The Urban Forest of Waitematā Local Board in 2013

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The urban forest of Waitematā Local Board in 2013

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Executive summary

Auckland's urban forest is remarkable and special. However, rapid population growth and legislative change is leading to significant change in the urban landscape, which is reflected in the urban forest. This report outlines the distribution, ownership and protection status of forest within the Waitematā Local Board (Auckland Council) area. Providing evidence to ensure decision-makers are well-informed and have a sound basis for their future decisions.

The data presented in this report is a snap-shot of urban forest cover in 2013; a one-off measure of canopy distribution and height within the Waitematā Local Board area. One of the most controversial issues relating to urban forest in Auckland, and the most important unknown, is the rate of change in the urban forest canopy. Auckland Council is undertaking another aerial LiDAR survey and the outputs of this survey are expected to be available for further analysis by December 2018.

'Urban forest' comprises all the trees within a city – including parks, coastal cliffs, stream corridors, private gardens and streets – both native and naturalised (i.e. exotic). For the purposes of this report 'urban forest' is defined as all of the trees and other vegetation three metres or taller in stature – and the soil and water that support these trees – within the Waitematā Local Board. A healthy urban forest provides a multitude of benefits for ecosystems, the economy and community health and well-being.

This report summarises the distribution, size-class structure, ownership and protection status of forest within Auckland Council's Waitematā Local Board area. The report was written for the Natural Environment portfolio of the Waitematā Local Board, to provide background information and some direction and context for an urban forest strategy. The data presented in this report is based on an analysis of 2013 LiDAR (Light Detection and Ranging) captured jointly by NZ Aerial Mapping and Aerial Surveys Limited for Auckland Council. Prior to the analysis presented in this report, the council had no reliable information on the extent, ownership, and protection status of Auckland's urban forest assets.

Urban forest covers 19 per cent of the local board area, including 15 per cent of roads, 39 per cent of public open space and 16 per cent of private land. Total coverage is moderate when compared to other urban local boards within the Auckland metropolitan area. Initial analysis of the urban forest layer highlighted a clear distinction within the local board into two zones; the Central Business District (CBD) and the much larger area of suburban housing and parkland surrounding the CBD. Analysis of urban forest cover and characteristics are reported separately for these two zones.

Total urban forest cover is around 12 per cent for the CBD and 21 per cent for the suburban zone. Within the CBD, urban forest cover is mostly (89%) concentrated on public

land, which includes public open space (i.e. public parks), street trees and other public land. Private land urban forest covers the largest proportion of the suburban zone (45%) with the remainder comprising public parks (34%), street trees (14%) and other public land (7%). Approximately 60 per cent of the urban forest cover in the CBD zone has some form of statutory protection, compared to 51 per cent for the suburban zone. Notable tree information has not been included in our analysis; therefore the actual area of high protection urban forest is larger than we have identified.

There are some obvious ‘gaps’ in tree cover throughout the Waitematā Local Board area. If even coverage of urban forest cover across the whole board area is one of the aims of the board and local community, then tree planting and incentives to retain existing trees could be concentrated in these ‘gaps’.

Public parks are probably a good place to focus additional urban forest planting as they offer the best opportunities for long-term sustainable management of the urban forest due to the lower chance of conflict with future housing intensification, less infrastructure conflicts (which is often an important negative associated with street tree plantings), more considered selection of appropriate species and location for plantings, better arboricultural management, and a coherent policy for ongoing planting of replacement trees. Public parks are also better able to accommodate the types of large trees which provide a disproportionate amount of many of urban forest benefits. The wider accessibility of trees on public parkland also means that the benefits they provide (e.g. better shade and increased emotional well-being for park users) apply to a larger number of people, which is a major positive in terms of overall cost-benefit outcomes.

The data presented in this report is a snapshot of urban forest cover in 2013: a one-off measure of canopy distribution and height within the Waitematā Local Board area. The Research and Evaluation Unit (RIMU) has undertaken to prepare another urban forest report for the Waitematā Local Board that will compare the 2013 and 2016 LiDAR runs and provide an in-depth analysis of any changes in urban forest detected over this three-year period. Additional analysis of LiDAR data will also be used to forecast the possible future changes in urban forest cover and height as a result of increased population growth and intensification.

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1.0 Preface

Jules d'Urville was having a rough day in the New Zealand bush. It was 1829 and d'Urville and company had earlier set out on an excursion to explore some local forest and gain a view of the surrounding land from the nearby mountain highpoint, which was their ultimate objective; the going was much tougher than expected:

> *"… [the] path vanished by degrees and ended in a small but thick wood… not more than two miles from the eminence I wished to obtain".* Undeterred, d'Urville pressed on, but the thick forest and scrub was such that *"… after half an hour of unheard of efforts and extraordinary fatigue, which permitted us to advance 200 paces, we found ourselves in a place so swampy and interlaced with ferns, dry shrubs and brushwood that it became impossible to place one foot before the other."*

The 'eminence' they were trying to reach was Maungawhau/Mt Eden. Having set out from Judges Bay on the Auckland waterfront, they had come to a grinding halt in a dense wetland occupying low ground in the Carlton Gore Road – Khyber Pass area. Hardly a challenging tramp by today's standards, but indicative of the great change that Auckland's urban forest has undergone over the past 180 years!

Prior to the arrival of humans the Waitematā Local Board was covered in lush tall forest for most of the last 15,000 years (Esler 2004, Horrocks et al. 2009, Wilcox 2012). However, centuries of burning from around 1300AD meant that the local board area was almost devoid of tall forest by the time early European explorers began to record their observations (Esler 2004). The recollections of Rough (1840 cited in Esler 2004) are typical of many of his contemporaries:

> *"I climbed up the cliffs to where Ponsonby now is, and I beheld a vast extent of undulating country, mostly covered with fern and manuka scrub; several volcanic hills in sight, and near the shore, valleys and ravines in which many species of native trees were growing, whilst the projecting cliffs and headlands were crowned with pohutukawa trees."*

Vegetation cover within the Waitematā Local Board has changed dramatically over the 176 years since these observations were made. Today significant pockets of native forest are confined to The Domain, Arch Hill and Ayr Street reserves, and the coastal fringe; collectively they cover only about 2.5% of the local board area. However, many new areas of native scrub have been planted in recent decades within local reserves and along the motorway corridors. Urban forest – which includes a wide range of other vegetation, such as exotic forest, park and street trees, and trees on private land – covers around 19% of the local board area, and it is these forest assets that are the subject of this report.

2.0 Introduction

This report summarises the distribution, size-class structure, ownership and protection status of forest within Auckland Council's Waitematā Local Board area. The report was written for the Natural Environment portfolio of the local board, to provide background information and some direction and context for an urban forest strategy. When the local board first began to consider the urban forest issue in 2014 it soon became clear there was a lack of basic data about key urban forest parameters required for informed decision-making.

The data presented in this report is based on an analysis of 2013 LiDAR (Light Detection and Ranging) captured jointly by NZ Aerial Mapping and Aerial Surveys Limited for Auckland Council. The LiDAR dataset was supplied in raw above ground point classified form. Data-points classified as 'vegetation' were used to form the foundation of an 'urban forest' layer for further analysis and interrogation with ArcGIS10.2 spatial software through combination with other spatial datasets.

'Urban forest' comprises all the trees within a city – including parks, coastal cliffs, stream corridors, private gardens and streets – both native and naturalised (i.e. exotic). This comprehensive definition is in line with the North American view of urban forest (Miller et al. 2015, Wilcox 2012), rather than the European one in which urban forest is defined as natural enclaves of natural forest within the city limits (Cliffin 2005, Carreiro and Zipperer 2008).

An urban forest provides a multitude of benefits for ecosystems, the economy and community health and well-being. Trees are crucial from an ecological standpoint, and also provide a wide range of additional landscape, environmental, social, economic, climatic, cultural and other practical benefits, including[1]:

1. Urban forest and other urban ecosystems are the primary contact with nature that many city-dwellers have; spending time in urban forest enclaves has been shown to improve mental health and well-being, and reduce anger and aggression
2. Urban forests provide critical ecosystem services such as air and water filtration, production of oxygen, carbon sequestration and nutrient cycling
3. Urban forest has been shown to have a diverse range of economic benefits such as enhanced property values, increased consumer spending in retail zones with street trees, reduced energy consumption, increased appeal to tourists, and increasing road and footpath longevity.

[1] See also https://www.treepeople.org/resources/tree-benefits

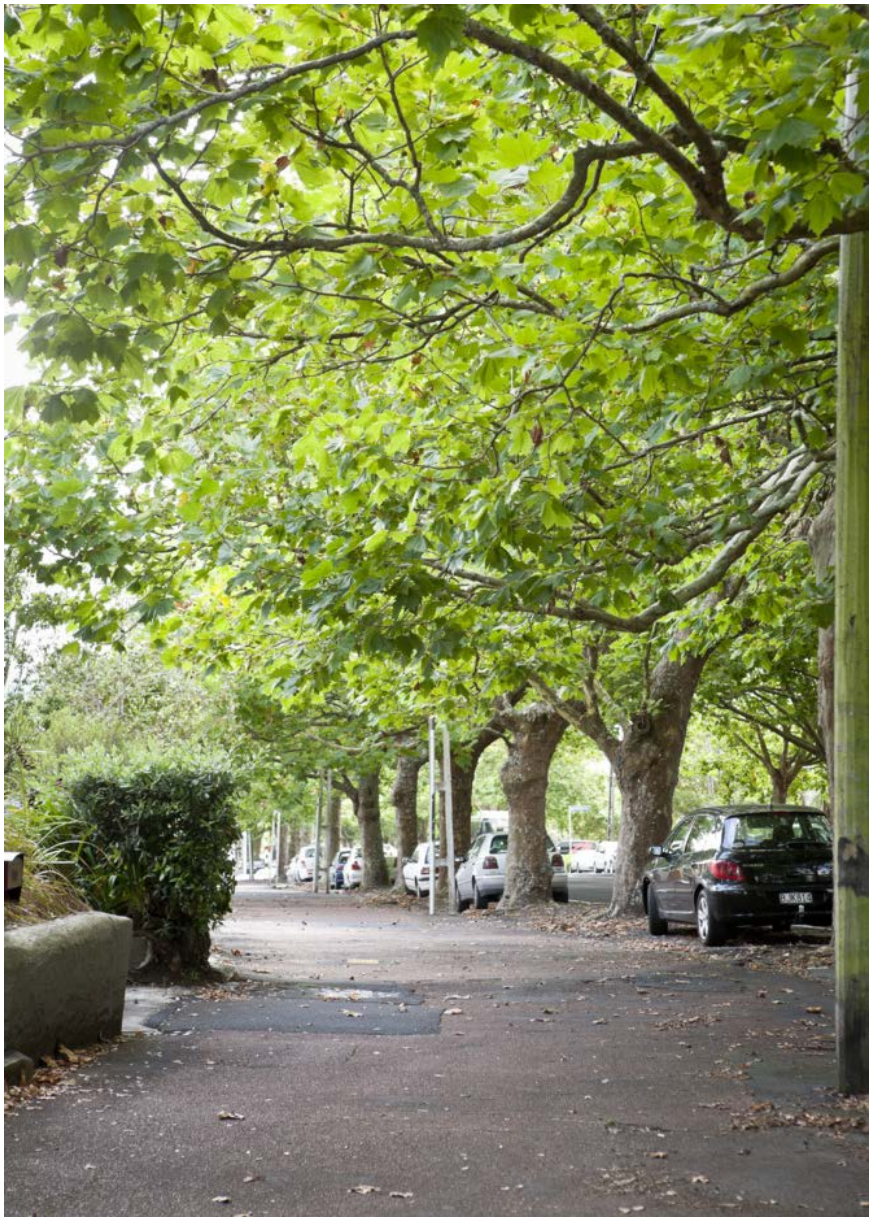
4. In a neighbourhood with more street trees, park trees and other plants, people judge walking distances to be less, and are therefore more likely to travel on foot, which has health benefits. They are also more protected from the sun while walking and playing, and from traffic by the physical barrier trees provide
5. The presence of street trees reduces the speed of drivers, and reduces the frequency and severity of crashes
6. Street trees and sidewalk gardens build neighbourhood and civic pride and neighbourhood park planting events are a great way to strengthen communities and bring neighbours together
7. In addition, many of the native ecosystems within Auckland's urban boundary are unique in their own right; being representative examples of special ecosystems that have been largely cleared to make way for urban growth. Urban forest also provides habitat for other biodiversity, including native birds, reptiles and insects.

