STREET TREE COMPOSITION, DISTRIBUTION AND URBAN RESIDENTS' PERCEPTIONS WITHIN AND BETWEEN EASTERN CAPE TOWNS

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NANAMHLA GWEDLA

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Abstract

Promoting urban sustainability is vital in the face of rapid human and urban population growth. A core tenet of urban sustainability, urban forestry, is poised to "go global" with the intent of mitigating the negative environmental and social effects of urbanisation through green infrastructure, spaces and trees. Amongst these, the planting of street trees has become a major strategy. The public functions of street trees as demonstrated through the provision of ecosystem services are highly dependent on the structure, composition and diversity of tree species within the urban forest. The bulk of available literature on the composition, diversity and perceptions of residents regarding street trees has largely focused on the developed world, while the few in the developing world have been conducted at only one or two sites. The aim of this study was to investigate the composition, diversity and density of urban street trees in relation to the perceptions of local residents and horticulturists, across a range of ecological and social contexts.

To do this, the species composition, diversity and dominance of street trees planted in 10 randomly selected Eastern Cape towns was assessed. Within each town ten replicate 200 m transects were located in three different suburbs. Perceptions and appreciation of street trees were assessed by 1 200 household questionnaires, as well as key informant interviews with personnel responsible for street tree planting and maintenance. Sixty-nine out of 300 sampled transects had street trees, with 888 trees enumerated, spanning ninety-seven species. Alien tree species accounted for 71 % of all the enumerated trees while indigenous trees species accounted for 12 %. The non-former homeland towns had a significantly higher (5.8±1.6 trees) mean street tree density per transect than the former homeland towns (0.6±03). There were no significant relationships between street tree density or richness to mean annual rainfall or the background biome in which the town was situated. However, density strongly was related to size of the town. RDP and township suburbs had fewer street trees and low species richness relative to the affluent suburbs. In selecting street trees, root system of the prospective tree, the eventual size or shape of the species, whether an alien or indigenous species, and the species' adaptability to the climate of the respective town are considered before planting. The biggest identified threats to street trees were the deliberate vandalism of trees by people and animals,

and lack of education and awareness regarding the importance of street trees among urban residents and municipal officials.

More than half of the respondents prefer that trees be planted both on the street and in their yards while a few do not want trees at all. The majority of respondents with this preference do so because they want shade and abundant fruit, and to have beautiful yards and streets. Those who do not want trees at all do so because they just do not like trees, there is no space for trees, or they fear that criminals hide behind trees. The presence of trees in peoples' yards correlated with a positive preference for trees in the street. The majority of respondents were neither satisfied with the general appearance of their street nor with the number of trees on their street. Residents from the RDP suburbs were the least satisfied with both the appearance and number of trees on their streets, while those from the affluent suburbs were the most satisfied. Street trees were seen as greatly important to have by the majority of people. The more educated people were more appreciative of the importance of street trees. Local municipalities were identified by the majority of respondents as the stakeholders responsible for the planting and maintenance of street trees, although a considerable proportion of respondents reported a willingness to volunteer to help plant and maintain trees on their streets. Municipalities were seen as doing very little to provide and maintain trees in the various suburbs by the majority of respondents. The majority of respondents also reported that they had never been consulted about tree planting activities in their suburbs before, and would like to have been consulted.

Declaration

I, Nanamhla Gwedla, hereby declare that the work described in this thesis was carried out in the Department of Environmental Science, Rhodes University, under the supervision of Professor Charlie Shackleton. The various components of the thesis comprise original work by the author and have not been submitted to any other university.

…………………………………

Nanamhla Gwedla

15 February 2016

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Any opinion, finding, conclusion or recommendation expressed in this material is that of the authors and the NRF does not accept any liability in this regard.

Dedication

I dedicate this piece of work to my mother for her unwavering support, love, prayers and for always encouraging me to fulfil my dreams.

Table of Contents

Abstract……………………………………………………………………………...i

Declaration……………………………………………………………………………iii

Acknowledgements…………………………………………………………………...iv

Dedication……………………………………………………………………………iv

Table of Contents……………………………………………………………………..v

List of Tables…………………………………………………………………………ix

List of Figures………………………………………………………………………...xi

Chapter One: General Introduction……………………………………………………1

1.1 Urbanisation……………………………………………………………………......1

1.1.1 Causes of urbanisation………………………………………………………2

1.1.2 Impacts of urbanisation on the natural environment………………………...3

1.1.3 Mitigating the impacts of urbanisation……………………………………......4

1.2 Urban Forestry……………………………………………………………………..5

1.2.1 Scientific discourses in urban forestry……………………………………...7

1.2.2 Benefits of urban forestry…………………………………………………...9

1.2.3 Components of urban forestry……………………………………………..12

1.3 Research Motivation……………………………………………………………..14

1.4 Aim, Objectives and Key Questions……………………………………………..15

1.5 Structure of thesis………………………………………………………………...16

Chapter Two: Methods and Study Areas………………………………………………18

2.1 Methods…..………………………………………………………………………18

2.1.1 Data collection……………………………………………………………………18

2.1.2 Data analysis……………………………………………………………………………19

2.2 Study Areas………………………………………………………………………………20

2.2.1 Study town profile…………………………………………………………………….22
2.2.2 Respondent profile……………………………………………………………………24
2.2.3 Horticulturists' profile………………………………………………………………..26

Chapter Three: The distribution, composition, and dominance of street trees…………….....28

3.1 Introduction………………………………………………………………………………28

3.2 Methods…………………………………………………………………………………..33

3.3 Results………………………………………………………………………………….....33

3.3.1 Distribution of street trees between and within towns……………..……………....33
3.3.2 Composition and attributes of street trees between towns……………………….....38
3.3.3 Distribution of street trees between suburbs………………………......................39
3.3.4 Composition and attributes of street trees between suburbs………….................39
3.3.5 Horticulturists' perceptions of street tree distribution, composition and dominance ………………………………………………………………………………………....41

3.4 Discussion………………………………………………………………………………..44

3.5 Conclusion………………………………………………………………………………..49

Chapter Four: Perceptions and preferences regarding distribution and composition of street trees……………………………………………………………………………... ………..51

4.1 Introduction………………………………………………………………………………51

4.2 Results……………………………………………………………………………………54

4.2.1 Preferences for trees in urban suburbs……………………………………………..54

4.2.1.1 Distribution of household trees within towns and suburbs…………………54
4.2.1.2 Composition of household trees……………………………………………55
4.2.1.3 Reasons for planting or retaining selected trees in homesteads……………56
4.2.1.4 Preferences for the location and distribution of new tree plantings………..57

4.2.1.5 Reasons for the preferred location of trees…………………………………60
4.2.1.6 Satisfaction with general appearance of street……………………………..60
4.2.1.7 Reasons for the dissatisfaction with the general appearance of street……..62
4.2.1.8 Satisfaction with the number of trees on street……………………………63
4.2.1.9 General satisfaction with overall condition of the street (appearance and street trees)……………………………………………………………64

4.2.2 Appreciation for trees by urban residents ………..……………………………..66

4.2.2.1 Importance of trees on the street…………………………………………66
4.2.2.2 Reasons for perceived importance of trees for quality of life…………….70
4.2.2.3 Street trees, their benefits and problems…………………………………70

4.3 Discussion……………………………………………………………………………..75
4.3.1 Preference for trees……………………………………………………………..75
4.3.2 Satisfaction with street and street trees…………………………………………...79
4.3.3 Appreciation for street trees……………………………………………………80

4.4 Conclusion……………………………………………………………………………82

Chapter Five: The attitudes of urban residents on street trees stewardship…………………84

5.1 Introduction…………………………………………………………………………...84

5.2 Methods………………………………………………………………………………86

5.3 Results…………………………………………………………………………………87
5.3.1 Stewardship for street trees……………………………………………………..87
5.3.2 Consultation about tree planting activities……………………………………...90
5.3.2.1 Reasons for wanting (or not) to be consulted about tree planting activities 93
5.3.3 Municipalities' progress in providing and maintaining trees……………………...94
5.3.4 Volunteering for urban greening……………………………………….……97
5.3.4.1 Reasons to volunteer or not to volunteer…………………………………98

5.4 Discussion…………………………………………………………………………99

5.5 Conclusion………………………………………………………………………103

Chapter Six: Synthesis, conclusions and recommendations………………………………..104

6.1 Introduction………………………………………………………………………104

6.2 General Discussion, Synthesis and Conclusion……………………………………...105

6.2.1 Composition and distribution of street trees……………………………………...105

6.2.2 Urban residents' perceptions, attitudes and preferences for street trees…………107

6.2.3 Urban residents' attitudes on street tree stewardship……………………………..108

6.3 Policy Implications and Recommendations……………………………………………110

References……………………………………………………………………………..114

Appendices……………………………………………………………………………138

List of Tables

Table 2.1: Physical characteristics of study towns……………………………………………...23

Table 2.2: Socio-economic characteristics of local municipalities where study towns are located……………………………………………………………………24

Table 2.3: Proportion of female respondents by town……………………………………….25

Table 2.4: Age distribution of respondents across all towns…………………………………25

Table 2.5: Employment status of respondents across all towns……………………………...26

Table 2.6: Highest educational attainment of respondents across all towns…………………26

Table 3.1: Distribution of street trees per town………………………………………………33

Table 3.2: Average number of species per transect encountered more than three times across all towns…………………………………………………………...34

Table 3.3: Attributes of street trees in 10 different sample towns…………………………...39

Table 3.4: Distribution of street trees between suburbs in each town……………………….40

Table 4.1: The proportion of households in ten towns and per suburb that had trees in their yards……..…………………………………………………………54

Table 4.2: Composition and distribution of household trees across all ten towns…………...55

Table 4.3: Reasons for planting or retaining (or not) trees in household gardens…………...56

Table 4.4: Preferences for the location of planted trees by respondents across all towns…...58

Table 4.5: Preferences for the location of planted trees amongst respondents with existing trees in the yards and those without trees………………………………..58

Table 4.6: Preferences for the location of planted trees amongst respondents from the various suburb types across all towns…………………………………………….59

Table 4.7: Five most common reasons for each of the various preferences for the location of planted trees…………………………………………………………...61

Table 4.8: Five most common reasons why respondents were satisfied or dissatisfied with the general appearance of their streets…………………………………………….63

Table 4.9: Cross-tabulation of respondents for all towns between their satisfaction with the appearance of the street and the number of trees on the street………………..65

Table 4.10: Cross-tabulation of respondents from the different suburbs across all towns between their satisfaction with the appearance of the street and the number of trees on the street ……………………………………………………..65

Table 4.11: Cross-tabulation of respondents from all towns between their preferred location for trees and their perceived importance of having trees on the street…………..68

Table 4.12: Respondents' perceived importance of trees for quality of life in towns across all towns ……………………………………………………………………...69

Table 4.13: Respondents' perceived importance of trees for quality of life in towns across all towns based on respondents' perceived importance of having trees on the street…………………………………………………………………………69

Table 4.14: Respondents ability to identify the most common trees on their streets among those whose streets have trees…………………………………………………...72

Table 4.15: Benefits and problems with street trees identified by respondents with trees on their streets …………………………………………………………….……74

Table 4.16: Cross-tabulation of the preferences for the location of street trees among respondents who experience (and do not) problems with the trees on their streets……………………………………………………………………………75

Table 4.17: Cross-tabulation of the perceptions respondents who experience (or do not) problems with the trees on their about the importance of having street trees………………………………………………………………………75

Table 5.1: Reasons for wanting and not wanting to be consulted about tree planting activities………………………………………………………………………94

Table 5.2: Respondents' agreement with whether their municipality does enough to provide trees in suburbs…………………………………………………………96

Table 5.3: Respondents' motivation for wanting to volunteer to help plant and maintain trees on their streets……………………………………………........................98

Table 5.4: Respondents' motivation for not wanting to volunteer to help plant and maintain trees on their streets……………………………………………........................99

List of Figures

Figure 2.1: Location of study province within South Africa……………………………….21

Figure 2.2: Location of study towns within the Eastern Cape province……………………22

Figure 3.1: The proportions of indigenous, alien and unknown tree species per town……..36

Figure 3.2: Mean street tree density as a function of town population size…………………37

Figure 3.3: Mean street tree density as a function of town area……………………………..37

Figure 3.4: Mean street tree density as a function of town mean annual rainfall……………38

Figure 3.5: Mean street tree density per transect between suburbs across 10 towns………...41

Figure 4.1: General dissatisfaction of respondents from all towns with the general appearance of their streets……………………………………………………..62

Figure 4.2: Dissatisfaction of respondents from ten towns with the number of trees on their streets…………………………………………………………………64

Figure 4.3: Respondents' perceptions of the importance of having trees on the street across all towns …………………………………………………………………66

Figure 4.4: Perceptions of respondents from the affluent, township and RDP suburbs across all towns on the importance of having trees on the street………………...67

Figure 4.5: The absence of trees on the street across all towns based on respondents' claims……………………………………………………………………………71

Figure 4.6: Ability to identify the most common types of trees on the street among respondents who have trees on their streets across all towns…………….72

Figure 5.1: Stakeholders identified by local residents as responsible for the planting and maintenance of street trees across all towns…………………………………89

Figure 5.2: Perceptions of respondents from the affluent, township and RDP suburbs regarding the stewardship of street trees…………………………….…….90

Figure 5.3: Respondents who reported never having been consulted about tree planting activities in their suburbs………………………………………………91

Figure 5.4: Proportion of respondents who would like to be consulted about tree planting activities in their suburbs and those who do not………………………..92

Figure 5.5: Respondents' willingness to help plant and maintain trees on their streets……..97

Chapter 1

General Introduction

1.1 Urbanisation

Human society has, in the last century, experienced two dramatic changes, which have now shaped the development of cities worldwide (Carreiro, 2008). Firstly, the global population had quadrupled to over 7 billion people by 2013, and secondly humans have become an urban species (Carreiro, 2008). Urbanisation is described as a demographic, ecological, sociological and economic trend that concentrates populations in urban areas and can potentially either promote or impede growth and development of these urban areas in both developed and developing countries (Tavernia and Reed, 2009; Bao and Fang, 2012; Cobbinah *et al.,* 2015). It is one of the most powerful and visible anthropogenic forces on the planet (Dawson *et al.,* 2009), and has in recent years become a global concern as the population balance between the rural and urban populations inexorably swing towards urban areas (United Nations, 2012). Although cities occupy approximately 2 % of the total surface of the earth, they are home to more than 50 % of the world population (Grant, 2012).

This trend has been noticeable over the last century mostly in Europe, North and Latin America (Sandström *et al.,* 2006). According to Benton-Short and Short (2013), only 10 % of the world's population lived in urban areas in 1900, by 2010 it was more than 50 %, and it is estimated that by 2050 close to 70 % of the world population will be urbanised. The United Nations projected in 2006 that the urban areas in developing countries would be responsible for approximately 90 % of the projected world population increase of 2.7 billion people between 1995 and 2030, and that by 2030 more than half of the African population will be urban (United Nations, 2012). Like most other African countries, the urban population in South Africa is also increasing, from 52 % in 1990 to 62 % in 2011 (SAIRR, 2013), even though the circumstances that led to this urbanisation are somewhat unique to South Africa (Tattey, 2005). The developed countries have seen a decline in urban growth and urbanisation mostly because of their already high urbanisation levels and are slowly approaching their urban maxima (Benton-Short and Short, 2013). This can clearly be observed in countries like Australia where

more than 90 % of the country's population already lives in its six largest urban areas (Benton-Short and Short, 2013).

1.1.1 Causes of urbanisation

There are various reasons attributed to the increase in urbanisation; however, there are three factors which remain central in the discussions surrounding the causes of urbanisation. These factors include natural population growth, rural-urban migration, and reclassification of rural settlements as urban (McGranahan *et al.,* 2009). Natural population growth is usually a result of excess birth rates over death rates (Watson, 2009), which in the African context has been accelerated by social and cultural conditions where children are sometimes perceived as providing security in old age (Boadi *et al.,* 2005). Additionally, the infiltration of Western culture throughout the developing world has consequently influenced decisions on premarital sex and teenage pregnancies, which have influenced fertility rates and population growth (Boadi *et al.,* 2005). This increase in population growth directly increases the pressure on land, tenure uncertainty, poor land use practices and environmental degradation, thereby creating opportunities for potential migration to urban areas (Boardi *et al.,* 2005).

The rural-urban migration facet of urbanisation has been on the rise for many decades on the African continent, accounting for approximately 50 % of urbanisation. (Redman and Jones, 2005). Rural-urban migration refers to the movement of people from rural to urban settings for purposes of residence and employment. The factors that are the driving forces behind rural-urban migration either push people from rural to urban areas or pull people from rural to urban areas. The pull factors include a perceived better life and economic opportunities in urban areas such as jobs, education, healthcare, and basic services (Cobbinah *et al.,* 2015). Additionally, the uneven spatial development between rural and urban areas is another pull factor, because of development trajectories being more inclined towards urban growth and limited consideration of rural areas (Fox, 2012). The push factors include poverty, land degradation, limited livelihood options, inadequate and sometimes poor infrastructure and poor service delivery in rural areas (Turok and McGranahan, 2013). Other drivers of migration from rural to urban areas include insecurity, conflict and war, droughts and the exhaustion of natural resources (Cobbinah *et al.,* 2015). In the case of South Africa, some of the unique circumstances that led to increased urbanisation between 1990 and 2011 were the repeal of laws that restricted where Black South Africans could live and work, and the establishment of the Reconstruction and Development Programme (RDP) by the newly elected government

(Shackleton *et al*., 2014). Most Black South Africans were previously expected to live in and become nominal 'citizens' of ethically defined, geographically separate homelands (Shackleton *et al*., 2014). If Black South Africans had to work in the city, they were required to live in separate areas, locally termed 'townships' (Wilkinson, 1998), which were characterised by relatively high density suburbs, lack of service delivery and poverty (Shackleton *et al*., 2014). The repeal of laws resulted in an enormous surge of people moving to urban areas for employment and perceptions of better living conditions and services (Shackleton *et al*., 2014). This resulted in the demand for housing, and thus the provision of houses to the indigent under the RDP. These housing developments and suburbs have since been referred to as RDP suburbs.

Although urbanisation seems to be a result of people seeking opportunities for improved livelihoods, and the implementation of development plans that aim to fulfil the needs of people, it can have negative effects both on the people and the natural environment. The natural environment is usually the hardest hit by the impacts of urbanisation and the reversal of these impacts is sometimes challenging.

1.1.2 Impacts of urbanisation on the natural environment

Rapid urbanisation is typically associated with the degradation of the environmental quality of towns and cities (Roy *et al.,* 2012). The transformation of land and resource use associated with urbanisation has been one of the most influential factors in human-induced environmental change over the last 200 years (Hutyra *et al.,* 2011). While urbanisation has greatly enhanced economic and social development (De Sherbinin *et al.,* 2007), it has created a number of environmental problems. Most of these problems are a result of urban population increases, the changes in peoples' incomes, which in turn change peoples' consumption patterns and behaviours. The rapid increase in urbanisation places a burden on town planners, municipalities and governments to provide for these growing urban populations. This is because the growing populations in urban areas need land, food, energy, clean water and they need to dispose of the waste they produce, all of which can have negative impacts on the environment. According to Sandström *et al.* (2006), increased urbanisation frequently impacts negatively on the biodiversity of towns, as in many instances land has to be cleared to accommodate the growing urban population and required infrastructure. This finding is also complemented by Broussard *et al.* (2008) who showed that town planners were more in favour of urban development than conservation of the environment.

From a development perspective, infrastructural urban development and accommodating large populations who all contribute to the economy seems to be the best way to enhance strong and developed economies but, as shown by McConnachie *et al.* (2008) and Nagendra and Gopal (2010), the clearing of land in urban areas leads to a reduction of green spaces, including street trees, and habitat fragmentation. Consequently, this accelerates changes in vegetation cover (Zhao *et al.,* 2006; Kowarik, 2011), changes in species dispersal and migration (Evans, 2010), as well as changes in species composition and abundance (Luck and Smallbone, 2010). The presence of alien invasive plant species can also often be attributed to urbanisation (Klotz and Kühn, 2010). This is because urban areas are hotspots for the intentional or accidental introductions of alien plants as hubs of transport systems and networks (Klotz and Kühn, 2010). Increased urbanisation and clearing of green areas also changes the microclimate through changes in the topographic configuration of space, the distribution and the provision of green spaces, and increased albedo (Georgi and Dimitriou, 2010). Other environmental problems associated with urbanisation and its impacts on the natural environment include increased air and water pollution and decreased water supply (Shao *et al.,* 2006), local climate alteration and increased energy demands (Zhou *et al.,* 2004), and a major reduction in natural vegetation production, carbon storage and sequestration (Fang *et al.,* 2003; Yuan, 2008) both at local and global scales (Zhao *et al.,* 2006). These problems can, for the most part, be attributed to land use change as a result of urban areas needing to accommodate growing human populations. According to Sudhira and Nagendra (2013), Bangalore, India attracts large numbers of migrants each year whose reasons for migrating include their desire to live in a city with a cool climate and widespread greenery. However, "the influx of people into this city has led to the encroachment and pollution of water bodies, the felling of thousands of trees, and large-scale conversion of opens spaces and parks to commercial, industrial and residential settlements (Nagendra and Gopal, 2010). Consequently, the sustainability of urban areas has now become an environmental issue of concern (Kuruneri-Chitepo and Shackleton, 2011; Pickett *et al.,* 2013).

1.1.3 Mitigating the environmental impacts of urbanisation

Promoting urban sustainability is one way to mitigate and deal with the negative impacts of urbanisation on the environment. Urban sustainability deals with the "fundamental character of interactions between nature and society within urban systems" (Kates *et al*., 2001). There are a number of descriptions but there is no uniform definition of urban sustainability; the best way to understand the term is to consider its characteristics. The characteristics of urban

sustainability include intra- and intergenerational equity, protection of the natural environment and living within its carrying capacity, minimal use of non-renewable resources, economic vitality and diversity, community self-reliance, individual well-being, and the satisfaction of basic human needs (Pickett *et al.,* 2013). Its aim is to ensure that cities are organised without excessively damaging the surrounding natural environment. Urban sustainability can be achieved through ensuring the sustainability of energy sources, better management of waste as well as better management of the environment, and ensuring cities have limited ecological footprints, while development is taking place (Maclaren, 2010). This can be achieved through ensuring that cities minimise pollution, use land efficiently, recycle, compost or convert used materials to energy, and to minimise contributions to climate change.

Urban forestry and green infrastructure are seen as promising strategies to address some of the negative impacts of urbanisation and the complex problems associated with it (Kambites and Owen, 2006; Hansen and Pauleit, 2014; Zhang and Jim, 2014). Carrerio (2008) suggests that "there has been an increasing comprehension that some of the solutions to most of these problems lie in making urban areas and cities more efficient in their energy and materials consumption, disposal of waste products, as well as in their changing or modifying the patterns of urban development so as to reduce the amount of 'grey' infrastructure which includes buildings and tar roads, and an increase in the amount of 'green' infrastructure which includes vegetation and especially trees". Coupled with urbanisation, "the illegal dumping of waste has become a persistent problem that can be mitigated by the presence of urban forestry or greening" (Joo and Kwon, 2015). According to Sassen (2009), one of the many ways in which urban areas can be planned to be more sustainable is by integrating trees within the broader urban landscape. Trees in and around urban areas supply a multitude of tangible and intangible benefits (Roy *et al.,* 2012), hence urban forestry and greening is a growing institutional strategy in promoting urban sustainability (Duinker *et al.,* 2015). Therefore, urban forestry and urban green spaces are necessary for the achievement of urban sustainability.

1.2 Urban Forestry

The concept of urban forestry has been weakly explored in developing countries when compared to developed ones, with evidence that despite the rich international research on urban forestry issues, there are limited contributions from the developing world in the peer-reviewed literature (Shackleton, 2012). Based on Miller (1997), urban forestry refers to the "art, science and technology of managing trees and forest resources in and around urban community

ecosystems for the ecological, physiological, sociological, economic and aesthetic benefits that trees provide society". Therefore, the concept of urban forestry mainly relates to the "establishment, promotion, maintenance and management of trees in urban and peri-urban landscapes" (Shackleton, 2006). Despite the limited exploration of the concept in the developing world, it is plausible that some of the sustainability challenges that urban areas are faced with can be mitigated or addressed through the advancement of urban forestry and green infrastructure initiatives. The concept and framework of urban forestry seeks to provide "an understanding and experiential framework that will enable urban planners, policy-makers and decision-makers to adopt policies and programmes to optimise the benefits of urbanisation for human beings" (McConnachie and Shackleton, 2010). Ideally, this would result in the optimisation of the density and amount of urban green spaces, either in the form of green servitudes, corridors, individual trees, green spaces or parks, private, community or public gardens and public facilities surrounded by green spaces such as churches, cemeteries, libraries, schools and sports fields.

The concept of urban forestry was formalised in 1965 by Jorgensen in Toronto, Canada (Randrup *et al.,* 2005). However, the practice of urban forestry was evident in some of the earliest cities in different countries, including Egypt, former Persia (now Iran), Greece, China, and Rome, where citizens of these respective countries cared for green spaces as cities expanded (Grey and Deneke, 1978). They did this by creating gardens, plantations and planting trees around their places of worship as well as buildings (Grey and Deneke, 1978). Grey and Deneke (1978) mention that during the middle ages (the period in European history between the 5th century and the 15th century), urban green spaces, including botanical gardens, were planted mainly for medicinal use. However, in the early 17th century this trend shifted towards landscape design at the onset of the arboriculture and horticulture disciplines (Grey and Deneke, 1978).

Broussard *et al*. (2008) argue that the advancement of urban forestry in towns globally is the responsibility of the local municipalities of the respective towns. However, this mandate seems to be slower in developing countries than in developed ones even though the concept of urban forestry is globally embraced (Pierce *et al.,* 2005). This is mainly because developing countries often prioritise more pressing developmental issues in their municipalities such as poverty, unemployment and inadequate shelter and services, resulting in more funds in the municipalities' budgets to curb these problems (Gwedla and Shackleton, 2015). Notwithstanding this, some of the largest South African municipalities of Johannesburg,

Durban, Cape Town and Port Elizabeth are making strides to advance urban forestry (McConnachie *et al.,* 2008). In line with this, Gwedla and Shackleton (2015) showed a strong, positive correlation between street tree density and town size.

As an evolving discipline and planning paradigm, there are multiple discourses that channel knowledge and describe current trends within urban forestry (Ostoić and Konijnendijk van den Bosch, 2015). Discourses in urban forestry contribute to a better understanding of how urban forests function, who uses them, how they are used, their roles in the broader environment and society, and how they can be protected. In their recent review, Ostoić and Konijnendijk van den Bosch (2015) identified six scientific urban forestry discourses of varying strength and geographical distribution, namely: the managerial discourse, the civic involvement discourse, the ecosystem services discourse, the biodiversity discourse, the green infrastructure discourse, and the urban planning discourse.

1.2.1 Scientific discourses in urban forestry

The managerial discourse

The managerial discourse is based on achieving healthy, resilient and safe urban forests and trees through sound urban forest management (Ostoić and Konijnendijk van den Bosch, 2015). Included in this discourse are practices of forests and natural resource assessments (Sreetheran *et al.,* 2011), woodland management (Nielsen and Jensen, 2007), tree risk assessment and management (Martinez-Trinidad *et al.,* 2010), together with legal-institutional aspects (Conway and Urbani, 2007), education and research within urban forestry and arboriculture (Wiseman *et al.,* 2011), rules and regulations addressing forest and tree management, and maintenance (Ries *et al.,* 2007).

The civic involvement discourse

The civic involvement discourse is based on making urban areas more pleasant and habitable for urban residents by suiting peoples' various needs from nature (Ostoić and Konijnendijk van den Bosch, 2015). This discourse seeks to address how quality green spaces that suit the needs and preferences of urban residents can be delivered, which aim to improve their quality of life and a sense of well-being (Ostoić and Konijnendijk van den Bosch, 2015). Additionally, this discourse encompasses the involvement and role of citizens and urban residents in decision-making and participation in relation to urban forestry through volunteering or any other participation (Buizer and Van Herzele, 2012).

The ecosystem services discourse

The ecosystem services discourse is based on viewing urban forests as providers of ecosystem services, although the benefits associated with these services are also associated with costs (Ostoić and Konijnendijk van den Bosch, 2015). It stresses the multiple tangible and intangible benefits urban dwellers receive from trees and green spaces. Much of the research effort and narrative has been on quantification and valuation of benefit flows (Roy *et al.,* 2012). Additionally, the justification of the costs for increased support has been crucial in this discourse (Krott, 2004).

The biodiversity discourse

The biodiversity discourse aims to highlight that urban areas can harbour biodiversity and thus contribute to biodiversity conservation (Alvey, 2006). However, urbanisation has been identified as a major challenge in the conservation of urban forest biodiversity (Ostoić and Konijnendijk van den Bosch, 2015).

The green infrastructure and urban planning discourses

The green infrastructure discourse is focused on the optimal distribution of urban forests and green spaces for effective and efficient provision of ecosystem services (Ostoić and Konijnendijk van den Bosch, 2015). On the other hand, the urban planning discourse prioritises the achievement of sustainable cities and green elements as part of the urban structure (Ostoić and Konijnendijk van den Bosch, 2015). This discourse suggests that urban planning needs to protect the existing green spaces and incorporate new green spaces to foster sustainable cities (Ostoić and Konijnendijk van den Bosch, 2015). However, incorporating green "elements" into existing urban infrastructure is still a challenge and requires a holistic approach to landscape and urban planning if it is to be successful (Ostoić and Konijnendijk van den Bosch, 2015).

Together, these discourses advocate for the development of sustainable cities where urban ecosystems, green spaces and urban forests are part of infrastructural development in cities. Each of these discourses suggests that most aspects of urban forestry ensure that humans, animals and the rest of the natural environment receive optimal benefits from having trees in urban areas.

1.2.2 Benefits of urban forestry

Urban forestry offers multiple contributions to people's well-being and urban sustainability as a whole (Duinker *et al.,* 2015). These contributions come as benefits both to people and to the natural environment and include ecological, social, and economic benefits. Trees in urban areas are vital components of the urban ecosystem and are therefore important for environmental quality, quality of life and sustainable urban development (Duinker *et al.,* 2015). Trees are usually found in recreational parks, along streets and servitudes, in residents' gardens, near waterways, in commercial zones and in protected or sacred areas (Nagendra and Gopal, 2010). Trees in urban areas not only add to the urban infrastructure; they also can, to some extent, help maintain and enhance the livelihoods of urban inhabitants. This is through the provision of consumptive benefits like fruits, medicinal plants, fuelwood and fodder, where the same products, when sold, provide direct or indirect cash benefits when used within the household by freeing cash income for other uses (Kaoma and Shackleton, 2015). A recent study by Shackleton *et al.* (2015) in South Africa showed that urban residents used a number of tree products to support their livelihoods, including firewood, fruits and herbal medicines from both the homestead gardens and public green spaces. The variety of benefits provided by trees in urban areas are sometimes ignored because some benefits are indirect and their monetary value impossible to compute (Soares *et al.,* 2011).

Ecological benefits

The ecological benefits of urban trees can be classified as physical and biological (Dwyer *et al.,* 1992). Trees in urban areas help moderate the urban climate (Ng *et al.,* 2012), improve air quality (Vailshery *et al.,* 2013), reduce runoff and flooding (Armson *et al.,* 2013), reduce energy used by buildings, absorb atmospheric carbon dioxide, and reduce noise levels or annoyance (Van Renterghem and Botteldooren, 2016). Many of the environmental impacts of urban growth can be minimised by the presence of trees in urban landscapes, thus improving the chemical and physical environment of urban areas (Soares *et al.,* 2011).

Urban trees help moderate the urban climate by reducing urban surface temperatures (Gillner *et al.,* 2015). Armson *et al.* (2012) found that concrete surfaces were always hotter than the surrounding air, rising to peaks of around 40 °C in the sun, and 28 °C in the shade, around 17 °C and 4 °C higher than peak air temperature, respectively. There is also evidence that urban woodland and trees are consistently among the coolest surfaces during hot summer days, where temperatures in large parks are 2-3 ^{0}C lower than in the surrounding built-up areas (Tyrväinen

et al., 2005). According to Tyrväinen *et al.* (2005), trees are the most effective vegetation element for reducing temperatures in urban areas. This corroborates the findings of Pauleit and Duhme (2000), who showed that open spaces with a high percentage cover of trees and water surfaces were the coolest areas in the city, where increasing the canopy cover by 10 % reduced surface temperatures by 1.4 ^{0}C on average during the day in a hot summer. Soares *et al.* (2011) also found that urban trees reduce energy used for air conditioning by almost 30 % in the case of using electricity to cool buildings. The greatest energy savers were large-stature deciduous trees, most of which have large leaves (i.e., *Platanus* sp., *Populus nigra* L., *Fraxinus angustifolia* Vahl., *Populus* × *canadensis* Moench) (Soares *et al.,* 2011).

