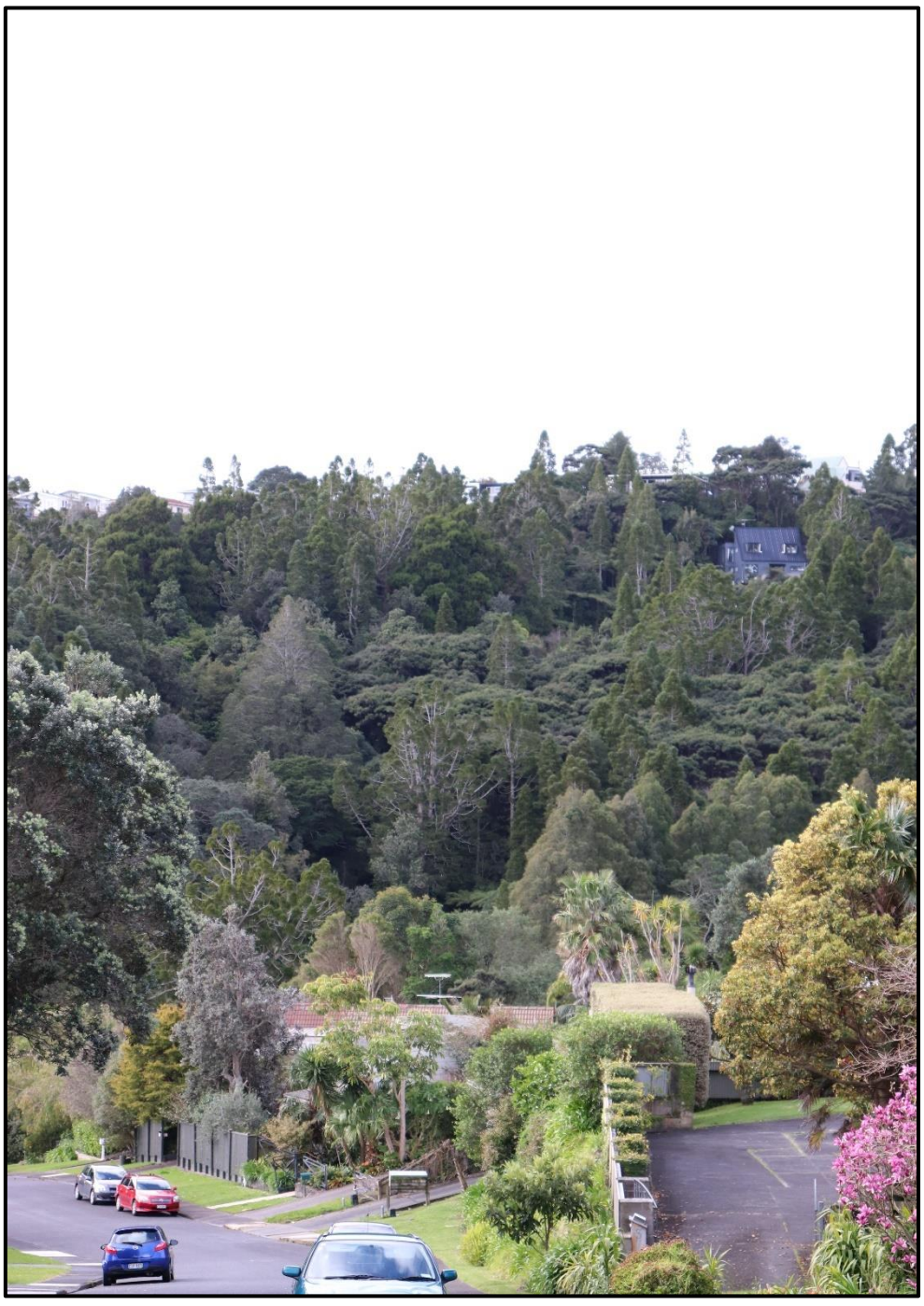

Local Development Initiative – Ngahere Work Program

Year 1 Knowing Phase

Urban Ngahere Analysis Report 2019 - Kaipātiki Local Board

EXECUTIVE SUMMARY

The Kaipātiki Local Board has provided funding through the Local Development Initiative program to enable the compilation of this analysis report. The data presented in this report is a snapshot of urban forest cover in Kaipātiki in 2013. It provides a valuable baseline for future comparisons and will assist decision-making and strategic planning for tree cover improvement and management going forward. Prior to the 2013 LiDAR survey, there was no reliable information on Auckland's urban forests. The data is discussed in the context of current land cover, demographic, socioeconomic and environmental issues in Kaipātiki.

Urban forest within the Kaipātiki Board area is among the most exceptional in New Zealand. It contains many of the largest areas of continuous urban native vegetation remaining in Auckland's ecological region, forming part of the North-West Wildlink. There are about 60 native bush reserves in Kaipātiki - most are located in southern and central Kaipātiki and in Bayview in the north-west.

The urban ngahere (forest) is an extraordinary natural asset important for the well-being of Kaipātiki residents and is a drawcard for visitors.

Detailed analyses of the LiDAR data, collected in 2017, will finally be available in September 2019. Once finalised, the updated data will be used as a comparator, to determine the extent of how tree cover and characteristics of urban ngahere have changed, along with the potential to identify issues that need action. A comparative canopy extent change chapter; will be added to this report once the finer grained data to a local board level has been finalised for release.

Aims of this project

- This report was written for the Kaipātiki Local Board, to provide a definitive baseline level of information on the distribution, size-class structure, ownership, and protection status of urban forest in Kaipātiki.
- The baseline detail will help to provide direction for planning, e.g., help identify key areas for greater protection of existing trees and help direct planting efforts to where the most value can be realised.
- The overall aim of Auckland's Urban Forest Strategy is to increase average canopy cover from 18 to 30% and wherever possible retain and protect notable trees and areas of ecological significance.

Threats to Auckland's urban ngahere

- There is concern that recent changes to the Resource Management Act have removed the ability of Auckland Council to use general tree protection rules to protect urban forest.
- There is some anecdotal evidence that the urban tree cover is undergoing a prolonged period of rapid change. The increases in housing density is limiting opportunities to retain larger trees. Site clearance and redevelopment to maximise the housing stock is resulting in the loss of space for planting trees or seeing poor tree selection and plantings that are destined to fail. Net long-term tree losses on private land are expected as housing density increases.
- There are other threats, including climate change, existing biosecurity issues (particularly kauri dieback), and incursions of new pests and diseases (myrtle rust, ambrosia beetle), which would be better managed if there is a better understanding of the characteristics and trends in tree cover.

Overview of the baseline LiDAR results for Kaipātiki

- Canopy cover in Kaipātiki in 2013 was 30% overall, the highest of any local board inside of the Metropolitan Urban Limits, when compared with the other urban and peri urban local boards, and much higher than the overall average for Auckland of 18%.
- However, tree cover varied greatly across Kaipātiki geographical area in 2013.
- Leafy suburbs of south-eastern and eastern Kaipātiki were classified as 'forested suburbs' with 34% to 55% cover in 2013. Eastern and central suburbs were classified as having 'good cover', with 20% to 27% cover. The northern suburb of Totara Vale had 'moderate cover' (17%), while industrial Wairau Valley had 'bare cover' at (7%).

Canopy cover and land tenure

- Compared with the overall figures for Auckland, tree cover in Kaipātiki Local Board area, is considerably higher in all land cover classes except for street trees, which was similar to the Auckland average.
- In Kaipātiki, a large proportion (63%) of public land has tree cover, which is the highest percentage of any urban local board.
- However, all but three areas have over half their urban forest on private land, with the main exception being Chelsea.
- This has important implications, as trees on public land are much more accessible to the public and are more likely to be protected.
- Parts of Kaipātiki that have proportionally a very low canopy cover on public land (public parks and, e.g., school grounds), are Birkdale South, Birkdale North, Glenfield Central, and Sunnybrae.

When the tree cover data is analysed per head of population, a slightly different trend is observed, as described below in forest cover and demographics.

Forest structure

- Most of the trees in Kaipātiki are in the smaller size classes: 58% of the tree cover is 3 to 10 m high; 82% is less than 15 m; only 5% is 20 to 30 m, and only 1% is taller than 30 m.
- This has important implications because larger trees provide a disproportionate amount of the many of the benefits associated with urban ngahere.
- Windy Ridge and Kauri Park have a higher proportion of taller trees.
- Areas that have a large proportion of trees with a lower stature are Glenfield North, Tuff Crater, Glenfield Central, and Birkdale North.
- The relatively high proportion of smaller trees indicates either a relatively recent surge of tree planting (assuming the smaller stature trees correspond to younger trees), or a large proportion of shrubs with a limited mature height.
- The former situation is more likely over much of Kaipātiki, particularly in Tuff Crater, as there have been major efforts with ecological restoration.

Forest protection status

- 61% of the urban forest in Kaipātiki has some form of protection, which is a higher proportion compared with most other local board areas, and higher than the overall figure for Auckland's ngahere, where only 50% of tree cover has some form of protection. And most of the protected trees have a high protection status.
- Almost half (49%) of the tree cover in Kaipātiki has a high protection status, i.e., are either **Significant Ecological Areas (SEAs)** or **Notable Trees**.
- The proportion of urban ngahere that is protected varies considerably across Kaipātiki.
- Chelsea, Windy Ridge, Glendhu, Kauri Park and Beachhaven South have more than half their urban ngahere under the highest protection category.
- Areas where tree cover has low levels of protection are Glenfield North and Glenfield South.
- **Notable trees** have been identified as specimens with exceptional arboricultural characteristics that contribute to the amenity, landscape and ecological values in the area.
- There are 401 Notable Tree records for Kaipātiki Local Board area, these include a diverse range of native and exotic species. The actual number of trees is not clear with the current numbering arrangement in Schedule 10 of the Auckland Council Unitary Plan.
- They are scattered throughout Kaipātiki except in Wairau Valley, the Target Road area, and along the southwest coast (where there are extensive SEAs).
- Notable Trees are in greatest concentration in Northcote Point.

Forest cover and demographics

Demographic related to urban forest cover were investigated, to help determine if urban forest is located where it would have the greatest benefit, i.e., where there are greater population densities and higher numbers of children. The results based on the 2013 LiDAR data are described below.

- Kaipātiki has a relatively high tree cover of 125 m^2 per person – ranked third behind Upper Harbour and Hibiscus and Bays Local Board areas.
- In terms of land tenure, Kaipātiki ranked fairly high for tree cover per person in public parks and private land, middling for street trees, and fairly low for tree cover per person on other public land (school grounds, etc.).
- Forest cover per person varies widely in different areas of Kaipātiki.
- Chelsea has a very high forest cover per person (more than 450 m^2). Windy Ridge and Kauri Park also have a fairly high forest cover per person. However, 12 census area units have less than/or equal to 100 m^2 forest cover per person with the following areas having particularly low cover per person: Birkdale North, Glenfield Central and Glenfield North.
- In most suburban areas, more than half of the urban forest (per person) is on private land.
- Compared with public land, trees on private land are less likely to be protected and are less accessible to the general public.
- The only areas that have a larger proportion of urban forest on public land rather than private land, per head of population, are Windy Ridge and particularly Chelsea.
- Chelsea has a very high forest cover per child (more than 2700 m^2) and Windy Ridge and Kauri Park have a fairly high forest cover per child (more than 1000 m^2). However, eight census area units have less than 500 m^2 forest cover per child.
- Probably the most important data to examine is the proportion of urban forest cover by land tenure, per child (under 15 years).

- The areas of Kaipātiki that have a proportionally low amount of canopy cover on public land, per child, are: Glenfield North, Glenfield Central, Sunnybrae, Birkdale North, Birkdale South and Beachhaven North. These areas also have a low forest cover per child, overall.

Shade Analysis

- There are 147 parks in Kaipātiki, with 44 including playgrounds.
- There was only one park (Taurus Crescent Reserve) that had no trees present and the playground within this park totally lacks shade.
- A shade analysis found that 50% of the playgrounds had no shade or negligible shade provided by trees; 25% have moderate canopy cover and only 25% have a high canopy cover.
- Where there is little or no shade in playgrounds, there are implications for the health and well-being of residents, particularly children.
- This could be improved by increased specimen tree planting closer to playgrounds and planting species that will develop a wider crown canopy area at maturity.

Change in urban forest cover 2013 – 2016

There is evidence from Auckland Council that suggests there has been an increase in the felling of trees on private land across the Auckland metropolitan area as outlined in the Waitemata Urban Tree loss Report 2018. In order to assess change in the urban forest canopy, the 2013 LiDAR is currently being compared with a more recent 2017 LiDAR dataset. A high-level comparison of the 2013 and 2017 data sets will be provided the detail for the update chapter which will be appended to this report once the analysis work has been completed and peer reviewed. A report on the Urban Ngahere (Forest) Strategy implementation will be presented to the Councils' Environment Committee in September 2019, an update on the LiDAR analysis will form part of that. Following on from this a more detailed change detection to tree canopy cover will be provided for the Kaipātiki Local board.

PRIORITY AREAS FOR FUTURE URBAN FOREST IMPROVEMENT WORK IN KAIPĀTIKI

Urban ngahere improvement work needs to be considered in the context of land cover, and local environmental, demographic, and socioeconomic issues. Kaipātiki has excellent tree cover overall, compared with other local board areas. However, there are parts of Kaipātiki where there is less than ideal forest cover, and in many areas, a high proportion of the tree cover is in the smaller size classes.

As well as focussed efforts for maintaining and improving tree cover where it is currently low; focus could also be placed where there are:

- greater population densities (current and anticipated), referencing the Auckland Plans future area zoning and the expectation of future growth;
- higher numbers of children, with particular emphasis on tree planting to provide shade in playgrounds, and in road parcels where children walk to school;
- areas with a low number of large trees – should be a priority area to review for protection;
- areas that are flood prone or predicted to be impacted by sea level rise;
- environmental values, including water quality, that are currently (or could potentially be) compromised by urban development;
- opportunities to improve ecological corridors, where biodiversity values would be enhanced; and aesthetic landscape and recreational values that would be improved by further plantings.

Strong synergies and mutual benefits could be realised through a coordinated approach in strategic planning at the local level. A local approach for Urban ngahere would benefit from coordination and integration of new plantings with the implementation ofg:

- Kaipātiki Connections Network Plan;
- planning for open space in new urban developments;
- the North-West Wildlink (NWW) project; and
- ecological restoration and tree planting initiatives undertaken by iwi and community groups.

There would be multiple benefits from investment in tree plantings and ecosystem restoration where the Connections Network Plan currently runs through areas with little vegetation cover. These benefits include: improvement of amenity and ecological values, improved safety and a better experience for pedestrians and cyclists, and improved green infrastructure and environmental outcomes, including increased biodiversity values through habitat restoration and provision of ecological corridors.

Large areas of natural vegetation in Kaipātiki form part of the North-West Wildlink. These natural areas are an extraordinary natural asset that is important not only for biodiversity and environmental values, but also for the well-being of local residents, and providing a drawcard for visitors.

There is excellent community engagement and contribution to local conservation efforts, which is acknowledged and supported by the Kaipātiki Local Board. The urban ecological restoration in Kaipātiki is an exemplar for other urban areas in New Zealand. It is important to involve these highly skilled and committed stakeholders in decision making regarding urban ngahere improvement work.

Another consideration is future-proofing measures to help combat the impact of predicted sea level rise and increased frequency of intense weather events associated with climate change. These issues will be particularly important in low-lying coastal and estuarine areas of Kaipātiki. Ongoing restoration of wetlands and tree planting efforts could be designed to boost green infrastructure, helping to restore the natural hydrological cycle and mitigate some of the negative impacts of climate change. Also, high amounts of impervious (hard) surface areas in the North Shore have been linked with water quality issues and increased green infrastructure would also help improve water quality. Green infrastructure is effective, economical, and has many other benefits that enhance quality of life in urban areas.

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1.0 PREFACE

This report was produced by Dr Jacqui Aimers and Mark Kimberley, of Tāne's Tree Trust. This work was guided by the Auckland Council Urban Ngahere (Forest) Strategy, and directed by Howell Davies (Senior Advisor Urban Forest) and supported by Craig Bishop (RIMU – Research Investigation & Monitoring Unit).

Auckland Council staff supplied the photos, data files, GIS maps, other relevant documents, and information relevant to tree cover within the Kaipātiki Local Board Area. Council staff who have contributed to this report are Howell Davies (Parks), Hannah Chapman-Carr (Parks), Craig Bishop (RIMU), Sam Brown and Joe Zhao (Geospatial IT)

The authors thank Dr David Bergin, for his support throughout the data analysis and report writing. We also acknowledge Dr Mike Wilcox's book 'Auckland's Remarkable Urban Forest' (Wilcox 2012) which an excellent resource. **Appendix 2** – Urban Trees in Kaipātiki Parks – is a summarised excerpt taken from this book (reproduced with permission from the author).

2.0 PROJECT OVERVIEW AND OBJECTIVES

The report was written for the Kaipātiki Local Board, to provide background information, direction and context for work on local urban forest improvement. The aim is to provide an evidence-based approach to ensure decision-makers are well informed on the distribution, structure, health and diversity of the urban trees in the Kaipātiki Local Board Area to enable the development of a sound and structured approach for future decisions.

This report summarises the distribution, size-class structure, ownership, and protection status of trees and urban ngahere (forest) within the Kaipātiki Local Board area. The data is based on an analysis of 2013 Light Detection and Ranging (LiDAR) data captured for Auckland Council by NZ Aerial Mapping and Aerial Surveys Limited. The LiDAR dataset was supplied in raw, above-ground, point classified form. Points in the data set classified as vegetation were used to form the foundation of an urban forest layer for further analysis and interpretation with ArcGIS10.2 spatial software, in conjunction with other spatial datasets.

There are many benefits of urban trees, as described below. Trees also bring problems: fallen leaves blocking gutters; branches or whole trees falling over; shading of properties; blocking views; roots damaging pavements and underground infrastructure; branches tangling in overhead wires (Wilcox 2012). So care must be taken to plant the right trees in the right place, and ongoing maintenance must also be factored into any strategic planning.

The urban ngahere within the Kaipātiki Board area is among some of the more exceptional found in urban areas of auckland, particularly in regards to the large amount of native forest protected in bush reserves. However, rapid population growth and recent legislative change to the Resource Management Act are leading to noticeable changes in Auckland's urban landscape, which is reflected in the scale, maturity and size of the urban ngahere. It is imperative that decision-makers are well informed on the distribution, scale, health and diversity of urban trees in their local board area so that they can develop a sound and structured approach for future decision making.

This report is framed around the following research queries:

1. What is the distribution and height-class composition of urban forest within the suburban zones of the Kaipātiki Local Board Area?
2. What is the ownership distribution of the urban forest within the suburban zones of the Kaipātiki Local Board Area?
3. What is the protection status of the urban forest within the Kaipātiki Local Board Area, and what is the strength of that protection?
4. Does the urban forest cover of the Kaipātiki Local Board vary between suburb areas within the board, and is this related to socio-economic factors?
5. How is the urban forest of the Kaipātiki Local Board changing over time, and what are future priority areas for investigation and research?
6. Where can efforts best be focussed for maintaining and improving tree cover?

3.0 INTRODUCTION

3.1 What is Urban Ngahere (Forest)?

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

For the purposes of this report, urban forest is defined as all of the trees and other vegetation 3 m or taller within the Kaipātiki Local Board Area, and the soil and water systems that support these trees. This urban forest definition encompasses trees and shrubs in streets, parks, private gardens, stream embankments, coastal bays along cliffs that edge the harbour, and the motorway corridor margin embankments'. It also includes both planted and naturally established plants, of both exotic and native provenance.

The tree cover in the local board area may not represent a forest in comparison to the image of the old-growth kauri forests of Northland. However, the scale of the tree cover and shrubland is sufficiently extensive on public and private land across the local board area to make a meaningful contribution to the liveability and sense of place for its residents, as well as provide significant environmental values, including biodiversity conservation and maintenance of water quality.

3.2 Benefits of Urban Ngahere

An urban forest provides a multitude of benefits for the environment, the economy, and community health and well-being. Trees are crucial from an ecological standpoint and provide a wide range of benefits for urban residents, as described below.

New Zealand is one of the most urbanised countries in the world, with 86% of our population living in cities and towns (OECD 2017a). Urban forests are the primary form of contact with nature for many city-dwellers, and spending time in urban forest has been shown to improve mental health and well-being as described below (Hartig et al. 2003).

Urban forests also provide a wide range of environmental services in New Zealand cities, including regulatory services that positively impact water quality, storm water management, flood and erosion control, waste disposal, protection from wind, carbon sequestration, noise reduction and improvement of air quality (Vesely 2007; Meurk et al. 2013), and street trees have been shown to assist with the calming and slowing of traffic (see Case Study 13, page 73 of Trees and Design Action Group 2014).

The USDA Forest Service estimated that trees in New York City provide US$5.60 in benefits for every US$1.00 spent on tree planting and ongoing maintenance (Peper et al. 2007). Trees provide shade, protect people from harmful ultraviolet radiation and reduce the risk of heat stroke. And the cooling effect of trees, due to evapotranspiration and provision of shade, reduces the urban heat island effect, all of which are increasingly important in an era of climate change (Peper et al. 2007; Salmond et al. 2016).

Urban forests and wetland complexes help moderate the impact of severe weather events (Forest Research 2010; Meurk et al. 2013). Lack of natural vegetation in many urban areas reduces interception of precipitation, and use of impermeable materials in urban construction decreases ground infiltration of precipitation. This subsequently increases the speed of run-off, and therefore, the risk of flooding is increased in urban areas. Green infrastructure in urban areas helps restore natural environmental services related to the hydrological cycle, such as flood alleviation and improvement and ongoing protection of water quality (Forest Research 2010). Green infrastructure can be created by planting trees and restoring wetlands, as opposed to creating man-made infrastructures. It is effective, economical, and has many other benefits that enhance quality of life in urban areas (Auckland Council 2018a).

Internationally, urban areas have been associated with poor air quality (Meurk et al. 2013). However, trees and vegetation are effective in absorption of gaseous air pollutants and the interception of air-borne particulate matter (PM), resulting in an improvement in air quality. This has a positive impact on people's health, i.e., lower incidences of respiratory and cardiovascular diseases, and a reduction in hospital emissions and health costs (Tiwary et al., 2009; Forest Research 2010).

There is limited information available on how effective urban trees are in improving air quality in New Zealand and how this translates into monetary values. However, there is a significant amount of evidence in international literature; e.g., Tiwary et al., (2009), Forest Research (2010), Nilsson et al. (2011), and UK National Ecosystem Assessment (2011).

The most widespread air quality problem in New Zealand is PM pollution, which is known to cause a wide array of health problems, including respiratory illness, cardiovascular diseases and premature death (World Health Organization 2013; Health Effects Institute 2018; Ministry for the Environment and Stats NZ 2018). In cooler months in some towns and cities in New Zealand, emissions from home heating can raise levels of airborne PM to above national standards and international guidelines, especially when air pollution is trapped near ground level by temperature inversions (Ministry for the Environment and Stats NZ 2018).

Urban vegetation mitigates the effects of gaseous and particulate air pollution, as shown in the UK (UK National Ecosystem Assessment 2011) and New Zealand (Fisher et al. 2007). Cavanagh et al. (2009) measured a 30% attenuation of PM_{10} (airborne particles that are 10 micrometres or less in diameter, i.e., includes coarse and fine PM) from the edge to the interior of native forest in Christchurch, New Zealand. This was in a distance of less than 200 metres in Riccarton Bush, which is a remnant podocarp-hardwood, floodplain forest, dominated by kahikatea.

Cavanagh and Clemons (2006) and Cavanagh (2008) (cited in Meurk et al 2013 and Roberts et al. 2015) estimated the many tonnes of various air pollutants that urban trees remove in Christchurch and Auckland, which is worth tens of millions of dollars in terms of health benefits. In Auckland, Cavanagh and Clemons (2006) estimated that the city's trees annually removed 1230 tonnes of nitrogen dioxide, 1990 tonnes of ozone, and 1320 tonnes of PM. Cavanagh (2008, cited in Meurk et al 2013 and Roberts et al. 2015) estimated that Christchurch urban trees removed 300 tonnes of pollutants, including 150 tonnes of PM_{10} (equivalent to 4.5% of the estimated PM emissions in 2002) and estimated that the value of urban trees in Christchurch was NZ$19.6 million. This value was largely due to PM_{10} removal and the significant health benefits of reduced exposure to PM_{10}.