Section 35(2) of the Resource Management Act 1991 (RMA 1991) requires councils to monitor the efficiency and effectiveness of any policy statements and plans prepared under the RMA. However, prior to the analysis presented in this report, the Council had no reliable information on the extent, ownership, and protection status of Auckland's urban forest assets. This is despite significant anecdotal evidence from council arborists, professional arborist groups, urban forest researchers, local board politicians and the general public that the urban tree-cover is undergoing a period of rapid change.

Baseline information about Auckland's urban forest is particularly important in light of the recent changes to the RMA which have removed the ability of the council to use general tree protection rules to protect urban forest. Sections 76(4A) and 76(4B) of the RMA were inserted under the Resource Management (Simplifying and Streamlining) Amendment Act 2009 (RMAA09). This was amended under the Resource Management Amendment Act 2013 (RMAA13) to align with its original policy intent – the prohibition of blanket tree protection rules in urban areas. It was hoped that removal of general tree protection would occur in conjunction with a systematic programme to identity and protect important trees through their incorporation onto the notable tree schedule. However, in Auckland this has not happened and important urban forest assets therefore remain unprotected.

For the purposes of this report 'urban forest' is defined as all of the trees and other vegetation three metres or taller in stature – and the soil and water that support these trees – within the Waitematā Local Board (Figure 1). Urban forest incorporates trees and shrubs in streets, parks, private gardens, stream embankments, coastal cliffs, rail corridors, and motorway margins and embankments. It also includes both planted and naturally established plants, of both exotic and native provenance.

The Environmental Defence Society of New Zealand (EDS) stated in 2015 “While other cities have targets of achieving 40% tree cover or more[2], Auckland is moving backwards with a minimalist approach reliant on a cumbersome and costly scheduling process,” (EDS 2015).



Street trees on Franklin Road

[2] Many of the cities which Auckland compares itself too, and which score consistently high on the various international indices of liveability, have adopted urban forest strategies and targets. For example: Melbourne has a 40% target for tree cover in the public realm by 2040 (Anon 2012), an almost doubling of urban forest cover in 2012; Vancouver has a goal of planting 150,000 trees by 2020 (over 10 years) and increasing the cities tree canopy cover; Sydney plans to increase its average total canopy cover from 16% (2013) to 23% by 2030, and then to 27% by 2050, through targeted programmes for trees located in streets, parks and private property (Anon 2013).

3.0 Research questions

- What is the distribution and height-class composition of urban forest within the CBD and suburban zones of the Waitematā Local Board?
- Who owns the urban forest within the CBD and suburban zones of the Waitematā Local Board?
- What proportion of the urban forest within the CBD and suburban zones of the Waitematā Local Board is protected, and what is the strength of that protection?

Urban forest of The Domain

Urban forest of the future in Newmarket Park

4.0 Methods

The best method for obtaining a universal sample of the urban forest, and how it is changing over time, is with LiDAR datasets. Other possible techniques for mapping Auckland's urban forest at a comparable resolution included manual digitization of aerial imagery, field-work with aerial imagery followed by manual digitization of field maps, or some combination of these two methods. Both these approaches involve considerable staff time and were therefore too expensive to allow us to obtain a universal sample of urban forest within the Auckland urban area. Automatic classification of satellite imagery could have provided a universal sample, but the resolution of this approach was insufficient to provide mapping and change data at the scale that was required for this work; i.e. down to individual trees and shrubs.

LiDAR stands for light detection and ranging, it is an airborne optical remote sensing technology that measures scattered light to find a range and other information on a distant target. The range to the target is measured using the time delay between transmission of a pulse and detection of a reflected signal. This technology allows for the direct measurement of three-dimensional features and structures and the underlying terrain. The ability to measure height of features on the ground or above the ground is the principle advantage over conventional optical remote sensing technologies such as aerial imagery. The current and most feasible way of assessing woody vegetation such as urban forest on a regional scale is using the LiDAR technology.

LiDAR data that is suitable for urban forest analysis is currently only available for 2013, however new LiDAR is being collected in mid to late 2016.

The urban forest data presented in this report was created from airborne LiDAR sensor data collected between 17/07/2013 and 23/11/2013. The classified Raw Point Cloud, that the urban forest layer was created from, is at least 1.5 points per square metre over open ground. Vertical accuracy is +/-0.1m @ 68% confidence. Data-points classified as 'vegetation' were extracted to form the foundation of an urban forest layer for further analysis and interrogation within the ArcGIS 10.2 geospatial software through combination with other spatial datasets (Table 1).

LiDAR data includes a height component and we used this information to set a cut-off point for urban 'forest' vegetation at 3m. That is, we used LiDAR data-points classified as vegetation that were 3m+ in height to derive the urban forest layer. This means that low-lying vegetation such as mown grassland, low stature hedges and gardens were not included in the urban forest layer. It also means that that new restoration and street tree plantings that have taken place in the 2013-2016 period may not be visible in this analysis.

However the numbers planted are significant enough to mention that approximately 6000 plant, shrubs and seedling trees were planted in parks as part of our volunteer programme, 2013-2016.

The initial urban forest layer underwent some quality control checks to eliminate obvious errors found in the supplied classified point cloud data. During this process we removed misclassified areas of man-made materials and other non-vegetation surfaces. Such errors are symptomatic of classification functions which classify surface objects of varying composition based on the strength of the LiDAR pulse return. Objects with similar reflectivity to vegetation, such as transparent materials (glass) and power lines, were common sources of these errors.

Table 1 List of data sources and descriptions used in analysis

Data	Description	Organisation source	Retrieved
Local Board	Waitematā Local Board area. A political division of the Auckland Council that covers the Auckland CBD and the inner city suburbs of Arch Hill, Freemans Bay, Grey Lynn, Herne Bay, Newmarket, Newton, Parnell, Saint Mary's Bay, Western Springs (part) and Westmere.	Statistics NZ	January 2016
City Centre, Unitary Plan Boundary	Auckland's CBD (Central Business District) which includes (approximately) all the land within the 'motorway ring' (see Figure 1).	Auckland Council	January 2016
Public Owned Land (parcel level)	This includes roads (both formed and unformed), public parks administered by the Auckland Council and land administered by central government agencies (e.g. Department of Conservation and Ministry of Education).	RIMU, Auckland Council	November 2015
Private Parcels (all primary parcels except above)	Current land parcel polygons with associated descriptive data (Land information New Zealand, 2010). This dataset does not include parcels that have been vested in council for roading.	LINZ	January 2016
Protected Land	See Table 2. Covers land within open space zones or protected in the Proposed Auckland Unitary Plan (e.g. as part of a Significant Ecological Area or Outstanding Natural Feature)	RIMU	August 2016

The level of urban forest protection was determined through an analysis of the underlying zones and protection layers in the proposed Auckland Unitary Plan (PAUP). Five different levels of protection were assigned (Table 3). The protection levels are based on the rules applying to vegetation clearance in the PAUP and our understanding of the practical barriers to vegetation clearance, based on past experience, for different zones and land uses.

Table 2 Level of protection for urban forest based on proposed Unitary Plan zone and overlay rules

Protection zone	Detail on rules and restrictions
0 – no protection	There is no statutory protection for urban forest and/ or rules preventing tree or vegetation clearance in this location
1 – some protection	Within an open space active recreation zone or a road corridor. For both these areas restricted discretionary resource consents are required to clear trees > 4m in height. However, development pressures are often high in these locations and trees are often regarded as incompatible with the main land uses. The proposed Auckland Unitary Plan rules for street trees are more permissive in terms of what utilities can do around and to trees – including pruning as permitted activity.
2 – low protection	Within a coastal natural character area, or an area zoned as 'Open Space Informal Recreation' (restricted discretionary consent needed to remove trees/ vegetation 4m+ in height). The proposed Auckland Unitary Plan rules for park trees are more permissive in terms of what utilities can do around and to trees – including pruning as permitted activity.
3 – moderate protection	Outstanding Natural Feature (restricted discretionary consent needed to remove 25m^2+ of contiguous indigenous vegetation)[A], Outstanding Natural Landscape (restricted discretionary consent needed for alteration or removal of 50m^2+of any contiguous indigenous vegetation)[A], Coastal yard (restricted discretionary consent needed to remove native trees/ vegetation 3m+ in height)[A] Open Space Conservation (restricted discretionary consent needed to remove trees/ vegetation 4m+ in height) Historic heritage (discretionary consent needed to remove trees/ vegetation 3m+ in height) Riparian yard (restricted discretionary consent needed to remove any trees or shrubs) Lake protection zone (restricted discretionary consent needed to remove any trees or shrubs)
4 – high protection	Significant Ecological Areas (SEA) (discretionary consent needed to remove any trees or vegetation), Notable trees (discretionary consent needed to remove any notable tree or shrub)

[A] = vegetation protection in these areas is restricted to indigenous species and does not cover exotic plants. In some cases (e.g. coastal zone) the removal of exotic vegetation is specifically mentioned as a permitted activity. Exotic trees can provide many of the same benefits as native species so this is a negative in terms of protection of urban forest values

5.0 Results

Figure 1 shows urban forest cover within the Waitematā Local Board. Urban forest covers 19% of the local board area, including 15% of roads, 39% of public open space and 16% of private land. Total coverage is moderate when compared to other urban local boards within the Auckland metropolitan area, although there is a group of four local boards with a very similar total coverage of 19-20% (Table 3). Urban forest cover of public parks in Waitematā Local Board is the 3rd highest of the urban local boards. This is due to the relatively high forest coverage in parks such as the Domain, Ayr Street, Arch Hill, Western Park, and the various parks along the Western Springs escarpment.

