Tree Collections of Auckland: Biodiversity and Management

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Abstract

Recent developments in New Zealand environmental legislation and government policies are based on an economic world-view where landscape is portrayed as a 'natural' resource. This paradigm largely ignores the human-made urban landscape where the highest proportion of population live. Our national legislation pays little attention to urban vegetation in general and exotic tree collections in particular. Research therefore has a vital role in highlighting the character and values of urban vegetation, and in analysing the current models used to manage its continued existence. This study examines the importance of charting and managing biodiversity and focuses on managed amenity and scientific tree collections in the Auckland region.

This regional study seeks to characterise the biodiversity of tree collections in Auckland, and describe how landscape management can best contribute to their biological and human-use values. The literature review establishes the importance and values of trees and urban vegetation as critical to the fabric of human lifestyles and the ecology of the city. It then reviews the basis for the preservation of biodiversity in managed plant collections. Management principles and systems are reviewed along with the legislative context in Auckland. No mandate is established for exotic plant collection managment under the Resource Management Act, 1991 (RMA1991). Management of this resource is found to lack the focus and funding from which natural and rural biodiversity benefit under the RMA and other national legislation.

A biodiversity survey of thirty-eight collections of trees characterises the biodiversity in the collections, and a survey of twelve tree collection managers provides data about the goals, practices and tools used in the management of those collections.

Results reveal the diverse and unique flora of Auckland tree collections, and establish a baseline for comparison over time. The regional mix of native and exotic species found in Auckland collections is compared with other national plant surveys, and demonstrates differences consistent with regional climatic character and a differing research focus. The largest collection of trees and the most specialist genera collections were found at the Auckland Regional Botanic Garden, while the University of Auckland provides the most extensive range of scientific plant-collection facilities. There is evidence of sequential open space acquisition for tree collections in the Auckland region. Comparison of best management practices put forward in current literature with current practices of collection managers in Auckland reveals some significant issues. There is little evidence found to suggest strategic plant acquisition goal setting. It is also of concern that only half the collection managers used computerised plant record systems such as inventories and specialised database systems. Only one third of the managers had management plans, and therefore documented collection goals. There was no significant difference in the use of best management practices between the private and publicly owned collections. Well-managed collections are characterised by high or specialist tree species diversity, clear strategic goal setting and management planning, computerised plant record systems, adequate resources, appropriate staffing and the use of monitoring tools.

Discussion of these research results leads to three recommendations. Firstly, the management of specific sites is discussed in light of a proposed model for plant collection management. Secondly, management policy for the regional Urban Forest is recommended. Lastly, the finding that Auckland's exotic tree collections are a valuable resource worthy of protection, currently having little status under the law, leads to the recommendation for the empowering of a national body (central agency) with a mandate for the national coordination of botanic gardens and plant collections.

This research therefore charts aspects of Auckland's urban biodiversity with reference to current legislation and management models. Its findings and recommendations are of importance to reviewers of national environmental legislation, regional policymakers and tree collection managers.

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1.0 An Overview of Chapter 1

This research project seeks to investigate the biodiversity of managed amenity and scientific tree collections in the Auckland region, and to examine their botanical significance and the adequacy of the management systems applied to them.

Chapter One is a review of literature relevant to this study. This begins with establishing the value of trees in the urban environment, then introduces the concept of biodiversity and how plant collections can be used to conserve biodiversity. Then the specific Auckland research context is described, highlighting the need for management of landscape resources. Next is a review of current management theory and external influences on management systems, such as the legislative environment. The chapter provides the reader with definitions of terms used, establishes existing background knowledge, and describes current theoretical frameworks used to examine the way plant collections and landscape management are understood. Lastly, this chapter poses the specific research question to be addressed by this project. **Appendix 1** provides a contact list for all personal communication referenced in this thesis.

1.1 The Human Use Values of Trees

1.1.0 Introduction

According to Nadel *et al.* (1977, p. 85):

> *trees reach up and link man with the sky. In a city they transcend the noise, confusion and disorder. Silently, they provide a resting place and refuge from the chaos of urban life. In the quiet early morning hours of dawn, in the rush of late afternoon business, city trees proudly stand protecting us from the loss of our humanity*

Trees embody many different values, some inherent and some ascribed to them by humans, termed human-use values (Given, 1994; Loxton, 1991; O'Neill, 1993; Phillips, 1993; Stone, 1996).

