [m] Blocking solar access will act to cool the building. Often trees are only used to block northerly winds which avoids this conflict [8]; [n] Pruning reduces canopy density, which would be expected to increase noise transmission; [o] Soft ground surfaces have been shown to account for a significant portion of the sound attenuation by vegetation [9];[p] Evergreen species will be effective all year-round [10]; [q] Pruning removes biomass, returning CO_2 to the atmosphere via decomposition or combustion. Maintenance can also have high carbon costs [11]; [r] Large-scale planting is required for a significant amount of CO_2 sequestration to occur and for broad savings to be accrued through summertime shade and wintertime insulation [11,12]; [s] Large trees will intercept substantially more rainfall and transpire more, thus being more effective [13]; [t] In-leaf trees are more effective due to interception of rainfall – consider seasonality of peak rainfall events; [u] Air temperature reductions likely to be of most value during high temperature episodes when water supply is most likely to be limited; [w] Water limitations will not affect particulate deposition but will reduce stomatal uptake of NO_2 and O_3. Thus effectiveness may be reduced under warm anticyclonic conditions which often exhibit low rainfall and high pollution episodes, or when supplementary watering ceases; [x] Generally large-scale planting is necessary, but trees in street canyons may be an exception [14]; [y] Trees in street canyons may increase exposure to pollutants through reducing ventilation, when emissions are high enough to overwhelm the pollutant capture effect of the tree [14]. The level of emissions varies according to situation (*ibid.*). These impacts can be reduced via high levels of pruning [15]; [z] Mature trees highly valued [16,17], but that does not mean immature trees will not provide any benefit; [aa] Good visibility increases feelings of safety (Kuo et al., 1998; Kuo and Sullivan, 2001) – an important aspect of reducing psychological stress; [bb] Leaf, branch and fruit detritus may impede movement and reduce positive feelings about trees and the local area; [cc] Roads and paved areas outside buildings are precisely the areas where trees may have to be placed to break up a dense city-scape; [dd] Owning property in a neighbourhood with trees may be desirable, due to the benefits enjoyed by residents, customers or staff. However, such trees may not be welcomed by all [18]. Public access to these trees may cause problems for local property owners in relation to increased social use of the space and risk of litigation [19]; [ee] Tall trees may generate conflict with CCTV security cameras [20]; [ff] Reductions in visibility are popularly associated with an increased risk of crime, although research doesn't always support this [21,22]; [gg] Re-development and increased use of an area would likely be associated with high noise levels; [hh] Root systems provide support to soil structure [23], although some stabilising function may still be preserved after the tree has died [24]; [jj] Public access, made more desirable by trees, might damage surface vegetation and encourage erosion of embankment; [kk] Sufficient water supply may prevent large root expansion in search for water and may reduce the risk of shrink-swell damage to buildings and other structures for clay-based soils. See www.bgs.ac.uk/products/geosure/shrink_swell.html; [mm] The chances of root expansion may be higher for a healthy tree; [nn] Drought may trigger early leaf and fruit fall as well as death of branches; [oo] Tree litter over a vegetated surface is less likely to be a slip hazard for pedestrians. For litter falling on paved surfaces maintenance requirements are higher.

