Tree Diseases in London: The Economic, Social and Environmental Impact
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June 2013

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Foreword

London is one of the greenest cities of its size in the world, which both benefits its residents and workers and helps attract its millions of visitors annually. The City of London Corporation is proud to be the custodian of almost 11,000 acres of open space for public use, a sizeable part of which is made up of forest and woodland, including Epping Forest, Hampstead Heath, Burnham Beeches, Ashtead Common and Highgate Wood.

Trees play a vital role in London’s green infrastructure and provide a range of benefits – from improving air quality and regulating temperature to boosting physiological and psychological wellbeing. It is therefore of serious concern that London’s trees are increasingly under threat from new and emerging pests and diseases. These include ash dieback, oak processionary moth (OPM), and massaria, which affects the iconic London plane tree.

The City of London is taking proactive steps to help effectively manage these and other threats to London’s trees. In January 2013 we hosted a conference, ‘Tackling the threats to London’s trees’, which raised awareness of the issues and considered practical options in going forward. More recently, the Corporation has been working alongside the Forestry Commission and others as part of the London OPM Advisory Group to help tackle the impact of oak processionary moth in London, and in May successfully secured £2 million in additional government funding.

We are also undertaking a number of smaller initiatives to counter the negative impacts of such threats on London’s tree population. These include:

- Taking action to reduce the impact of massaria on large limbs of London’s plane trees on all of our sites and in particular the City Gardens, Hampstead Heath and southern parts of Epping Forest including Wanstead Park and Flats;

- Coordinating with the Greater London Authority and the Forestry Commission in managing tree disease in London;

- Commissioning research into the impact of powdery mildew on young oak growth, which appears to be having a significant impact on oak regeneration;

- Training and supporting volunteers to help with the inspections and checks needed to look after the City of London’s trees.

This paper highlights the need for close coordination across London’s boroughs, to help build up resilience within our tree stock against pests and diseases. The City of London is committed to working to protect London’s trees, an iconic resource to our capital.

Mark Boleat
Chairman of Policy & Resources Committee
City of London

Alderman Robert Hall
Chairman of Open Spaces & City Gardens Committee
City of London

June 2013
Executive summary

Now more than ever, London’s tree population is facing a range of new and serious threats. Given the vital role that trees play in London’s green infrastructure and the benefits they bring, policymakers are trying to find ways to address these issues. This special interest paper, commissioned by the City of London, outlines the economic, social and environmental benefits that trees bring to London, notes the key challenges faced, and raises a number of ways in which these can be addressed.

Section one looks at the role of trees in urban centres like London. Trees, as the largest component of the urban ecosystem, are essential to making urban centres pleasant for their inhabitants. As the urban population grows, so the importance of the green infrastructure that trees provide, increases. Yet, as trees in townscapes become more important, they are under threat from novel pests and diseases.

Almost 40% of London is green space, making it one of the greenest cities of its size in the world.1 It is this that attracts people to work, rest and play in its midst. London is a world-leading business centre, with many global businesses located there. High quality green space is believed to be a consideration in businesses’ decision to locate in townscapes.2 Green space also aids social interaction, community cohesion and integration among city residents3, and London’s parks and gardens are an influential factor in tourists’ choice to visit the city.4

Green space, with its attendant wildlife, is known to benefit human wellbeing in various ways.5 These are explored in more detail in section two, and include:

- Air filtering;
- Micro-climate regulation;
- Noise reduction;

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• Rainwater interception;
• Recreational and cultural values.

Trees contribute significantly to these wellbeing benefits of green space. Trees provide one of the key elements of life, oxygen, and extract carbon dioxide from the air in the process. Less tangible - but very important - is their contribution to shading, reducing urban temperatures, supporting biodiversity, and intercepting rainfall to reduce surface water run-off. These benefits, known as ecosystem services, are considered in more detail later.

Putting these and other benefits at risk are the many threats to tree health, of which novel pests and diseases are of increasing significance. Section three examines how, in recent years, we have seen a dramatic escalation in the number of such threats, and the introduction of novel types of pest and disease.\(^6\) This is mostly as a result of the global trade in plants, timber products and other packaged commodities, with the demand for instant new landscapes for example, seeing plants drawn from far and wide. Climate change is another contributing factor to the prevalence and introduction of threats, as it alters the natural relationship between pests, diseases and their tree host.\(^7\)

To date, plant health legislation has not been effective at stopping the entry of pests and diseases into the UK, because it tends to be reactive rather than preventative in approach. The UK tree population needs to be proactively managed to ensure that it is resilient to these threats when they arrive, and to provide a sustainable green network for future generations to enjoy. In section four of this paper, some of the ways in which we can sustain a tree resource in London are explored. The Forestry Commission has taken such a proactive role in trying to combat the onslaught of threats to urban trees. For example, in January 2013 the Commission organised a conference, hosted by the City of London.\(^8\) This brought together policymakers to hear experts’ views on how threats to trees might be countered. The consequences of failing to effectively manage the threats to the UK tree population are briefly set out in section five of this paper.

The final section draws together the evidence discussed throughout the paper and provides suggestions for how London can effectively address the threats to its trees.