There are differences in how various species of trees help improve air quality (Meurk et al. 2013; Roberts et al. 2015). In winter, evergreen trees are more effective at removing air pollutants (Meurk et al. 2013). Most deciduous trees cease these functions after leaf drop, which often occurs at the time of year when pollutant levels are highest in New Zealand (Cavanagh 2008, cited in Roberts et al. 2015). However, some (mainly exotic) species emit natural volatile organic compounds that can contribute to air quality issues (Meurk et al. 2013).

A recent New Zealand study has demonstrated that exposure to natural vegetation can protect against asthma in children, but this was not thought to be due to a reduction in air pollution. Donovan et al. (2018) assessed the association between the natural environment and asthma in a longitudinal study of 49,956 New Zealand children born in 1998 and followed up until 2016. They found that children who lived in greener areas were found to be less likely to be asthmatic. Also, exposure to a greater number of natural vegetation-cover types provided an additional increment of protection. Not all land-cover types were protective; exposure to gorse *(Ulex europaeus)* and exotic conifers was found to be a risk factor for asthma.

The reasons for the observed protective effects of exposure to greenness and a diversity of vegetation are unclear. However, Donovan et al. (2018) found no evidence that it was due to a reduction in air pollution. Instead, they hypothesized that the natural environment may protect against asthma through greater and more diverse microbial exposure (i.e., the hygiene hypothesis), or via currently unknown biological mechanisms.

Urban forests are also important for biodiversity values (Meurk et al. 2013). Cities are often biodiversity 'hotspots', because they frequently sit astride convergences of several biomes, and there is often an educated and well-resourced population that is actively involved in conservation efforts. Remnants of natural vegetation commonly remain in gullies, floodplains and aquifer protection zones. These urban forest remnants provide habitat for native birds, reptiles, and insects and help provide ecological corridors connecting the mountains to the sea (Meurk et al. 2013).

Many of the remnants of natural ecosystems within Auckland's urban boundary are unique in their own right, being representative examples of unique ecosystems that have largely been cleared to make way for urban growth (Lindsay et al. 2009; Wilcox 2012; Singer et al 2017; Auckland Council 2019).

Urban forests also provide cultural services such as recreation and education about nature, and spiritual values that contribute to mental health and well-being, including providing 'a sense of place'. These cultural services are difficult to value economically, but are:

> *"valued very highly by most urban residents and contribute significantly to quality of life and social capital in cities, with consequences for mental well-being, innovation, and economic activity"* (page 254, Meurk et al. 2013).

Meurk et al. (2013) noted that while many ecosystem services may be provided equally, or sometimes better, by introduced tree species in urban settings, it is native biodiversity that underpins New Zealand's unique sense of place (e.g., silver fern), cultural values (e.g., harakeke), and adds to tourism, international obligations and reputation (e.g., conservation of indigenous flora and fauna).

Within the New Zealand context, Durie (1999) describes the strong link between human health and the surrounding environment under the concept of **waiora**, i.e., human well-being and the natural environment are strongly interconnected. Durie emphasises the importance of striking a balance between development and environmental protection for the benefit of human wellbeing:

> *"… health promotion must take into account the nature and quality of the interaction between people and the surrounding environment. It is not simply a call for a return to nature, but an attempt to strike balance between development and environmental protection and recognition of the fact that the human condition is intimately connected to the wider domains of Rangi and Papa"* [the sky father and earth mother, respectively] (page 3, Durie 1999).

Durie states that this involves environmental protection, so that "*water is free from pollutants, earth is abundant in vegetation"* and *"opportunities are created for people to experience the natural environment"* (page 3, Durie 1999).

Urban trees are highly valued by local residents. A study was undertaken by Vesely (2007) to determine the perceived value of urban trees in New Zealand using the contingent valuation method. Households in 2003 were, on average, willing to annually pay NZ$184 over a 3-year period to avoid a (hypothetical) 20% reduction in urban trees in their local area. The benefits perceived to be most important were aesthetics, followed closely by having nature in the city, habitat for wildlife, and fresh air - these benefits were rated important or very important by over 80% of respondents. Shade, carbon storage and protection from wind and noise were rated important or very important by 60% to 70% of respondents. Urban forest has also been linked to enhanced property values (Vesely 2007; Forest Research 2010; Meurk et al. 2013).

Swedish and American researchers (Hartig et al. 2003) provided evidence of the positive effects of natural settings on well-being, including improved attention functioning, emotional gains and lowered blood pressure. Participants in the research were either required to drive to a natural area or were asked to perform a 40-minute cognitive task designed to induce mental fatigue. Participants were then exposed to various environments and activities. Walking in a nature reserve had a more positive impact, including greater stress reduction, than walking in a purely urban setting; and even sitting in a room with views of trees resulted in a rapid decline in diastolic blood pressure, compared with sitting in a viewless room.

A study based in the UK examined the value of urban green space for health enhancing activities such as walking, running or cycling (Forest Research 2010). The authors reviewed international epidemiological studies, and found evidence for a positive relationship between green space and population health. This included research showing evidence for the restorative effects of green space on the well-being and development of children, as well as the mental health and well-being of adults (Forest Research 2010). This is presumed to be due to an increase in exercise and reduction in health issues associated with a sedentary lifestyle, as well as improved mental health and well-being. There is evidence that people living in urban areas tend to experience more stress and have poorer mental health, but it is not clear why this is so. However, green spaces in urban areas counteract this by providing a restorative environment that helps alleviate stress and mental fatigue. This has important economic implications because a healthy population is more productive and has less health costs (Forest Research 2010).

Considering the considerable economic burden of mental health illnesses on the economy (RANZCP 2018) and research showing evidence for the positive impact that natural areas have on mental well-being and social cohesion, there is good justification for investing in green space in urban areas. Ecotherapy, which involves exercise activities in nature, has become a recognised treatment programme that utilises the restorative effects of green space to benefit mental health and well-being (Forest Research 2010).

In a study in the USA, Bratman et al. (2015) showed that spending time in nature improves mental health. Participants who went on a 90-minute walk through urban green space, with scattered oak trees and shrubs, were compared with participants who walked nearby, in a highly urbanised area by a busy highway. Participants who went on the 90-minute nature walk showed reductions in self-reported rumination, a known risk factor for mental illness, and also decreases in neural activity in an area of the brain linked to risk for mental illness. Those who went on a walk in the highly urbanised area did not show these effects. The authors argue that these results suggest that access to natural areas may be vital for mental health in our rapidly urbanising world (Bratman et al. 2015).

When cultural and environmental services of urban trees are aggregated, these benefits can:

> *"make a considerable contribution to adaptation and mitigation against climate change, helping climate proof our towns and cities and their communities, whilst improving people's mental and physical health"* (page 195, Forest Research 2010).

Many of the benefits attributed to urban forest are disproportionally provided by larger trees (Davies et al. 2011, Nowak et al. 2013, Trees and Design Action Group 2014, Moser et al. 2015). Because of the larger and wider canopy spread:

- they create more shade per tree (Moser et al. 2015);
- intercept larger amounts of particulate pollutants and absorb more gaseous pollutants (Nowak and Crane 2000);
- intercept more rainfall due to larger leaf areas and assist with the reduction of volume and rate of surface water runoff entering the drainage system (Trees and Design Action Group 2014);
- contain more carbon and have higher carbon sequestration rates (Beets et al. 2012, Schwendenmann and Mitchell 2014, Dahlhausen et al. 2016);
- are often less susceptible to careless or malicious vandalism by passers-by, can be pruned to provide higher canopy clearance over roadways, parking lots and pedestrian footpaths;
- and contribute more to calming and slowing traffic on local streets than small trees (Howell Davies pers. comm.).

Retention of existing, larger-growing trees should be a priority, particularly in densely built-up areas where the associated benefits are high, and opportunities are limited for new plantings (Trees and Design Action Group 2014).

3.3 Why do we need Data on Urban tree coverage?

Decision-makers need to be well informed on the trends and status of the urban trees in their region, so that they can support evidence-based, strategic approach for future decisions about tree cover. A better understanding of the trends and status of the canopy cover will help identify key areas for improving monitoring and protection of existing urban tree cover along with helping to direct planting efforts to where the most value can be realised.

Section 35(2) of the Resource Management Act 1991 ("RMA") 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 (and other local board reports), Auckland Council had no reliable information on the extent, ownership, and protection status of Auckland's urban forest assets.

This report aims to verify locally specific details on urban tree cover in Kaipātiki to enable more accurate tracking on the changes that the urban tree cover is undergoing, with the development of urban and peri-urban areas in the current and future urban zone parts of the board's area.

Baseline information about Auckland's urban forest is particularly important in light of the recent changes to the RMA that have removed the ability of Auckland Council to use general tree protection rules to protect urban forest. Sections 76(4A) and 76(4B) of the RMA were inserted under the RMA (Simplifying and Streamlining) Amendment Act 2009 (RMAA09). This was amended under the RMA Act 2013 (RMAA13) to align with the original policy intent of prohibiting blanket tree protection rules in urban areas.

It was hoped by legislators at the time of the changes that the removal of general tree protection would occur in conjunction with the implementation by local councils of a systematic program to identify and protect important trees through their incorporation onto the notable tree schedule on the councils district and regional plans.

Unfortunately the limited amount of time and resource invested prior to the release of the Proposed Unitary Plan (PAUP) has resulted in a schedule that is limited and the opportunity to include a significant number of trees and areas of Ecological Significance has not been fully realised. While the Auckland Unitary Plan (Operative in Part) 2016 offers degrees of protection to urban forest, meeting specific characteristics (e.g. pre-identified significance, vegetation by coasts or streams), other important urban forest assets have no statutory protection and can, therefore, be removed.

The Environmental Defence Society of New Zealand (EDS) stated in its findings in 2015:

> "*While other cities have targets of achieving 40% tree cover or more, Auckland is moving backwards with a minimalist approach reliant on a cumbersome and costly scheduling process"* (EDS 2015).

Many of the cities comparable to Auckland, which score consistently high on the various international indices of liveability, have adopted ambitious urban forest strategies and targets:

- Brisbane's canopy cover is currently 44% (Brisbane City Council 2019). There has been extensive use of green infrastructure with native bush retained in riparian areas of newer suburbs. Brisbane also has extensive plantings of amenity trees in its many parks throughout the city. Protected heritage trees are a prominent feature of the CBD.

- Melbourne has a 40% target for tree cover in the public realm by 2040 (City of Melbourne 2012), an almost doubling of urban forest cover in 2012. The latest data shows that current canopy cover is at 23.7% (The Urban Forest and Ecology Team, City of Melbourne, pers. comm.)
- In 2013, the City of Sydney published strategic 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 (City of Sydney 2013). Sydney's total canopy cover, based on a 2019 assessment, is 18.1% (Karen Sweeney, Urban Forest Manager, pers comm.)

The aim of Auckland's Urban Ngahere (Forest) Strategy is to increase average canopy cover from 18 to 30% (Auckland Council 2019). This is a proactive first step towards enhancing the regions tree cover for the benefit of all of its residents and visitors.

3.4 Why use LiDAR data?

The techniques considered for mapping Auckland's urban forest at a high resolution included LiDAR, along with manual digitisation (marking up) of aerial imagery and field-work with aerial imagery followed by manual digitisation of field maps, or some combination of these methods. However both the latter approaches involved considerable man hours and were therefore too expensive to allow us to obtain a universal sample of urban forest within the Auckland urban area. Computer automated classification of satellite imagery could have provided a universal sample, but the resolution of this approach would not provide the scale required for more detailed analysis work, i.e., down to the level of individual trees and shrubs.

For these reasons, LiDAR was considered the best method for obtaining a universal sample of the urban forest for the purposes of this study.

The term 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.

4.0 METHODS

Data suitable for the urban forest analysis was available from LiDAR data captured in 2013. Auckland Council has recently undertaken another series of aerial LiDAR surveying. The fly-overs of the Auckland region were completed in 2016-2017 as part of a 2-year project, and the processing of this data to create the vegetation cover layer is well advanced. The final results for the Local Board were not available at the time when this report was being prepared. The Local Board will be updated on the outcomes of the comparative analysis following a presentation to the Environment Committee in September 2019. A fine grained analysis for the board area will be appended to this report along with a change detection chapter outlining the changes that have been detected from the comparative work with the baseline 2013 results contained in this report and the updated 2017 data.

4.1 Desktop Analysis of Kaipātiki Board – Environmental and Socioeconomic Context

Context relevant to urban ngahere in Kaipātiki was obtained via a literature search. This included Auckland Council reports and Mike Wilcox's book 'Auckland's Remarkable Urban Forest' (Wilcox 2012) along with review of the local board plan, greenways document, as well as other relevant information found on-line

4.2 LiDAR Analysis Methodology

The 2013 urban forest data presented in this report was created from airborne LiDAR sensor data collected between 17/07/2013 and 23/11/2013. This was around the time trees first lost their blanket protection. The classified Raw Point Cloud data, which 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. These other datasets are shown in **Table 1**, below.

Table 1: List of data sources and descriptions used in analysis

Data	Description	Organisation source	Retrieved
Local Board	Kaipātiki Local Board area. A political division of the Auckland Council that includes the suburbs of Beach Haven, Birkenhead, Chatswood, Bayview, Birkdale, Northcote, Glenfield, Hillcrest, Totara Vale and Marlborough.	Statistics NZ	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 3**. 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

Quality control checks on the urban forest layer generated by the LiDAR data eliminated obvious errors found in the supplied classified point-cloud data. Misclassified areas of man-made materials and other non-vegetation surfaces were removed in the processing of the raw data. These types of errors are symptomatic of classification functions that 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.

4.3 Urban Forest Structure

LiDAR data includes a height component and we used this information to set a cut-off point for urban 'forest' vegetation at 3 m. That is, LiDAR data-points classified as vegetation that were over 3 m in height were used 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 since 2013 will not be visible in this analysis.

4.4 Urban Forest Tenure

To determine the tenure of urban forest, the data points were compared to the zoning of different land parcels within the Kaipātiki Local Board. The zoning as corresponding to land tenure classification is summarised in **Table 2**.

Table 2: Classification of land parcels in relation to land tenure assessment

Tenure Category	Detail on classification in relation to zoning and land ownership
Street Trees	Trees within the roading network, located in road reserves (i.e., along footpaths and berms) and within the motorway corridor1.
Private Land	Private residential land and privately owned businesses and commercial space.
Public Parks	Publicly owned land accessible to the public for recreational and conservation purposes, including all public parks.
Other Public Land	All publicly owned land that is not classified as a public park, including tertiary campuses, schools, road reserves without formed roads on them, and Council owned commercial spaces.

[1] Note that 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 Auckland Unitary Plan.

4.5 Urban Forest Protection Status

The level of urban forest protection was determined through an analysis of the underlying zones and protection layers in the Auckland Unitary Plan. Note that this classification method is arbitrary and has no legal weighting. It reflects work to develop five different protection levels (shown in **Table 3**) based on the rules applying to vegetation clearance in the Unitary Plan, or other practical constraints to vegetation clearance for different zones and land uses, based on past experience.

Table 3: 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 a 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	Includes the following: - Outstanding Natural Feature (restricted discretionary consent needed to remove 25m^2+ of contiguous indigenous vegetation) [1], - Outstanding Natural Landscape (restricted discretionary consent needed for alteration or removal of 50 m^2+ of any contiguous indigenous vegetation) [1], - Coastal yard (restricted discretionary consent needed to remove native trees/ vegetation 3m+ in height)[1], - Open Space Conservation (restricted discretionary consent needed to remove trees/ vegetation 4m+ in height),
4 – moderately high protection	Includes the following: - 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).
5 – high protection	**Significant Ecological Areas** (SEAs) (discretionary consent needed to remove any trees or vegetation), **Notable trees** (discretionary consent needed to remove any notable tree or shrub).

[1] 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.

For the Notable Trees, the operative list in Schedule 10 of the Auckland Unitary Plan was utilised. This list is dated February 2017, so does not include the latest plan updates. This list includes some anomalies, such as trees that have been removed since being scheduled, errors in individual versus group listings, and entries that have not been ground-truthed. However, on the whole, the list provides a useful tool for examining the distribution of Notable Trees throughout the Local Board area. GIS maps in this report showing the spatial distribution of the trees have been based on the same schedule.

The Significant Ecological Areas (SEAs) identified in this study are from the operative list in the Auckland Unitary Plan. SEAs are identified as having significant indigenous vegetation or significant habitats of indigenous fauna located either on land, freshwater or marine environments. In order to maintain indigenous biodiversity, these areas are protected from the adverse effects of subdivision, land use and development.

4.6 Urban Forest in Relation to Socio-Economic Factors

The socio-economic census data included in this report has been sourced from the 2013 New Zealand census records. This includes data on resident population and age distribution. The urban forest data was categorised into Census Area Units (CAU) for the Kaipātiki Local Board to potentially identify trends between the data and demographic and socioeconomic factors. The CAUs covered by the Local Board area are shown in **Figure 1**, below, with 17 CAU in total.

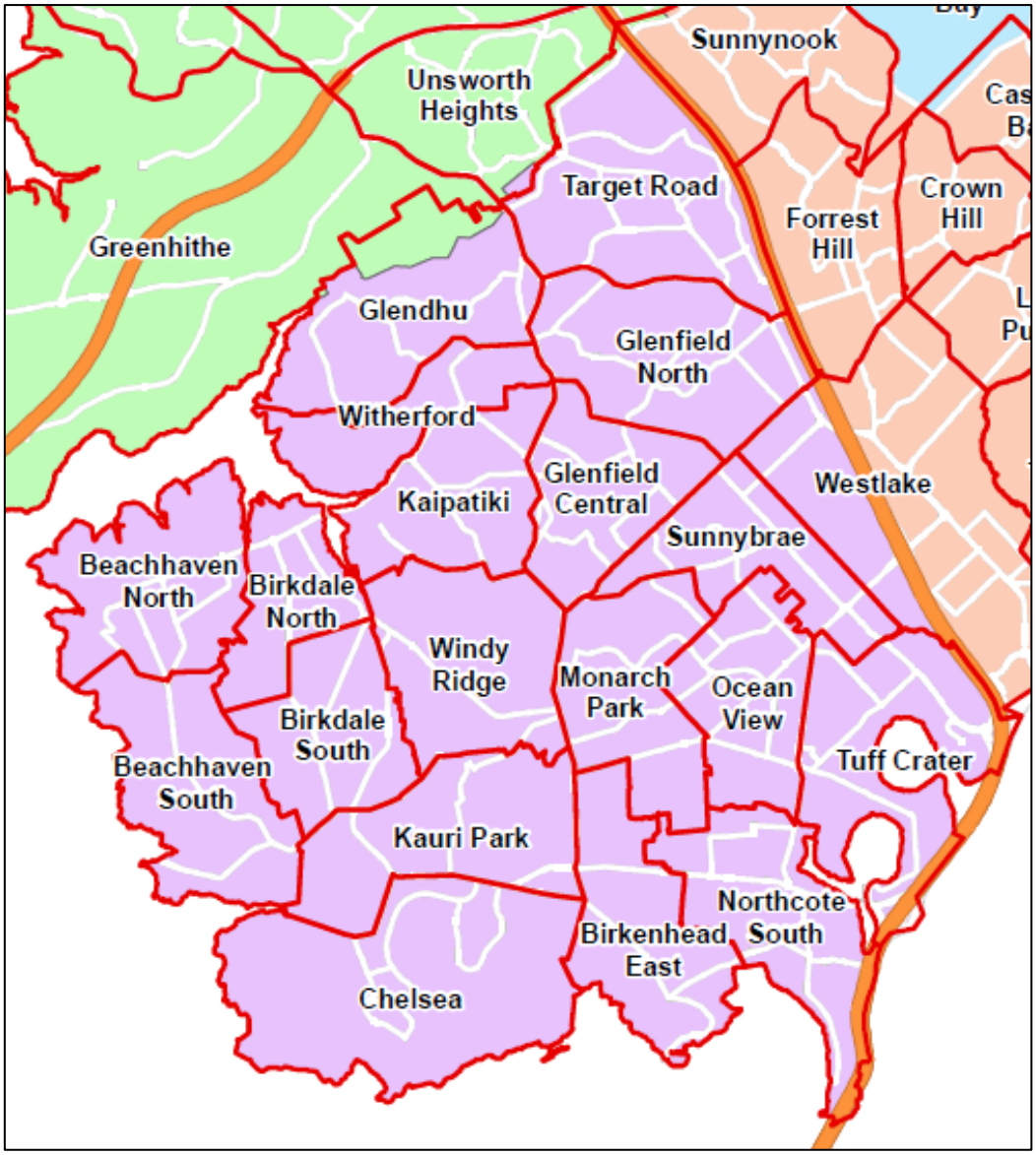


Figure 1: Census Area Units (2013) of the Kaipātiki Local Board (highlighted in purple)

Where CAUs within Kaipātiki cross over the Local Board boundary (e.g., Westlake and Glendhu CAUs) they are covered in this report, unless the area of overlap is very small (e.g., Unsworth Heights CAU, which is largely in Upper Harbour Local Board Area).

4.6.1 Parks and Open Space Shade Analysis Study

In addition, a previous study undertaken by Auckland Council RIMU (the Research and Evaluation Unit) was consulted in regard to assessment of trees in local parks, including nearby sports fields and playgrounds. This Parks and Open Space Shade Analysis Study was undertaken through desktop analysis of high-resolution aerial imagery, with interpretation on park maintenance (i.e., maintained or unmaintained), size of park, number of trees present, percentage of canopy cover, presence of playgrounds or sports fields, and amount of shade provided to playgrounds where trees were present. All the parks within the Kaipātiki Local Board were assessed.

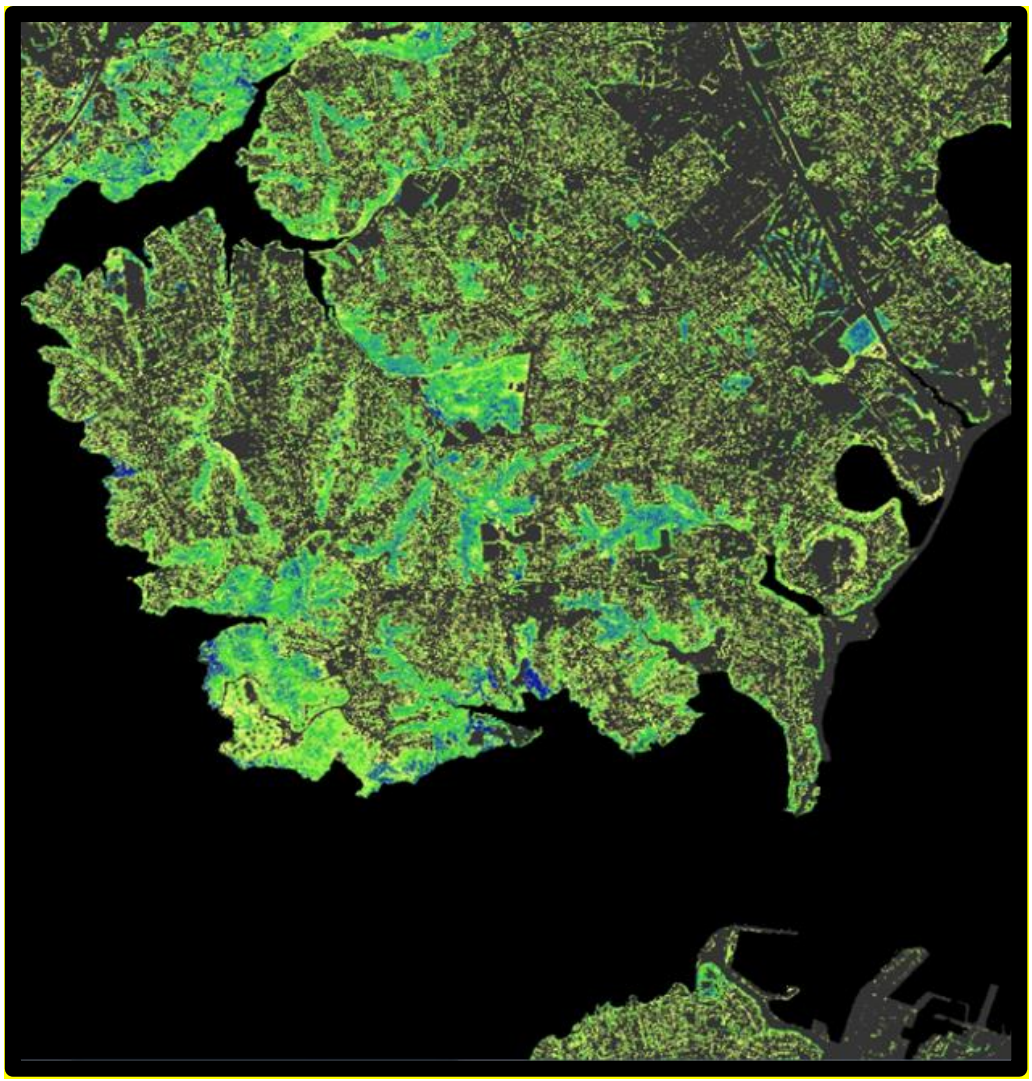
Further information on the methodology for The Parks and Open Space Shade Analysis Study is presented in **Appendix 1**. The aim of the study is to show where there are opportunities for improvements in tree cover in local parks, to benefit the well-being of the local and wider community.