Urban trees help improve air quality by trapping dust (Blanusa *et al.,* 2015) and removing air pollutants such as sulphur dioxide, nitrogen oxides, carbon monoxide and other particulates (Jim and Chen, 2008). Blanusa *et al.* (2015) found that *Platanus hispanica* and *Tilia cordata* leaves intercepted and retained sodium chloride aerosol and talcum particles more efficiently than *Olea europea*, *Quercus cerris*, and *Quercus ilex* leaves. In terms of noise reduction, Van Renterghem *et al.* (2015) found that having a row of trees behind a noise wall was more likely to improve the noise wall efficiency under downward conditions, and further reduce the visual impact of motorway noise walls in an open landscape.

Economic benefits

Urban trees contribute significantly to the economies of most towns by changing the economic vitality and character of the respective town or suburb (Nowak and Dwyer, 2007). They generate significant economic benefits for communities and local governments, regardless of the reporting format (Mullaney *et al.,* 2015). Unlike conventional forestry and fruit trees, it is not easy to quantify the economic benefits of urban street trees because they do not usually have a market value (Pandit *et al.,* 2013). Thus, an estimation of the economic benefits of street trees can provide a quantifiable basis for maintaining municipal tree care programs and planting more trees (Mullaney *et al.,* 2015).

The sales value of many properties reflects the benefits that buyers and sellers attach to the attributes of the respective property, including the trees and forest resources found within the property, along the street and in the nearest park (Soares *et al.,* 2011). Therefore, the most prominent economic benefit of urban trees is their influence on the property values in towns. Pandit *et al.* (2013) reported that homeowners in Perth, Western Australia, value trees and that different types of trees have different effects on sale prices of houses, with broadleaved trees

increasing the sales prices and with palms having no effect. Additionally, broadleaved trees on the street verge and not on the property were found to increase the median property price of a house by about 4.3 % (Pandit *et al.,* 2013).

Other economic benefits of urban trees involve the quantification of how much is saved when all other benefits of urban trees are recognised and embraced. A clear example of this is how much a municipality saves on the costs of maintaining the infrastructure associated with storm water and sewage channelling. These benefits can be recognised through estimating the amenity value and thus benefits of urban forests and trees in monetary terms (Tyrväinen *et al.,* 2005). These methods include the hedonic pricing method, the contingent method, the tree pricing method, and the valuing of the environmental benefits method (Tyrväinen and Miettinen, 2000). The hedonic pricing method can be used to calculate the value of urban trees based on property characteristics and sales prices or assessed values of properties (Sander *et al.,* 2010), while the contingent valuation method is useful for assessing the existence values that people assign to natural elements like urban trees and green spaces (Lo and Jim, 2015b). The tree pricing method can be observed by assuming that the value of any one tree is based on its size, expected age, aesthetic value, location or form. The valuing of the environmental benefits method can be observed by quantifying the impacts trees have on the entire urban environment and the costs of environmental control in the absence of the trees (Tyrväinen *et al.,* 2005). Zhang *et al.* (2012) determined that the economic benefits of rainwater-runoff reduction by urban green spaces in Beijing could almost offset the maintenance cost of green spaces, which underlines the importance and necessity of creating green spaces in urban areas. The study further found that the total economic benefit of rainwater-runoff reduction by urban green spaces was equal to RMB1.34 billion in 2009 (Zhang *et al.,* 2012). Lisbon's street trees were found to intercept approximately 186,773 m^3 of rainfall annually, with an estimated $1.97 million value of associated storm water runoff reduction (Soares *et al.,* 2011). Donovan and Butry (2009) found that trees planted on the west and south sides of houses in Sacramento, California, reduced summertime electricity use by 185 kWh (5.2 %) per household, while Pandit and Laband (2010) found that electricity consumption was decreased by 1.29 kWh/day for every 10 % of shade coverage by trees in Auburn, Alabama.

Social benefits

The contributions urban trees make to peoples' lives are sometimes difficult to quantify as they usually do not have monetary value and are seen as indirect. These benefits mostly have to do

with how urban residents interact with the environment and how it makes them feel (Dwyer *et al.,* 1992). Urban green spaces and trees promote contact between community residents and generate social interaction, encourage physical activity, reduce stress levels and improve physical health (Nowak and Dwyer, 2007). In addition, they stimulate social cohesion and provide emotional and spiritual experiences that are important in peoples' lives and can nurture a strong attachment to specific places and trees (Schroeder, 2004). Wells (2000) also found that urban trees contributed to the improved learning and behaviour of children living in towns where urban trees are present. According to Tarran (2009), urban areas with a high abundance of street trees have been associated with reduced crime and increased public safety. Troy *et al.* (2012) reported that a 10 % increase in tree cover was associated with a 12 % decrease in crime in the greater Baltimore region.

Urban forestry also contributes to friendships among neighbours, increased supervision of children in outdoor spaces, healthier patterns in children's play, greater use of neighbourhood common spaces, less discourtesies, and fewer property and violent crimes (Kuo and Sullivan, 2001; Kuo, 2003). It has also been shown that sick patients in hospitals with a window view of trees have been observed to recover faster and with fewer complications than those who have no view of trees from their rooms (Sugiyama *et al.,* 2009). To corroborate this, Sugiyama *et al.* (2009) suggest that the nature and characteristics of urban green spaces and trees are a strong motivation for people to participate more in outdoor activities, thus having a positive impact on their health.

1.2.3 Components of urban forestry

The urban forest is comprised of different types of vegetation at different locations within the urban environment, and people. The various vegetation types all have different roles in the contributions they make to the urban environment, either as individuals or as agglomerations. There have been three widely recognised components of the urban forest, which include woodlands, parks and individual trees (Konijnendijk, 2003). A woodland is described as a "forested ecosystem of natural, semi-natural or man-made origin that can be used for recreation, as a form of protecting nature, and rarely as a means of wood production (Bell *et al.,* 2005). A woodland is mainly covered in trees, with other elements including open spaces, water, and paths (Bell *et al.,* 2005). On the other hand, a park is described as an open space set aside for recreational purposes, and contains an abundance of trees to provide visual screening, shelter, shade and aesthetic pleasure (Bell *et al.,* 2005). Trees can be found anywhere, space

permitting, within the urban landscape. Street trees are planted and maintained in public open spaces, within residential areas, between buildings, and along streets and avenues (Bell *et al.,* 2005).

Street trees

Street trees are an integral part of the urban forest and it has become imperative that the processes surrounding their planting and maintenance are understood (Gwedla and Shackleton, 2015). Consequently, it is important to first understand the nature of the urban forest, and its intended use before decisions about the planting of street trees are taken. Additionally, it is advisable that these decisions are taken once there is clear understanding of urban residents' attitudes and preferences towards trees (Chishaleshale *et al.,* 2015). In this regard, the managerial and civic involvement discourses become the starting points.

The planting and maintenance of street trees is usually the responsibility of the local municipality (Broussard *et al.,* 2008; Gwedla and Shackleton, 2015), but the actual selection and propagation of the street trees is the responsibility of horticulturists who can either be employees of the respective municipality or be contracted by the municipality. However, the continuing development of urban areas often creates environmental conditions that will hinder the growth and survival of street trees. Various factors such as the likely stresses (biotic and abiotic) the tree species is most vulnerable to (Sæbø *et al.,* 2003) need to be considered before a particular species is selected to be planted on the street. Thus, it is crucial that horticulturists have scientific knowledge about the propagation and growth habits of all the species that are considered for planting. Various studies (i.e. Santamour, 1990; Sun, 1992; Tello *et al.,* 2005; Raupp *et al.,* 2006; Bassuk *et al.,* 2009) recommended the use of a wide selection of species to promote the resilience of urban tree populations against recurring outbreaks of pests and diseases, and the threat of future diseases. Additionally, the use of a wide selection of species is more likely to meet the varied cultural and aesthetic needs of urban residents. However, urban planners and horticulturists nowadays find themselves struggling to find tree species that can withstand the sometimes unfavourable conditions on urban paved streets (Sjöman and Nielsen, 2010). Compared to all the other vegetation and trees in other parts of the urban environment, street trees experience the highest stress levels, which subsequently decreases their growth and lifespan (De Lacy and Shackleton, 2014). It is therefore important for species to be given full consideration before they are planted along streets. Thus, peoples' perceptions and opinions of what trees are important to them and what trees they want need to be taken into

consideration in conjunction with what species horticulturists perceive as most suitable for street planting.

Urban residents and street trees

The perceptions and attitudes of urban residents towards urban trees and green spaces is largely influenced by the presence or absence of green spaces, the condition of these green spaces and trees as well as the impacts they have either on the environment or on residents (Dilley and Wolf, 2013; Shackleton and Blair, 2013). Although there are some exceptions, e.g. Breuste's (2013) survey of street trees and residents' perceptions in Mendoza, Argentina, where it was found that people generally appreciate urban forestry and have a positive perception of trees (Shackleton and Blair, 2013; Shackleton *et al.,* 2015). Lohr *et al.* (2004) offered respondents a number of reasons to have trees in their town and 83 % of the respondents were in complete agreement with the reasons, which were mainly in support of urban forestry, even though there were some problems identified. A better understanding of the way urban residents interact with trees in their surroundings and their preferences, perceptions and attitudes towards street trees can play a significant role in helping policy-makers and developers make the right decisions as far as urban forest management is concerned, while also helping urban residents to be better stewards of the natural amenities at their disposal (Janse and Konijnendijk, 2007; Zhang *et al.,* 2010).

1.3 Research Motivation

The majority of studies regarding urban forestry and green spaces, the composition of the urban forest, and perceptions and attitudes towards urban forests and green spaces have been conducted in developed countries. In Sub-Saharan Africa, the few that have been conducted have been done so in South Africa (Shackleton, 2012; Ostoić and Konijnendijk van den Bosch, 2015). The majority of the studies done in South Africa, specifically in the Eastern Cape province, have been done in one or two study sites (i.e. McConnachie *et al.,* 2008; McConnachie and Shackleton, 2010; Ward *et al.,* 2010; Kuruneri-Chitepo and Shackleton, 2011; Shackleton and Blair, 2013; Richardson and Shackleton, 2014; Shackleton; *et al.,* 2014). Consequently, there is only limited understanding of how patterns and processes of urban forestry vary with ecological or social contexts, and how generalisable the results are. This current study seeks to advance on this through use of a common research approach across multiple sites. In addition, this study will help reinforce (or disagree with) the findings from previous studies through results that are reflected in multiple contexts. Moreover, most

previous work in South Africa and internationally, considers either the ecological or the social dimensions of urban forestry, with relatively few that look at the two simultaneously, e.g. Breuste (2013). This is particularly true for street trees. Internationally, Kirkpatrick *et al.* (2012) looked at the influence of residents' attitudes to the planting and removal of different types of trees in eastern Australian cities and found that attitudes towards trees had a direct impact on planting and removal behaviour for both trees in general and specific types of trees. Zhang *et al.* (2010) assessed preferences for and attitudes towards urban forests in Alabama, Georgia and Florida, and found that urban greening was important in residential landscapes, and that people prefer to live in houses with more trees. In South Africa, there has been work on resident's use and appreciation of green spaces (Ward *et al.,* 2010; Cilliers *et al.,* 2013; Shackleton and Blair, 2013). However, with regards to street trees, only Dotwana (2012) has considered both the composition, and appreciation and attitudes of residents in the same situation, in a single town in the Eastern Cape. Similarly, many urban tree management plans focus on ecological and arboricultural aspects at the expense of the social (Ordóñez and Duinker, 2013). Thus, the aim of this study was to examine both the ecological and social dimensions of the Eastern Cape urban forest. It is also imperative that studies that seek to address the perceptions of stakeholders be done in conjunction with those that seek to understand the physical characteristics of the urban forest or street trees so that informed decisions are made about stakeholders' preferences and what is currently available.

1.4 Aim, Objectives, Key Questions and Hypotheses

The aim of this study was to investigate the composition, diversity and density of urban street trees in relation to the perceptions of local residents and horticulturists, across a range of ecological and social contexts.

Objectives

In fulfilling this aim, the following objectives guided this study:

1. To assess the abundance, species composition, diversity and dominance of street trees planted in a range of Eastern Cape towns.
2. To investigate why specific tree species are planted and the characteristics of what horticulturists regard as good species for street planting.
3. To assess the perceptions and appreciation of street trees and species by residents across different suburbs and towns.

4. To assess urban residents' attitudes regarding the stewardship for street trees in their respective suburbs and towns.

Key Questions

1. What is the abundance, species composition, diversity and dominance of street trees in towns and their different suburbs?
2. How do these relate to a town's biophysical and socio-economic attributes?
3. Why are certain species of trees favoured over others?
4. What characteristics do horticulturists consider make a good species for street planting?
5. Do perceptions and attitudes towards street trees differ between residents in the different suburbs?
6. Who is and should be responsible for the planting and maintenance of street trees in suburbs and towns?
7. How does the respondent profile influence attitudes and perceptions of street trees?

Hypotheses

I hypothesised the following:

1. The larger and wealthier towns would have high street tree densities and species richness.
2. The affluent suburbs would have higher street tree densities and richness than the township and RDP suburbs.
3. Respondents with trees in their yards would have greater appreciation for street trees than those who do not.
4. Urban residents would be willing to be stewards for street trees and volunteer to help plant and maintain them in their suburbs.

1.5 Structure of the thesis

The empirical basis of this thesis was based on physical assessments of street trees and household surveys of urban residents and semi-structured interviews with horticulturists (or individuals deemed to be responsible for the sourcing, planting and maintenance of street trees) regarding their perceptions of street trees in towns of the Eastern Cape province. Therefore, this thesis has been divided into six chapters.

Chapter 1 (this chapter) provides a broad introduction and background for this study, and presents the aim, objectives and key questions. The second chapter presents the study area, profile of the respondents, and the methods used in this study. The third chapter addresses the first and second objectives of this study, presents the findings and discusses the results relating to the abundance, species composition, diversity and dominance of street trees in towns and their different suburbs. Chapters 4 and 5 address the third objective of this study, and present the findings and discuss the results relating to the perceptions of urban residents on street trees. Perceptions from horticulturists are also embedded throughout the third, fourth and fifth chapters. Each of the third, fourth and fifth chapters has an introduction, results, discussion and conclusion. The sixth and final chapter provides an overall synthesis of chapters 3, 4 and 5, bringing together key messages and recommendations. The study sites and methodology will not be included in each of the results chapters to avoid repetition and all cited references are provided at the end of the thesis.

Chapter 2

Methods and Study Areas

2.1 Methods

2.1.1 Data collection

To address the research questions posed in this study, two intertwined methods were employed to collect data from households and to conduct street tree assessments. Ten sample towns were randomly selected on Microsoft Excel from 19 municipal capitals/seats previously sampled in a different study by Gwedla and Shackleton (2015). Within each town, sample streets were randomly selected using geographic information systems (GIS) on ArcMap 10. An image of the respective town was brought into ArcMap and polygons were used to divide the town into three zones to outline the three different suburb types (affluent, township and RDP) to allow for a stratified sampling approach. The central business district (CBD) was excluded from the sample as the majority of people in towns are not resident in the CBD. A 100 m x 100 m fishnet grid was created in each polygon and 10 squares were randomly selected and later labelled. In a situation where a selected square did not fall over a road or street, the nearest possible road intersection or street with houses was selected for sampling. The maps were brought to the field to sample the exact plots as generated on ArcMap. The selected plots, verified on Google Earth Street Visualisation for directions, were physically visited and sampling was done within a 200 m transect measured with a measuring wheel in each road or street. The 200 m transect was measured from the beginning of the intersection where a grid fell. Thirty transects were visited in each town, 10 transects in the affluent suburbs, 10 transects in the township suburbs and 10 transects in the RDP suburbs.

Within each transect, the number of trees on either side of the road were counted, and the density of trees was determined by dividing the number of trees in a transect by the number of sampled transects in the respective town. The basal circumference of each tree was measured (using a dressmaker's tape) at 35 cm from the ground (to accommodate the younger or recently planted trees) (Chhetr and Fowler, 1996) using a pre-measured stick. The circumference was recorded to one decimal place, and each tree species was identified. Thorough observations

were made and a sample of each unknown species was collected, marked, and photographed for later identification at the Selmar Schonland herbarium. After identification, the list of known species were recorded and categorised into alien for introduced tree species and indigenous for trees native to South Africa. The unidentified or unknown species were not characterised into either of these categories, as it was impossible to do so without the name or family of the species. The unknown species were then coded for differentiation and ease of analysis.

Within each transect, four households, in no particular order, were visited. Eight-hundred and ninety-six households were visited across all ten towns. The household surveys consisted of 31 questions relating to the respondents' perceptions, preferences and attitudes towards street trees and 13 questions relating to the respondent's profile. Where a household was found to be unoccupied or the members of the household were unwilling to participate in the study, the next available household was visited.

Face-to-face structured key informant interviews were conducted with horticulturists or personnel responsible for street tree planting and maintenance in the respective towns. Six key informant interviews were conducted and these represented eight sample towns (one of the respondents represented three towns). The topics of discussion during these interviews were centred around the respondents' perceptions of street trees and included i) the characteristics of trees thought to make them suitable for street planting, ii) the types of trees suitable for street planting in their respective towns, iii) the types of tree species planted in their respective towns, iv) the reasons that could lead to the removal of street trees and v) the biggest threats to street trees in their respective towns. All respondents agreed that the interviews could be recorded to ensure that full details were available for later analysis. The interviews were 0.75–1.00 hour long and conducted either in IsiXhosa or English according to the respondent's preference. Port St John's, Tsolo and Libode all had a common respondent who is a forester from the district municipality.

2.1.2 Data analysis

Preliminary data analyses (descriptive statistics) were conducted using Microsoft Excel 2010. The diversity of the trees was assessed using measures of species richness and the Shannon index of diversity at the species level. The Shannon index of diversity (H) ranging from zero to infinity but with typical values ranging from 1.5 to 3.5, is commonly used to characterise species diversity in a community and considers both the abundance and evenness of the species

present (Kuruneri-Chitepo and Shackleton, 2011). Species richness was calculated directly by summing up the number of species recorded in each transect, and ultimately the entire sample town. All statistical data analyses were executed in Statistica 12. A Principal Component Analysis (PCA) was conducted to determine related variables. Where no relation could be established between an independent variable and any of the dependent variables, the independent variable was not used to test any relationships or differences.

Regression was used to analyse the relationships between continuous variables, such as town size (area and population), mean annual rainfall and mean street tree density, or between education levels and rating of the importance of street trees. Differences in means of continuous variables were analysed using either t-tests (if only two levels; for example, between former homeland and non-former homeland towns; or between genders) or Anova (if three or more levels; such as between the three suburb types or between the three classes of street tree density towns) after checking for normality. If the data were not normally distributed then non-parametric equivalents, Mann-Whitney and Kruskal-Wallis, were used respectively. If any Anova was significant, a post-hoc test was conducted based on the Least Significant Difference. Proportional data, mostly the percentage response of respondents, were analysed via Chi-square analysis or 2x2 contingency tables.

2.2 Study Areas

Data collection took place between the months of August and November 2014 in the Eastern Cape province of South Africa (Figure 2.1).

Figure 2.1: Location of study province within South Africa

The Eastern Cape is situated in the south-eastern seaboard of South Africa, bordering Kwa-Zulu Natal in the north-east, Free State and Lesotho in the north, and the Western and Northern Cape in the west. It is the second largest province in the country after the Northern Cape province and occupies an area of 169 580 km^2 (approximately 14 %) of the total area of South Africa (Joyce, 2008). The northern and north-western parts of the province are characterised by arid areas of the Great Karoo, the north-eastern parts are characterised by the Drakensburg Mountains, and the southern and eastern parts of the province are bordered by the warm waters of the Indian Ocean (Joyce, 2008). The Eastern Cape is the "transitional zone between the Mediterranean-type winter rainfall and the subtropical summer rainfall regions, where air temperatures increase with high rainfall in summer towards the northeast, and very hot but long days in the Karoo" (Joyce, 2008). The north-eastern interior of the province experiences cold and clear days in winter but become hotter and drier towards the western parts of the province (Joyce, 2008).

The province has 6.56 million people, of which 53 % are females, representing 12.7 % of the total population of South Africa (Stats SA, 2012). The province is divided into 37 local municipalities, with the smallest municipality having 10 537 people and the largest having 1.1

million people, and the sizes of the municipalities range from 1 291 km^2 to 11 668 km^2 (Stats SA, 2012).

The ten towns in the province selected for this study were Burgersdorp, Cradock, Graaff-Reinet, Libode, Matatiele, Peddie, Port St John's, Queenstown, Tsolo and Willowmore (Figure 2.2).

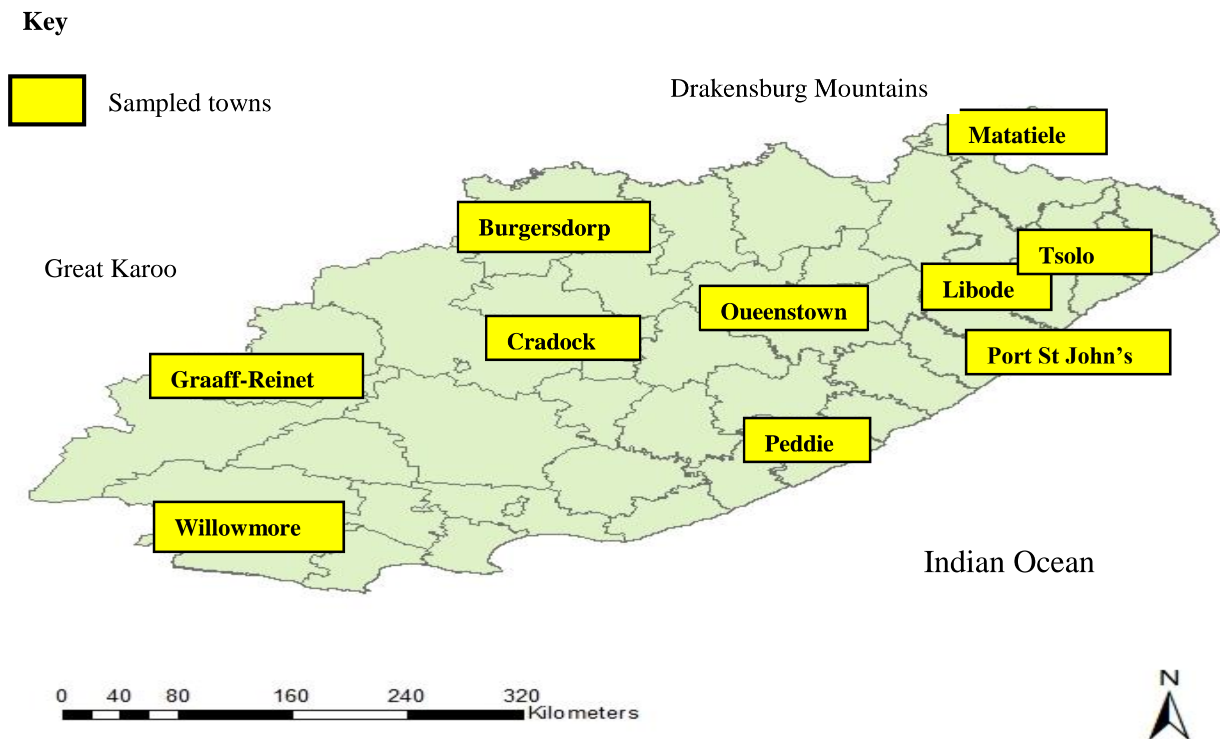

Figure 2.2: Location of study towns within the Eastern Cape province

2.2.1 Study Town Profile

Most of the sample towns (30 %) are in the grassland biome (Table 2.1). Fifty percent of the towns had previously been classified as having medium street tree density, while 30 % had been classified as having low density (Gwedla and Shackleton, 2015) (Table 2.1). The largest town (by area) was Graaff-Reinet and the smallest was Libode (Table 2.1). Port St John's had the highest recorded mean annual rainfall while Willomore had the lowest (Table 2.1).

Table 2.1: Physical characteristics of study towns.

Town	Local Municipality	Location	Size (km^2)	Biome[a]	MAR (mm)[b]	Classified Street Tree Density [b]
Burgersdorp	Gariep	30°59′32″S; 26°19′29″E	30.9	Nama-Karroo	367	High
Cradock	Inxuba Yethemba	32°11′S; 25°37′E	25.9	Nama-Karroo	248	Medium
Graaff-Reinet	Camdeboo	32°15′08″S; 24°32′26″E	20.6	Thicket/Nama-Karroo	236	High
Libode	Nyandeni	31°32′S; 29°01′E	3.9	Savana	620	Low
Matatiele	Matatiele	30°20′32″S; 28°48′22″E	11.2	Grassland	609	Medium
Peddie	Ngqushwa	33.196°S; 27.116°E	37.3	Thicket	412	Low
Port St John’s	Port St John’s	31.63°S; 29.54°E	8.0	Forest	990	Medium
Queenstown	Lukhanji	31°54’S; 26°53’E	71.3	Grassland	400	Medium
Tsolo	Mhlontlo	31.31°S; 28.75°E	46.7	Grassland	599	Low
Willowmore	Baviaans	33°17′S; 23°29′E	21.7	Succulent Karroo/Fynbos	152	Medium

[a] From Mucina and Rutherford (2006)
[b] From Gwedla and Shackleton (2015)

Table 2.2 presents data for entire local municipalities where the study towns are situated, and this includes both the urban and rural areas. Nyandeni local municipality has the highest population and biggest households, while Baviaans local municipality has the lowest population and Ngqushwa the smallest households (Table 2.2). Most unemployed people are from Ngushwa local municipality while the least unemployed are from Inxuba Yethemba (Table 2.2). The highest proportion of people above the age of 20 who have no schooling come from Port St John’s local municipality, while the majority of those with post-matric education are from Lukhanji local municipality (Table 2.2).

Table 2.2: Socio-economic characteristics of local municipalities where study towns are located.

Town	Local Municipality	Population Size	Unemployment Rate (%)	Average household size	Educational Attainment aged 20+ (%)		
					No schooling	Grade 12	Higher Education
Burgersdorp	Gariep	33 677	25.8	3.4	14.9	16.2	7.4
Cradock	Inxuba Yethemba	36 671	13.8	3.4	10.5	23.7	10.1
Graaff-Reinet	Camdeboo	50 993	30.1	3.8	9.0	19.6	9.5
Libode	Nyandeni	290 390	44.8	4.6	18.2	15.2	4.2
Matatiele	Matatiele	203 843	38.7	3.7	9.4	12.7	5.8
Peddie	Ngqushwa	72 190	52.8	3.2	13.7	15.0	3.9
Port St John's	Port St John's	156 136	50.3	4.5	23.5	11.9	3.9
Queenstown	Lukhanji	190 723	36.8	3.5	7.8	22.1	11.4
Tsolo	Mhlontlo	188 226	48.9	4.2	14.7	12.3	4.9
Willowmore	Baviaans	17 761	29.4	3.8	8.0	16.4	4.7
Mean		124 061	37	4	13	17	7

Source: Stats SA (http://www.statssa.gov.za/?page_id=964).

2.2.2 Respondent Profile

The majority of surveyed respondents were female (Table 2.3). Compared to all other towns, Graaff-Reinet had the most males who participated in the study, while Libode and Tsolo had the least.

The most represented age group among respondents were those between 40-50 years of age (Table 2.4). Respondents below 18 years of age were interviewed after consent had been granted by older members of the household. There were more full-time employed respondents than those who were unemployed (Table 2.5).

Table 2.3: Proportion of female respondents by town.

Town	**Females (%)**
Burgersdorp	69
Cradock	72
Graaff-Reinet	61
Libode	77
Matatiele	70
Peddie	69
Port St John's	68
Queenstown	64
Tsolo	77
Willowmore	66
Total	70

Table 2.4: Age distribution of respondents across all towns

Age structure	**Age distribution (%)**		
	Female	**Male**	**Total Proportion (%)**
13-17 years	81	19	4
18-25 years	64	36	15
26-30 years	70	30	12
31-39 years	70	30	21
40-50 years	67	33	23
51-60 years	65	35	13
61+ years	81	19	12
Total	70	30	100

Table 2.5: Employment status of respondents across all towns

Employment Description	Proportion (%)
Employed full-time	38
Unemployed	28
Employed part-time	7
Retired	13
Student/Learner	9
Self employed	5

The majority of respondents (95 %) who participated in this study had some form of schooling (Table 2.6). Most of them (27 %) had Grade 12 or a Higher Certificate as their highest educational attainment, while those who had a post-graduate qualification were the least (Table 2.6).

Table 2.6: Highest educational attainment of respondents across all towns

Highest Education Attained	Proportion of Respondents (%)
No Education	5
Primary Education	4
Junior Secondary Education	20
High School	20
Grade 12/ Higher Certificate	27
Diploma	16
Undergraduate Degree	6
Post-Graduate Degree	2

2.2.3 Horticulturists' profile

Horticulturists were represented by two females and four males (Appendix 2). Although professional horticulturists were the target of this study, some of the respondents were foresters, open spaces and parks supervisors, while others were environmental managers or environmental officers. Their ages ranged between 32-51 years. None of the respondents were

professional horticulturists, one was a landscaper, one was an environmental and waste management officer, two were parks and open spaces supervisors, another was a conservation officer, while one was a forester. The shortest serving respondents had been doing the job related to tree planting and maintenance for a year while the longest serving had been doing the job for 30 years. The respondents' jobs ranged from supervising the planting and maintenance of street trees, maintaining sports fields and cemeteries, looking after protected areas, waste management, helping to establish new forests and providing technical expertise relating to tree planting, to planting trees and maintaining landscapes as part of a community service and sometimes on a contract basis.

Chapter 3

The distribution, composition, and dominance of street trees

3.1 Introduction

Urban forestry is poised to "go global" with the intent of using trees to mitigate several of the negative environmental and social effects of urbanisation, and to contribute to the long-term goal of creating more liveable and environmentally sustainable eco-cities (Carreiro, 2008). In promoting urban forestry, street trees have become the major strategy to fulfil this goal in many cities worldwide. The planting of trees can be seen by many as the simplest and most popular way of greening urban streets and suburbs (Grant, 2012). Trees in urban areas can be found in parks and open spaces, conservation and natural areas, civic and institutional facilities, community gardens, greenways and streets (Strom, 2007). Streets are the single most abundant public spaces within the urban structure and are the primary setting for public life (Strom, 2007). However, streets are underutilised in many cities, especially as an urban forest resource (Strom, 2007). Streets provide passages that can be planted to create vegetated and "treed" linkages between parks and open spaces, and civic and institutional facilities while enhancing the pedestrian scale and aesthetic quality of the urban environment (Strom, 2007). Many cities globally are actively increasing green space areas or planting trees to improve the livelihoods of urban dwellers (Churkina *et al.,* 2015). Street trees are a widespread, common form of urban nature, often found in urban areas even in the absence of nearby parks and other green spaces (Grant, 2012). They have in the past been planted for their aesthetic benefits such as beautifying the streetscapes but in recent years, more of their benefits have been identified and appreciated (Grant, 2012). Besides park trees and trees in private gardens, street trees play the biggest role in improving the climatic conditions for the urban population in arid cities (Breuste, 2013). Notwithstanding this, there have been many towns that have been observed as having a number of treeless spaces but are biophysically suitable for the establishment of trees, which suggests that there are instances where social factors are actively preventing the establishment and planting of trees (Kirkpatrick *et al*., 2011).

Despite their benefits, street trees represent a minority of the overall urban forest, but they often receive special attention because of their public functions and benefits to the broader urban area (Cumming *et al.,* 2008). The public functions of street trees as demonstrated through the provision of ecosystem services are highly dependent on specific design principles, which include the composition and diversity of tree species within the urban forest (Kendal *et al.,* 2014). Tree species composition and diversity contribute directly to some services, such as the provision of aesthetic and psychological benefits (Fuller *et al.,* 2007), and enhances the resilience of the provision of ecosystem services in systems that are subject to change (Elmqvist *et al.,* 2003; Dobbs *et al.,* 2011; Kendal *et al.,* 2014). Therefore, the selection of the most appropriate trees is important for the success of any tree-planting program (Gerhold and Porter, 2007). In selecting the most appropriate species to plant on streets, it is important that the purpose of the trees be defined, and that the site conditions that will affect the choice be evaluated (Gerhold and Porter, 2007). Additionally, the arboriculture practices that can impact on the trees need to be considered and the development of a selection criteria that is based on purpose, site and managerial impacts also needs to be put in place (Gerhold and Porter, 2007). In addition, the characteristics of candidate trees need to be matched to the criteria for identifying suitable varieties, which will ultimately lead to the final choice of tree species to plant (Gerhold and Porter, 2007). Once these conditions have been identified and met it is most likely that street trees will serve their intended purposes, their vulnerability to stresses will decrease and so will their mortality rates.