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6 Forestry Commission Pest and disease outbreak timeline, see http://www.forestry.gov.uk/forestry/infd-8ziqag
7 Forestry Commission (2002) ‘Bulletin 125 Climate change – impacts on UK forests’ Ch.7: Effects of climate change on fungal diseases of trees by Lonsdale D and Gibbs J, and Ch.8: Climate change implications for insect pests by Evans H., Straw N., and Watt A, see http://www.forestry.gov.uk/fr/INFD-SZYHMC
8 Tackling the threat to London’s trees – conference papers (24\(^{th}\) January 2013), see http://www.forestry.gov.uk/forestry/infd-94eippc
1. The role of trees in urban centres

1.1 The urban ecosystem

Ecosystems are made up of two major components – biotic and abiotic. Biotic components are those that relate to, or result from, living organisms – plants, animals, fungi, bacteria and so on. Abiotic components are physical rather than biological – soil, water, air. In an ecosystem, neither is independent of the other. The biotic components of the ecosystem are influenced by man. This leads to semi-natural ecosystems where man has had an influence. There are few, if any, entirely natural ecosystems, which have developed without some human intervention, within the UK. At the opposite end of the spectrum are artificial ecosystems, where landscapes are fully man-made. This is often the case in urban areas where a former landscape has been displaced to make way for built form and a new landscape created around it – formal parks and gardens, street trees, flower beds etc.

Though alive and well, the urban ecosystem is fragmented and largely of artificial creation. London for example, contains semi-natural fragments, perhaps the best known being Richmond Park. As one moves towards the core of London, so the human influence comes to the fore and by the time one is in the urban heart of London, so the artifice of nature is prevalent. Those managing the urban ecosystem achieve great things given the fragility of nature in these heavily built-up zones.

1.2 Green infrastructure

Underpinning the urban ecosystem is what is termed green infrastructure. As its name suggests, this is the network of plants, grass, shrubs and trees that intermingle with built form - the grey infrastructure - and are often found alongside water, referred to, unsurprisingly, as blue infrastructure.

Green infrastructure’s network of corridors, patches of green space and stepping stones, often in the form of trees, are vital to support wildlife and provide people with accessible contact with nature.

1.3 Tree populations

Trees are at the core of the green infrastructure. They often provide the only or most visible greenery in city streets, making trees one of the most tangible components of the green infrastructure. While trees often form part of the background, their absence results in hostile environments, uninviting to people.

We talk of tree populations as, like human populations in urban centres, there is variety in their make-up. Tree populations often have several species, several age cohorts and several forms co-existing simultaneously. It is common for there to be a
preponderance of one or two species, age groups or form, and this is noticeable in London.

The bulk of London’s tree population is derived from plane, lime and cherry species (see Table 1). Plane is a particularly iconic tree, known in the UK as the London plane. These species have come to dominate because they tolerate the growing conditions and the pruning regimes that are sometimes necessary to contain their size within an urban ecosystem such as London. Cherry is often planted solely for its attractive show of flowers in spring.

Table 1: Most abundant genera within the City of London⁹

<table>
<thead>
<tr>
<th>Rank</th>
<th>Genera</th>
<th>Common name</th>
<th>% of tree cover in the City</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Platanus</td>
<td>Plane</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>Tilia</td>
<td>Lime</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>Acer</td>
<td>Maple</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Prunus</td>
<td>Cherry</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Carpinus</td>
<td>Hornbeam</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Betula</td>
<td>Birch</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Sorbus</td>
<td>Rowan / Whitebeam</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Quercus</td>
<td>Oak</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Broadleaf (other)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>Magnolia</td>
<td>Magnolia</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>Robinia</td>
<td>Locust tree</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>Fraxinus</td>
<td>Ash</td>
<td>3</td>
</tr>
</tbody>
</table>

The dominance of a few species renders the tree population vulnerable to threats. A pest or disease that preferentially attacks one of the dominant species can have a catastrophic effect on the tree population, drastically altering the townscape and reducing or altogether removing the benefits trees provide.

Allied to this are difficult growing conditions such as a constrained rooting environment, air pollution and altered hydrological regimes that reduce trees’ resistance to pests and diseases.

2. The benefits trees provide

2.1 Ecosystem services

In 2000, then Secretary General for the United Nations Kofi Annan, called for the UN Millennium Ecosystem Assessment.\(^{10}\) The Assessment ran from 2001 – 2005, and examined the impacts to human wellbeing of changes to ecosystems, and provided suggestions to help enhance the conservation and sustainable use of ecosystems.

The Assessment identified those benefits to mankind provided by ecosystems, including those of urban environments, as ecosystem services. These services fall within four broad categories, as listed in Table 2.

