The ageing tree population of Christchurch

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ABSTRACT

The Christchurch City Council is preparing various strategies to deal with a rising number of declining trees in urban parks, streets and reserves. It is predicted that hundreds and even thousands of over-mature and declining trees in Christchurch need to be replaced over the next 10 to 30 years.

This provides an opportunity to work towards an 'ideal' urban environment, increased biodiversity, and other long-term planning objectives.

Systematic assessments are in progress to evaluate trees for their conservation status and degree of decline. Timely intervention will reduce the risk of loss of rare and unusual indigenous and exotic plants that are part of the natural and cultural heritage. For the urban tree environment to function to its highest potential, sustainable tree management strategies are promoted, to ensure overall vitality, and to maximise the aesthetic significance of the collection for future generations.

The management and the restoration of these valuable tree assets are of utmost importance to Christchurch's Garden City image. Combined team effort has been promoted to deal with oncoming issues in a proactive manner.

This paper provides an overview of considerations, the work that is needed, and practical ways to sustain a wide range of suitable trees in the urban environment that make Christchurch a 'Garden City of the World'.

INTRODUCTION

Christchurch's Garden City image is substantiated largely from its more than 740 parks, private gardens, green corridors and numerous trees found throughout the City.

The urban environment is made up of more than 6000 ha of green space and 348 km of open waterways. Furthermore, the City Plan protects some 1800 notable and heritage trees and also more than 1500 trees are protected as a condition of land development.

Four smaller rivers — the Avon, Heathcote, Styx and the Halswell Rivers — meander through various suburbs, and in the case of the Avon River, through the central city, adding to the special ambiance of Christchurch City.

Early tree plantings along the Avon riverbanks date back to the 1860s when, under the guidance of the Christchurch Town Council's chairman John Hall, willows and other trees were planted along Oxford Terrace.

The planting of oriental plane trees along Cambridge Terrace between Montreal and Cashel Street bridges dates back to 1878. Some dramatic plantings such as the weeping willows along Park Terrace and Lombardy poplars along Oxford Terrace are the result of continued plantings more than 60–100 years ago.

The Christchurch Beautifying Association, formed in 1897, is an organisation that developed parallel to the urban development

[1] Editor's note: now known as the Greenspace Unit.

of Christchurch. They were responsible for beautifying many areas, and their organised efforts and outstanding achievements have helped create Christchurch's Garden City image and identity.

Today, more than ever before, tree-lined streetscapes have an enormous impact on the quality of life of most who live or work in the city. Trees can increase people's enjoyment and the aesthetic appearance of the urban environment, creating a sense of identity, community and space.

Benefits of trees especially in the city are manifold. Their ability to absorb carbon dioxide and filter toxins from the air, among other qualities, are urgently needed in the city to assure a healthier and more vibrant environment, that contributes to the general well-being of the community.

TREE MAINTENANCE AND REPLACEMENT STRATEGIES

For an urban tree environment to function at its highest potential, sustainable tree management strategies are required, to ensure overall vitality, and to maximise the aesthetic significance of the collection for future generations.

In Christchurch, this strategy has been prompted by the previous absence of a defined tree management plan for future plantings. A major component of the City's identity and heritage is likely to be compromised over time if these shortcomings are not rectified.

Over a 13-year period, several thousand of the city's trees were surveyed revealing the presence of various diseases and signs of over-maturity in a number of specimen trees. This aging tree infrastructure will necessitate the replacement of several hundred of these specimens over the next 20 years. Consequently, Christchurch City Council is in the process of establishing various strategies to deal with what is now recognised as 'the aging tree population.'[2]

The aim of this particular strategy is to promote a long-term vision to ensure that the collection of trees in the city is maintained, replaced and increased in a condition that supports the growing city as a venue for many cultural and business activities alike.

Restoring and improving all areas in a holistic and sustainable way, at the same time as general tree maintenance, ensures that individual sections reach their full potential in the overall green space design of the city.

GOAL ONE

The first goal is the development of a comprehensive urban tree maintenance and replacement strategy. This goal has several objectives:

- Systematic stock-take of all trees
- Identify their location
- Inspect their condition
- Establish their maintenance and replacement requirements.