Table 3: Percentage cover of urban forest in Auckland's urban local board areas: data includes percentages for different land tenures and the overall cover within each board

Urban local board*	Public open space	Private land	Roads	Overall
Kaipatiki	63	25	12	30
Puketapapa	44	17	11	20
Albert-Eden	30	19	18	20
Orakei	25	20	14	20
Waitematā	**39**	**16**	**15**	**19**
Whau	30	17	12	17
Devonport-Takapuna	23	17	10	16
Henderson-Massey	31	14	7	15
Manurewa	25	11	6	12
Maungakiekie-Tamaki	22	9	10	11
Otara-Papatoetoe	13	8	6	9
Mangere-Otahuhu	17	7	7	8

* A number of local boards have been excluded from this table as they contain significant pockets of rural land (i.e. Hibiscus and Bays, Upper Harbour, Howick and Papakura local boards) or are largely rural in character (i.e. Waitakere, Franklin, Rodney, Great Barrier and Waiheke local boards)

An initial analysis of the urban forest layer highlighted a clear distinction within the local board into two zones (Figure 1); the Central Business District (CBD) and the much larger area of suburban housing and parkland surrounding the CBD. In the remainder of this report the urban forest cover and characteristics of these two distinct zones are reported on separately.

Figure 1: Urban forest cover within the Waitematā Local Board boundary showing the two distinct zones for which results are presented in the this report. They are the CBD zone (Auckland City Centre – inside the red line) and suburban zones (outside the red line)

5.1 Urban forest within the Waitematā Local Board – CBD zone

The total land area of the CBD zone is around 453ha and there is approximately 55ha of tree canopy >3m in height across this same area (Figure 2). This gives a total of 12% tree cover for the CBD, which is not much more than half the value for the suburban parts of Waitematā Local Board (21%). However, it is still greater than the urban forest cover of several other largely suburban local boards (Table 4). There is an obvious concentration of urban forest in the southern and eastern parts of the CBD. With the exception of Victoria Park there is only very scattered coverage of much smaller trees in the northern and western areas. The reclaimed parts of the CBD – approximately north of the Fanshawe Street, Customs Street, Beach Road line – are almost devoid of urban forest and have no trees >10m in height.

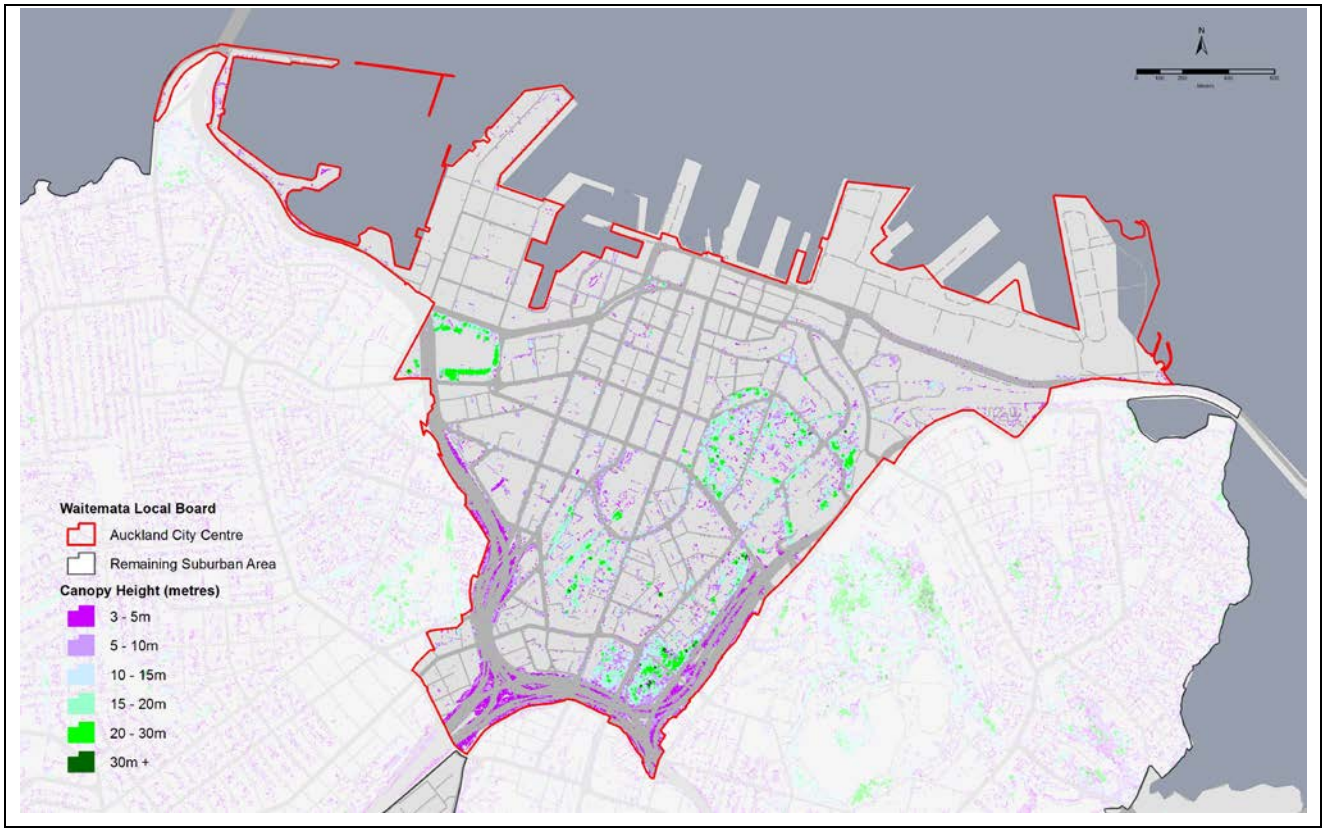


Figure 2: Urban forest cover within the CBD zone of Waitematā Local Board showing the maximum height of urban forest patches (in metres)

Research has shown that the greatest benefits are provided by large trees. Large trees typically (Anon 2012):

- Create more shade per tree due to a larger and wider canopy spread (Moser et al. 2015)
- Create better shade to buildings as they are taller and can cast shadow over roofs and walls of buildings (Moser et al. 2015)

• Intercept larger amounts of particulate pollutants and rainfall due to significantly larger leaf areas

• Absorb more gaseous pollutants. For example, Nowak and Crane (2000) found that large trees greater than 80cm diameter remove 70 times more air pollution annually than small trees less than 8cm diameter

• Contain more carbon and have higher carbon sequestration rates (Beets et al. 2012, Schwendenmann and Mitchell 2014, Dahlhausen et al. 2016)

• Can provide larger canopy cover with potentially less intrusion at the ground from stems, trunks and lower branches

• Are often less susceptible to careless or malicious vandalism by passers-by once established

• Can be pruned to provide higher canopy clearance over roadways, parking lots and pedestrian footpaths

• Typically contribute more to calming and slowing traffic on local streets than small trees.

Around half of the CBD's urban forest is <10m in height (Figure 3) and half >10m. Most of the largest (20m+) trees are located on public parks and other public land. In particular the larger and longer established public land such as Victoria, Albert, Constitution Hill and Myers parks, Grafton Cemetery, and the northern part of the University of Auckland campus, around Old Government House (Figures 2 and 4). With a few exceptions – notably Greys Ave, Grafton Road, and Vincent and Alfred streets – street trees are mostly smaller than 20m in height (Figure 2). In fact, more than 85% of street trees were <15m in height and 65% <10m (Figure 4). While private trees comprise only a small percentage of the urban forest within the CBD (11%, see below) they represent an even smaller proportion of the tree canopy that is 10m+ in height (7%).

In contrast to the suburban zone (see below), CBD urban forest cover is mostly (89%) concentrated on public land, which includes public open space (i.e. public parks), street[3] trees and other public land (Figures 5 and 6). Other public land includes areas such as tertiary campuses, schools, road reserves without formed roads on them, and council owned theatres, commercial and office space. Street trees are the major contributor to

[3] Within the CBD the category of 'street trees' includes both tree canopy above the roading network controlled by the Auckland Council and tree canopy/ plantings within the motorway corridor. The motorway corridor is actually owned and managed by the New Zealand Transport Agency (NZTA). The council has no control over the motorway corridor greenspace and trees planted here are not covered by the street tree rules in the proposed Auckland Unitary Plan.

publicly-owned urban forest in the CBD, accounting for almost half (47%) of trees on public land. A significant proportion of these street trees are new plantings associated with the motorway network that forms a ‘moat’ around the inland margins of the CBD.

Only around 60% of the urban forest cover in the CBD zone has some form of protection. There is no Significant Ecological Area (SEA) within the CBD and notable tree information has not been included in our analysis (see below), therefore no high protection urban forest has been identified in Figures 7 and 8. Protection of CBD urban forest is almost totally due to trees being located within street corridors (class 1 protection – 26% of total canopy area) and open space conservation and/ or heritage conservation zones (class 3 protection – 33% of total canopy area).

Notable trees were not included as their canopies have yet to be digitized and incorporated into a spatial dataset (see Sections 6 and 7 below). There are almost 300 individually scheduled trees within the CBD zone (Appendix A) along with more than 5ha of extensive ‘closed canopy’ notable tree patches within parks (e.g. Victoria Park) and over road corridors (e.g. Greys Ave. and Vincent, Alfred and Symonds streets). Collectively these notable trees cover approximately 9.6 ha, which would all have the highest protection status. Most CBD notable trees are already protected in some way (i.e. they are on roads, parks or other public land) so incorporating notable tree data is likely to raise the strength of protection, but not dramatically increase the total amount of protected urban forest.