The increase in the development of urban areas often creates environmental conditions that will not support the continuous existence of street trees and in some instances, street trees are highly stressed by environmental influences because of their location and sometimes poor maintenance, which can ultimately lead to increased mortality (Breuste, 2013). Street trees are constantly fighting for survival, competing for sunlight with urban infrastructure, and diminished oxygen, water and volume in compacted soils (Consolloy, 2007). Street trees are also prone to a variety of pests and diseases (Tomlinson *et al.,* 2015) and vandalism (Richardson and Shackleton, 2014). There are many street floras that are introduced and are therefore alien in the countries in which they are found (Kowarik, 2011; McConnachie *et al.,* 2008). Urban trees are particularly at risk of contracting diseases and pests when there is low diversity of tree species, where monoculture planting potentially means that an entire population of trees can be devastated during a single pest outbreak (Raupp *et al.,* 2006). The occurrence of indigenous and alien species in urban flora follows different patterns of dispersal

between cities, which act as immigration sources from which the alien species can disperse into the surrounding landscape (Alston and Richardson, 2006; McConnachie *et al.,* 2008). Various studies (i.e. Santamour, 1990; Sun, 1992; Tello *et al.,* 2005; Raupp *et al.,* 2006; Bassuk *et al.,* 2009; Subburayalu and Sydnor, 2012) suggest that the use of a wide selection of species to plant on streets is generally professed as one of the most important instruments to ensure the resilience of urban tree populations against recurring outbreaks of diseases, the threat of future diseases, and the infestations of pests on the most commonly used tree species.

In attempts to minimise the risks of tree loss due to pests and disease, the diversification of trees at higher taxonomic levels has been recommended because pests generally operate at the genus and family levels (Nowak, 2001; Raupp *et al.,* 2006; Laćan and McBride, 2008). To achieve diversity in street tree species, an initial evaluation of diversity in the existing tree populations should be conducted before any new planting or replacement is undertaken (Subburayalu and Sydnor, 2012). The evaluation of diversity can be achieved through any or a combination of the methods as used by Sanders (1981); McPherson and Rowntree (1989); Santamour (1990); Sun (1992); Galvin (1999); Raupp *et al.* (2006); and Laćan and McBride (2008). The two most commonly used methods of assessing street tree diversity are the target-based 10/20/30 heuristic guideline (Santamour, 1990) and the non-target-based mathematically computed indexes, such as the Simpson and Shannon-Weiner indexes (Sanders, 1981; Sun, 1992). The “target-based 10/20/30 heuristic guideline”, which was proposed for protecting urban forests from serious pest outbreaks, suggests that the street tree population should consist of not more than 10 % of a single tree species, 20 % of a single genus and 30 % of a single family (Santamour, 1990). However, this guideline does not consider that most pests attack more than one tree species, genus or family at any given time (Raupp *et al.,* 2006). To mitigate this, Raupp *et al.,* (2006) then suggested that diversification takes place at the genus, family and possibly the ordinal levels. This had previously been challenged in 1983 by Richards (1983), who argued that there is little scientific base in this method and could result in a less stable population if the adaptability of various taxa is not considered. The “non-target-based mathematically computed indexes” use indices to calculate species diversity (Keylock, 2005). The most commonly used indices of species diversity in the ecological arena are the Shannon–Wiener index and the Simpson index (Keylock, 2005). Similarly to the “target-based 10/20/30 heuristic guideline”, they are limited because they are based entirely on the number and relative abundance of all the taxa being evaluated (Subburayalu and Sydnor, 2012). Despite having a scientific basis, the use of these indices as an evaluation tool in the tree selection process is

limited to the number and evenness of the taxonomic unit being evaluated (Subburayalu and Sydnor, 2012). To mitigate these limitations, Richards (1983) outlines guidelines for street tree diversity, correctly noting that such diversity should relate to the set of conditions and objectives for a given community. Thus, urban foresters and municipal officials responsible for urban greening should consider several factors and limitations such as location and tree species during the planting of new trees or the replacement of old ones (Subburayalu and Sydnor, 2012). Pest vulnerability, environmental benefits, and tree adaptability are some of the factors that could also be considered (Subburayalu and Sydnor, 2012).

The planting and presence of trees and other vegetation in the urban landscape is important for the quality of life of urban residents, and therefore need to be diversified to effectively play this role (Othman *et al.,* 2015). The contributions of trees to the quality of life of urban residents are demonstrated through their provision of various ecosystem services that contribute to the health and well-being of people and enhanced environmental quality (Kuruneri-Chitepo and Shackleton, 2011). In this regard, municipalities globally are actively planting trees, with China having reported a consistent growth in urban green spaces from 17 % of urban green cover in 1989 to 37 % in 2009 (Churkina *et al.,* 2015). The species composition within the urban forest varies with climate (Kendal *et al.,* 2012a), and patterns of diversity in the urban forest within cities are also varied in relation to biophysical (Kirkpatrick *et al.,* 2007) and socio-economic factors (Kendal *et al.,* 2012b). Moreover, some studies have shown that species diversity may be affected by land use where diversity may be lower in streetscapes, particularly in cold climates (Pauleit *et al.,* 2002; Sæbø *et al.,* 2003; Sjöman and Nielsen, 2010) and higher in gardens (Smith *et al.,* 2006; Kendal *et al.,* 2012b). Therefore, it is plausible that the global patterns of diversity, and therefore the relative abundance of the most common tree species, genera and families in the urban forest will most likely be related to both physical environmental variables and social variables (Kendal *et al.,* 2014).

In South Africa, the legacy of apartheid has left visible disparities in the distribution, diversity and variation of street trees both between and within towns (Kuruneri-Chitepo and Shackleton, 2011; Shackleton *et al.,* 2014). This is evident in the low abundance or absence of street trees in many former homeland towns compared to the abundance of street trees in towns that were not part of the homelands during apartheid. The towns in the former homelands are mostly characterised by poverty, with a large proportion of its residents living in rural areas surrounding the town, and with low socio-economic attributes and underdevelopment (Gwedla and Shackleton, 2015). The majority of the towns that were not part of the homeland system

have higher populations and have higher socio-economic attributes than the former homeland towns. Within these towns, there are also disparities in the distribution and variation of street trees between residential areas. The affluent, and in many instances, formerly white suburbs are characterised by a greater distribution and abundance of street trees than both the townships and the post-1994 housing developments under the Reconstruction and Development Programme (Kuruneri-Chitepo and Shackleton, 2011). The latter two suburbs are characterised by a lower abundance, distribution and diversity of street trees, with the township suburbs having more street trees than the RDP suburbs. The township suburbs and the RDP suburbs are where most black South Africans still live, and are characterised by poverty, high-density housing, poor service delivery and in some instances limited commercial activities. On the other hand, the affluent suburbs are characterised by infrastructural and social attributes typical of cities in the first world, with well laid out and maintained leafy suburbs with low housing densities, adequate infrastructure and efficient service delivery.

In light of the above, tree inventory is one of the most important aspects of managing street trees because it provides municipal officials with the detailed information they may need to manage and plan for maintenance, new tree planting and planning for greater species diversity (Cowett and Bassuk, 2014; Chishaleshale *et al.,* 2015). It is crucial that data on tree species distribution including composition, diversity, size, age structure and spatial inventories be assessed and made available for effective long-term management of street trees (Nagendra and Gopal, 2010; Chishaleshale *et al.,* 2015). This information becomes necessary especially for urban planners, urban managers or municipal officials who seek to maximise the benefits provided by street trees. However, a significant number of officials who are responsible for establishing and maintaining urban tree populations lack the necessary knowledge for the appropriate tree species selection, care and maintenance, as well as information on the street trees of their respective towns, including basic information on the city street tree inventory (Jim and Chen, 2008; Gwedla and Shackleton, 2015; Chisaleshale *et al.,* 2015). This has been found to be true in many Asian countries (Jim and Chen, 2008), and unfortunately the same can be said about the developing countries in Africa, with South Africa being no exception (Gwedla and Shackleton, 2015; Chishaleshale *et al.,* 2015). This chapter sought to determine and contrast the abundance, composition and diversity of street trees between, and within, selected Eastern Cape towns.

3.2 Methods

See Chapter 2, Section 2.1 paragraph one, two and four for full details.

3.3 Results

3.3.1 Distribution of street trees between and within towns

Of the 300 sample transects, only 69 (23 %) had any street trees, ranging between three transects in Libode and Peddie, and 11 transects in Matatiele. Within the 69 transects, 888 trees were enumerated, with the highest number of trees (293) encountered in Graaff-Reinet and the least (four) in Libode (Table 3.1).

Table 3.1: Distribution of street trees per town.

Town	**Number of transects with trees(n=30/town)**	**Number of street trees**
Burgersdorp	8	117
Cradock	7	90
Graaff-Reinet	10	293
Libode	3	4
Matatiele	11	95
Peddie	3	12
Port St John's	6	43
Queenstown	8	131
Tsolo	5	12
Willowmore	8	91
Total	69	888

Of the 888 enumerated trees, three could not be measured because they were either enclosed or impossible to measure because there were two or more trees intertwined and growing together. The highest number of street trees per 200 m transect was 51 in Graaff-Reinet. There were several instances where only one tree was encountered in at least one transect across all towns. Ninety-seven species were encountered, of which 71 were identified to the species level, seven to the genus level, namely *Acer, Cupressus, Fraxinus, Pinus, Prunus, Pyrus, and Senna sp.*, and three to the family level, namely *Arecaceae, Bignoniaceae, Myrtaceae*. The remaining

16 species could not be identified (Table 3.2). Unidentified species were not categorised according to their origin.

Table 3.2: Average number of species per transect encountered more than three times across all towns (*= Indigenous species).

Species	Burgersdorp	Cradock	Graaff-Reinet	Libode	Matatiele	Peddie	Port St John's	Queenstown	Tsolo	Willowmore
Acer buergerianum	-	-	-	-	0.7	-	-	1.3	-	-
Agathis robusta	-	-	-	-	-	-	0.5	-	-	-
Bauhinia forficata	-	-	-	-	-	-	-	0.5	-	-
Betula pendula	0.5	-	-	-	1.5	-	-	-	-	-
Bignoniaceae spp.	-	-	-	-	-	-	0.8	-	-	-
Brachychiton populneus	-	-	1.0	-	-	-	-	0.4	-	-
Cedrus deodara	0.3	-		-	0.2	-	-	-	-	-
Celtis africana*	1.1	0.4	1.2	-	0.3	-	-	2.4	-	-
Celtis sinensis	-	-	1.1	-	-	-	-	-	-	-
Ceratonia silique	-	0.4	1.9	-	-	-	-	-	-	-
Cotoneaster glaucophyllus	0.4	-	-	-	0.1	-	-	-	-	-
Delonix regia	-	-	0.9	-	-	-	-	-	-	-
Erythrina caffra*	-	-	-	-	-	-	0.5	-	-	-
Fraxinus americana	1.4	0.1	4.3	-	-	-	-	1.5	-	-
Fraxinus spp.	0.4	-	0.2	-	0.6	-	-	1.1	-	-
Fraxinus velutina	5.6	-	3.0	-	-	-	-	2.9	-	-
Grevillea robusta	-	-	0.5	-	-	-	-	-	0.4	1.9
Hakea salicifolia	-	-	-	-	-	-	-	-	0.8	-
Harpephyllum caffrum*	-	-	0.8	-	-	2.7	-	-	-	-
Ligustrum lucidum	0.3		-	-	0.1	-	-	-	-	-
Ligustrum ovalifolium	0.1	0.3	-	-	-	-	-	-	-	-
Melia azedarach	0.5	-	0.3	-	0.1	-	-	-	-	-
Morus japonica	0.1	0.6	-	-	1.9	-	-	-	-	-
Musa paradisiaca	-	-	-	-	-	-	0.5	-	-	-
Olea africana*	-	2.1	0.4	-	0.1	-	-	-	-	-
Pinus halepensis	-	-	-	-	-	-	-	-	0.4	4.3
Pinus spp.	0.1	2.1	2.2	0.3	-	-	-	-	0.2	-
Platanus acerifolia	-	-	-	-	1.2	-	-	-	-	-

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Table 3.2 continued…

Robinia pseudoacacia	**2.1**	**0.4**	**0.2**	**-**	**-**	**-**	**-**	**0.1**	**-**	**2.0**
Schinus molle	**-**	**-**	**0.4**	**-**	**0.1**	**1.3**	**-**	**-**	**-**	**-**
Schinus terebinthfolius	**-**	**-**	**0.4**	**-**		**-**	**-**	**-**	**-**	**-**
Searsia lancea*	**-**	**0.7**	**0.1**	**-**	**0.9**	**-**	**-**	**-**	**-**	**3.3**
Sophora japonica	**0.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Tamarix gallica	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**-**
Thuja occidentalis	**-**	**-**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Trema orientalis	**-**	**-**	**-**	**-**	**-**	**-**	**0.5**	**-**	**-**	**-**
Ulmus parvifolia	**0.5**	**-**	**-**	**-**	**-**	**-**	**-**	**3.5**	**-**	**-**
Unknown 1	**-**	**0.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

The following species were only encountered as two trees across the 10 towns: *Acacia galpinii*, Albizia julibrissinn, Allophylus natalensis*, Asimina triloba, Bauhinia blakeana, Callistemon citrinus, Citharexylum fruticosum, Crataegus lavallei, Ficus elastica, Persea americana, Pittosporum tobira, Prunus persica, Prunus sp., Senna sp., Syzygium paniculatum*

The following species were only encountered as one tree across the 10 towns: *Acacia karroo*, Acer spp., Araucaria heterophylla, Arecaceae spp., Bauhinia natalensis*, Brachychiton rupestris, Cupressus spp., Casuarina cunninghamiana, Eucalyptus cinerea, Ficus sur*, Malus domestica, Myrtaceae spp., Pinus patula, Podocarpus latifolius*, Populus deltoides, Prunus africana, Prunus domestica, Psidium guajava, Pyrus sp., Quercus robur, Rubus ursinus, Rubus villosus, Salix babylonica, Schinus ariera, Thuja orientalis*

The most dominant street tree species across all towns were *Fraxinus velutina* (98 trees across three towns), *Jacaranda mimosifolia* (77 trees across two towns), and *Fraxinus americana* (67 trees across four towns). The most dominant indigenous street tree species across all towns were *Celtis africana* (48 trees across five towns), *Searsia lancea* (42 trees across four towns), and *Podocarpus falcatus* (23 trees in one town). The most common tree species which were encountered in at least 40 % or more of the towns were *Celtis africana, Fraxinus americana*, *Fraxinus sp., Pinus sp., Robinia pseudoacacia* and *Searsia lancea*. No indigenous species were encountered in Tsolo, while 50 % of the species encountered in Peddie were indigenous (Figure 3.1). Altogether, alien tree species accounted for 71 % of the sample, indigenous tree species 12 %, and unknown species (likely to be alien) 17 % (Figure 3.1).

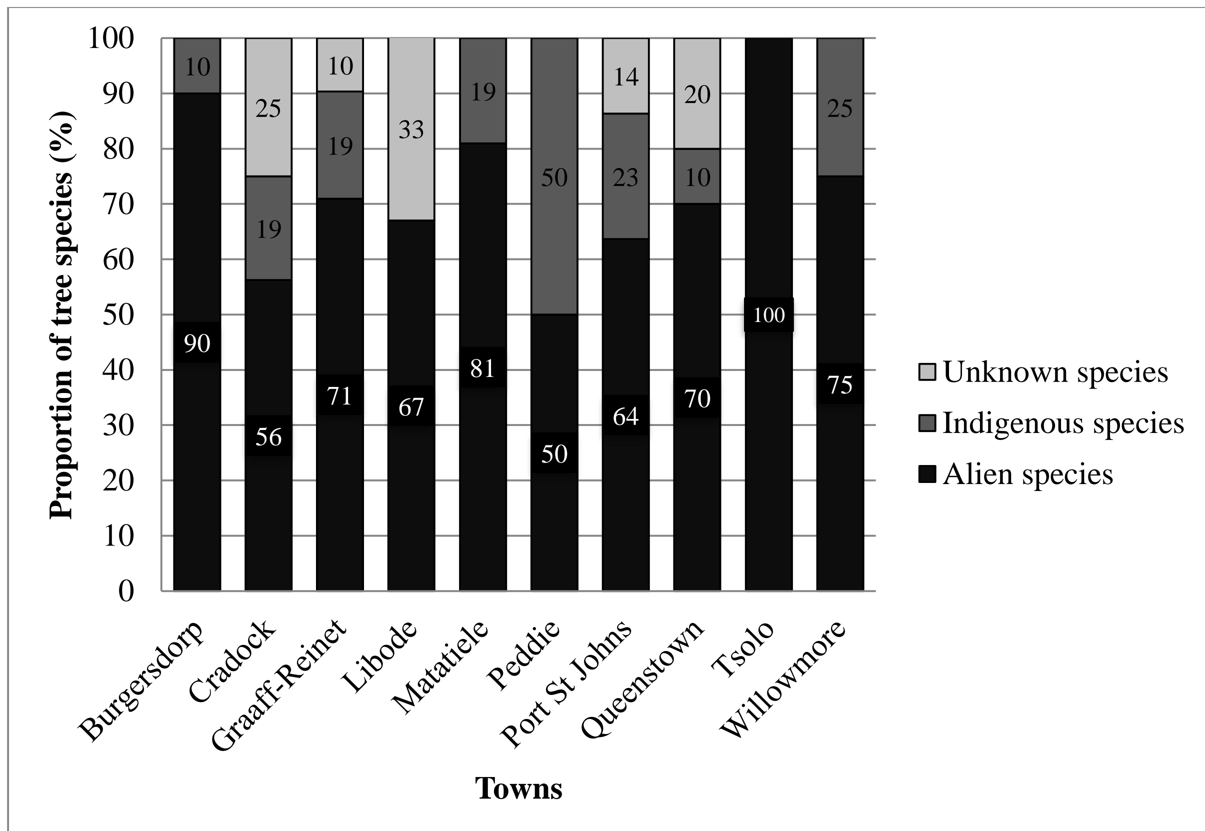

Figure 3.1: The proportions of indigenous, alien and unknown tree species per town.

There was a significant positive relationship between the mean density of street trees per town and the size of the town in terms of population (r^2=0.5; p<0.05). The towns with a larger population had a higher mean street tree density than those with a smaller population (Figure 3.2). There was no significant association between mean street tree density and the area of towns (r^2=0.3; p>0.05). Graaff-Reinet was an outlier in both instances with a high mean tree density relative to its size (both population and surface area) (Figure 3.2 and Figure 3.3).

Mean street tree density was 0.6±0.3 trees per transect in the former homeland towns compared to 5.8±1.6 trees per transect in the non-former homeland towns (*t*=2.9; p<0.05). There was a significant difference in mean street tree density between the low (0.3±0.2), medium (3.0±1.0) and high (6.9±4.2) density towns (H=7.03; p<0.05). Post-hoc analysis showed that the high density towns were significantly higher than the low and medium, which were not significantly different from one another.

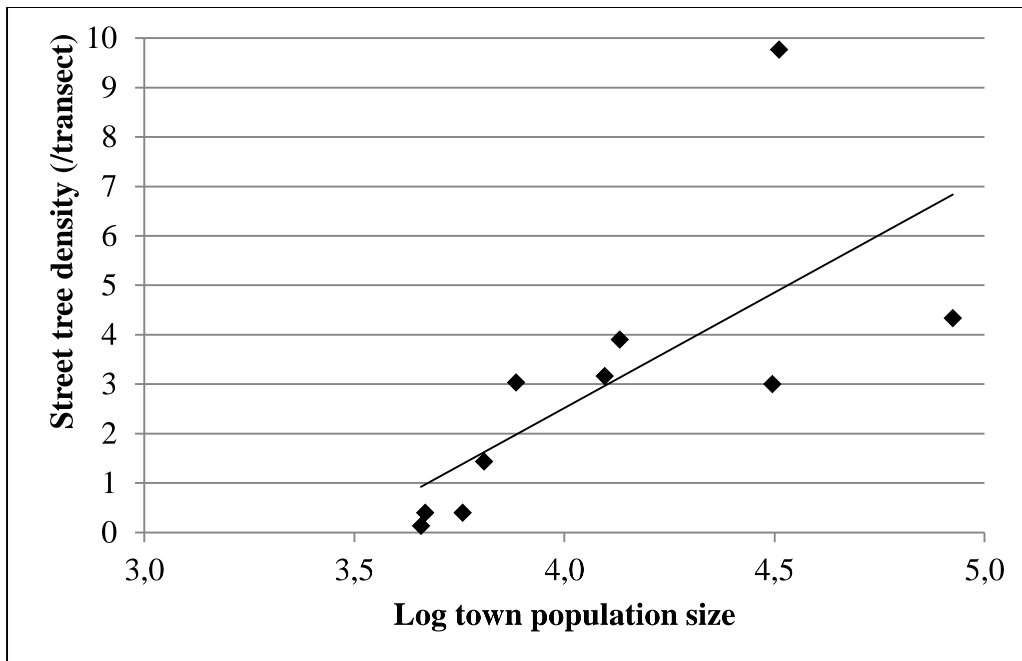

Figure 3.2: Mean street tree density as a function of town population size (r^2=0.5, $p<0.05$).

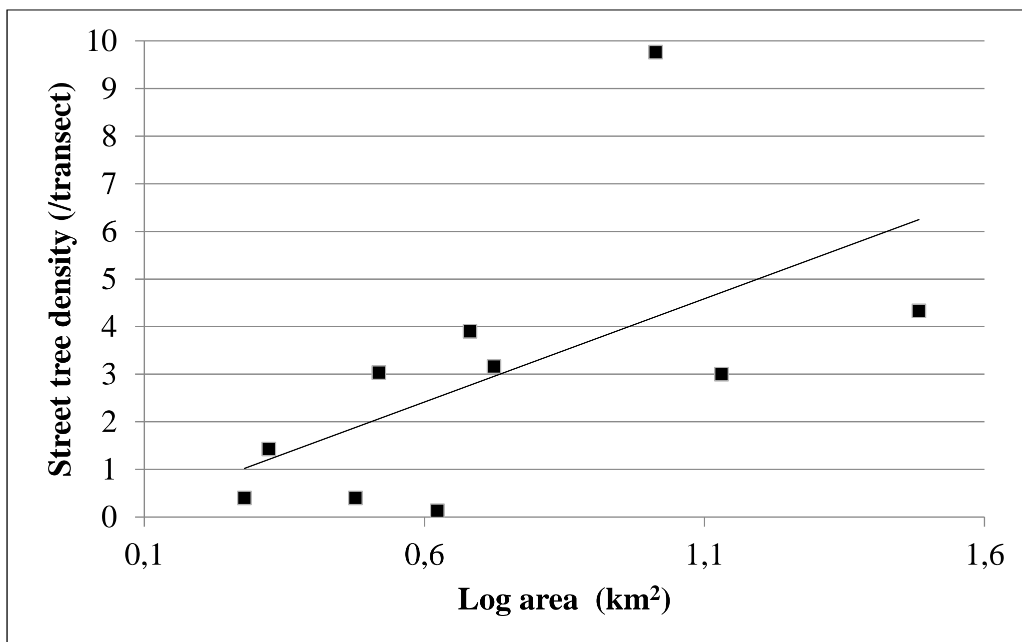

Figure 3.3: Mean street tree density as a function of town area (r^2=0.3; $p>0.05$).

All the towns with a classified low street tree density were also situated in the former homelands, and all those with a classified high street tree density are situated in the non-former homelands. Only one of the towns (Port St John's) with a classified medium street tree density was situated in the former homeland.

There was no significant relationship between mean annual rainfall and street tree density per transect (r^2=0.25; p>0.05) (Figure 3.4). The town with the lowest mean street tree density (Libode) has a mean annual rainfall above 601 mm, while the town with the highest (Graaff-Reinet) has a mean annual rainfall less than 250 mm.

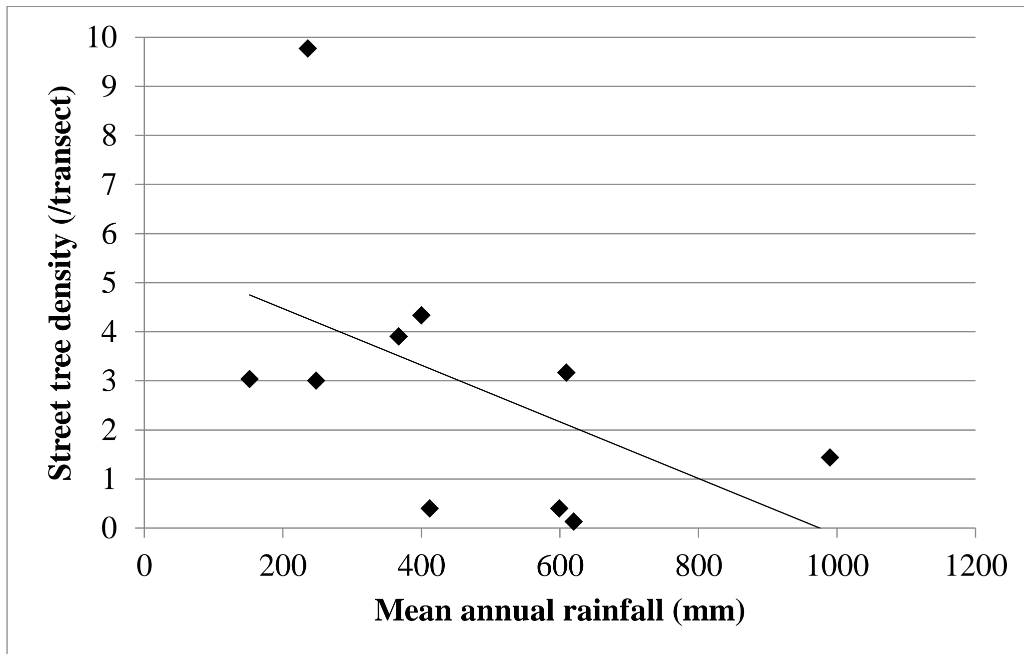

Figure 3.4: Mean street tree density as a function of town mean annual rainfall (r^2=0.25; p>0.05).

3.3.2 Composition and attributes of street trees between towns

There were no significant differences in the mean street tree density per transect between towns (H=9.0; p>0.05), with mean street tree density per transect per town ranging from 0.1±0.1 trees in Libode to 9.8±2.9 trees in Graaff-Reinet (Table 3.3). There was also no significant difference in the mean stem circumference of trees between towns (H= 9.0; p>0.05), ranging from 51.6±20.1 cm in Peddie to 166.5±20.0 cm in Port St John's (Table 3.3). The average size of trees per transect across all towns was 106.5 cm, implying that most of the trees were relatively large and therefore planted some time ago. The smallest tree sampled was 3.2 cm, in Matatiele, while the largest tree was 598.9 cm in Port St John's (Table 3.3). Graaff-Reinet had the biggest range of street tree density, with the lowest number of trees per transect found being zero and the highest being 51, while Libode had the lowest range (Table 3.3). There were considerable differences in the number of species recorded between towns (Table 3.3). Species richness was highest in Graaff-Reinet with 31 species recorded, followed by Port St John's (22) and Matatiele (21), and the lowest in Peddie with two species (Table 3.3).

Table 3.3: Attributes of street trees in 10 different sample towns.

Towns	Tree density per 200 m transect		Tree circumference (cm)		Diversity	
	Mean ± SE	Range	Mean ± SE	Range	Species richness per town	Shannon Diversity Index
Burgersdorp	3.9±1.6	0-40	90.4±4.2	6.6-200.3	19	4.0
Cradock	3.0±1.2	0-22	103.2±5.6	8.3-290.2	16	2.3
Graaff-Reinet	9.8±2.9	0-51	102.6±2.9	7.9-329.8	31	2.7
Libode	0.1±0.1	0-2	125.7±8.1	103.9-143.0	3	1.0
Matatiele	3.2±1.1	0-22	103.6±6.7	3.2-276.3	21	2.4
Peddie	0.4±0.3	0-7	51.9±20.1	9.1-233.5	2	0.6
Port St John's	1.4±0.6	0-15	166.5±20.0	13.2-598.9	22	2.9
Queenstown	4.3±1.5	0-28	115.9±5.7	3.8-360.2	20	2.4
Tsolo	0.4±0.2	0-4	134.5± 28.7	50.7-420.3	7	1.7
Willowmore	3.0±1.1	0-19	70.9±6.0	6.1-246.8	4	1.3
Significance	p>0.05	n/a	p>0.05	n/a	n/a	n/a

3.3.3 Distribution of street trees between suburbs

Significantly more of the trees enumerated were found in the affluent suburbs than both the township (χ^2=10124.4; $p<0.05$) and RDP suburbs (χ^2=450.0; $p<0.05$). Seventy-seven percent of the enumerated trees across all towns were found in the affluent suburbs, 16 % in the township suburbs and 7 % in the RDP suburbs (Table 3.4). The density of street trees between the different suburbs ranged from 0-267 trees per transect in the affluent suburbs, 0-26 trees in the township suburbs and 0-8 trees in the RDP suburbs (Table 3.4).

Table 3.4: Distribution of street trees between suburbs in each town.

Town	Number of transects with trees (n=10/suburb/town)			Number of street trees		
	Suburb			Suburb		
	Affluent	Township	RDP	Affluent	Township	RDP
Burgersdorp	7	1	0	115	2	0
Cradock	5	2	0	78	12	0
Graaff-Reinet	8	2	0	267	26	0
Libode	3	0	0	4	0	0
Matatiele	5	3	3	63	25	7
Peddie	1	0	2	4	0	8
Port St John's	6	0	0	43	0	0
Queenstown	7	1	0	123	12	0
Tsolo	5	0	0	12	0	0
Willowmore	6	2	0	65	26	0
Total	53	11	5	774	99	15

3.3.4 Composition and attributes of street trees between suburbs

The affluent suburbs had a significantly higher mean density of street trees per transect than both the township and the RDP suburbs ($H=20.9$; $p<0.05$), which were not significantly different to one another. The mean street tree density in the affluent suburbs across all towns was 7.7±2.5 trees per transect, 1.0±0.7 trees in the township suburbs, and 0.2±0.1 in the RDP suburbs (Figure 3.5). Most of the trees in the affluent suburbs were found in Graaff-Reinet (26.7±5.8), while the least were found in Peddie (0.4±1.4) (Figure 3.5). Most of the trees in the township suburbs were found in Graaff-Reinet (2.6±1.9) and Willowmore (2.6±1.7), respectively, while most of the trees in the RDP suburbs were found in Peddie (0.8±0.7) (Figure 3.5).

Ninety tree species were found in the affluent suburbs, while 19 species were found in the township suburbs and two were found in the RDP suburbs. Graaff-Reinet's affluent suburbs had the highest species richness with 24 species. Species richness in the affluent suburbs was the lowest in Peddie with one tree species. The township suburbs in Graaff-Reinet had the highest species richness with 12 species, while Willowmore and Burgersdorp had the least with one species. The biggest trees were found in the affluent suburbs in Port St John's with a mean circumference of 166.5±20.0 cm, while the smallest trees were found in the RDP suburbs of Peddie with a mean circumference of 11.11±0.4 cm.