Table 2: Key ecosystem services, general provision and specific provision by trees

<table>
<thead>
<tr>
<th>Ecosystem service</th>
<th>General provision</th>
<th>Provision by trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supporting</td>
<td>Supporting services provide the general infrastructure of life on earth, such as using energy from the sun to make chemical compounds, and the water cycle.</td>
<td>As a woody plant, trees use the sun’s energy to create wood that is then used for timber. The roots of trees extract moisture from the ground, with surplus leaving as water vapour into the sky.</td>
</tr>
<tr>
<td>Regulating</td>
<td>Strongly linked to other services, regulating services effect vital aspects which impact on human life such as climate, hydrological cycles, air quality and hazard mitigation.</td>
<td>Trees are one of the most important providers of regulating services, making a generally positive contribution to air quality(^ {11}), offering shade and shelter(^ {12}), cooling temperatures, and intercepting rainfall(^ {13}), to name a few.</td>
</tr>
<tr>
<td>Provisioning</td>
<td>Dependent on the supporting and regulating services, provisioning services are the goods derived from ecosystems.</td>
<td>Timber and fruits such as chestnuts, hazelnuts and mulberries.</td>
</tr>
<tr>
<td>Cultural</td>
<td>Cultural services are those services derived from human</td>
<td>Many festivals celebrate trees(^ {14}) or are associated with trees.</td>
</tr>
</tbody>
</table>

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\(^{14}\) For example see [http://www.forestry.gov.uk/westonbirt-treefest](http://www.forestry.gov.uk/westonbirt-treefest)
interaction, with each other, and with nature. This has connections with outdoor recreation, learning, association, and spirituality.

example in the City, The Worshipful Company of Girdlers, and Sutton’s Hospital in Charterhouse each hold a special dinner to celebrate mulberry fruits. Certain tree species are iconic, such as the English oak and the London plane. Other symbolic cultural traditions include the green man, and tying a yellow ribbon onto an old oak tree.

2.2 Micro-climate regulation

Some may be familiar with the term ‘urban heat island’. Due to the many buildings and hard surfaces in London acting as heat stores, the temperatures in London tend to be higher than in the surrounding countryside. The presence of trees mitigates this effect. Trees cool in a variety of ways but mainly via the shading effect and by evapotranspiration, a process of water loss via the leaves, which cools the air.

2.3 Air quality

The London Climate Change Partnership has recently made explicit the link between trees and health, for example through improving air quality. Trees do so foremost by generating oxygen. A number of tree species also improve air quality through the capture of health-damaging airborne particulates and uptake of gaseous air pollution such as sulphur dioxide and nitrogen oxide, through their leaves. Subsequently tree planting has been used to improve air quality in urban centres. The East London Green Grid strategy for example, proposes the use of species-diverse tree populations as a cost-effective means of reducing air pollution.

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18 Forest Research (October 2010) – Op Cit.
2.4 Psychological and physiological wellbeing

Trees provide a number of psychological and physiological benefits. For example, the combined effect of biodiversity hosted in urban centres by trees, makes for pleasant places. Bird song comes about only because birds have places to rest, feed and breed. Those places are often the trees. Loss of trees directly equates to a loss of birds, which is just one form of biodiversity that we appreciate, and which provides psychological wellbeing as a result.

Trees also provide people with a sense of place. London has its iconic plane, widely planted in the capital from that gave it its name. The English oak, another iconic tree species, symbolises strength. Early London was built with oak and the ships that sailed from London crafted from it. Examples of oaks in London today can be seen along Cheapside and London Wall, and more ancient examples can be found in the Royal Parks.

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20 For example Dunnett N., Swanwick C., and Woolley H (May 2002) Improving urban parks, play areas and green spaces, Department of Landscape, University of Sheffield Urban Research Paper, Department for Transport, Local Government, and the Regions; London, see http://www.ocs.polito.it/biblioteca/verde/improving_full.pdf
3. The threats to London’s trees

Threats to trees come in many guises. Leaving aside deliberate tree loss which can be necessary to facilitate change, there are a gamut of pests and diseases that trees face. These can be long-standing or novel, host specific to trees or particular tree species or more generalist, which can result in collateral damage.

The rate at which these threats have emerged has escalated markedly in the last decade (see Figure 1). Much of this is attributable to global trading, though this is not confined to trade in plant material. Pests and diseases are also introduced in packaging materials, especially wooden crates. The Asian longhorn beetle arrived in North America and the UK hidden within the timber of wooden crates imported from China, and the gypsy moth, discussed later, is believed to have entered the UK by attaching itself to vehicles.

Figure 1: New tree disease and pest outbreaks UK

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21 The Food & Environment Research Agency (FERA) (13th June 2013) Extension of infestation zone for exotic beetle pest found in Kent, see http://www.fera.defra.gov.uk/showNews.cfm?id=549.
22 Forest Research (March 2007) Tree pest advisory note: gypsy moth, see http://www.forestry.gov.uk/pdf/gypsy_moth_advisory_note_mar07.pdf/$file/gypsy_moth_advisory_note_mar07.pdf
Trees provide food and homes for many organisms so inevitably, some pests and diseases have always been present within UK native tree stock. It is the influx of novel pests and diseases which causes concern. Our trees have not yet evolved a resistance to these and therefore can be severely impacted once they arrive, a phenomenon being witnessed of late.

3.1 Long-standing threats

Many are probably familiar with Dutch elm disease, which caused widespread destruction of elms in the UK in the 1970s, and continues to do so today. Following the initial impact of this disease in London, which caused significant damage to its elm stock, there are now very few, if any, of this species left to infect in the capital. Trials with elms are underway and those species believed to be resistant to the disease have been planted, in places, in the City.

Another well-known and still very active disease is honey fungus. The relationship between the tree and the fungus, like many in nature, is complex. It is thought that this fungus helps a tree grow, nurturing its food source, before then decaying and/or killing it at some later stage. Sudden tree death in summer is often attributable to this fungus. Honey fungus operates in urban areas but is relatively low impact, killing only a few individual trees in London annually.