These objectives will enable an estimate of the number of trees growing in areas of Christchurch City, what species they are, where they are, their health, and how many may need to be replaced over the following years.

GOAL TWO

The second goal is to restore and enhance Christchurch's species richness. The objectives to achieve this are:

- Recognise species richness in the city for their aesthetic, recreational, educational, amenity, environmental and heritage values
- Undertake timely propagation of commemorative tree plantings to assure continuity in the collection
- Estimate the useful life expectancy of all specimens and forecast their approximate replacement period
- Evaluate tree species in relation to their positive and negative contribution to the landscape

[2] Editor's note: further information is on the trees pages of the Christchurch City Council website: http://www.ccc.govt.nz/parks/trees.

- Monitor all trees for the presence of serious diseases and their structural integrity (control threats of various pests)
- Select vigorous and well-structured trees suitable to perform in the urban environment
- Use well-established replacement trees to reduce vandalism where necessary
- Replace trees via a phased approach where possible to reduce the impact on the surrounding landscape.

When considering species richness, the individual values of tree species must be balanced against one another, as the values may not always be complementary.

Fig. 1 Both positive and negative qualities of trees must be assessed without resorting to this extreme.

It is important to undertake timely propagation. People often react only when trees of commemorative value are over-mature or dying. Some species are difficult enough to successfully propagate through cuttings and tissue culture using healthy material, let alone with the diseased or unhealthy material of a declining tree. If left too late, there is a real risk that the historical and genetic values of the tree will be lost forever — commemorative plaques become meaningless if they are all that is left in the ground.

Today with asset management it is essential to have an accurate estimate of the useful life expectancy of trees, so that their replacement can be properly planned for. Although this seems a rather heartless perspective, the fact remains that trees have a finite life expectancy, even when measured in centuries.

It is also important to evaluate the positive and negative contribution to the landscape; for example, some people may be allergic to certain tree species. Again there is a balance to be struck (unlike the extreme depicted in Fig. 1).

Another objective is to monitor Christchurch City's trees for serious diseases and to check their structural integrity. The importance of effective monitoring is highlighted by a recent outbreak of Dutch elm disease at Murvale Reserve, Pakuranga.

This disease has the potential to wipe out all elm trees in New Zealand, and was first reported in central Auckland in December 1989. After continuous response actions, the disease appeared to be almost eradicated in New Zealand. Suddenly, in 2002, an outbreak was discovered infecting 32 large trees and 117 smaller trees. Manukau City Council removed the elms from Murvale Reserve during November 2003. This was at an estimated cost of NZ$145 000 (Corbett et al. 2003). Manukau City has 6500 elm trees, but in Christchurch City we do not know how many there are or where they are located.

The urban environment can provide harsh growing conditions. For new plantings to be successful, it is important to select well-grown, vigorous material, and to plant and establish them following best practice.

Because of vandalism in the city especially, we need to plant well-established (or well-hidden) trees. Plants that are large or vigorous enough not to require staking is ideal. Staking is expensive and often presents an increased target for vandals.

Trees need to be replaced by adopting a phased approach. This has now been recognised as a major issue for Christchurch City, as there are a large number of declining trees around Hagley Park. Large avenues will need replacing over the following 5–20 years, significantly altering the long-standing cityscape.

WHAT ARE WE TRYING TO ACHIEVE?
To effectively plan, manage and further develop:

- Christchurch's Garden City image
- Quality of life
- Sustainable environment
- Species Richness / Biodiversity
- Aesthetic/amenity values
- Sense of place.

Species richness and biodiversity go hand-in-hand, and exotic plants can have nurturing effects on native species. Well-known examples include *Eucalyptus* trees providing a nectar source for native birds, and gorse providing a nurse species role for regenerating native bush.

Biodiversity and suitability are essential during species selection, due to the presence of soil and airborne diseases that affect some species or cultivars more than others. The recent discovery of the arrival of the willow sawfly (*Nematus oligospilus*) in Canterbury will make diversification of plantings necessary. The risk posed by this particular sawfly to existing and new willow plantings is serious.

Sense of place, such as commemorative plantings, connects people to the urban environment. This connection extends to wherever trees are planted.