1.1.1 Symbolic Values

From ancient times trees were given symbolic status in human art, mythology and literature. This can be seen in the role of trees in the imagery of major Eastern and Western religions, such as the tree of life and knowledge in Judaism, 'sacred groves' in ancient Greece and Italy set aside as temples, and tree worship of *Ficus religiosa* in Pakistan (Bell, 1997; Bernatzky, 1978; Nadel *et al.*, 1977; Westoff, 1983). Many nations select plants as national symbols, for example the New Zealand silver-fern emblem. The fern was used as an example of the symbolic value of native fauna by then Prime Minister Jenny Shipley in her endorsement of the Draft Biodiversity Strategy in 1998 (Department of Conservation and Ministry for the Environment, 1998).

As well as these positive images of vegetation there are also examples of negative imagery. Forests represent the primeval or mythical world, and are one of the archetypal landscapes of the Western world, which humans have gradually sought to convert into the cultural landscape (Bell, 1997; Schama, 1995). Forests have also been seen as a place of hiding for enemies and evil spirits and as somewhere posing the threat of becoming lost (Dwyer *et al.*, 1991; Westhoff, 1983). A range of these different views of vegetation can be expected to have a place in the psyche of even the most modern city dweller, and to influence his or her attitude to urban trees (Arnold, 1993; Schama, 1995).

1.1.2 Psychological and Physiological Benefits

Another benefit of vegetation which is well supported in the literature is the positive physiological and psychological benefit of nearby nature, with trees playing a major role (Honeyman, 1992; Kaplan, 1992; Miller, 1988; Phillips, 1993; Relf, 1992; Schroeder, 1990; Ulrich, 1983; Ulrich & Parsons,1992).

Interaction with nature has a number of direct positive physiological effects on the human body. Research has centred on people suffering from symptoms of stress, such as high blood pressure, muscle tension and increased heart rate. Research reviewed by Ulrich and Parsons (1992) gives evidence of stress recovery indicators such as reduction in blood pressure, muscle tension and normalised heart rate after exposure to natural environments. Studies on brain waves by Ulrich (1981) indicate that nature scenes elicit a wakeful, relaxed state. Particularly interesting is a study by Heerwagen (1990) on heart rate comparisons of people visiting a dentist. A nature scene mural in the waiting room was shown to reduce stress symptoms for the visitor.

The positive effects of gardening projects on interpersonal and community wellbeing in American housing estates are documented by Lewis (1992). Neuberber (1992) reports on benefits of horticultural therapy for sufferers of mental illness in Germany. Browne (1992) reports her research into how important 'landscaped grounds' are to potential rest home residents. Ninety nine percent of respondents considered this either 'essential' or 'important' in their preference criteria for selecting a rest home. Some of the benefits reported were aesthetic enjoyment, motivation for physical exercise, social interaction and opportunity for self-expression in the gardens. McDonald and Bruce (1992) review research showing that in institutions for geriatric and handicapped people, human interaction with plants heightens self-esteem, increases purposeful behaviour, creativity and self-expression, and helps in adjustment to new environments (Hill & Relf, 1982; Inman & Duffus, 1984; Isaacs, 1986; Watkins, 1982). Providing views to nature for prison inmates is known to reduce admissions to prison hospitals (Moore, 1982; West, 1985).

Models such as Ulrich's Information Processing Model (1981; 1986) enable preference predictions to be made about a particular landscape scene. Trees are a very clear content preference in landscape scenes whether it be in regional work, such as done by Fabos & McGregor (1979) in Australia, or on localised urban scenes research by Kaplan (1985). Urban dwellers value natural features such as trees, grass and water (Schroeder, 1982). Urban ratepayers value tree programs highly compared with other municipal services in Detriot, e.g. tree lined streets were very popular (Getz *et al.*, 1982) with residents. Trees' aesthetic qualities, provision of shade and effect of increasing property values were considered their most important contributions to urban environments in that study. In a study by Schroeder (1990) trees rank highly in preference factors for parks, and Hull (1992) found that thirty percent of residents identified the urban forest as the most significant urban feature that was damaged in a hurricane in Charlston, and listed a range of psychological benefits for having trees in the city. A New Zealand study (Kilvington & Wilkinson, 1999) on community attitudes to urban vegetation in Christchurch, found that psychological and physiological benefits, such as stress relief and a sense of peace, were the most commonly identified values of urban vegetation by focus group participants. From the sample of studies reviewed above, it is clear that psychological and physiological research has demonstrated the positive effect of plants on people, and has led to better understanding of human preferences for landscape and vegetation.