4.7 Change in Urban Forest Cover 2013 – 2016

In addition to the 2013 LiDAR data, Auckland Council has recently undertaken another series of aerial LiDAR surveying. The fly-overs of the Auckland region were completed in 2017 as part of a 2-year project. The data has been through quality control and council staff are currently processing the data to produce a vegetation or canopy extent layer that can then be used to develop the metrics for tree sizes, heights and a range of other factors including canopy coverage. A comparison of the 2013 and 2017 data sets will be provided in a subsequent update report on progress of the urban ngahere work program for the Kaipātiki Local Board.

The 2016-17 LiDAR produced a data set of 88 billion data points so processing of this requires time, it is expected that early results, which will show a comparison between the 2013 and 2016-17 datasets, will be available later this year.

LiDAR Imagery 2013



5.0 RESULTS OF ANALYSES

5.1 Kaipātiki Local Board Context

5.1.1 Geographic, Demographic and Socioeconomic Factors relevant to urban ngahere

The Kaipātiki name means *'to eat flounder'* or the *'feeding ground of the flounder'*, giving an indication of the important ecological heritage of the area.

The Kaipātiki Local Board area's boundaries are the northern motorway to the east, the inner Waitematā harbour to the south-west, and Hellyers Creek forms the northern boundary near Glendhu and Sunset roads (Auckland Council 2012; Wilcox 2012). Kaipātiki includes the suburbs of Beach Haven, Birkenhead, Chatswood, Bayview, Birkdale, Northcote, Glenfield, Hillcrest, Totara Vale, and Wairau Valley (**Figure 2,** below). Kaipātiki Local Board area is 3,400 ha. It neighbours Upper Harbour Local Board to the north-west and Devonport-Takapuna Local Board to the north-east.

Wairau Valley in northwest Kaipātiki is largely industrial but the other suburbs are predominantly residential (Auckland Council 2012; Wilcox 2012). There has been recent development in the Northcote area (Auckland Council 2017). The central portion of the Kaipātiki Local Board area is the most developed, and has the highest population density, with the coastal fringe more constrained by topography and, therefore, more sparsely populated (Auckland Council 2012).

There is a reasonably high proportion of open space and natural vegetation, with the southwest suburbs intersected by multiple vegetated stream valleys (Auckland Council 2012). Kaipātiki has approximately 540 ha of local parks and reserves, including destination parks like Onepoto Domain and Chelsea Heritage Park, Kauri Point Domain, Birkenhead Domain, and the Tuff Crater Reserve (Auckland Council 2016a, 2017). Other features include the Auckland University of Technology campus at Northcote and the iconic Chelsea Sugar Refinery at Birkenhead (Auckland Council 2016a).

According to the 2013 Census, there are about 82,500 people living in Kaipātiki, ranking it fifth in population size among Auckland's 21 local board areas (Auckland Council 2017). Kaipātiki has three main town centres – Birkenhead, Glenfield and Northcote – which are complemented by smaller local centres (Auckland Council 2017). About 65% of Kaipātiki residents are employed, which is similar to the Auckland average (Auckland Council 2016a). Of these, 29% work within the local board boundary (Auckland Council 2017). Wairau Valley is a significant area of employment and industry but many Kaipātiki people commute to other locations (Auckland Council 2016b, 2017). Overall, employment numbers remained essentially unchanged from 2010 to 2015, compared with an increase of 13% for the Auckland region as a whole (Auckland Council 2016a).

Because Kaipātiki is close to the harbour bridge and Auckland's CBD, it is attractive to young families, professionals and students (Auckland Council 2016a). There are higher proportions of people in the 25- to 44-year-old age group and children under 5-years-old, compared with the Auckland average. The population density of children, aged 0 to 14 years, is moderately high in Kaipātiki, relative to the other northern boards of Auckland, and is particularly high in the suburbs of Beach Haven and Hillcrest; and is also fairly high in Bayview, Glenfield and Totara Vale (Auckland Council 2018a).

Figure 2: Map of Kaipātiki Local Board area

Two-thirds (65%) of the Kaipātiki population are of European ethnicity and 26% is of Asian ethnicity - slightly higher than the Auckland average. Māori and Pacific populations are at 8.5% and 5.9% respectively, which are lower than the Auckland average (Auckland Council 2017). A relatively large percentage (40%) of Kaipātiki residents was born overseas (Auckland Council 2016a).

Kaipātiki has a well-qualified and relatively affluent resident population (Auckland Council 2016b). In 2013 (the last available census data) the median household income was $78,600, which is slightly higher than the regional median at $76,500 (Auckland Council 2016a). The economic growth rate averaged 1.3% per annum over the last decade, which is lower than the national average of 2.1% pa (Infometrics 2018). In 2013, 66 per cent of households owned the dwelling they lived in, compared with 61 per cent regionally. Based on 2016 data, there are 26 schools, most decile 5 and over (Auckland Council 2016a). Educational qualification levels are above the Auckland average (Auckland Council 2016b).

Both employment and GDP growth in Kaipātiki have lagged the regional average over the decade 2006 to 2016, with the area seeing an average decline in both (Auckland Council 2016b). Wholesale trade and manufacturing are main employment sectors, but GDP and employment has declined in recent years. Although economic growth in Kaipātiki is low, there are significant opportunities for tourism and business growth that would come with the development of the SkyPath, SeaPath and a second harbour crossing (Auckland Council 2016b).

The well-established suburbs in southern Kaipātiki have a large number of parks and reserves (see **Figure 2** above) and there are high-quality bush walkways (Wilcox 2012). The Local Board recognises the importance of these many parks and bush reserves scattered throughout the area (Auckland Council 2014, 2017). Amenity trees in Kaipātiki parks are described in **Appendix 2** and remnant native forest in the many bush reserves is described in section 5.5.1. Notable Trees are described later in this report (section 5.5.2).

5.1.2 Land Use and Environmental Factors in Kaipātiki

Kaipātiki has one of the largest areas of continuous urban native vegetation remaining in Auckland's ecological region (Auckland Council 2012). There are significant areas of remnant native forest, which are protected as Significant Ecological Areas, as described below in section 5.5.1 of this report.

However, despite these extensive areas of remnant natural vegetation and the large number of parks, there are large areas of Kaipātiki that are highly urbanised, and northeast Kaipātiki is heavily industrial (Auckland Council 2012). This has led to very high levels of impervious (hard) surfaces, as shown below in **Figure 3** (green-shaded surfaces) particularly in Wairau Valley and Northcote Point, and much of Totara Vale, Glenfield and Hillcrest.

In 2016, the freshwater report card was assessed at **Grade C** for the North Shore reporting area, which includes Devonport-Takapuna and Kaipātiki Local Board areas (**Appendix 3**). The relatively low water quality has been linked to urban development and very high levels of impervious surfaces (52%) in the North Shore reporting area, compared with the regional average of 9% (Auckland Council 2016c).

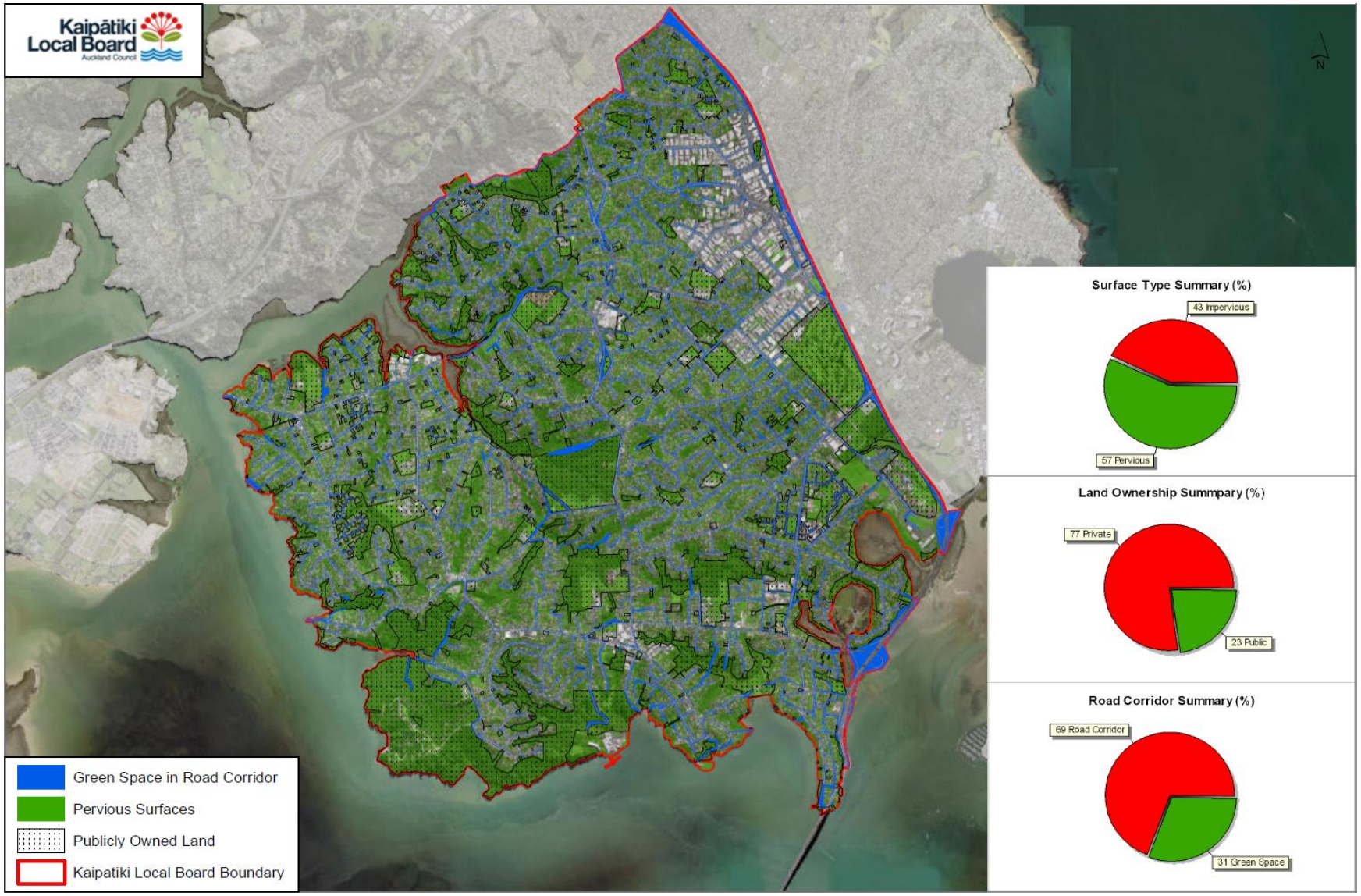


Figure 3: Pervious surfaces in Kaipātiki Local Board area (highlighted in green)

Kaipātiki Local Board area has as an estimated 43% impervious surface area (**Figure 3,** above), which is lower than the overall average for the North Shore reporting area. However, when compared with the estimated 20% impervious surface area for neighbouring Upper Harbour Local Board area, the proportion of impervious surface area in Kaipātiki is relatively high.

High proportions of impervious surfaces leads to poor water quality as there is less ground infiltration of precipitation, increased water temperatures, changes to the natural flow patterns and increased pollution from contaminated stormwater (Auckland Council 2016c).

Auckland Council's State of the Environment monitoring programme has been collecting data for over 30 years (Auckland Council 2016c). The data shows that there is a strong relationship between the health of waterways and the type of land cover in the catchment. Waterways that drain through forested catchments (particularly native forest) typically have excellent water quality and high ecological values, while rivers that drain from urban catchments typically have poor water quality and lower ecological values (Auckland Council 2016c). This is corroborated by data collected from other regions of New Zealand (Gluckman 2017) and overseas (Forest Research 2010).

In addition to this, lack of natural vegetation reduces interception of precipitation, and reduced ground infiltration also increases the speed of run-off, therefore, the risk of flooding is increased in urban areas with high levels of impervious surfaces (Forest Research 2010; Meurk et al. 2013). Therefore, restoration of riparian zones in Kaipātiki has not only increased ecological values, it has also boosted green infrastructure. Efforts to restore riparian areas and wetland complexes to the north and east of Kaipātiki, where there is a relative lack of tree cover would improve environmental outcomes.

5.1.3 Kaipātiki Connections Network Plan

The Kaipātiki Connections Network Plan is a long-term plan aimed at improving walking, cycling and ecological connections across the local board area, with the commitment to promoting the community's connections to the coastline, harbour and natural spaces (Auckland Council 2012, 2014, 2017). The aims are to make native bush more accessible and known to Kaipātiki residents by improving the walking and cycling connections through parks and reserves, easing pressure on roads, and encourage people to stay healthy and active.

Where the network runs through areas with little vegetation cover, there would be significant benefit from investment in tree planting - for pedestrian and cyclist safety, and improvement of ecological and amenity values.

There is an opportunity for coordinating the local urban forest work program with the Kaipātiki Connections Network Plan, so that when fully completed, ecological areas and amenity trees planted public places would be connected across the entire local board area. This process would be expedited by consultation (and ideally partnership) with the many highly engaged and experienced stakeholders in Kaipātiki, particularly the North Shore branch of Forest & Bird, the Kaipātiki Project, and Pest Free Kaipātiki.

5.1.4 Community partnerships in ecological restoration

Kaipātiki is one of the stand-out areas in New Zealand for community-based conservation programmes (Howell Davies, pers. comm.). As well as good environmental outcomes, community cohesiveness and local identity have benefitted from the strong local community commitment to conservation programmes, which have been fortified by good partnerships with the Kaipātiki Local Board (Auckland Council 2014, 2017). The Kaipātiki Explorer booklet, which is available on-line (Kaipātiki Local Board 2018), provides information on, and encourages, volunteering for dedicated "Bush Groups" set up for individual reserves and bush areas.

The most recent Local Board Plans (released in 2014 and 2017) recognise the importance of the work undertaken by community groups to maintain the ecological values in Kaipātiki. The Board has an approach of empowering and supporting the community to take its own action, (Auckland Council 2014, 2017). There are several well-established community groups, e.g., the North Shore branch of Forest & Bird; the Kaipātiki Project and the linked Pest Free Kaipātiki programme (Auckland Council 2017) and (Wilcox 2012; Auckland Council 2014, 2017).

According to Dr Mike Wilcox, the Forest & Bird Protection Society's project at 31-ha Tuff Carter is a good example of a successful revegetation project – it had a comprehensive plan for weed and pest control as well as planting (Forest & Bird 2009, cited in Wilcox 2012). The North Shore branch of Forest & Bird has an ongoing programme at their flagship project at Tuff Crater (Forest and Bird, North Shore branch 2019).

Pest Free Kaipātiki is a highly successful organisation that works in coordination with the Kaipātiki Local Board and Auckland Council (Auckland Council 2017; Pest Free Kaipātiki 2019). It promotes removal of pest plants and animals, coordinates more than 25 active volunteer groups in the Kaipātiki Restoration Network, and promotes the ecological halo concept. The ecological halo involves surrounding and encompassing valuable ecological areas with a buffer area of guardian households who can intercept any incoming pest species of plants and animals, and thereby help protect native fauna and flora (Pest Free Kaipātiki 2019).

Pest Free Kaipātiki operates a Tool Shed at the Birkenhead Senior Citizens Hall, which provides tools for trapping and for restoration planting, and herbicide (Pest Free Kaipātiki 2019). Street weed bags are available at multiple collection points. There is currently a campaign to encourage people to remove three top pest plant species: Moth Plant, Woolly Nightshade & Wild Ginger. There is also up-to-date information about kauri dieback and track closures (Pest Free Kaipātiki 2019).

There is also the highly successful Kaipātiki Project, which is one of New Zealand's largest urban ecological restoration projects (Wilcox 2012). It started in 1998 and has its own environmental centre, native plant nursery and teaching garden; plus a long-running educational programme that includes native plant propagation courses. The main focus of revegetation has been in the Eskdale catchment area. Plants have been also been grown to order for other local restoration groups including Tuff Crater and Le Roys Bush. The Kaipātiki Project Committee became a Trust in 2009. Their website describes the ongoing activities of this dynamic, proactive organisation (Kaipātiki Project 2019) and the important tenets underpinning this extraordinary organisation:

- **The Vision of the Kaipātiki Project is:** Connected, resourceful, healthy families, neighbourhoods and communities regenerating our planet's environmental systems.

- **The Mission of the Kaipātiki Project is**: To unleash the creativity of the community to identify and solve local environmental challenges (Kaipātiki Project 2019).

Best-practice ecological restoration starts with eco-sourced seed, i.e., seed collected from the closest remnant stands, wherever possible, preferably within the North Shore and at least within the Tamaki Ecological District (Auckland Council 2012; Wilcox 2012; Auckland Council 2018b). Eco-sourcing is defined as the sourcing of local, wild seed sources to propagate native planting stock for planting in the same locality (Ferkins 2001, MacGibbon 2009). The overall aim is to sustain (rather than undermine) the genetic integrity and resilience of local plant populations, and to ensure that planting stock is well adapted to local conditions (Porteous 1993; Ferkins 2001; MacGibbon 2009; Simpson 2009).

In the 2017 Kaipātiki Local Board Plan, one of the key principles identified was the need to protect and enhance the Kaipātiki environment (Auckland Council 2017). Of the seven identified outcomes described in the Plan, three have direct relevance to urban green space and urban ngahere:

- Outcome 1: Our people identify Kaipātiki as their kāinga (home).
- Outcome 2: Our natural environment is protected for future generations to enjoy.
- Outcome 3: Our people are active and healthy.

There is evidence that environmental volunteering and involvement in community activities in natural areas benefits the health and well-being of participants (e.g., Townsend 2006; Forest Research 2010; Roberts et al. 2015). Meurk et al. (2013) and Roberts et al. (2015) discuss, within the New Zealand context, the importance of people being involved in ecological restoration and conservation efforts and how this has benefits for personal well-being and the well-being of communities. Roberts et al. (2015) note that thousands of New Zealanders volunteer every year for biodiversity restoration projects, and the collective action needed to protect natural ecosystems is a unifying force in communities. Blaschke (2013) suggested that volunteer ecological restoration programmes may be important for increasing health and well-being in New Zealand society. Meurk and colleagues concluded that *"Ecological restoration indeed is often as much about restoring communities and spirit as it is about ecology"* (Page 268, Meurk et al. 2013).

There are also cultural values associated with ecological restoration and people's connection to the natural environment. Mātauranga Māori (the traditional knowledge base and philosophy) has become increasingly integrated into natural resource management in New Zealand. It has direct relevance to urban ngahere and conservation efforts, particularly the following principles:

- **Kaitiakitanga** (guardianship of natural resources) defines the important role of tangata whenua (people of the land) as temporary guardians of the environment with the responsibility to maintain it for future generations (Harmsworth and Awatere 2013; Roberts et al. 2015; OECD 2017).
- **Whanaungatanga** (community connectivity) refers to how well-being and social prosperity are improved through connection to, and interactions with, the natural environment. (Scheele et al. 2016).
- **Tūrangawaewae** (sense of place) refers to how well whānau, hapū and iwi well-being is reflected in, and connected to, the natural and urban environment (Harmsworth and Awatere 2013; Scheele et al. 2016).

These Māori principles now go beyond Mātauranga Māori - they have become increasingly part of the wider New Zealand ethos. And they have relevance to urban ngahere and the well-being of city dwellers. The principles of Whanaungatanga and Tūrangawaewae are important to uphold in communities where many people were born elsewhere, such as in Kaipātiki, where many residents were born overseas.

5.1.5 The battle against Kauri dieback

Kauri dieback has recently been found in Kaipātiki, resulting in the closure of Kauri Park and Muriel Fisher Reserves (Pest Free Kaipātiki 2019). A map of kauri locations, including trees confirmed to have kauri dieback, is provided in **Appendix 4**. In some cases the cause of the symptoms of poor health has not been fully established.

Links are available on the Pest Free Kaipātiki website for people to find more information about Kauri dieback, this includes:

- How you can help;
- Kauri hygiene precautions;
- Advice for private landowners;
- Kauri dieback documents.

Information about which tracks are safe to use is provided in a special "Kauri Dieback" edition of the Kaipātiki Explorer booklet, which is available on-line (Kaipātiki Local Board 2018). In addition to this, the Kaipātiki Explorer booklet provides a guide to safely explore walkways and tracks through the many parks, bush and reserves of Kaipātiki.

Phytophthora agathidicida (PA) is the causal agent for kauri dieback and it is a major threat to the iconic kauri. It is a soil-borne disease that is spread primarily through movement of contaminated soil (Black and Dickie; Waipara 2018). However, zoospores (mobile spores specialised for dispersal) can also be released under flood conditions and swim towards plant roots. Once they reach a host root, they penetrate the root and initiate infection. Also, recent research indicates that PA can potentially survive in the soil for many years, even in the absence of a suitable host (Black and Dickie; Waipara 2018).

Any soil-borne diseases such as *Phytophthora* species are difficult to contain. The Kauri Dieback Programme has recently produced best practice guidelines for all aspects of interactions with, and protection of kauri (Kauri Dieback Programme 2019). This includes the following “How to” guidelines:

- How to help save kauri ...
    - when walking your dog.
    - when horse riding.
    - when mountain biking.
    - when walking or running.
    - when hunting.
    - when trapping.
    - by looking after the ones you've got.
    - by following hygiene guidelines.
    - when disposing of material contaminated with the disease.

- when working around kauri.
- when operating vehicles and heavy machinery near kauri.
- when pruning or removing kauri.
- during propagation and planting of kauri.

In addition to this, New Zealand Plant Producers Incorporated (NZPPI) is developing the National Kauri Dieback Management Plan and Kauri Dieback Module, which will be available later this year.

5.1.6 Myrtle rust

Myrtle rust *(Austropuccinia psidii)* has now been found across most of the North Island. Taranaki, Auckland, and Bay of Plenty are the most seriously affected areas (Biosecurity New Zealand 2019). Myrtle rust spores are microscopic and easily spread across large distances via wind, insects, birds, people, or machinery. Most infections have been found on two types of native myrtle: ramarama (*Lophomyrtus* species) – used widely for residential hedging; and in the iconic pōhutukawa and rātā (*Metrosideros* species). Introduced myrtles have also been affected, including lilly pilly *(Syzgium)*, bottle brush (*Callistemon*) and eucalypts (*Eucalyptus*) (Biosecurity New Zealand 2019).

Excellent resources have been made freely available to assist local government, organisations and groups to effectively manage the biosecurity risks associated with myrtle rust.

Project Crimson update on myrtle rust is a web page that is regularly updated: https://projectcrimson.org.nz/myrtle-rust-update-february-2019/. It includes an excellent fact sheet that Biosecurity New Zealand has developed in collaboration with the Department of Conservation. The update also includes a link to an online training course about myrtle rust that Biosecurity New Zealand has developed, in collaboration with the Department of Conservation. The courses are available to everyone but are particularly suited to those running community education events.