GUIDING LEGISLATION
The development of a tree maintenance and replacement strategy is subject to overarching legislation.

The *Health & Safety in Employment Act* (1992) dictates an increase in prioritised replacement programmes for declining and diseased trees to reduce any existing and potential hazards. Management plans often apply to individual parks, where trees are declining and scheduled for replacement. However, these plans need to be extended to the whole city, and some reprioritisation made for removal and replacement of the most hazardous trees.

The *Local Government Act* (2002) circumscribes relevant principles relating to local authorities:

- The social, economic and cultural well-being of people and communities
- The need to maintain and enhance the quality of the environment
- The reasonable foreseeable needs of future generations.

These principles all fit well with the tree maintenance and replacement strategy.

BENEFITS OF TREES IN THE CITY
There are a multitude of environmental benefits, including:

- Atmospheric purification
- Absorption of carbon dioxide
- Production of oxygen
- Shade from harmful UV rays
- Noise reduction
- Habitat for wildlife
- Reduction of wind tunnel effects and deflection of wind
- Reduction of glare from various buildings and building materials
- Relief from hard and artificial surfaces
- Tree roots bind soil and reduce erosion.

Aside from improving our outlook and lowering stress levels, trees have a capacity for absorbing pollution and filtering the air. Trees absorb toxins, dust, sulphur dioxide, lead, carbon dioxide, reflections, heat and noise.

In Christchurch, Hagley Park plays a pivotal role in the overall health of the city. One mature beech tree in prime condition produces 20.5 kg of oxygen and locks 28.2 kg of carbon in 12 hours. As there are about 5000 mature trees in Hagley Park and the Botanic Gardens, this equates to about 105.5 tonnes of oxygen produced each day during the growing season and 141 tonnes of carbon locked (Hider 2004).

As streets and highways become noisier and busier, trees are increasingly important for our physical and emotional well-being. There is so much noise and reflected light in city streets that people really need trees and other plants to make their environment bearable.

Tree roots bind soil and reduce erosion. New Zealand loses 200–300 million tonnes of topsoil into the oceans annually (see Seafriends website at http://www.seafriends.org.nz).

WHY DO TREES DIE?
Trees die due to a wide variety of abiotic (non-biological) and biotic (biological) causes.

Abiotic causes can be human induced or natural. Examples of the 'human factor' are habitat destruction, pollution, and poor cultural practices like planting in the wrong position, planting too deeply, and not providing enough space for the roots, all creating unfavourable conditions for tree establishment.

Natural abiotic factors that can damage tree health include mineral deficiencies in the soil as well as climatic stresses such as extreme temperature or moisture conditions like droughts and flooding.

Biotic factors are often the more easily observed causal agents of tree decline. These include fungi, viruses, bacteria, parasitic nematodes, wood and bark borer, and insects such as defoliators (willow sawfly and others).

INTERACTIONS
Attention is often focused on the damage caused by the more obvious biological agents, but it is important to also recognise the role of abiotic factors, especially in the urban environment. Trees in the urban landscape are stressed in many ways that compromise their vigour and vitality and make them more susceptible to disease.

Damage to the roots, bark, crowns or soil during construction work are responsible for putting trees under stress and therefore making them more susceptible to secondary infections.

EFFECTS OF CONSTRUCTION
Trees react to construction based on three factors:

1. **Species**: How a tree reacts to damage during construction often depends upon what species it is. For example, a plane tree is more tolerant of construction effects than an English beech tree.

2. **Health**: A tree with good vigour and no signs of dieback is more resilient than a tree already in poor condition.

3. **Size and age**: The smaller the tree, the more resilient it may be to construction. Older trees may be in a more delicate environmental balance, making them more susceptible to harm.

Trees in the urban environment not only receive direct sunlight, but are baked between buildings, suffer from heat reflection off asphalt and cobblestones, are affected by channelled winds, dust, insects, artificial light, construction above the ground, lawnmower damage, animals, vandalism, and underground trenching (Fig. 2). There is little coordination with trenching activities between utility companies, causing repeated damage to the roots of the trees growing above. The construction of deep foundations cause a drop in the water table, again placing trees under stress.

