The 2014 Banks Memorial Lecture: Auckland's remarkable urban forest

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Summary
Auckland is a sprawling New Zealand city approaching 1.5 million people covering 514,000 ha, embracing both rural countryside and urban environments. The urban tree cover includes numerous small remnants of public native bush totalling 1800 ha, and private bush-clad residential properties; patches of man-made native forest established mostly by community groups in regreening projects; areas of exotic woodland; amenity and fruit trees in home gardens; trees planted in streets; and public parks and gardens, campuses, golf courses and cemeteries with a diversity of old and historic trees.

Each of these six forest types is described, and analyses made of species composition to determine the dominant trees to be found in Auckland.

Introduction
Urban forest comprises the trees within a city: in parks, gardens and streets; planted singly, in groups or dense stands; or of natural occurrence, both native and naturalised. This comprehensive definition follows the American view (Miller, 1998), rather than the European concept which confines urban forest to meaning the peri-urban forest or enclaves of natural forest which border the city (Cliffin, 2005; Carreiro and Zipperer, 2008). Urban forest is worth studying and understanding for its many positive values (Payton et al., 2008), and also for the high cost of its management. This resource has multiple owners yet is recognised as a shared community asset appreciated by everyone. The benefits are many: beauty, shade, cooling, shelter, recreation, carbon absorption, noise mitigation, wildlife habitat, stream protection, and increased property values. Trees also bring problems: leaves falling and blocking gutters, branches breaking off or the whole tree falling over, shading neighbours, roots cracking or lifting pavements and affecting underground services, and branches getting entangled in overhead wires, to mention a few (French et al., 1985).

At the time of European settlement in 1840, the isthmus of central Auckland was a bleak wilderness of bracken fern and mānuka scrub, by then only sparsely inhabited by Māori, with pockets of harakeke or flax (*Phormium tenax*), raupō (*Typha orientalis*) and ti kōuka or cabbage tree (*Cordyline australis*) swamp covering the volcanic soils derived from the tuff, scoria and lava of the volcanic cones of Three Kings, Mt Eden, Maungakiekie (One Tree Hill), Mt Albert, Mt Smart, Mt Hobson and Mt St John (Hayward et al., 2011). The soil was a rich and friable loam and the topography gentle, and the land was progressively cleared and developed for farms and market gardens. There were few or no trees present then and the earliest settlers at first lived in tents or raupō huts (Campbell, 1881; Esler, 2004; McLauchlan, 2008). As in lower Northland (Beever, 1981), the pre-European scrublands of Auckland are considered to be the result of repeated burning during intensive Māori occupation over hundreds of years, destroying the forest originally there (Esler, 1991).

A Government Garden was established in what is now The Domain and was introducing and producing tree seedlings by 1842 (Adam, 2007). Early photographs show that settlers planted trees for shade and shelter on their farms (Johnson, 1988; Bush, 2006). Species early in evidence were Norfolk Island pine (*Araucaria heterophylla*), Monterey pine (*Pinus radiata*) and Monterey cypress (*Cupressus macrocarpa*) – all renowned for their tolerance of salt-laden winds; golden weeping willow (*Salix* × *chrysocoma*), Lombardy poplar (*Populus nigra* 'Italica'), pedunculate oak (*Quercus robur*), hawthorn (*Crataegus monogyna*), and Australian gum trees (*Eucalyptus* spp.). As the commercial development of Auckland flourished, wealthier citizens built stately homes with big gardens and ornamental trees, and some public parks came into existence, with tree planting a feature. Nearly all the Auckland isthmus was under cultivation by 1870 but eventually the farmland disappeared as Auckland's population grew, to be replaced by houses and networks of streets. Some of the foundation trees still remain, and planting has continued to the present day, in streets, gardens and parks as the urban area has expanded.

Of the total area of Auckland – 514,000 ha, supporting a population of 1.5 million people (2011) – some 45,000 ha (8.8%) can presently be considered built up or urban, with the balance of 469,000 ha (91.2%) rural, including 51,000 ha of islands in the Hauraki Gulf (Auckland Regional Council, 2010). It is primarily the urban area comprising residential suburbs and business districts that is the subject of this account.

Auckland as a whole (rural and urban) has an impressive 4200 public parks and reserves covering about 50,000 ha, including the network of rural Regional Parks. The urban component of this Auckland Council estate is a very important part of the urban forest. Recognition and definition of the different kinds of forest is a necessary starting point for a description of the Auckland urban forest. Six types have been identified:

- Native bush remnants
- Native revegetation
- Exotic woodland
- Home garden trees

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- Street trees
- Larger sites: trees in parks, historic homesteads, schools, campuses, golf courses and cemeteries.

