The Right Tree in the Right Place for a Resilient Future

This Urban Tree Manual provides advice on selecting and procuring the right tree[1] for the right place in urban areas. For the purposes of this manual urban areas are defined as places in and around where people live and work. The manual also highlights long term issues of the threats to existing trees from pests, disease and climate change, and describes the benefits to the environment and for well-being that urban trees can provide.

The Manual is not intended as an exhaustive compendium on tree selection, aftercare and management. Instead, it presents current thinking on these matters and provides valuable sign posting to further relevant information.

Urban tree manual foreword

Sir William Worsley, Tree Champion

My role as the country's Tree Champion is to advocate for trees everywhere, from the rural upland forests to those in and around our towns and cities. This is why we are committed to planting one million trees in our towns and cities and eleven million trees nationally. This commitment stands alongside our ambitious 25 Year Environment Plan, which will see us strive to ensure we leave this environment in a better state for the next generation.

Urban trees bring about many benefits for people living in our cities and towns. They improve health and wellbeing, they encourage outdoor activity, they absorb noise and they reduce temperatures through shading. Underpinning these benefits is a key requirement: that the right tree is planted in the right place.

This manual sets out best practice for this decision-making process. It is intended for anyone looking to plant a tree in the urban environment, ranging from Local Authorities to community groups. Many local authorities and other organisations are taking on new projects for urban tree planting and management. For example in the past year, the Mersey Forest has co-ordinated the planting of over 66,000 trees in Community Forests across England as part of Defra's Trees for Learning programme, ensuring the next generation values trees as key parts of our urban environment

Successful establishment of urban trees requires a series of informed decisions, from choosing the best site, to selecting the best species, to maintaining young trees and protecting them from biosecurity threats. Our treasured trees are under threat from an increasing number of pests and diseases, and as our climate changes these threats will increase with pressures such as drought or extreme temperatures.

I would like to thank the authors who came together to write this manual. Arboricultural expertise is invaluable in planning for and delivering green infrastructure. I am grateful to the experts who have contributed their time and experience over the past few months. I hope the hard work that went into creating this manual will result in improved practice in tree planting and establishment across the country, and ensure that our invaluable trees are preserved now – and for future generations.

Sir William Worsley, Tree Champion

The Manual is useful for anyone involved in planting trees in towns and cities.[1]

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Further reading and reference materials

[1] This manual avoids using the term "species" to denote different types of tree. The many hundreds of types of trees available **(as described in Section 4: Biodiversity)** mean "species" is too narrow a term to encompass all the various attributes and characteristics of trees used today in urban tree planting.

Section 1 Location

Choosing the site and assessment of constraints

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The Site

The **first step** when planning to plant a tree is identifying the planting location. This will determine what attributes the selected tree must have and **influences all subsequent decisions**. This decision ultimately determines whether the tree will **thrive** and **fulfil** its true potential and provide all its possible benefits. Tree planting locations should always be one of the first and **most important** decisions when considering space allocation in the built environment.

The urban context is a very cluttered environment. This means that choosing a planting site in an urban area can be fraught with problems. There is the general view that tree roots damage utility services, intact water pipes in particular, but there is no research to support this.

However, many other human-made services, infrastructure and land uses compete with trees for the same space, both above and below ground, including underground and overhead utility services, highway sightlines, interaction with road and footway kerb edging, paving or nearby property and its foundations. This can determine how well the planted tree fits into the chosen environment and what management actions will be required to ensure a trouble free life for the tree and its neighbours. Obtaining professional advice and the permission of the local tree officer (for planting on public land) is essential. Obtaining the advice of an arboricultural consultant (for planting on private land) is also recommended when considering these first steps.

The Soil

Understanding what type of soil is present at your chosen planting site is the second step in deciding what type of tree is best suited to the location. One way of doing this is to observe the local area and see what types of trees or plants are doing well locally and what trees are absent, especially if you can identify trees that are self-seeded rather than being planted.

Most soils in urban areas are not true soils in the scientific sense. They do not have the same structure and profile as natural soils found in rural or natural settings. They are called ‘made ground’ and are a mixture of material that has accumulated in place as a result of human activity over many years. They may be lacking in structure, nutrients and organic matter, have high levels of acidity or alkalinity or be contaminated from salt spreading or previous industrial or other human activity. They may also be bacteria dominant rather than fungal dominant which can present a problem for newly planted trees. (see Section 6: Planting and Establishment).

Soil Permeability and Compaction

Permeable soils drain freely and permit air and water movement to and around the root system. Some ecosystem service benefits depend strongly on the structure of the ground in which the trees are growing.

Trees grow most successfully in uncompacted soils. Compaction in certain types of soil, sometimes described as 'panning', will inhibit the movement of air and water in the immediate vicinity of a tree's root plate. This can create conditions within the soil that are disadvantageous for root growth. In extreme circumstances this can lead to the death of the tree. Fine roots in particular are affected.

If soil compaction is suspected at a planting location some form of de-compaction process such as high pressure air injection should be used. This is particularly relevant on development sites where vehicles or materials have been used or stored on site prior to planting. There are many organisations that provide accredited soil testing.

Constraints and Opportunities

The constraints of the planting location will also inform the choice of tree. Constraints may be so extensive as to dictate that the site is not suitable for tree planting, for example where there are other nature or heritage conservation considerations and specialist archaeologist, ecologist or nature conservation advice is required. Other considerations may include drainage and other environmental factors such as shading from nearby buildings, or urban micro-climates creating frost hollows and sun or heat traps.