Myrtle rust resources are provided in a web page: https://www.biosecurity.govt.nz/protection-and-response/responding/alerts/myrtle-rust/ that is regularly updated by the myrtle rust programme, which is a partnership between Biosecurity New Zealand and DOC. A step-by-step guide is available to help landowners on managing myrtle rust on their property. There is also specific advice for:

- planting and restoration programmes,
- nurseries,
- orchardists,
- beekeepers.

New Zealand Plant Producers Incorporated (NZPPI) has excellent biosecurity resources available on the Biosecurity Myrtle Rust webpage: (https://nzppi.org.nz/biosecurity). This has the latest information and updated protocols including:

- nursery management for myrtle rust,
- plant survey methods,
- myrtle rust spray programme,
- nursery dispatch declaration, and plant transport protocol and declaration.

5.2 An Overview of Urban Forest Cover in 2013

Canopy cover varied greatly across Auckland suburbs in 2013 and also within Kaipātiki Local Board area (**Figure 4**, below).

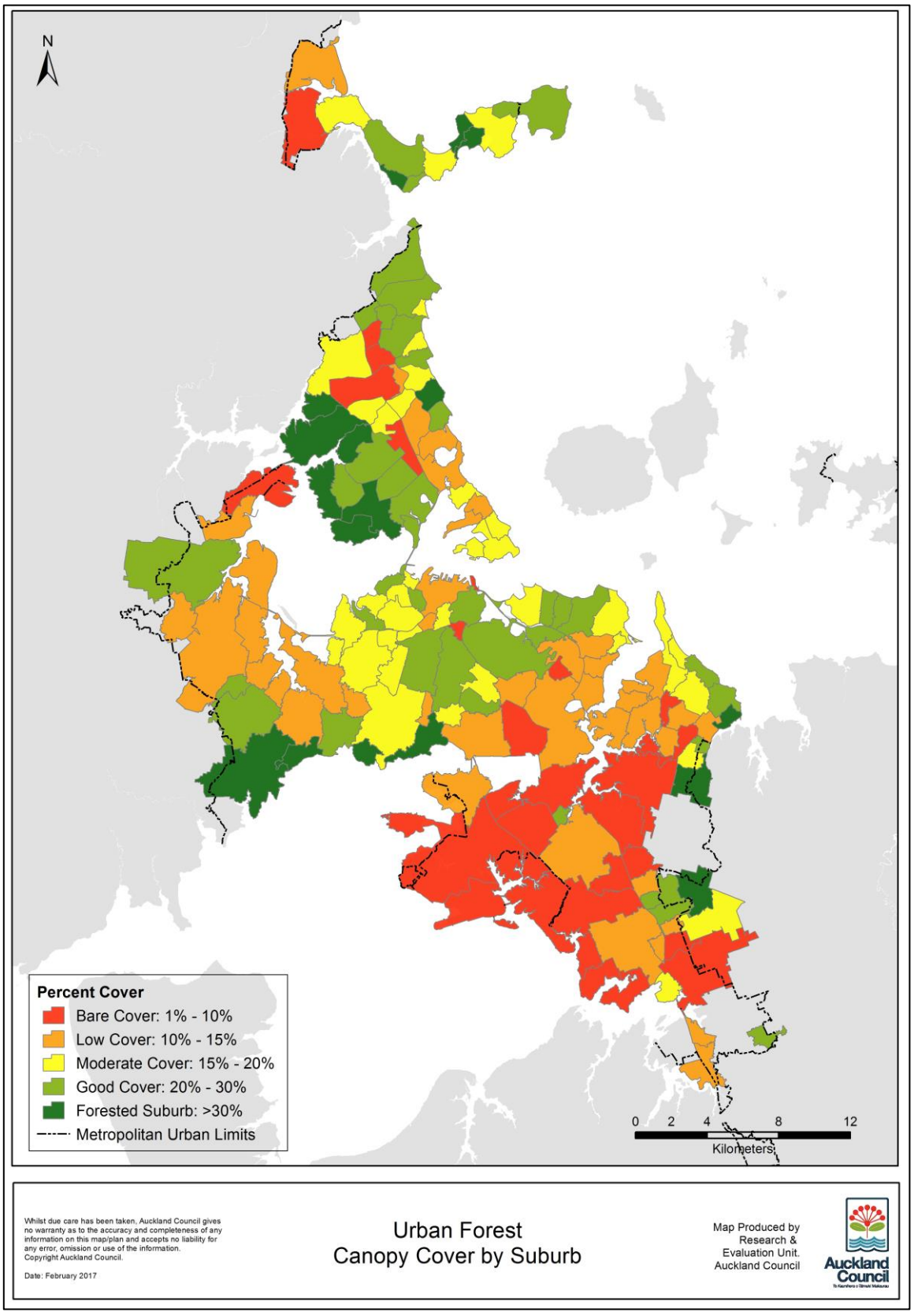


Figure 4: Auckland's urban forest canopy cover by suburb, in 2013 (data shown in **Appendix 5**)

These results are from the LiDAR data captured in 2013, which was around the time trees first lost their blanket protection.

Leafy suburbs of south-eastern and eastern Kaipātiki have been classified as 'forested suburbs' with canopy covers of 55% for Chatswood, 47% for Birkenhead, 42% for Bayview, and 34% for Beach Haven (**Figure 4** and **Appendix 5**). Eastern and central suburbs of Kaipātiki have 'good cover', including Birkdale (27%), Glenfield (25%), Northcote (23%), and Hillcrest (20%). The northern suburb of Totara Vale has 'moderate cover' (17%), while industrial Wairau Valley has 'bare cover' at (7%).

Canopy cover in Kaipātiki was 30% in 2013, which is considerably higher than the 18% overall cover for Auckland (**Table 4**, below) and was also the highest tree cover in 2013 for all urban boards in Auckland.

Table 4: Percentage of land with tree cover for each of Auckland's urban boards in 2013. Values are given for different land tenures and overall. Area units with population density less than 1000 people per square kilometre were excluded from the calculation.

Urban Local Board[1]	Public open space	Private land	Roads	Other public land	Overall
Albert - Eden	30	19	18	17	20
Devonport - Takapuna	23	17	10	13	16
Henderson - Massey	31	14	7	13	15
Hibiscus and Bays	36	24	16	23	25
Howick	26	17	6	13	16
Kaipātiki	63	25	12	27	30
Mangere - Otahuhu	17	7	7	7	8
Manurewa	25	11	6	7	12
Maungakiekie - Tamaki	22	9	10	10	11
Orakei	25	20	14	16	20
Otara - Papatoetoe	13	8	6	10	9
Papakura	22	14	9	13	13
Puketapapa	44	17	11	14	20
Upper Harbour	50	29	11	13	27
Waitemata	39	16	15	13	19
Whau	30	17	12	14	17
Overall	**31**	**17**	**11**	**14**	**18**

[1]A number of local boards have been excluded from this table as they are largely rural in character (i.e. Franklin, Rodney, Waitakere Ranges, Great Barrier and Waiheke Local Boards)

Table 4 (above) lists the percentage of land with tree cover in 2013, within each land cover class. Compared with the overall figures for Auckland, tree cover in Kaipātiki is higher in all land cover classes except for Street Trees, which was similar, i.e., 12% compared with 11% overall. In Kaipātiki, 63% of public land had tree cover in 2013, the highest of percentage in Auckland's urban boards. Also,

Kaipātiki had a high proportion of tree cover (25%) on private land compared with other boards; bettered only by Upper Harbour (at 29%).

5.3 Urban Forest Cover and Land Tenure

Figure 5 below shows how urban forest was distributed in 2013 across the different classes of land tenure in Kaipātiki. Just over half (52%) of tree cover in Kaipātiki was on private land (i.e., private gardens and lawn areas); and 37% was in public parks, which is relatively high compared with other local boards. There was only 6% on other public land (such as school grounds) and 5% was in road parcels (street trees), both of which are relatively low compared with other local boards.

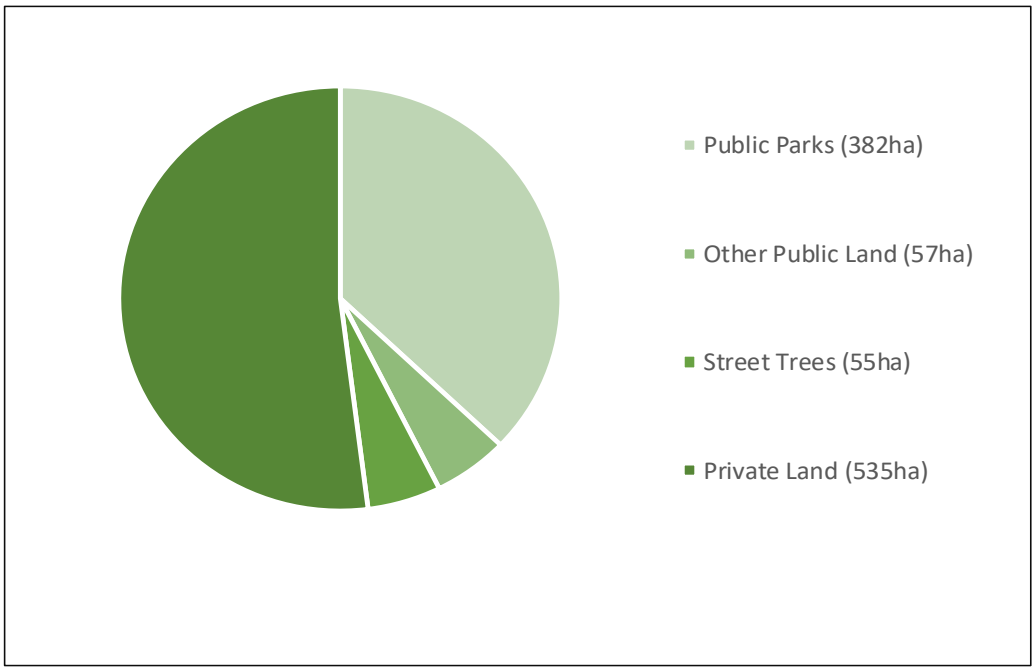


Figure 5: Tenure of urban forest canopy within the Kaipātiki Local Board area

The tenure of urban forest cover in Kaipātiki in the different census area units (CAUs) is shown below in hectares (**Figure 6**) and percentages (**Figure 7**). Note that some CAUs (particularly Glendhu and Westlake) cross over the Kaipātiki Local Board boundary into neighbouring board areas (see **Figure 1**), therefore, include tree cover that is partly in neighbouring local boards. The area with the highest forest cover was Chelsea Park, one of the leafiest areas of Auckland with nearly 180 ha of tree cover – and most of this in the public domain. Windy Ridge, Kauri Park, Glendhu, and Beachhaven South all had over 70 ha of tree cover, but close to half of this was in the private domain. Areas with less than 30 ha of tree cover are Birkdale North, Glenfield Central, Glenfield North, and Sunnybrae (**Figure 6**).

Most areas in Kaipātiki have over half their urban forest on private land (**Figure 7**). The exceptions are Chelsea, and to a lesser extent Windy Ridge, Westlake and Tuff Crater – these are the only areas that have more tree cover on public land rather than private land. This has important implications, as trees on public land are more accessible to the public and more likely to be protected. Parts of Kaipātiki that have proportionally a very low canopy cover on public land (public parks and school grounds), are Birkdale South, Birkdale North, Glenfield Central, and Sunnybrae. All areas of Kaipātiki have a relatively low percentage of street trees, except for Glenfield North and Northcote South.

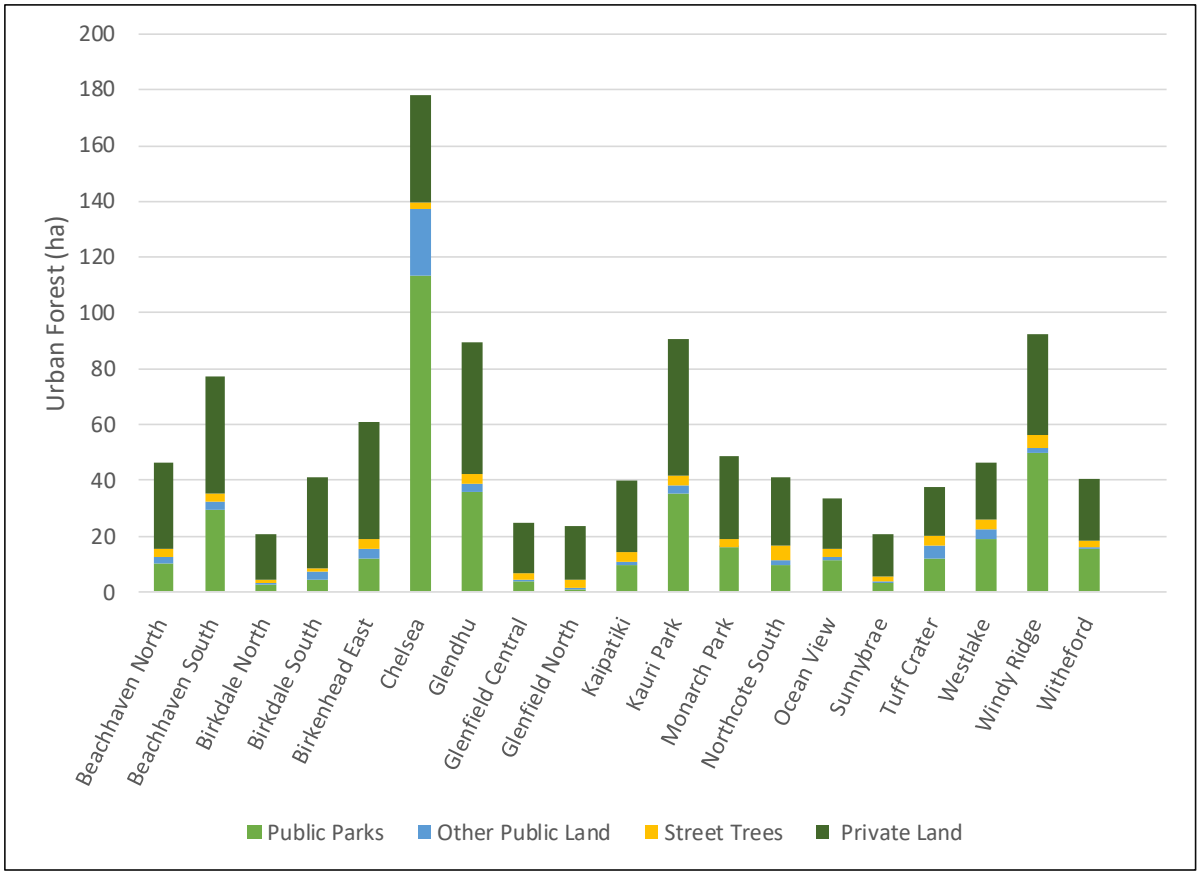


Figure 6: Tenure of urban forest per area unit within the Kaipātiki Local Board.

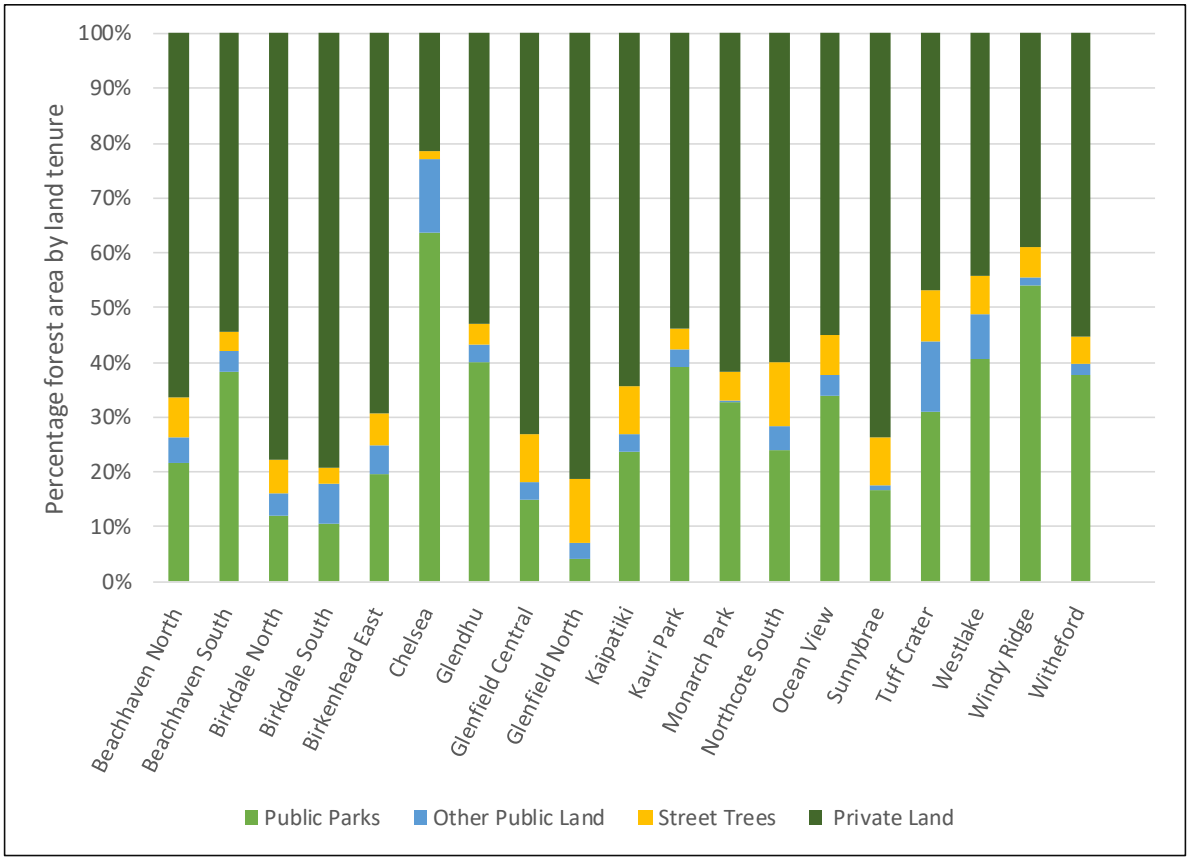


Figure 7: Percentage tenure of urban forest per census area unit within the Kaipātiki Local Board.

5.4 Urban Forest Structure

The height class distribution of the urban forest canopy, in Kaipātiki in 2013, is shown below in **Figure 8**. Most of the trees were in the smaller size classes: 58% of the tree cover was 3 to 10 m high; 82% was less than 15 m; only 5% was 20 to 30 m, and only 1% was taller than 30 m. This has important implications because larger trees provide a disproportionate amount of the many of the benefits associated with urban ngahere, as explained above.

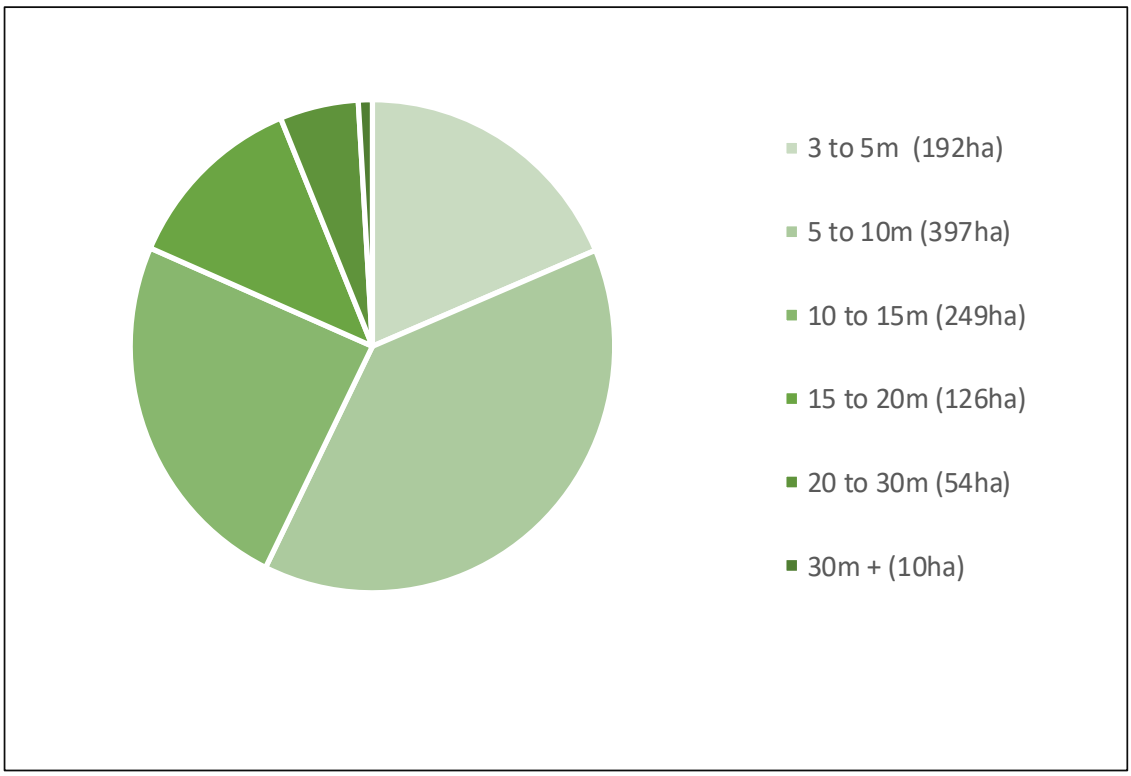


Figure 8: Height class distribution of urban forest canopy within the Kaipātiki Local Board area

Canopy height is mapped in the Significant Ecological Areas map in **Figure 12** (in section 5.5.1, below).

The relatively high proportion of smaller trees across much of the local board indicates that, in 2013, there was either a relatively recent surge of tree planting (assuming the smaller stature trees correspond to younger trees), or a large proportion of shrubs with a limited mature height. In the case of Tuff Crater, the former situation is more likely as there were major efforts with ecological restoration in the area at the time, as described above.

When broken down into suburb areas (**Figure 9**, below) it is apparent that there were areas in Kaipātiki that had a higher proportion of trees over 15 m tall in 2013 - particularly Windy Ridge and Kauri Park, and to a lesser extent, Chelsea, Birkenhead East, Glendhu and Beachhaven South.

Areas that had proportionally more trees with a lower stature were Glenfield North, Tuff Crater, Glenfield Central, and Birkdale North.

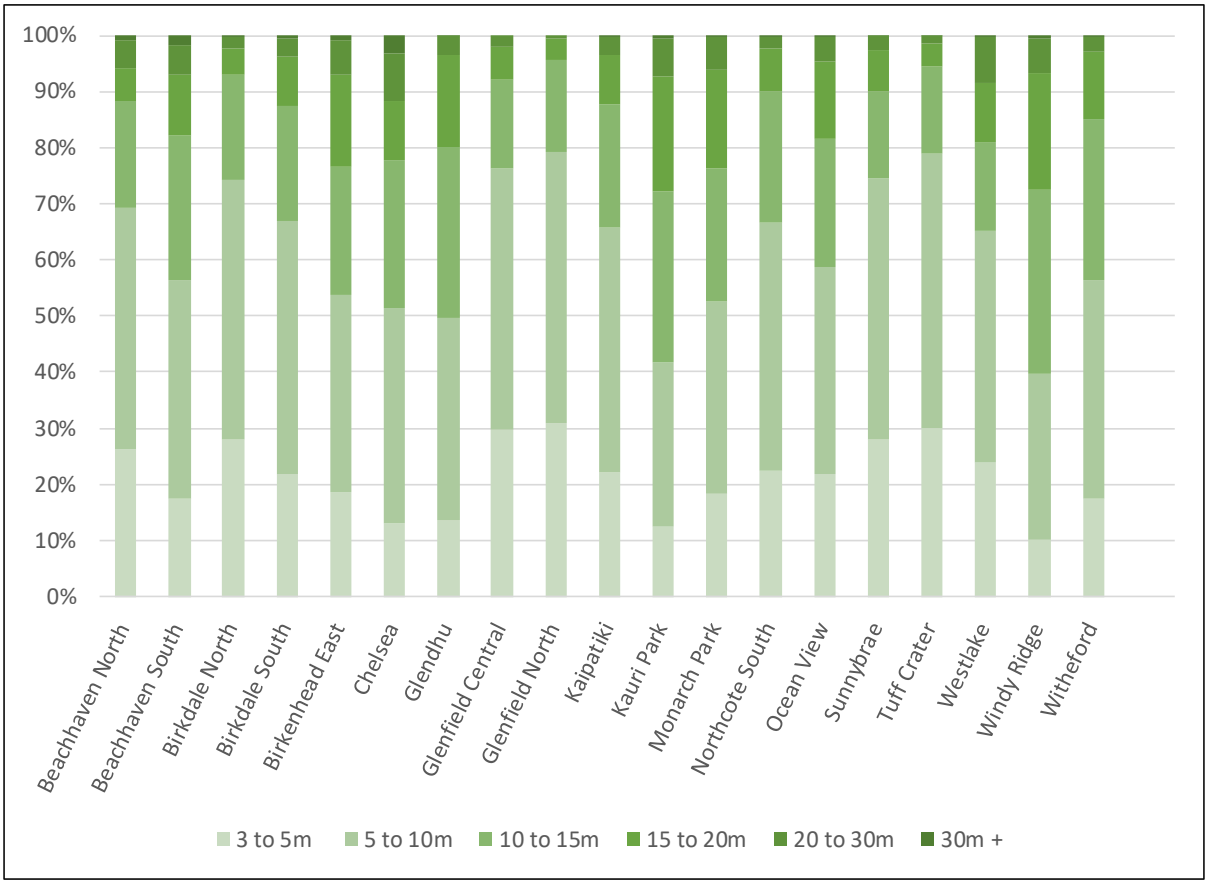


Figure 9: Height class distribution of urban forest canopy per census unit area in Kaipātiki

5.5 Urban Forest Protection Status

The protection status of urban forest within Kaipātiki is graphically illustrated below (**Figure 10**). A considerable proportion (61%) of the urban forest has some form of protection, which is a higher proportion compared with most other local board areas, and higher than the overall figure for Auckland's ngahere, where only 50% has some form of protection (Auckland Council 2019).