Whilst most patches of urban forest can be predominantly classified into one of these categories, some reserves comprise a mixture of types. For instance, many city parks have planted ornamental specimen trees and also native revegetation shrub borders (particularly along stream banks) and sometimes a 'wild wood' of naturalised exotic trees. Each forest type contributes to Auckland's urban environment, sometimes separately, but commonly blending together as an entity to give a suburb its particular treescape and character. The local park, school grounds, streets, and home gardens are the core urban forest of most suburbs, sometimes intensified by having creeks or walkways with native revegetation plantings, a piece of residual native bush or a woodland of exotic trees filling a gully. Every suburb or neighbourhood will have its own urban forest, and is something citizens could get to know and appreciate, wherever they live. No part of Auckland is without some form of urban forest.

Native bush remnants

Embedded within the residential suburbs of Auckland are numerous pockets of native bush in public parkland, and on private land. Auckland's public urban bush, numbering 233 separate reserves and covering 1800 ha, has come into being through direct purchase, as gifts, or by the creation of reserves under Statute. The Local Government Act and the Resource Management Act (RMA) allows for the vesting of reserves during subdivision of land for new residential areas, and the vesting of 20 metre-wide esplanade reserves adjoining the coast or inlets. Though mostly small in area, these fragments are a much valued component of the urban forest, often having high plant biodiversity and birdlife, providing protection of stream courses, and containing a good representation of the native forest types and tree species of the region. They are also popular for recreation. Many are south-facing gully forests which have survived because they escaped fire (Esler, 1991, 2004). The remnant native forests have a diverse tree flora, with good examples of kauri (*Agathis australis*), tōtara (*Podocarpus totara*), kahikatea (*Dacrycarpus dacrydioides*), tānekaha (*Phyllocladus trichomanoides*) and kānuka (*Kunzea ericoides*), and broadleaved canopy trees such as taraire (*Beilschmiedia tarairi*), pūriri (*Vitex lucens*), karaka (*Corynocarpus laevigatus*) and kohekohe (*Dysoxylum spectabile*). Tree ferns, especially the silver fern (*Cyathea dealbata*), and nīkau palm (*Rhopalostylis sapida*) are prominent in the subcanopy or understorey. There are also some small fragments of volcanic 'rock forest' (Fig. 1) with species such as tītoki (*Alectryon excelsus*), puka (*Griselinia lucida*), mangeao (*Litsea calicaris*) and māhoe (*Melicytus ramiflorus*).

Fig. 1 Withiel Thomas Reserve, Mt Eden. This is a rare example of 'rock forest', the main species being tītoki (*Alectryon excelsus*), puka (*Griselinia lucida*), mangeao (*Litsea calicaris*) and māhoe (*Melicytus ramiflorus*). Photo: Mike Wilcox, 6 March 2011.

The pattern of Auckland's bush fragments is related to soil, topography and past history. In brief, it is that the conifers – especially tōtara, kauri, kahikatea and tānekaha – occur gregariously where there has been past disturbance by fire or logging and/or where soils are poor in nutrients or are poorly drained, while broadleaved trees – especially taraire, pūriri, kohekohe, and karaka – dominate on the damper, more fertile and more sheltered sites. This pattern is easily observed in many of the bush reserves. In some reserves, native conifers are presently dominant, but broadleaves are beginning to colonise abundantly so that the forest may eventually progress to a mixed forest with emergent native conifers above a broadleaved subcanopy. Kānuka (*Kunzea ericoides*) deserves special mention for its importance in nurturing the regeneration of conifers; yet natural kānuka forest is now a comparative rarity in urban Auckland. While most of it was cleared away for the first farms in the early days of settlement, some hilly farmland on the urban fringes, such as at Albany, has reverted back to kānuka, and eventually will again become mixed native forest if allowed to do so.

Auckland's urban bush varies widely in its condition. Some, even quite small reserves, have dense canopies of trees and vigorous understories, and are reasonably free of invasive weeds. Such reserves effectively absorb stormwater, help keep the creeks and harbours clean, are attractive to native birds, and are pleasant for recreation. Others are degraded to the point where the original canopy has gone, and the forest floor is exposed to wind, drought and flooding. And furthermore, some have become local garden rubbish dumps, havens for wild cats, and are over-run by carpets of choking weeds on the ground, weedy climbers and creepers on the margins, and invasive trees and shrubs that have contaminated the integrity of the forest. Possums and rats can play havoc with the ecology of native bush, affecting the native animal life, and the plants. Where these pests, particularly the possum, are being effectively controlled or even exterminated, the condition of the forest dramatically improves. A good indicator species is kohekohe: it bounces back with vigorous regeneration in the understory when its foliage and fruit are not devastated by possums.