These constraints are generally relevant to pre-existing locations, where choosing the right tree for the right place is the rule. New developments present an opportunity to **create** the right place for the right tree. In this context the engineering and landscape design should accommodate trees of stature that can provide the most benefits to the urban environment and the people who live and work there.

The location of existing trees may already suggest the right trees in the right place.

References

- British Standard (2014)
  BS 8545:2014 Trees :
  From nursery to independence in the landscape - recommendations
- Craul,. P.J. (1992)
  Urban Soil in Landscape Design, Wiley.
- Trees and Design Action Group (2014)
  Trees in Hard Landscapes: A Guide for Delivery
- Trees and Design Action Group (2018)
  Trees, Planning and Development
- Centre for Ecology and Hydrology (2006)
  Tree Roots in the Built Environment,
  TSO. National Joint Utilities Group (2004)
  NJUG Guidelines for the planning, installation and maintenance of utility apparatus in proximity to trees.
- NJUG Volume 4 (2007)

Case study – Good Practice Tree Planting

The regeneration of the East London landscape for the London 2012 Games involved the planting of many thousands of standard, semi-mature and mature trees. They were planted within the park itself and around the hard landscaping of the games' venues and access infrastructure.

Planting trees in the hard landscaping was especially challenging due to the poor nature of the soils and the need to ensure the survival and longevity of the trees. They were predominantly chosen to be climate change resilient in line with the advice available on The Right Trees for Changing Climate website. Around the venues some of the larger trees planted had specially constructed voids created to provide sufficient soil rooting volumes for the trees' future growth. These voids provided aerated, moist good quality soil without compromising the load-bearing integrity of the supported surface above, allowing the passing of vehicles and pedestrians above the tree's roots without any of the negative effects usually associated with high levels of pedestrian and vehicle traffic.

Photo credit: Jim Smith, Forestry Commission

Section 2 Tree Selection

Decision support and thinking long term

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Many factors must be considered if a tree is to establish, be healthy, grow to its full potential and offer optimal benefits for the location. These 'selection criteria' define the tolerances and qualities that the tree must meet. Carefully defining these criteria will help ensure an optimal tree selection for the location.

The Selection Criteria can be grouped under four headings:

- **Tree suitability**: for example site category and substrate availability (see Section 1: Location), tree characteristics, growth requirements and constraints
- **Ecosystem services delivery**: such as amenity values, shading and supporting wildlife (see Section 3: Ecosystem Services)
- **Disservices**: the unintended problems of some species including high pollen production, proliferation of fruit, raised roots or a degradation in air quality (see Section 3: Ecosystem Services)
- **Climate change resilience**: for example tolerance to drought, frost hardiness, temporary water logging, response to elevated air temperatures and shortened winter dormancy, and pests and diseases (see Section 7: Pests and Diseases).

Tree selection will be driven by identifying which selection criteria are pertinent to the planting location and collating all relevant information. Once the selection criteria have been identified there are a number of databases, decision support systems and guides available that are useful in searching for the right tree. Some of these are presented in Table 1.

Table 1

Searchable databases	
Reference and Source	**Notes**
Right Trees for a Changing Climate (UK)	Focuses on tree species suitable for the UK and on the effect of a changing climate. Does not have options to select by pest/disease risk or ecosystem service delivery.
RHS (UK) https://www.rhs.org.uk/plants/trees https://www.rhs.org.uk/advice/advice-search	Detailed information and advice on species suitable for the UK, including pest and diseases risks, maintenance required and a list of potential suppliers. Focuses on private gardens rather than public land (e.g. stating when good for smaller areas) though will return results for taller trees where height is specified in search criteria.
Citree (Germany)	European database: multiple criteria to guide species selection including natural distribution, site characteristics, appearance, management requirements, ecosystem services and disservices. Species list not restricted to UK suitability.
SelecTree (USA)	Approximately 40 selection criteria divided into tree characteristics, site conditions, pest & disease information, health, safety & environmental concerns, special uses. Species list is not restricted to UK suitability.
i-Tree species (USA)	Tool to select species according to a particular ecosystem service rating, hardiness zone or height. Also features pest risk. Based on American context[2], though allows UK regions to be selected.
Woody Plants database (USA)	Provides information on species, cultivars, ornamental and environmental characteristics, moisture tolerance, and pest and disease risk. Species list is not restricted to UK suitability.
PLANTS Database (USA) Natural Resources Conservation Service	Provides information on the US distribution for different forms of plants, including many species of trees. Some species have associated plant guide sheets with information on ecology, physiology, management and suitability for use. Species list is not restricted to UK suitability.
Hirons, A. and Sjöman, H. (2018). Tree Species Selection for Green Infrastructure: A Guide for Specifiers, TDAG.	UK centric database presenting information on tree characteristics, natural habitat, environmental tolerances, ornamental qualities, issues to be aware of and use potential.
International Dendrology Society (UK)	Information on trees and shrubs based on descriptions supplied in two books: - Grimshaw J., Bayton, R. (2009) New Trees: Recent Introductions to Cultivation. Kew Publishing. - Bean, W. J. (1976) Trees and Shrubs Hardy in the British Isles. 8th Edition.

Decision Support Systems	
Reference (and Source)	**Notes**
Trees4Future (EU)	Climate matching tool: identifies parts of Europe that currently experience the climate that a 'location' is forecast to experience in the 2050s or 2080s under different Special Report on Emissions Scenarios (SRES) scenarios.

[2] Some species planted in the UK may not appear in the generated short-lists; likewise some shortlisted species may not be available in the UK.