The majority of protected trees in Kaipātiki have a high protection status. Indeed, almost half (49%) of the total tree cover in Kaipātiki has a high protection status, i.e., Protection Class 5, and are, therefore, either Significant Ecological Areas (SEAs) or Notable Trees, as described below. This is a comparatively high proportion in Protection Class 5 compared with other local boards. Less than 1% has a Protection Class 4 status, which pertains to trees in riparian and lake protection zones.

Approximately 10% of the tree cover has a low to moderate degree of protection status (Protection Classes One, Two and Three, combined) (**Figure 10**). These Protection Classes are described in the Methodology above. In these areas, restricted discretionary resource consents are required to clear trees either over 3 m, or over 4 m in height (depending on the Protection Class). However, development pressures are generally high in these locations and trees are frequently regarded as incompatible with the main land uses (Auckland Council 2019).

Protection status varies widely across the suburb areas of Kaipātiki (**Figure 11**).

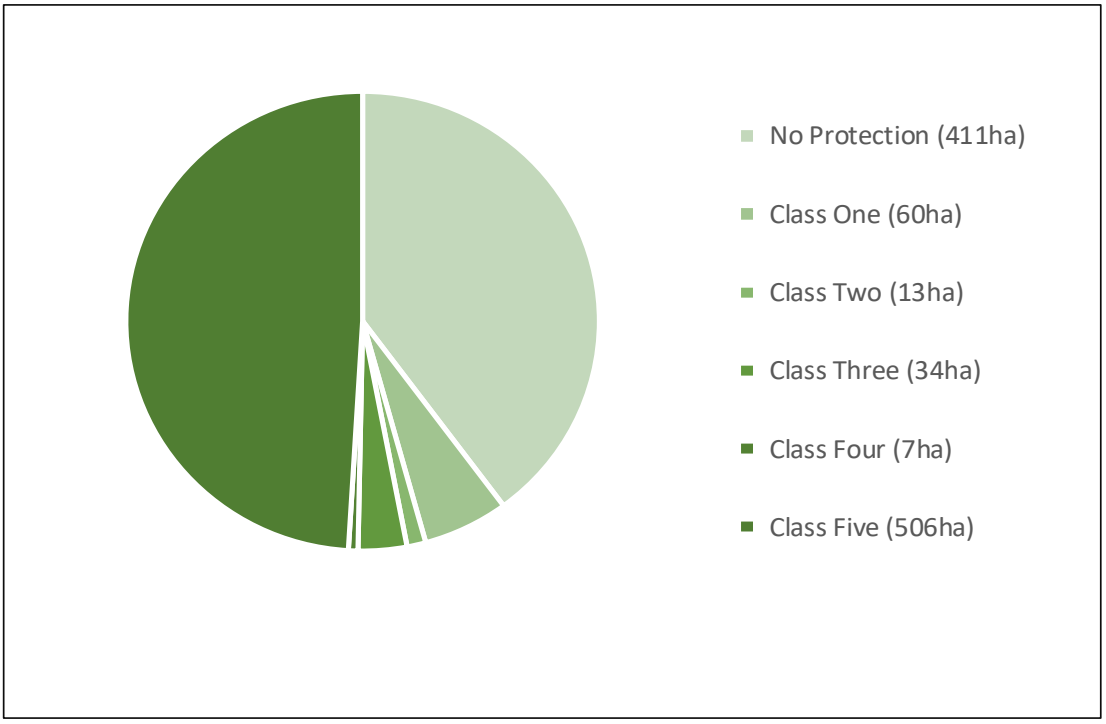


Figure 10: Protection status of urban forest within the Kaipātiki Local Board

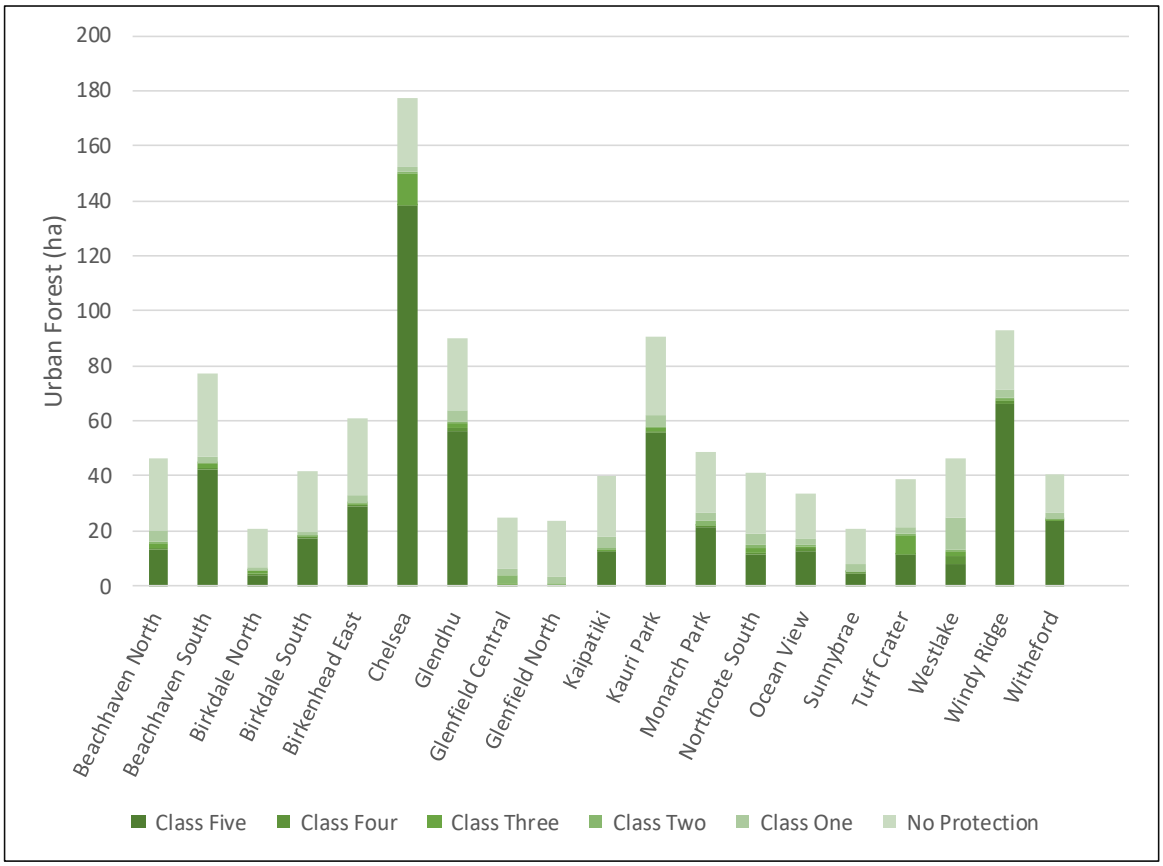


Figure 11: Protection status of urban forest within area units within the Kaipātiki Local Board.

Chelsea, Windy Ridge, Glendhu, Kauri Park and Beachhaven South have more than half their urban ngahere under the highest protection category. Areas that have the most trees with little or no protection are Glenfield North and Glenfield South (**Figure 11**).

5.5.1 Significant Ecological Areas

Terrestrial SEAs within the Kaipātiki Local Board area are shown in **Figure 12**[2], below.

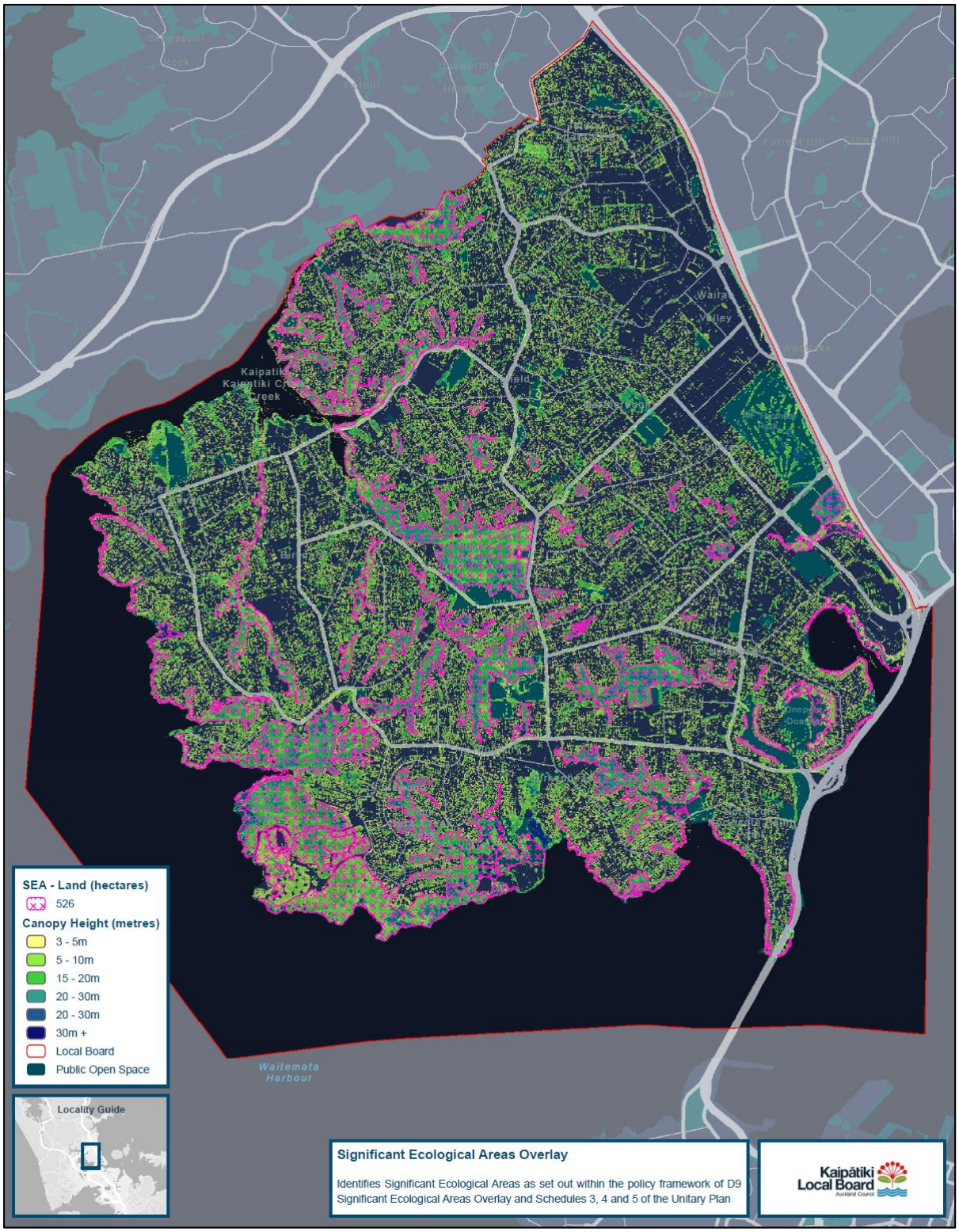


Figure 12: Map of Kaipātiki Local Board showing Significant Ecological Areas

[2] The current SEA overlay is based on the Operative Unitary Plan, whereas the data used in this study in relation to protection status is from the Proposed Unitary Plan (as of 2013). There is a slight variation between the two versions of the plan relating to submissions to the proposed overlay and consequent removals/additions.

In order to maintain indigenous biodiversity, SEAs are protected from the adverse effects of subdivision, land use and development.

Kaipātiki is centrally located between the significant natural areas of the Hauraki Gulf Islands and the Waitakere Ranges, within the North Shore Section of the Tamaki Ecological District Kaipātiki (Auckland Council 2012). The Tamaki Ecological District covers the Auckland Isthmus from Manurewa to Long Bay and is one of the eight ecological districts in the wider Auckland Region.

Native vegetation cover across the Tamaki Ecological District has been significantly reduced. Much of the remaining vegetation is found within the North Shore section, particularly Kaipātiki; therefore, has increased ecological significance (Auckland Council 2012). Indeed, Kaipātiki has one of the largest areas of continuous urban native vegetation remaining in Auckland's ecological region. It forms part of the North-West Wildlink, i.e., it has an important role in providing an ecological corridor between the Waitakere Ranges and Hauraki Gulf Islands (Auckland Council 2012, 2017).

The vegetation in these SEAs can be determined by comparing the SEAs map (**Figure 12**, above) with a map of vegetation classes in Kaipātiki (**Figure 13**, below).

The vegetation classes shown in **Figure 13** have been defined from the North Shore City Ecological Survey (April 2005, cited in Auckland Council 2012) and include the following:

- **Kauri Forest**: dominated by kauri *(Agathis australis)*, this includes young kauri stands, kauri broadleaved-podocarp forest and kauri-tanekaha forest. Kauri forest was once the most common vegetation type on North Shore, found from almost sea level through to ridges. Examples of mature kauri forest are now only found at four sites, three of which are within the Kaipātiki Local Board area, i.e., Kauri Glen, Kauri Park and Chatswood Reserve.
- **Podocarp Forest:** kahikatea-dominated podocarp forest would have once been extensive in low lying areas of Northcote and Wairau Valley. Kahikatea *(Dacrycarpus dacrydioides)* is now a nationally-threatened vegetation type. Smith's Bush on Northcote Road is the largest and most significant remnant of this vegetation type within the Tamaki Ecological District. According to Mike Wilcox (Wilcox 2012) 946 different species of plants, fungi and animals were found in a 24-hour "BioBlitz", on 4 – 5 April, 2008, in 10-ha Smith's Bush.
- **Broadleaved - Podocarp Forest:** is present as many small remnant stands, consisting of a canopy of broadleaf species, including pūriri (*Vitex lucens*), taraire (*Beilschmiedia tarairi*), tawa (*Beilschmiedia tawa*) and kohekohe (*Dysoxylum spectabile*), with emergent podocarp species including kahikatea, totara *(Podocarpus totara)*, tanekaha *(Phyllocladus trichomanoides)* and matai *(Prumnopitys taxifolia).*
- **Broadleaved Forest:** naturally occurring in large gully systems and lower hill slopes, particularly within gully heads. Includes mature pūriri, taraire, tawa and kohekohe. Onepoto Basin and Tuff Crater are examples of only four remaining remnant broadleaved forests on volcanic tuff crater soils within the North Shore.
- **Pohutukawa Forest:** *Metrosideros excelsa* was once commonly distributed along the foreshore but is now mostly reduced to scattered individual trees on the coastal fringe. There are some remaining areas within sheltered bays and estuaries where there are remnants of a more diverse vegetation type that is a better representative of the full suite of species within this forest type, including pūriri, taraire, tawa and kohekohe.

- **Successional vegetation:** typically dominated by manuka *(Leptospermum scoparium*) or kanuka *(Kunzea ericoides)*.
- **Mixed native-exotic forest:** forest where exotic trees (typically pine species) dominate, with a native understorey.
- **Freshwater wetlands/lakes:** kahikatea-dominated forest would have typically covered swampy areas. Remnant swamp forest, raupo (*Typha orientalis*) and sedge communities are associated with restored wetland areas.
- **Saline wetlands:** typically mangroves *(Avicennia marina var. resinifera)*.

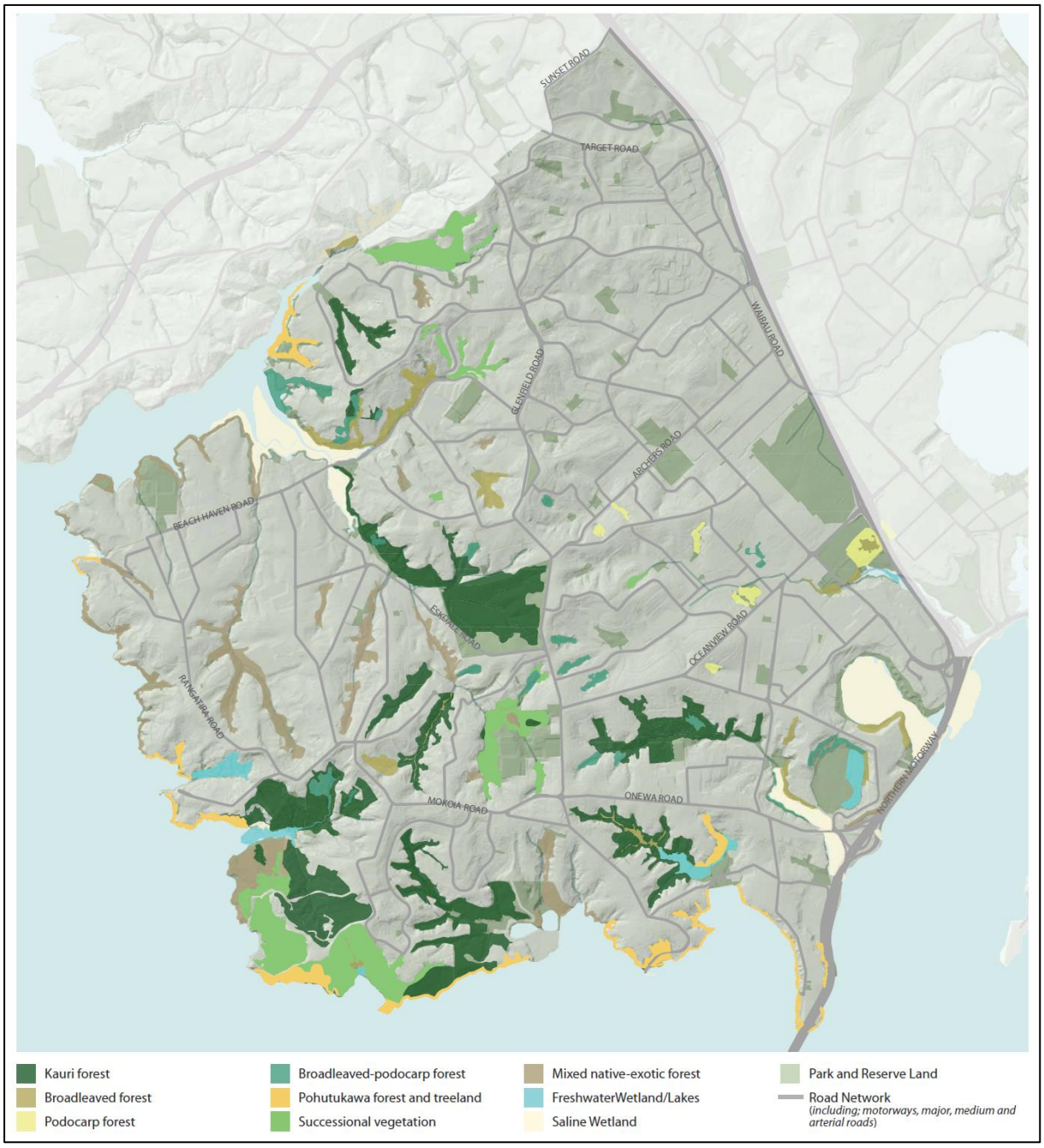


Figure 13: Map of vegetation classes in Kaipātiki Local Board area (Auckland Council 2012)

There are about 60 native bush reserves in Kaipātiki, which are listed with a brief description in Dr Mike Wilcox's book 'Auckland's Remarkable Urban Forest' (see Table 2: Urban native bush reserves in Auckland's northern suburbs and outlying towns, pages 29 – 35 in Wilcox 2012). They range in size from 0.1 to 83 ha but most are small (less than 2 ha). The more significant reserves in Kaipātiki (and other northern boards) are described in more detail on pages 24- 28 in Wilcox (2012).

The largest remnants of the native forest include:

- Kauri Park to Birkenhead Area (Oruamo Headland) 200 ha,
- Eskdale Bush, 72 ha,
- Kauri Glen, 30 ha.

Some of the largest stands of native forest in Kaipātiki occur in Eskdale Reserve (Wilcox 2012; Stanley 2018). This patch of bush is an amalgam of eight gazetted reserves, i.e, 'Eskdale Reserve Network', which covers 63 ha. A botanical survey was recently undertaken (Stanley 2018). There are a number of exotic tree and shrub species, but the majority of trees and shrubs are native, some of which were planted but many are either naturally regenerating or are remnants of mature forest.

This mixed-age, secondary forest in Eskdale Reserve is largely kauri-podocarp-broadleaved forest with patches of taraire/tawa-podocarp forest, wetland and gumland scrub (Stanley 2018). It contains the most abundant population of swamp maire *(Syzygium maire)* on the North Shore. Podocarps include kahikatea, matai, totara, and tanekaha. Large kowhai trees (*Sophora chathamica)* are prevalent (Wilcox 2012; Stanley 2018).

5.5.2 Notable Trees

The distribution of the 401 Notable Tree(s) records within Kaipātiki is shown in **Figure 14,** below. Notable trees have been identified as specimens with exceptional arboricultural characteristics that contribute to the amenity, landscape and ecological values in the area (Schedule 10, Auckland Unitary Plan).

Once they are registered and numbered, these notable trees (and groves of trees) have a high level of legal protection (Protection Class 5). They cannot be felled or severely pruned unless permitted to do so by a resource consent. Any significant modification applications are potentially considered as Discretionary Activities and can be subject to the public notification process along with a hearing. Permission to do any works within the dripline of these trees must be obtained through the Resource Consent process (Auckland Council 2012).

Notable Trees in Kaipātiki include a diverse range of native and exotic species. They are scattered throughout Kaipātiki except in Wairau Valley and the Target Road area, and along the southwest coast (where there are extensive SEAs). Notable Trees are in greatest concentration in Northcote Point, along Queens Street and the Northern Motorway; and to the north, along Sylvan Avenue, near Onepoto Domain. Birkenhead, Northcote, Hillcrest, Chatswood and Beach Haven also have good numbers of Notable Trees.

Dr Mike Wilcox mentions the following Kaipātiki Notable Trees in his book 'Auckland's Remarkable Urban Forest': flooded gum (*Eucalyptus grandis*) in Marlborough Park, Glenfield; horizontal wych elm (*Ulmus glabra*) in Pearce Place, Northcote Town Centre; and pohutukawa/northern rata hybrid (*Metrosideros excelsa* x *M. robusta*) in Nikau Reserve, Bayview (pp 265 – 267, Wilcox 2012).