What are the most serious weeds in Auckland's bush remnants? To start with, monocotyledons: these as a group constitute a particularly significant nuisance. Many are shade-tolerant and moisture-loving, adapting them well for taking over damp gullies. Wandering jew (*Tradescantia fluminensis*), wild ginger (*Hedychium flavescens* and *H. gardnerianum*), palm grass (*Setaria palmifolia*), walking stick bamboo (*Phyllostachys aurea*), climbing asparagus (*Asparagus scandens*), elephant's ear (*Alocasia brisbanensis*), Indian shot (*Canna indica*), stinking iris (*Iris foetidissima*), Canary Island date palm (*Phoenix canariensis*), and Chinese windmill

palm (*Trachycarpus fortunei*) are the most troublesome, with ginger probably the worst of the lot. When it comes to dicotyledon trees and shrubs it is species with bird-dispersed seeds and shade-tolerant seedlings that are the most regularly problematic invaders of intact bush. Monkey apple (*Syzygium smithii*), Japanese hill cherry (*Prunus serrulata*), tree privet (*Ligustrum lucidum*), Chinese privet (*L. sinense*), Japanese spindle tree (*Euonymus japonicus*), loquat (*Eriobotrya japonica*), queen of the night (*Cestrum nocturnum*) and elaeagnus (*Elaeagnus* × *reflexa*) are all widespread in Auckland's bush, mainly as contaminants in the understorey or subcanopy, though tree privet can reach into the canopy itself. Others such as woolly nightshade (*Solanum mauritianum*), brush wattle (*Paraserianthes lophantha*) and shrub balsam (*Impatiens sodenii*) are quick to exploit disturbance and canopy gaps. Plectranthus (*Plectranthus ciliatus* and *P. ecklonii*) and bartlettina (*Bartlettina sordida*) are common marginal weeds in the higher-rainfall urban forest at Titirangi.

On the poorer gumland soils of the North Shore and western suburbs, sclerophyllous (drought and fire tolerant) species of Australian origin are common contaminants of fire-induced kānuka-dominated reserves, the main invasive species being prickly hakea (*Hakea sericea*), willow-leaved hakea (*H. salicifolia*), Sydney golden wattle (*Acacia longifolia*), black wattle (*A. mearnsii*), and more rarely, cedar wattle (*A. elata*). Common weeds of pōhutukawa (*Metrosideros excelsa*) and karo (*Pittosporum crassifolium*) coastal cliff forest are evergreen buckthorn (*Rhamnus alaternus*), boneseed (*Chrysanthemoides monolifera*), sweet pea shrub (*Polygala myrtifolia*), *Cotoneaster glaucophyllus*, agapanthus (*Agapanthus orientalis*), and sometimes Indian hawthorn (*Rhaphiolepis umbellata*). The most widespread climbing weeds include climbing jasmine (*Jasminum polyanthum*), moth plant (*Araujia hortorum*) and climbing asparagus (*Asparagus scandens*). Spore-bearing plants, too, have weedy representatives, the most troublesome being sword fern (*Nephrolepis cordifolia*) and selaginella (*Selaginella kraussiana*).

Native revegetation

In recent times there have been numerous community-based regreening projects in the greater Auckland area that have restored degraded vegetation or bare land by planting mixtures of local native trees. Perhaps the best-known of these are those on islands in the Hauraki Gulf, and a useful reference to the principles and techniques is the guidebook by Chapple et al. (2001). Several projects have also been carried out within the Auckland urban area, examples being Western Springs, Meola Reef Reserve in Westmere, Meola Creek in Mt Albert (Fig. 2), Oakley Walkway in Point Chevalier/Waterview, Hamlin's Hill Reserve in Otahuhu, Tahuna Torea in Glendowie, the Puhinui Stream restoration project in Wiri, Seaside Park Landfill Rehabilitation & Wildlife Protection Project in Otahuhu, Mt Smart in Te Papapa, Macleans Park in Howick, Waiatarua Reserve in Meadowbank, Arch Hill Scenic Reserve, Tuff Crater, the Kaipatiki Project on the North Shore, and the comprehensive Twin Streams project in Waitakere involving riparian tree planting in the catchments of Henderson Creek and Huruhuru Creek which flow into the Waitemata Harbour.

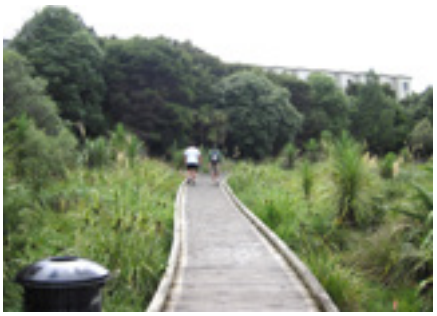

Fig. 2 Roy Clements Treeway, Meola Creek, Mt Albert. Photo: Mike Wilcox, 13 Feb 2012.