Bacterial canker of horse chestnut has impacted heavily on this candle-flowered and conker-bearing tree, found in streets and parks. It causes death of the bark, exposing the underlying wood to decay. In some cases, long-term infection can cause part or all of the tree to die. Horse chestnuts are often felled to avoid their untimely failure, and in so doing, remove a source of infection.

Also affecting horse chestnut trees is the horse chestnut leaf miner. The larvae of this ‘micro-moth’ mines between the upper and lower surface of the leaf, causing extensive browning of foliage in late summer. This leads to a reduction in photosynthetic rate and energy production, reducing the vitality of the trees and rendering them susceptible to other ills.

3.2 Novel pests and diseases

Making headlines recently are a number of pests and diseases that are new to the UK, having arrived from continental Europe, Asia and the Americas. These pose a significant threat to native UK trees, which have no natural resistance to such threats, given a lack of adaptation and/or an absence of natural predators.

Currently the main novel threats in urban areas are the oak processionary moth, ash dieback, and massaria. Massaria is most significant to London as its host is the London plane tree.
3. The threats to London’s trees

3.2.1 Oak processionary moth

It is the caterpillar of the oak processionary moth (OPM) that causes trouble. It is a defoliator of predominantly oak trees and on the continent, tree dieback has resulted from large scale, intensive OPM outbreaks. Of most concern are the human health problems it causes, placing it on London’s Risk Register\(^{24}\) - the caterpillars in their later stages of development carry barbed hairs that cause severe skin irritation and breathing difficulties.

The outbreak of this pest in the UK was first discovered in West London, near Kew Gardens, having been brought in on imported oak trees. It quickly gained a foothold and spread to Kew Gardens, through Richmond and its Park, and is now progressing through Surrey, and before long, will spread to neighbouring counties.

Attempts to eradicate this pest have been through the use of Plant Health Notices, which demand treatment by landowners. Despite best efforts, treatment of the pest has turned to containment. Though, effective control of this pest is difficult because the collateral damage is high. Kew Gardens for example has managed to limit the impact of OPM by the use of a chemical insecticide, but this treatment is not selective. Widespread use eradicates any other species susceptible to the chemical, many of which are beneficial to the natural system, with some being endangered species.

In London, the built environment seems to be limiting the spread of the pest, as well as the relative lack of host oak trees compared to the surrounding countryside.

3.2.2 Ash dieback

Also known as *chalara fraxinea*, this fungus has been the basis of much media coverage, and has alarmed the Government to such an extent that in November 2012 a crisis response meeting (COBRA - Cabinet Office Briefing Room A) was convened, a taskforce established, and financial resources dedicated to an action plan.

The disease is thought to have arrived in this country via two means. The first is natural spread from the continent, as fungal spores can travel 20km to 30km in air streams. The second is from the importation of infected plant stock. The demand for ash trees as part of recent woodland creation initiatives has required the sourcing of plant stock from the continent, where the disease has been spreading over the past decade.

Causing the death of mainly young trees, and patchy dieback in the crowns of mature ash trees, the disease is a very real threat to this native species.

The native ash is less common in London than in other parts of the country. For example, in the City of London, ash is the twelfth most abundant family of closely related species, representing 3% of the total tree population. As this family includes other species of ash that are thought to be more resistant to the disease, the impact on the City will likely be slight. That said, this is another species of tree that, as a result of the disease, would no longer be planted, leading to a loss of diversity. It is

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possible that abiotic conditions in the City will inhibit the entry of the disease, though only time will tell as we learn more of its impact in the UK.

### 3.2.3 Massaria

Less well known, but still a threat to safety in London is the branch decaying disease massaria, caused by a fungus (see Figure 2). This disease infects the planes, which are iconic to London. Massaria is not a killer of trees but causes the collapse of branches.

Some London boroughs, including the City of London, have undertaken rigorous inspection to ascertain if the disease is present and, if so, to remove the infected branches. While limiting the likelihood of collateral damage, this will not be sufficient to stop the spread of disease as the omnipresent fungal spores enable reinfection.

**Figure 2: Frequency of occurrence of trees infected with massaria within each area of the City**


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A 2012 City of London study[^26] adopted the method of aerial inspection of its trees, as used on the continent where massaria has been present for some time. The study revealed that, across the Square Mile, 39% of the London planes are infected. In the North West quarter and in Bunhill Fields, a graveyard to the north of the City, this increased to a 50% infection rate. Islington, the London borough to the north of the City, found that 12.5%^[^27] of its plane trees were infected, though this was based on a less exact form of inspection, from ground level.

If the disease only infected small branches, the risk to public safety would not be more than that posed by any healthy tree. However the survey encountered infected branches mainly between 25mm and 100mm in diameter, with some up to 300mm in diameter. If branches of this size fail, this could cause damage, debilitation or even in some cases death, hence the importance of regular checks on tree health.

![Figure 3: Branches infected with massaria within the City][^28]

Like many tree diseases, there is no eradicating treatment for massaria, which leaves only cultural controls to check for and remove infected branches. Massaria can be managed but it is costly. On the continent they undertake aerial inspections and necessary pre-emptive branch removal of their trees three times per annum, such is the speed at which this disease weakens the branch.

There is talk of irrigation and very light crown pruning as methods to reduce the incidence of infection, but no clear evidence of their success is available.