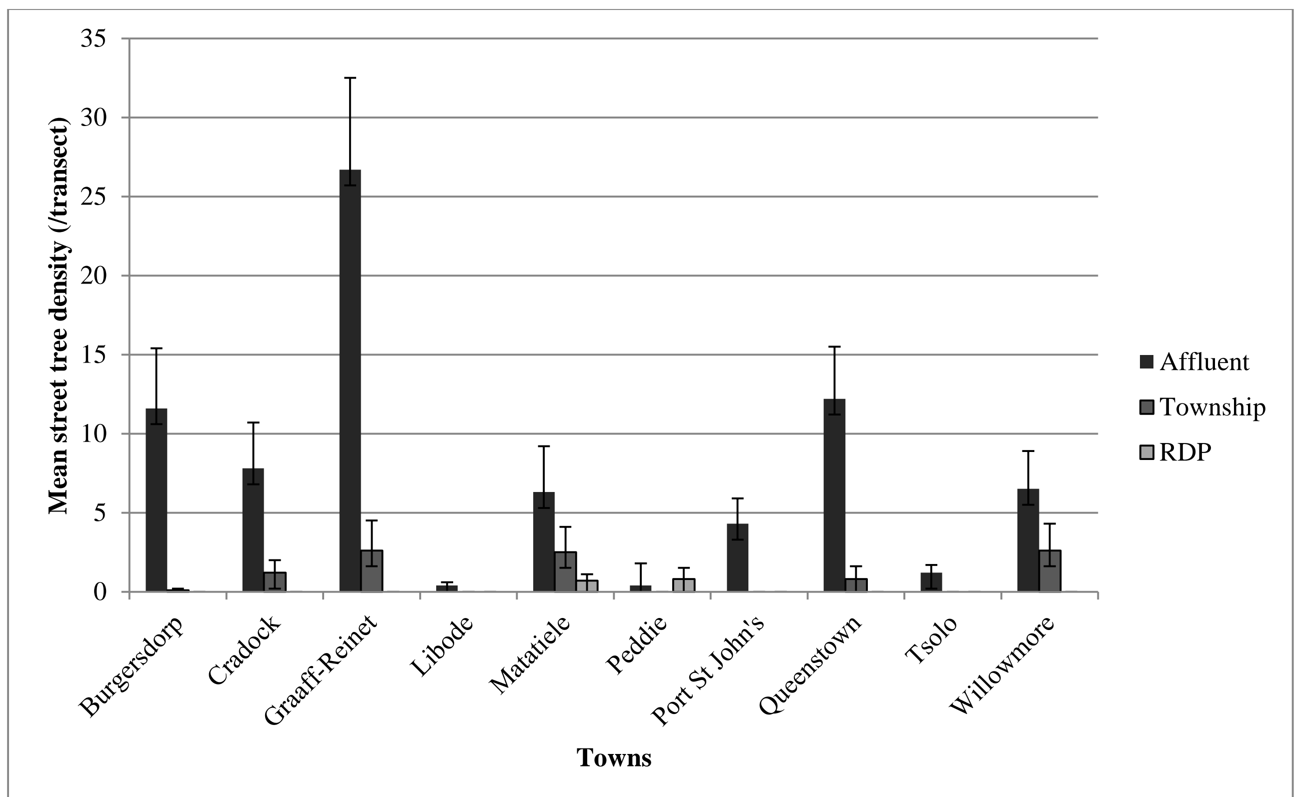

Figure 3.5: Mean street tree density per transect between suburbs across 10 towns.

3.3.5 Horticulturists' perceptions of street tree distribution, composition and dominance

In selecting street trees, all the respondents agreed that the four most important characteristics they consider before planting are the root system of the prospective tree, the eventual size or shape of the species, whether alien or indigenous, and the species' adaptability to the climate of the respective town. These characteristics of trees were often complemented by the location where the tree will be planted, availability of space in the respective location and the purpose the tree will serve.

The criterion most used by all respondents in selecting species suitable to plant in their respective towns is the water requirements of the prospective species and their adaptability to the climate of the town. Because all the respondents have been doing the job for less than 10 years, knowledge that has been passed on from previous horticulturists and municipal standards with regards to tree planting is often used. Five of the respondents mentioned that the most suitable species for street planting in their respective towns were those that met the criteria described above, with additional considerations regarding the cost of the trees. In contrast, one of the respondents mentioned that cost considerations were not an issue in the choice of species

because some of the trees planted in their town were some of the most expensive (~ZAR200), and these were planted because they grow fast and are neat.

Port St John's is a coastal town and is characterised by natural coastal evergreen forests and as such, there is hardly any new planting of trees. Trees were mostly planted at the entrance to the town where seeds from existing trees around the town were harvested and used. In contrast, a respondent from Queenstown reported that the species planted there are mostly deciduous with very few evergreen ones. This is because the municipality felt that evergreen species become layered with dust, rendering them untidy and less attractive, especially for ornamental purposes, whereas the deciduous species become more attractive during their season of bloom.

In siting street trees in the different parts of the town, various strategies were mentioned by the respondents. One of them mentioned that they just plant trees when they are available and they see a need for them with no consideration of the suburb. Another respondent mentioned that they randomly select areas to plant trees and then distribute trees to community members who then decide with their councillors on where the trees should be planted. In one instance, it is preferred that people plant trees in their yards to minimise vandalism and lack of maintenance. Another consideration when situating street trees in the various suburbs is the cost of the tree and the likelihood of vandalism; in this case the more expensive trees are likely to be planted in suburbs that are less prone to vandalism whereas the cheaper ones are planted in suburbs prone to vandalism.

Five of the respondents identified obstruction to traffic and interference with electricity lines as reasons that could lead to the removal of street trees. A respondent from Matatiele explicitly mentioned that they have had numerous requests from residents to remove some trees on their streets because they either cracked the foundations of their houses or lifted the tar road. Another reason mentioned by two of the respondents is that they usually remove trees when they are too old and their branches start falling off, posing a potential danger to people and cars. The respondent from Queenstown mentioned that they did not identify any reasons that could lead to the removal of street trees in their town.

The respondents also identified perceived threats to street trees in their respective towns. The biggest threats identified by all respondents were vandalism to the trees, both by animals and people (who mostly steal the trees just after they have been planted), and the lack of education and awareness regarding the importance of street trees among urban residents. To counter this, four of the respondents mentioned that their respective municipalities have opted to give trees

to people that ask for them to plant in their yards. One of the respondents mentioned that they have not recently planted any new trees since the last ones had been vandalised, emphasising that their department does not have enough funds to buy more trees. Another respondent mentioned that crime has also become a threat to acceptance of street trees because most residents request for trees to be cut down because of the criminal activity they believe happens as a result of having trees near their home. Another perceived threat was political conflict whereby certain population groups, not in favour of the current political party in their town, would make it their mission to destroy anything they think has been erected by the municipality. Additionally, some residents feel that the political party in power favours and takes care of certain residential areas and therefore they try to show their anger in this regard by destroying any developments in those respective residential areas. Another threat identified by two of the respondents was climate change. These respondents mentioned that due to the changing climate, most trees they already have will die as a result of not being suited to the warmer temperatures being experienced. This then poses a challenge to them as personnel responsible for tree planting in having to keep up with these trends and ensuring that they have trees that can withstand all weather conditions at all times.

The biggest challenges faced by the respondents as pertaining to their jobs, and to the planting and maintenance of street trees, was limited funding for urban greening programmes, and lack of skilled personnel and equipment suitable for planting and maintaining trees. One of the respondents mentioned that the unskilled people they employ to plant and maintain the trees are the ones who end up vandalising the trees because they have no regard for what they are doing. Three of the respondents also mentioned that the vandalism and stealing of street trees is a challenge they are faced with daily. One of the respondents mentioned that there is a lack of communication between the residents and the municipality. As a result, residents do not inform the municipality when they need certain trees to be removed but resort to vandalising the trees. Another respondent mentioned that having to replace trees that have either been vandalised or stolen is a challenge for them and they end up not seeing progress in urban greening programmes. Two of the respondents mentioned that they do not get enough support from the municipality when initiating urban greening programmes. This is because there are no departments in their municipalities dedicated solely to urban greening (development and maintenance of parks, sports fields, street trees and cemeteries), but rather these functions are performed by different departments who are perceived to be related to such activities.

In addressing these challenges, all respondents believe that education and awareness about the importance of urban green spaces is crucial, both to urban residents and to senior municipal officials in order for them to understand why there is a need for street trees and other green infrastructure in towns. One of the respondents suggested that officials need to have clear programmes on awareness for both municipal officials and residents to get buy-in from senior managers because they are usually the ones who hold back in supporting urban greening programmes. Another strategy mentioned four of the respondents was to lobby for funds, participate in fundraising projects and apply for donations to ensure that there are sufficient funds to support any urban greening projects they might have.

3.4 Discussion

This chapter sought to assess the abundance, species composition, diversity and dominance of street trees planted in a range of towns, to investigate why specific tree species are planted and the characteristics of what horticulturists regard as good species for street planting. It provided valuable information on the structure of the Eastern Cape urban forest. The study revealed significant variability in the number and distribution of street trees between and within towns. The distribution is not uniform across all towns, with some towns having significantly more trees than others, although they are all in the same province. Similarly, the abundance of street trees between the various towns is variable. These results concur with Gwedla and Shackleton (2015) who found Graaff-Reinet to have the highest abundance of street trees, with towns like Burgersdorp and Queenstown also having higher street tree densities than most towns. These towns and their municipalities are larger and more affluent (Stats SA, 2012), which according to Conway and Urbani (2007) are associated with high street tree densities, owing to the fact that they usually have sufficient resources, skills and more extensive urban forestry policies while the poorer towns do not (Gwedla and Shackleton, 2015; Chishaleshale *et al.,* 2015).

Variation in street tree abundance has also been seen to be substantial in many towns in the developed world, attributed to the size of the ecoregion and town (e.g. Nowak *et al.,* 1996, 2001). On the contrary, Fuller and Gaston (2009) found that the proportion of green spaces in European towns increased with the area of the town, and mildly declined with population density. Low abundance of street trees in the poorer towns, which were all part of the former homelands, demonstrates the stark image of apartheid in South Africa where attention was mostly given to towns that were not part of the homelands. According to McConnachie *et al*. (2008), the former homeland towns have smaller and lower quality of urban green spaces than

the non-former homeland towns. Thus, compared to some Australian cities (Kendal *et al.,* 2012a), the variability in street tree cover and distribution can be partially attributed to the differences in the social environment of cities and historical patterns of development. While street trees are largely planted and maintained through human agency, there was evidence of the influence of abiotic factors in the size of the trees. The towns with the largest trees also have a high mean annual rainfall. This can be seen in Willowmore which has small trees and receives less than 200 mm of rain a year.

In 2006, Nowak *et al*., reported that the nature of the biome in which towns are situated, influences to some degree the extent of tree cover. They found that towns in forested areas had 31 % tree cover, compared to 19 % for those in grasslands and 10 % for those in deserts. This indicates some influence of biophysical determinants over social ones. However, my study did not corroborate this with regards to street trees. Port St John's is in the forest biome, but it did not boast the highest density nor species richness of street trees; however, it did have the largest trees. The three towns in the grassland biome (Matatiele, Queenstown and Tsolo) did not have the lowest density species richness.

None of the towns complied with the 10/20/30 rule proposed by Santamour (1990) that the street tree population should consist of not more than 10 % of a single tree species, 20 % of a single genus and 30 % of a single family. The proportion of dominant species did not translate to them being the most common, as the most dominant street trees across all towns were alien species and only two of the most common were indigenous. The results in this study support those by Thaiutsa *et al.* (2008) where although there may be high species richness in a city, only a few species dominate. This was evident in towns like Burgersdorp, which was dominated by *Fraxinus velutina,* Graaff-Reinet by *Jacaranda mimosifolia* and *Fraxinus americana*, and Queenstown by *Ulmus parvifolia*. Findings in this study do not correlate with those by Nagendra and Gopal (2010) where, "compared to other cities, Bangalore's streets have low tree densities but high species diversity". This study showed that the towns with the lowest street tree density also have the least diversity.

More than 70 % of street trees across all towns were alien, reflecting that they were planted a long time ago, when there was less concern about the promotion of indigenous biodiversity (Kuruneri-Chitepo and Shackleton, 2011). This is true, particularly for Tsolo, where all the sampled trees were alien, there was no recent planting of street trees, and the few planted on the main street in the CBD have since been destroyed. Various other studies show that alien

species constitute a significant proportion of the urban forest (e.g. Frank *et al.,* 2006; Nagendra and Gopal, 2010; Sjöman *et al.,* 2012; Breuste *et al.,* 2013; Seburanga *et al.,* 2014a). Although less than in most other towns, 40 % of trees sampled in Greater Melbourne (Frank *et al.,* 2006), 67 % in Bangalore (Nagendra and Gopal, 2010) and 75 % in Rwanda were all alien (Seburanga *et al.,* 2014b). However, the proportions change depending on the scale of analysis (Kowarik *et al.,* 2013). McConnachie *et al.* (2008) found that the majority of woody species (trees and shrubs) sampled in public green spaces across 10 different towns in the Eastern Cape province were alien, the majority of which were found in towns located in the former homelands. These examples illustrate that urban forests in cities of developing countries are mostly characterised by alien trees species.

Horticulturists and personnel responsible for the planting of street trees in Eastern Cape towns are not oblivious of this pattern, and have thus identified the provenance of trees as one of the four characteristics they consider before planting street trees. Evidently, *Celtis africana* was found in 50 % of the sample towns. Kuruneri-Chitepo and Shackleton (2011) also found that municipal officials were aware of the prevalence of alien species and were promoting the planting of indigenous species nowadays. A municipality in California described its efforts to emphasise the planting of indigenous trees on streets in an effort to provide habitat for indigenous wildlife (Muller and Bornstein, 2010). Notwithstanding this, Sjöman *et al.* (2012) suggest that it is barely practical to restrict urban street tree populations to predominantly indigenous species as not all of these can tolerate all environmental stresses. Therefore, the invasive attributes of some alien species and the practicality of having them on the street need to be examined before these species are completely disqualified from being used as street trees.

Similar to the disparity in the distribution of street trees between towns, there is wide variability in distribution between suburbs, largely associated with ethnic and socio-economic differences (Landry and Chakraborty, 2009). Marked differences in the distribution and abundance of green spaces and street trees within towns in the Eastern Cape have been previously established by McConnachie and Shackleton (2010); Kuruneri-Chitepo and Shackleton (2011) and Shackleton and Blair (2013). The more affluent suburbs have been found to have a high abundance of street trees while the newly established low income RDP suburbs have the lowest, and the older townships intermediate between the two (Kuruneri-Chitepo and Shackleton, 2011; Gwedla and Shackleton, 2015). Such discrepancies were also observed by Pedlowski *et al.* (2002) in Brazil, and Seburanga *et al.* (2014b) in Rwanda, who found that the wealthier neighbourhoods were characterised by larger urban green spaces. Neighbourhood socio-

economic conditions play a significant role in determining the patterns of the urban forest (Bourne and Conway, 2014). Low street tree abundance in the different suburbs within towns is often associated with low household income (Landry and Chakraborty, 2009; Kirkpatrick *et al.,* 2011), and in South Africa these are typical of the RDP suburbs where housing is reserved for the indigent (Gilbert, 2004). Housing in RDP suburbs is characterised by a general lack of planning that incorporates recreational green space and visually appealing elements (Shackleton *et al.,* 2015). On a per unit basis, household income plays a significant role in the distribution and abundance of street trees in various suburbs (Iverson and Cook, 2000). This is because people with economic means are more likely to move to suburbs with higher tree abundance (Kendal *et al.,* 2012a), or plant and invest in programmes that promote the planting of street trees in their suburbs (Mennis, 2006). On the other hand, households in low income suburbs are usually faced with a number of obstacles like limited financial means, power and lack of space in their efforts to ensure the greening of their streets (Talarchek, 1990).

The diversification of street tree populations has been identified as one of the most important factors to be considered before street tree planting or replacement, as a way of ensuring the resilience of urban tree populations (Subburayalu and Sydnor, 2012; Sjöman and Nielsen, 2010). This is because high species diversity in an urban forest is "thought to provide greater security against environmental changes and stochastic events" (Alvey, 2006). Additionally, the adaptability of tree species to the environmental site conditions, the functions of the tree, and the low cost of propagation, production, establishment and management of the trees are important factors that need to be considered in the selection of street trees (Sæbø *et al.,* 2005). The horticulturists interviewed in this study did not put much emphasis on the importance of diversity before planting or replacing street trees, but mentioned the functions of the tree and the tree's adaptability to the site conditions; this echoes Breuste's (2013) findings in Mendoza, Argentina. This could be because they are not trained as horticulturists but are employed by municipalities to oversee the planting and maintenance of street trees. In this instance, they might not have the technical and theoretical skills and knowledge required when selecting trees for street planting. None of the respondents mentioned that they have experienced high street tree mortality rates in their towns. This could be the reason why they did not put much emphasis on diversification of tree species, translating to them having never seen the need for a diverse urban forest.

Jim (2008) suggests that long-term planting success is dependent on the proper assessment of the match between the desired plant species and site conditions. This study revealed that

horticulturists consider this match when they think about the root system of the prospective tree, its eventual size or shape, and whether an alien or indigenous species. It also revealed that they consider the tree's adaptability to the climate of the respective town, the location where the tree will be planted, availability of space in the respective location and the purpose the tree will serve. Selection criteria for species varies according to site variation and priority given to the actual selection criteria (Sæbø *et al.,* 2005). Thus, the criteria for tree selection mentioned by the horticulturists in this study is acceptable as it is in line with their respective towns and the priority that they put into the process.

It is not uncommon for street trees to be removed because they either pose a danger to infrastructure or human beings, are old or to create space (Kirkpatrick *et al.,* 2012). The reasons identified by some horticulturists for removing trees in situations where the trees became an obstruction to traffic or interfered with electricity lines, or because they either cracked the foundations of houses or broke the tar road are consistent with various studies. These are by Summit and McPherson (1998) on residential tree planting and care in California, Head and Muir (2005) on trees in back yards in Australia, and Kirkpatrick *et al.* (2012) on the influence of residents' attitudes towards the planting and removal of different types of trees in eastern Australian cities. However, all these studies focused on the perceptions of residents rather than those of horticulturists or municipal officials.

The perceptions of threats to street trees expressed by horticulturists echo the findings of Richardson and Shackleton (2014), who reported that vandalism was one of the biggest threats to the survival of street trees in three Eastern Cape towns. The trees were reported to be vandalised by people and animals, especially when there are no protective structures around the trees. The option to have trees largely planted in yards as opposed to the streets is viable, as it will encourage residents to look after them considering the direct benefits they will receive (Shackleton *et al.,* 2015). Additionally, it will give residents direct control over how much greenery they expose themselves to and the freedom to choose the kinds of trees they want. Kronenberg (2015) addresses institutional barriers, such as financial constraints and the reluctance of urban residents to align themselves with stewardship towards street trees as reasons why officials opt not to green cities, and their failure to provide sufficient care for existing trees in their respective towns. This could be because they do not perceive the barriers outlined by Kronenberg (2015) as physical threats to street trees. Climate change as a perceived threat to street trees is validated because climate change is "already affecting ecological communities across the globe" (Primack *et al.,* 2009). Although not specific to street trees,

with warmer conditions many “rare species may no longer be able to survive at their present locations due to the altered temperatures and precipitation regimes” (Thomas *et al.,* 2004).

Limited funding for urban greening programmes is a global challenge that many local municipalities are faced with in their efforts to promote urban greening. In South Africa, the majority of studies (e.g. Kuruneri-Chitepo and Shackleton, 2011; Gwedla and Shackleton, 2015; Chishaleshale *et al.,* 2015) report that one of the biggest limitations faced by officials responsible for urban greening is the lack of funds. Richardson and Shackleton (2014) state that “South African local municipalities have an annual budget and an obligation to plant trees in and around their towns”. While this may be true, it has become apparent that the funds allocated in these budgets are not enough for the amount of work that needs to be done when planting and maintaining street trees. This becomes especially true in municipalities where less than 10 % of the annual departmental budget is dedicated to tree planting activities (Gwedla and Shackleton, 2015). Lamichhane and Thapa (2012) corroborate these findings by stating that in Nepal “urban forestry has been accorded a low priority as evidenced with the allocation of inadequate human and financial resources for it”. The lack of skilled personnel and equipment for planting and maintaining street trees were also identified as major constraints to the advancement of urban greening by more than 80 % of municipal parks’ managers from 24 municipalities in the Eastern Cape (Gwedla and Shackleton, 2015).

3.5 Conclusion

The assessment of the urban forest to determine the distribution, composition, and dominance of street trees is an important exercise, that when conducted effectively, can help reduce the mortality of street trees and thus enhance the benefits they provide to people and the broader environment, and inform where street trees are needed most. While it is understandable and unfortunate that limited resources are channelled to urban greening initiatives, it is critical that frequent street tree inventories and assessments are conducted by municipalities. This will help produce a clear picture of the composition of the urban forest and what still needs to be done. The disparities in the distribution of street trees both between and within various towns because of the apartheid legacy in South Africa need to be addressed. Similarly, more work needs to be done in greening the newly built RDP suburbs, as they have low densities and diversity of street trees when compared to both the affluent and township suburbs. The new housing developments in the RDP suburbs fail to incorporate the need for green infrastructure and with more demand for housing space, trees are cleared to make space for development (Shackleton

et al., 2014). As such, there needs to be cooperation and constant communication between the various government departments throughout the development of new suburbs to ensure that green infrastructure is incorporated into the building and development plans. The government needs to rigorously incorporate standards that will promote the development of green infrastructure into new housing developments, and implement these standards (Shackleton *et al.,* 2014).

The results show that while alien species constitute the majority of the street forest, there is progress in the planting of indigenous species, and the prioritising of this by horticulturists and municipal officials means that there is hope for an indigenous and diverse urban forest. To achieve this, personnel qualified and skilled in propagating, planting and maintaining trees need to be mobilised as they are more likely to understand the importance of diversification of the urban forest. The lack of horticultural training amongst most of the respondents who are responsible for the propagation, planting and maintenance of street trees has a direct influence on the criteria they employ when selecting trees for street planting. This means that if they are required to act as horticulturists, then they should be given the necessary horticultural training that will enable them to make sound and appropriate decisions on what types of trees to plant, and why it is important to diversify the species planted. Planting what is available or replanting what is already there is not enough because diversity and function are important. The lobbying of large corporations, as part of their corporate social responsibility, for donations towards urban greening initiatives, as well as promoting awareness amongst officials and elected councillors can go a long way in mitigating the backlogs caused by lack of funds for urban greening in municipalities.

Chapter 4

Perceptions and preferences regarding distribution and composition of street trees

4.1 Introduction

There has been remarkable consistency in human preference for natural landscapes as opposed to urban landscapes with limited vegetation (Özgüner and Kendle, 2006; Home *et al.,* 2010). Jorgensen *et al.* (2007) reported that most respondents from Birchwood, UK, identified green spaces as their favourite in the local area, because they provide them with rich meaning and design associated with nature and wildlife conservation, human coexistence with nature, relaxation, contentment, and stress relief. The experience of nature and nature-related leisure in the everyday lives of many urban residents largely takes place in public urban green spaces (Voigt and Wurster, 2015), and much of the time spent by urban residents is on streets (Todorova *et al.,* 2004). As such, Jacobs (1997) suggests that a street should be comfortable, safe to walk at a leisurely pace, and should have eye-engaging features. According to Antupit *et al.* (1996), vegetation is one of the best features any street can have. People generally prefer natural over built landscapes, and natural elements such as trees, forested areas and well maintained parks are among the most preferred (Özgüner, and Kendle, 2006; Poudyal *et al.,* 2009).

Urban green spaces are the closest common places where residents can undertake outdoor recreational activities and get aesthetic satisfaction (Zhang *et al.,* 2013). As part of urban green spaces, the urban forest is often one of the natural features to which urban residents are most exposed. Residents vary in their interactions with the urban forest (Nagreda and Gopal, 2010), based on their preferences and what they derive from the urban forest. Thus, there are considerable variations in people's appreciation of the urban forest in general, some with adoration for its various components, while some report fear of these components (Skår, 2010). These variations are mostly based on the different contributions made by different trees to the well-being of people and other sentient beings (Kirkpatrick *et al.* 2012). Understandably, some tree species are better than others for optimising particular benefits (Morgenroth *et al.,* 2016),

and as a result may be favoured more by urban residents than others. Gerstenberg and Hofmann (2016) reported that coniferous trees provide a higher percentage of shade than deciduous trees because of their columnar shape and needle-shaped leaves. Deciduous trees are usually less preferred because they have large crowns and shed their leaves (Gerstenberg and Hofmann, 2016). Additionally, small-leaved deciduous and evergreen trees are considered inferior to large-leaved deciduous trees for the thermoregulation of buildings in temperate climates (Yoshiki and Mitashiro, 2007). Trees have been found to reduce urban heat stress (Shashua-Bar *et al.,* 2010), building energy use (Escobedo *et al.,* 2011), wind speed (Nowak and Dwyer, 2007), and to remove air pollutants (Nowak *et al.,* 2014). Notwithstanding these other benefits, urban residents mostly perceive and respond to the aesthetic quality of their everyday residential environment (Zhang and Lin, 2011). For example, a study by Poudyal *et al.* (2009) found that residents of Roanoke, USA, placed a positive value on green space and having a variety. Another study by Heimlich *et al.* (2008) found that the majority of respondents from Ohio, United States, preferred to have attractive street trees with an array of summer and autumn colours, textures and densities, and that respondents liked large trees that gave the neighbourhood a mature appearance, satisfying the aesthetic need for beauty.

There is also variation in perceptions of nature and importance of trees to different people in urban environments (Kirtpatrick *et al.,* 2011). Some urban residents predominantly acknowledge the sacred, useful, decorative and precarious nature of urban trees, while there are those who are indifferent or see them as growing in the wrong places (Kirkpatrick *et al.,* 2012). According to Chen (2015), "the biological and cultural (or historical) value of some urban trees are usually the focus of traditional management because they are an important biological legacy to serve as living specimens and a gene pool for enhancing biological diversity in urban landscapes". This sacred nature of some urban trees suggests that they are more likely to be preserved and protected as they are useful and add value to natural biodiversity through their "likelihood to harbour a wide range of endemic, rare and threatened species resulting from natural processes and human introduction" (Jim and Zhang, 2013). Additionally, urban residents usually bestow religious, spiritual, and cultural values to heritage trees (Jim, 2004; De Lacy, 2014). For example, *Pinus armandi* and *Quercus pannosa* have been linked to residents' cosmological and spiritual thoughts, resulting in them being traditionally worshipped in Lijiang city, south China (Yang, 2011). Laing *et al.* (2009) reported that the addition of more trees in the urban landscape reduces visibility, thus making an area appear less safe and possibly less attractive because of the restricted view. These negative

perceptions towards urban and street trees usually result in strong resistance towards new municipal plantings or the intentional removal of street trees adjacent to peoples' places of residence (Kirpatrick *et al.,* 2011). Kirkpatrick *et al.,* (2013) found that although the majority of residents of eastern Australian cities value trees, they are also more likely to remove healthy trees regularly because of their aesthetic and lifestyle preferences.

From the above, it is clear that the solicitation of urban residents' attitudes, perceptions and preferences regarding street tree planting is an important exercise in ensuring that residents get the most out of the trees in close proximity to them (Ng *et al.,* 2015) and that city authorities plant species that residents prefer. Street and garden trees are close to peoples' homes and are therefore more vulnerable to capricious human sentiments (Kirkpatrick *et al.,* 2012), hence the need for insight into people's perceptions before planting decisions are made. Perceptions of the landscape may influence the behaviour of users, and often mirrors their motives, attitudes and preferences that could inform the planning and management of urban green spaces (Jim and Shan, 2013).

The achievement of high quality residential environments that exhibit the aesthetic, social, economic and ecological benefits afforded by urban green spaces and trees is an important requirement that needs to be met during urban landscape planning (Blaschke, 2006; Poudyal *et al.,* 2009). Thus, emphasis needs to be placed on the perceptions of residents and users during the planning and management of public resources like urban green spaces (Polat and Akay, 2015). In these exercises, urban planners or municipal officials need to appreciate what urban residents would like to have and what works for them before decisions are made about what types of trees should be planted and where they should be planted.

This chapter set out to explore how urban residents perceive street trees, and how they would like the urban forest in their towns to be structured. This was done by investigating the perceptions and preferences of urban residents for street trees with a focus on their distribution, composition and priority. Because I hypothesised that the preference of residents may be shaped by whether or not they have trees in their own yards, I also asked about trees at their home, which is the first part of the results section. The methods of data collection and analysis are provided in Chapter 2, Section 2.2, paragraph 2.

4.2 Results

4.2.1 Preferences for trees in urban suburbs

4.2.1.1 Distribution of household trees within towns and suburbs

The majority of respondents (75 %) across the 10 towns reported having at least one tree in their yard while the rest reported not having any trees at home. The proportion of households with trees was similar between the former homeland towns (71 %) and the non-former homeland towns (77 %) (t=1.0; p>0.05). There was no difference in the proportion of households that had trees across the three town street tree density classes (low=64 %, medium=81 %; high=75 %) (H=4.28, p>0.05) (Table 4.1). No significant differences were observed in the proportion of households with trees between the affluent and township suburbs (χ^2=15.2; p>0.05), which were both significantly higher than the RDP suburbs (χ^2=127.9; p<0.05 and χ^2=63.8; p<0.05) (Table 4.1).

Table 4.1: The proportion of households in ten towns and per suburb that had trees in their yards.

Town	Former homeland	Classified density of street trees	Proportion of households with trees (%)	Proportion of households per suburb with trees (%)		
				Affluent	Township	RDP
Burgersdorp	No	High	75	70	73	83
Cradock	No	Medium	81	88	75	80
Graaff-Reinet	No	High	75	78	90	58
Libode	Yes	Low	58	53	60	63
Matatiele	No	Medium	78	93	73	68
Peddie	Yes	Low	58	70	75	30
Port St John's	Yes	Medium	89	88	88	93
Queenstown	No	Medium	68	85	78	40
Tsolo	Yes	Low	77	85	70	75
Willowmore	No	Medium	88	90	98	78
Total			75	80	78	67

4.2.1.2 Composition of household trees

Fifty-seven tree species (including one species regarded as "other" because respondents did not know the names) were mentioned across the 896 households. An average of 22.5±1.5 tree species per town and 2.2±0.1 per household were mentioned (Table 4.2). Households in affluent suburbs reported 98 % of all species recorded, those in the township suburbs reported 81 % and those in the RDP suburbs reported 65 %. Fruit species were the most common, and accounted for 63 % of all household trees mentioned. The most abundant and common tree mentioned across all towns was *Prunus persica* (Table 4.2), followed by *Ficus burtt-davyi*, and *Prunus armeniaca* (Table 4.2). *Prunus domestica* was another common tree encountered in nine towns, with the exception of Graaff-Reinet. Another common tree was *Malus domestica*, recorded in nine towns with the exception of Port St John's. Thirty percent (264) of households across all towns mentioned they have "other" tree species that they do not know the names of. Many respondents mentioned having more than one species, resulting in overlaps in the proportions of each species in households.

Table 4.2: Composition and distribution of household trees across all ten towns.

		Towns										**Mean**
		Burgersdorp	**Cradock**	**Graaff-Reinet**	**Libode**	**Matatiele**	**Peddie**	**Port St John's**	**Queenstown**	**Tsolo**	**Willowmore**	
Total species		21	21	30	20	18	16	24	26	19	30	22.5±1.5
Average known species per household		2.3±0.1	2.4±0.1	2.1±0.1	2.0±0.2	1.8±0.1	2.2±0.2	2.4±0.1	2.4±0.1	1.4±0.1	2.7±0.1	2.2±0.1
Common trees (%)	*Prunus persica*	14	8	5	11	17	13	3	14	12	4	55
	Ficus burtt-davyi	16	15	18	3	1	12	-	13	2	21	21
	Prunus armeniaca	21	2	13	10	16	7	-	27	21	2	19
	Prunus domestica	2	13	-	8	13	17	1.9	33	8	4	12
	Malus domestica	28	12	13	2	6	15	-	20	3	2	12

4.2.1.3 Reasons for planting or retaining selected trees in homesteads

There were significant differences in the reasons why respondents have planted or retained species between the affluent and township suburbs (χ^2=89.4; p<0.05), the affluent and RDP suburbs (χ^2=337.1; p<0.05), and between the township and RDP suburbs (χ^2=87.7; p<0.05). In most instances, people in the affluent suburbs had a lot of trees and tree species because those trees were already planted when the respondents occupied the property. More respondents from the township suburbs have planted or retained certain trees because they appreciate the benefits provided by the particular species (Table 4.3).

There were also differing reasons why some respondents from the affluent and township suburbs (χ^2=31.1; p<0.05), the affluent and RDP suburbs (χ^2=192.6; p<0.05), and from the township and RDP suburbs (χ^2=54.5; p<0.05) opted not to plant or retain trees in their households. The most common reasons were because they do not own the property, and therefore cannot make any alterations to it, or because there is insufficient space within their property to plant trees (Table 4.3).

Table 4.3: Reasons for planting or retaining (or not) trees in household gardens

	Reasons	Number of mentions			
		Affluent	**Township**	**RDP**	**Total**
Reason to have or retain	Trees were here when I arrived	174	90	53	317
	I like the particular fruit	62	81	79	222
	The respective tree grows well in this town, easy to grow and easy to obtain	72	76	32	180
	I love trees in general	49	43	37	129
	They just grew on their own	31	47	43	121
	Other: i) the trees were planted by parents or family members; ii) for shade; iii) beautify the property; iv) given as a gift; v) the municipality had given out the trees.				
Reason not to have or retain	I rent this property or home and therefore cannot plant	40	59	41	140
	There is no space in the yard for trees	21	24	63	108
	I cannot afford to buy trees	3	13	18	34
	The trees were vandalised and criminals hide behind them	5	9	16	30
	I do not know why my parents have not planted	19	8	2	29
	Other: i) does not like trees; ii) the fear of roots cracking respondents house; iii) is still planning to plant some trees; iv) does not have the time to plant trees; v) has just arrived in the respective place of residence.				