Common features and activities of these forests are the deployment of volunteers to plant and maintain the trees, the use of several native tree species chosen for their ease of propagation and establishment and expected adaptation to the site, and control of weeds and animal pests. The most popular species planted are ngaio (*Myoporum laetum*), lemonwood (*Pittosporum eugenioides*), kōhūhū (*P. tenuifolium*), karo (*P. crassifolium*), cabbage tree (*Cordyline australis*), mānuka and kānuka.

Ecologically-based manuals for restoring native vegetation have been published by the Waitakere City Council (Lucas et al., 1997) and Manukau City Council (2008). These publications contain lists of plants suitable for planting in particular ecosystems, and guidelines for carrying out restoration projects. Restoring native ecosystems in Auckland has been the subject of experimental research (Sullivan et al., 2009) which investigated the effects of planting density, choice of species, soil treatment (e.g., mulching vs. soil ripping) and proximity to existing native forest. High planting densities (e.g., 17,000 plants/ha) coupled with soil ripping quickly gave a thick canopy that suppressed competing weeds like kikuyu grass (*Cenchrus clandestinus*; syn. *Pennisetum clandestinum*) and helped prevent invasion by woody weeds like privet (*Ligustrum lucidum* and *L. sinense*) and brush wattle (*Paraserianthes lophantha*).

An issue in Auckland revegetation schemes is whether initial planting of bare sites should be with just fast-growing pioneers such as mānuka, kānuka, kōhūhū, ngaio, cabbage tree and karamu (*Coprosma* spp.), to be followed up later, once the protective thicket is in place, with tall local forest trees such as pūriri, taraire, tītoki, kohekohe, karaka, tōtara and rimu (*Dacrydium cupressinum*), or if the tall trees should be planted from the outset or just left to colonise on their own. It seems from the examples discussed below that if something resembling a natural forest is the eventual desired result, then some tall tree species need to be planted from the beginning, otherwise the result is an artificial, man-made shrubbery of flax, cabbage trees, mānuka, kānuka, kōhūhū, lemonwood, and coastal species such as ngaio, taupata, houpara and karo. Bergin and Gea (2005) and Bergin (2011) discuss and compare various planting options, and their 'Scenario 4' (concurrently planting a mixture of native trees and shrubs) has considerable appeal for creating a native timber resource and a well-balanced ecological forest at a reasonable cost.

Exotic woodland

This forest type is a mixed bag of exotic trees that have been planted as woodland or have spread as self-sown trees to form naturalised forest.

The main species involved are Monterey pine (*Pinus radiata*), maritime pine (*Pinus pinaster*), various eucalypts (*Eucalyptus* spp.), black wattle (*Acacia mearnsii*) and pedunculate oak (*Quercus robur*), but there are also 'weed' forests where tree privet (*Ligustrum lucidum*; Fig. 3), crack willow (*Salix fragilis*), Japanese hill cherry (*Prunus serrulata*), monkey apple (*Syzygium smithii*) and woolly nightshade (*Solanum mauritianum*) are commonly present.

Fig. 3 Privet forest (*Ligustrum lucidum*), Oakley Creek. Photo: Mike Wilcox, 1 Oct 2008.

Notable eucalypt woodlands occur in Auckland at the Waikumete Cemetery, at Waiatarua Reserve in Meadowbank, in the Auckland Domain, in Cornwall Park, at the Pupuke Golf Course in Campbells Bay, and in Fowlds Park, Mt Albert. The Waikumete eucalypts occur in several discrete patches, the largest of which is of *Eucalyptus obliqua*. There are also some stands of *E. saligna*, while numerous other species have been planted bordering the property, the main species being *E. pulchella*. The Waiatarua eucalypt grove is comparatively young, but made up of 15 species in the form of small individual plots. Among the best performers there are *E. maidenii*, *E. ovata*, *E. pilularis*, *E. regnans* and *Corymbia maculata*. The Auckland Domain eucalypts on 'Eucalypt Hill' are a mixture, with tallowwood (*E. microcorys*) being particularly impressive (Wilcox et al., 2004). Auckland's most famous eucalypt grove is the collection in Cornwall Park, dating back to the 1930s. Here there are 40 or so species planted line-by-line for convenient comparison. Many of these are now enormous trees, among the biggest being *E. fastigata*, *E. microcorys*, *E. muelleriana*, *E. nitens*, *E. quadrangulata* and *E. smithii*. Coast box (*E. bosistoana*) is another good performer in Cornwall Park, forming a long shelterbelt.