Trees in the urban landscape must also cope with high levels of air pollution in addition to soil conditions that are often far from ideal. The soil around trees in high use areas can become compacted and polluted over time. This reduces the soil's ability to hold the water and air that are essential for tree growth through root absorption.

Tree death is often best explained in terms of environmental stresses that predispose trees to being attacked and killed by secondary agents. However, in the case of Dutch elm disease, painted apple moth and willow sawfly for example, it seems that any pre-disposing stress it not necessary for infection or attack. These are rather aggressive pathogens and can infect and kill otherwise healthy trees.

THE IMPORTANCE OF TREE DEATH
All trees have a finite life expectancy, ranging from a few years to centuries or even millennia. However, these figures are often misleading in

the urban context, as they are based on trees growing under 'ideal' conditions in their natural environments.

Tree death is a natural and necessary aspect of the forest ecosystem. The death of old and often large trees is necessary for the regeneration of new trees and the continuation of the forest.

Death is important for life. Tree diseases that attack especially weak trees can improve the overall vigour of a stand. The loss of the dead tree creates a gap in the canopy, letting sunlight reach the forest floor, and allowing for the subsequent regeneration of emergent trees.

BENEFICIAL FUNGI

Fungi are mostly known for their role as pathogens (disease-causing agents). However, fungi are an integral part of the forest ecosystem and are essential for the overall health of the forest. Many fungi do not cause disease at all but rather cause decay of dead organic material. They act as recyclers, breaking down logs and leaf litter, returning nutrients to the soil where they are used by other plants and trees.

Many trees live associated with a group of fungi called mycorrhizae (root fungus). This beneficial association helps trees with their ability to absorb water and nutrients. In return the fungi receive, or better, takes, energy in the form of sugars from the tree. Seedlings of many tree species would not establish without the presence of mycorrhiza fungi.

In the urban environment the take-and-take relationship between trees and certain fungi must remain in balance. Root-rot causing fungi like *Armillaria* and trunk-rot causing fungi such as *Ganoderma* cause trees to become unstable and hazardous. Timely replacement is necessary to prevent injury to people and damage to property.

It is important to appreciate that while arboricultural practices such as the removal of dead branches in over-mature trees may extend a tree's useful life visually, these techniques do not reverse or arrest the tree decline associated with natural life expectancy, and biotic and abiotic stresses.

SUSTAINABLE LIFE EXPECTANCY

Some factors that are taken into account include:

- Genetic pre-disposition of certain species to have low vigour, or are of poor form
- The need to improve the growth of a more desirable specimen nearby
- Whether preventative or corrective tree maintenance work can prolong the attractive, safe life of a tree
- The need to provide for the future and renew an even aged, aging tree population.

An example of an aging tree population are the plantings in the Christchurch Botanic Gardens. Over the last six years (1997–2003), the Christchurch City Council have removed 150 over-mature trees. It is predicted that over the next five years, they will have to replace more than 50, over the next 10 years another 100, and suddenly, in 20 years time more than 300 trees will need to be replaced (Fig. 3). These specimens were originally planted during the 1860–1870s, so consequently are reaching the end of their life expectancy at a similar time. This scenario will apply to wider Christchurch City areas as well, such as the central city riverbanks.

Fig. 4 maps the total tree collection currently in the Christchurch Botanic Gardens, and Fig. 5 depicts how many trees may be left in 30 years time if there was no replacement programme.

To mitigate the peak period of tree removal, it is essential that we act now with a phased replacement programme. For this, the worst trees should be targeted first, which will reduce hazards at the same time.

During a survey of all trees on council property, it is important that the number of most common problem trees are identified:

- To calculate the cost of wind damage in various species per year
- Number of trees that produce an above average amount of debris

- Number of high hazard trees
- Number of trees that might cause allergies to the public and/or visitors
- Number of trees that are particularly susceptible to diseases.

PREDOMINANT SPECIES

Fig. 6 graphs the numbers of most common tree genera in the Christchurch Botanic Gardens. It is interesting to note how may acers are growing in the Botanic Gardens, with a reasonably well-balanced collection of genera remaining. The graph can be used as a management tool, with the ultimate goal of developing an ideal mix of genera and species.