Section 3 Ecosystem Services

The benefits of trees

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Ecosystem services are the benefits provided to society by the natural environment that can be priced into economic calculations. Ecosystem service calculations clarify how nature fits into our market economy and so can help to justify spending decisions, but they are not intended to capture the full depth of our spiritual and cultural connections to nature.

In urban areas, trees provide a range of different ecosystem services that improve human health and wellbeing. For example they can reduce surface temperatures by shading and through evapotranspiration, improve water quality (when planted in catchments supplying urban areas), contribute to sustainable urban drainage, provide habitats for wildlife, create wind breaks, reduce traffic noise, and enhance air quality under certain circumstances.

Air Quality

Air quality refers to the amount of harmful air pollutants which people are exposed to from outside air. Poor air quality is the biggest environmental public health risk globally, and brings forward an estimated 50,000 deaths in the UK each year.

In UK urban areas, the pollutants currently associated most often with deterioration of air quality are nitrogen dioxide (NO_2) and microscopic airborne particles (PM)[3]. In extended periods of very warm weather, air quality can deteriorate due to the production of ground level ozone (O_3).

A related problem associated with plants (including trees) and not usually considered with the more conventional pollutants is the production and atmospheric transport of allergenic pollen.

Because it is not harmful to humans at the concentrations in the atmosphere, carbon dioxide (CO_2) is not usually considered in air quality discussions. Trees, like all plants, absorb CO_2 during photosynthesis. Globally, plants absorb 25-30% of the CO_2 emitted by burning fossil fuels and by deforestation. However, the carbon stored in an urban forest is typically only 2-3 weeks of the fossil fuel emissions of that city, and so makes a negligible contribution to carbon offsetting at a city scale.

[3] When their abundance is measured as a mass concentration of particles below a specified diameter (in micrometers), the concentrations of microscopic particles are referred to as PM10, PM2.5, etc. For the very smallest particles, down to a few nanometres in diameter, the number concentration is more meaningful, and this measure is often referred to as the ultrafine particle concentration (UFP).

How trees affect air quality

Urban air quality in the UK is most affected by road traffic emissions producing NO_2 and PM. Commercial food cooking and wood-fuel stoves are also significant sources of PM in some areas.

A simple and effective way to think strategically about air quality management is **Reduce, Extend, Protect**. The simplest and best way to improve air quality is to plan urban places to reduce sources of pollution. Green infrastructure[4] can help **reduce** pollution by providing welcoming spaces through which people will prefer to walk or cycle rather than drive. Where **reduce** is not possible, some improvements can be made from modifications to the urban environment, including the number, size, and position of urban trees and hedges. These improvements are aimed at **extending** the distance between the pollution source and people or providing **protective** green oases that absorb pollution.

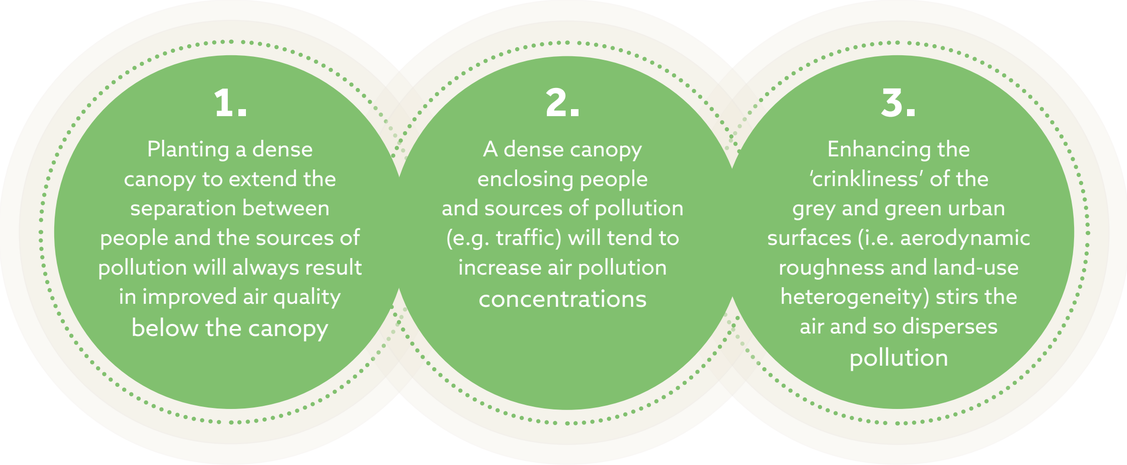
Guidelines from the National Institute of Clinical Excellence provide evidenced options for air quality improvement, including a role for green infrastructure.

Trees absorb some gases, including NO_2, as a by-product of photosynthesis. Trees remove PM from air by acting as a kind of filter. By absorbing gases and PM, trees always reduce the overall burden of pollution in the air, but air quality in any particular place depends on the balance of emissions, ventilation or dispersion by air flow, and absorption or deposition on surfaces like leaves. When emissions dominate over dispersion and absorption, pollution concentrations can exceed government-defined thresholds.

[4] Green infrastructure is the totality of urban vegetation, blue and green space in an area, and incorporates the urban forest.

Guidelines and **tools** exist to calculate the improvement trees can make to the **overall pollution burden**.