Monterey pine first found its way to Auckland in the 1860s. Sir George Grey brought in seed supplied by William Hooker, from Kew, in 1862 – the origin of the first plantings on Kawau Island. David Hay, an early Auckland nurseryman, was selling Monterey pine seedlings to settlers in 1862, probably also derived from seed sourced from England. The pine trees at Potters Park, Balmoral, are thought to be among the earliest surviving plantings. Another early introduction of this pine, this time directly from California, was by McLoughlin in 1865, where a planting was made on his Puhinui Station in south Auckland (Shepherd, 1990). One of the most prominent stands of Monterey pine in Auckland is on the slopes between the Auckland Zoo and Western Springs Stadium. These were planted in 1923, and are now a rare example of a fully mature plantation of this species. Other notable old stands of pines are the landmark grove of 45 m tall trees in Windmill Park in Mt Eden, on Pigeon Mountain, on Mt Wellington, at Kauri Point Domain, where a dense understorey of houpara (*Pseudopanax lessonii*) has developed, in Unsworth Reserve, Ayton Reserves and Rosecamp Road Foreshore Reserve (Beach Haven), in the Chelsea Estate Heritage Park, in Claverdon Park (Royal Heights), in Oakley Creek, in Churchill Park, in Waikumete Cemetery, in the Glendene Reserve, and in Zita Maria Park (Massey).

As well as Monterey pine, Chelsea Estate Heritage Park has some of Auckland's largest trees of maritime pine (*Pinus pinaster*). This park is very extensive – perhaps the largest exotic woodland in the city – with a considerable understorey of native trees (including plentiful tānekaha) developed beneath the pines. Another good example of a maritime pine forest is Penguin Drive/Speedy Bush Reserve in Murrays Bay, and there are stands of it, too, in Moire Park (Royal Heights).

There are several old black wattle forests in west Auckland, such as Moire Park (Royal Heights), Henderson Creek Walkway (Henderson), Kowhai Reserve (Konini), Crestwood Retirement Village and Titirangi Golf Course (New Lynn), Cyclarama Reserve (Massey), Wattle Bay Reserve (Lynfield), Avondale South Domain, Craigavon Park (Blockhouse Bay), and also on the North Shore (e.g., Kauri Point Domain, Northcross Reserve, Bushglen Reserve, Penguin Drive/Speedy Bush Reserve, Malters/Helvetia Road Reserve, Woodridge Reserve, Rawene Reserve, Unsworth Reserve, Rangatira Reserve, Spoonbill Reserve and Lyford Reserve/Sunnynook Bush) and at Silverdale (Silverdale Scenic Reserve). Particularly huge wattle trees are found in the 2.3 ha Oratau Reserve at Greenhithe; old wattle trees in Auckland can attain a height of 30 m and a diameter of around 80 cm, such large specimens likely to be around 100 years old. Vigorous young stands of self-sown black wattle have developed in Sunhill Scenic Reserve adjoining Waikumete Cemetery. These forests also contain large Monterey pines and some also have maritime pine, and typically prickly hakea (*Hakea sericea*), willow-leaved hakea (*H. salicifolia*), Sydney golden wattle (*Acacia longifolia*), prickly Moses (*A. verticillata*), mānuka, kānuka, and some characteristic gumland species such as neinei (*Dracophyllum sinclairii*), *Schoenus tendo* and sword sedge (*Lepidosperma laterale*). Willow-leaved hakea can form dense stands, as in parts of Gill's Road Reserve, Albany. Black wattle was originally grown to produce tannin from the bark, but the plantations were abandoned, though have persisted for a century. The wattle-pine forest at Crestwood Retirement Village in Golf Road, New Lynn, has the very notable additional presence of long-leaved wattle (*Acacia longissima*) – the only recorded place in New Zealand where this attractive Australian tree has become naturalised. Parramatta wattle (*A. parramattensis*) has naturalised along the Otara Creek in Highbrook Park, and also in Walmsley Road Reserve, Mangere. Green wattle (*A. decurrens*), conspicuous with its bright yellow flower heads in August, and silver wattle (*A. dealbata*) are sporadic in their occurrence in Auckland, but both can be seen near the eastern end of the Manukau Coastal Walkway at Southdown. Cedar wattle (*A. elata*) is likewise sparsely distributed.

The old pine and wattle forests of Auckland usually have a dense understorey of native shrubs, most commonly shining karamu (*Coprosma lucida*), coastal karamu (*Coprosma repens*), *Coprosma rhamnoides*, hangehange (*Geniostoma ligustrifolium*), māhoe, māpou (*Myrsine australis*), mingimingi (*Leucopogon fasciculatus*), pigeonwood (*Hedycarya arborea*) and silver fern. Māpou is particularly abundant.