1.1.3 Recreation Values

Most tree collections are sited within parks and gardens which also provide space and facilities for one or more forms of active or passive leisure or recreational pursuits. This defines them as sites with recreational value (Cobham, 1990). Recreation is a recognised role of botanic gardens (Given, 1984), and is an important reason why many people visit botanic gardens (ARC, 2000). Clark and Stankey (1979) propose the Recreation Opportunity Spectrum (ROS) which seeks to explain a continuum of recreational experiences, ranging from primitive or wilderness experiences where the environment is pristine, and little management is required, through to sophisticated cultural experiences where the site is likely to be highly designed, developed and managed. This spectrum represents the range of experiences the recreational user has to choose from, and also a relationship between the biophysical site, management and the visitor's choice. This continuum has similarities to the landscape spectrum proposed by MacKay (1996), in both content of the continuum and the level of management input ascribed for the continuance of different types of recreation landscapes. The biophysical attributes of the site, the services on the site and the social setting, all influence the visitor's choice to come to the site (Jubenville and Twight, 1993), along with factors such as the distance and ease of transport to the site (Jubenville and Twight,1993; Miles & Seabrook, 1977).

Biophysical site qualities such as scenic quality, favourable climate and opportunities for participatory activities are factors which attract visitors

(Miles & Seabrook, 1977). Recreational use often conflicts with biological resource values (Lemons, 1987), and so must be considered in landscape management systems. This is where resource monitoring reviewed in Section 1.6.6, such as resource carrying capacity and limits of acceptable change are useful to gather evidence of recreational use effects on the environment.

Recreation values can clearly be seen as part of the human use being managed in a tree collection. Therefore the conflict between human use and the biological resources must be understood and actively managed. The recreational impacts of visitors to a collection need to be accounted for in any management model considered in this research.

1.1.4 Historic Values

Gardens are increasingly being recognised as an important reflection of cultural and social history (Goulty, 1993). Garden design traditions developed within distinct geographic and cultural situations (Barnett, 1993; Bradbury, 1995; Goulty, 1993). Individual trees have been planted throughout history to commemorate special visits, events or people (Heritage Victoria, 1999). Certain tree species were introduced at particular times and these dates can help identify historical periods (Banks, 1988). Knowledge of gardens in general, and trees as major structural elements, may, through interpretation, give us access to the knowledge of history, a depth of understanding of the contemporary cultural landscape and how landscapes reflect cultural values (Boisset,1980; De Lambert, 1986; Goulty, 1993).

Protection and management of historic cultural landscapes is evident in countries with many centuries of cultural history, such as in Britain, where historic gardens receive protection and funding through the National Trust. The historical significance of landscapes and trees is less well conceptualised and valued in New Zealand. This lack of recognition is apparent in the Historic Places Act (1993), where there is no protection provided for gardens and trees except in association with a building. Many Australian states are similar to New Zealand, but the State of Victoria provides protection for different kinds of landscapes, including gardens and individual trees e.g. the 'Federal Oak' in

Melbourne (Heritage Victoria, 1999). Tree collection heritage values are therefore unlikely to be managed effectively under the Historic Places Trust, unless an historic buiding is associated with the site.

1.1.5 Economic Values

Economic values of trees include direct monetary values such as those gained from plant products and crops, such as timber, paper, food, medicines, eco-tourism profits and contributions to real estate values (Barbier *et al.,* 1994; Groombridge, 1992; McNeely, 1988; Miller, 1988; Phillips,1993).