References

1. Rhodes, M.; Wardell-Johnson, G.W.; Rhodes, M.P.; Raymond, B. Applying network analysis to the conservation of habitat trees in urban environments: A case study from Brisbane, Australia. *Conserv. Biol.* **2006**, *20*, 861–870.
2. Carpaneto, G.M.; Mazziotta, A.; Coletti, G.; Luiselli, L.; Audisio, P. Conflict between insect conservation and public safety: The case study of a saproxylic beetle (Osmoderma eremita) in urban parks. *J. Insect. Conserv.* **2010**, *14*, 555–565.
3. Forman, R.T.; Alexander, L.E. Roads and their major ecological effects. *Annu. Rev. Ecol. Syst.* **1998**, *29*, 207–231.
4. Parris, K.M.; Schneider, A. Impacts of traffic noise and traffic volume on birds of roadside habitats. *Ecol. Soc.* **2009**, *14*, Article 29.
5. Gaston, K.J.; Bennie, J.; Davies, T.W.; Hopkins, J. The ecological impacts of nighttime light pollution: A mechanistic appraisal. *Biol. Rev.* **2013**, *88*, 912–927.
6. Hale, J.D.; Fairbrass, A.J.; Matthews, T.J.; Sadler, J.P. Habitat composition and connectivity predicts bat presence and activity at foraging sites in a large UK conurbation. *PLoS ONE* **2012**, *7*, e33300.
7. Kennedy, C.; Southwood, T. The number of species of insects associated with british trees: A re-analysis. *J. Anim. Ecol.* **1984**, *53*, 455–478.
8. McPherson, E.G.; Simpson, J.R.; Xiao, Q.; Wu, C. *Los Angeles 1-Million Tree Canopy Cover Assessment*; Department of Agriculture, Forest Service, Pacific Southwest Research Station: Albany, CA, USA, 2008; p. 52.
9. Nowak, D.J.; Dwyer, J.F. Understanding the benefits and costs of urban forest ecosystems. In *Urban and Community Forestry in the Northeast*; Kuser, J.E., Ed.; Springer: Berlin/Heidelberg, Germany, 2000; pp. 11–25.
10. Petroff, A.; Zhang, L. Development and validation of a size-resolved particle dry deposition scheme for application in aerosol transport models. *Geosci. Model Dev.* **2010**, *3*, 753–769.
11. McPherson, E.G.; Kendall, A. A life cycle carbon dioxide inventory of the million trees Los Angeles program. *Int. J. Life Cycle Assess.* **2014**, *19*, 1653–1665.
12. Akbari, H.; Pomerantz, M.; Taha, H. Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. *Solar Energy* **2001**, *70*, 295–310.
13. Seitz, J.; Escobedo, F. Urban forests in Florida: Trees control stormwater runoff and improve water quality. *City* **2011**, *393*, Article 6.
14. Pugh, T.A.; MacKenzie, A.R.; Davies, G.; Whyatt, J.D.; Barnes, M.; Hewitt, C.N. A futures-based analysis for urban air quality remediation. *Proc. Inst. Civ. Eng. Eng. Sus.* **2012**, *165*, 21–36.
15. Jin, S.; Guo, J.; Wheeler, S.; Kan, L.; Che, S. Evaluation of impacts of trees on pm2.5 dispersion in urban streets. *Atmos. Environ.* **2014**, *99*, 277–287.
16. Dwyer, J.F.; Schroeder, H.W.; Gobster, P.H. The significance of urban trees and forests: Toward a deeper understanding of values. *J. Arb.* **1991**, *17*, 276–284.
17. Hansen-Møller, J.; Oustrup, L. Emotional, physical/functional and symbolic aspects of an urban forest in denmark to nearby residents. *Scand. J. For. Res.* **2004**, *19*, 56–64.

18. Conway, T.M.; Bang, E. Willing partners? Residential support for municipal urban forestry policies. *Urban For. Urban Green.* **2014**, *13*, 234–243.
19. Mortimer, M.J.; Kane, B. Hazard tree liability in the united states: Uncertain risks for owners and professionals. *Urban For. Urban Green.* **2004**, *2*, 159–165.
20. TDAG. Trees in Hard Landscapes: A Guide for Their Delivery. Available online: http://www.tdag.org.uk/trees-in-hard-landscapes.html (accessed on 1 October 2014).
21. Kuo, F.E.; Sullivan, W.C.; Coley, R.L.; Brunson, L. Fertile ground for community: Inner-city neighborhood common spaces. *Am. J. Commun. Psychol.* **1998**, *26*, 823–851.
22. Kuo, F.E.; Sullivan, W.C. Environment and crime in the inner city does vegetation reduce crime? *Environ. Behav.* **2001**, *33*, 343–367.
23. Reubens, B.; Poesen, J.; Danjon, F.; Geudens, G.; Muys, B. The role of fine and coarse roots in shallow slope stability and soil erosion control with a focus on root system architecture: A review. *Trees* **2007**, *21*, 385–402.
24. Ammann, M.; Böll, A.; Rickli, C.; Speck, T.; Holdenrieder, O. Significance of tree root decomposition for shallow landslides. *For. Snow Landsc. Res.* **2009**, *82*, 79–94.