Home garden trees

The predominant component of the urban forest is the varied assemblage of trees planted in private gardens, at the front and back of houses. A survey was conducted by the author in August 2008 to find out what were the most popular species planted. Eight suburbs were sampled and surveyed by driving or walking around numerous streets. To be counted in the survey the trees had to be of overhead-wire height (c. 8 m) or taller. Some 1561 trees were counted and tallied by species and suburb. The survey recorded 145 tree species, the 30 most frequent species being listed in Table 1.

There were some differences between suburbs in the frequency of species, reflecting perhaps soil differences (e.g., volcanic loam vs. clay), affluence, and age of the suburb. For instance, big pūriri and tītoki trees are rarely seen in 'clay' suburbs such as Hillsborough, and there is a greater frequency of palms in Epsom. Some streets in the older parts of Mt Eden (Fig. 4), Three Kings and Epsom have garden after garden with interesting and diverse trees; Mountain Road, Owens Road and St Andrews Road being prime examples.

Many home garden trees of special merit because of their rarity, age, size and historic importance, have been afforded protection under the Auckland Unitary Plan. Such trees are called scheduled trees, and require resource consent for felling or major surgery.

Fig. 4 *Schizolobium parahyba*, 29c Kingsview Rd, Mt Eden. Photo: Mike Wilcox, 7 March 2009.

Street trees

Street trees are a significant and visible component of the urban forest. Each of the former city councils in Auckland had a programme of maintaining and planting street trees.

Table 1 Sample of 1561 home garden trees in Auckland ranked by abundance.

Species	Onehunga	Epsom	Mt Albert	Mangere	Mt Eden	North Shore	Remuera	Hillsborough	**Total**
Metrosideros excelsa	42	15	26	9	27	29	12	19	**179**
Araucaria heterophylla	10	6	14	20	7	7	4	20	**88**
Liquidambar styraciflua	9	13	13	6	13	14	4	12	**84**
Betula pendula	18	21	8	5	15	3	2	5	**77**
Phoenix canariensis	10	9	8	7	8	7	8	4	**61**
Vitex lucens	19	4	6	5	8	7	2	3	**54**
Cryptomeria japonica	6	4	15	3	4	3	1	11	**47**
Podocarpus totara	14	8	3	2	9	2	3	5	**46**
Cedrus deodara	6	11	9	9	2	2	3	1	**43**
Eucalyptus nicholii	5	6	4	11	0	0	0	13	**39**
Quercus robur	2	7	3	6	3	3	7	7	**38**
Cordyline australis	4	1	1	3	7	6	1	9	**32**
Syzygium smithii	8	0	6	3	3	2	2	6	**30**
Syagrus romanzoffiana	0	1	4	0	8	7	4	6	**30**
Dacrydium cupressinum	1	11	4	0	11	0	1	1	**29**
Grevillea robusta	5	1	4	10	1	0	1	7	**29**
Jacaranda mimosifolia	8	6	1	0	6	6	1	1	**29**
Agathis australis	10	2	5	1	5	0	1	3	**27**
Cupressus macrocarpa	6	0	0	6	0	1	0	8	**21**
Eucalyptus cinerea	2	1	1	3	0	2	1	11	**21**
Ginkgo biloba	4	6	0	0	4	4	0	1	**19**
Magnolia grandiflora	1	6	0	2	3	4	1	1	**18**
Casuarina cunninghamiana	3	1	3	6	0	0	1	3	**17**
Casuarina glauca	0	0	0	7	0	1	0	9	**17**
Washingtonia robusta	3	0	5	0	1	7	1	0	**17**
Melia azedarach	2	1	1	0	4	6	0	1	**15**
Banksia integrifolia	7	2	1	3	0	0	0	1	**14**
Fagus sylvatica	1	3	1	1	6	0	1	1	**14**
Populus nigra 'Italica'	4	3	0	0	0	1	1	5	**14**
Prunus serrulata	2	9	1	0	2	0	0	0	**14**
All others	59	71	34	50	56	38	35	55	**398**
Total	**271**	**229**	**181**	**178**	**213**	**162**	**98**	**229**	**1561**

A survey was conducted by the author in July-August 2008 to determine the predominant species planted in residential streets. Some 546 streets with street trees were sampled in the former Auckland, Manukau, North Shore and Waitakere cities (Fig. 5–6). Many streets, particularly in Manukau, Waitakere and North Shore, had no street trees at all, and these were not counted in the sample, and nor were streets that had a mixture of species. The older inner Auckland suburbs, such as Mt Eden and Epsom, had by far the greatest proportion of tree-lined streets.