Trees also have indirect values of, such as maintaining the options for future generations to directly utilise plant species for purposes as yet not realised, as described by Given (1994). The non-saleable products of ecosystem functioning include the release of oxygen, absorption of carbon and pollutants such as sulphur dioxide, cooling and shading effects, run-off and erosion control (Bradley, 1999). These indirect benefits are sometimes termed ecosystem services, and are (generally unacknowledged) subsidies to economies (Costanza *et al.,* 1997; Folke, 1992). The New Zealand Biodiversity Strategy (Department of Conservation and Ministry for the Environment, 2000, p. 3) states:

> that New Zealand bases much of its economy on the use of biological resources and benefits from the services of healthy ecosystems.

In the current Western economic paradigm of 'user-pays' arguments that seek to demonstrate economic value or utility of natural resources, are perhaps seen as more persuasive than moral or aesthetic arguments (Groombridge, 1992). Economic techniques are essential tools in valuing natural resources (Contanza & Daly, 1992; Folke and Kaberger, 1992; Mykletun, 1990; Wagner *et al.,* 1998). Methods which seek to calculate economic values to natural resources include opportunity or alternative cost approaches, cost benefit analysis (Hampicke, 1994; Moll, 1995), contingent valuation, revealed preference surveys and travel cost analysis (Jakobsson & Dragun, 1996).

One example of an alternative cost method is the calculation of energy equivalents for urban ecosystems services such as reduction in storm water run-off, temperature reduction from tree canopies, and improvements in air quality. These energy equivalents can be compared to the cost of alternative services such as extending storm water reticulation systems and air conditioning or filtering costs and are therefore useful complimentary bio-physical estimates to a monetary analysis (Bradley, 1995; Folke, 1992).

A particularly difficult issue in economic valuation is the importance of acknowledging intrinsic or existence value of natural resources. Contingent valuation methods ask users about their willingness to pay for recreation opportunities or to accept compensation for giving up the right to that recreation or use. This method is gaining support, with 1600 documented works reported, may provide a more holistic approach to economic valuation (Jakobsson & Dragun, 1996).

There are several different valuation models in use for placing economic value on individual trees, such as used by the Royal New Zealand Institute of Horticulture (Flook, 1996), the Arboricultural Association (1990) in Britain, the Australian Institute of Horticulture (1997), the Council of Tree and Landscape Appraisers with the International Society of Arboriculture (1995) in the USA. These systems all award points on the basis of qualitative criteria and then award a dollar value rate per point scored. In student comparative studies at Waikato Polytechnic, valuation systems have been found to give very different values for the same tree (Collett, 1997). Each system of valuation gave a relative measure of values between trees evaluated by that system, but the dollar values generated were inconsistent.

Auckland City council prepares evaluations of trees scheduled in its district plan (Auckland City, 1999a), which give numerical scores without converting the score to a dollar value (Auckland City arborist Bryan Gould, personal communications, February 2000). Monetary values can be calculated for species with commodity values and ecosystem function values, but there is still no reliable evaluation system available to measure additional amenity and social values in monetary terms (Dobson, 1998).

1.1.6 Aesthetic and Design Values

Trees add beauty to our environment through graceful shape, foliage, fragrance, flowers and fruit as well as their ability to define and articulate space, and to enhance or control views (Phillips, 1993; Thomas, 1983). Vegetation is the landscape architect's unique material palette, making landscape design distinct from other design professions. Trees are the largest structural plant elements in that palette. They are long-lived and provide the main framework for planting design. Their selection and placement must therefore be designed following principles of landscape design such as balance, proportion, scale and unity. Size and form must be considered to avoid long-term problems such as view obstruction. Visual control includes being able to provide privacy; enframe, create focal points, emphasise and screen views and buildings; and therefore control movement of viewers around a site (Booth & Hiss, 1991; Carpenter & Walker, 1990; Clouston, 1990; Grey & Deneke, 1978; Hackett, 1979; Robinson, 1992).