QUALITY CONTROL

A selection of well-structured vigorous plants is of vital importance for long-term success, and a high standard of plant cultivation to minimise premature loss.

Unfortunately, it is all too easy to find examples that do not meet these ideals. Fig. 7 (A,B) shows a tree that was pot-bound and collapsed after 15 years of being planted-out. This represents a 15-year loss in time that could instead have been used for a high-quality specimen that would have endured. Figs. 8 and 9 show further examples of inadequate root structures. Fig. 10 shows a wind-thrown tree after 25 years of planting.

Included bark is a common physiological fault that occurs in both native and exotic trees (Fig. 11). If trees with this fault are planted, they will prematurely fail after about 10–50 years, and may injure people or damage property when they fall.

Preventative, best practice care of established tree collections helps to maintain their health. Lawn-mower damage can be minimised by fitting trees with protective plastic collars and spraying the surrounding grass with herbicide (Fig. 12).

It is difficult to maintain a healthy grass sward under a tree canopy (Fig. 13), due to light, water, and nutrient depletion. Because of this, there is increasing use of bark mulch under a tree canopy (Fig. 14). The use of bark means less herbicide usage, and better water-retention, microbial activity, and soil condition.

MANAGEMENT CONSIDERATIONS

To ensure thoroughness and continuity, responsibility for implementing the tree maintenance and replacement strategy will be assigned to teams with the time, resources and interest required to give the strategy the attention it deserves.

An annual review will assess implementation and overall performance, and a review after five years to update planning issues and possible change of priorities or staff.

Professional tree management will help to keep the Garden City a green and vibrant place for ourselves and future generations (Fig. 15).

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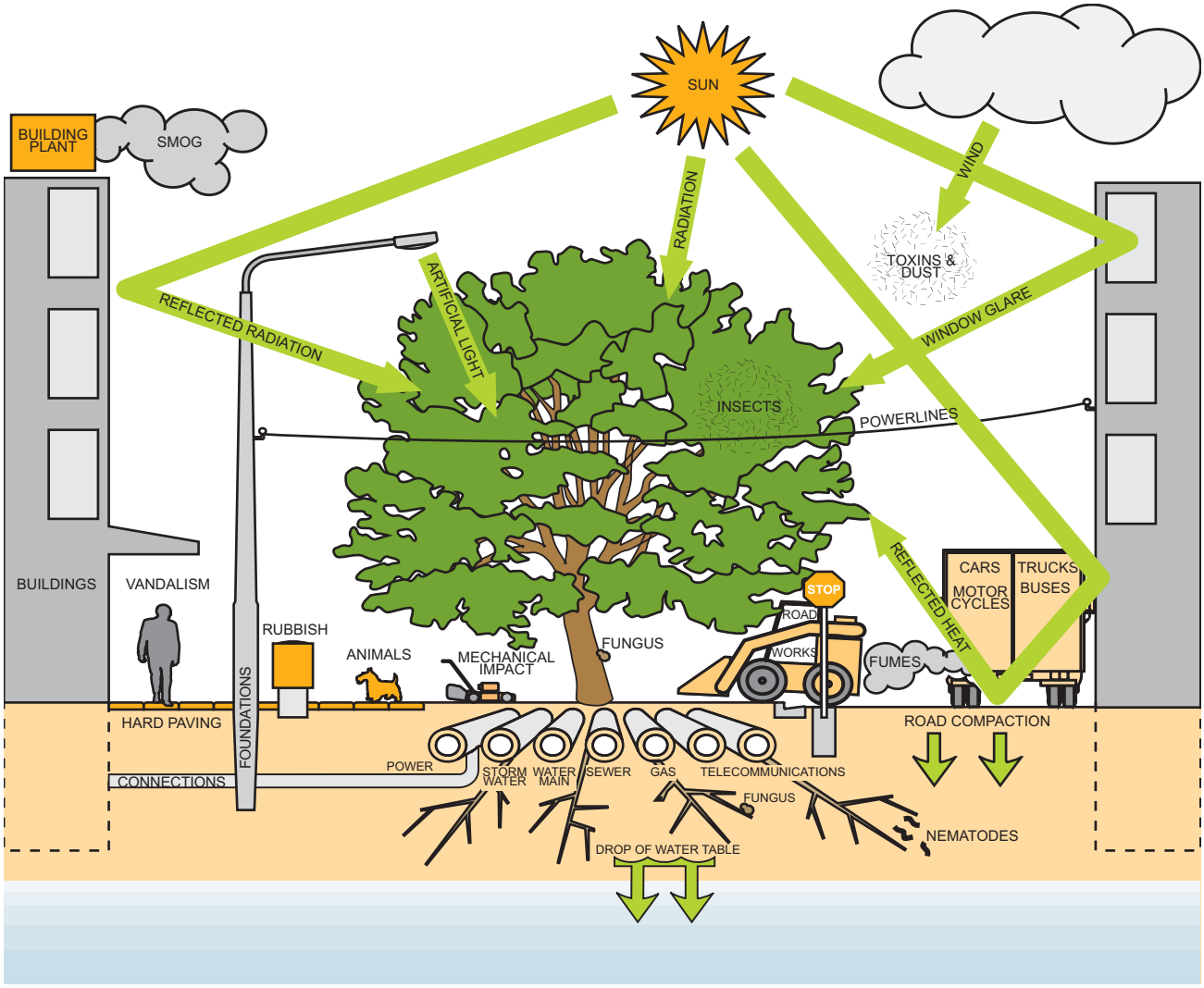