[^26]: See Keen J (24th January 2013) – Op Cit for summary results of the survey.
3.2.4 Sudden oak death

The name of this disease is misleading. It was named in the United States and actually has no bearing on English oaks. In the tree profession the disease is known by its scientific name of *phytophthora ramorum*. It is a fungal disease that causes dieback and kills certain trees and shrubs, notably the Japanese larch, by disrupting the flow of water and nutrients in conducting tissue.

To date this has been a forestry problem, destroying thousands of hectares of forest along the west coast of England, Wales, Scotland and Northern Ireland. Spread by foliage-produced spores, transmitted in moist air, it ravages forests of Japanese larch. Though there are not many Japanese larch in urban centres, it is included here as there is a high possibility that that the disease will spread through the south of England, and towards London.

Where there are intense outbreaks of the disease, other species of tree other than the Japanese larch are being killed. For example the disease is also known to kill a very popular shrub, the rhododendron. It is clearly a serious threat.

There is no control of, or cure for, this disease, but the imposed felling of trees on infected sites helps slow the rate of progress and has been the method of choice to date.

3.2.5 Gypsy moth

This defoliating moth of many broadleaf trees and shrubs has been known to occur in small numbers in this country.

It is another imported pest, but one that is yet to prove a serious problem. A few examples were seen in the City last summer but there was no significant defoliation of false acacia trees where found.

Gypsy moth caterpillars also bear irritant hairs but the results are not as bad as those brought about by the oak processionary moth.

Control measures are similar to those for the oak processionary moth in terms of insecticide, and also tend to result in high collateral damage.

3.3 Tree disease threats from the continent

Outlined in this section are just a few examples of the pests and diseases that are present on the continent\(^{29}\), not including those from farther afield.\(^{30}\)

\(^{29}\) For more information see Forestry Commission *Pests in EU posing a threat to the UK*, [http://www.forestry.gov.uk/pdf/Pests_in_EU_posing_threat_to_UK.pdf/$FILE/Pests_in_EU_posing_threat_to_UK.pdf](http://www.forestry.gov.uk/pdf/Pests_in_EU_posing_threat_to_UK.pdf/$FILE/Pests_in_EU_posing_threat_to_UK.pdf)

\(^{30}\) For more information see Forestry Commission *Other pest threats globally*, [http://www.forestry.gov.uk/pdf/Other_pest_threats_globally.pdf/$FILE/Other_pest_threats_globally.pdf](http://www.forestry.gov.uk/pdf/Other_pest_threats_globally.pdf/$FILE/Other_pest_threats_globally.pdf)
3.3.1 Pine processionary moth

Reportedly as close to UK shores as Paris, this relative of the oak processionary moth is a defoliator of pines and other conifers. While defoliation can reduce the vitality of trees, it is the irritating hairs which pose a health threat to people, and are of most concern.

3.3.2 Plane wilt

Massaria, already here in London, only decays branches and is not known to kill trees. Plane wilt is very much a killer of trees however, and has caused widespread destruction of planes on the continent. The loss of many miles of plane trees from the Canal du Midi for example made the headlines in 2011, and it continues to kill.

Plane wilt disease is related to Dutch elm disease. It operates in much the same way by causing the blockage of tissues transporting water and nutrients, leading to tree death.

If this disease arrives in London it is highly likely to lead to the loss of the iconic London plane. Without a swift response once its presence has been identified, the disease will gain a foothold with rapid transmission from tree to tree. In recognition of this, in January 2013 DEFRA has imposed a notification requirement for the importation of Plane trees into the UK.

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4. Sustaining a tree resource in London

The previous section identified the many different threats to UK trees - the embedded, the novel, and those yet to come.

What is being done about this? What can be done about it? What is realistic and achievable? What is, as the UK Health and Safety Executive term it, a ‘reasonably practicable’ goal for the management of urban tree populations?

While we await the results of epidemiological studies to identify the proximal and distal causes of these threats, we are prudent to consider other measures here.

4.1 Building resilience

The UK is a trading nation. That trade has been a vehicle for the many exotic species of tree we now enjoy in this country. It is also the vector for many novel pests and diseases.

In an attempt to seek control of the spread of these threats, some have called for a ban on plant imports. Yet this runs counter to the free trade between European countries and the international trade which the UK relies upon. A ban on plant imports does little to stave off the import of pests and diseases via packaging, timber, movement of vehicles and many other means.

In a global trading scenario, we will inevitably see the entry of pests and diseases via many channels. Preventing their entry, while desirable, is unlikely to be ‘reasonably practicable’. This leaves us with the goal of ensuring our tree stock can absorb the impact of these threats, while still retaining a viable population.

It is easy to think that all trees are the same. While trees are alike in many ways, there is variation between different types of tree. Each sits along a spectrum of the functions they perform, with some being very good and others less effective - whether that function is the support of biodiversity, carbon sequestration, contribution to air quality, aesthetics, or noise reduction, to name a few. Of course we also see positive and negative responses from trees to their environment. Some are very tolerant of root disturbance, air pollution, pruning, damage, climatic change - but, at the other end of the spectrum, some trees are very intolerant of these environmental factors, to the point where they cannot endure urban settings.