Figure 3: Height of urban forest canopy – within CBD zone

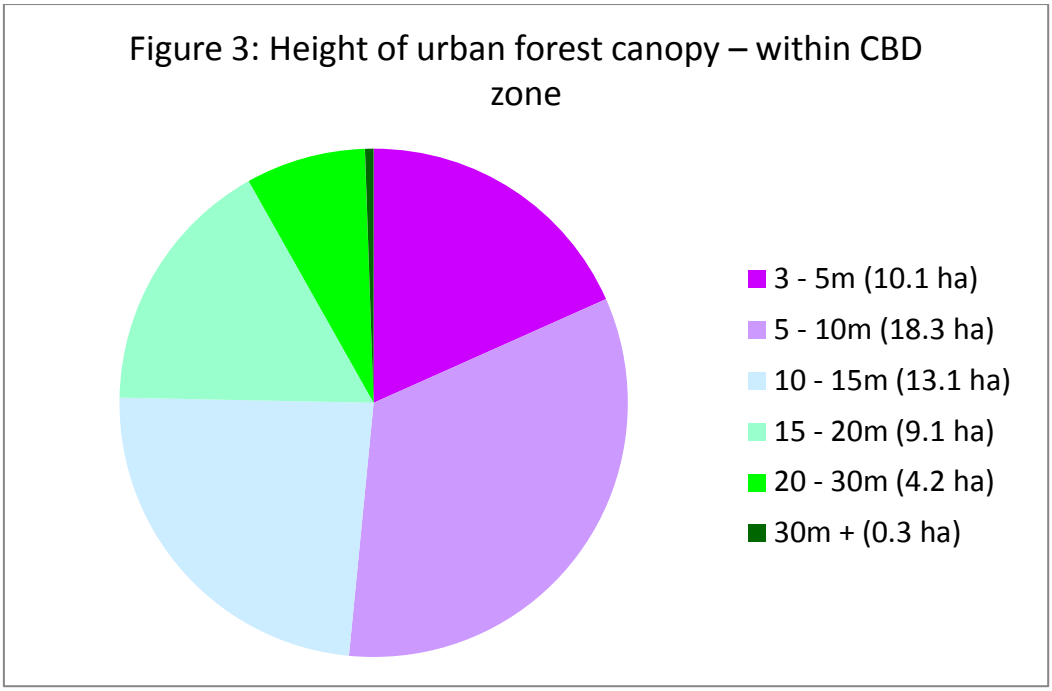
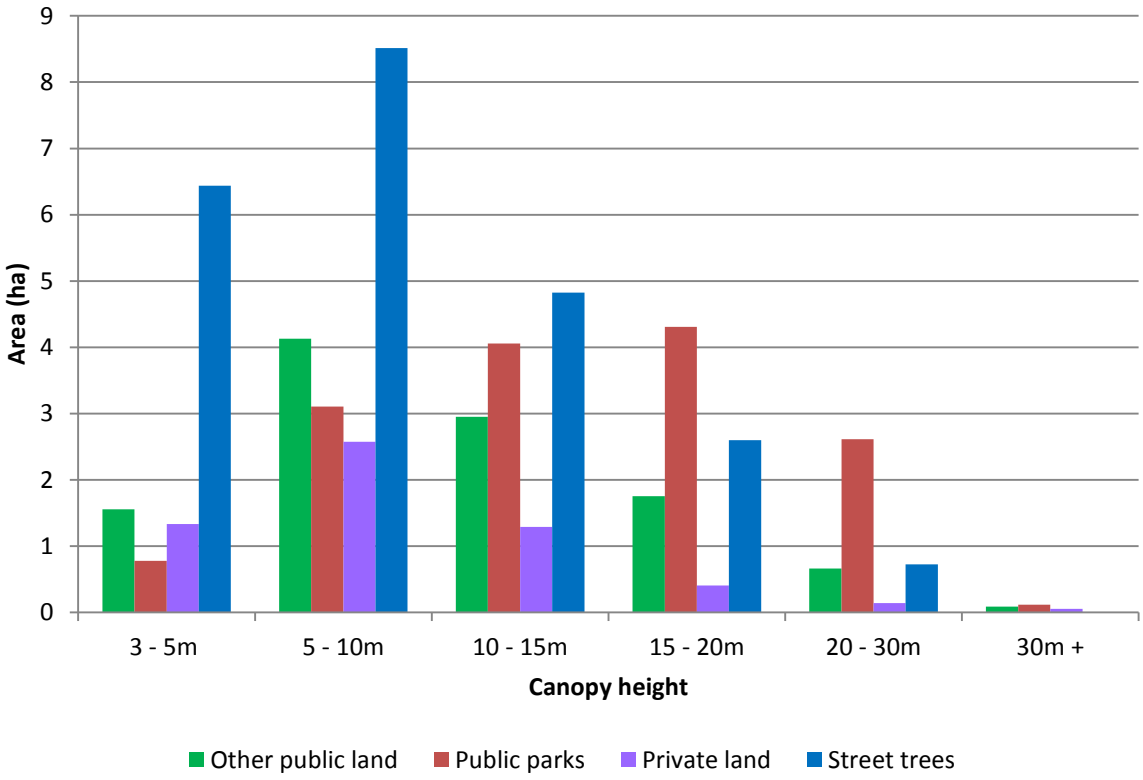


Figure 4: Height-class structure of urban forest canopy – within CBD zone



Grafton Bridge showing new plantings of indigenous shrubs and other plants (c.12 years old) along the road corridor margins

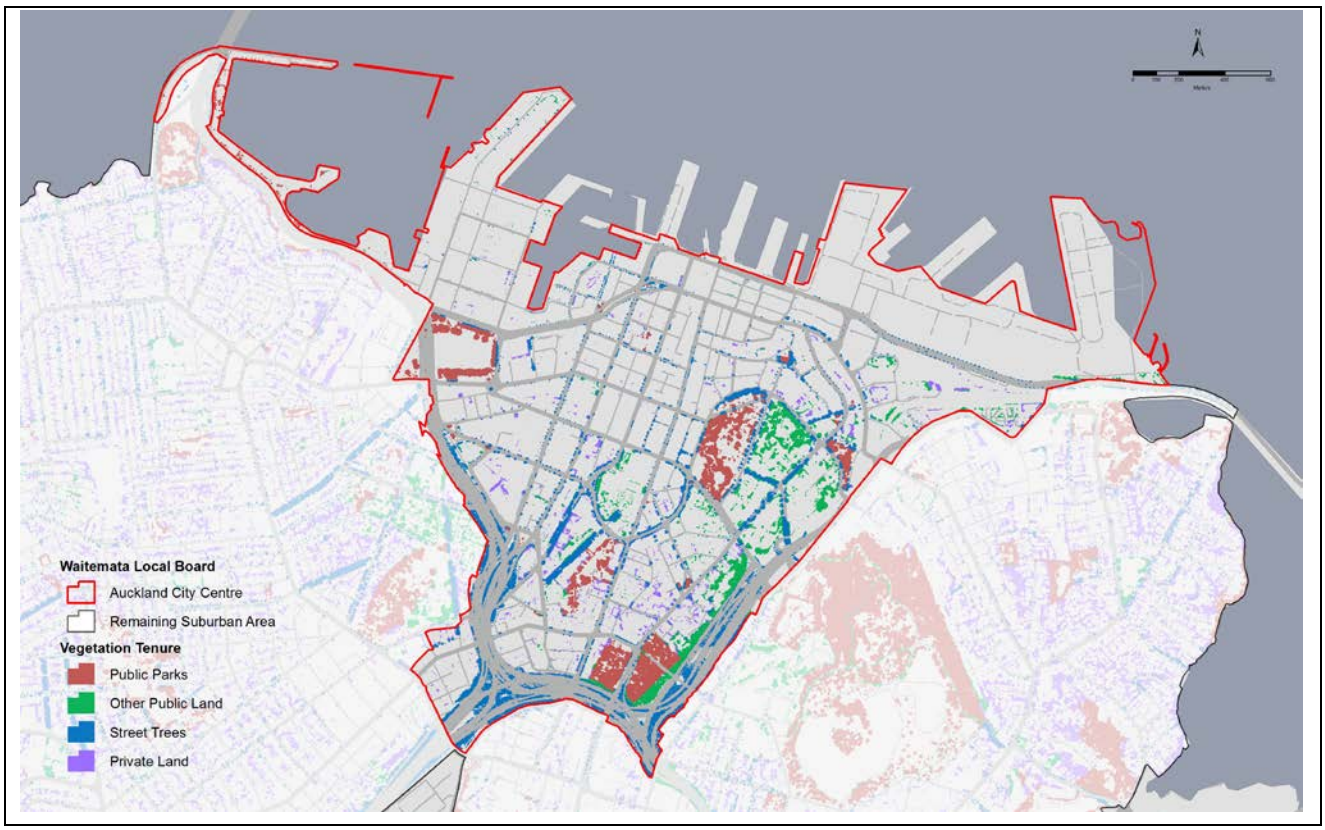
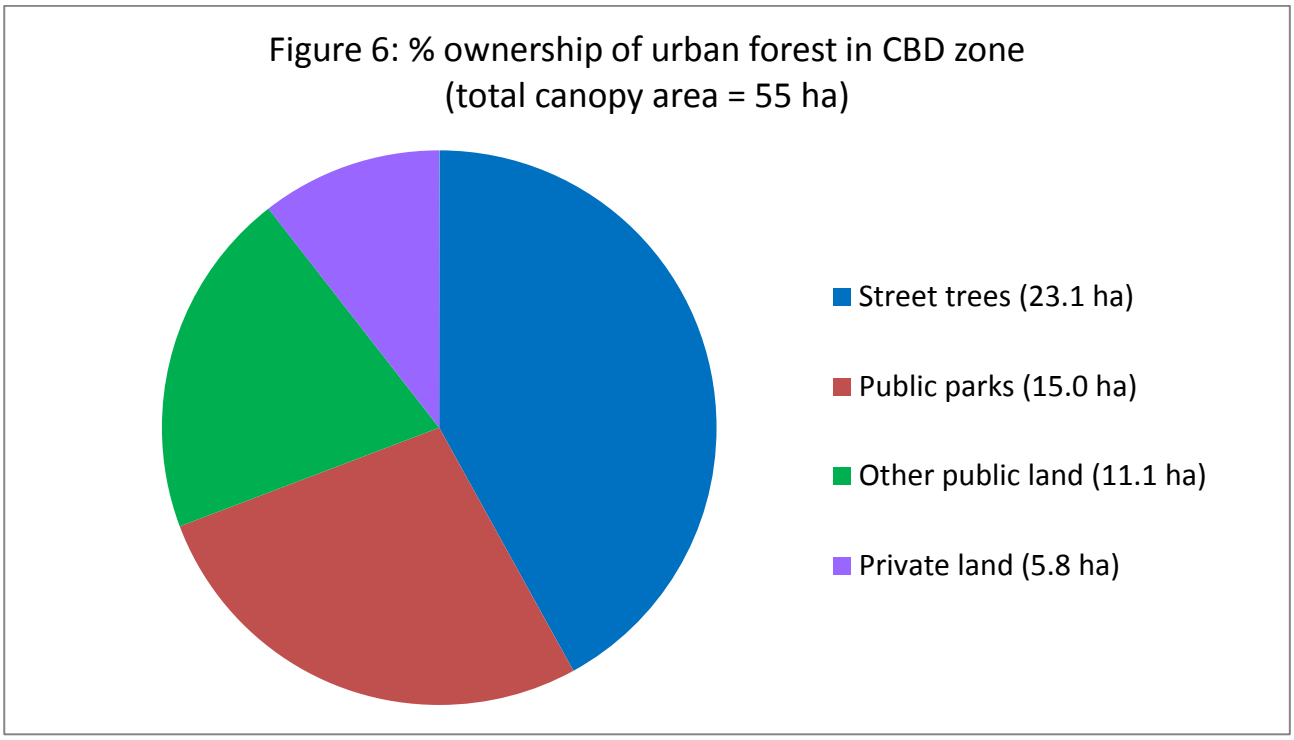
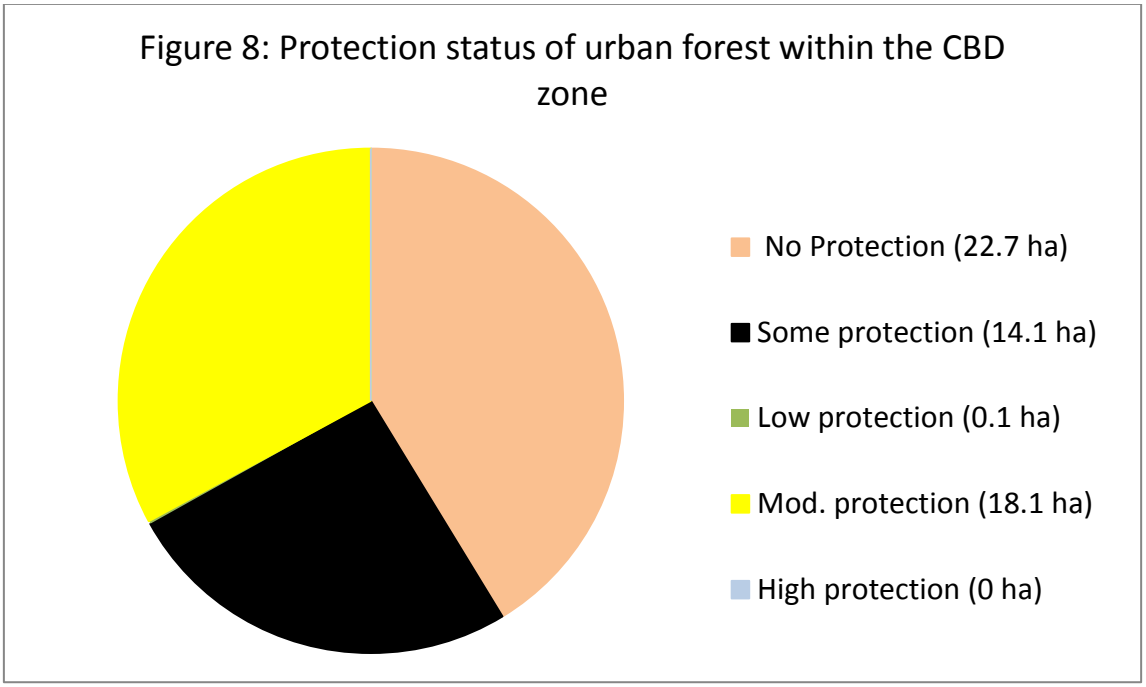