Fig. 2 Biotic and abiotic effects on trees in the urban environment.

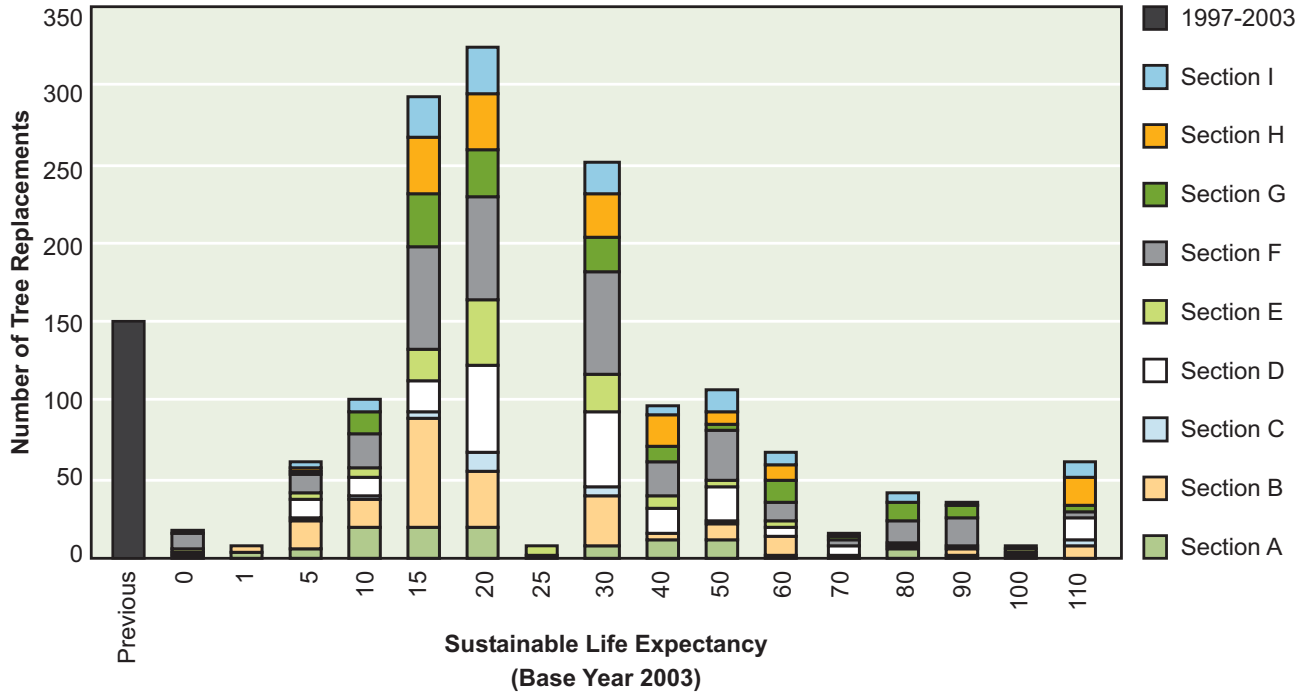

Fig. 3 Sustainable life expectancy of trees growing in the Christchurch Botanic Gardens (base year 2003).