Complicated, and therefore expensive, modelling studies are so far the only way to estimate the impact of trees on air quality in a particular neighbourhood or the impact of large-scale planting on ozone episodes. **However three general rules of thumb can provide guidance:**



Favourable plant traits for improving air quality

The plant traits which can be linked with better particulate capture include:

- Being in leaf year round
- Large canopy leaf area
- A high canopy density that is still porous enough to allow air movement through it
- Wrinkled leaf surface, the presence of micro-roughness, veins or hairs

Absorption of gaseous pollutants usually requires leaf-gas exchange ('leaf stomatal conductance') so trees must be healthily photosynthesising rather than stressed. The resilience of planted trees therefore needs to be considered, for example tolerance to pollution, drought and urban heat.

The allergenicity and season for common trees and crops varies. Maintaining diversity of species and tree gender are the simplest strategies for controlling pollen from urban trees. Guidelines have been produced for the reduction of urban pollen counts.

Case study – Valuing Ecosystem Services of Trees

To fully appreciate the benefit of the ecosystem services provided by trees, it helps to understand their value. This value can be calculated through assessing the whole tree population in a town, which can also help uncover and address other strategic issues such as resilience of the urban trees. A number of tools are available, including ‘i-Tree Eco’. Application of the ‘i-Tree Eco’ tool in Petersfield town revealed that their trees provide environmental services valued at £75,000 each year. However, it also revealed that the population is dominated by several tree species which are very vulnerable to devastating pests and diseases. Decisions are now being made on which species to plant for a more diverse population, safe in the knowledge that the financial investment will yield an economic as well as a social return associated with high levels of pedestrian and vehicle traffic.

Photo credit: Andy Moffat

Shading and Cooling

Trees can actively reduce temperatures in urban areas through a combination of shading and evapotranspiration (i.e. use of sunshine to evaporate water). The larger the tree canopy and the denser the shade, the greater the effect. Tree canopy cover is also more effective than other green infrastructure for reducing overall temperatures in towns and cities. This shading and cooling constitutes an important direct climate adaptation mechanism.

Practical guidance for the UK on how to select trees for cooling potential is available

The Disservices of Trees

Urban trees can also cause disservices such as excessive fruit fall on pavements or vehicles, honeydew sap on parked vehicles or ornamental plants and shrubs, direct or indirect damage to property, or excessive shading caused by dense high hedges.

These disservices can be completely avoided by careful and considered species selection or regular maintenance.

(see Section 1: Location and Section 2: Tree Selection).

References

- Woodland Trust (2012)
  Urban Air Quality – how trees can improve air quality
- iTree: tools for assessing and managing forests and community trees
- (2016) Landscape Institute
  Case study: Eastern Curve
- (2014) TDAG
  Trees in Hard Landscapes: A Guide for Delivery
- European Commission (2011)
  Measures to reduce the urban pollen count
- UK National Ecosystem Assessment (2011)
  The UK National Ecosystem Assessment
- Davies, H et al (2017)
  Delivery of ecosystem services by urban forests , Forest Research

See also academic research papers at:

- Effectiveness of green infrastructure for improvement of air quality in urban street canyons
- Computational Fluid Dynamics Air Pollution Dispersion Modeller
- Development and application of an urban tree air quality score for photochemical pollution episodes using the Birmingham, United Kingdom, area as a case study
- First steps in air quality for built environment practitioners
- Green infrastructure and ecosystem services - is the devil in the detail?
- Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments - a review
- Urban green zones and related pollen allergy: a review.
  Some guidelines for designing spaces with low allergy impact
- Air temperature regulation by trees and green infrastructure

Section 4 Biodiversity

Tree selection to enhance and support biodiversity

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Trees support biodiversity across a wide range of functional groups, including epiphytes, herbivores, predators and omnivores. They provide structure (cover, shelter, roosting and nesting sites) and food resources for vertebrates, invertebrates, fungi, lichens and other organisms. The number of insect species associated with trees in Britain generally increases with host tree abundance, and depends on the number of years a tree type has been present in Britain and whether or not it is evergreen or coniferous. Other contributing factors to the species-richness of insects on trees include time of year, leaf size, tree height, tree age, size and structure and the environment they are planted in.

Biodiversity Benefits of Trees

All trees support biodiversity and urban trees have considerable potential to sustain and enhance urban biodiversity and to help reduce biodiversity loss. If trees are being planted to maximise biodiversity, then the longer a tree species has been present in the British Isles the wider the range of other species it can support. For example trees such as native oaks and willows support the greatest number of species at over 400 species each, whereas introduced species such as Persian Walnut and Holm oak support far fewer species. This is supported by a study of urban trees in Bracknell which found that the number of native trees correlated with higher abundance of true bugs (Hemiptera) and birds.

In urban gardens the best way to enhance invertebrate abundance in the widest possible range of invertebrate taxa is to plant a tree (regardless of tree species). This may be due to the amount of foliage that a tree provides: the more plant matter the more invertebrates are supported.

Biodiversity loss and invasive trees

Invasive plant species are recognised as a major direct and indirect driver of biodiversity loss across the globe. The disruption of an ecosystem from invasive trees may cause economic or environmental harm, adversely affect human health or impact adversely upon biodiversity, including the decline or elimination of native species (through competition, predation, or transmission of pathogens) and the disruption of local ecosystems and ecosystem functions.

However in urban centres cultivars have and will continue to play an important role in contributing to diverse and resilient tree populations. The key is to select the right tree for the right place whilst not adversely impacting on biodiversity.

Cultivated Plant Genetic Diversity

The UK has a rich cultivated plant diversity (circa 400,000 species, varieties and forms) all originating from, or derived from, wild collected material, and there are hundreds of types of trees cultivated in the UK. This diversity is of significant human, conservation and scientific value.