Figure 5: Urban forest cover within the CBD zone of Waitematā Local Board showing the tenure/ownership of urban forest



Two urban forest street scenes of Ponsonby Road (left) and (right) a close-up view of (left to right) Albany Road, Wanganui Ave and Ardmore Road in Ponsonby

Figure 7: Urban forest cover within the CBD zone of Waitematā Local Board showing the protection status of urban forest



5.2 Urban forest within the Waitematā Local Board – suburban zone

At around 1460ha the total land area of the Waitematā Local Board suburban zone is more than three times bigger than the CBD zone. There is approximately 313ha of tree canopy >3m in height across this same area (Figure 9) which gives a total of 21% tree cover for the suburban zone. This puts the suburban parts of the local board in second place in comparison with the other purely urban local boards within the Auckland metropolitan area (Table 4).

Urban forest is relatively evenly distributed throughout the suburban zone, the only significant gaps being in Newmarket, and built-up areas surrounding Newton Road and the Great North Road – Ponsonby Road intersection. There are a number of other obvious 'gaps' in urban forest coverage in Figure 9. However, these are all associated with pasture dominated green-space in parks such as Cox's Bay, Seddon Fields/ Meola Reef, Western Springs fields and The Domain.

Two thirds of the suburban zone urban forest is <10m in height, and only 15% is >15m (Figure 10). As the benefits of urban forest are disproportionally provided by the largest trees[4] the protection of this relatively small proportion of the overall urban forest is of particular importance. Much like the CBD, most of the largest (20m+) trees within the suburban zone are located on public land (84% of total cover). However, in contrast to the CBD, public parks are of primary importance (80% of total cover) with other public land contributing much less to urban forest cover.

[4] see the CBD zone results section above

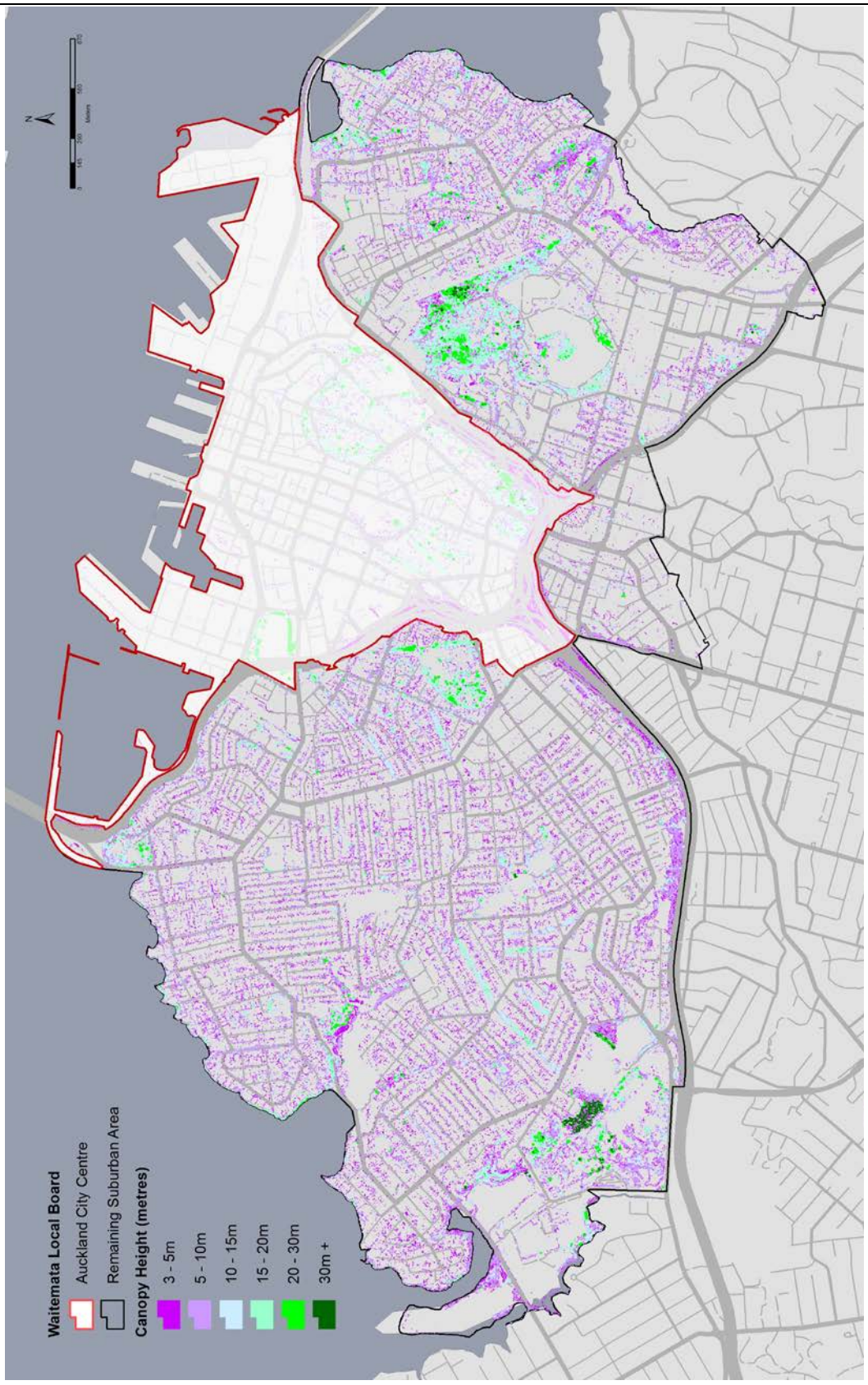


Figure 9: Urban forest cover within the suburban zone of Waitematā Local Board showing the maximum height of urban forest patches (in metres)

The majority of trees greater than 20m are concentrated in a small number of public parks, including The Domain, the Western Springs area including the steep escarpment below Old Mill Road, Western Springs Park and the zoo, Cox's Bay Reserve, small pockets within Ayr Reserve, and Western Park (Figures 9 and 11). There are also scattered examples taller trees in some smaller parks, including Alberon Reserve, Scarborough Reserve and Dove Myer-Robinson Park (Parnell) and Point Erin Park.

Most street trees are smaller than 20m in height (Figure 11). In fact, more than 91% of street trees were <15m in height and 67% <10m (Figure 11). However, while they were a small proportion of the overall total, there are a number of excellent examples of contiguous corridors of large streets within the suburban zone. Most notably within the suburbs of Ponsonby and Grey Lynn and including Franklin Road, and Howe, Picton, Hakanoa, Francis, Castle, Browning and Selbourne streets.

In contrast to the CBD zone (see above), private land urban forest covers the largest proportion of the suburban zone (45%). Collectively public land accounts for just over half of urban forest cover in the suburban zone, with the other half in private ownership. However, the private urban forest is biased towards smaller trees and shrubs; despite comprising almost one half of total cover, private land trees provide only 18% of the forest canopy above 15m, and 12% of the forest canopy greater than 20m tall.

Around one half (51%) of the urban forest cover in the suburban zone has some form of protection. There are a number of Significant Ecological Areas (SEA) within the suburban zone (Auckland Council 2016). Collectively these SEA sites[5] provide the highest level of protection for 58.2ha (19 %) of urban forest habitat. Notable tree information has not been included in our analysis (see below); therefore the actual area of high protection urban forest is larger than that identified in Figures 14 and 15. Other protection of urban forest is provided by street corridors (class 1 protection – 15% of total canopy area), open space informal recreation zoning (class 2 protection – 6% of total canopy area), and open space conservation, outstanding natural feature (class 3 protection – 11% of total canopy area).

Notable trees were not included as their canopies have yet to be digitized and incorporated into a spatial dataset (see Sections 6 and 7 below). There are almost 320 individually scheduled trees within the suburban zone (Appendix A), along with more than 4ha of extensive 'closed canopy' tree avenues along road corridors (e.g. Franklin Road and Howe, Picton and Hakanoa streets). Collectively these notable trees cover approximately 15.5 ha, which would all have the highest protection status and would

[5] SEA sites include parts of The Domain, Ayr Street Reserve, Alberon Reserve, Dove-Myer Robinson Park, Meola Reef Reserve, Western Springs Park and the Western Springs escarpment (including Jagger's Bush, but not including vegetation within the Zoo), and coastal cliff vegetation dominated by native trees all along the margin of the Waitematā Harbour and Judges Bay.

increase the total area of high protection urban forest by 27%. Many of the notable trees within the suburban zone are currently on un-protected private land so incorporating notable tree data is likely to raise the total area of protected trees to around 170ha (54%) of the total urban forest area.