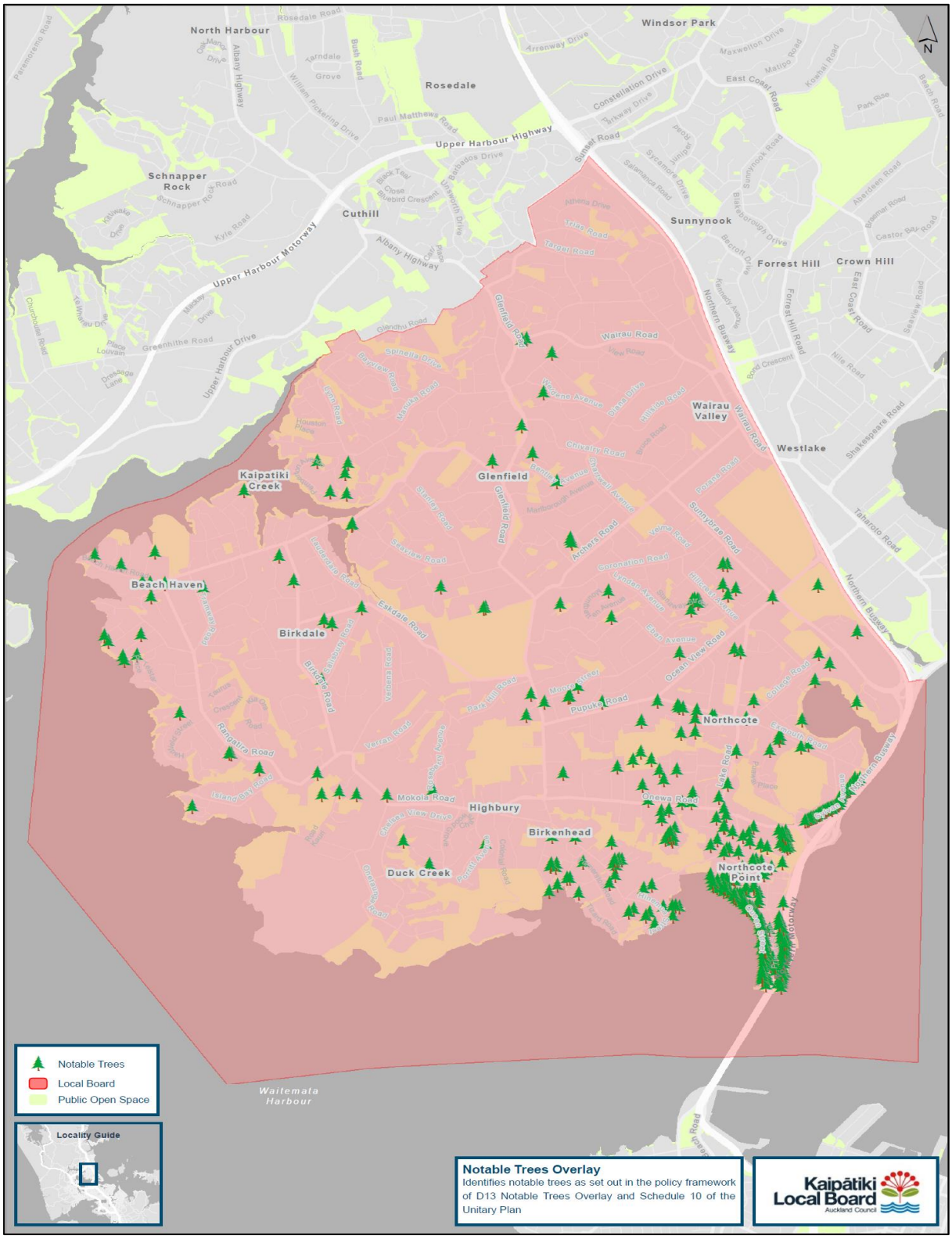


Figure 14: Distribution of Notable trees within the Kaipātiki Local Board

5.6 Urban Forest in Relation to Demographic and Socio-Economic Factors

5.6.1 Forest Cover and Demographics

Across the urban areas of Auckland, there is a general trend for urban forest cover to decrease as population density increases (**Figure 15**). The tree canopy cover per person in Kaipātiki (blue dots) follows this trend, although the trend is possibly not as pronounced as in some other densely populated local boards.

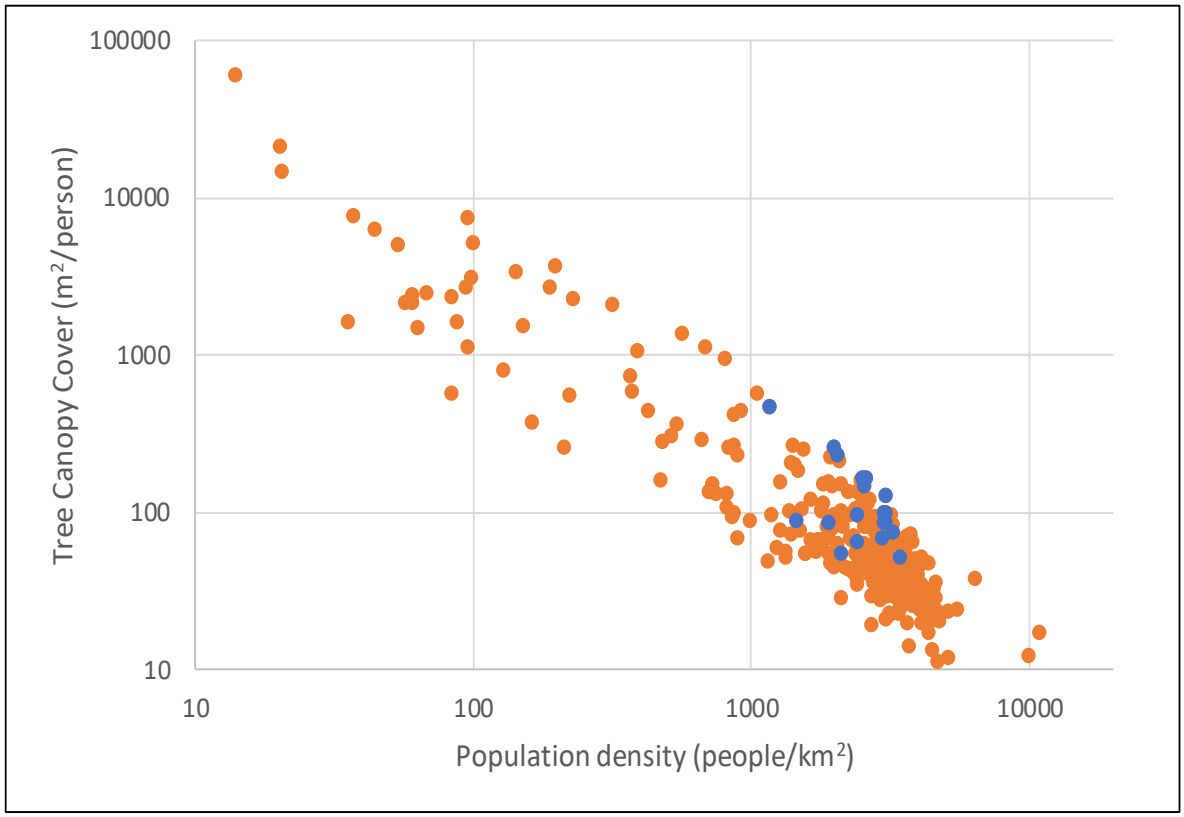


Figure 15: Tree canopy cover per person versus population density for area units within the Kaipātiki Local Board (blue dots) compared with all area units within Auckland (orange dots)

Further intensification of development is predicted in Kaipātiki, and across Auckland as a whole; and the concern is that there will be further loss of green space and canopy cover (Auckland Council 2019).

Table 5 below lists the population density (number of people per m^2) and tree cover per person for each of Auckland's urban local boards. Values are given for different land tenures and also the overall figure for Auckland.

Kaipātiki has a population density fairly typical of Auckland urban boards. In comparison with other urban boards, Kaipātiki ranks fairly high at 125 m^2 per person for overall tree cover per head of population - third behind Upper Harbour and Hibiscus and Bays. In terms of tree cover per person under different land tenures, Kaipātiki ranks fairly high for tree cover per person in public parks and private land, in comparison with other urban boards. Kaipātiki ranks moderately for street trees per person, and fairly low for tree cover per person on other public land (school grounds, etc.).

Table 5: Population density and tree cover per person for each of Auckland's urban local boards in 2013. Values are given for different land tenures and overall.

Urban Local Board	Population density (N/m^2)	Tree cover per person (m^2/head)				
		Public parks	Other public land	Street trees	Private land	Overall
Albert - Eden	3,342	10	6	9	35	59
Devonport - Takapuna	2,784	10	4	7	39	59
Henderson - Massey	2,034	15	5	5	47	73
Hibiscus and Bays	838	64	7	20	210	301
Howick	1,829	15	4	5	64	88
Kaipātiki	2,428	46	7	7	65	125
Mangere - Otahuhu	1,370	14	10	5	30	59
Manurewa	2,220	17	4	4	28	53
Maungakiekie - Tamaki	1,929	17	8	7	27	58
Orakei	2,474	17	4	9	50	80
Otara - Papatoetoe	2,055	10	7	4	23	44
Papakura	1,137	9	8	9	89	116
Puketapapa	2,825	27	7	6	32	72
Upper Harbour	773	75	25	16	238	352
Waitemata	4,031	16	4	9	19	48
Whau	2,731	11	4	6	42	63

A map of Kaipātiki showing forest cover per head of population in 2013 is provided below (**Figure 16**). Generally, the south-eastern suburb areas have a higher tree cover compared with the north-eastern part of Kaipātiki.

The graphs below show the forest cover by land tenure for suburb areas within Kaipātiki, per head of general population (**Figure 17,** below) and per child (under 15 years) (**Figure 18,** below) in 2013.

Forest cover per person varies widely in different areas of Kaipātiki (**Figure 17,** below). Chelsea has a very high forest cover per person (over 450 m^2). Windy Ridge and Kauri Park also have a fairly high forest cover per person. However, 12 census area units have less than/or equal to 100 m^2 forest cover per person.

In most suburb areas, more than half of the urban forest (per head of population) is on private land. Compared with public land, trees on private land are less likely to be protected and are less accessible to the general public. The only areas that have a larger proportion of urban forest on public land, per

head of population, rather than on private land are Windy Ridge and Chelsea, with Chelsea having a particularly high amount of tree cover in parks and other public land, such as school grounds.

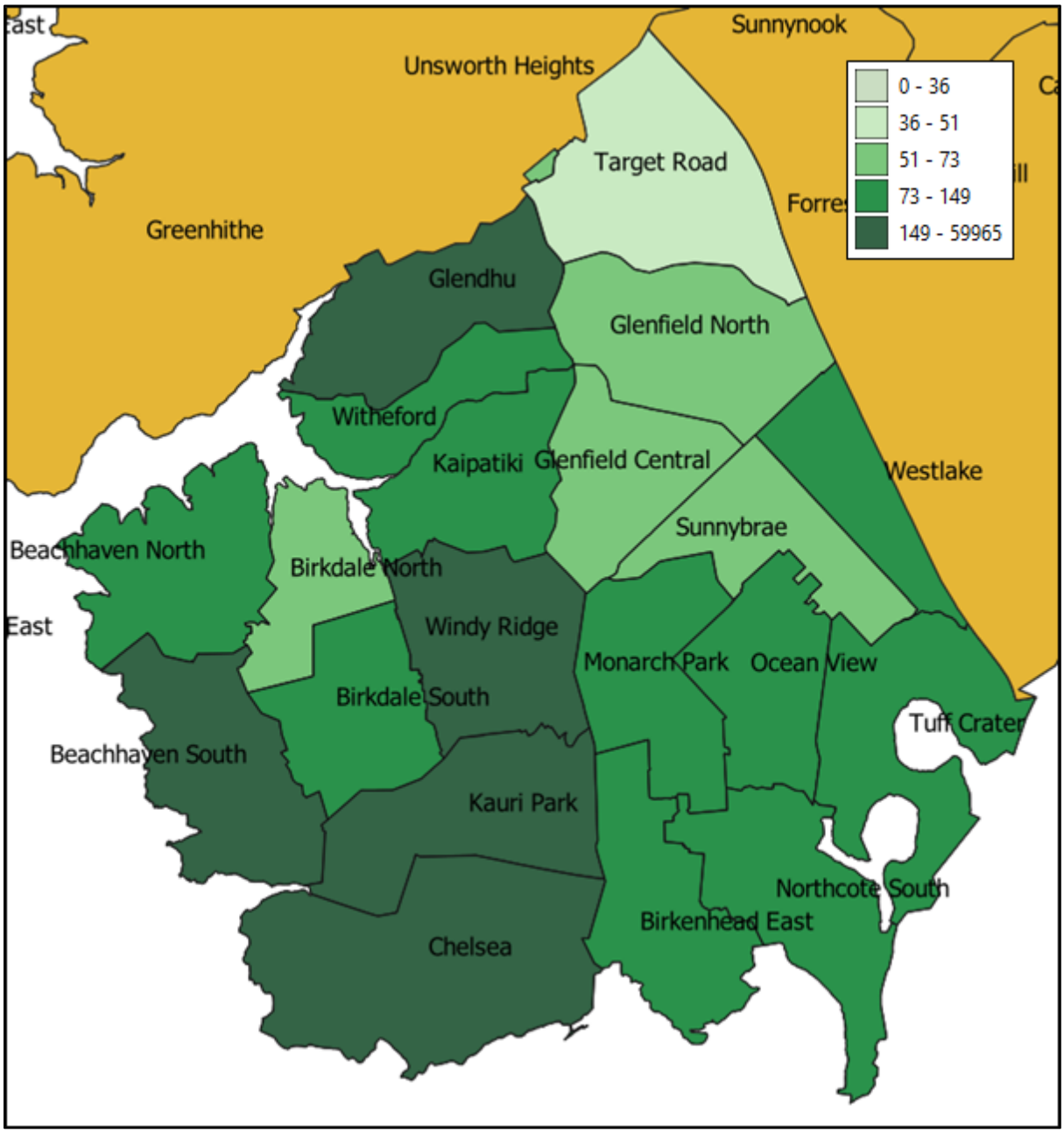


Figure 16: Map of Kaipātiki showing forest cover per head of population (m^2/person) in each census area unit.

The areas of Kaipātiki that have a proportionally low amount of forest canopy cover on public land, per head of population, are Glenfield Central, Glenfield North, Sunnybrae, Birkdale North, and Beachhaven North – these census area units also have a low forest cover per person overall (**Figure 17,** below). Most areas have a low proportion of street trees per person, except for Northcote South, and Windy Ridge.

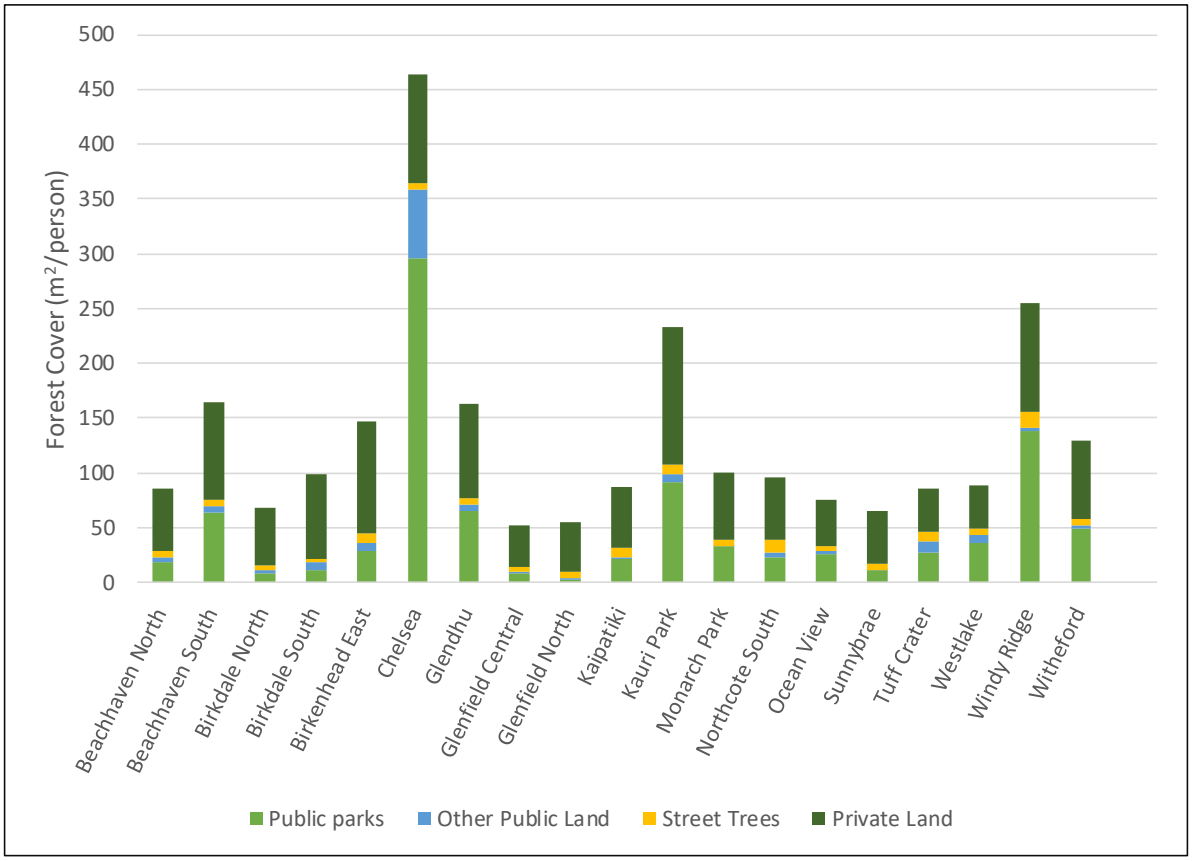


Figure 17: Urban forest cover per head by land tenure, per area unit within Kaipātiki. Unit areas with population density less than 1000 people/km^2 are not shown.

Probably the most important data to examine is the proportion of urban forest cover by land tenure, per child (under 15 years) (**Figure 18,** below), particularly in regards to the amount of street trees and urban forest in public parks and other public land.

Forest cover per child (under 15 years) varies widely between the different census area units in Kaipātiki (**Figure 18,** below) and follows a similar pattern to forest cover per person (**Figure 17,** above). Chelsea has a very high forest cover per child (over 2700 m^2) and Windy Ridge and Kauri Park have a fairly high forest cover per child (over 1000 m^2). However, eight census area units have less than 500 m^2 forest cover per child, including Birkdale South, Kaipātiki, Ocean View, Sunnybrae, Beachhaven North, and particularly Birkdale North, Glenfield Central and Glenfield North.

In most areas, more than half the urban forest (per child) is on private land. The only areas that have a larger proportion of urban forest on public land, per child, are Windy Ridge and Chelsea, with Chelsea having a particularly high amount of tree cover in parks and other public land, per child.

The areas of Kaipātiki that have a proportionally low amount of canopy cover on public land, per child, are: Glenfield North, Glenfield Central, Sunnybrae, Birkdale North, Birkdale South and Beachhaven North. These census area units also have a low forest cover per child overall. (**Figure 18,** above). Most areas have a low proportion of street trees per child, except for Northcote South, and Windy Ridge.

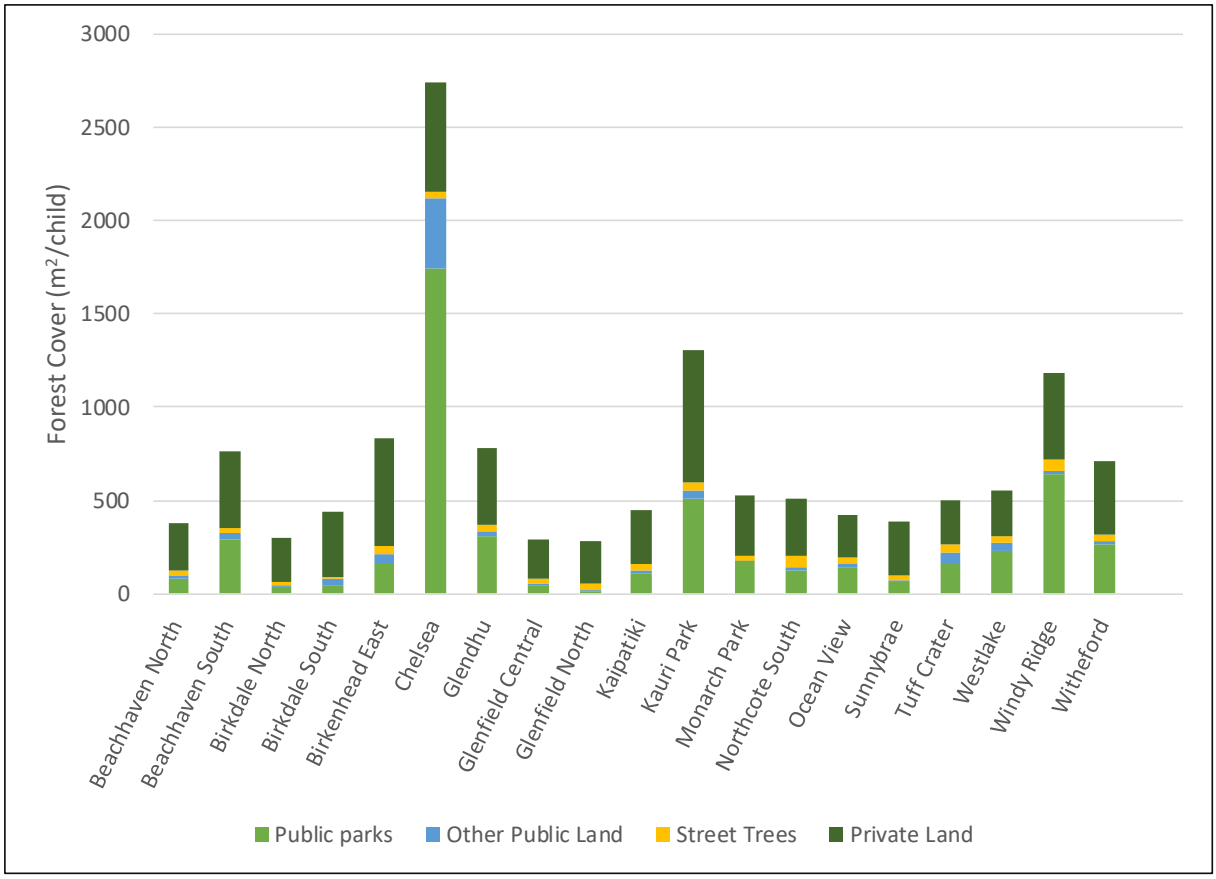


Figure 18: Urban forest cover per child by land tenure, per area unit within Kaipātiki. Unit areas with population density less than 1000 people/km^2 are not shown.

5.6.2 Shade Analysis

The aim of the shade analysis is to show where there are opportunities for improvements in tree cover in local parks, to benefit the well-being of the local and wider community. It is based on visual estimates of high-resolution aerial imagery. More information on the methodology for The Parks and Open Space Shade Analysis Study is presented in **Appendix 1**.

Public parks account for approximately 6% of the Kaipātiki Local Board area. There are 147 parks in Kaipātiki, with 144 being regularly maintained by Council contractors, including all 44 playgrounds that are within parks. Parks play a vital role in the community by providing a range of recreational opportunities and opportunities to connect with nature. There are many magnificent trees in parks in Kaipātiki (Wilcox 2012) - a description is provided in **Appendix 2**.

There was only one park (Taurus Crescent Reserve) that had no trees present. Unfortunately, this park also had a playground that totally lacks shade. The lack of shade in this particular park is not the only concern. Currently there is no opportunity for park users to interact with trees whilst in the park. Of the 44 playgrounds located in parks within the Kaipātiki Local Board area, eight playgrounds do not have some form of shade provided by trees. Note that seven of these parks have trees but they are not planted where they provide shade for the playground. This could be improved by increased specimen tree planting closer to playgrounds and/or planting species that will develop a wider crown canopy area at maturity.

The shade analysis assessment found that of the 44 playgrounds, half (50%) had negligible or no shade provided by trees (**Figure 19**, below). Eleven (25%) have a moderate amount of canopy cover (i.e., 21 to 50% tree cover) and only 25% have a high canopy cover (i.e., 51 to 100% cover).