Planting trees of all the same type can limit biodiversity and present biosecurity issues for resilience. Some trees may be genetically identical, with large populations of the same clone potentially more vulnerable to pests and diseases.

Cultivated Plant Genetic Diversity

Growing and conserving a wide range of native and cultivated plant genetic diversity in urban landscapes helps to build resilience to climate change, and maintains diversity to select and breed from for resistance against pests and diseases, for example resistant elms. It may also serve to provide conservation refuges for vulnerable plant species in the wild (e.g. Monkey Puzzle tree). Furthermore, as new knowledge arises it provides new uses for tree diversity that improve well-being and the urban environment.

Planting a wide diversity within urban landscapes further supports the delivery of the Convention on Biological Diversity Strategic Plan for Biodiversity 2011-2020, including Aichi Biodiversity Targets and the UN Sustainable Development Goals.

In seeking to avoid monocultures or over reliance on a few particular types of tree urban foresters frequently apply the 10, 20, 30 Rule. This Rule states that the target for an urban tree population should be to have no more than 10% of a particular Species, no more than 20% of a particular Genus and no more than 30% of a particular Family. This rule helps to build resilience into the urban forest.

(See reference to The Tree Health Resilience Strategy in Section 5: Procurement)

References

- **IUCN Species Survival Commission (SSC) Invasive Species Specialist Group (ISSG), namely the IUCN Global Invasive Species Database**
- **The Global Register of Introduced and Invasive Species**
- **European and Mediterranean Plant Protection Organization (EPPO) list of invasive plants species**
- **European Network on Invasive Alien Species NOBANIS**
- **Delivering Alien Invasive Species Inventories for Europe DAISIE**
- **The GB non-native species secretariat NNSS**
- **Non-native Species Information Portal**
- **Trees and Shrubs On-line**
  incorporates Bean's Trees and Shrubs Hardy in the British Isles and New Trees: Recent Introductions to Cultivation
- **The Hillier Manual of Trees and Shrubs (2014) 8th Revised edition**
- **The Royal Horticultural Society Plant Finder (2017)**
- Santamour, F.S. (1990) **Trees for urban planting: Diversity, uniformity and common sense, in: Proceedings of the Conference Metropolitan Tree Improvement Alliance (METRIA). pp. 57–65.**

See also academic research papers at:

- Alexander, A., Butler, J. and Green, T. (2006) British Wildlife 18(1): 18 - 28
- Alvey A.A (2006) Promoting and preserving biodiversity in the urban forest Urban Forestry & Urban Greening 5:195–201.
- Alvin J. Helden, Gemma C. Stamp and Simon R. Leather (2012) Urban biodiversity: comparison of insect assemblages on native and non-native trees. Urban Ecosyst 15:611–624
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- Salisbury A., Al-Beidh S., Armitage J., Bird S., Bostock H., Platoni A., Tatchell M, Thompson K. and Perry J. (2017) **Enhancing gardens as habitats for plant-associated invertebrates: should we plant native or exotic species? Biodiversity and Conservation. 26: 2657-2673**
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Section 5 Procurement

Contract growing, procurement policies and standards

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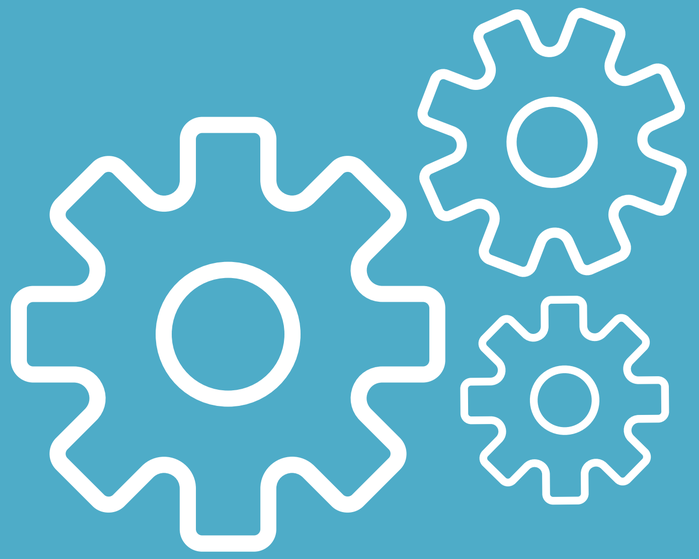

Trees should not be considered an off-the-shelf item. Several of the long term challenges to urban trees continuing to survive and thrive for the benefit of future generations demand a response from the tree consumer and supply chain.

Contract Growing

The largest purchasers of standard trees for urban tree planting in England are **local authorities**, **government agencies** and **the development sector**.

Traditionally they have been passive consumers of what tree nurseries are able to supply both from home and abroad. Decisions on tree selection, tree size and production system used (principally bare root, rootballed, containerized or container-grown systems) are usually taken by the purchasing authority and are to a certain extent driven by what is available at the time.

Production lead time is a significant barrier for suppliers providing 'future proofed' trees.

As significant players in a market-driven economy, the major purchasing organisations could use their combined purchasing power to instigate change.

Considerations such as the delivery of ecosystem services **(see Section 3: Ecosystem Services)**, genetic diversity **(see Section 4: Biodiversity)** and biosecurity **(see Section 7: Pests and Diseases)** can be allied to specified contract growing and taken into account when either purchasing trees or specifying supply contracts.

Similarly strategic (national and regional) policy can inform and direct local policy. Local authority policies and tree and woodland strategies should be integrated into Strategic, Local and Neighbourhood Plans and detail can be provided through Supplementary Planning Documents. Implementation of policy through contract preparation and specification together with contract growing should be a priority, referencing good practice guidelines and relevant British Standards.