Figure 10: Height of urban forest canopy – within suburban zone

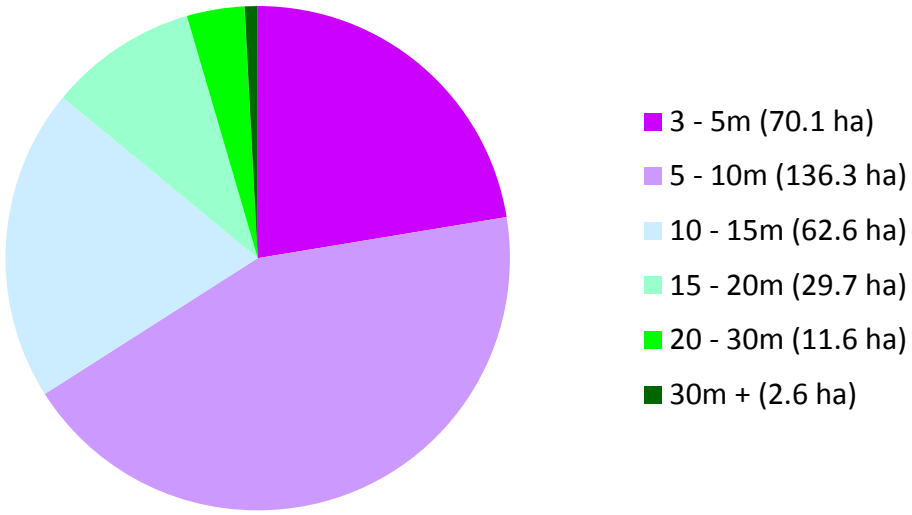
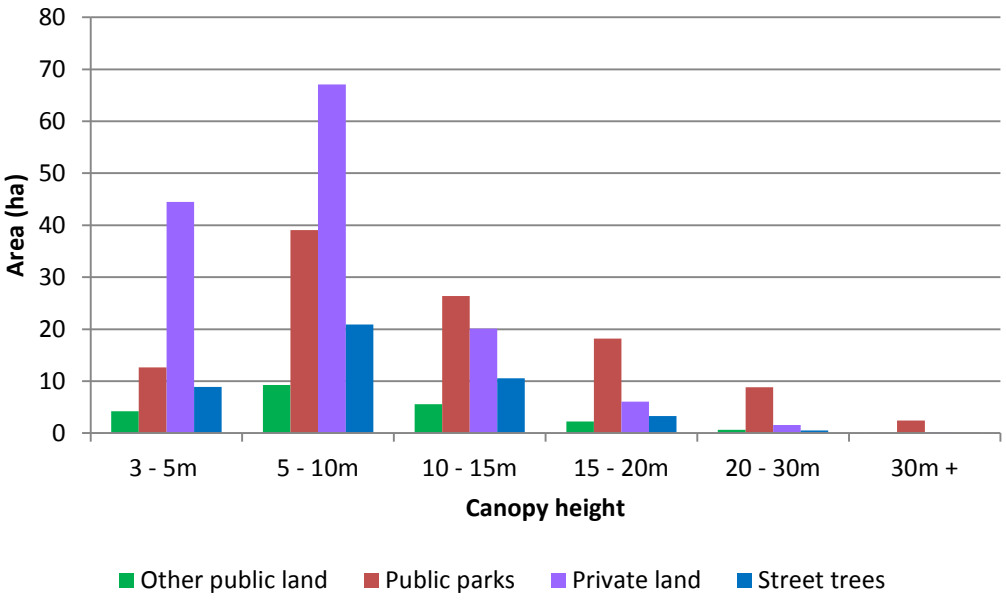


Figure 11: Height-class structure of urban forest canopy – within suburban zone



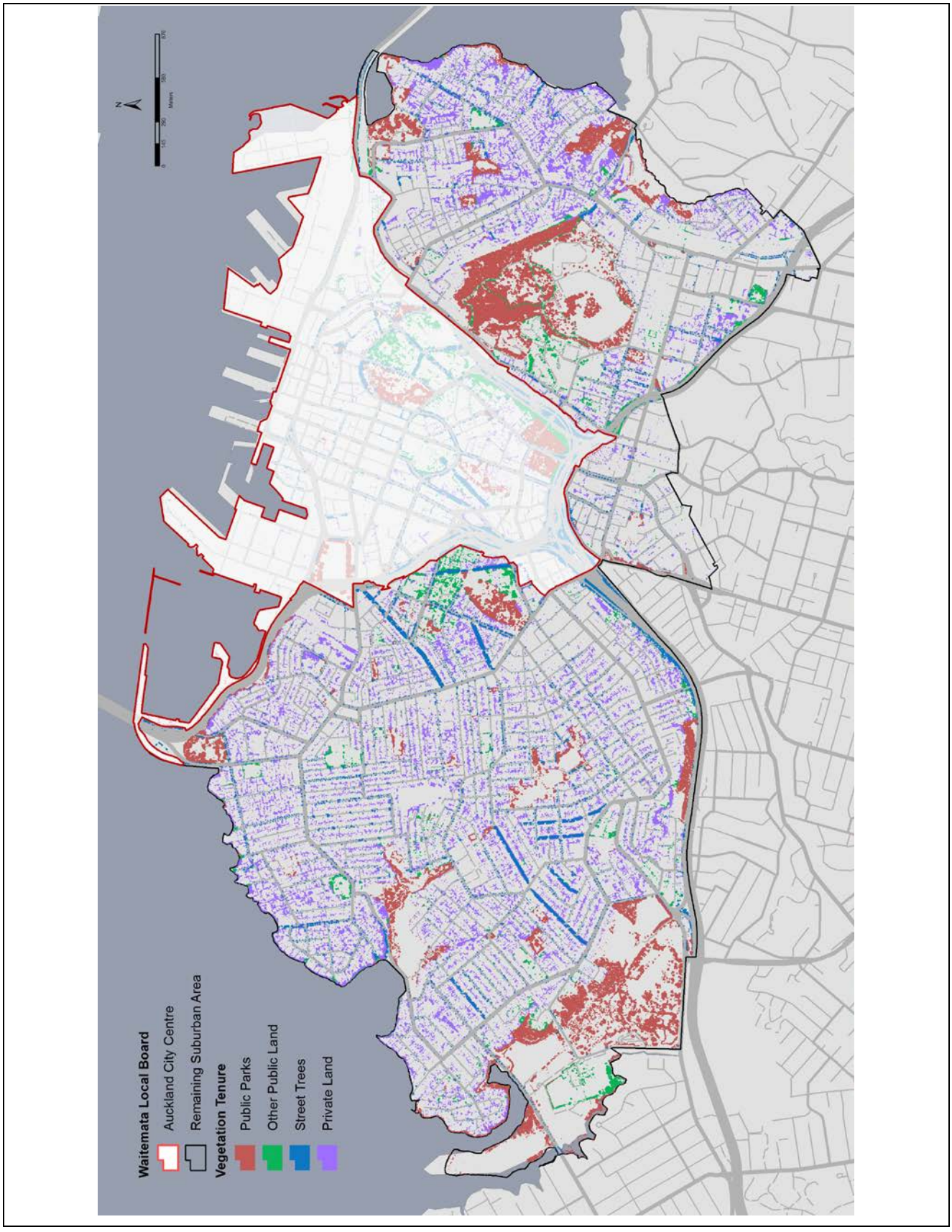
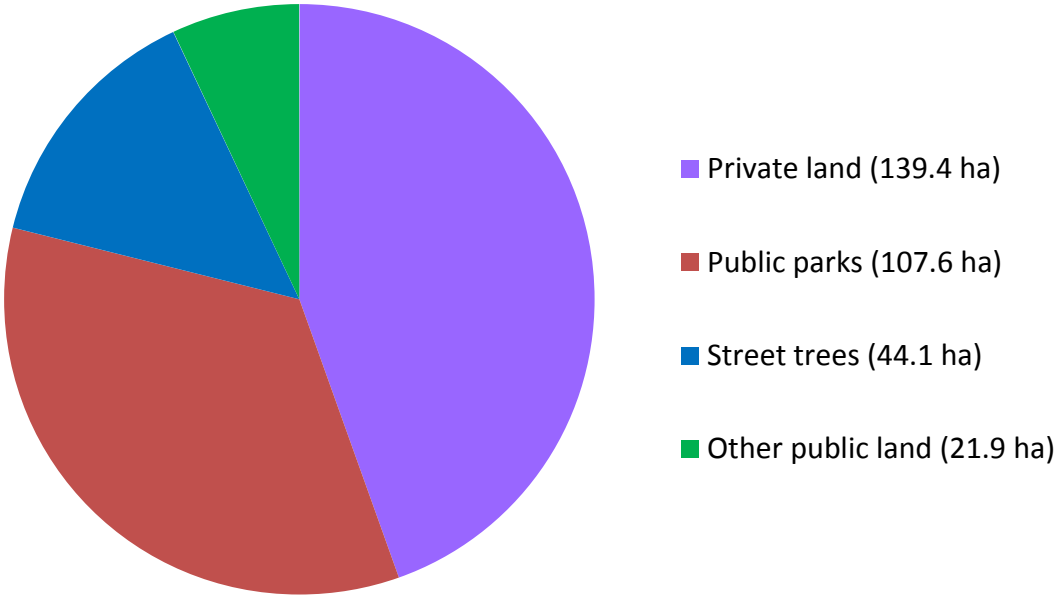


Figure 12: Urban forest cover within the suburban zone of Waitematā Local Board showing the tenure/ ownership of urban forest

Figure 13: % ownership of urban forest in suburban zone
(total canopy area = 313.1 ha)



Urban forest within Western Park (Tuna Mau). This park is one of Auckland's oldest; its trees were planted in the late 1870s according to the 'Lily of the Valley' concept of Hammond and Blackmore which was the winning entry in a park design competition

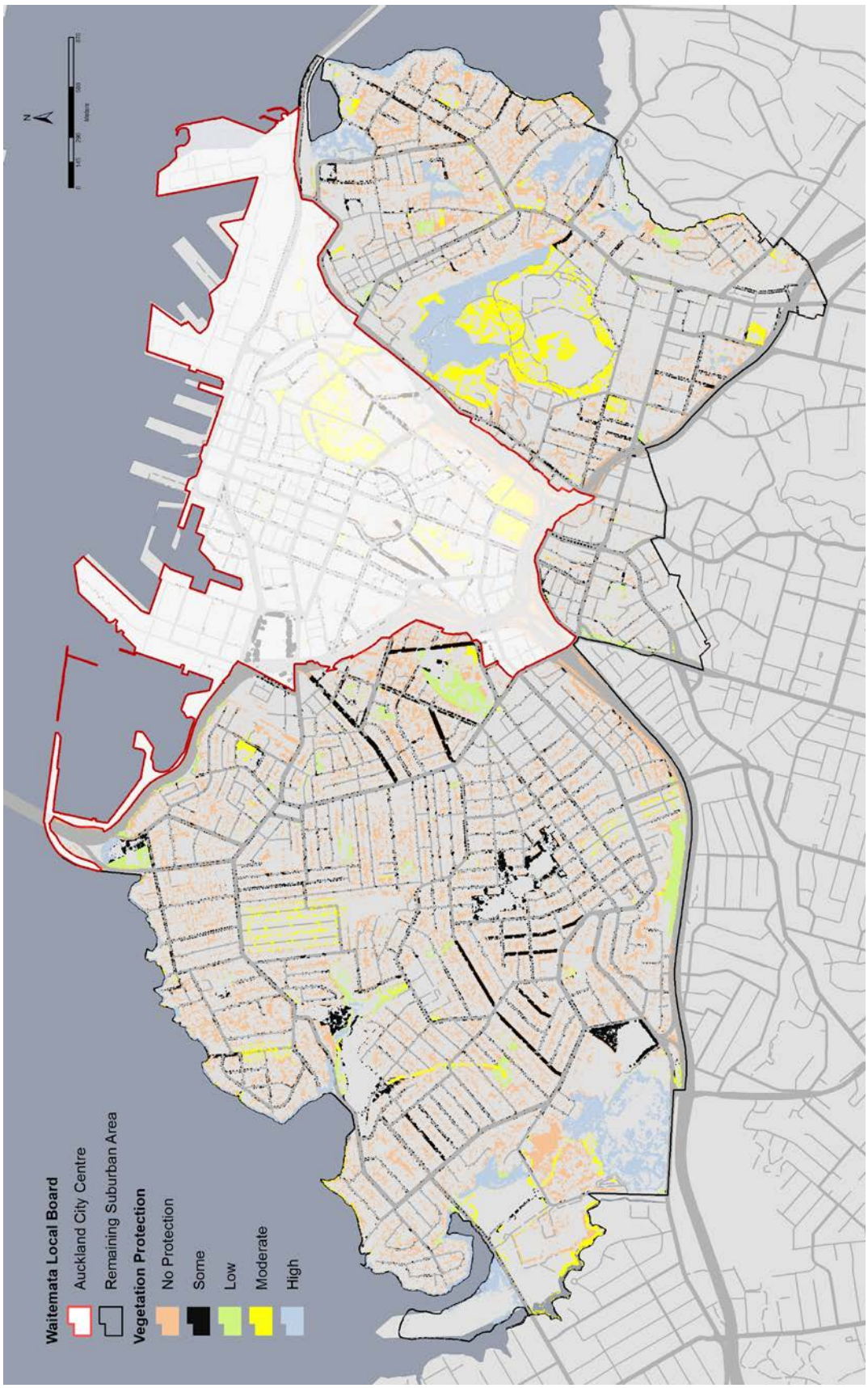
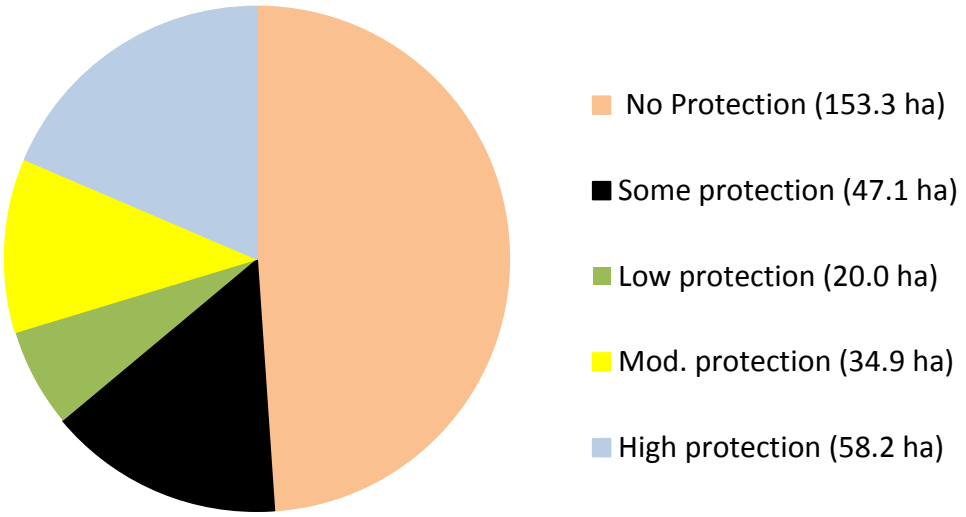