4.2.1.4 Preferences for the location and distribution of new tree plantings

Residents' preferences for the location of street trees is closely related to and may influence peoples' attitudes towards trees in general (Zhang at al., 2010). In response to where respondents would most like to have trees planted within their town and respective suburbs, most respondents (55 %) would prefer to have trees both in their yards and on the street (Table 4.4). A sizeable proportion (29 %) of the respondents mentioned that they would prefer to have trees only in their yards, while 13 % of the respondents mentioned that they would prefer that trees only be planted on the street (Table 4.4). A small proportion (3 %) mentioned that they would prefer to have no trees planted anywhere (Table 4.4). Compared to all other towns, Cradock had the most (73 %) respondents who would prefer trees to be in their yards and on the street, while Burgersdorp had the least (42 %). There were more (43 %) respondents in Tsolo than in any other town who would prefer to have trees in their yards only, while Graaff-Reinet had the least (20 %). Queenstown had more (22 %) respondents than all towns who would prefer to have trees on the street only, while Cradock had the least (5 %). Although there were generally few respondents who prefer not to have trees across all towns, Burgersdorp had more (6 %) respondents with this preference than all other towns.

There were no significant differences (χ^2=3.8; p>0.05) in the respondents' preferences for the location of street trees between the former homeland and non-former homeland towns. Most respondents from the non-former homeland (59 %) and former homeland towns (50 %) would like to have trees both in their yards and on the streets, while slightly more from the former homeland towns (34 %) would prefer to have trees only in their yards than those from the non-former homeland towns (26 %).

When comparing across the three levels of classified street tree density, there was a significant difference in preferred location between the low and medium towns (χ^2=8.7; p<0.05). However, no significant differences were observed between the high and low density towns (χ^2=3.2; p>0.05) or medium density towns (χ^2=4.6; p>0.05). Most respondents from the low (46 %), medium (61 %) and high (54 %) density towns would prefer to have trees both in their yards and on the street. Thirty-seven percent of respondents from the low density towns would prefer to have trees only in their yards compared to 25 % from the medium and 30 % from the high density towns.

Table 4.4: Preferences for the location of planted trees by respondents across all towns.

Town	Former homeland	Street tree density class	Preferences for location of planted trees (% respondents)			
			Yard and Street	Yard only	Street only	Nowhere
Burgersdorp	No	High	42	41	12	6
Cradock	No	Medium	73	23	5	0
Graaff-Reinet	No	High	66	20	12	3
Libode	Yes	Low	43	37	17	4
Matatiele	No	Medium	58	26	12	5
Peddie	Yes	Low	59	30	10	1
Port St John's	Yes	Medium	59	26	13	2
Queenstown	No	Medium	57	21	22	1
Tsolo	Yes	Low	38	43	15	4
Willowmore	No	Medium	59	28	11	3
Total			55	29	13	3

The presence of trees in respondents' yards had a significant positive impact on their preferences for the location of planted trees ($\chi^2=26.6$; $p<0.05$). Of the respondents who have trees in their yards, more of them (60 %) preferred to have trees both on the street and in their yards, than those who do not have trees (41 %) (Table 4.5). Additionally, of those who had trees in their yard, there were more (31 %) who preferred to have trees in their yard only, than those who do not have trees (26 %). Similarly, the majority of respondents who would prefer to have trees on the street only (27 %) and those who do not want trees at all (6 %) do not have trees in their yards (Table 4.5).

Table 4.5: Preferences for the location of planted trees amongst respondents with existing trees in the yards and those without trees.

Presence of existing trees in yard	Preferences for location of planted trees (%)			
	Yard and Street	Yard only	Street only	Nowhere
Yes	60	31	8	2
No	41	26	27	6
Totals	55	29	13	3

Significant differences were observed in respondents' preferences for tree location among residents from the affluent and RDP suburbs (χ^2=16.5; p<0.05). The majority of respondents (65 %) who would like to have trees both in their yards and on the street were from the affluent suburbs, while less than half of the respondents from the RDP suburbs had the same preference (Table 4.6). Additionally, more respondents (39 %) from the RDP suburbs than the affluent suburbs (20 %) would prefer to have trees in their yards only, while more respondents from the affluent suburbs than the RDP suburbs prefer to have trees on the street only, and to have no trees at all, respectively (Table 4.6). Although there were more respondents who would prefer to have trees in the yard only, on the street only, and not anywhere amongst respondents from the township suburbs than the affluent suburbs, no significant differences were observed in respondents' preferences for tree location among respondents from these suburbs (χ^2=6.84; p>0.05). Similarly, no significant differences were observed in the preferences of respondents for tree location among respondents from the RDP and township suburbs (χ^2=5.6; p>0.05).

Table 4.6: Preferences for the location of planted trees amongst respondents from the various suburb types across all towns.

Respondents' suburb of residence	**Preference for location of planted trees (%)**			
	Yard and Street	**Yard only**	**Street only**	**Nowhere**
Affluent	65	20	13	3
Township	53	30	14	4
RDP	48	39	12	2
Totals (%)	55	29	13	3

The majority of both males (56 %) and females (55 %) would prefer to have trees both on the street and in their yards, and no significant differences were established in this regard (t=0.2; p>0.05). Similarly, no significant differences in the proportion of males compared to females who would prefer to have trees in their yards only (t=0.5; p>0.05), on the street only (t=0.4; p>0.05) or nowhere at all (t=0.6; p>0.05). When comparing across the different age groups, significantly more middle-aged respondents than the young (χ^2=38.3; p<0.05) and old (χ^2=27.3; p<0.05), which were also significantly different to one another (χ^2=68.0; p<0.05), would prefer to have trees both in their yards and on the street.

4.2.1.5 Reasons for the preferred location of trees

There were various reasons why respondents preferred to have trees planted in specific locations. The majority of respondents who would prefer to have trees in the yard and on the street do so because they want to have shade everywhere (Table 4.7). Most of the respondents who would prefer to have trees in their yard only do so because they feel that the trees will be vandalised if they are on the street (Table 4.7). Most of those who would prefer to have trees on the street only do so because of perceived lack of space in their yards (Table 4.7). There were some overlaps in the reasons and some respondents mentioned more than one reason.

4.2.1.6 Satisfaction with general appearance of street

In this research, the general appearance of a street was taken as referring to anything that has to do with either the size of the street, the cleanliness of the street, the physical condition of the street and the appeal of the street to the eye. The general appearance of the street was ranked by respondents in comparison to the general appearance of other streets within the same suburb. The majority of respondents (75 %) were not satisfied with the general appearance of their streets. Respondents from Peddie (90 %) were the most dissatisfied, while respondents from Willowmore (59 %) were the least dissatisfied (Figure 4.1). Among respondents from non-former homeland towns, those from Burgersdorp were the most dissatisfied (76 %) and as already mentioned those from Willowmore the least (59 %). Amongst the former homeland towns, respondents from Port St John's were the most dissatisfied (89 %) while respondents from Tsolo were the least (84 %).

There was a significantly higher proportion of respondents (t=4.9; $p<0.05$) from the former homeland towns (88 %) than the non-former homeland towns (67 %) who were dissatisfied. There were no significant differences ($H=2.09$; $p>0.05$) in proportions of respondents from the various suburbs who were dissatisfied with the general appearance of their street. The majority of respondents who were not satisfied were from the RDP suburbs (83 %), although significant proportions of respondents from both the affluent (73 %) and township (71 %) suburbs were also not satisfied with the general appearance of their street.

Table 4.7: Five most common reasons for each of the various preferences for the location of planted trees.

Preference for location of planted trees	Reason for preference	Number of mentions			
		Suburb			Total
		Affluent	Township	RDP	
Yard and Street	Shade everywhere	176	131	137	462
	Abundant fruit everywhere	90	103	112	305
	Beautiful yards and streets	117	90	68	275
	Complete protection from strong winds	31	36	49	116
	Oxygen provision	29	25	14	68
Yard only	Vandalism of trees on the street	28	38	41	107
	Criminals hide behind the trees on the street	13	22	24	60
	Shade for my house	16	18	25	59
	Directly benefit from all tree benefits	9	18	28	55
	Not enough space on the street	8	13	29	50
Street only	Not enough space in the yard	10	26	26	62
	Trees will make the yard look messy and dirty	12	20	6	38
	Tree roots will crack the walls of my house	8	13	10	31
	Trees will provide shade for passers-by	3	12	14	27
	I will not have to take care of them on the street	5	8	9	22
Nowhere	I do not like trees	4	6	7	17
	No space for trees anywhere	2	2	4	8
	Criminals hide behind trees	1	3	2	6
	Trees are more dangerous than beneficial	1	2	3	6
	Trees cause allergies and make people sick	2	1	1	4

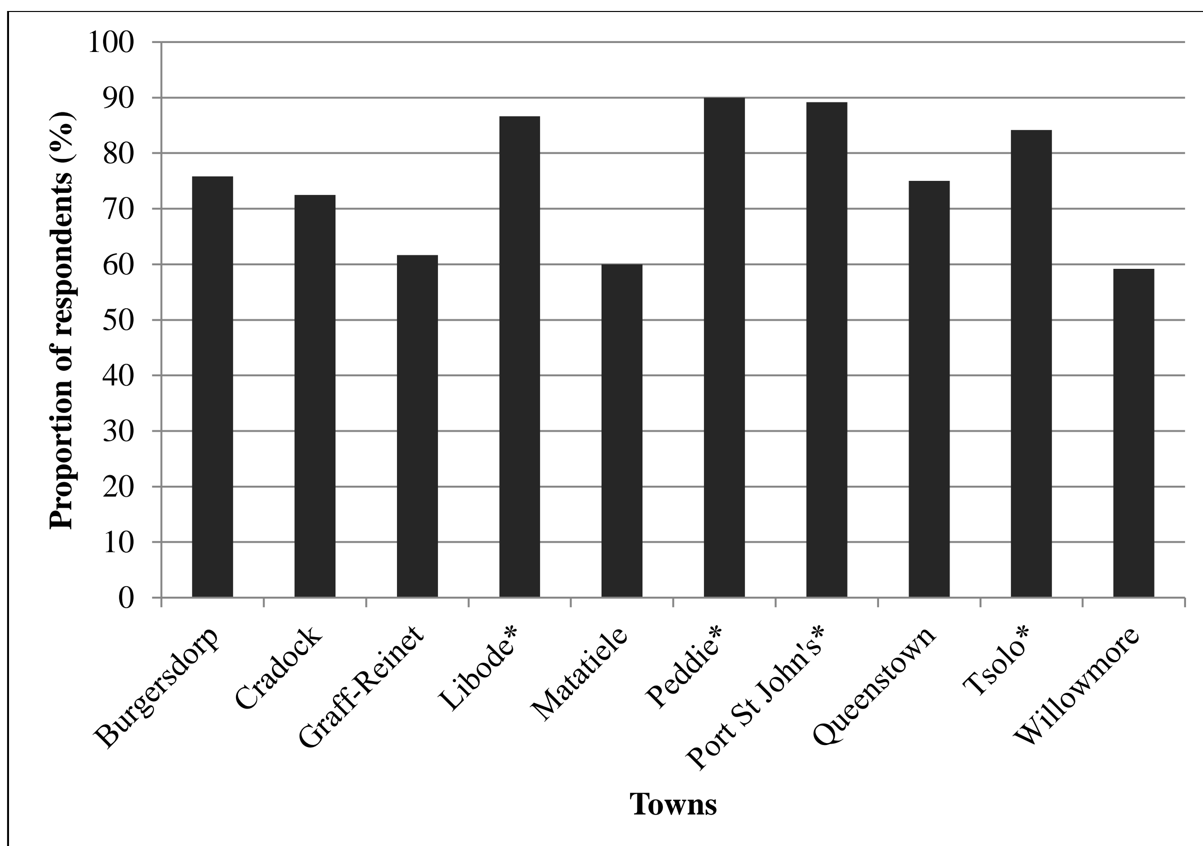

Figure 4.1: General dissatisfaction of respondents from all towns (*=former homeland towns) with the general appearance of their streets

4.2.1.7 Reasons for the dissatisfaction with the general appearance of street

Most respondents' reasons for their dissatisfaction with the general appearance of their street were confined to the five reasons outlined in Table 4.8, although there were some overlaps. "Other" reasons were mostly mentioned by less than 10 % of respondents across all towns. The majority of dissatisfied respondents who said it was because it was not tarred (50 %), it was not clean (50 %), it was dusty/muddy (51 %), it had no drainage system (46 %) or it had no trees (43 %) were from the RDP suburbs. The majority of respondents who were satisfied with the general appearance of their street in that their street had a tarred road (71 %), it was mostly clean and well maintained (71 %), and had many trees (62.4 %), were from the affluent suburbs. The majority (47 %) of those respondents who were satisfied with the general appearance of their street because "it looked fine to them" were from the township suburbs, 31 % from the RDP suburbs and 22 % from the affluent suburbs.

Table 4.8: Five most common reasons why respondents were satisfied or dissatisfied with the general appearance of their streets.

Reason for satisfaction	**Number of mentions**			**Reason for dissatisfaction**	**Number of mentions**		
	Suburb				**Suburb**		
	Affluent	**Township**	**RDP**		**Affluent**	**Township**	**RDP**
Has tar road	101	60	0	No tar road	69	107	326
Clean	89	57	14	Not clean	119	148	198
Well maintained	116	30	6	Dusty/Muddy	58	103	277
Has many trees	95	11	3	No drainage system	26	82	162
Looks fine to me	42	31	17	No trees	39	77	113
Other: I like the way it is; wide road; has a proper drainage system; everyone else is satisfied; everything looks fine for this kind of settlement; clear street view; has a lot of grass; proper gravel road.				Other: potholes; no paving/pavement; narrow road; not appealing and dull; has smelly water all over; not maintained; no variety of trees; no flowers; rocky road; the government is failing us; not safe; many demolished old houses; everything is falling apart; too many shrubs; vacant and abandoned sites for criminals to hide, no street lights.			

4.2.1.8 Satisfaction with the number of trees on street

The majority of respondents (67 %) across all towns were not satisfied with the number of trees on their street (Figure 4.2), citing that either there are no trees at all on their streets (81 %), there are too few trees compared to other streets and other suburbs (16 %) or there are too many trees on the street (3 %). More respondents from Peddie (93 %) than all other towns were dissatisfied with the number of trees on the street, while Willowmore (55 %) had the least number of respondents who were dissatisfied. There were no significant differences between the proportion of dissatisfied respondents in the former homeland towns and those from non-former homeland towns (t=1.9; $p>0.05$), 74 % and 62 %, respectively. Whilst the regression of the proportion of dissatisfied respondents against street tree density was not significant ($r^2=0.1$; $p>0.05$), the three towns with the most dissatisfied residents were the ones with the lowest densities.

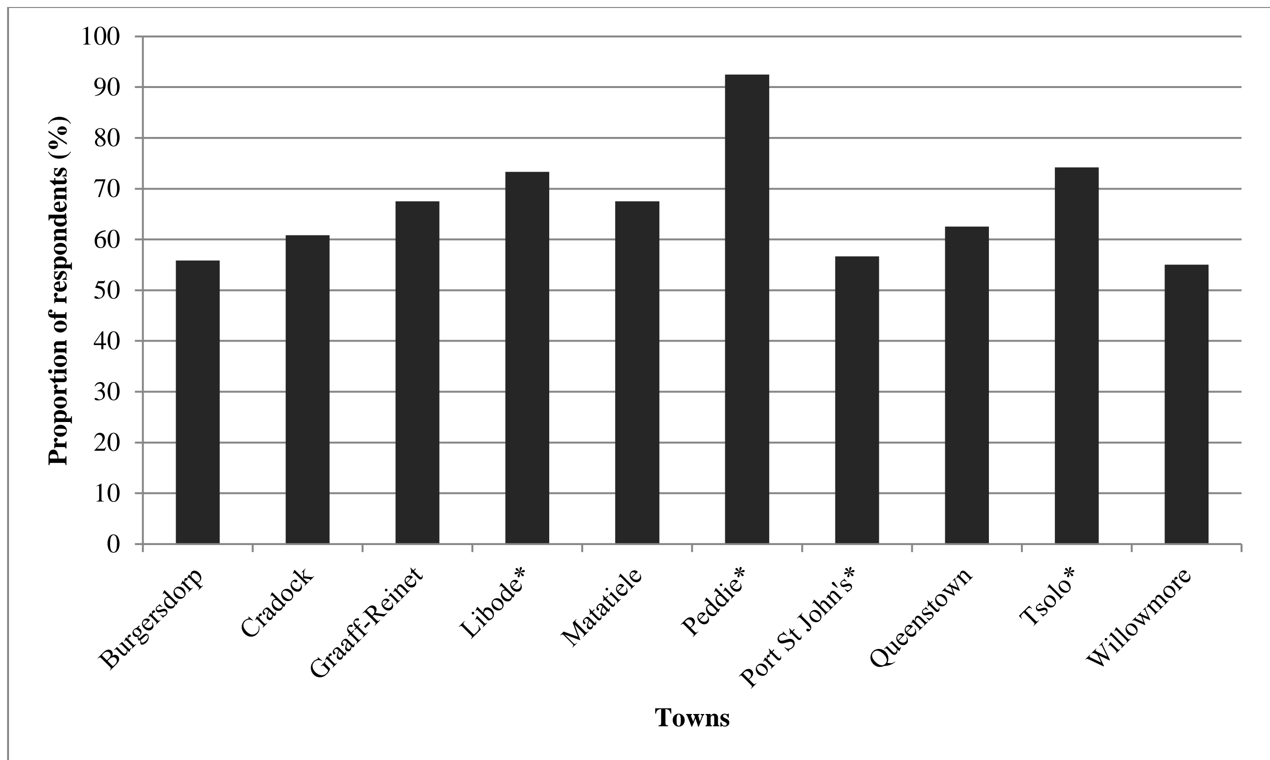

Figure 4.2: Dissatisfaction of respondents from ten towns (*=former homeland towns) with the number of trees on their streets.

No significant differences in the proportions of dissatisfied respondents between the different suburbs were observed (H=5.1; $p>0.05$). The majority of respondents who were not satisfied with the number of trees on their streets were from the RDP suburbs (74 %), compared to 71 % in the township suburbs and 55 % in the affluent suburbs.

Not unsurprisingly, significantly more respondents (80 %) living in towns with low street tree densities were dissatisfied with the number of trees on their street than respondents living in towns with medium (61 %) ($\chi^2=16.6$; $p<0.05$) or high street tree densities (62 %) ($\chi^2=14.4$; $p<0.05$), which were both not significantly different to one another ($\chi^2=0.45$; $p>0.05$).

4.2.1.9 General satisfaction with overall condition of the street (appearance and street trees)

Significantly more respondents were satisfied with the general appearance of their street than with the number of street trees ($t=2.3$; $p<0.05$). There was generally no satisfaction among most respondents concerning the general appearance of the street and the number of trees on the street (Table 4.9). However, a noteworthy proportion (41 %) of respondents were satisfied with both the general appearance of their street and the number of trees on their street (Table 4.9).

Table 4.9: Cross-tabulation of respondents for all towns between their satisfaction with the appearance of the street and the number of trees on the street.

Satisfied with the general appearance of street (%)	Satisfied with the number of trees on the street (%)		
	No	**Yes**	**Total**
No	84	59	75
Yes	16	41	25
Total	67	33	100

There were more respondents from the affluent and RDP suburbs (87 %) respectively that were neither satisfied with the general appearance of their street nor the number of trees on their street (Table 4.10). On the other hand, there were more respondents from the affluent (45 %) and township suburbs (47 %) who were satisfied with both the general appearance of their street and the number of trees on their street (Table 4.10). There were more respondents from the RDP suburbs (73 %) who were not satisfied with the general appearance of their street but were satisfied with the number of trees on their street compared to both the affluent (55 %) and township suburbs (53 %) (Table 4.10). The affluent suburbs had the least proportion (13 %) of respondents who were satisfied with the general appearance of their street but not satisfied with the number of trees on their street.

Table 4.10: Cross-tabulation of respondents from the different suburbs across all towns between their satisfaction with the appearance of the street and the number of trees on the street.

Suburb	Satisfied with the general appearance of street (%)	Satisfied with the number of trees on street (%)	
		No	**Yes**
Affluent	No	87	55
	Yes	13	45
RDP	No	87	73
	Yes	14	27
Township	No	8	53
	Yes	22	47

4.2.2. Appreciation for street trees by urban residents

4.2.2.1 Importance of trees on the street

The presence of trees on the street was seen to be greatly important (67 %) or moderately important (20 %) by most respondents (Figure 4.3). With the exception of Libode, more than half of respondents from each town believe that it is greatly important to have trees on the street. There were no significant differences in the proportion of respondents who believe that it is greatly important to have trees on the street between the former homeland and non-former homeland towns (t=0.11; p>0.05). There were significantly fewer respondents from the low street tree density towns than both the medium (χ^2=14.3; p<0.05) and high density towns (χ^2=12.9; p<0.05), which were both not significantly different to one another (χ^2=0.3; p>0.05), who recognised the importance of having trees on the street. Both females and males across all towns equally acknowledged the great importance of street trees (t=0.3; p>0.05). Significantly more middle-aged respondents acknowledged the great importance of having trees on the street than both younger (χ^2=18.3; p<0.05) and elderly people (χ^2=28.6; p<0.05), which were also significantly less than young people (χ^2=50.7; p<0.05). There was a significant positive relationship between the education attainment of the respondents and their perception of the importance of having trees on the street (r^2=0.27; p<0.05); the more educated the respondents, the more they thought it is greatly important to have trees on the street.

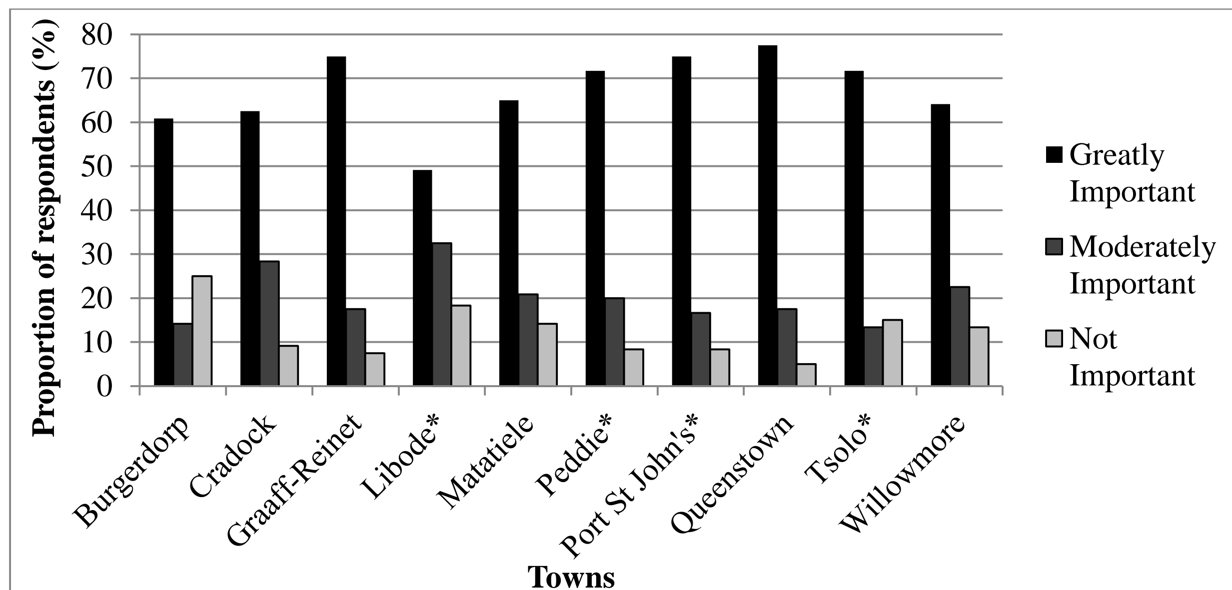

Figure 4.3: Respondents' perceptions of the importance of having trees on the street across all towns (*=former homeland towns).

There were significantly more respondents from both the affluent and township suburbs (71 %), respectively, than the RDP suburbs (60 %) who believe that it is greatly important to have trees on the street (χ^2=35.0; p<0.05) (Figure 4.4). Compared to other suburbs, respondents from the RDP suburbs were in least support of the importance of having trees on the street (Figure 4.4).

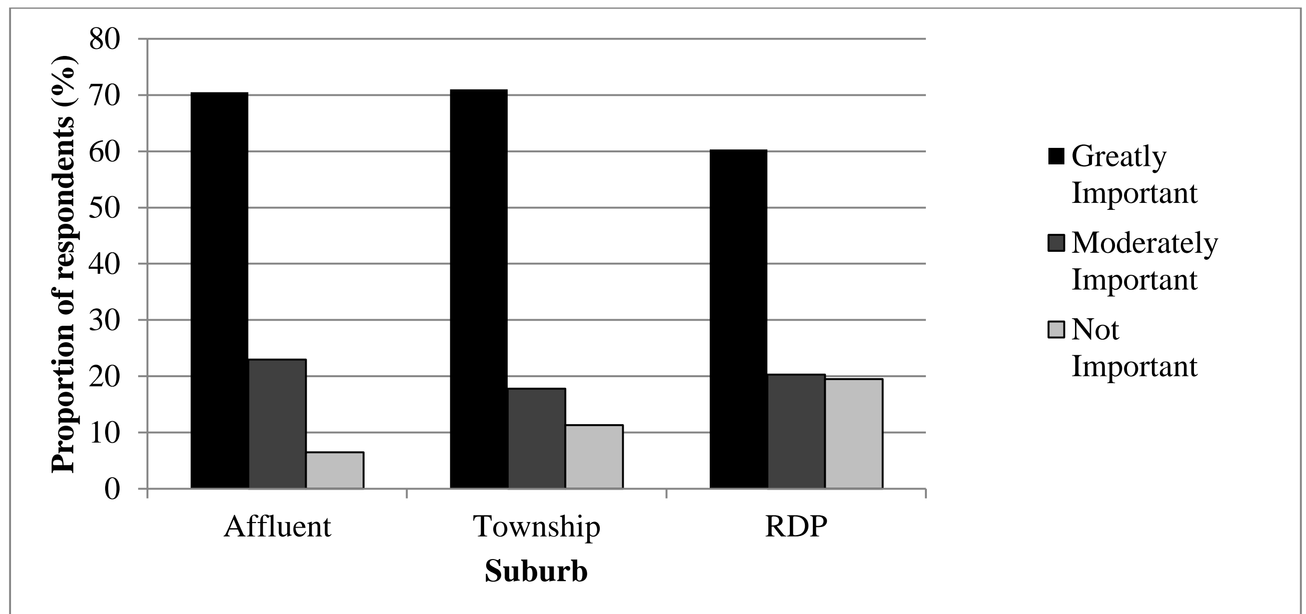

Figure 4.4: Perceptions of respondents from the affluent, township and RDP suburbs across all towns on the importance of having trees on the street.

There were significantly more respondents (χ^2=281.0; p<0.05) who would prefer to have trees both on the street and in their yard, and who also believe that it is more important to have trees on the street (83 %) than not (Table 4.11). Additionally, most of the respondents who would prefer to have trees on the street only believe that it is greatly important to have trees on the street. The differences in the perceived importance of having trees on the street between the respondents who would prefer to have trees both on the street and in the yard and those who would prefer not to have trees at all were significant (χ^2=235.09; p<0.05). For example, more than 90 % of respondents who would like to have trees in their yards and on the street believe that it is important to have trees on the street, while less than 5 % of respondents with a similar preference do not recognise the importance of having trees on the street (Table 4.11). There were also significantly more respondents who would prefer to have trees on the street only who also recognise the importance of having trees on the street than those who would prefer to have trees in their yards only (χ^2=78.3; p<0.05).

Table 4.11: Cross-tabulation of respondents from all towns between their preferred location for trees and their perceived importance of having trees on the street.

Preferred Tree Location	Perceived importance of street trees (%)			
	Greatly Important	Moderately Important	Not Important	Total
Yard and street	83	14	3	55
Garden	42	31	27	29
Street	69	25	6	13
Nowhere	21	15	64	3
Total	67	20	13	100

While the majority of respondents believe that it is greatly important to have trees on the street, there were even more (75 %) respondents who strongly agreed that trees are important for quality of life in towns (Table 4.12). More than 80 % of respondents from Peddie and Port St John's believe that trees are important for quality of life, while significantly fewer respondents from Burgersdorp (64 %) share a similar sentiment (Table 4.12). The most cited reasons why respondents strongly agree or agree with this statement included that trees provide shade, purify the air, provide fruit, and they protect respondents from strong winds. Although the production of oxygen by trees in urban areas is insignificant to the global atmospheric content, a significant proportion of respondents in this study rated it as one of reasons they believe that trees are important for the quality of life in towns. The majority of those who were neutral in their agreement did so because they identified that trees are good and sometimes bad, some did not know how trees are important for quality of life, while others noted that trees provided limited benefits like fruit and shade. For some respondents who did not agree that trees are important for quality of life in towns thought so because trees provide hiding places for criminals, the fallen leaves and fruits make a mess, trees are just bad, they occupy a lot of space and trees are meant to be in the forest and not in town.

There was a significant positive association between the respondent's perception of the importance of having trees on the street and their perception of the importance of trees for quality of life in towns (χ^2=19.8; $p<0.05$). The majority (89 %) of the respondents who felt that it is important to have trees on the street also strongly agreed with the statement that "*trees are important for quality of life in towns*" (Table 4.13). Similarly, there were more respondents

who just agreed with the statement among those that felt it was moderately important to have trees on the street (Table 4.13).

Table 4.12: Respondent's perceived importance of trees for quality of life in towns across all towns.

Town	Importance of trees for quality of life in towns (%)				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Burgerdorp	64	32	2	3	0
Cradock	66	31	0	3	0
Graaff-Reinet	76	16	3	3	2
Libode	72	19	3	3	3
Matatiele	80	16	1	3	1
Peddie	84	13	1	2	0
Port St John's	83	11	3	1	3
Queenstown	73	25	1	2	0
Tsolo	77	14	4	3	2
Willowmore	73	21	3	3	0
Total	74	20	2	3	1

Table 4.13: Respondents' perceived importance of trees for quality of life in towns across all towns based on their perceived importance of having trees on the street.

Importance of street trees	Trees and quality of life in towns (%)				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Greatly Important	89	11	0	0	0
Moderately Important	51	43	3	3	0
Not important	38	30	10	15	7
Total	74	20	2	3	1

4.2.2.2 Reasons for perceived importance of trees for quality of life

Respondents identified various reasons why they agree or disagree with the statement that trees are important for quality of life in towns. The most mentioned reasons were that they felt they get fruit from the trees and thus do not have to buy from the shops so often, trees provide shade and reduce air temperatures. The majority of those who were neutral in their agreements did so because they felt the disservices brought by the presence of trees (such as making the streets and yards look messy, causing allergies, provide places for criminals to hide and them causing accidents) outweighed their benefits. A few respondents were neutral because they felt that there are some useful trees while others are useless. Ninety-one respondents disagreed with the statement because they did not see how trees are important for quality of life or how they benefit from them.

4.2.2.3 Street trees, their benefits and problems

Although most respondents felt that it is important to have trees on the street, and that trees are important for quality of life in towns, not all respondents had trees on their street. Seventy-seven percent of respondents across all towns claimed that they have no trees on their street (Figure 4.5). These responses were taken as per the respondents claim and were not disputed based on the interviewer's observations of the presence or absence of trees on the respective streets. There were more respondents from Libode (93 %) and Peddie (90 %) than all other towns who claimed not to have trees on their street, while Matatiele (63 %) and Graaff-Reinet (67 %) had the least respondents with this claim. There were also significantly more respondents from the former homeland towns than the non-former homeland towns who claimed not to have trees on their streets (t=4.63; $p<0.05$). Additionally, most of the respondents who claimed absence of trees on their street are from the RDP suburbs (41 %), some from the township suburbs (38 %), and the least from the affluent suburbs (21 %). Only a few respondents from two towns (Matatiele and Peddie) in the RDP suburbs reported having trees on their street, while some respondents from the township suburbs of Libode, Peddie, Port St John's and Tsolo reported that there are no trees on their street. There was at least one respondent from the affluent suburbs across all towns who claimed that they have no trees on their street.

As a result of not having trees on the street, the majority of respondents could not rate their knowledge of the most common types of trees on their street and the benefits or problems associated with trees. The majority of respondents (77 %) could not name the most common

trees on their street, and the benefits and problems associated with street trees because there were no trees on their streets, 14 % reported not knowing the most common trees on their street, while 9 % of the respondents claimed to know, and subsequently named them. The highest incidence of not knowing the most common trees on the street were from Matatiele (86 %) (Figure 4.6). More than half of the respondents with trees on their street from Cradock (72 %), Graaff-Reinet (65 %), Peddie (58 %) and Burgerdsorp (53 %) were knowledgeable of the most common types of trees on their street (Figure 4.6). Sixty-five percent of respondents from the former homeland towns were not knowledgeable about the most common types of trees on their street while 53 % of those from the non-former homeland towns were not knowledgeable (t=0.9; p>0.05).