Procurement Policies

All large organisations have procurement policies that are based on financial probity, support headline policies and strategies (such as tree policies and tree and woodland strategies), and fulfil Corporate Social Responsibility objectives. The following considerations should also built-in as conditions of procurement, either singly or in combination.

Biosecurity

The primary driver for including biosecurity in procurement policy is to prevent the transmission of pests and diseases due to transportation of tree stock, specifically transportation without adequate oversight or an effective audit trail attributing ownership and a chain of custody from seed to planted tree at its final destination. (see Section 7: Pests and Diseases).

Procurement policy should favour:

- Trees grown from seed in the UK, or those subject to a period of isolation for one full growing season following importation from abroad. Trees should not be imported and planted directly into an environmental setting.
- Contract growing of stock wherever possible
- Suppliers that are able to demonstrate a supply chain audit trail (for example, are part of a recognised Plant Health Assurance scheme) that ensures plant material sourced within the UK is under a regime of biosecurity-aware production and following nationally agreed good practice guidelines
- Suppliers that demonstrate a combination of all of the above.

Procurement Policies

Ecosystem Services

Procurement policy should:

- Favour planting trees that have low pollen loads near highly vulnerable sites such as schools, hospitals care homes etc.
- Avoid planting trees with high allergenic potential near highly vulnerable sites such as schools, hospitals, care homes etc. Diversity of population (tree type and gender) is the simplest approach to limiting the impacts of trees with high pollen loads or allergenic potential
- Favour trees with attributes known for filtering PM10 and PM2.5
- Favour trees with attributes known for extracting gaseous pollutants.

See also Section 3: Ecosystem Services.

Sourcing a Healthy Tree

Procurement policy should follow the recommendations in Section 8 of BS 8545 Trees:

From nursery to independence in the landscape (2014) to ensure the purchase of a healthy tree. An Animal and Plant Health Agency (APHA) Notification is required on all imports of restricted and prohibited species either pre-import or within 5 days of landing. See APHA notification information at the .gov website for more details.

Resilience including climate adaptation

Our trees are facing a range of threats, from changing climatic conditions to novel pests and diseases. When planting or managing trees, it is important that procurement policy should consider both tree diversity and genetic variation as this can help the treescape to survive and adapt to future threats.

Procurement policy should favour:

- Trees identified as being resilient and adaptable to the range of circumstances expected in urban areas as a consequence of climate change
- Planting a wide range of trees and plant material sources that increase genetic diversity. Avoid weighting tree planting towards more than 20% of the same species in a single scheme whilst relating this decision to the population species mix as a whole.

See also Section 4: Biodiversity.

The above notwithstanding, procurement policy should also acknowledge that:

- Limiting choice based on ecosystem service or disservice provision alone is not compatible with creating tree population diversity for resilience
- Tree selection should be tailored to local site conditions.

References

- (2012) TDAG Trees in the Townscape: A Guide for Decision Makers
- (2014) TDAG Trees in Hard Landscapes: A Guide for Delivery
- British Standards Institute (2014), **BS 8545:2014 Trees: from nursery to independence in the landscape**
- (2013) The Big Tree Plant Working Group The Barriers and Drivers to Planting and Retaining Urban trees
- Defra (2018) Tree Health Resilience Strategy

Section 6

Planting and Establishment

Ground preparation, production system choice, mulching, weeding, watering, formative pruning

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The level of intervention required when planting and then maintaining a tree is a matter of professional judgement, and many larger schemes fail because of insufficient follow up care and maintenance.

This can happen through a lack of dedicated resources, a conflict of priorities or not appreciating the importance of aftercare in the establishment of young newly planted trees. The advice of an expert should be obtained to ensure the investment is not wasted due to lack of adequate maintenance.

Ground preparation

When planting a tree, it is usually necessary to undertake some ground preparation when digging the planting pit to assist in the tree's establishment. Often the simplest approach is the most effective if the tree's basic physiological needs (water, an aerated root system, sunlight and access to nutrients) are met.

The type of preparation required will be informed by the type of production system chosen. It may simply be ensuring that the volume of the tree pit can accommodate the roots of the tree, with some space for backfilled soil to encourage initial growth of the small fibrous roots important for establishment. In certain clay soil types it may be more complicated and involve scarifying the top edges (but not the base) of the pit to avoid the tree's roots girdling the pit. Most often it involves adapting the make-up of the backfilled soil with a top-soil/organic matter mix, and the fitting of a watering pipe or above ground slow release water bag. On larger sites a subterranean void filled with soil mix using a cellular block system may need to be constructed to ensure sufficient rooting volume for the mature size of the chosen species of tree. Air vents and irrigation pipes will further ensure that the tree's roots have access to adequate water and oxygen.

Tree production systems and planting

The type of tree production system chosen determines how the tree will be planted. **The four main production systems are:**

- Rootballed
- Bare root
- Container grown
- Containerized.

Each system has advantages and disadvantages, and due to physiological factors some species of tree are more readily provided by one system than another. For example, conifers are not tolerant of being lifted as bare root stock and so are usually supplied as either root balled, container grown or containerized. Deciduous trees by contrast, when dormant, are readily lifted and can be transplanted and supplied easily as bare root and rootballed, as well as containerized or container grown. Choosing which system to use is also heavily dependent on site and aftercare considerations for the tree's long term survival. The chosen system will determine which staking or underground guying method needs to be used to secure the tree in place prior to the establishment of a stable and independently supportive root system. Expert advice should therefore be sought prior to opting for one system or another. Avoiding ground settlement after planting will ensure that the tree is planted at the correct depth, thereby avoiding burying the root flare.