Figure 14: Urban forest cover within the Suburban zone of Waitematā Local Board showing the protection status of urban forest

Figure 15: Protection status of urban forest within the suburban zone



Street tree plantings in the CBD zone associated with the re-design and renewal of O'Connell Street

6.0 Discussion

Urban forest gaps and priority planting locations

Examination of the overall urban forest cover maps (Figures 1, 2 and 9) shows that there are some obvious 'gaps' in tree cover throughout the Waitematā Local Board area. If even coverage of urban forest cover across the whole board area is one of the aims of the board and local community, then tree planting and/ or incentives to retain existing trees could be concentrated in these 'gaps'.

Within the CBD zone the waterfront and north western parts of the CBD are (with the exception of Victoria Park) almost devoid of urban forest cover and street tree planting could be prioritized in these locations. However, we note that the data presented in this report is from 2013. Since 2011 there have been around 400 new street trees planted within the Wynyard Quarter area, and only a small number of these are visible in the 2013 LiDAR data. As these trees grow and reach the 3m cut-off for inclusion in the canopy layer they will dramatically improve the urban forest cover of this area.

The suburban zone is much richer in street and privately owned trees and therefore shows a more even distribution of urban forest. However, there are several locations with a notably lower density of urban forest, which can be divided into two general categories:

1. Urban forest 'gaps' associated with a high density of buildings and extensive paved areas typical of commercial, industrial, retail and and/ or multi-storey residential precincts. This occur in Newmarket, Newton and the area surrounding the intersection of Great North and Ponsonby roads
2. Urban forest 'gaps' associated with extensive areas of grassland typical of sports fields (e.g. Western Springs sports fields, Seddon Fields, Cox's Bay Reserve and Grey Lynn Park and some larger schools) or urban parkland which has few tall trees (e.g. Meola Reef Reserve).

Public parks are probably a good place to focus additional urban forest planting within the suburban zone as they comprise around one third of the total area of the suburban zone and are widely distributed throughout this area. In addition, public parks offer the best opportunities for long-term sustainable management of the urban forest due to the lower chance of conflict with future housing intensification, less infrastructure conflicts (which is often an important negative associated with street tree plantings), more considered selection of appropriate species and location for plantings, better arboricultural management (provided this is adequately funded)[6], and a coherent policy for ongoing

[6] As trees get bigger and older they need to be cared for more frequently. However, council arborists are concerned that Auckland Council's standard model for asset depreciation does not provide sufficient funding to achieve the level of

planting of replacement trees. Public parks are also better able to accommodate the types of large trees which provide a disproportionate amount of many of urban forest benefits (see below). The wider accessibility of trees on public parkland also means that the benefits they provide (e.g. better shade and increased emotional well-being for park users) apply to a larger number of people, which is a major positive in terms of overall cost-benefit outcomes.

The type of planting that could be carried out within the existing public reserve network in the suburban zone falls into two main categories. The first category is plantings around the margins of sports parks where this does not conflict with the sports fields themselves (e.g. Cox's Bay Reserve, Seddon Fields and Grey Lynn Park); all of these parks have grassy margins and odd-shaped corners that are separated from the playing fields. The second category is establishing urban forest in reserves zoned for informal recreation use that are currently dominated by grassland (e.g. Tole Reserve, Fraser Park, Hukanui Reserve, Meola Reef Reserve and Basque Park). Fraser Reserve and Basque Park are probably the most strategic and important of the second group of reserves as both of these parks are in locations that currently have relatively poor cover of urban forest in the immediately surrounding landscape. There are some relatively large areas of new plantings within Meola Reef Reserve that had not reached sufficient height (i.e. 3m) to be included in the 2013 urban forest layer. However, it is likely that these will register in the 2016 LiDAR measure and therefore reduce the urban forest 'gap' in this part of the local board.

While there are many benefits to establishing a higher density of trees – and large trees in particular – on public land, we acknowledge that there are some potential conflicts and costs in replacing extensive areas of grassland with urban forest and/ or treeland. These include perceptions of public safety with areas of dense vegetation on public land (Jansson et al. 2013), the additional cost of managing more large trees for a parks department that struggles currently to meet the competing demands of different park users, and ensuring that urban forest plantings are compatible with existing use such as sports fields, open space for dog recreation etc. Nevertheless, many of these conflicts can be resolved through appropriate species selection, planting design and location, and good community consultation.

Street trees have a prominent role in the provision of urban forest within the CBD zone, where they make up nearly half of the total cover. This is in direct contrast to the suburban zone, where more than 75% of the urban forest is on private land or public parks and street trees are much less prominent. Protecting existing street trees and establishing new street tree plantings provides the greatest opportunity to increase urban forest cover within

maintenance necessary to manage very large trees to international standards. Therefore at times trees that could be retained through expensive maintenance are felled instead.

the CBD zone. Public open space within the CBD is intensively used by relatively large numbers of people and is probably near its maximum limit in terms of its ability to accommodate large trees. Myers Park, Victoria Park and the northern extension of Albert Park (between Bowen Ave and Kitchener Street) have some remaining grassed areas that are not given over to hard-stand surfaces, sports fields or other park infrastructure. However, the total areas that could be practically planted – given that there is also a need for open informal grass spaces within the CBD – are relatively small. In addition, these areas are already relatively well provided for with existing urban forest cover.

Notable trees

The information on urban forest protection in Figures 7, 8, 14 and 15 above, does not include notable[7] trees. Notable tree locations have not been digitized (although this is being done, see Section 7) and therefore were not able to be incorporated into a spatial dataset for analysis with the LiDAR information. Individually digitizing the crown extent of the 1,100+ notable trees within the Waitematā Local Board area (Table 4) is a time consuming task and was not available for this report. If these trees were included, they would have increased the amount of urban forest with high levels of protection (Table 2) by a relatively large amount, particularly for the CBD zone, where none of the urban forest was in the high protection category, as this was totally provided by notable trees within the CBD zone.

Appendix A outlines the estimated canopy area of notable trees in the suburban and CBD zones. This was done by direct measures (in the Auckland Council GIS viewer) of the area covered by closed canopy street tree avenues (e.g. Greys Ave, Vincent Street, Franklin Road etc.) and by assigning single notable trees a typical value for their canopy coverage based on four crown size-classes (small, medium, large and very large). Figures presented below are therefore estimates of the total canopy coverage of notable trees, rather than exact data.

[7] These trees were previously known as ‘scheduled trees’ in the Auckland City CBD and Isthmus District Plans which cover the Waitematā Local Board area. These plans are about to be superseded by the Proposed Auckland Unitary Plan in which individually protected trees are known as ‘notable trees’. The data presented in this report uses Schedule 10 of the Proposed Auckland Unitary Plan (decision version) as its source data.

Table 4: Summary of Notable Trees in the Waitematā Local Board. Based on Schedule 10: Notable Tree Schedule in Chapter L, decision version of the Proposed Auckland Unitary Plan

Zone	Number of native or exotic trees		Total number of notable trees
	Native	Exotic	
CBD zone	72	463	535
Suburban zone	150	466	616
Waitematā Local Board	222	929	1151

Total area was 9.6ha for the CBD zone (Appendix A). Based on this data, around 17% of all the urban forest in the CBD zone would fall into the highest protection category, a major improvement on the 0% presented in Figure 8. Most of these notable trees are on parks and streets, rather than private land. This means they are already counted as 'protected' in figures 7 and 8, it is just that their 'protection status' is lower.

Total area was 15.5ha for the suburban zone (Appendix A). Based on this data, the highest protection category would increase by 27% (from 58.2ha to 73.7ha). Like the CBD zone, a significant proportion of these notable trees are on public parks and (especially) road corridors. However, the majority of notable trees within the suburban zone are on private land and this would change from no-protection to high-protection category trees.

While only the canopy area of notable trees was estimated for this report. We note that, with some relatively minor exceptions, notable trees are generally larger in stature than an average urban forest tree. Therefore their inclusion would provide both increased urban forest canopy protection and protection of a disproportionally large amount of the 'ecosystem services' that the urban forest provides; as these ecosystem services benefits are concentrated in the larger trees.

Management of the CBD motorway 'moat'

A significant proportion (3534%) of the total area of 'street trees' within the CBD zone are new plantings associated with the motorway network that forms a 'moat' around the inland margins of the CBD. These areas of densely planted, mostly indigenous trees and shrubs provide – or have the potential to provide – a substantial area of "new urban forest" within the most densely populated and intensively developed part of the Auckland urban area. That is, urban forest right where we need it. The motorway plantings have no statutory protection and are not subject to council control or management. In future, the Waitematā

Local Board may need to advocate for sympathetic management and preservation of this important component of the CBD's urban forest with NZTA. It might therefore be appropriate to begin consultation with NZTA and develop a working relationship before problems arise.

Importance of large trees

International research has shown that many of the benefits attributed to urban forest are disproportionally provided by larger trees (Davies et al. 2011, Nowak et al. 2013, Moser et al. 2015,). This is particularly true for environmental-ecosystems benefits such as providing shade, sequestering carbon, trapping pollutants and reducing water run-off. It seems intuitively correct that larger trees will cast more shade, have higher wood volume, greater total leaf area to trap pollutants and higher water requirements, and this is backed up by experimental evidence.