Like any living thing, trees are susceptible to pests and diseases. Most pests and diseases are kept in check by the natural balance, for example, a rise in the mass of sap-sucking aphids being followed by an increase in their predators, ladybirds. The natural order works effectively where nature has had time to adapt to change. However, when a novel pest or disease arrives, one that has been imported or arisen through mutation, there are no natural checks in place. This is why we often see the rapid establishment and spread of new problems and, given the many constraints on resources, it can be very difficult, to control these newly emerged problems. This is not to say we cannot be successful; in 2012 the Forestry Commission were able to contain, and it is believed, eradicate, an outbreak of the tree-eating Asian longhorn beetle in Kent. Early identification and sanitisation felling helped to effectively control this pest.
Often a pest or disease is host specific. In other words, it has a preference for only one type of tree. If a tree population contains an abundance of that preferred tree, the impact on the population can be severe. The UK has a little over 30 native species, with oak, ash, beech, hornbeam, lime, and holly being some of the most common around London. The remaining tree population is made up of trees native to other countries, of which there is probably in excess of 1,000 different species in the UK. Native UK trees have adapted to the native pests and diseases over millennia, but imported trees have no such associations locally.

The threat to trees is therefore double-edged. Native trees are exposed to novel pests and diseases inadvertently brought in, and exotic trees are susceptible to pests and diseases that are native to their country of origin. The common thread is a lack of natural predation, checks, immunity or resistance, rendering trees susceptible to catastrophic damage and loss.

As shown in Figure 4, to achieve urban resilience it is essential to achieve resilience in the underpinning systems - the tree stock. Simply, we need to avoid a reliance on one, or a few, species. There needs to be plenty of trees to absorb the impact of novel pests and diseases, and still retain tree cover, and those trees need to be in good condition - a healthy tree is more able to resist attack than an unhealthy tree.

**Figure 4: Constituent parts of urban resilience adapted to show where trees and the sub-set of one genera, plane, lies** (adapted from the Resilience Alliance)³³

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³³ Resilience Alliance (February 2007) Urban resilience research prospectus: a Resilience Alliance initiative for transitioning urban systems towards sustainable futures, see [http://www.resalliance.org/index.php/urban_resilience](http://www.resalliance.org/index.php/urban_resilience)
The term ‘resilience’ used here does not refer to the engineering definition of returning to the same position after the application of force. Nature does not work in that way. A force of sufficient strength to disrupt nature will cause some degree of irreversible change. However, nature has the ability to absorb change and continue in a similar state, while never returning to its exact original form. For example, a few trees blown down in a forest do not fundamentally alter it from forest to grassland. It remains forest, but with an altered composition. Such change is often a catalyst for regeneration, adding to diversity in nature. It is essential therefore that we have an urban tree population that can absorb the impact of change brought about from pests and disease, and yet continue to provide the urban forest we rely upon.

In nature, such resilience is achieved through diversity. As noted earlier, reliance on one tree species makes the tree population susceptible to catastrophic loss. If a tree population contains many types of tree, it is more likely that a pest or disease destroys only a small proportion of the total tree stock.

Unfortunately this is not the situation at present within UK urban tree stock. Fashion trends, availability of nursery stock and growing conditions in the past have resulted in a range of trees that are reliant on only a few species, particularly in London. In the City of London, for example, there are 220 varieties of tree, yet 45% of the tree population is contained in just five genera – planes, limes, maples, cherries and hornbeams. Of these, planes are the most abundant at 14% of the tree stock, followed by limes at 9%. Abundance is not the only concern. Planes and limes are large trees, so as well as being the most abundant, they provide the most canopy cover within the City. The loss of planes or of limes would therefore denude the City of most of its green infrastructure.

The answer then seems to be fairly simple – plant more tree varieties to avoid reliance on a few. This is indeed the right premise, but there is more to consider. Trees serve a purpose within urban landscapes. Trees provide functions that are of benefit to humans and their wellbeing. Hence, in trying to boost resilience, we need to consider the difference in function between trees, as well as variety. If a tree population contains many species of tree that all provide the same function, and at the same rate, if these trees are lost, that function is also lost. Therefore, alongside planting many varieties of tree, we need to plant trees that perform each function to varying degrees, to ensure a tree population diverse in functions such as contribution to air quality, carbon sequestration, support of biodiversity, noise attenuation, aesthetics and so on.

There are additional factors to consider, however, as we also need varieties of tree that respond differently to perturbation, whether that be pest or disease, climatic change in the form of increased temperature, altered hydrological regimes, air quality or even wind speed.

An example of functional differences between trees is provided by a pioneering research project undertaken by this author, enabled by the City of London. The research found that, in the City, there are significant differences between species of tree, and between native and exotic trees, in the support of biodiversity. The tree population as a whole is lacking in the support of numbers and variety of bird, mammal and lichen species, so the major difference is in the support of arthropods:

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Keen J (forthcoming) The support of biodiversity by urban trees: a case study in the City of London.
the insects, spiders, millipedes, and others, that form the underpinning of a food web to sustain the more visible species, such as birds, that humans associate with trees.