Choice of plant material will depend on a combination of the following four criteria. Firstly the functional goals for the site and the three dimensional effect required for the particular use. Secondly the physical constraints of the site must be considered e.g. soil type, climate, management practices. Next, all the plants selected for a design should contribute to the overall theme or effect to be created. This must be done in sympathy with the architecture, site and location (Barnett, 1993). Using trees from local and nearby flora contributes to establishing a local theme or identity, e.g. the iconic pohutukawa used to symbolise Auckland's coastal identity (Auckland City, 1999b).

Lastly, the aesthetic goals of the designer are brought to bear. The form or overall shape and size of the tree, colour (from its leaves, bark, seasonal flowers and fruit) and texture (surface characteristics of the tree, determined mainly by leaf size and arrangement) are each considered in relation to the whole (Booth, 1983; Robinson, 1992).

The individual (specimen) appeal of trees is seen by some, as a handicap to designers using trees effectively at an urban scale. Arnold (1993, p. 1) suggests that:

> *the most persistent problem confronting every designer who works with trees is their seductive appeal. The remarkable aesthetic power of trees distracts artists so much that their potential for building dense organic compositions has been replaced by an over-refined, precious reverence for individual trees*

Although Arnold's comment may be critiqued as limiting the design use of trees, he does express the different approach required when using trees at an urban or city scale, compared with a residential or garden scale. Reverence for the individual or specimen value of trees is important for designers to consider. At the city scale however, the bold framework approach he advocates is more effective in providing a link between open space and providing a sense of hierarchy of transport corridors or carriageways. Signature tree species of differing scale may convey this hierarchy. Auckland City (2000) describes eight street typologies within its boundaries, for which it selects different types of street tree to suit different functions e.g. heritage areas have street planting which allow the buildings to be clearly viewed, pedestrian areas have small scale trees to keep with the intimate human scale. Commercial areas have large scale trees to balance the scale of the buildings. The anomaly here is that the street design cross-section does not allow enough width to give large trees enough space to grow properly. Queen Street is an example of this where the *Platanus orientalis* are etoliated due to lack of light and damaged due to physical contact with the shop canopies. A new streetscape design is being proposed for Queen Street in conjunction with plans for light rail transport system, which provides unimpeded tree spaces (Cumming, 2000).

Arnold (1993) advocates using large trees in single species grid formations in urban areas. Large trees give an appropriate scale to large buildings in the city. Using a large number of the same species of tree provides linking or unifying elements amongst mixed architecture, and grids of trees add to that unity. Grids or avenues also create a sense of movement and linkage of open spaces such as parks and plazas. Fredrick Law Olmsted's park systems recognised the increased visibility and accessibility afforded by linkage of urban open space (Smith & Hellmund, 1993). The wide, treed boulevard was the design form he advocated to achieve this linkage, along with walking trails and greenbelts, together encouraging use by pedestrians (Bella, 1987). The public use of the tree collections surveyed would therefore be enhanced by creating linkages such as advocated by Olmsted (Smith & Hellmund, 1993).

1.1.7 Engineering Values

The biological values and 'ecological services' which vegetation provides in natural areas are often utilised by engineers, architects and landscape designers in urban areas. Additional engineering functions of vegetation in general and trees in particular are well documented in landscape architectural texts from authors such as Carpenter & Walker (1990), Jackman (1986), Motloch (1991) and Robinette (1972).

Erosion control is afforded both by canopy cover interrupting the impact of the rain on soil, and by the reinforcing nature of plant root systems in the soil structure. Plants also absorb large quantities of rainwater, contributing to the balance of the hydrological cycle. Noise abatement by plant material is not as efficient as more solid barriers to deflect sound waves, but visual screening using plants does give psychological relief from the effect of noise pollution, as well as effective control of glare e.g. for houses along motorway margins (Robinette, 1972). Climatic control may be achieved by the use of tree wind breaks, designed to deflect and/or filter strong or cold winds, or to channel cooling summer winds to lower high temperatures. Deciduous plants provide effective shade from summer sun, while allowing winter light to penetrate into outdoor spaces and indoor rooms. Air filtering and oxygen production values of trees are also available to urban designers to contribute to the air quality benefits of the Urban Forest (Beckett *et al.*, 2000).