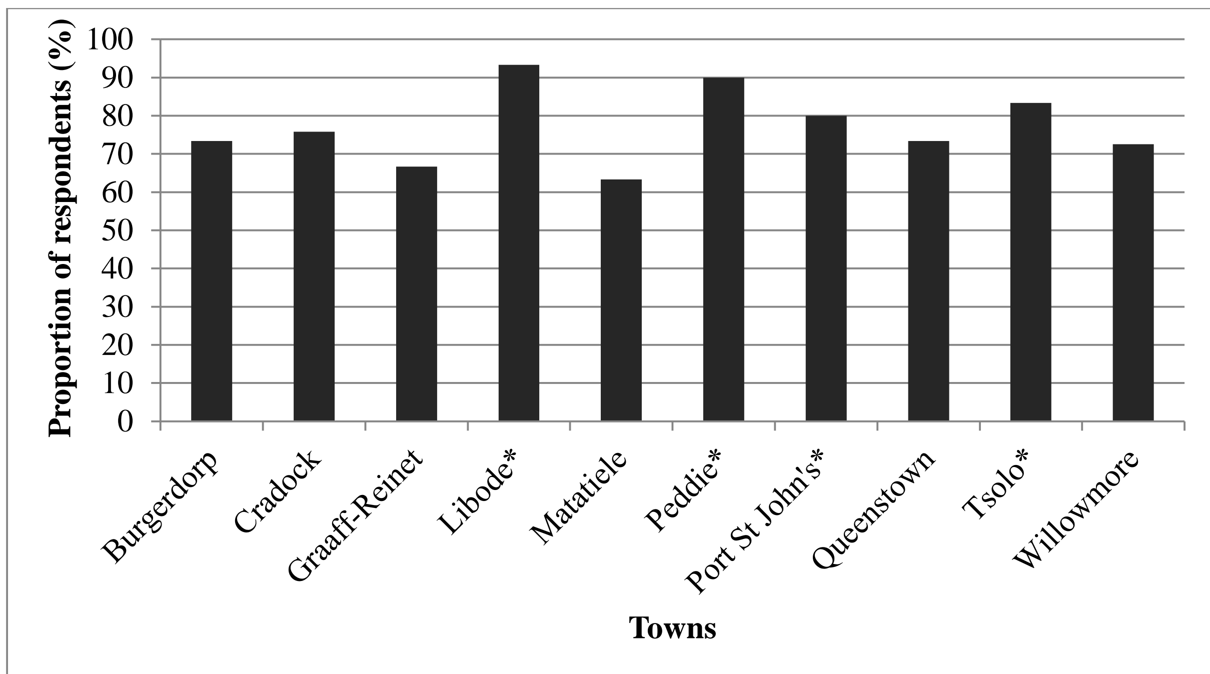

Figure 4.5: The absence of trees on the street across all towns based on respondents' claims (*=former homeland towns).

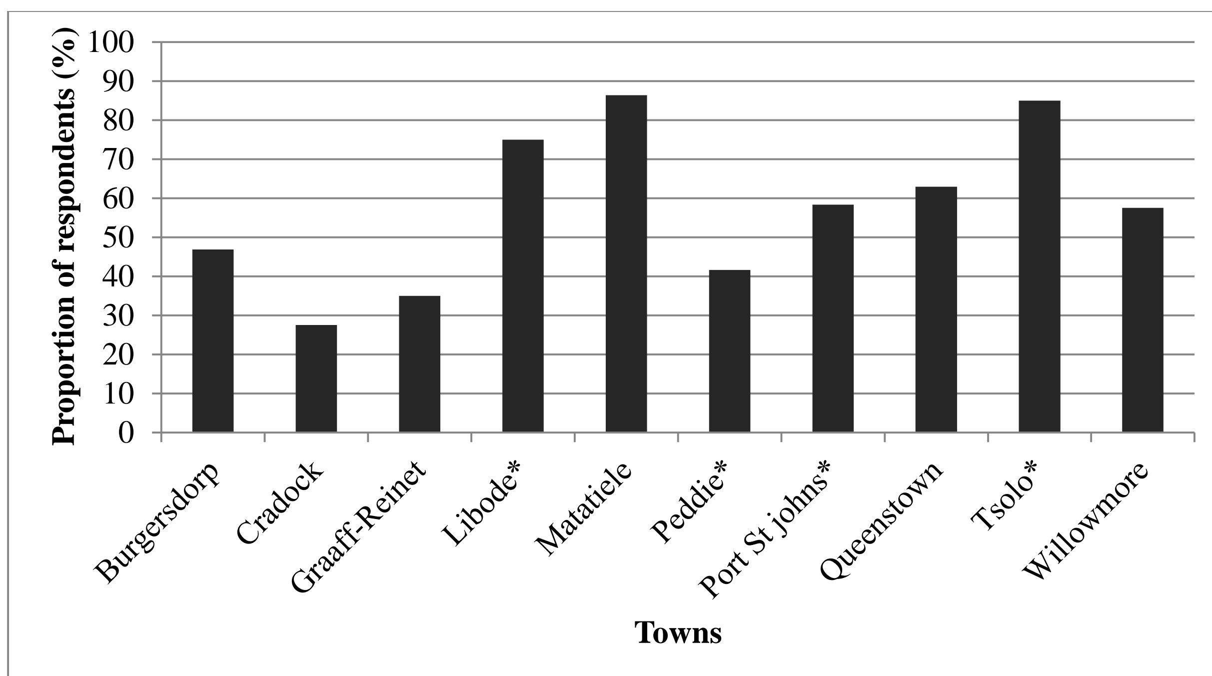

Figure 4.6: Ability to identify the most common types of trees on the street among respondents who have trees on their streets across all towns (*=former homeland towns).

Compared to the medium and high street tree density towns [that were significantly different to one another (χ^2=92.2; p<0.05)], the low density towns had significantly more respondents who were unable to identify the most common types of trees on their streets (χ^2=37.9; p<0.05). The majority of respondents (60 %) who were knowledgeable about the most common types of trees on their street come from towns classified as high street tree density towns (Table 4.14). This suggests that the presence of street trees has a positive impact on people's interest in knowing about the trees around them (r^2=0.13; p<0.05).

Table 4.14: Respondents ability to identify the most common trees on their streets among those whose streets have trees.

Towns (street tree density class)	Ability to identify common trees (%)	
	Yes	No
Low	30	70
Medium	33	67
High	60	40
Total	40	60

Marginally more males (45 %) were able to identify the most common types of trees on their street than females (37 %) (t=6.3; $p<0.05$). There was a significant positive association between the respondent's highest education and their ability to identify the most common trees on their streets ($r^2=0.26$; $p<0.05$).

With respect to the tree species respondents would like to have on their street, most respondents referred to the characteristics of trees they would most desire (such as size, shape, and root type of trees) and to the functions or benefits they would like the trees to provide. Seven percent of respondents across all towns reported that they would like to have indigenous species like *Olea africana*, *Harpephyllum caffrum*, *Acacia karroo* or *Erythrina lysistemon*. More than 40 % of respondents across all towns reported that they would like to have ornamental trees, while 33 % preferred to have fruit trees. The most desired trees were from the *Myrtaceae* family (*Eucalyptus, Angophora* or *Corymbia* genera), while species of *Pinus* were also a favourite. More than 11 % of respondents reported that they would like to have evergreen trees planted. A few reported that they would be happy with any species, while others preferred those similar to the ones planted in the CBD and more affluent suburbs. In terms of size, 18 % of respondents across all towns reported that they would like to have big or tall trees that will provide shade on their street, 9 % preferred medium-sized trees, while only 6 % preferred small trees.

The proportion of respondents mentioning each benefit or disservice of street trees are listed in Table 4.15. The majority of respondents mentioned ecological and aesthetic benefits of street trees, while economic benefits received minimal recognition (Table 4.15). Most of the problems with street trees mentioned by respondents are those that have directly affected them in the past, e.g. make the street look messy and dirty.

Table 4.15: Benefits and problems with street trees identified by respondents with trees on their streets.

Benefits of street trees	Proportion of respondents (%)	Problems with street trees	Proportion of respondents (%)
Shade provision	75	Make the street look messy and dirty	78
Beautify the street	69	Attract insects and other scary animals	46
Air purification	54	Branches sometimes fall on people or cars	45
Home for birds and small animals	43	Criminals hide behind them	37
Protection from strong winds	42	Interfere with street lights/electricity lines	32
Stress relief and mood improvement	33	Roots destroy road	31
Temperature reduction	27	Attract undesirable people to our street	30
Enhance community appeal	24	Cause allergies	26
Increase property value	22	Host bad spirits and attract lightening	21
Oxygen provision	22	Use up a lot of space	21
Fruit provision	18	Branches and leaves fall inside yard	15
Soil erosion reduction	10	Hide traffic signage	15
Provide environment for children to play	9	Dead tree leaves block drains	10
Cultural and spiritual fulfilment	8	Hide sunlight	7

Very few (2 %) of the respondents who do not want trees anywhere found problems with the trees on their street, although most (67 %) who would prefer to have trees both in their yards and on the street found problems with the trees on their street (Table 4.16).

Table 4.16: Cross-tabulation of the preferences for the location of street trees among respondents who experience (and do not) problems with the trees on their streets.

Problems with street trees	Preference for the location of planted trees (%)				Total (%)
	Yard and Street	Yard only	Street only	Nowhere	
No	76	17	6	1	36
Yes	67	15	16	2	64
Total	70	16	12	2	100

More (21 %) of the respondents who had problems with the trees on their street also perceived the presence of trees on the street as more moderately important than those who had no problems (Table 4.17). Additionally, more (78 %) of those who had problems perceived having trees on the street as greatly important compared to those that had no problems with the trees on their street (74 %) (Table 4.17).

Table 4.17: Cross-tabulation of the perceptions respondents who experience (or do not) problems with the trees on their about the importance of having street trees.

Problems with street trees	Perceived importance of having trees on the street (%)			Total (%)
	Greatly Important	Moderately Important	Not Important	
No	78	17	5	36
Yes	74	21	5	64
Total	75	20	5	100

4.3 Discussion

4.3.1 Preference for trees

Urban residents have direct control of their private gardens and actively take decisions regarding types and species of trees to plant, remove or retain. In some Australian cities, residents also have influence on the presence and species of trees on the public land between their property boundary and the roadway (Kirkpatrick *et al.,* 2012). Similar to Shackleton *et al.* (2014), the majority of respondents in this study reported that they have at least one tree in their gardens, which may be interpreted to mean that they appreciate trees. This study also found

that the new RDP suburbs had significantly lower numbers of trees in their yards compared to both the affluent and township suburbs, mirroring findings by Shackleton *et al.* (2014). Lack of space can be a contributing factor to the low densities of household trees in RDP suburbs, which was emphasised by the majority of respondents from households without trees. The prevalence of fruit trees in most households suggests that they appreciate the direct and tangible benefits offered by the trees (Shackleton *et al.,* 2014). This study found that the most planted trees in household gardens were fruit trees. This could be because the "promotion of trees in private gardens is not just an environmental agenda, but is desirable for the supply of a number of tangible and intangible benefits" (Shackleton *et al.,* 2014).

The variety of reasons why respondents in this study plant, retain or remove certain trees in their homesteads are supportive of those by Kirkpatrick *et al.* (2012) who showed that respondents plant or retain trees for beauty, and some are removed because their roots damage infrastructure. However, most of the reasons given by respondents in my study were not based on perceptions or their experience and interactions with the trees, but rather with the attributes they have no control over, such as retaining trees because "they were already there when the occupant arrived", or not having trees because "the occupants rent the property". None of these reasons were found by Kirkpatrick *et al.* (2012) as most of the reasons in that study were centred on peoples' direct perceptions of trees and interactions with them. This could be because Kirkpatrick *et al.* (2012) asked respondents to "select as many options as they wished from lists of reasons for planting and removing trees". This study, however, simply asked them why they have the trees they have or why they have no trees in their gardens (depending on whether they had trees in their gardens or not) (Appendix 1). The reason for planting selected trees in homesteads because the municipality had given out the trees suggests that while the municipality might be seen as not doing enough to provide trees in suburbs (Chapter 5), they are making strides to ensure that if their towns cannot have tree-lined streets, then there should be an abundance of trees in peoples' gardens. Other reasons mentioned by respondents regarding their desire to have shaded and beautiful homes and streets are similar to those mentioned by Summit and McPherson (1998), who found that the desire for shade and beauty and energy conservation and any other environmental reasons were the biggest motivators for tree planting in private gardens in Sacramento, California. On the other hand, trees were removed because they were dying, to avoid damage to infrastructure, and causing a mess in the yard.

While residents appreciate trees, both in public and private spaces predominantly because of their benefits (Shackleton *et al.,* 2015), they have varying preferences of where they would most like trees to be planted based on how they perceive the impact of the location on the delivery of benefits. Preferences are usually based on how people perceive the environment around them (Zhang *et al.,* 2010), and peoples' preferences regarding the landscape surrounding them are an important part in the assessment of landscape quality (Lothian, 1999; Poudyal *et al.,* 2009). Tree placement is a key element in landscape design (Wu *et al.,* 2008), and peoples' perceptions and acceptance of the decisions for tree placement need to be considered (Tyrväinen *et al.,* 2005). The majority of respondents in this study reported that they would prefer to have trees planted both on the street and in their yards, highlighting that they are aware of the "multi-functionality of trees in urban landscapes with varying uses, benefits and values attached to them, depending on whether they are in public or private space" (Shackleton *et al.,* 2015). This finding corroborates those by Zhang and Zheng (2011) who concluded that "people like to have trees on their property and in the community, an observation that is not based on their gender, age, race, income, and family background." On the contrary, Ng *et al*. (2015) found that the majority (94 %) of respondents surveyed in Hong Kong indicated that they favoured tree planting on streets, while only 6 % did not favour tree planting or expressed no opinion.

Richardson and Shackleton (2014) found that approximately 80 % of respondents from Grahamstown and Adelaide preferred to have trees along their street because they thought that street trees added value to the neighbourhood. The reason for these differences could be the way in which the question regarding their preferred location for planting trees was phrased differently (Appendix 1). Some of the reasons (abundant fruit everywhere) why respondents would prefer the selected locations for tree planting support the findings by Shackleton *et al.* (2015) that respondents from Tzaneen and Bela-Bela collected fruit from their gardens and outside of their yards in public green spaces. Other reasons (to have shade everywhere) were also reported by Ng *et al.* (2015), who reported that more than 80 % of respondents surveyed in Hong Kong favoured trees because they could provide shade. Most of the respondents who would like to have trees both on the street and in the yard or in the yard only already have trees in their yards, while most of those who would prefer to have trees on the street only, do not have trees in their yards. This supports the hypothesis that people with trees in their yards are more appreciative of street trees than those who do not. Richardson and Shackleton (2014) also found that the perceptions of having trees on the street were positively influenced by the

presence of trees in respondents' homes, where 87 % of respondents with trees in their homes had more appreciation for street trees compared to the 70 % of respondents who did not have trees in their homes. These results also corroborate those of Zhang *et al.* (2010) that "greening is important in residential landscapes, and people prefer to live in houses with more trees.

Similar to Shackleton *et al.* (2015), respondents from the RDP suburbs are more appreciative of the regulating and provisioning services of trees, which could account for why more of them than from other suburbs would prefer that trees be planted in their yards. The negative connotations associated with why respondents prefer to have trees on the street only or not at all suggests that they are more comfortable having trees in their yards than anywhere else. In the same light, these reasons imply that the negative attributes associated with trees far outweigh the positive. However, some residents are aware of the need to protect nature as their preferences suggest that they would rather have trees in their yards in order to protect them from vandalism, while others are happy with the fact that they will not have to take care of the trees on the street. Urban residents in Adelaide (55 %) and Grahamstown (48 %) claimed to have seen someone or something damaging a street tree (Richardson and Shackleton, 2014). The respondents identified ways in which vandalism of street trees could be reduced, including planting trees in sensible areas and installing protective structures around the trees (Richardson and Shackleton, 2014). These ideas suggest that they appreciate trees so much that they would rather have them protected than in danger, which is a similar perception exhibited by respondents in my study.

The idea that trees may provide cover to criminals suggests that respondents would rather have trees and enjoy their benefits in the comfort of their homes than to enjoy benefits from trees on the street and put their lives in danger. There have been contrasting schools of thought in studies on the relationship between crime and urban trees (Shackleton *et al.,* 2015). While some studies indicate increased incidences of crime due to urban trees (i.e. Sreetheran and Konijnendijk van Den Bosch, 2014), others show that trees reduce the incidence of crime by getting residents out into the neighbourhood (i.e. Kuo and Sullivan, 2001). Preferences not to have trees on the street revealed in this study support the idea that the presence of trees contributes to criminal activity. This concurs with findings by Pincetl (2010) that "residents in areas with high criminal activity often do not want trees planted in front of their properties as they fear that criminals will be able to hide in the trees."

Fear of crime is not the only factor prohibiting residents from embracing the presence of trees on their streets. This study also showed that there are people who generally just do not like trees for various reasons, and would rather not have trees on their streets. Pincetl (2010) also found that there are people who would be resistant towards the planting of trees on their streets, simply because they do not like trees and would not want the added burden of having to fix infrastructure that may be damaged by tree roots. Additionally, Perkins (2011) noted that inner city African Americans in the United States tend to resist the planting of trees outside their houses because they are concerned about tree maintenance and damage to their property by trees.

4.3.2 Satisfaction with street and street trees

This study also reported on residents' satisfaction with the general appearance of their streets and with the number of trees on their streets. Satisfaction refers to the extent to which needs are met (Lovejoy *et al.,* 2010). In this context, this study sought to understand what residents perceived as an ideal street for them both in terms of appearance and contents. There are four dimensions of neighbourhood quality indicators which can be used as measures of satisfaction, i.e. physical environmental conditions, locational characteristics, local services or facilities, and sociocultural environment (Basolo and Strong, 2002). Most respondents were not satisfied with the general appearance of their street, pointing to the undesirable state of the street infrastructure, cleanliness and absence of drainage systems.

Being a developing country, South Africa faces massive backlogs in urban infrastructure with blatant development discrepancies where some urban areas are more developed than others (Shackleton *et al.,* 2014). Respondents from the former homeland towns were the least satisfied with the general appearance of their street, and this can be attributed to the fact that their towns have historically been neglected under the apartheid regime in South Africa (Shackleton *et al.,* 2014). The general infrastructure in these towns is of a lower standard than most other towns, with fewer tarred roads, poor maintenance of tarred surfaces and limited pedestrian pavements. This is similar to the situation in the RDP suburbs where there were more dissatisfied respondents than both the affluent and township suburbs. The immediate focus in the establishment of these RDP suburbs is the provision of housing for the indigent at as low a cost as possible (Gwedla and Shackleton, 2015), with little regard for broader aesthetics and environmental services. The high levels of dissatisfaction with general appearance of streets among township and RDP suburbs is plausible as, according to Ellis *et al.* (2006), the

availability of nearby trees, well-landscaped grounds, and places for taking a walk are some of the most important factors in neighbourhood satisfaction. Similar to respondents from South Bronx, New York, who agreed that more trees were needed in their neighbourhood (Broussard-Allred *et al.,* 2010), most respondents in my study were dissatisfied with the number of trees on their streets and suggested more vigorous tree planting. The dissatisfaction with the number of street trees by respondents from the township and RDP comes as no surprise as these suburbs have very few street trees compared to the affluent suburbs (Chapter 3).

Martinez *et al.* (2015) found that residents from the richer neighbourhoods in Cali, Colombia, were more satisfied with public space in their neighbourhoods compared to those from the poorer neighbourhoods, corresponding to the results of this study. Qin *et al.* (2013) suggested that people are more satisfied by attractive natural environments, as observed where overall satisfaction by respondents was highest in a more vegetated and colourful garden. Most of the respondents in this study who showed satisfaction with the general appearance of their streets did so because they have many trees and a lot of grass. Most people generally prefer environments that have trees more than those dominated by inanimate objects (Lohr and Pearson-Mims, 2006). Heimlich *et al.* (2008) asked respondents how well they liked the street on which they lived, and many of them identified the cleanliness of the street, its attractiveness, and the mature trees on their streets. Concerning overall satisfaction with the appearance of streets and the number of trees, the results of this study do not corroborate those by Schroender *et al.* (2006) who found that "residents in all the communities surveyed held similarly high levels of overall satisfaction with the trees outside their homes". Similarly, Jorgensen *et al.* (2007) found that "Birchwood respondents appeared to be very satisfied with the landscapes of their residential streets, although they had powerful positive and negative attitudes towards the tree and shrub planting used by the designers to structure and decorate spaces on the street". This study revealed that the majority of residents were neither satisfied with the number of trees on their streets nor the general appearance of their streets. In their dissatisfaction, most respondents noted the infrastructure, cleanliness of their streets, and absence of trees, flowers or vegetation.

4.3.3 Appreciation for street trees

The findings support evidence found in previous studies (i.e. Lohr *et al.,* 2004; Schroeder *et al.,* 2006; Zhang *et al*., 2007; Zhang and Zheng, 2011; Kirkpatrick *et al.,* 2013; Shackleton *et al.,* 2015) that most urban residents have a positive attitude towards trees and appreciate them.

Zhang *et al.* (2007) found that 90 % of respondents from Alabama appreciated urban trees in choosing their residential location and community. The importance of street trees, and thus their contribution to the quality of life of urban residents can be established through the contributions made by trees to people and other biodiversity. In emphasising the importance of street and other trees for quality of life in towns, the majority of respondents in this study affirmed the importance, noting their provision of shade, oxygen, fruit, purifying the air and buffering wind. Lo and Jim (2015a) found that respondents in Hong Kong expressed general recognition of the main ecosystem services provided by urban trees, including providing shade and mitigating the greenhouse effect in their perceived importance of urban tree functions. Gorman (2004) also found that the majority of respondents from State College, Pennsylvania, emphasised the importance of having street trees by recognising that they provide shade, have flowers, are pleasing to the eye, and render the neighbourhood more liveable.

Part of this research (Chapter 3) revealed that only 23 % of the sampled transects had street trees, underlying the fact that the majority of respondents in this part of the study could not report on their benefits, problems, or which trees are most common. Most of the benefits and problems selected by respondents who had trees on their street are similar to those identified by Lohr *et al.* (2004) who found that the highest ranked reasons to have trees by respondents surveyed in the United States included the shade provided by trees, helping people feel calm, and their reduction of smog and dust. Most respondents from Tzaneen and Bela-Bela, South Africa, also mentioned that the trees in their surrounding green spaces provide them with shade (Shackleton *et al.,* 2015). Breuste (2013) also found that the majority of respondents from Mendoza, Argentina, value the improvement of climate and beautification provided by the urban trees. Lohr *et al.* (2004) reported that the highly ranked problems with street trees include causing allergies, cracking of sidewalks, and that they can fall across power lines. These problems were not mentioned the most in this study, although they were each mentioned by more than 20 % of respondents. Corroborating these findings, Daniels and Kirkpatrick et al. (2013) found that most landowners in Australia expressed aversion to trees because they believed trees harbour nuisance animals, are messy, create too much shade, damage infrastructure, provide cover for burglars, and their leaves block gutters. On the other hand, the same group of people recognised that trees increase real estate values, provide habitats for wildlife, provide privacy and shelter, and shade. Moro *et al.* (2009) also reported the problems with street trees causing allergies in their probe into toxicological hazards of natural environments. People attach importance to street trees via the benefits the trees provide because

they gauge importance by their usefulness. The results from this study revealed that people who found problems with street trees equally thought that trees were not important. This could be because the problems they identified did not outweigh the benefits provided by the trees. Kitchen (2013) concluded that while urban trees possess inherent value, they are not always good, primarily because of environmental injustice where trees can be planted in areas where most residents do not approve of or there can be certain species that people do not like, and urban forest governance issues where residents feel excluded from the management of urban forests.

Some preferences and attitudes to street trees were influenced by respondent characteristics. For example, my study revealed that age had a bearing on preferences for where trees should be planted, but gender did not. Yet, there was a gender difference regarding ability to identify the most common trees on the street. This latter attribute was also positively related to respondents' level of education. Other studies have also found such correlations, but with inconsistencies between them. For example, Tian *et al*. (2015) reported age and gender differences in the interest to manage private forests for ecosystem services, but there was no relationship with education. In contrast, Avolio *et al*. (2015) found positive links between respondent education and income, and appreciation of street trees in private spaces, but not public ones. Todorova *et al.* (2004) found strong links between respondent age and preferences regarding street trees, whilst Williams (2002) revealed both gender and education effects in Melbourne, Australia.

4.4 Conclusion

Most households have trees, and this can be related to people's appreciation of trees and their desire to be surrounded by nature. In this desire, people mostly prefer to plant or retain trees that will make direct contributions to their livelihoods and quality of life, as was seen with the abundance of fruit trees in peoples' gardens. However, lack of space, inability to afford the trees that people want, and people's fear of crime and vandalism deter some from having trees. While most people have trees in their yards, they also would like to have tree-lined streets, especially for the aesthetic benefits and provisioning ecosystem services of street trees. Consequently, most people are currently dissatisfied with both the number of trees on their streets and with the general appearance of their street, mostly because there are too few trees on the street, and their streets are not clean or have no proper road infrastructure. Most of those

who are satisfied with either the number of trees on their streets or the general appearance of their streets are from the affluent suburbs.

The dissatisfaction with the number of trees on their streets suggests that urban residents would like to have more trees on their street, they appreciate street trees and recognise their importance. Most people recognise that it is important to have trees on the street and trees are important for quality of life in towns. As such, most of the benefits of street trees they recognise echo their importance for quality of life in towns. Notwithstanding this, problems associated with street trees should not go unnoticed. Urban planners and municipal officials have a significant role to play in ensuring that the preferences of urban residents regarding street trees are addressed. This will go a long way in reducing incidences of vandalism and lobbying for public support for urban forestry and urban greening. There have recently been shifts in the relationship between urban forests and communities towards a more democratic governance that involves and addresses residents' preferences and perceptions (Kitchen, 2013). People's recognition of the importance of street trees and their contribution to quality of life should be a start towards involving residents in decision-making regarding street tree planting.

In light of people's general support for household trees, urban planners and municipalities need to have a strong focus on the private urban forest as part of the broader initiatives to promote urban greening. This will require encouragement and constant interaction with communities that they fully participate in tree planting initiatives and programmes like Arbor Week (which in South Africa is the first week of September every year) where residents can be challenged to plant and maintain trees in their gardens and in close proximity to their homes. There needs to be more emphasis on greening competitions within communities, where residents are rewarded for the amount and condition of greenery in their gardens and streets. This will encourage urban residents to embrace urban greening, advance it and ensure that their preferences and perceptions are considered.

Chapter 5

The attitudes of urban residents on street tree stewardship

5.1 Introduction

Urban planners and managers have significant roles to play in shaping the structure and appearance of towns and cities (Broussard *et al.,* 2008). Municipalities are usually at the forefront in these tasks, and have a significant influence on the potential urban and environmental sustainability of towns (Gwedla and Shackleton, 2015). There has been widespread recognition of the many benefits of urban forestry and its contributions to environmentally sustainable towns, but little has been done to probe the processes through which these urban forests are established (Pincetl, 2010). In some developed world cities like New York City, the planting and maintenance of street trees is a shared responsibility between local governments and non-government or community-based organisations, and often the local citizens (Moskell and Broussard-Allred, 2013). In South Africa, the planting and maintenance of street trees in urban areas is the responsibility of local municipalities (Gwedla and Shackleton, 2015; Chishaleshale *et al.,* 2015). However, municipalities do employ the services of other stakeholders based on the needs in specific tree planting programmes. According to Chishaleshale *et al.* (2015), more than 60 % of municipalities in the Limpopo and Eastern Cape provinces of South Africa involve other stakeholders like national government departments, non-government organisations, churches and schools in their tree planting activities, especially to source tree seedlings.

While urban residents can be actively involved in the maintenance of street trees following planting, they strongly believe that the provision of funds towards tree planting should be the responsibility of the local government more than the state or federal government (Zhang and Zheng, 2011). This is not to say that urban residents should be limited in their involvement with both planting and maintenance because after all, they are the ones who benefit directly from having trees on the street. Although municipalities and non-government organisations may have the funds and resources to facilitate the planting of street trees, they might not be

able to perform maintenance duties like watering or pruning timeously (Moskell and Broussard-Allred, 2013). Chishaleshale *et al.* (2015) found that only one out of 17 local municipalities in the Eastern Cape and Limpopo provinces of South Africa have a tree maintenance schedule in place, and that maintenance of trees was largely dependent on the municipalities being informed by the general public about any trees that need attention. Thus, there is increased reliance on residents to help maintain the trees. Such actions and contributions can enhance the potential benefits of trees by prompting their survival (Moskell and Broussard-Allred, 2013). Additionally, involving local residents in street tree planting and maintenance could help "to transfer a citizen's sense of ownership over the sidewalk through giving them more investment in new street trees" (Rae *et al.,* 2010), thus fostering a sense of responsibility for the trees. Black (1978) opined that "a lack of ownership is generally experienced in areas with low levels of resident occupancy, which results in lower levels of street trees care".

Street trees that are monitored by local residents have a significantly higher rate of survival than those that are not (Boyce, 2011). The involvement of local residents in the planting and maintenance of street trees can "lead to outcomes that respect the local culture, religion or history of the community" (Matsuoka and Kaplan, 2008), wherein residents can advocate for their needs in relation to street trees. In this regard, consultation becomes crucial as mobilising people to help with tree maintenance can prove difficult if they had not been consulted about the tree planting activities to begin with (Janse and Konijnendijk, 2007; Rae *et al.,* 2010). Consequently, urban residents may be led to believe that as a result of not having been consulted, they should not be expected to share responsibility for the maintenance of the planted trees (Moskell and Broussard-Allred, 2013). Public consultation is an important exercise aimed at ensuring that service providers are aware of the needs and wants of the public, rather than making decisions for them, and to encourage residents to participate in tree planting activities (Richardson and Shackleton, 2014). Consultation can help ensure that urban forest resources make positive contributions to local people and avoid possible conflicts related to the urban forest and its resources in future (Lawrence *et al.,* 2011).

Involving multiple stakeholders in tree planting and stewardship activities outside of local government is important to large cities because trees are usually planted by contractors who are only able to maintain trees for the first few years after they have been planted, thereby requiring as much participation in maintenance as possible (Moskell and Broussard-Allred, 2013). The improved allocation of urban forest benefits can be achieved when the public and

private sectors work together, with collaboration with professionals and other stakeholders (Carreiro and Zippere, 2008). Some urban forest managers and practitioners usually "expect the residents who live, work and recreate in neighbourhoods where trees are planted to take responsibility for post-planting care and maintenance" (Moskell and Broussard, 2013). However, no clear evidence has been presented on whether urban residents believe that they are responsible for any activity related to street trees, whether before, during or after planting when the trees need to be maintained. According to Pincetl (2013), "the planting of trees by public and non-profit partners and the reliance on private residents to maintain the trees is a novel form of urban environmental governance."

There have been many suggestions regarding how local residents can be involved in the planting and maintenance of street trees, paramount of which include volunteering (Moskell *et al.,* 2010). This is where urban residents "devote their time and efforts to assist with tree planting stewardship without pay" (Asah *et al*., 2014), and their willingness to contribute time or funding resources towards urban greening projects (Lorenzo *et al.,* 2000; Shackleton and Blair, 2013). There have been a number of successful urban greening projects that incorporated the services of volunteers. For example, Thompson *et al.* (2004) reported on a successful externally funded program in tree planting and maintenance as part of community forestry that was largely implemented by volunteers. While it may be common knowledge that help is needed in community projects and municipal initiatives in providing green infrastructure in urban areas, it is essential that municipalities reach out to residents about planned tree planting activities to "more clearly and directly communicate to residents that their help is needed to maintain newly planted trees" (Moskell and Broussard-Allred, 2013). This chapter set out to solicit urban residents' beliefs regarding whose responsibility they think it is to plant and maintain street trees, why they think the identified stakeholder should be responsible, and whether the municipality is doing enough to plant and maintain trees in their towns. The willingness of residents to help plant and maintain trees on their streets, and the reasons for such were also examined.

5.2 Methods

See Chapter 2, Section 2.1 paragraph two for full details.