**Figure 5: Abundance vs. frequency of top 20 arthropods on City trees**

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Arthropod abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.c = Alnus cordata</td>
<td>3.0</td>
</tr>
<tr>
<td>A.h = Aesculus hippocastanum</td>
<td>2.7</td>
</tr>
<tr>
<td>A.pl = Acer platanoides</td>
<td>2.4</td>
</tr>
<tr>
<td>A.ps = Acer pseudoplatanus</td>
<td>2.1</td>
</tr>
<tr>
<td>A.ps.P = Acer pseudoplatanus ‘Purpurea’</td>
<td>1.8</td>
</tr>
<tr>
<td>A.s = Acer saccharinum</td>
<td>1.5</td>
</tr>
<tr>
<td>C.b = Carpinus betulus</td>
<td>1.2</td>
</tr>
<tr>
<td>F.e = Fraxinus excelsior</td>
<td>0.9</td>
</tr>
<tr>
<td>F.s = Fagus sylvatica</td>
<td>0.6</td>
</tr>
<tr>
<td>P.BH = Pyrus ‘Beech hill’</td>
<td>0.3</td>
</tr>
<tr>
<td>P.h = Platanus x hispanica</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Key: Red cross = native tree  Blue star = non-native tree

Taken from Keen J (forthcoming) – Op Cit.
Tree Diseases in London

London’s iconic plane tree proved to be poor at supporting biodiversity whereas the English oaks, hornbeams and large-leaved limes, proved to be the best performers.

It is clear then that if we selected a variety of species from the poor performing biodiversity end of the spectrum, tree species diversity could be achieved, but at cost to the essential function of supporting biodiversity. An informed selection therefore will maximise the benefits from the necessarily restricted number of trees that can be accommodated in the urban core.

There are other vital factors that need consideration to achieve resilient tree populations. One is the concept of redundancy - that natural systems have spare capacity and some duplication of function, response and even the same species. Where there is spare capacity, continued tree cover is easy to ensure - but urban tree populations often do not have that spare capacity. In high density business centres, for example, other structures exist that can severely limit the possible tree cover. A classic example of this is the subterranean services network that is placed below hard surfaces, limiting planting opportunities. In many cases these networks will have developed over time, so they may not be logically ordered in a way that minimises space usage. Installing services in the most space-efficient way would allow more space for tree planting, therefore increasing urban tree cover, ideally to a level that will allow some resilience.

The ideas discussed above can best be understood through the concept of econics. Econics is a theory which posits the mimicking of ecological systems, dynamics and function, to improve the function of socio-economic systems, in this case the urban landscape.36

Direct replication of natural tree cover is severely constrained within urban centres, London being no exception. There is little or no opportunity for the natural regeneration of trees through genetic exchange, hence the need to plant trees. There is, however, the opportunity to replicate diversity in the age of trees, the form of tree, and in the horizontal layers of tree cover seen in woodlands. The City of London has been able to achieve this in places. Take, for example, some of the larger open spaces, such as Finsbury Circus, the garden of St. Paul’s Cathedral or the gardens of the Barbican Centre, where large dominant trees often have understorey trees, below which are further layers of shrub and ground cover. The combination of layers improves growing conditions for the trees while increasing biodiversity and often the aesthetics.

Of course this added strand of diversity cannot be achieved in all situations. Often there is only room for a single tree surrounded by hard paving, but as long as there is diversity of age, form and structure across the tree population, there is built-in resilience.

4.2 Effective and co-ordinated management

Achieving resilience cannot be achieved in isolation. It is of limited use for example for one London borough to provide a model tree population, if those around it remain vulnerable to threats.

36 For more information on the concept of econics, see http://www.centreforeconics.org
Effective resilience will only come through a co-ordinated effort on a large scale. The Greater London Authority’s Green Grid for example, could be a role model for this\textsuperscript{37} if built in an informed way. London boroughs could share information and data, pooling resources to combat threats. Policy and guidance would need to be targeted to meet these objectives. Targets, which are now typically centred on the number of trees and tree replacement, could be more focused on diversity. There would need to be monitoring of the number and percentage of tree species, together with the age structure, within the tree population.

The UK has a superb resource of people, skills and technical ability. However, there is a strong need for investment into research to identify the best composition of tree stock, the management of tree stock to provide a strong resilient core to green infrastructure and the means to monitor potential threats, the impact of threats now present and scenario modelling of their impact. We are reliant on there being adequate investment into these research areas, if we are to avoid the consequences of a London devoid of trees.

\textsuperscript{37} For more information, see http://www.london.gov.uk/priorities/planning/publications/all-london-green-grid-spg
5. The consequences of failure

There are a number of potentially serious implications arising from tree loss, but these are seldom given thought until a catastrophic event. This section explores some of the consequences of failing to effectively manage our tree population, with a particular focus on how this negatively impacts the benefits trees provide for human wellbeing.

Build infrastructure, if damaged, can be replaced fairly swiftly. It is costly but achievable to reconstruct a building, and can indeed be the catalyst for change and improvement. Loss of tree cover cannot be swiftly replaced in the same way. New trees can be planted, but it takes decades and even centuries, before mature tree cover is re-established.

Picture London tomorrow, without its plane trees. The effect on the townscape would be dramatic – the loss would be sudden – the replacement not forthcoming for decades. The loss of benefits to human wellbeing would be drastic.