1.1.8 Amenity Values

Somewhere in-between aesthetic, social and recreational values is the ill-defined or rather broad term 'amenity value'. Cobham (1990) lists a range of values of land used for amenity purposes which include leisure and recreation, visual beauty, historic and cultural interest, habitat, social and economic values. The Resource Management Act (1991) also gives a broad definition, 'natural and physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes'.

For the purposes of this research the term amenity value will be considered a general term encompassing a wide range of landscape values. It provides a useful term to describe the values of the surveyed tree collections sited in parks.

Commentary

This section has clearly shown that trees influence people, especially in the city (Arnold, 1993; Honeyman, 1992; Kaplan, 1992; Miller, 1988; Phillips, 1993; Relf, 1992; Schroeder, 1990; Ulrich, 1983; Ulrich & Parsons,1992). Urban vegetation is a critical component of the fabric of urban lifestyles, and is understood as many things, including open space, scientific collection, ecological service, historic artifact or economic asset. People can also be seen to have a fundemental influence on the landscape as they constantly design, use and manipulate their environment (Laurie, 1986; Meinig, 1979; Relf, 1992). There is a large body of research which seeks to provide models for landscape assessment of both human-use and biological values (Daniel & Vining, 1983; Fabos & McGregor, 1979). In the next section on the biological values of trees, biodiversity and its conservation are considered, with a focus on scientific plant collections and botanic gardens as tools to conserve biodiversity as key, and well-described collection types in the biodiversity literature reviewed. Plant collection research in New Zealand is then reviewed to establish the context in which this study sits.

1.2 The Biological Values of Trees

Plants are an essential part of the ecological systems and biological cycles which constitute the complex web of life on Earth (Chapman & Reiss, 1992; Folke, 1992; McNeely, 1988; White *et al.*, 1984). As plants take in carbon dioxide and water to photosynthesise their own food, they release oxygen as a by-product and accumulate carbohydrates. Plants therefore provide oxygen and food for the animal kingdom (Chapman and Reiss, 1992). Forests play a crucial role both globally, in climatic regulation, (Given, 1994) and locally in terms of temperature, humidity, wind control and providing habitat for animals (Bradshaw *et al.,* 1995). They also provide the carbon sink which regulates the levels of carbon dioxide and oxygen in the earth's atmosphere (Chapman and Reiss, 1992; Dobson, 1998). These biological roles are sometimes termed 'ecosystem services' (Costanza & Daly, 1992, p. 37; Costanza *et al.,* 1997, p. 253).

Deforestation of land for agriculture and urban development reduces the buffering capacity of natural ecosystems and cycles and therefore threatens the stability of the Earth's climate (Given, 1994; Groombridge, 1992). Global warming and ozone depletion are examples of human effects on environmental stability. Limiting deforestion and vegetation clearance, and planting more trees is considered a key strategy in attempts to regain environmental equilibrium (Dobson, 1998; Given, 1994). Plants therefore maintain the biosphere as a functioning system and provide the material basis for human life (Folke, 1992; Groombridge, 1992; McNeely, 1988).

1.2.1 The Concept of Biodiversity

Biodiversity is a contracted form of the term 'biological diversity', and has been identified as a key indicator of biological quality (DOC & MOE, 2000; RMA, 1991 section 2).

Biodiversity can be understood at three different levels: The first is in terms of genetic variability within a species. A plant taxonomist or systematist would usually describe biodiversity in terms of the number of species in a monophyletic taxon i.e. genetic variability (Eldredge, 1992). The second is in terms of the number of species in any given area. An ecologist would be interested in the number of species and the relationship between species in a particular ecosystem. A taxonomic plant collection or botanic garden curator may view biodiversity in terms of the number of species and cultivars within a plant collection, but must also consider genetic diversity within the collection. All three levels of diversity are important concepts in conserving overall biological quality (Groombridge, 1992).

Biodiversity is important to the health of the environmental setting, and is a required consideration for management of State lands in New Zealand (Department of Conservation and Ministry for the Environment, 2000). Human actions on the landscape in industry, horticulture, agriculture, housing and forestry all tend to reduce species and ecosystem biodiversity. Worldwide research clearly indicates that plant species biodiversity is declining at an alarming rate (Given, 1994; Groombridge, 1992). Native forests have been cleared all over the world in the wake of Western colonisation, and present day tropical forests are still being cleared at a rapid rate (Given, 1984). Modification or destruction of natural plant habitats is the main cause of plant biodiversity decline, followed by direct collection or harvesting (Groombridge, 1992). Plant collections are one way of conserving plants under threat. New Zealand has been suggested as a potential botanical Noah's Ark, for conserving threatened temperate and subtropical floras (Given 1986/1987).