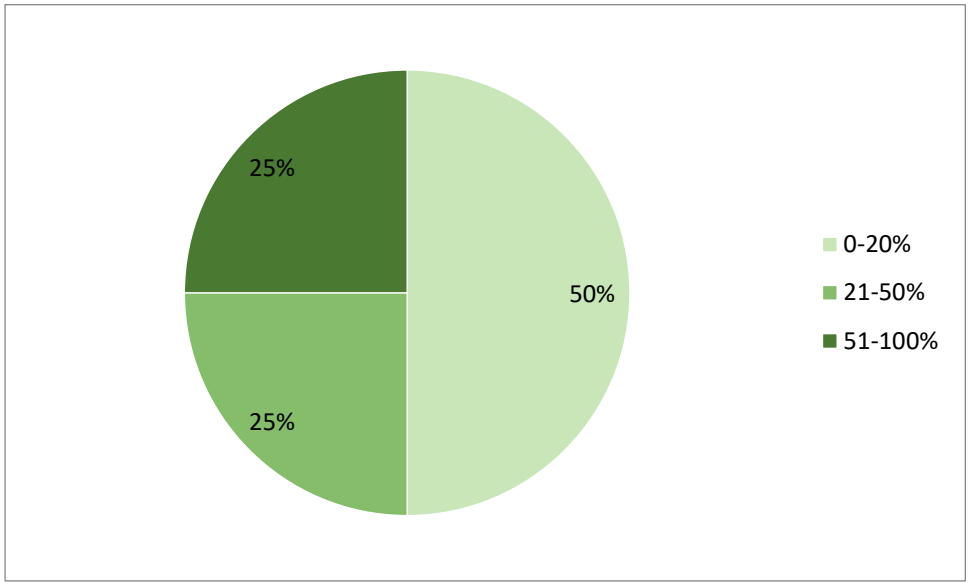


Figure 19: Canopy cover of parks with playgrounds in Kaipātiki

An idea of the type of tree species that are likely to grow well in Kaipātiki parks, and provide good shade and amenity values, can be deduced from the description of trees in public parks provided in **Appendix 2**, which includes information about the parks with playgrounds.

6.0 DISCUSSION

6.1 Benefits of Urban Forest

A healthy urban ngahere provides a multitude of benefits including: a greater resilience to extreme weather events, improved water quality, improved air quality, increased biodiversity values, increased landscape values; and benefits to human well-being due to increased shade and temperature moderation, counteracting the 'heat island' effect, and physical and mental health benefits associated with time spent in nature.

Areas of remnant forest, as well as planted trees in Kaipātiki, are highly important for ecosystems services related to the hydrological cycle and water quality. Green infrastructure in urban areas helps restore natural environmental services related to the hydrological cycle, such as flood alleviation and improvement and ongoing protection of water quality. Green infrastructure is effective, economical, and has many other benefits that enhance quality of life in urban areas (Forest Research 2010; Auckland Council 2019).

6.2 Urban Forest Cover 2013 Overview

Canopy cover in Kaipātiki was 30% in 2013, which was the highest tree cover for all urban boards in Auckland, and considerably higher than the 18% overall cover for Auckland.

Auckland has a moderately low level of tree cover compared with similar cities internationally. Brisbane's canopy cover is currently 44% (Brisbane City Council 2019). Melbourne's canopy cover was 23% in 2012 with plans to significantly increase this figure (City of Melbourne 2012). In 2013, the City of Sydney published strategic plans to increase its average total canopy cover from 16% (2013) to 23% by 2030, and then to 27% by 2050, through targeted programmes (City of Sydney 2013). Sydney's total canopy cover is now 18.1% (Karen Sweeney, Urban Forest Manager, pers comm.)

The aim of Auckland's Urban Ngahere (Forest) Strategy is to increase average canopy cover from 18 to 30% (Auckland Council 2019).

In spite of a relatively high canopy cover in Kaipātiki, there are obvious 'gaps' in tree cover in the Local Board area. The southern suburb areas have a moderate to high level of tree cover, whereas the northern and central suburb areas generally have a low level of tree cover. Also, much of the urban tree cover in Kaipātiki is on private land and a high proportion is of low stature.

As described in the Introduction, many of the benefits attributed to urban forest are disproportionally provided by larger trees. Although Kaipātiki has good tree cover overall, most of these trees are in the lower size classes. These larger trees should be a priority for protection, to ensure they are not removed prior to younger trees being able to grow tall enough to replace them.

The relatively high proportion of smaller trees across the local board indicates either a relatively recent surge of tree planting (assuming the smaller stature trees correspond to younger trees), or a large proportion of shrubs with a limited mature height. Further analysis of more recent LiDAR data, in comparison to the 2013 data covered in this report, may highlight which trend is occurring, i.e., young trees versus shrubs of low stature. However, the portion of shorter trees may increase in future data

sets due to restoration planting efforts, even if there is no loss of the total area of urban forest in taller height categories.

It is also important to ensure that at least some of the future urban forest plantings are prioritised in locations that can provide for the growth of large trees; i.e., sites where they do not conflict with future buildings and other infrastructure. In Kaipātiki, a large proportion (63%) of public land has tree cover, which is the highest percentage of any urban local board. However, all but three census area units have over half of their urban forest on private land, with the main exception being Chelsea. This has important implications, as trees on public land are much more accessible to the public and are more likely to be protected.

Parts of Kaipātiki that have proportionally a very low canopy cover on public land (public parks and, e.g., school grounds), are Birkdale South, Birkdale North, Glenfield Central, and Sunnybrae.

The importance of monitoring the changes in urban forest and the effectiveness of policy interventions, particularly tree protection rules, has been demonstrated in an assessment undertaken by Marie Brown (Environmental Defence Society) and research scientists from Landcare Research (Brown et al. 2015). Their analyses showed that rules to protect trees can be effective at slowing down vegetation loss and increasing desirable native vegetation during urban expansion and intensification, while allowing significant urban development to proceed. Without tree protection rules, it would be difficult to maintain a healthy and high-quality urban environment (Brown et al. 2015).

A relatively high proportion (61%) urban forest in Kaipātiki has some form of protection, which is a higher proportion compared with most other local board areas, and higher than the overall figure for Auckland's ngahere, where only 50% of tree cover has some form of protection. And most of the protected trees have a high protection status, i.e., Significant Ecological Areas (SEAs) or Notable Trees. Notable Trees in Kaipātiki include a diverse range of native and exotic species, which are scattered throughout much of Kaipātiki, but are in greatest concentration in Northcote Point.

There are about 60 native bush reserves in Kaipātiki, which are protected as SEAs - most are located in southern and central Kaipātiki and in Bayview in the north-west. Indeed, Kaipātiki has some of the largest areas of continuous urban native vegetation remaining in Auckland's ecological region, forming part of the North-West Wildlink, i.e., it has an important role in the ecological corridor between the Waitakere Ranges and Hauraki Gulf Islands.

However, there are areas in Kaipātiki where most of the trees have little or no protection, particularly Glenfield North and Glenfield South.

6.3 Urban Forest in Relation to Demographic and Socioeconomic Factors

Demographic and socio-economic factors related to urban forest have been investigated on a broad scale in this study, with comparisons based on urban cover, land tenure and population, population density, number of children, and shade analysis in regards to playgrounds. The overarching aim has been to determine whether the urban forest is located where it has the greatest benefit.

To achieve the greatest benefit from the existing urban forest for people, it would be preferable to have higher levels of urban forest in areas with greater population density. However this study showed

a general decrease in forest cover with increased population. This is probably due to one or more of the following factors: (i) urban forest being cleared in the past for development as population density increased; or (ii) newer suburbs where less urban forest has been incorporated in the development, or (iii) many of the trees are small as they are new plantings in new suburbs, i.e., less than the minimum 3 m height used in this study.

The results based on the 2013 LiDAR data showed that Kaipātiki ranked fairly high with 125 m^2 tree cover per person - third behind Upper Harbour and Hibiscus and Bays Local Board areas. However, forest cover per person varies widely in different areas of Kaipātiki. Chelsea has a very high forest cover (over 450 m^2) per person. However, 12 census area units have less than/or equal to 100 m^2 forest cover per person with the following areas having particularly low cover per person: Birkdale North, Glenfield Central and Glenfield North.

In most suburb areas, more than half of the urban forest (per person) is on private land. Compared with public land, trees on private land are less likely to be protected and are less accessible to the general public. The only areas that have a larger proportion of urban forest on public land, per head of population, are Windy Ridge and particularly Chelsea.

Chelsea has a very high forest cover per child (over 2700 m^2) and Windy Ridge and Kauri Park have a fairly high forest cover per child (over 1000 m^2). However, eight census area units have less than 500 m^2 forest cover per child. Probably the most important data to examine is the proportion of urban forest cover by land tenure, per child (under 15 years). The areas of Kaipātiki that have a proportionally low amount of canopy cover on public land, per child, are: Glenfield North, Glenfield Central, Sunnybrae, Birkdale North, Birkdale South and Beachhaven North. These area also have a low forest cover per child overall.

6.4 Change in Urban Forest Cover 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 Kaipātiki Local Board area. One of the most pressing issues relating to urban forest in Auckland, and the most important unknown, is the rate of change in the urban forest canopy. Questions include:

- How has the total area of urban forest in the board area changed following the removal of general tree protection?
- 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?
- 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?

In order to assess change in the urban canopy cover, the 2013 LiDAR is being compared against the more recent 2016-17 aerial LiDAR survey. The outputs of this comparative analysis is expected to be available by the end of September. The time period between these two LiDAR surveys (i.e., between 2013 and 2016/17) is likely to give insight into whether there have been noticeable changes to the extent of tree cover on public and private land.

The analysis will also be further distilled to a local board scale and an update on the result of this work will be provided to the board as the information becomes available. An addendum and comparative chapter will be added to the report once this work is completed. It is a complex and very technical piece of work which councils' specialists need to ensure is correct before public release.

There have been media reports on losses of large trees in Auckland due to urban intensification, and the changes resulting from the RMA reform and the new Unitary Plan taking effect. The update on tree canopy coverage and the change detection work is likely to reignite this debate. It is hope that the scientific approach that has been taken to this work will help to provide valuable information on the rate of change and how this may impact the region in the longer term.

6.5 Examination of Zoning and Development Potential

Combining the urban forest layer with other spatial datasets (for example Auckland 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 unprotected 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.

A more sophisticated approach to this type of analysis is also possible, by combining 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 Kaipātiki Local Board area.

6.6 Priority Areas for Future Urban Forest Improvement Work in Kaipātiki

The next step for the Kaipātiki Local Board is to identify priority areas for the urban ngahere work programme. This needs to be considered within the context of current and proposed future land use, local planning requirements, and the local environmental, demographic and socioeconomic issues. Kaipātiki has excellent tree cover overall, compared with Auckland's other local board areas. However, there are parts of Kaipātiki where there is less than ideal forest cover, and a high proportion of the tree cover is in the smaller size classes.

As well as focussed efforts for maintaining and improving tree cover where it is currently low; focus could also be placed where there are:

- greater population densities (current and anticipated), referencing the Auckland Plans future area zoning and the expectation of future growth (Auckland Council 2018a);
- higher numbers of children, with particular emphasis on tree planting to provide shade in playgrounds, and in road parcels where children walk to school;

- areas with a low number of large trees – the existing large trees should be a priority for protection;
- areas that are flood prone or predicted to be impacted by sea level rise;
- environmental values, including water quality, that are currently (or could potentially be) compromised by urban development;
- opportunities to improve ecological corridors, where biodiversity values would be enhanced; and aesthetic landscape and recreational values that would be enriched and improved by plantings.

Strong synergies and mutual benefits could be realised through a coordinated approach in overarching strategic planning at the local level. Urban ngahere strategy would benefit from coordination and integration with the following:

- Kaipātiki Connections Network Plan;
- planning for open space in new urban developments;
- the North-West Wildlink (NWW) project; and
- ecological restoration and tree planting initiatives undertaken by iwi and community groups.

There are potentially multiple benefits to be gained from investment in tree plantings and ecosystem restoration where the Connections Network Plan currently runs through areas with little or no vegetation cover. These benefits include: improvement of amenity values, improved safety and a better experience for pedestrians and cyclists, encouragement of environmentally-friendly and healthy alternative transport options, health benefits from time spent in nature, and improved green infrastructure and environmental outcomes, including increased biodiversity values through habitat restoration and provision of ecological corridors.

Large areas of natural vegetation in Kaipātiki form part of the North-West Wildlink. These natural areas are an extraordinary natural asset that is important not only for biodiversity and environmental values, but also for the well-being of local residents, and providing a drawcard for visitors. The urban ecological conservation work in Kaipātiki is an exemplar for other urban areas in New Zealand.

There is an ongoing need to engage and work with tangata whenua, local community groups, private land owners, and the private sector to try to highlight the benefits of urban ngahere and the importance of stakeholders helping to plant, grow and protect ngahere on their land as well as on public land. Kaipātiki Local Board already has an excellent relationship with community groups involved in ecological restoration work and there is an opportunity to engage with motivated stakeholders regarding urban ngahere improvement work.

Another consideration is future-proofing measures to help combat the impact of predicted sea level rise and increased frequency of intense weather events associated with climate change. These issues will be particularly important in vulnerable low-lying coastal and estuarine areas of Kaipātiki (Auckland Council 2018a).

Ongoing restoration of wetlands and tree planting efforts could be designed to boost green infrastructure, helping to restore the natural hydrological cycle and mitigate some of the negative impacts of climate change. In addition to this, high amounts of impervious (hard) surface areas in the North Shore have been linked with water quality issues; therefore, increased green infrastructure would also help improve water quality. Green infrastructure is effective, economical, and has many other benefits that enhance quality of life in urban areas (Auckland Council 2019).

Kaipātiki is an area that is attractive to young families. There are higher proportions of children under 5-years-old, compared with the Auckland average. So shade in playgrounds is important. Analysis of playground data suggests there is a need within the Kaipātiki Local Board area to provide more tree cover around playgrounds where benefits such as providing shade will make the playgrounds more attractive for families to bring their children. Low forest cover or a total lack of trees in parks and playgrounds means there is little or no shade. This has implications for the health and wellbeing of residents and is particularly critical for children due the higher risk of sun damage resulting in skin cancers later in life. The amount of shade provided could be improved by increased specimen tree planting closer to playgrounds and in parks, and by planting species that will develop a wider crown canopy area at maturity.

Low street tree numbers are a common theme in a number of areas across the local board area, opportunities exist to plant new trees in the road corridor to provide benefits to local communities and to help with the continued work that is necessary to improve and retain the overall tree canopy coverage across the local board area.

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APPENDIX 1: Parks and Open Space Shade Analysis Study

A desktop analysis of high-resolution aerial imagery was undertaken to understand tree canopy cover, the number of trees in community parks and whether shade was provided to playgrounds in each park. The work was completed to show where opportunities exist for improvements to the numbers of trees in local parks that can provide future health benefits for individuals, groups and the wider community. New tree plantings can provide long-term shade benefits. Obviously, a larger park has the potential to have more trees, but it may not have a high canopy cover percentage compared to a small park with one large tree offering high percentage of canopy cover.

Methodology

Using digital photo interpretation of aerial imagery, the factors recorded were:

- Park selection and type of park maintained or unmaintained
- Size of park
- Number of trees present
- Percentage of canopy cover
- Playgrounds or sports field presence
- Amount of shade provided to the playground if present

Park selection and Type of Park

All parks in the specified local board were assessed. Parks were identified using the Auckland Council GeoMaps Geospatial Information System (GIS), which records whether the park is maintained or unmaintained. Unmaintained parks are defined as parks owned by council but are not maintained under the current full facility maintenance contracts. Most of the unmaintained parks are stormwater ponds or narrow esplanade strips in areas that are not easily accessible or unpopular areas with little to no infrastructure. All parks that are owned by council are recorded in Auckland Council GIS data.

Size of Park

The Auckland Council GIS system provided the area of each park in square metres (m2) this was recorded to calculate the total percentage of land in the local board that is occupied by park space. Parks size and typologies ranged from; community parks to regional parks, sports parks and cemeteries.

Number of Trees Present and Percentage of Canopy Cover

Digital photo interpretation through visual estimates of high-resolution aerial imagery was used to estimate the number of trees and the percentage of canopy cover. If there were less than 20 trees an accurate figure could be made, and the number recorded, anything higher was an approximation. Visual estimations of the percentage of canopy cover extent versus land areas were made (**Figure 18**, below). For consistency and validity, the same person carried out all estimation of number of trees and the percentage of canopy cover. For the tree to be counted in the approximation, the majority of the tree needed to be within the park boundary.

Playgrounds or Sports Field and Shade

Recording the presence of a playground and sports field presence utilized GIS aerial imagery and infrastructure layers.

Amount of Shade Provided if Present

Visual Estimation of the amount of Shade on playgrounds provided by trees was recorded as three different categories; 'trees provide some shade to the playground', 'trees provide a little shade to the playground' and 'trees provide no shade to the playground'.

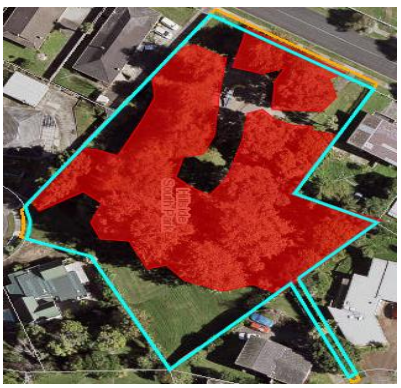
Figure 18: The visual estimation of tree cover is shown in the aerial photos below. The blue line is the park boundary and the red areas are the digitised areas of tree canopy extent.

5% Canopy Cover
Redcastle Park (Howick)

10% Canopy Cover
Mcleod Park (Henderson-Massey)

20% Canopy Cover
Jamie Hansen Park (Hibiscus & Bays)

40% Canopy Cover
Potters Park (Albert-Eden)



More than 60% Canopy Cover
Hillside Park South (Otahuhu-Papatoetoe)

APPENDIX 2: Urban trees in Kaipātiki Parks

The following information is adapted from Dr Mike Wilcox's book: *Auckland's Remarkable Urban Forest* (Wilcox 2012, pages 121 - 126). The information has been reproduced with permission from the author. Most of the trees in Kaipātiki parks are exotic amenity trees, but there are also planted and naturally occurring native trees.

Note that much of the urban forest in Kaipātiki is in numerous native bush reserves, which are described in section 5.5.1 of this report.

Agincourt Reserve, Glenfield, 0.8 ha
The reserve has a kindergarten. The dominant trees are sweet gum and pin oak.

Camelot Reserve, Glenfield, 1.0 ha
In this pleasant neighbourhood park there is a children's playground. The main trees of interest are two splendid groups of pin oaks, numerous pohutukawa and a line of kowhai.

Diana Reserve, Glenfield, 0.7 ha
The reserve is a pleasant open green with a few perimeter trees, including black alder, sweet gum, narrow leaved ash, silky oak, pohutukawa, hybrid black poplar and Japanese hill cherry. On the margin is an attractive specimen of *Araucaria biramulata*, which is a native conifer of New Caledonia.

Downing Street Reserve, Glenfield, 1.1 ha
This reserve is close to the main Glenfield Westfield shopping centre. Trees commonly planted here are jacaranda and manuka.

Elliott Reserve, Bayview, 1.5 ha
As well as accommodating the Glenfield Tennis Club, this lovely reserve has a children's playground and the usual perimeter of trees. Prominent are Arizona cypress, crimson bottlebrush, coast banksia, camphor laurel, monkey apple, Norfolk Island hibiscus, pohutukawa, red maple, river sheoak, silky oak and Taiwan cherry.

Glenfield Domain and Hall, Glenfield, 0.2 ha
The Glenfield Hall and Girl Guides centre are housed in this small park. The most significant trees are several specimens of mottled gum - a rarity in Auckland. There are numerous pohutukawa.

Greenslade Reserve, Northcote, 1.4 ha
The reserve comprises a rugby field, impressively ringed by pin oaks.

Greenvalley Reserve, Glenfield, 0.2 ha
Part of this reserve has been planted with Australian species. There are groves of coast banksia and bracelet honey myrtle. There is also hybrid between pohutukawa and rata.

Health Reserve, Northcote, 2.4 ha

Adjoining Tuff Crater, the reserve comprises open grassed areas with planted trees. Notable ones are a group of four impressive paperbarks and a group of five green ash.

Hilders Park, Beach Haven, 0.4 ha
The main attraction of this seaside park is its position on the point at Beach Haven, overlooking the Waitemata Harbour to Hobsonville. Pohutukawa and some large Monterey pines are the dominant trees, and there are also Norfolk Island pine, river sheoak, Monterey cypress and a grove of kanuka. Coastal shrubs such as karo, karaka and wharangi grow beneath the pohutukawa trees, but there are some naturalised shrubs too, mainly Japanese spindle tree and *Roldana petasitis*. There are step-ways to the shore and a lookout platform.

Hinemoa Park, Birkenhead, 2.2 ha
Located near Birkenhead Wharf, this is one of the most remarkable parks in Auckland. A seaside section features historic boat lockers, a band rotunda and numerous large, multi-trunked pohutukawa. Lining the road are large Norfolk Island pines and Canary Island date palms.

Above the road is a pohutukawa forest, partly natural and partly planted. There is a diverse mixture of other trees in this dense forest, including kauri, rimu, totara, miro, tawa, kanuka, kowhai, karaka and puriri. The understory is extraordinary, with a diversity of native pigeonwood, hangehange, mahoe, houpara, *Coprosma rhamnoides*, and several colonies of kiekie. Naturalised exotics, however, dominate the understory, prominent species being elaeagnus, bangaglow palm, windmill palm, wild ginger and Japanese spindle tree.

Holyoake Place Reserve, Chatswood, 0.1 ha
This tiny reserve contains eight large specimens of Algerian oak.

Inwards Reserve, Birkdale, 2.3 ha
The reserve has a children's playground and an open grassed area with a few planted trees, namely river sheoak and Cook pine. There is also a wildwood comprising a mixture of exotic species, dominated by black wattle, tree privet and monkey apple, with natural admixture of native species, the most common being mahoe, mapou and silver tree fern. There is a sprinkling of kahikatea and tanekaha. Monkey apple is starting to form a significant grove within the native bush.

Jacaranda Avenue Reserve, Beach Haven, 0.1 ha
This s a small roadside reserve the main feature being a large specimen of Camden wollybutt.

Kaipātiki Park, Glenfield, 5.3 ha
The park comprises a series of rugby fields surrounded by attractive borders of trees. There is also a children's playground. An impressive belt of river sheoak lies along the boundary with Glenfield College. The main trees elsewhere are Mexican weeping pine, camphor laurel, narrow-leaved black peppermint and numerous pin oaks.

Lenihan Reserve, Northcote, 0.3 ha
This attractive neighbourhood reserve features an impressive group of five large pedunculate oaks.

Locket Reserve, Wairau Valley, 1.2 ha
The reserve has few trees, the only big ones being some Victorian blue gums. There have been plantings of about 20 hybrid black poplar.

McFetridge Park, Glenfield, 5.8 ha
The headquarters of the Glenfield Rovers Football Club, most of the park is soccer fields. Trees of interest are paulownia and a grove of hybrid poplars under-planted with seven specimens of Queensland kauri.

Manuka Reserve, Bayview, 5.6 ha
Although primarily a coastal esplanade bush reserve, bordering Hellyers Creek, it also has a children's playground, boat ramp and a wonderful view out across Hellyers Creek to the escarpment forest across the water. The walkway through the Kaipātiki Esplanade Reserve starts/ends here.

Marlborough Park, Glenfield, 5.1 ha
The park comprises a sports ground, skateboard area and playground with numerous mature trees. There is a magnificent group of Shamel ash, fine specimens of flooded gum and many pin oaks and swamp cypress.

Monarch Park, Hillcrest, 2.5 ha
As well as a children's playground and walkways, the park features an extensive native revegetation zone, including wetlands in conjunction with a stormwater control system. There are also vestiges of original native bush (mainly kahikatea and mahoe). Crack willow grows along the creek.

Normanton Reserve, Glenfield, 2.4 ha
A very nicely landscaped reserve in an industrial area of the North Shore. There is a children's playground. The dominant trees are sweet gum and river sheoak.