There is little available data for London but a study38 of the benefits of trees in the towns of Torquay, Paignton and Brixham in Devon reveals the scale of damage that may be encountered through tree loss. The study found that trees:

- Represent a structural asset worth over £280 million;
- Provide ecosystem services to the value of £345,811 annually;
- Store 98,100 tonnes of carbon worth £1,474,508;
- Sequester 4,279 tonnes of carbon annually worth £64,316;
- Remove over 50 tonnes of pollutants every year equating to £281,495.

It could therefore be expected that the negative impacts of tree loss on human wellbeing would manifest in some of the following areas.

5.1 Micro-climate regulation

As mentioned earlier, trees help mitigate against the fact that temperatures tend to be higher in London than the surrounding countryside. A loss of tree cover would

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The London Tree Officers’ Association is looking to undertake a similar study of the benefits London’s trees provide.
therefore lead to increased and uncomfortable temperatures, in turn leading to increased energy consumption to power air conditioning\textsuperscript{39}, increasing carbon footprint and further increasing temperatures. This would also have knock-on effects on climate change processes, and the impacts of these.

5.2 Air quality

Most trees, through the generation of oxygen, improve air quality. A loss of tree cover therefore has significant negative implications for human wellbeing. The contribution of trees to air quality has been the subject of recent research\textsuperscript{40} in the United States, which revealed the dramatic cost to human health of tree loss. When the emerald ash borer, a destroyer of ash trees in the United States denuded city streets, it led to an additional 15,000 deaths from cardiovascular disease and 6,000 deaths from respiratory disease. In light of this and other evidence\textsuperscript{41} of the links between green space and physical health, there are of course, also implications in terms of the costs to the NHS and health insurers from a loss of trees.

5.3 Psychological and physiological wellbeing

Trees act as an ecosystem for a host of insects and animals, thereby contributing to biodiversity. This biodiversity has a positive impact on our psychological wellbeing, an example being bird song, provided by birds residing in trees. A loss of trees is a loss of habitat for dependent wildlife, and results in a reduction in the wildlife which previously inhabited those trees. This in turn has negative implications for human health.

Trees also provide people with a sense of place, and are linked to a number of cultural traditions and festivities. The loss of these cultural emblems would be felt deeply, and would likely lead to emotive responses and a ‘save at all costs’ approach.

5.4 Financial impacts

There is also a financial impact from the loss of trees. This is not just from the cost of taking them down and replacing them, but also, for example, from the impact on house prices\textsuperscript{42}, the increased cost of power consumption touched on above, and the cost of alternative techno-centric solutions to improve air quality while we wait for trees to grow. As more and more people look to reside in urban centres, the

\textsuperscript{40} US Forest Service Pacific Northwest Research Station (July 2012) The emerald ash borer – eating away at our health?, see http://www.dcvb-nc.com/ScenicNC/EAB_3_pnw_header.pdf
\textsuperscript{41} For example Richardson D and Parker M (October 2011) A rapid review of the evidence base in relation to physical activity and green space and health, HM Partnerships, see http://www.hmpartnerships.co.uk/wp-content/uploads/2011/10/Physical-Activity-Green-Space-and-Health-FINAL-DRAFT.pdf
\textsuperscript{42} This is based on a study undertaken in 1988, before an appreciation of the value of trees, which reported a 3.5% - 4.5% uplift on houses nestled within mature trees. See Anderson LM and Cordell HK (1988) ‘Influence of trees on residential property values in Athens, Georgia (USA): a survey based on actual house prices’ Landscape and Urban Planning, no.15, pp153–164, see http://www.srs.fs.usda.gov/trends/pdf/ufathens.pdf
A recent modelling exercise looking into the relationship between green space and house prices in London similarly found a positive link., see Smith D (September 2010) Valuing housing and green spaces: understanding local amenities, the built environment and house prices in London, GLA Economics working paper 42, see http://www.london.gov.uk/sites/default/files/GLAE-wp-42.pdf
most pleasant of areas will increase in demand and so a loss of ecosystem services provided by trees, will be felt more greatly.

It is clear then that fragility in the size, form, and diversity of the UK urban tree stock exposes us to a number of very real dangers, making the need to seek resilience before catastrophe forces action, even more important.
6. Conclusion

Trees are fundamental to the quality of life within our urban centres. Without trees, human wellbeing is diminished, pleasant green spaces are no longer complete, heat mitigation vanishes, and the attractiveness to tourists, residents and businesses is substantively reduced.

Financially there are impacts from a potential loss of tree stock; the cost of increased power consumption, a reduction in property prices, the costs of developing a techno-centric solution, the burden on the NHS and insurers, and the cost of removal and replacement of diseased and dying trees. The unquantifiable value of the ecosystem services provided by trees is also lost.

The importance of trees in urban centres is well established and is now the subject of international, regional and national policy. Despite this, there is still a lack of co-ordinated response to the many existing and novel threats to trees.

There has been a marked escalation in the rate of occurrence of novel threats, from pests and diseases, in the UK, mainly through importation, and we need to act now to ensure future generations benefit from green infrastructure. The costs of action now are far less than the cost of action when under attack, when trying to work out what went wrong or when trying to seek replacement. Managing tree populations in urban centres is essential to human wellbeing.

Early action such as that instigated by the City of London when confronted with massaria, the Forestry Commission’s containment of the Asian longhorn beetle in Kent, ‘resilience thinking’ applied to tree stock, and the sharing of information between boroughs, give hope that we can be prepared and can combat the threats to London’s trees.