Fig. 5 *Broussonetia papyrifera*, High St, Otahuhu. Photo: Mike Wilcox, 18 July 2008.

Fig. 6 *Lophostemon confertus*, Richmond Rd, Ponsonby. Photo: Mike Wilcox, 13 July 2008.

The results are of considerable interest and when it comes to choice of species, size matters, and so does shape. Seventy-five species were recorded, the 43 commonest across all suburbs being listed in Table 2.

The popularity of tītoki deserves comment. It has been widely planted on the volcanic soils of central Auckland, where it seems to thrive. Furthermore, this tree is a native, seemingly safe and harmless, it is rarely complained about, it is evergreen, it seems to grow well on street berms, it usually maintains a good shape (with erect trunk and spreading, dense crown), and does not grow too fast (or too tall) so as to seriously interfere with overhead wires. Australian kanooka is a highly successful street tree, being of handsome appearance, excellent health, even growth, and not growing too tall. It is a species of natural occurrence in eastern Australia, lining streams. London plane when left to grow to full size is Auckland's grandest street tree, with several splendid avenues in the downtown area (e.g., Symonds Street, Alfred Street, Greys Avenue, Vincent Street) and adjoining suburbs of Ponsonby (e.g., Franklin Road, Picton Street), Freemans Bay (Howe Street) and Grey Lynn (e.g., Francis Street, Hakanoa Street). It was once common practice to pollard Auckland's plane trees, but they are now mainly left to grow tall (Auckland City Council, 1997). Oriental plane (*Platanus orientalis*) is not common and not particularly successful as a street tree in Auckland, but features in the upper part of Ponsonby Road. Its distinctive bronzy leaf tips show out in summer and autumn.

Table 2 Frequency of tree species in a sample of 546 streets in Auckland.

Rank	Species	Number of streets
1	tītoki (*Alectryon excelsus*)	62
2	willow myrtle (*Agonis flexuosa*)	40
3	Persian lilac (*Melia azedarach*)	39
4	flowering cherries (*Prunus campanulata* & *P. serrulata*)	39
5	Australian kanooka (*Tristaniopsis laurina*)	38
6	pōhutukawa (*Metrosideros excelsa*)	30
7	silver birch (*Betula pendula*)	27
8	brush box (*Lophostemon confertus*)	23
9	London plane (*Platanus* × *acerifolia*)	19
10	claret ash (*Fraxinus angustifolia* subsp. *oxycarpa* 'Raywood')	17
11	bottle brush (*Callistemon citrinus* & *C. viminalis*)	14
12	evergreen magnolia (*Magnolia grandiflora*)	14
13	lemonwood (*Pittosporum eugenioides*)	13
14	Australian tea tree (*Leptospermum morrisonii* 'Copper Sheen')	11
15	elms (*Ulmus* spp.)	11
16	pūriri (*Vitex lucens*)	10
17	Brazilian pepper tree (*Schinus terebinthifolius*)	8
18	maples (*Acer* spp.)	8
19	sweet gum (*Liquidambar styraciflua*)	7
20	Illawarra flame tree (*Brachychiton acerifolius*)	6
21	Australian frangipani (*Hymenosporum flavum*)	6
22	monkey apple (*Syzygium smithii*)	6
23	tōtara (*Podocarpus totara*)	6
24	olive (*Olea europaea*)	5
25	photinia (*Photinia serratifolia*)	5
26	kōwhai (*Sophora microphylla*)	5
27	Canton lace (*Radermachera sinica*)	4
28	broadleaf (*Griselinia littoralis*)	4
29	coast banksia (*Banksia integrifolia*)	4
30	cabbage tree (*Cordyline australis*)	4
31	queen palm (*Syagrus romanzoffiana*)	4
32	Chinese elm (*Ulmus parvifolia*)	3
33	karaka (*Corynocarpus laevigatus*)	3
34	Japanese spindle tree (*Euonymus japonicus*)	3
35	rewarewa (*Knightia excelsa*)	3
36	lime (*Tilia cordata*)	3
37	Norfolk Island hibiscus (*Lagunaria patersonii*)	2
38	Turkey oak (*Quercus cerris*)	2
39	pedunculate oak (*Quercus robur*)	2
40	kusamaki (*Podocarpus macrophyllus*)	2
41	Canary Island date palm (*Phoenix canariensis*)	2
42	Kermadec pōhutukawa (*Metrosideros kermadecensis*)	2
43	puka (*Meryta sinclairii*)	2
44–75	All others	29
	Total	**546**

Fig. 7 Historic pōhutukawa (*Metrosideros excelsa*), Emily Place Reserve, central Auckland. Photo: Mike Wilcox, 31 Dec 2010.