5.3 Results

5.3.1 Stewardship of street trees

Respondents identified a number of key stakeholders they believe are responsible for the planting and maintenance of street trees in their respective towns and suburbs. The respondents' beliefs about the stewardship of street trees were captured against a predetermined list as well as any other stakeholders mentioned, such as the government and donors. Stakeholders suggested by only a few respondents were grouped into one category labelled "other". (Figure 5.1). The majority of respondents (68 %) believe that their local municipality is responsible for the planting and maintenance of street trees (Figure 5.1). Compared to all other towns, fewer respondents from Peddie (53 %) believed that the responsibility to plant and maintain street trees lay with the municipality, with Cradock having the most respondents (89 %) with this belief. Significantly more respondents from the non-former homeland towns than the former homeland towns believe that the stewardship for street trees is the responsibility of the municipality (t=3.5; $p<0.05$). On average, a proportion of 58 % of respondents from the former homeland towns believe that the municipality is responsible for the planting and maintenance of street trees while 76 % of respondents from the non-former homeland towns believe this. Additionally, with the exception of Libode, a little more than half of the respondents from each of the former homeland towns believe this, while more than 60 % of respondents from each of the non-former homeland towns hold this belief. There were also significantly fewer respondents (58 %) from the classified low street tree density towns than both the medium (71 %) (χ^2=13.4; $p<0.05$) and high density towns (77 %) (χ^2=11.4; $p<0.05$), which both had significantly different proportions of respondents (χ^2=5.6; $p<0.05$), who believe that the municipality is responsible for the planting and maintenance of street trees.

The most cited reasons across all towns as to why respondents believe that the municipality is responsible for planting and maintaining street trees are that the land belongs to the municipality; the municipality has the resources; and because tree planting and maintenance is part of service delivery, the municipality should provide that service. The majority of those that believe community members are responsible for street tree planting and maintenance recognise that community members are the direct beneficiaries of the ecosystem services provided by trees, and because they live in the respective suburbs, they should be the ones taking care of the suburb, which includes taking care of the trees. Most of those that believed that street tree planting and maintenance should be and is a combined exercise by any interested and affected

stakeholder, identify that each of the stakeholders have a unique contribution they can make to reduce the burden of a single stakeholder. They recognised that the municipality plants the trees that were donated by other stakeholders, and residents maintain those trees. Some respondents felt that if everybody is involved then everyone will have a sense of ownership for the trees, which will decrease incidents of vandalism. This reason was mostly directed towards who should be responsible rather than who is currently responsible. The most popular reason why some respondents felt that it is nobody's responsibility to plant and maintain street trees was that trees are supposed to grow naturally without human interference, and that whoever felt the need to plant or maintain trees should do so without any obligation. The former reason was particularly popular among respondents from Port St John's, while the latter was mentioned by at least one person across eight towns.

Significant differences were observed in the beliefs about the municipality being responsible for the planting and maintenance of street trees between respondents from the affluent and township suburbs (χ^2=38.2; p<0.05), and between those from the township and RDP suburbs (χ^2=43.9; p<0.05). Proportions of 67 %, 72 % and 67 % of respondents from the affluent, township and RDP suburbs respectively, believe that the municipality is responsible for the planting and maintenance of street trees (Figure 5.2).

The most cited reasons why respondents from the affluent suburbs thought that it is the municipality's responsibility to plant and maintain street trees was that the municipality has the resources and respondents pay rates and taxes for them to be able to take care of the environment. Less than 15 % of those that felt that community members should be responsible for planting and maintaining street trees in the affluent suburbs did so because they felt it instils a sense of responsibility for the trees. More than 90 % of respondents from both the township and RDP suburbs thought that the planting and maintenance of street trees is the municipality's responsibility because the public land in urban areas belongs to the municipality. More than 40 % of the respondents who answered that street tree planting and stewardship in the RDP suburbs is the municipality's responsibility did so because they feel that municipal officials know best regarding which trees should be planted, and when, where and why those particular trees should be planted.

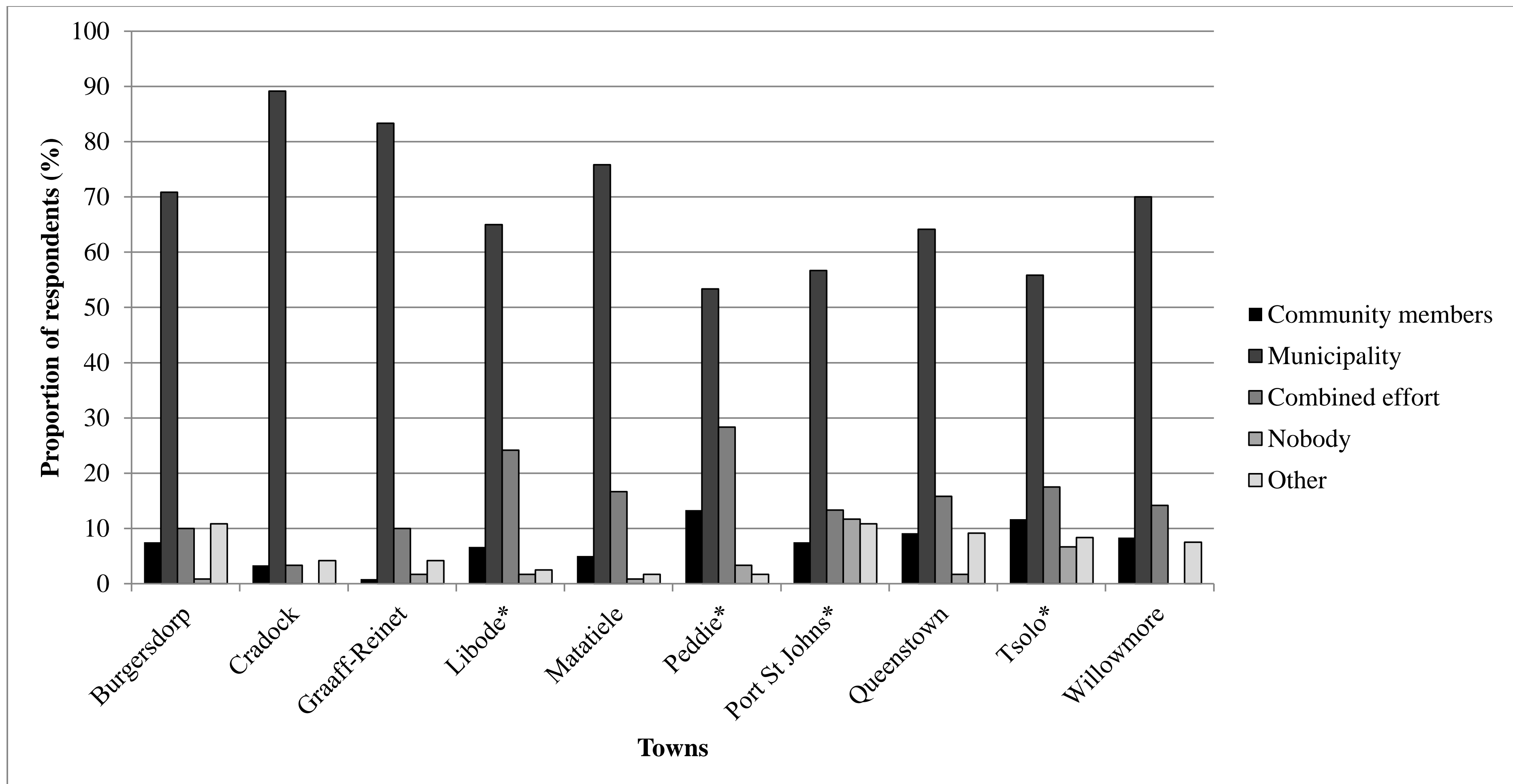

Figure 5.1: Stakeholders identified by local residents as responsible for the planting and maintenance of street trees across all towns.

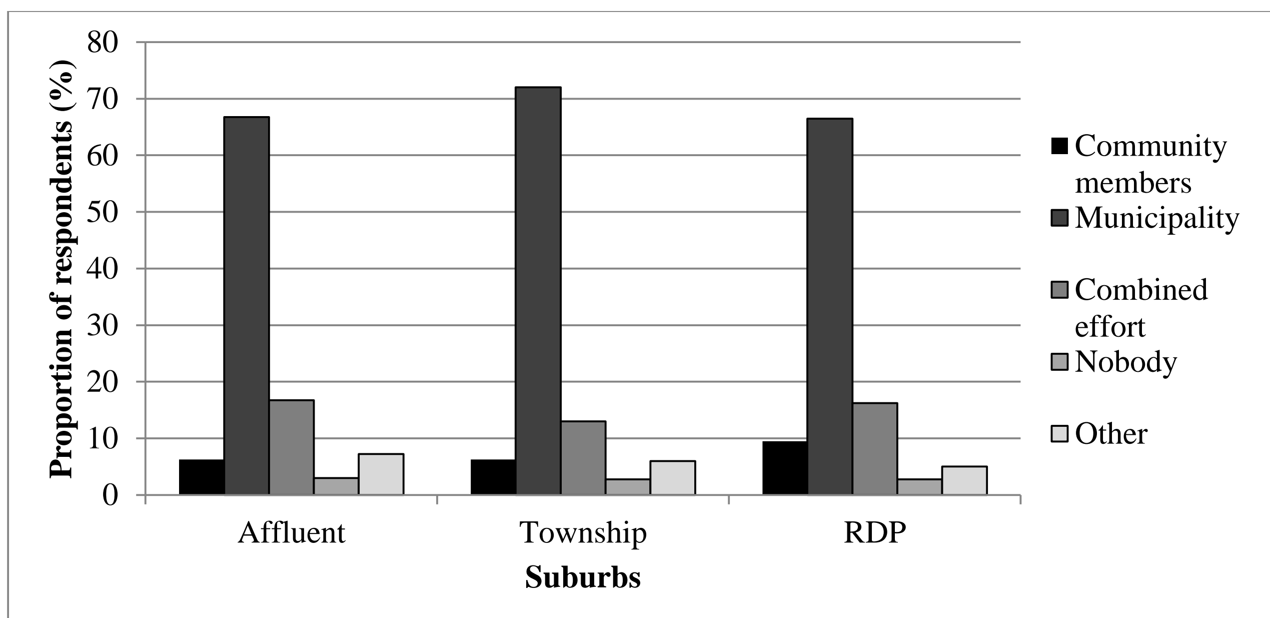

Figure 5.2: Perceptions of respondents from the affluent, township and RDP suburbs regarding the stewardship of street trees.

5.3.2 Consultation about tree planting activities

The integrated development plan (IDP) of all municipalities requires that before anything is planned for the town there should be an open public consultation process where urban residents are involved in planning and priority setting (Ruwanza and Shackleton, 2015). With regards to tree planting activities happening in various suburbs, the majority of respondents (93 %) reported that they have never been consulted about tree planting activities in their respective suburbs (Figure 5.3). No respondents from Queenstown have ever been consulted about tree planting activities before (Figure 5.3), with proportions of 85-95 % not being consulted in the other towns. On the contrary, four of the horticulturists interviewed reported that urban residents are involved in the decision-making process regarding street tree planting. However, all the respondents noted that they would like urban residents to be involved in street tree planting and maintenance, especially by availing themselves and volunteering to maintain newly planted street trees and by committing themselves to take care of a certain number of trees on their streets.

The majority (86 %) of the respondents who reported that they had been consulted about tree planting activities said that this had been done within the last 10 years, while 11 % reported that it had been more than 10 years ago and 3 % could not recall when they were consulted. More than half of the respondents who had been consulted reported that they had been consulted by the municipality, 29 % did not know who they had been consulted by, while 14

% reported that they had been consulted by staff from the Department of Agriculture, Forestry and Fisheries (DAFF), a health clinic or private companies. Ninety-four percent of respondents reported that this consultation was mainly in the form of the respondents being given trees (mostly fruit trees) to plant in their gardens rather than about tree planting on the streets. None of the respondents who mentioned that they had been consulted about tree planting activities in their suburb mentioned that the consultation involved the trees that would be planted on the streets.

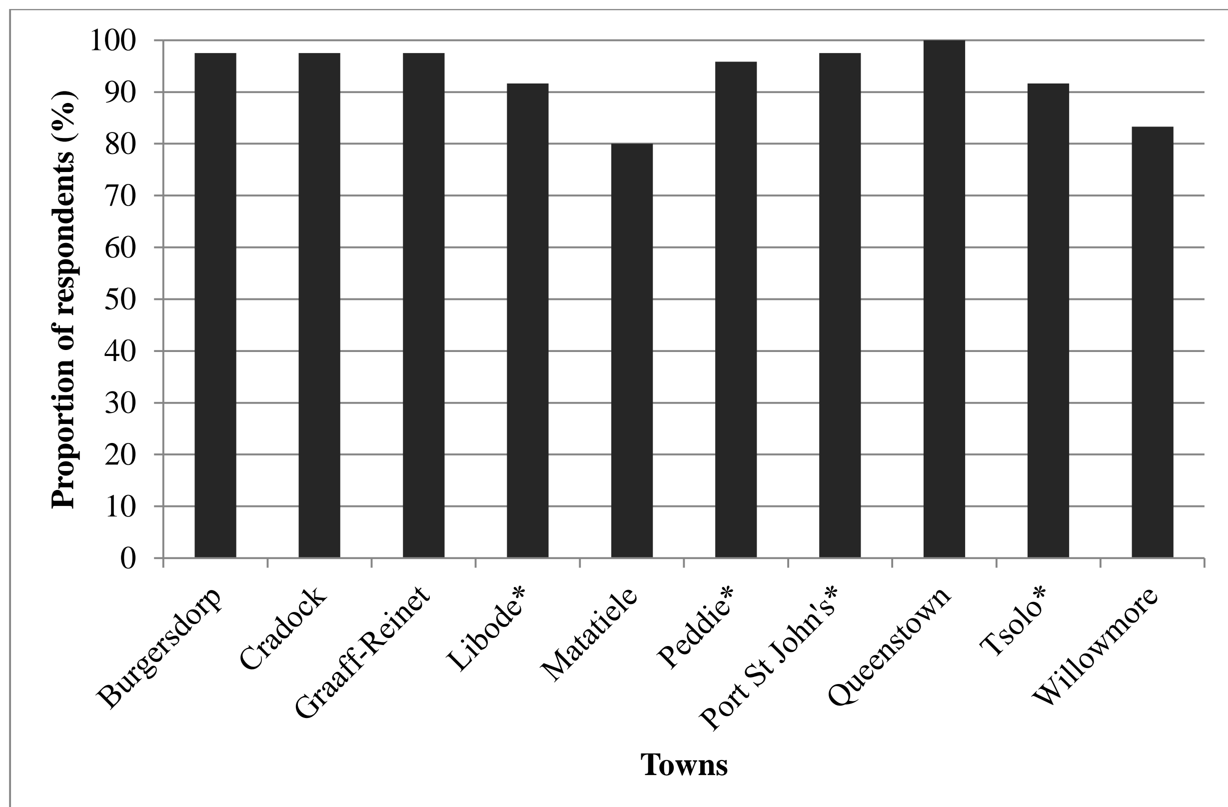

Figure 5.3: Respondents who reported never having been consulted about tree planting activities in their suburbs.

Despite the reported lack of consultation with residents, there were significantly more respondents who would have liked to be consulted about tree planting activities in their suburbs than those who do not (t=26.6; $p<0.05$). The majority of respondents (81 %) across all towns would have liked and would like to be consulted about tree planting activities taking place in their suburbs in the future, compared to 12 % of respondents who do not want to be consulted and have concerns with never having been consulted, while the remaining respondents reported having been consulted. There were more respondents from Wilowmore (17 %), Burgersdorp (16 %) and Libode (15 %) than all other towns who have no concern with not having been

consulted about tree planting activities or do not want to be consulted in the future (Figure 5.4). There were no significant differences in the proportion of respondents who desire consultation about tree planting activities in their suburbs between respondents from the former homeland towns and those from non-former homeland towns (80 % and 79 %, respectively) (t=0.7; p>0.05).

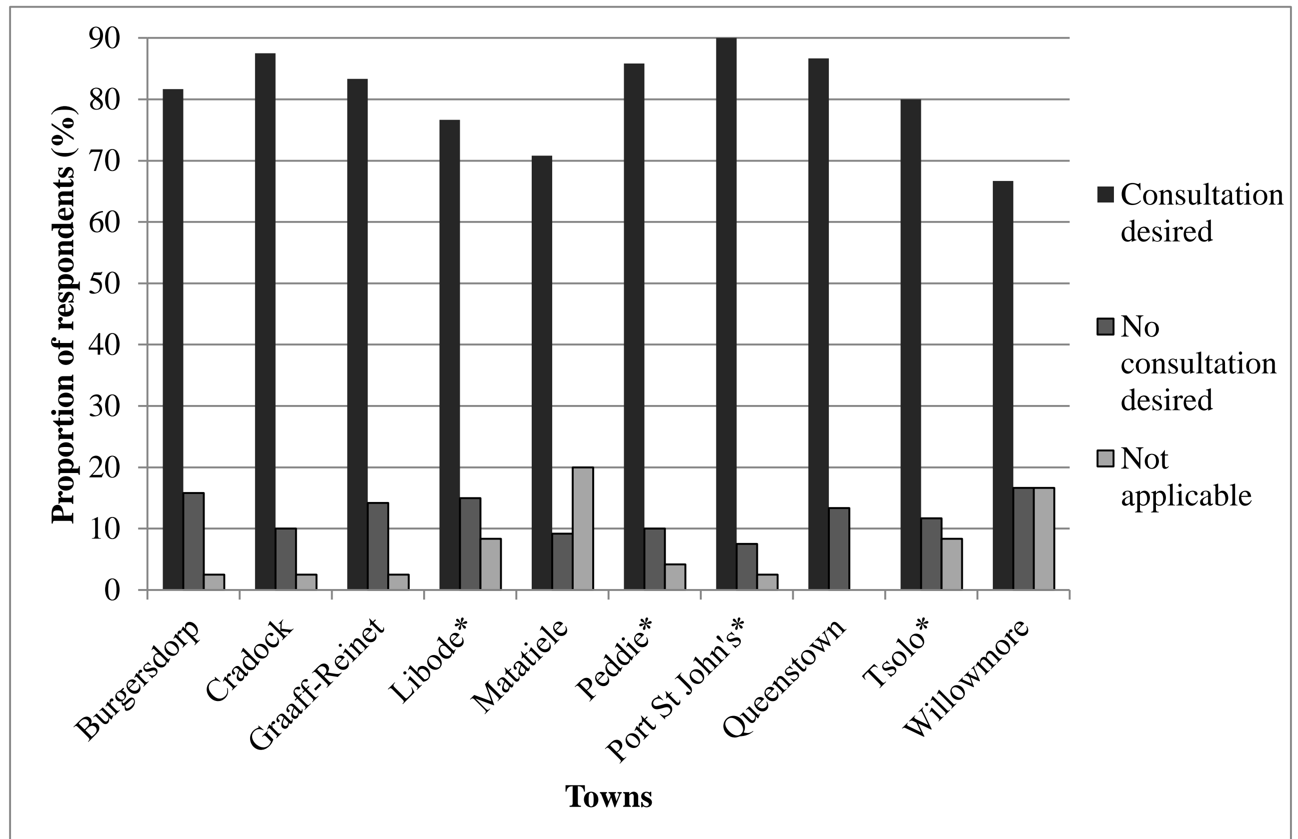

Figure 5.4: Proportion of respondents who would like to be consulted about tree planting activities in their suburbs and those who do not.

There were significantly fewer respondents from the affluent than the township (χ^2=17.7; p<0.05) and RDP suburbs (χ^2=38.0; p<0.05), that were also significantly different to one another (χ^2=23.4; p<0.05), who would like to be consulted about tree planting activities in their suburbs. More than 80 % of respondents from the township and RDP suburbs respectively, would like to be consulted about tree planting activities in their suburbs compared to 74 % of respondents in the affluent suburbs across all towns. Significantly more young people than old people (χ^2=27.9; p<0.05), who were also significantly less than the middle-aged respondents (χ^2=20.5; p<0.05) would like to be consulted, while no significant differences in the proportion

of young and middle-aged respondents were established (χ^2=1.8; p>0.05). More than 80 % of the young and middle-aged respondents desired to be consulted, compared to 76 % of old people.

Three of the horticulturists revealed that they, together with their managers, decided which street trees to plant and where. In most occasions, residents are informed about such decisions during community meetings, which residents hardly attend. One horticulturist explicitly mentioned that urban residents are never part of the decision-making process relating to street tree planting because when the municipality attempted to include them on previous occasions, they received very little support in terms of the attendance of meetings. Despite this, five horticulturists mentioned that would like urban residents to be involved in street tree planting, especially by volunteering or making donations towards the procurement of trees and maintaining them. Five horticulturists mentioned that they receive little support in their efforts to "green" their towns from senior municipal officials. One horticulturist said that since he works for the district municipality, he is the one who usually gives suggestions to local municipalities and in that regard, he is senior. Thus, horticulturists or officials need to get his support in their urban greening strategies, which he gladly gives.

5.3.2.1 Reasons for wanting (or not) to be consulted about tree planting activities

There were significant differences between respondents of the three suburbs regarding why they would like to be consulted about tree planting activities in their suburbs (Table 5.1). Most people would like to be consulted so that they can voice their opinions on the types of trees they would like planted and the locations where the trees should be planted (Table 5.1). There were more residents from the RDP suburbs who wanted to give their opinion on the choice of trees to be planted and where, and who wanted to learn more about trees and encourage tree planting than residents from the affluent and township suburbs (Table 5.1). There were also significant differences in the reasons given by respondents from the affluent and township suburbs (χ^2=30.6; p<0.05), than those from the affluent and RDP suburbs (χ^2=12.4; p<0.05), while the reasons given by respondents from the township and RDP suburbs were not significantly different to one another (χ^2=3.7; p>0.05). Most respondents from the township suburbs who did not desire consultation said they "do not care" and were not interested in tree planting activities, while there were many from the affluent suburbs who had "nothing to say about tree planting activities", and therefore did not want to be involved (Table 5.1). There

were very few people across all towns and suburbs who did not want to be consulted about tree planting activities in their suburb because they “do not have the time” (Table 5.1).

Table 5.1: Reasons for wanting or not wanting to be consulted about tree planting activities.

Reasons		Number of mentions			
		Affluent	Township	RDP	Total
Reason for wanting consultation	To give my opinion on my choice of trees and where they should be planted	102	113	138	353
	To know what is going on in my suburb	87	65	52	204
	To learn more about trees	47	51	83	181
	To encourage tree planting	18	20	21	59
	To report that I do not want trees	18	13	6	37
	Other: i) to ask them to fix our street; ii) to participate in community projects; iii) to get a job, iv) to ensure that my views are implemented; v) no one can just do anything in this suburb without our knowledge.				
Reason for not wanting consultation	I do not care and I am not interested	16	19	14	49
	People who plant trees know what they are doing and do not need me	7	9	10	26
	Tree planting is good so there is no need to be consulted about it	4	8	9	21
	I have nothing to say and I do not want to hear about it	11	5	3	19
	I do not have the time	7	4	3	14
	Other: i) I do not see how I have a say; ii) everything is fine the way it is; iii) I am never at home; iv) I do not want to be involved; v) I am not from here; vi) it is not my business.				

5.3.3 Municipalities’ progress in providing and maintaining trees

Although the municipality was recognised by the majority of respondents as being responsible for the planting and maintenance of street trees, there were significantly more respondents who strongly felt that the municipality was not doing enough to provide trees in suburbs than those who felt otherwise ($H=112.4$; $p<0.05$). Seventy-eight percent of respondents strongly felt that the municipality was not doing enough to provide trees in suburbs while only 3 % of them

strongly felt that the municipality was doing enough and 10 % of respondents felt the municipality just does enough (2 % disagreed) (Table 5.2). Seven percent of the respondents were neutral in their opinion of their municipality's provision of trees, mostly citing that their municipality is already doing quite a lot in terms of service delivery and therefore could be swift in providing trees for everyone and every street. Some of the respondents were neutral in their opinion about their municipality's provision of trees because the respondents themselves do not want trees anyway, and there are already some streets that have trees in their suburbs.

There were significantly more respondents from the former homeland towns (87 %) than the non-former homeland towns (64 %) who strongly felt that their municipality is not doing enough to provide trees in their respective suburbs (t=3.9; $p<0.05$). More than 85 % of respondents from Libode, Peddie and Tsolo respectively, felt strongly that their municipality was not doing enough to provide tree in their suburbs, while less than 65 % of respondents from Cradock, Matatiele, Queenstown and Willowmore felt this way. There were no more than 5 % of respondents from each town who agreed that their municipality was doing enough to provide trees.

Once trees have been provided and planted, they require maintenance to ensure that they deliver as many benefits as possible. While the municipality may have been seen as playing a role in providing trees, there were significantly more respondents who could not verify that their municipality was doing enough to maintain trees (H=48.4; $p<0.05$), citing that there were no trees to maintain in the first place. Sixty-four percent of respondents across all towns could not ascertain or dispute their municipality's progress in maintaining trees in their suburbs (Table 5.2). Only 7 % of respondents agreed that their municipality was doing enough to maintain trees in suburbs while 29 % (22 % strongly disagreed and 7 % just disagreed) of respondents across all towns felt that their municipality was not doing enough (Table 5.2).

There were significantly more respondents (87 %) from the classified low street tree density towns than the medium (63 %) (χ^2=24.6; $p<0.05$) and high density towns (75 %) (χ^2=7.2; $p<0.05$), which were significantly different to one another (χ^2=7.1; $p<0.05$), who felt that the municipality was not doing enough to provide trees in their suburbs.

Table 5.2: Respondents agreement with whether their municipality does enough to provide trees in suburbs.

Town	Municipal provision and maintenance of trees in suburbs (%)									
	Strongly Agree		**Agree**		**Neutral**		**Disagree**		**Strongly Disagree**	
Burgersdorp	0	1	9	11	3	63	4	12	84	13
Cradock	3	0	19	7	6	56	12	7	61	31
Graaff-Reinet	2	0	13	8	6	51	14	23	66	18
Libode*	4	0	3	0	5	89	1	0	87	11
Matatiele	4	3	16	6	11	51	10	9	59	31
Peddie*	0	0	3	0	6	83	4	0	88	18
Port St John's*	2	0	3	1	11	56	0	3	85	40
Queenstown	3	3	14	12	7	57	15	5	62	24
Tsolo*	2	0	3	0	8	84	0	0	88	16
Willowmore	10	8	15	13	9	51	16	12	50	18
Total	3	1	10	6	7	64	8	7	73	22

There were significantly more respondents from the RDP (86 %) than both the affluent (55 %) (χ^2=207.3; p<0.05) and township suburbs (78 %) (χ^2=85.0; p<0.05), both of which had significantly different proportions (χ^2=112.7; p<0.05) of respondents who felt strongly that the municipality was not doing enough to provide trees in their suburb. Most (97 %) respondents from the RDP suburbs who thought that the municipality was not doing enough to provide trees said it was because there were hardly any trees visible on the street, nor had the residents ever witnessed street tree planting. Others noted that the municipality only planted in the CBD and affluent suburbs but not in the RDP suburbs. Ninety-one percent of the respondents who felt that the municipality was doing enough to provide trees were from the affluent suburbs, 6 % were from the township suburbs and 3 % from the RDP suburbs. There were no significant differences in the proportion of respondents who thought that the municipality does not do enough to provide trees in the suburbs between those who have trees in their yards and those who do not (t=1.1; p>0.05).

5.3.4 Volunteering for urban greening

Recognising that the municipality was neither doing enough to plant or maintain trees in suburbs, there were significantly more respondents across all towns who would be willing to volunteer to help plant and maintain trees on their street compared to those who would not be willing (t=8.1; $p<0.05$). Almost 70 % of respondents from Graaff-Reinet and Queenstown, respectively, reported that they would be willing, while less than half of those from Libode would be willing (Figure 5.5). There were no significant differences in the proportions of respondents from the former homeland towns (59 %) and those from non-former homeland towns (65 %) who would be willing (t=1.4; $p>0.05$). Among the former homeland towns, Peddie had the most willing respondents, while respondents from Graaff-Reinet and Queenstown, respectively, were the most willing respondents among the non-former homeland towns (Figure 5.5). There were no significant differences in the proportion of respondents from the classified low and medium density towns (χ^2=0.4; $p>0.05$), and from the low and high density towns (χ^2=3.7; $p>0.05$), while the medium density towns had significantly more respondents than the high density towns (χ^2=8.0; $p<0.05$) who would be willing to volunteer to help plant and maintain trees on their streets.

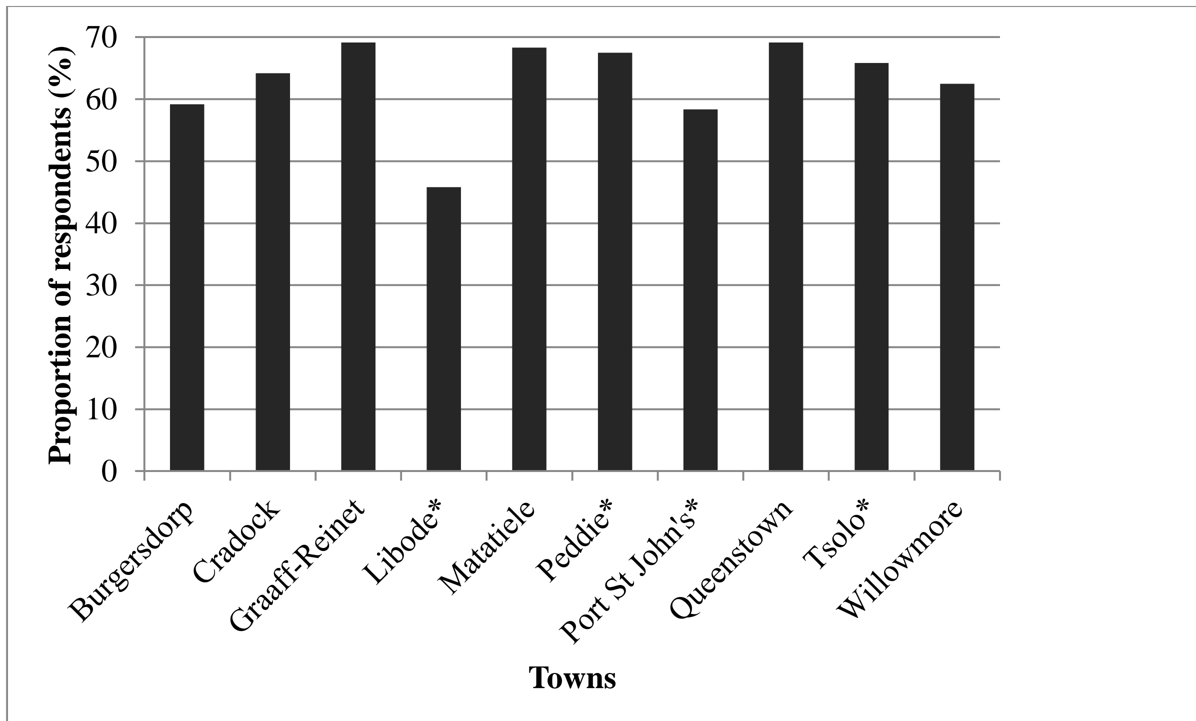

Figure 5.5: Respondents' willingness to help plant and maintain trees on their streets.

There were significant differences in the proportions of respondents from the affluent and township suburbs ($\chi^2=40.5$; $p<0.05$), affluent and RDP suburbs ($\chi^2=56.4$; $p<0.05$), and between those from the township and RDP suburbs ($\chi^2=44.2$; $p<0.05$) who would be willing to volunteer to help plant and maintain trees on their street. The RDP suburbs had the largest proportion (67 %) of willing respondents compared to both the township (64 %) and affluent (58 %) suburbs.

5.3.4.1 Reasons to volunteer or not to volunteer

Respondents identified a number of reasons why they would be willing (or not) to volunteer to help plant and maintain trees on their streets. Some of the reasons mentioned by respondents in this study were associated with respondents' desire for the aesthetic benefits associated with street trees, while others were mostly interested in being useful in their communities (Table 5.3).

Table 5.3: Respondents' motivation for wanting to volunteer to help plant and maintain trees on their streets

Reasons		Number of mentions			
		Affluent	**Township**	**RDP**	**Total**
Motivation for wanting to volunteer to help plant and maintain street trees	To beautify my street	79	93	111	283
	For my street to have trees	70	103	106	279
	To be useful and involved in community projects	96	107	46	249
	I love trees	66	68	92	226
	To enjoy the benefits of street trees	53	74	89	216
	Other: i) I enjoy gardening; ii) to learn more about trees and tree planting; iii) to be well integrated in my community and interact more with other people; iv) I have nothing else to do; v) to be exposed to employment opportunities; vi) to gain work experience; vii) I care about my street; vii) to get a stipend; viii) to learn new skills.				

Many of those who would not be willing to volunteer to help plant and maintain trees were either too busy to volunteer or not willing to "work for free", did not have the time to volunteer, and are either too old or too sick (Table 5.4). The majority (73 %) of the respondents who would not be willing to volunteer because they were too old or too sick were above the age of 55, while the majority (78 %) of those who would not be willing because they would not want

to work without pay were below the age of 50. The "other" reasons were mentioned by less than 10 % of respondents in each category of reasons across all suburbs.