Fig. 4 Total tree collection currently in Hagley Park, Christchurch.

Fig. 5 Trees remaining in Hagley Park, Christchurch, in 30 years time in the absence of a tree replacement programme.

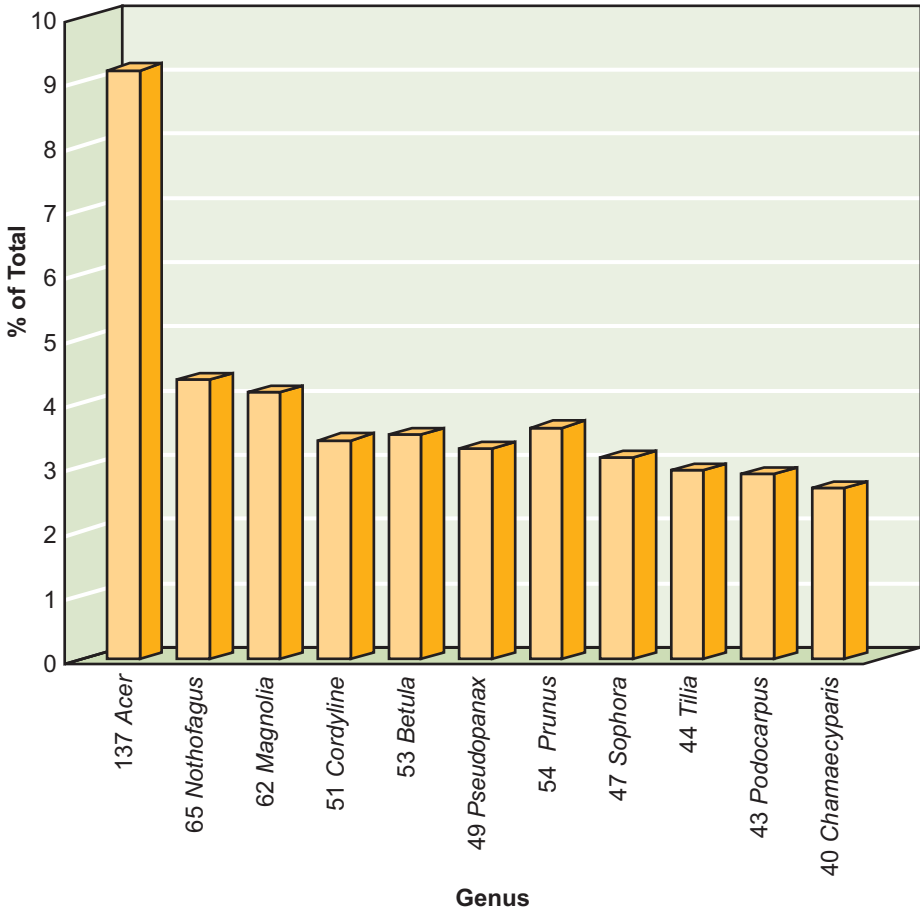

Fig. 6 Percentage and frequencies of the 11 most common genera of trees growing in the Christchurch Botanic Gardens, Christchurch.

Fig. 7 Pot-bound tree that collapsed after 15 years of being planted out. **A**, entire tree; **B**, close-up of constrained root development.

Fig. 8 Inadequate root structure.

Fig. 9 Deformed root systems can cause premature death by girdling roots that restrict trunk development.

Fig. 10 A 25-year old tree wind-thrown due to an inadequate root system.

Fig. 11 Included bark is a pattern of development at branch connections where branch bark is turned inward towards the trunk, like a wedge between two cylinders.

Fig. 12 Trees with plastic collars and with the surrounding grass sprayed with herbicide to minimise lawn-mower damage.

Fig. 13 Difficulty in establishing grass under a tree canopy.

Fig. 14 Effective use of mulch under a tree canopy.

Fig. 15 An option for enjoying the benefits of trees in a neglected environment.