Fig. 8 *Ilex cornuta*, Monte Cecilia Park, Hillsborough. Photo: Mike Wilcox, 7 June 2012.

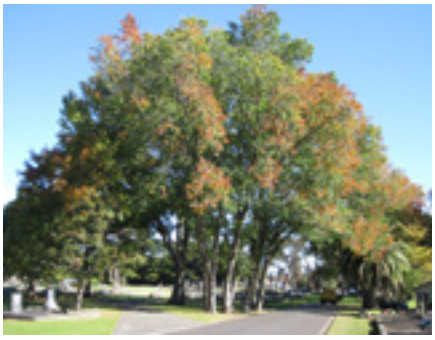

Fig. 9 *Ulmus* × *hollandica*, Papakura Cemetery. Photo: Mike Wilcox, 4 May 2012.

Larger sites: trees in parks, historic homesteads, schools, campuses, golf courses and cemeteries

Whereas home gardens and streets are restricted by overhead wires and proximity to buildings as to the number and size of trees that can be grown, parks and reserves have few such limitations as they have the advantage of space. The role of these places in the urban forest is therefore of major importance for it is here we find the greatest dendrological treasure of big trees of a great number of species (Fig. 7–11). Auckland's oldest parks dating back 150 years have an assemblage of trees from various parts of the world, with Norfolk Island pine, Queensland kauri (Agathis robusta), Moreton Bay fig (Ficus macrophylla), po¯hutukawa (Metrosideros excelsa), pu¯riri, holm oak (Quercus ilex), camphor laurel (Cinnamomum camphora), oaks (Quercus) and elms (Ulmus) being particularly prominent. There are records of Norfolk Island pines first being introduced in the 1850s, with Bishop Selwyn bringing in several hundred seedlings from Norfolk Island in 1858–1860 for planting in Auckland (Adam, 2007). The big trees to be seen at Mission Bay (Selwyn Domain) and at St Johns College, Meadowbank, for instance, are likely to have been from the bishop's introductions. It is on record that the Mission Bay trees were planted on 24 February 1861 (More, 1968). Farmers planted Bishop Selwyn's seedlings also, near their homesteads throughout Auckland, and many survive to this day.

A survey of the tree composition in 660 urban parks, industrial estates, cemeteries, school grounds, campuses, and large historic gardens, covering 3000 ha, showed that the commonest big trees (15 m or more tall) in the city are pōhutukawa, eucalypts, pūriri, tōtara, pin oak (*Quercus palustris*), sweet gum, pedunculate oak, London plane (*Platanus* × *acerifolia*), monkey apple, Monterey cypress (*Cupressus macrocarpa*), Norfolk Island pine (*Araucaria heterophylla*), Monterey pine, Canary Island date palm (*Phoenix canariensis*), brush box (*Lophostemon confertus*), river sheoak (*Casuarina cunninghamiana*), claret ash (*Fraxinus angustifolia* subsp. *oxycarpa* 'Raywood'), silky oak (*Grevillea robusta*) and poplars (*Populus yunnanensis*, *P. nigra* 'Italica', *P.* × *canadensis*). These are the species that give the primary structure to Auckland's urban forest. The predominant eucalypts are *Eucalyptus botryoides*, *E. cinerea*, *E. nicholii* and *E. saligna*. The most abundant smaller trees (<10 m) are cabbage tree, karaka, lemonwood, tītoki, evergreen magnolia (*Magnolia grandiflora*), karo, kōhūhū and broadleaf (*Griselinia littoralis*).

Notable trees form a subset of the trees on larger sites. The Tree Council (2003) and Wilcox (2012) list Auckland's notable trees, and the New Zealand Tree Register database includes several entries from Auckland. Wilcox (2012) also provides a comprehensive inventory of the trees to be found in Auckland, grouped by region of origin: New Zealand, Australia, Pacific, North America, South and Central America, Europe, Africa and Asia.

Concluding remarks

The forest type classification adopted here as a way of describing Auckland's urban forest should have application in helping with managing the forest in the future. This forest-type model should also be applicable to description and management of urban forest in other cities. The urban forest is ecologically, socially, commercially and politically complex. A mechanism such as an 'Urban Forest Alliance' is needed to record and share information about the city's urban trees and to promote research, effective management and future improvement of the urban forest for the benefit of all citizens.

Fig. 10 *Ficus macrophylla*, a notable tree growing at Glen Taylor School, Glen Innes. Photo: Mike Wilcox, 2 Feb 2012.

Fig. 11 *Callicoma serratifolia*, University of Auckland city campus. Australian species are a prominent feature of Auckland's urban forest. Photo: Mike Wilcox, 19 Oct 2005.

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