Northcote Town Centre, Northcote, 1.5 ha
The shopping and social centre of Northcote features shops, parking areas, library, and other community facilities. It is very popular with the Chinese and Korean communities. There are numerous trees, among which Chinese windmill palm is the most abundant. Tipu, olive and titoki are other feature trees.

The most prominent individual tree is a large weeping or horizontal wych elm, providing pleasant shade in the shopping precinct of Pearn Place, and a gathering place for playing Chinese chequers and draughts. Adjoining public parks are Cadness Reserve (0.4 ha), which has a children's playground, and Greenslade Reserve (1.4 ha), which is a sportsfield with a perimeter of trees.

Onepoto Basin (Onepoto Domain), Northcote, 23.2 ha
One of the largest parks and one of six extinct volcanoes on the North Shore, the domain features a man-made lake, playgrounds, fields, wetlands, walkways and numerous planted trees. A grove of forest red gums is noteworthy.

Oruamo Reserve, Glenfield, 1.0 ha

Oruamo Reserve was earlier known as Horton's Hill. The tree plantings on this exposed hill are comparatively recent, and they are stunted and struggling. The dominant species are Norfolk Island pine and pohutukawa.

Rewi Alley Reserve, Totara Vale, 4.5 ha
This large park has poor soil and is wet in winter. It contains the Trias Road Stormwater Quality Pond for filtering and purifying stormwater. There are native shrubberies and also numerous trees scattered about, the best-grown being Chinese white poplar and Yunnan poplar. The park honours Rewi Alley, a New Zealander who spent much of his life in China, helping to set up technical training schools.

Shepherds Park, Beach Haven, 14.2 ha
Shepherds Park is Beach Haven's sportsfield complex. It is a large, spacious park hosting bowls and tennis as well as field sports, a children's playground, a fitness trail and a splendid perimeter cycleway/walkway. Coastal tracks and boardwalks lead down to or give views of Oruamo or Hellyers Creek. The Friends of Shepherds Park have done great work planting native trees on the coastal margins, attending to tracks and constructing a fale-style shelter.

The plantings include a number of areas of natural kanuka, with mapou, coastal karamu, mingimingi, prickly mingimingi and akepiro in the understory, and there is one large rimu. The outstanding exotic trees in this park are the large flooded gums growing near the Bowling Club. They are unpopular with the bowlers, as branches sometimes break off and land on the greens. There are younger ones planted in the children's playground. Old Monterey pines and, less commonly, maritime pine are also a feature, and there is some black wattle bushland, and plantings of monkey apple, rive sheoak, pohutukawa and pin oak.

Spinelle Reserve, Bayview, 0.3 ha
Six well-grown claret ash are the only prominent trees in this playground reserve, but there is a pleasant walkway through the bush behind (Bonito Reserve), at the start of which are some huge black wattles.

Stafford Park, Birkenhead, 3.3 ha
In this attractive park, which has a sportsfield, the dominant trees are pohutukawa, sweet gum and swamp cypress.

Target Reserve, Totara Vale, 0.6 ha
The park has rather a meagre collection of trees the most noteworthy being a big, spreading Monterey pine and a specimen of knife-leaf wattle.

Teviot Reserve, Totara Vale, 0.6 ha
This is a pleasant neighbourhood reserve with a children's playground. There are good specimens of pin oak, pedunculate oak and Shamel ash.

Totaravale Reserve, Totara Vale, 0.9 ha

This reserve has a playground, including a flying fox. The main trees are a belt of river sheoak with some silky oaks bordering the motorway and several pin oaks.

Tui Park, Beach Haven, 2.1 ha

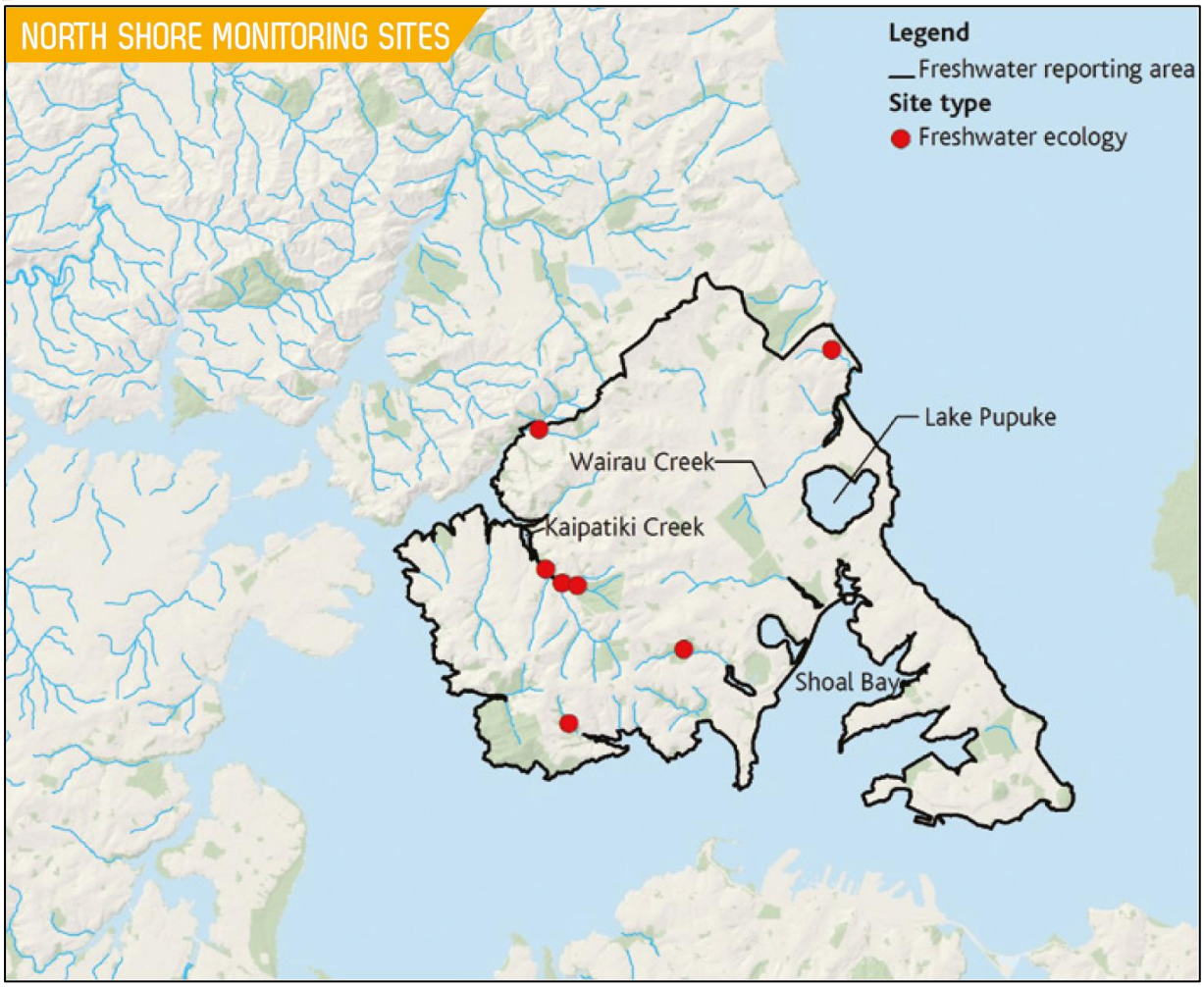
Part of this park has a fine children's playground and a public barbecue. An open-grassed area is surrounded by some big Monterey cypress, Monterey pine, pohutukawa and puriri. The coastal fringe, adjoining Hellyers Creek, comprises an attractive natural kanuka forest with an understory of mapou, and *Coprosma rhamnoides*, with some emergent Monterey pine. Adjoining this is a planted native shrubbery comprising taupata, kowhai, pohutukawa, puriri, akeake, karo, kanuka, karaka and native broom (*Carmichaelia australis*).

Windy Ridge Reserve, Glenfield, 0.3 ha

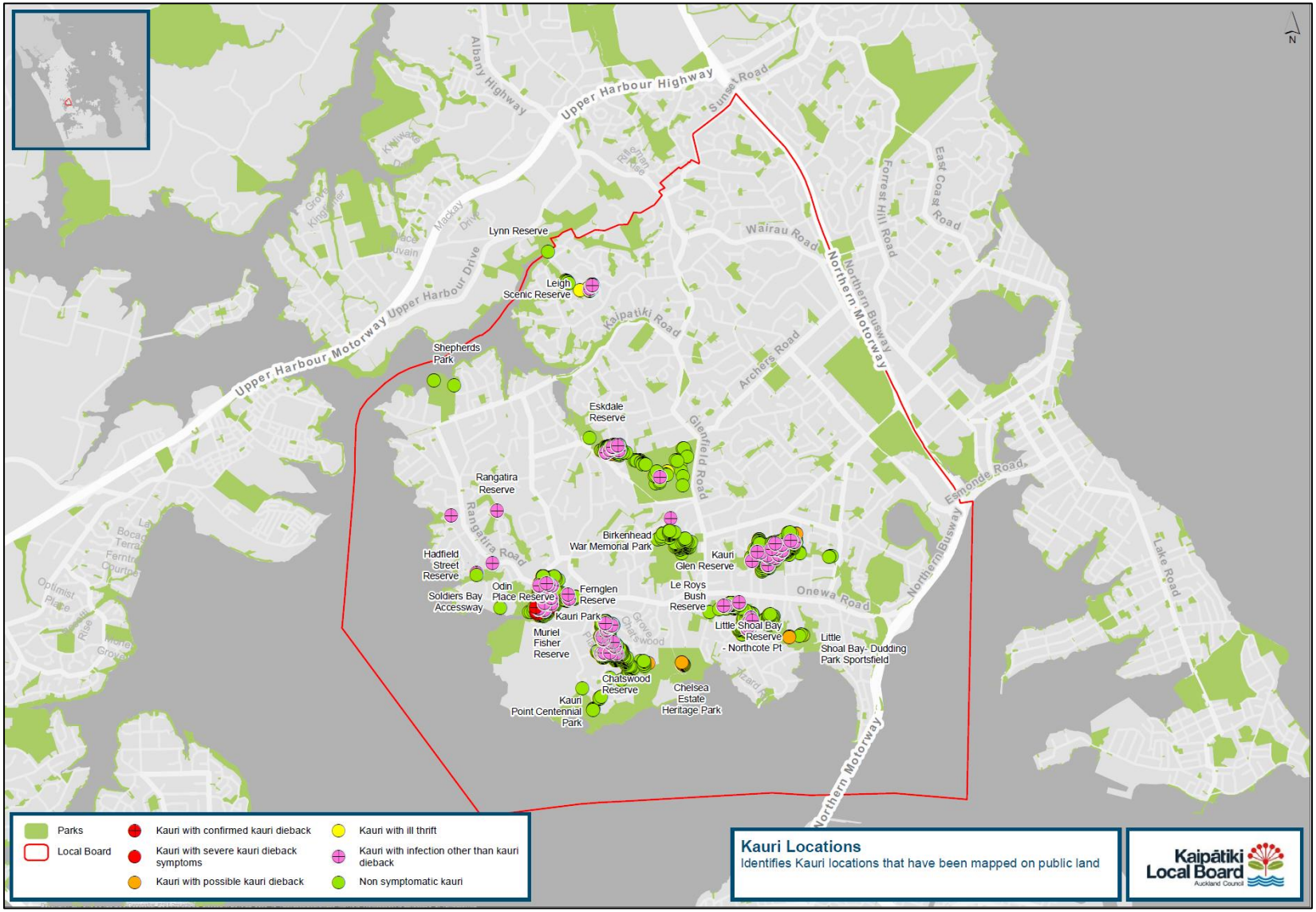
This very small reserve has a children's playground and just a few trees, the most common being sweet gum.

APPENDIX 3: North Shore monitoring sites for State of Auckland Freshwater Report Card

Area Grade C. Note that the North Shore reporting area includes Devonport-Takapuna and Kaipātiki Local Board areas. The land cover is mainly urban (86%) with small pockets of native vegetation. Poor water quality has been linked to the very high impervious surface area (hard surfaces) of 52%, compared with the regional average of 9% (Auckland 2016c).



APPENDIX 4: Location of kauri on public land in Kaipātiki, including trees with kauri dieback



APPENDIX 5: Key urban forest parameters for Auckland suburbs based on 2013 LiDAR data, Kaipātiki suburbs highlighted

Note that the categories for percent cover are:

- Bare cover: 1 – 10%
- Low cover: 10 – 15%
- Moderate cover: 15 – 20%
- Good cover: 20 – 30%
- Forested suburb: greater than 30%

Suburb name	Suburb group	Total land area	Total urban forest canopy area	% urban forest cover	% urban forest 'other public land'	% urban forest 'park-land'	% urban forest 'private'	% urban forest 'road'	% urban forest protected
Albany	Moderate	717.7	132.9	19	21	51	24	5	77
Arkles Bay	Good	67.1	18.7	28	0	13	78	8	46
Army Bay	Good	664	134.7	20	0	90	9	1	96
Auckland Central	Low	394.2	39.7	10	18	28	12	42	70
Avondale	Low	766.9	96.6	13	12	13	63	13	31
Bayswater	Moderate	107.1	15.9	15	12	19	59	10	39
Bayview	Forest	249.6	104.2	42	3	37	55	4	69
Beach Haven	Forest	367.6	124.6	34	4	32	58	5	55
Belmont	Low	131.5	18.6	14	20	10	60	9	27
Birkdale	Good	283	75.3	27	6	11	79	5	43
Birkenhead	Forest	469.1	221.1	47	8	40	48	5	71
Blockhouse Bay	Good	428.5	94.9	22	4	36	49	11	53
Botany Downs	Low	173.9	21.9	13	1	21	67	11	33
Browns Bay	Good	351.2	71.1	20	1	11	79	10	24
Bucklands Beach	Low	330.8	49.9	15	3	36	55	7	44
Burswood	Bare	90.7	4.4	5	0	33	60	7	50
Campbells Bay	Forest	173.7	63.5	37	1	56	39	4	66
Castor Bay	Good	146.7	35.2	24	3	8	78	10	28
Chatswood	Forest	289.8	159.8	55	8	70	21	1	84

Clendon Park	Bare	220.3	17.3	8	15	28	44	13	40
Clover Park	Low	248.4	23.6	10	8	23	45	24	40
Cockle Bay	Good	227.1	54.4	24	2	10	83	5	29
Conifer Grove	Moderate	168.2	25.6	15	3	14	52	30	42
Devonport	Moderate	242.6	46.3	19	1	25	60	13	44
East Tamaki	Bare	1048.1	46.8	4	9	24	56	10	52
Eastern Beach	Moderate	94.5	14.3	15	2	63	30	5	70
Eden Terrace	Low	67.2	9.4	14	4	23	33	39	40
Ellerslie	Low	312.4	41	13	7	7	72	13	18
Epsom	Good	681.3	155.7	23	7	11	64	17	35
Fairview Heights	Good	133.2	30.2	23	6	7	79	8	56
Farm Cove	Low	95.6	10.7	11	7	15	65	14	28
Favona	Bare	254.3	20.8	8	14	14	64	8	27
Forrest Hill	Moderate	287.4	42.8	15	3	10	76	12	20
Freemans Bay	Good	88.1	25	28	19	19	35	27	47
Glen Eden	Good	876.3	213.3	24	6	27	63	4	49
Glen Innes	Low	243.4	30.2	12	30	29	32	9	38
Glendene	Low	257	34.4	13	4	24	65	7	35
Glendowie	Moderate	369.9	69.5	19	4	24	58	14	48
Glenfield	Good	514.8	128.3	25	3	21	68	8	42
Golflands	Low	159.3	17	11	6	7	82	5	18
Goodwood Heights	Low	154.1	21.8	14	2	27	60	11	48
Grafton	Moderate	104.2	20.2	19	30	19	22	29	33
Green Bay	Forest	214.6	71.1	33	3	16	76	6	64
Greenhithe	Forest	795.2	334.6	42	2	22	69	6	71
Greenlane	Good	253.5	49.7	20	4	33	47	16	48
Grey Lynn	Moderate	305.5	55.7	18	4	16	56	24	38
Gulf Harbour	Moderate	439.6	66.6	15	2	17	77	4	59
Half Moon Bay	Low	276.6	30	11	3	26	59	12	40
Hauraki	Moderate	137.3	24.9	18	15	9	67	10	28

Henderson	Moderate	1726.1	252.2	15	9	19	66	6	45
Herald Island	Good	35.7	8.7	24	0	18	68	13	42
Herne Bay	Good	105.8	24.9	24	5	7	72	16	35
Highland Park	Low	112.3	10.9	10	1	31	58	10	42
Hillcrest	Good	313.6	63.9	20	2	12	78	9	37
Hillsborough	Forest	339.6	115.3	34	6	44	42	8	56
Howick	Moderate	315.8	49.3	16	4	7	81	7	19
Huntington Park	Bare	29.3	1.6	5	2	30	48	20	54
Kelston	Low	167.3	20.4	12	18	17	58	7	30
Kingsland	Moderate	62.3	11.3	18	6	16	62	17	30
Kohimarama	Good	157.2	31.6	20	12	19	60	9	42
Long Bay	Good	514.7	103.8	20	3	25	71	2	64
Lynfield	Forest	149.3	49.6	33	1	64	32	3	70
Mairangi Bay	Moderate	173	31.9	18	2	6	80	12	19
Mangere	Bare	2551.7	200	8	16	33	44	8	58
Mangere Bridge	Low	696.1	74.8	11	23	20	47	10	49
Mangere East	Low	619.2	60.8	10	18	19	51	13	31
Manly	Moderate	219.5	34.9	16	1	18	69	12	38
Manukau	Bare	305.2	20.5	7	37	17	33	13	29
Manurewa	Low	1134.4	151.7	13	10	15	67	8	29
Manurewa East	Low	84.2	9	11	12	4	78	6	10
Maraetai	Good	686.7	184.1	27	0	16	80	4	62
Massey	Good	1772.9	419.9	24	4	11	80	4	44
Matakatia	Forest	119.5	36.3	30	2	7	85	6	56
Meadowbank	Good	164.7	41.8	25	14	28	52	6	54
Mechanics Bay	Bare	17.8	0.2	1	100	0	0	0	0
Mellons Bay	Good	158.9	35.9	23	4	13	80	4	27
Middlemore Hospital	Good	69.4	16.4	24	21	0	79	0	33
Milford	Moderate	227.3	33.9	15	2	13	75	10	35
Mission Bay	Good	147.1	39.3	27	1	38	53	8	52

Morningside	Moderate	108	19.1	18	3	24	56	16	40
Mount Albert	Moderate	636.6	123.7	19	16	20	52	12	37
Mount Eden	Good	639.8	136.4	21	3	13	67	17	31
Mount Roskill	Moderate	1118.7	168.6	15	15	34	44	7	47
Mount Wellington	Low	1195	120	10	8	21	61	10	36
Murrays Bay	Good	153.6	38.6	25	4	29	58	9	42
Narrow Neck	Moderate	122.8	21.2	17	5	45	40	11	62
New Lynn	Low	612.1	85.1	14	7	9	75	9	31
New Windsor	Moderate	182.5	27.4	15	5	2	85	8	14
Newmarket	Bare	59.7	3	5	19	5	45	31	38
Northcote	Good	440.8	102.4	23	7	46	40	7	64
Northcote Point	Good	93.2	18.9	20	1	14	71	14	42
Northcross	Good	118.3	24.5	21	8	18	68	6	27
Northpark	Bare	138.6	8.5	6	0	7	81	12	19
One Tree Hill	Good	202.1	41.4	20	3	64	26	7	72
Onehunga	Low	708.9	77.2	11	16	11	57	16	28
Orakei	Moderate	298.5	55.1	18	6	31	48	15	59
Orewa	Low	685.4	93.2	14	7	13	69	11	39
Otahuhu	Low	637.4	62.8	10	11	17	62	10	33
Otara	Low	756.6	75	10	24	30	34	12	40
Oteha	Bare	115.1	9.3	8	1	17	63	19	38
Pahurehure	Low	129.7	17.6	14	2	19	61	17	37
Pakuranga	Low	348.2	44.1	13	10	20	57	13	34
Pakuranga Heights	Low	349.8	42.7	12	4	31	57	9	43
Panmure	Low	240.1	29.3	12	27	20	39	14	35
Papatoetoe	Low	1173.7	117.6	10	10	7	74	9	24
Parnell	Good	319.2	93.1	29	5	53	35	7	68
Penrose	Bare	537.6	36.8	7	10	38	36	16	52
Pinehill	Bare	165.6	15.2	9	6	42	45	7	48
Point Chevalier	Moderate	324.7	51.3	16	22	22	45	11	42
Point England	Low	160.4	17.8	11	31	27	26	16	43

Ponsonby	Moderate	120.6	21.4	18	8	10	63	19	37
Ranui	Low	368.2	53.1	14	8	33	51	7	46
Red Beach	Moderate	429.4	74.8	17	9	8	75	8	42
Red Hill	Good	135.8	38.2	28	11	27	53	10	55
Remuera	Good	1058.2	234.4	22	2	19	70	9	34
Rosedale	Bare	536.5	44.4	8	31	39	26	5	63
Rosehill	Low	317.4	37.9	12	11	16	67	7	33
Rothesay Bay	Moderate	97.8	16.9	17	2	4	82	13	20
Royal Oak	Moderate	146.6	22.1	15	5	23	56	17	39
Saint Johns	Low	318.4	43.6	14	17	18	54	11	41
Saint Marys Bay	Moderate	56.1	9.4	17	1	15	75	9	26
Sandringham	Moderate	256.1	41.5	16	6	12	63	20	34
Schnapper Rock	Forest	218	66	30	22	24	52	2	75
Shelly Park	Forest	107.1	32.9	31	1	25	69	5	60
Silverdale	Low	710.5	67.8	10	9	21	59	12	57
Somerville	Low	151.5	15.9	10	0	41	52	7	49
St Heliers	Good	401.6	89.5	22	2	13	71	14	39
Stanley Point	Moderate	102.5	17.7	17	14	11	66	8	25
Stanmore Bay	Good	617.2	142.5	23	19	8	66	7	55
Stonefields	Bare	95.9	1	1	2	24	64	10	81
Sunnyhills	Low	153.7	20.4	13	1	11	75	13	24
Sunnynook	Moderate	142.1	23.2	16	3	21	65	11	29
Sunnyvale	Good	155.1	31.5	20	8	19	65	8	35
Takanini	Bare	1109.6	91.1	8	3	3	87	7	15
Takapuna	Low	343.5	46.4	14	9	17	61	13	44
Te Atatu Peninsula	Low	551.7	66.1	12	6	31	54	9	41
Te Atatu South	Low	439.8	63.5	14	4	15	74	7	24
The Gardens	Good	371.6	86.7	23	0	83	13	3	84
Three Kings	Low	92.6	11.7	13	14	12	65	9	29
Tindalls Beach	Forest	110.2	39	35	0	6	90	3	70

Titirangi	Forest	1377.3	929.7	68	2	22	69	8	84
Torbay	Good	455.9	116.4	26	1	17	74	8	34
Totara Heights	Good	87.2	25	29	0	48	45	6	61
Totara Vale	Moderate	166.6	28.9	17	4	13	75	8	20
Unsworth Heights	Moderate	191.9	32.5	17	2	35	54	9	51
Wade Heads	Forest	87.4	49.5	57	0	5	86	9	75
Wai O Taiki Bay	Moderate	61.6	10.1	16	16	38	36	10	50
Waiake	Good	52.4	10.3	20	2	9	79	11	26
Wairau Valley	Bare	240.7	17.6	7	0	51	38	11	56
Waterview	Good	111.2	22.2	20	14	37	39	10	52
Wattle Downs	Low	304.4	29	10	4	25	63	9	35
West Harbour	Low	414.5	57.9	14	3	37	52	7	48
Western Springs	Good	128.3	35	27	6	90	0	3	77
Westgate	Bare	412.6	32.6	8	5	7	87	2	23
Westhaven	Good	16.1	3.5	22	0	85	0	15	76
Westmere	Moderate	133.7	24.7	18	7	20	62	11	37
Weymouth	Low	256.8	25.3	10	13	20	55	12	36
Windsor Park	Low	85.3	8.6	10	31	13	48	8	31