Figures 16 and 17 present raw data provided in Moser et al. (2015) that shows the dramatic increase in three urban forest benefits provided by one exotic tree species (black locust; *Robinia pseudoacacia*) in North American conditions. We were unable to find New Zealand specific data for this type of size-related calculation for urban forest, our national carbon sequestration work is based on large tracts of indigenous forest and scrub (c.f. Payton et al. 2004). However, black locust has been used as a (minor) component of street tree plantings in Auckland and can assumed to be representative of the pattern of benefits provided by larger urban forest trees in Auckland conditions, if not the exact amount of that benefit.

Figure 16: Area shaded and shading effects of different sized *Robinia pseudoacacia* growing in urban environments (data from Moser et al. 2015)

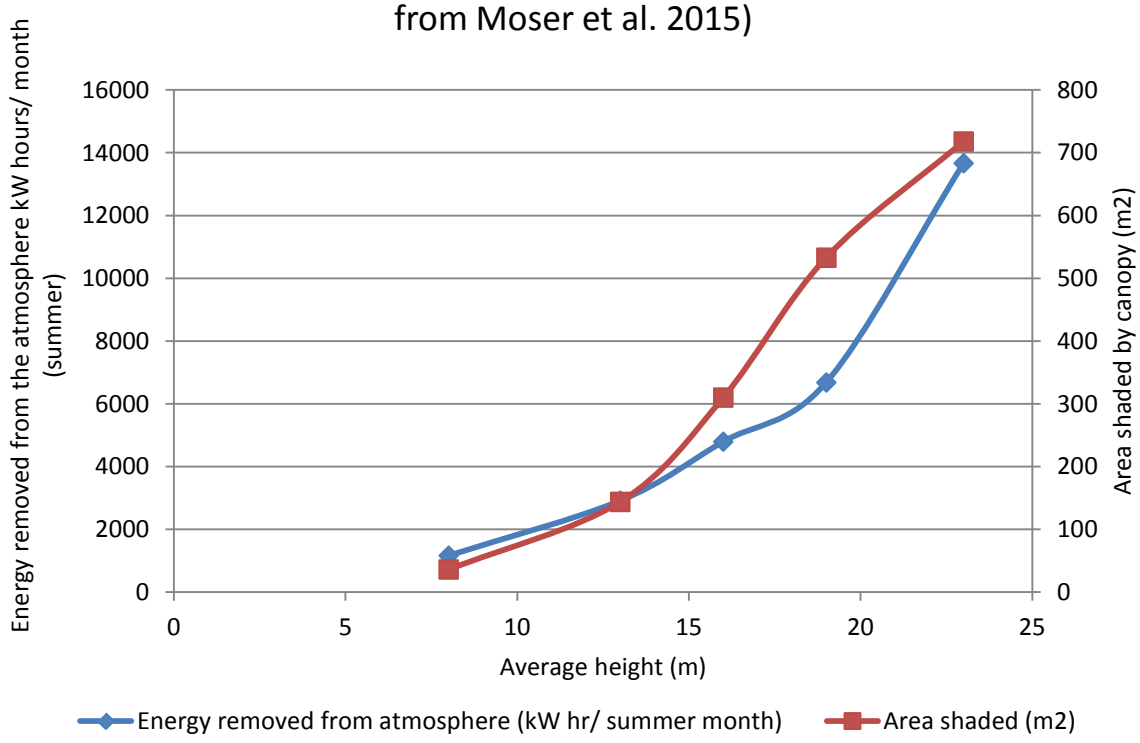
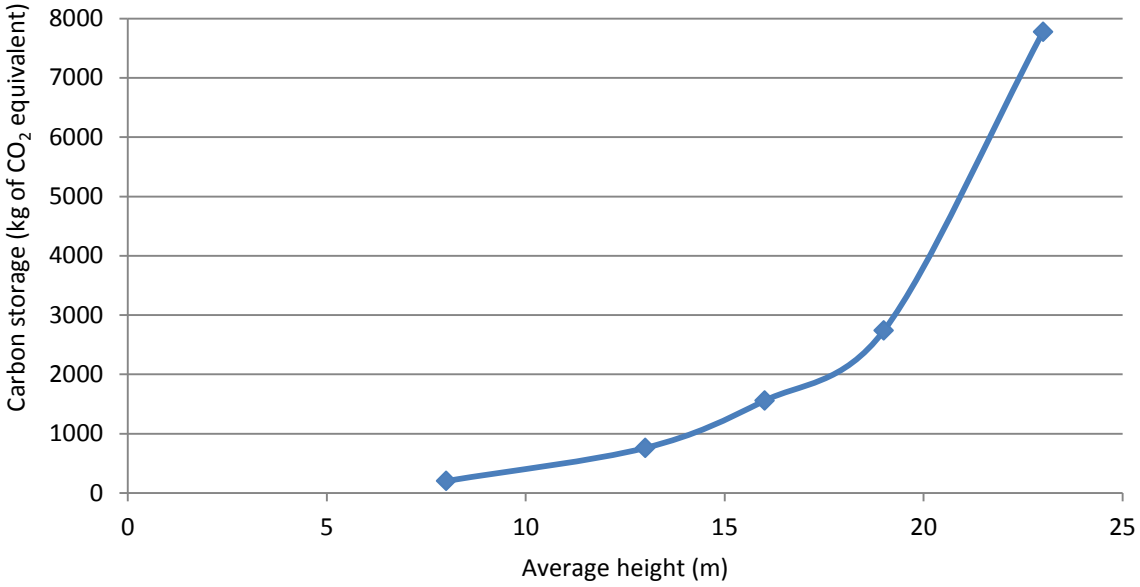


Figure 17: Carbon storage by different sized *Robinia pseudoacacia* growing in urban environments (data from Moser et al. 2015)



7.0 Proposed future urban forest monitoring and analysis

Notable trees

As we have noted above, the protection data presented in this report does not include spatial information on the distribution of notable trees. We have provided some estimates of the total canopy area of scheduled trees in Section 6, but these are based on some broad assumptions. The best outcome would be to get the notable tree canopies digitized and combined with the LiDAR based spatial dataset. This means these trees could be included in a comprehensive urban forest analysis, and provides for easier future monitoring of the distribution and canopy extent of notable tree assets. Combination with LiDAR data would also provide height-class data for notable trees and facilitate further analysis of this key component of the benefits they provide.

We have commenced digitizing of notable tree locations for the Waitematā Local Board area and this process will be continued (as time permits) in future years over the 2016-2017 financial year. We are planning to have the board area completed in time for a spatial notable tree layer to be included in the 2013-2016 urban forest change analysis (see below).

Analysis of urban forest changes 2013-2016

The data presented in this report is a ‘snapshot’ of urban forest cover in 2013; a one-off measure of canopy distribution and height within the Waitematā Local Board area. One of the most controversial issues relating to urban forest in Auckland, and the most important unknown, is the rate of change in the urban forest canopy. Questions such as:

1. How has the total area of urban forest in the board area changed following the removal of general tree protection?
2. How has the size-structure changed? For example, has there been an increase in smaller trees and a decrease in larger trees, or vice versa?
3. If there have been significant gains and/ or losses in tree canopy cover are they concentrated on a particular type of land tenure, or a within a specific geographical area?

are critical to the future management of Auckland’s urban forest in terms of understanding which issues and locations to focus management efforts such as community education, tree planting and subsidies.

In order to assess change in the urban forest canopy the 2013 LiDAR needs to be compared with a more recent LiDAR dataset that has been collected using the same methodology. Auckland Council is currently (October 2016) undertaking another aerial LiDAR survey and the outputs of this survey are expected to be available for further analysis by December 2018. The time period between these two LiDAR surveys (i.e. three

years between 2013 and 2016) covers the same time period that anecdotal evidence from Auckland Council and external arborists suggest coincides with a dramatic increase in the felling of trees on private land. This has occurred throughout the Auckland metropolitan area, including the Waitematā Local Board.

The Research and Evaluation Unit (RIMU) has undertaken to prepare another urban forest report for the Waitematā Local Board that will compare the 2013 and 2016 LiDAR runs and provide an in-depth analysis of any changes in urban forest detected over this three year period.

Zoning examination/ development potential

Combining the urban forest layer with other spatial datasets (for example proposed Unitary Plan zoning) is a useful tool for predicting the possible impact of growth pressures on the cover and size-class distribution of urban forest. The location of un-protected trees has a significant impact on how likely a tree is to 'survive' the intensive phase of growth and development that is currently underway in Auckland. For example, all other things being equal, we would expect that trees on a large private land section that is 'Residential – single house' zoned are less likely to be felled than trees on a large site that is 'Residential – mixed housing urban' zoned. The 2013-2016 change report will include an analysis of urban forest across the different Unitary Plan zonings within the Waitematā Local Board area.

A more sophisticated approach to this type of analysis is also possible, by combing urban forest spatial data with information from the Auckland Growth Model (Fredrickson and Balderston 2013). The growth model incorporates proposed unitary plan zoning with a range of data on topography, location, lot size and other plan restrictions to predict the economic return of constructing new dwelling(s) on a specific lot. Combining the economic return of constructing new dwellings on individual sites with the current urban forest cover on those same sites should give a better indication of the potential loss of urban forest from the increasing density of dwellings within the Waitematā Local Board area.

Indigenous vs. exotic urban forest protection

At present the protection data analysis (Figures 7, 8, 14 and 15) makes the assumption that all urban forest cover within the different protection overlays is protected. However, the specific rules for some overlays mean that not all vegetation might be protected. This is particularly the case with exotic trees in Outstanding Natural Landscape, Outstanding Natural Feature and Coastal Protection Yard overlays (Table 2). The change analysis report will include a more sophisticated analysis of the proportion of vegetation within these overlays is native, and therefore a better estimate of the proportion of urban forest that is actually protected.

8.0 Acknowledgements

Deborah Yates and Rob Thomas (Waitematā Local Board 2013-2016) for their support of this project from its initial inception, their enthusiasm for urban forest issues in general and the future of urban forest within the Waitematā Local Board area in particular, and their recognition of the important contribution of accurate data to good decision-making.

The Waitematā Local Board provided some financial support.

The wider ‘urban forest’ community within Auckland for their ongoing interest in urban forest issues, encouragement and general enthusiasm for getting better urban forest data.

Graham Hinchliffe of the Auckland University of Technology (AUT) carried out the analysis of the raw LiDAR data that was used to construct the urban forest layer.

Jonathan Boow, Deborah Yates and Jenny Fuller provided helpful comments on an earlier draft of this report.

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10.0 Appendix: Estimate of total area of notable trees

Estimate of total area of notable trees in suburban and CBD zones

Zone	Tree crown type and size	# of trees	Average area of tree crown (ha)	Area (ha)	Total area of notable trees (ha)
CBD zone	Street tree avenue	n/a	n/a	5.00	9.55
	Very large	4	0.08	0.32	
	Large	48	0.05	2.40	
	Medium	64	0.02	1.28	
	Small	182	0.003	0.55	
Suburban zone	Street tree avenue	n/a	n/a	4.00	15.54
	Very large	28	0.08	2.24	
	Large	147	0.05	7.35	
	Medium	90	0.02	1.80	
	Small	51	0.003	0.15	

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