Table 5.4: Respondents' motivation for not wanting to volunteer to help plant and maintain trees on their streets

Reasons		Number of mentions			
		Affluent	**Township**	**RDP**	**Total**
Motivation for not wanting to volunteer to help plant and maintain	I am busy/ I have a job	85	100	48	233
	I can never work for free	29	82	79	190
	It is the municipality's job	37	31	23	91
	I am sick/old to volunteer	22	25	35	82
	I do not want trees	16	21	44	81
	Other: i) no space for more trees; ii) do not enjoy gardening; iii) I am not from here; iv) I am hardly at home; v) I know nothing about trees; vi) the municipality restricts what we can do on the street and I am not willing to help them; vii) they should employ people for such.				

5.4 Discussion

Most respondents in this study believe that the responsibility to plant and maintain trees in their town and suburb lay with the municipality, rather than themselves or any other stakeholders outside of the municipality. This was mostly because they believed that the land they occupy as well as the town itself belong to the municipality, the municipality has the necessary resources for planting and maintaining street trees, and it was responsible for service delivery. These results are consistent with those by Moskell and Broussard (2013) where the majority of respondents from Jamaica and Canarsie believed that the responsibility for tree stewardship lay with the government, rather than the residents themselves, other non-governmental entities or shared responsibility between the government and other stakeholders. Similarly, Zhang *et al.* (2007) found that most people in Alabama considered the promotion and development of urban forestry as the responsibility of the local, state or federal government. The reason for assigning responsibility to local municipalities because they have the resources is consistent with those by Zhang *et al.* (2011), who found that "more people from Alabama believed that local government is important for funding community tree planting and tree stewardship activities

than state or federal government". The results in this study also suggest that the beliefs towards who is responsible for the planting and maintenance of street trees are place-specific. The significant differences between beliefs of respondents from the former homeland and non-former homeland towns, and between those of respondents from the low, medium and high street tree density towns could be a result of respondents having previously seen municipal officials planting or maintaining trees around the town or suburbs. The former homeland towns were found to have much lower densities of street trees than the non-former homeland towns (Chapter 3), and it could be that most respondents from the former homeland towns had never seen municipal officials performing such duties. As a result, these respondents, using past experiences, believe the municipality is responsible for planting and maintaining trees.

Consultation is one of the key components of the IDP process in South Africa, whereby municipalities consult with local residents and other stakeholders before they prioritise and implement certain projects within the municipality (Government Gazette, 2000; Ruwanza and Shackleton, 2015). The IDPs explicitly outline the plans of the municipality for the next five years based on The Municipal Systems Act of 2000 (Government Gazette, 2000), which, when not adhered to, can lead to disciplinary offences. The municipal IDPs are also based on responses to issues that had previously been identified by members of the community during the communication consultation process of the IDP development stage (Government Gazette, 2000). The IDP planning process includes a stage where "vision, objectives, development strategies, projects and programmes can be identified and prioritized by each municipality, with public consultation on the design and specifications of each project to be implemented in the municipality" (Ruwanza and Shackleton, 2015). This suggests that consultation with the public is a crucial phase in the implementation of any municipal project. Consultation enables residents to be part of the decision-making process where their views about identified projects are taken into consideration, and provides them with a platform to be actively involved in municipal projects. Unfortunately, the majority of respondents in this study reported never having been consulted about tree planting projects in their communities, rendering them unaware of the activities taking place in their communities.

The strong belief about the municipality being responsible for planting and maintaining street trees can be associated with the residents not being consulted, therefore being unaware of tree planting activities in their communities and thus disassociating themselves from any responsibility. Zhang *et al.* (2007) found that residents in Alabama were more inclined to associate the responsibility for urban forest management with the government due to a lack of

awareness about natural resource management programmes in their communities. Rae *et al.* (2010) reported that street trees in New York were previously planted on an individual request basis, where residents could request free trees to be planted in front of their property and those who had not requested were given an option to refuse tree planting. This form of consultation was never implemented in any of the communities sampled in this study, although the majority of residents would have liked to have been consulted. The lack of consultation about tree planting activities found in this study are consistent with those of Richardson and Shackleton (2014) who found that the majority of urban residents from 11 Eastern Cape towns had not been consulted by the municipality in any way about tree planting activities. Both of these results are contrary to those reported by Gwedla and Shackleton (2015) of municipal officials who claimed to have consulted local residents about tree planting initiatives in their respective municipalities.

Municipalities are faced with various challenges in their attempts to implement urban forestry initiatives in their towns (Chapter 3; Gwedla and Shackleton, 2015; Chishaleshale *et al.,* 2015). Thus, it comes as no surprise that residents feel the municipality does not do enough to provide trees. Paramount in these challenges are limited funds and resources allocated to urban greening (Chishaleshale *et al.,* 2015). The significant differences in respondents' perceptions about the municipality's progress in providing and maintaining trees in suburbs, based on their towns and suburbs, is a classic indication of the inequalities in street tree distribution. This was found in a study by Landry and Charkraborty (2009) who concluded that there is wide variability in distribution between suburbs, largely associated with ethnic and socio-economic differences. These results are further corroborated by Kuruneri-Chitepo and Shackleton (2011) and Seburanga *et al.* (2014b) who found that the more affluent suburbs had higher street tree densities than the poorer ones; in addition, McConnachie and Shackleton (2010) showed marked inequalities in the distribution of public urban green spaces.

The challenge of limited financial resources for urban forest management has led managers and organisations to actively seek lower cost solutions to achieve conservation and greening goals, resulting in the enlistment of volunteers as part of this strategy (Daniels *et al.,* 2014). Neighbourhood tree planting activities present positive opportunities for forestry professionals to work closely with local citizens (Austin, 2002; Roman *et al.,* 2015). The primary objective of volunteering initiatives in urban forestry is to implement tree planting programmes within communities (Bloniarz and Ryan, 1996). Volunteers have previously been used to conduct street tree inventories, maintain street trees, and in ecosystem restoration projects (Austin,

2002). Volunteering has also been used as a means of augmenting city stewardship resources, where volunteers are solicited to participate in tree planting events (Young and McPherson, 2013). Young and McPherson (2013) mention that as part of governing metropolitan green infrastructure in the United States, permanent volunteers have been sought to care for urban forests in Salt Lake and New York City. The majority of respondents in this study reported that they would be willing to volunteer to help plant and maintain trees on their street. These results correspond with those by Broussard-Allred *et al.* (2010) who found that although almost 83 % of residents in a New York study had never participated in a tree planting or tree care program in their neighbourhood before, 76 % of them would like to participate. However, this study did not specify to what capacity these respondents would like to participate (whether as volunteers or as part of an organisation where they would be remunerated for their participation).

People often have varying reasons for volunteering, such as their love for planting or to learn new skills (Moskell *et al.,* 2010). The motivations mentioned by respondents in this study regarding why they would be willing to volunteer to help plant and maintain trees on their streets are consistent with those by Moskell *et al.* (2010). They found that urban forestry volunteers in New York volunteered because they recognise the environmental benefits of street trees, to serve their communities, they enjoy planting trees, and because they recognised the need for more street trees. The results in this study about motivations to volunteer cover the personal desires and social goals people wish to fulfil with tree planting, as mentioned by Moskell *et al.* (2010). No respondents explicitly sought to fulfil the environmental goal (such as to have clean air or for reduced soil erosion) of volunteering identified by Moskell *et al.* (2010). According to Thompson *et al.* (2004), volunteering in tree planting programs provides social benefits to the volunteers such as having a sense of community. This benefit was one of those sought by respondents in my study when they reported that they would be willing to volunteer to help plant and maintain trees on their streets in order to be well integrated in their communities and interact more with other people.

The results show that the current street tree density and street appearance have strong effects on resident perceptions and willingness to engage. The RDP suburbs had the lowest street tree density and unsurprisingly therefore, they were the least satisfied that their municipality is doing enough. Similarly, residents of the low density street tree towns had a high level of dissatisfaction, and the former homeland towns, which have lower street tree densities (Chapter 3) were more dissatisfied with their municipalities' efforts than residents of non-former homelands. Whilst the considerable majority of respondents across all towns and suburbs

would like to be consulted about street tree plantings, the proportion increased with increasing density of street trees; thus, it was highest in the RDP suburbs, which had the lowest street tree density, intermediate in the townships and lowest in the affluent suburbs. Mirroring this was the higher proportion of respondents in the RDP suburbs willing to volunteer, followed by the township and least in the affluent. This echoes the findings of Shackleton and Blair (2013) around willingness to volunteer to maintain public green spaces. These results clearly show that urban residents are acutely aware of the state of their neighbourhood and are willing to participate to redress shortfalls or perceived needs.

5.5 Conclusion

Local municipalities are usually at the forefront of urban greening and are in a strong position to influence the potential urban and environmental sustainability of towns. Street tree planting and maintenance has been recognised as the responsibility of local municipalities with help from other stakeholders including non-government organisations and community members. Other stakeholders are can be deemed to be responsible because they are in a position to either donate funds or trees for street planting or by providing equipment for planting. In most instances, urban residents participate in urban greening initiatives as volunteers or by donating much needed resources. This study emphasised the role of municipalities in being responsible for urban forestry from residents' perspectives. While consultation is crucial as guided by the IDP of municipalities, most respondents in this study had never been consulted about tree planting activities, most of who would like to have been consulted or to be consulted in the future.

The evident inequalities in the distribution of street trees between and within towns were emphasised by residents in this study, with the majority pointing out that the municipality does not do enough to provide and maintain trees in suburbs. However, the majority were willing to volunteer to help ensure that once trees are available, they are planted and cared for. The respondents' willingness to be consulted about tree planting activities in the future and to volunteer to help plant and maintain trees suggests that they would like to be actively involved and be aware of activities taking place in their suburbs, calling on municipal officials to heed this interest in their plans to implement urban greening initiatives in communities. To do this, municipalities need to be in communication with community leaders to mobilise support from residents. Educating local residents about street trees, their importance and benefits will greatly contribute to their willingness to participate and volunteer for urban greening activities.

Chapter 6

Synthesis, conclusions and recommendations

6.1 Introduction

The aim of this study was to investigate the composition, diversity and density of urban street trees across a range of ecological and social contexts and how this is perceived by local residents and horticulturists. This aim was addressed within three results chapters. This chapter synthesises core findings and messages from Chapters 3, 4 and 5, and briefly discusses possible policy implications of the results. Conclusions from each of these chapters are also drawn to highlight recommendations for urban planning that incorporates urban greening within Eastern Cape towns; possibilities of future research are also presented.

Urbanisation has become a global concern as the population balance between the rural and urban population inexorably swings towards urban areas (United Nations, 2012). The increased levels of urbanisation have compromised the quality of the natural environment due to land transformation, resource use and waste disposal to accommodate the growing population (Hutyra *et al.,* 2011). To counter this, urban forestry and green infrastructure have been identified as viable strategies to address some of the negative social and ecological impacts associated with urbanisation and its impacts on the natural environment (Kambites and Owen, 2006). Current trends and the channelling of knowledge within urban forestry have been identified and grouped into five discourses, i.e. managerial, civic involvement, ecosystem services, biodiversity, and green infrastructure and urban planning discourses (Ostoić and Konijnendijk, 2015). Ultimately, these discourses suggest that the urban forest needs to be structured and managed in a manner that will ensure optimal and equitable distribution of the benefits of street trees to urban populations, other organisms and the natural environment in general, and minimise the problems associated with street trees. The benefits provided by street trees can be ecological, economic or social. Ecological benefits of street trees include air quality improvement (Jim and Chen, 2008) and temperature reduction (Ng *et al,* 2012), economic benefits include the influence of trees on property value (Soares *et al.,* 2011) and reduced expenditure on air pollution removal and storm water infrastructure (Roy *et al.,* 2012),

and social benefits include increased public safety associated with high street tree abundances (Tarran, 2009).

This thesis presented findings on the perceptions of urban residents and horticulturists regarding the distribution, composition and dominance of street trees planted in several Eastern Cape towns and their different suburbs. Building on the work on the assessment of the urban forest in South Africa and that of Kururneri-Chitepo and Shackleton (2011), this work showed the structure of a part of the Eastern Cape urban forest through the composition and distribution of its street trees against certain biophysical and socio-economic attributes. This was complemented by the perceptions of urban residents and horticulturists of the current structure of the urban forest. With the exclusion of the biodiversity discourse, the discourses put forward by Ostoić and Konijnendijk (2015) were a useful construct in addressing the various aspects of this study. Within the managerial discourse, this study sought to investigate why specific tree species were planted and the characteristics of what horticulturists regard as good species for street planting. The civic involvement discourse in this study sought to solicit urban residents' perceptions, appreciation and preferences for street tree distribution and composition across different towns and suburbs, and their attitudes towards street tree stewardship. The ecosystem services discourse was addressed within civic involvement through the investigation of the benefits and problems associated with existing street trees. The green infrastructure and urban planning discourse was addressed through the assessment of the distribution, composition and dominance of street trees in the various towns.

6.2 General Discussion, Synthesis and Conclusion

6.2.1 Composition and distribution of street trees

Street trees have become a major strategy to fulfil the long-term goal of creating "more liveable and environmentally sustainable eco-cities" (Carreiro, 2008). Strom (2007) asserted that streets are the single most abundant public spaces within the urban structure and are the primary setting for public life. Thus, street trees are an important component of the urban forest as they provide critical ecosystem services and benefits which contribute to human health and environmental quality (Roy *et al.,* 2012). This study found low abundance of street trees in 10 medium and small-sized Eastern Cape towns, with only 23 % of sampled transects containing street trees. Furthermore, Chapter 3 demonstrated the unequal distribution of street trees both between and within towns. The larger towns (by population), and those that were not part of the former homelands during the apartheid regime, were found to have a higher density of street

trees than the smaller towns and those that were part of the former homelands. Species richness was also higher in the non-former homeland towns than in the former homeland towns, which are dominated by alien species. The history of South Africa, including its settlers from many countries accounts for the widespread planting of alien trees, whereby most of the trees which were introduced by the settlers for various aesthetic needs, replicated the types of trees planted in most western cities. The results of this study corroborate those of Kuruneri-Chitepo and Shackleton (2011) and Gwedla and Shackleton (2015), whereby the majority of street trees are planted as a result of human agency, with neither vegetation biome nor mean annual rainfall having any significant impact on the distribution and density of street trees between towns. The stakeholders responsible for planting and maintaining trees follow instructions that will promote the survival of planted trees, and thus the trees do not depend on nature. As such, with continued care, expertise and resources, street trees have a better chance of survival. Although most of the towns with a low street tree density have relatively high mean annual rainfall, their lack of resources to support urban greening initiatives is the main contributor to their low densities.

The affluent suburbs were also found to have higher street tree densities than both the township and RDP suburbs, echoing findings by Kuruneri-Chitepo and Shackleton (2011). The affluent suburbs in South Africa, which during the apartheid period were reserved for people of European colonial descent, were historically advantaged and typical of most first world cities. This is in stark contrast to the township suburbs which were reserved for black South Africans and were poorly serviced, with high density housing and limited commercial activities and widespread poverty (Gwedla and Shackleton, 2015). Consequently, the disparities in these suburbs mirror a pattern of neglect, which meant that there were less municipal services and less beautification than in the affluent suburbs. The RDP suburbs are a different case as they are a product of a democratic country created to address the racially defined backlogs of service provision and housing created during apartheid (Hunter and Posel, 2012). The development focus in the establishment of these suburbs is to deliver large numbers of houses for the poor and homeless with as little cost as possible (Gilbert, 2004). There is no agenda for incorporating environmental quality and other services such as urban greening, hence the low densities of street trees in these suburbs.

Horticulturists noted the root system of the prospective tree, its eventual size or shape, whether an alien or indigenous species, and the species' adaptability to the climate of the town as the four most important characteristics they consider before selecting and planting street trees.

Optimising diversity was not mentioned as a consideration. They use the water requirements of the prospective tree and its adaptability to the local climate as a criterion for selecting species suitable for street planting. Knowledge that has been passed on from previous horticulturists and municipal standards is also often used. The cost of the trees and likelihood of vandalism were some of the strategies mentioned to be used by horticulturists in siting street trees in the different parts of the town. Trees interfering with electricity lines or becoming an obstruction to traffic were identified as the most common reasons for trees to be removed by the majority of horticulturists, together with specific requests from residents. Vandalism of planted trees and the lack of awareness among urban residents regarding the importance of trees were identified as the biggest threats to street trees.

6.2.2 Urban residents' perceptions, attitudes and preferences for street trees

The determination of urban residents' preferences and perceptions is an important exercise when seeking public support for urban green spaces and street tree management (Treiman and Gartner, 2005). This study emphasised urban residents' appreciation of trees, revealed by the majority of respondents currently having trees in their yard and preferring to have trees both in their yards and on the street. These preferences were not gender specific, but rather age specific, with more middle-aged than both the youth and elderly preferring to have trees planted both in their yards and on the street. Additionally, these preferences were suburb specific, with more people from the affluent than both the township and RDP suburbs preferring to have trees planted both in their yards and on the streets. This study also revealed that although the majority of residents were not aware of the types of trees on their streets, they still wanted to have trees around them, suggesting that lack of knowledge about trees does not lead to depreciation in the perceived importance and preference for trees. Similarly, although there were more males than females who were knowledgeable about the most common types of trees on their street, there was still substantial appreciation for trees from both genders. Knowledge of the most common street trees was found to be low across all towns, but was influenced by the current street tree density of towns, with more residents in high street tree density towns more knowledgeable than those from the medium and low density towns. This suggests that the presence of trees arouses peoples' interest in learning more about trees. Education also had a more positive contribution to residents' knowledge of the most common tree species on their streets, with the more educated people having better knowledge of the most common trees than the less educated.

Urban residents were also aware of the contributions made by trees to their quality of life in towns, mostly citing the provisioning and regulating services of fruit, shade and air temperature reduction, respectively, provided by trees. Residents with trees on their streets mostly highlighted the shading, beautifying and air purifying benefits of street trees, while very few acknowledged the cultural and spiritual fulfilment they get from the trees on their streets and their provision of an environment for children to play. Fruit provision was not a widely acknowledged benefit of street trees mainly because there were very few fruit trees, i.e. *Ficus sur, Malus domestica, Mangifera indica, Morus japonica, Prunus africana, Prunus domestica, Psidium guajava* and *Pyrus sp*, encountered during street tree assessments as shown in Chapter 3. Notwithstanding the benefits, residents also noted the problems they experienced from having trees on their streets, chief of which was making the street look messy and dirty. Other residents mentioned that the trees on their street attract insects and other scary animals, and the branches from trees sometimes fall on people or cars. Some, though not many, were concerned about tree branches and leaves falling onto their property, trees hiding traffic signage, dead tree leaves blocking drains or trees hiding sunlight. Despite these problems, the majority of people still preferred to have some trees planted on their streets. For the majority of them, ornamental and fruit trees were the most preferred, while a sizeable proportion preferred tall or big trees that would provide shade. Residents' preference for alien species could be a result of them being more familiar with these types of trees and deriving certain benefits from them, like their ability to aid in the treatment of cough ailments and as an antiseptic. Additionally, peoples' limited knowledge of the types of trees may have contributed to their limited choice of preferred species; hence most preferences were based on tree characteristics. Street trees were generally perceived as important, although more so by township and affluent suburbs residents than RDP residents.

6.2.3 Urban residents' attitudes on street tree stewardship

Local municipalities are usually at the forefront in shaping the structure and appearance of towns and cities, and have a significant influence on the potential urban and environmental sustainability of towns (Gwedla and Shackleton, 2015). However, it is important that other stakeholders, such as community members, are part of decision-making when it comes to the planning and implementation of urban projects aimed at contributing to residents' quality of life. The local municipality was identified by residents as the entity that is and should be responsible for the planting and maintenance of street trees supported by other stakeholders such as non-government organisations, community members and government. There were no

differences in belief about the responsibility for planting and maintaining street trees among residents from the different suburbs, with unanimous support that the municipality is responsible for tree planting and maintenance. Age and gender also had no influence on this belief, and neither did educational attainment. These sentiments correspond with those shown by Moskell and Broussard-Allred (2013) who found that most respondents from Jamaica and Canarsie believed the government to be responsible for street tree stewardship rather than urban residents themselves. To mitigate the limited provision of trees and lack of tree maintenance, the majority of residents in this study revealed that they would be willing to volunteer to help plant and maintain trees on their streets, mostly because they wanted to have beautiful streets, and to be useful and involved in community projects. This was in tune with the extent to which most horticulturists/municipal officials, responsible for street tree planting and maintenance, mentioned that they would appreciate the help of community members in planting and especially maintaining trees.

Although the majority of respondents in this study put the responsibility for planting and maintaining street trees on the local municipality, they expected to be consulted before such activities took place. Consultation is a key component of the IDP process in South Africa (Ruwanza and Shackleton, 2015), but the majority of respondents in this study revealed that despite their expectation, they had never been consulted about tree planting activities in their towns before. This was contrary to what was reported by Gwedla and Shackleton (2015) who interviewed municipal officials, the majority of whom claimed to have consulted urban residents about tree planting activities in their respective municipalities. Perkins (2011) states that people responsible for tree planting should not just go into any community and plant trees, because people have indifferent and sometimes antagonistic notions of trees in urban areas. Thus, education and awareness about the benefits of street trees should be part of the consultation phase prior to planting (Perkins, 2011). Residents mostly desired consultation to give their opinion of the types of trees they would like planted, where those trees should be planted, to ensure that their views are implemented, to be aware of the activities taking place in their suburbs and possibly participate in such activities and projects. A respondent in Perkins' (2011) study revealed that in attempts to promote trees, they are faced with a number of challenges including the fact that most people do not want trees next to their properties, and they retaliate by yelling at the planters because of their perceived danger and nuisance of having trees closer to their homes. In such instances, had consultation been conducted, all stakeholders

involved and affected would have had the opportunity to communicate their preferences about whether they would like trees or not, and where those trees could be planted.

Most respondents also mentioned that although they thought the local municipality was responsible for planting and maintaining street trees, it was not doing enough in this regard, mostly because of the evident absence of street trees and lack of evidence for tree maintenance where trees were planted. Horticulturists and personnel responsible for tree planting in this study were not oblivious to the limited provision and maintenance of street trees and mentioned several challenges they face pertaining to both their jobs and to the planting and maintenance of street trees. These challenges include limited funding for urban greening programmes and lack of skilled personnel and equipment suitable for planting and maintaining trees. Such challenges are not unique to South Africa, being constraints in both developed and developing countries (Stevenson *et al.,* 2008; Lamichane and Thapa, 2012; Chishaleshale *et al.,* 2015). The lack of support within the municipality for urban greening programmes was also an identified challenge, where such programmes gain the least support because there are no fully fledged departments that deal with tree planting. Rather, such activities are incorporated into other departments like waste management (Gwedla and Shackleton, 2015; Chishaleshale *et al.,* 2015) which are perceived to be related to urban greening.

6.3 Policy Implications and Recommendations

This study established the composition and unequal distribution of street trees between and within towns. To address this, changes need to first be implemented within towns as these will influence the overall outlook of the town. Assessments of the urban forest by municipalities need to be encouraged so that the importance of urban trees can be recognised by senior managers within municipalities who appear to have little regard for the importance of street trees. While the government has initiated programmes to address the socio-economic disparities in the living conditions of citizens, environmental quality needs to be part of the plans to improve the quality of life of urban residents (Ruwanza and Shackleton, 2015). As suggested by Gwedla and Shackleton (2015), there needs to be communication between both different scales of government and between different sectors of government where issues hindering the provision of green spaces and trees are dealt with during the planning phase of development. Additionally, consultation with the affected stakeholders is crucial. Using communication tools such as information, consultation, and public participation are crucial to reduce or avoid conflicts between residents, planners, and managers (Eriksson *et al.,* 2012).

Residents need to be consulted to avoid general assumptions before any greening activities take place, so that it can be established whether they want trees or not, the types of trees they want, and where they would like the trees to be planted. An update of peoples' preferences also needs to be done regularly as preferences change over time, together with changes in urban cultures, leisure time activities and environmental knowledge (Tyrväinen *et al.,* 2007). In situations where residents appear not to be in support of having street trees, municipalities need to embark on awareness and education campaigns that will address the importance of having trees in urban areas. People need to have all the information about trees before they can make informed decisions about whether or not they want street trees. In situations where new residential suburbs are being developed, initial planning and development need to include urban greening rather than incorporating it after development has taken place. This can be done by incorporating standards that will promote the development of green infrastructure into new housing developments and implementing these standards (Shackleton *et al.,* 2014). In so doing, constraints to urban greening, such as lack of space can be avoided, and in such instances, research is crucial. Developers and those responsible for the supply and planting of street trees together need to be aware of what trees are suitable for the respective town and all other characteristics to look for, as outlined in Chapter 3. While there is undeniable evidence for the contribution of socio-economic attributes and wealth in the density of street trees in various towns, residents and professionals alike can work towards bridging these gaps together by accommodating each other and working together. Residents' preferences need to be taken into account while the professional opinions of officials and urban planners also need to be considered.

To aid in research around the current trends in urban greening and what types of trees would be most appropriate for planting as mentioned above, academic and research institutions also need be part of the solution. Young and McPherson (2013) found that most respondents involved in tree planting initiatives in the United States rate the role of scientific research in developing their city's tree planting initiatives' vision as very important. There is a colossal gap in communication between academic research and productive sectors (Smith *et al.,* 2010). This gap can be narrowed through involving various stakeholders, making them aware of the implications of the research and providing feedback on research questions that have been addressed. In the context of this study, the academic sector needs to be in communication with municipalities, and make research findings available to them as a guideline of the current state of the urban forest in their towns. These can be done most viably through frequent interaction,

social learning and information materials such as popular articles and pamphlets that can easily be accessed and understood by local people, as well as policy briefs for municipalities that add to the knowledge base in urban forestry and urban greening research. Many of the individuals responsible for planting and maintaining street trees are not necessarily qualified horticulturists or arboriculturists and they perform these duties because they are assigned to them (Gwedla and Shackleton, 2015). Thus, such people do not necessarily have the technical understanding or expertise of what tree planting and maintenance is about, mostly practising them from a non-professional perspective. As such, the research sector needs to forge relationships with municipalities where researchers can assist by dispensing the results of their studies and advise where necessary. While the goal is to have green suburbs and towns, officials need to be creative about it and not rely on one strategy which may or may not work.

This study also established that the majority of residents would be willing to volunteer to help plant and maintain trees on their streets. Municipalities need to make the most of this willingness by involving residents in tree planting activities. However, municipalities need to explicitly communicate the physical boundaries of where trees can be planted and assure residents that they can plant trees with the permission of the municipality. Many residents could be reluctant to participate as they believe that urban land and streets belong to the municipality and that they, as urban residents, do not have the right and permission to do anything on the streets. As a start, giving residents opportunities to "adopt a tree" where a household or individuals can have a tree planted in front of their yards and they would have to take care of it. This strategy seems successful in peoples' gardens as the majority of households in this study reported having at least one tree in their yards. A similar principle of stewardship can be applied to willing residents to produce greener streets. The municipality also needs to fully participate in such projects and monitor their progress. As an encouragement for people to participate, competitions about the greenest street or suburbs can be put in place to give residents something to look forward to. Naturally, all of this will require financial resources, which have already been identified as one of the key challenges to providing and maintaining street trees. While lobbying for funds and embarking on fundraising initiatives can assist, municipalities need to acknowledge the need to integrate such costs into their normal budget. As such, municipalities need to formulate policies and clear plans with well-defined long-term objectives for their urban greening programmes that address why there is a need for street trees and how they plan on promoting maximum survival rates for the trees planted. This will

demonstrate the municipalities' commitment to urban greening, and thus encourage donors and funders to invest in such projects.

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Appendices

Appendix 1: Residents' Questionnaire

Date________Start time________ Sample no.______ Name of town____________________

Name of suburb______________ Type of suburb______ Street name_____________________

Perceptions of Street trees

1. Do you have trees in your yard/garden? [ ] Yes [ ] No
   If yes, what
   types?____

2. Why do you have these types of
   trees?____

3. Where would you prefer to have trees? [ ] In your garden [ ] On the street [ ] Both
   Why?____
   ____

4. How important do you think it is to have trees on your street?

Greatly important		Moderately important		Not important	

5. Are trees important to your quality of life? [ ] Yes [ ] No
   Why?____
   ____

6. Are there any benefits from having trees in your street? [ ] Yes [ ] No
   If yes, what are they? (People will name them and I will tick as they mention)

Benefits	Tick	Benefits	Tick
1.Protection from strong winds		7. Environment for children to play	
2.Temperature reduction		8. Stress relief & mood improvement	
3. Home for birds small animals		9. Increase property value	
4. Air purification		10. Attract new business to our suburb	
5. Beautify the street		11. Enhance community appeal	
6. Cultural & spiritual fulfilment		12. Other (specify)	

7. Are there any problems or undesirable results associated with having trees in your street? [ ] Yes [ ] No

Problems	Tick		Tick
1.Dead tree leaves block the drains		7. Criminals hide behind them	
2. Make the street look messy and dirty		8.Roots destroy the road	
3. Cause allergies		9.Hide traffic signage	
4. Attract insects & other scary animals		10.Interfere with street lights/electricity lines	
5. Host bad spirits & attract lightening		11.Branches sometimes fall on people	
6. Use up a lot of space		12.Other	

If yes, what are they? (People will name them and I will tick as they mention)

8. Can you name the types of trees on your street? [ ] Yes [ ] No
   If yes, name
   them____
   ____
9. What tree species would you like to have on your street?
   ____
   ____
   ____
10. Compared to other streets, are you satisfied with the number of trees on your street?
    [ ] Yes [ ] No
    Why?____
    ____
    ____
    ____
11. Are you satisfied with the appearance of your street? [ ] Yes [ ] No
    Why?
    ____
    ____
    ____
    ____
    ____
12. Have you ever been consulted about tree planting activities in your area?
    [ ] Yes [ ] No
    If yes, by who and when was
    this?____
13. Whose responsibility do you think it is to plant trees on the street and maintain them?

NGO		Community		Municipality		Mine		No one	

Why?
____
____

14. Do you agree that the municipality does enough to provide trees in your suburb?
    [ ] Strongly agree [ ] Agree [ ] Disagree [ ] Strongly disagree
    Why?
    ____
    ____
    ____
    ____

15. Do you agree that the municipality does enough to maintain trees in your suburb?
    [ ] Strongly agree [ ] Agree [ ] Disagree [ ] Strongly disagree
    Why?
    ____
    ____
    ____
    ____

16. Would you be willing to volunteer with help planting and maintaining trees on your street? [ ] Yes [ ] No Why?
    ____
    ____
    ____
    ____

Respondent profile

1. Gender [ ] Male [ ] Female Age______________ How many people live in your home?________
2. How long have you lived in this town?____________________________
3. What is your highest level of education?___________________________
4. What is your current employment status?
   [ ] Employed full-time [ ] Unemployed [ ] Part-time/Casual worker [ ] Retired [ ] Student/Learner

5. If you are employed, what kind of work do you do?
   ____
6. How many other people in your home are employed? ________________
7. How many children in your home receive a social grant? ________________
8. On average, what is your family gross income per month?
   [ ] <R2000 [ ] R2001-R4999 [ ] R5000-R9999 [ ] R10000-R20000 [ ] >R20000

9. Do you have any questions for me or anything you would like me to clarify for you?

Thank you very much for your time and for participating in this study.

Appendix 2: Horticulturists' Questionnaire

Date___________ Start time__________ Sample no. ____ Name of town_____________

Horticulturist' profile

10. Gender [ ] Male [ ] Female
11. Age_____________
12. How long have you lived in this town? _________________
13. What does your job entail?

____
____
____
____

14. How long have you been doing this job? ___________________________________
15. Besides being the horticulturist of this town, what other responsibilities do you have both within this town and the municipality?

____
____
____
____

Perceptions of street trees

1. What characteristics make a good species for street planting in different areas of this town?

____
____
____

2. What criteria do you use to select trees to plant?

____
____
____

3. Why are certain tree species favoured over others?

____
____

4. How do you accommodate these trees in the different parts of the town?

____
____
____

5. Who decides which trees to plant and where? _________________________________

6. What type of street trees do you have planted in this town?

____

____

7. What reasons could lead to the removal of street trees in this town?

____

____

____

8. Are urban residents involved in the decision-making process regarding street tree planting?

____

9. To what extent would you like urban residents to be involved in street tree planting and maintenance, and in what capacity?

____

____

____

10. Do you work closely with senior municipal officials and how involved are they in "greening" the town?

____

____

11. What do you perceive are the biggest threats to street trees in this town?

____

____

____

12. What challenges are you faced with pertaining to your job as a horticulturist, and pertaining to the planting and maintenance of street trees in this town?

____

____

____

____

13. What strategies do you think would be best to overcome these challenges?

____

____

____

____

Thank you very much for your time and for participating in this study.