Establishment and formative pruning

Once planted and secured in place in its new location, effective weed control and watering are essential during the first three to five years of the tree's life.

In nurseries young trees receive optimal care and attention; transplanting them into a hostile urban environment can often 'shock' their physiological condition resulting in stress, a reduction in growth and difficulty establishing. Controlling the weeds in the planting pit around the tree, either by chemical control, plastic mulch mats or wood/bark chippings, together with a regular and adequate watering regime are the best possible antidote. Research provides good evidence that using single species woodchip is better at aiding establishment due to supporting fungal soil biology.

Applying fertilizer to newly planted trees is not recommended; this tends to encourage competing weed growth as trees cannot utilise the fertilizer nutrients as effectively or as speedily as grasses or other weeds.

Formative pruning - often undertaken in the nursery prior to dispatching the tree to site - should continue after planting to avoid future problems. This may involve the selection of a dominant leader and removal of competing co-dominant ones, or the removal of lower branches to support the development of a crown architecture consistent with the requirements of the location the tree is planted in. Formative pruning should continue until the desired final crown architecture is achieved. If correctly applied, formative pruning will extend a tree's life span and reduce the need for intervention in later life.

References

- British Standards Institute (2014)
  BS 8545 Trees: From nursery to independence in the landscape
- Ferrini, F et al (2017)
  Handbook of Urban Forestry Routledge

Section 7 Pests and Diseases

Threats, signs, symptoms and management solutions

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Our trees are under threat from an increasing number of pests and diseases. Being aware of symptoms to look out for and the trees that may be affected can help in making informed choices, maintaining healthy trees and developing resilience.

Pests and Diseases

Take time to familiarise yourself with pest and diseases that may be relevant to your planting scheme:

- planthealthportal.defra.gov.uk the UK Plant Health Information Portal
- forestry.gov.uk describes the UK's top tree pests and diseases, including both present and new threats
- www.forestry.gov.uk describes signs and symptoms of tree pests and diseases, e.g. Oak Processionary Moth, Asian Longhorn Beetle, and advice on what to do if you suspect the pest or disease is present
- www.rhs.org.uk provides information about additional pests and diseases, their establishment, and other problems
- www.rhs.org.uk describes pests and diseases of less frequently planted trees and the more unusual pests
- secure.fera.defra.gov.uk provides comprehensive information and a tool for government, industry & stakeholders to prioritise action on pests and diseases which threaten our trees, crops, gardens and countryside
- observatree.org.uk for training resources and field guides
- opalexplorenature.org provides training resources and field guides

Environmental factors, including salt, animal damage, maintenance activities, drought, waterlogging, weed competition, nutrient stress, root damage, soil compaction and tree size on transplanting can also cause symptoms and can affect tree health and resilience longer term.

Prevention

Following good biosecurity practices is critical for preventing the introduction of pests & diseases.

- forestry.gov.uk/England-keepitclean Forestry Commission England guidance, including the "Keep it Clean" resources
- ltoa.org.uk Biosecurity & LTOA experience

Monitoring & Reporting

Establishing a tree monitoring programme will give an early warning of pests, diseases and threats, which can then be managed. There may be monitoring opportunities within local authority tree safety programmes, by encouraging public reporting, or through engaging with local groups.

Everyone can play an important part in looking for pest and diseases which can be a valuable supplement to formal surveillance for signs of trouble. So get familiar with the pests and diseases of concern, keep alert for them, and report suspicious symptoms.

- forestry.gov.uk for reporting tree pests & diseases and problems affecting the health of trees
- For concerns in nursery stock and recently planted trees, email APHA at planthealth.info@apha.gsi.gov.uk or call 01904 405 138

The adoption of a Tree and Woodland Strategy that encourages local community involvement may support and complement good tree health.

Further Information

- Tree Pests and Diseases - An Arborists' Field Guide (2013)

Case Study
Monitoring & Reporting Pests and Diseases

Observatree is a collaborative citizen science project which aims to spot new pest and disease threats to UK trees. Some 200 core volunteers have been trained to recognize 22 priority pests and diseases. They carry out a range of survey activities to help find new pest and disease outbreaks earlier and also track the spread and impact of ones already established. The second finding of Oriental Chestnut Gall Wasp was made by an Observatree volunteer, on street trees in St Albans. This changed the understanding of the known distribution of this pest and led to actions being taken by Forestry Commission England and the Animal and Plant Health Agency. Working together gives a better chance of finding something sooner and to be able to do something about it.

observatree.org.uk/tree-health/pests-and-diseases/

Observatree is a project between **Forest Research**, **Forestry Commission England**, **Forestry Commission Scotland**, **Animal and Plant Health Agency**, **Defra**, **Fera Science Ltd**, **the National Trust**, **Natural Resources Wales and the Woodland Trust**.

Photo credit: Observatree

Section 8

Tree Retention and Removal

Transparent decision making and effective timely consultation

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Public organisations that are responsible for managing large numbers of trees and urban woodland should use a variety of mechanisms to promote transparent decision making when trees need to be removed and replaced with new tree planting.

Trees are biological entities and if not managed in concert with the built environment problems can arise. The urban landscape already contains many trees of great value, and retaining them wherever possible conserves the benefits they provide. Incorporating existing trees into the design of new development is well documented, and guidance is available on how trees may be retained when future-proofing developments so that new trees may be planted in proximity to structures.

Management of a large population of urban trees, including those in urban woodlands, implicitly means that some tree removal will be required to ensure a safe and reliable urban environment. Management is also required in order to maintain a healthy and diverse population that is resilient and able to provide the many benefits detailed in this guide. Since trees are often very highly valued by local communities, it is important that decisions around tree removal be made in consideration of the views of residents with a view to minimising environmental loss.

The reasons for a tree's removal may be important factors in determining what type of replacement tree should be planted, how and where.

A licence may be required for tree felling; the Forestry Commission's website provides details of when felling licence exemptions apply. Maintaining records of felling decisions is recommended in order to show that no illegal felling has taken place.

Consultation

Building community engagement into the decision making processes allows decisions on tree removal to be clearly communicated and understood, and potentially challenged and amended prior to felling taking place.

Good consultation practice engages residents, the local community and other interested parties on the details of felling and associated replanting activities (where applicable). Clearly communicating the reasons behind felling decisions can help to avoid significant negative responses. However, when these are received it may be useful to consider pursuing expert arboricultural advice and seek alternatives to felling.

For health and safety reasons consultation would not be expected in cases where a tree creates or poses immediate risk or danger or is a biosecurity threat.

Tree and Woodland Policies and Strategies

Published trees and woodland management policies establish a consistent approach and explain the criteria that will be used for decisions on tree removals.

Tree and Woodland Strategies promote engagement and provide detail, context and a greater depth of understanding for tree works, and may be used to augment a tree and woodland policy.

References

- Barnet Council (2017)
  London Borough of Barnet Tree Policy
- Camden Council (2015)
  Camden Council's Policy for Council Owned Trees
- Research for Amenity Trees No.9 (2009)
  Trees in Towns II
  A new survey of urban trees in England and their condition and management
- Greater London Authority (2013)
  Green Infrastructure and Open Environments:
  Preparing Borough Tree and Woodland Strategies
- CIRIA (2012)
  www.ciria.org
- TDAG (2014)
  Trees in Hard Landscapes: A Guide for Delivery

Section 9

Appendix

Further Reading & Reference Materials

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Information and further general advice on several of the aspects mentioned in this manual can be found at:

ltoa.org.uk
charteredforesters.org
nato.org.uk
mtoa.co.uk
trees.org.uk
tdag.org.uk
treecouncil.org.uk
treesforcities.org

Books & Further Reading	
Reference and Source	**Notes**
Samson et al. (2017) **Species-specific information for enhancing ecosystem services. In The Urban Forest, Springer.**	Book chapter on ecosystem services and disservices provided by 150 of the most common urban tree species in Europe. Not restricted to the UK context3.
Goodwin, D. (2017) **The Urban Tree. Routledge.**	Book on the benefits of urban trees with an overview of tree selection, planting and establishment. Does not give detailed information on ecosystem services and disservices to aid tree selection.
Wood, P. (2017) **London's Street Trees: A Field Guide to the Urban Forest. Safe Haven.**	Contains information on many of the tree species that can be found in London, describing some of their attributes and rating how rare they are in London streets.
Roloff, A. (ed.) (2016) **Urban Tree Management. Wiley Blackwell.**	Book linked to the Citree database; describes the benefits of urban trees and gives an overview of considerations to have in species selection.
Stokes, J., White, J., Miles, A. and Patch, D. (2005) **Trees in Your Ground. The Tree Council.**	Book on selection, establishment and management of trees. Easily accessible language; May not be sufficiently detailed for professionals.
Hibberd, B. G. (ed.) (1989) **Urban Forestry Practice. Forestry Commission, Handbook 5. HMSO.**	Guidance for species selection, selection of planting stock, tree establishment and aftercare and management.
Sacre, K. (2018) **A view from the nursery, in EssentialARB. February 2018, 8-9pp.**	Article in 'Essential Arb' on key considerations to be made in tree species selection for urban planting.
Bassuk, N. et al. (2009). **Recommended Urban Trees: Site Assessment and Tree Selection for Stress Tolerance. Urban Horticulture Institute, Cornell University.**	Compiles information on site assessment and descriptions of common urban trees contained in the Woody Plants database.

Nursery Guides	
Reference and Source	**Notes**
Glover, M. (2016). Time for trees. Edition 3. Barcham Trees Plc barcham.co.uk/accessories/time-for-trees barcham.co.uk/products	Catalogue and website resource with references to the suitability of different tree species/cultivars for different urban site conditions. Website also gives information on stock availability and pricing. Focuses on trees for the UK market.
Deepdale Trees - The Tree fact file deepdale-trees.co.uk/trees/tree-information	Website describing trees for the UK market. Associated information sheets contain interesting facts about the species.
The Hilliers Manual of Trees and Shrubs (1971) cabdirect.org/cabdirect/abstract	Catalogue providing detailed descriptions of a large number of trees species suitable for the northern hemisphere.
Majestic's Tree-finder www.majestictrees.co.uk/treefinder	Online catalogue: describes ornamental attributes and recommended site conditions; as well as stock availability and pricing.
www.forestresearch.gov.uk/tools-and-resources	The Ecological Site Classification Decision Support System (ESC-DSS) is a PC-based system to help guide forest managers and planners to select ecologically suited species to sites, instead of selecting a species and trying to modify the site to suit.
J. Frank Schmidt and son co. (2018) **Tree reference guide**	Catalogue with brief descriptions of species and cultivars, and recommended site conditions. Targeted for an American audience (tree species).

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