New Zealand relies heavily on exotic plants and animals for its world trade (Hammett, 2000). Plant conservation strategies, including plant collections, seek to ensure the maintenance of plant biodiversity for biological and ecological reasons as well as human uses such as food, fibre, timber, fuel and medicinal. Other values of vegetation such as aesthetic and the future option values of plants, are covered in Section 1.1. Preservation of diversity of garden plants is reliant on the plantsmanship and horticultural knowledge and skills of home gardeners, landscape planting designers, plant collection managers the nursery industry (Given 1986/1987; Hammett, 2000). Design trends to have fewer types of plants in gardens to give a minimalist or modernist look, encourage nurseries to stock a more limited range of plants (Bradbury, 1995). Keith

Hammett (2000) describes this as a trend towards "more and more of less and less". This trend poses a threat to the continuing availability of a wide range of garden plants. An analysis of availability of the trees found in this study will be undertaken to assess current species availability. Trade availability becomes important to tree collection managers when replanting programmes are undertaken, especially when historic values of the collection dictate direct replacement of existing species.

1.2.2 Plant Conservation Management

Conservation of species biodiversity is concerned with maintaining viable populations of species. For short-lived plant species in the wild, population viability is a serious issue, due to the necessity for frequent seed production cycles for the continuance of the species. Fifty plants is considered a minimum number for a viable breeding population (Given, 1986/1987). For the amenity tree species considered in this study, population viability is not such a serious issue, as the trees are long-lived, and vegetative propagation is possible. However this type of reproduction does lead to a decline in genetic variability, and therefore to vulnerability problems inherent in monocultures, such as susceptibility to pests and diseases, may become a threat (Given, 1986/1987). In order to maintain biodiversity, two approaches to maintaining viable populations of species are well established:

In situ conservation is used to conserve viable plant species populations in their natural ecosystem environments. The habitats must often be protected in order to ensure their continued existence. New Zealand's National Parks and Protected Natural Areas scheme seek to preserve a range of threatened habitat types, so as to conserve our plants species *in situ.*

In contrast, *ex situ* conservation maintains plant species in cultivation. Botanic gardens and plant collections form a major part of world's ex situ plant conservation efforts (Given, 1986/1987; Groombridge, 1992). Conservation of rare and endangered plants, the habitats of which are already seriously depleted or under threat, are often managed from an ex situ approach. New Zealand is considered an ideal location for *ex situ* conservation of rare and endangered plants around the world, due to its small population, isolation and freedom from major pollution (Given, 1986/1987). Other *ex situ* plant conservation approaches include field gene banks and seed banks. Field gene banks are areas of land set aside in which collections of viable plants are assembled, at a lower cost than, and without the other functions of a botanic garden. Field banks are useful for long-lived perennial species such as some tree and woody shrub species, with low maintenance requirements and slow seed production rates. Seeds are collected regularly for propagation of the species (Groombridge, 1992). Seed banks are a space-efficient way of storing genetic material for the future. Not all seeds are suitable for storing in this way, but there are many species which do have seed suitable for long-term storage. The Auckland Regional Botanic Garden is planning to start a seed bank in the near future (Auckland Regional Council, 2001).

Horticulture provides useful tools for *ex situ* plant conservation. An example of this is the use of vegetative propagation techniques e.g. hardwood cuttings, used to propagate shrubby tororaro (*Muehlenbeckia astonii*) by the Hutt City Council and the Department of Conservation in Wellington. Plantings of *Muehlenbeckia astonii* were established in traffic islands and street verges in the Lower Hutt town centre for conservation purposes (De Lange & Silberry, 1993). Philip Simpson and Peter de Lange (1993) have documented a history of plants saved by people bringing them into their gardens, both in New Zealand and internationally. Plants conserved in this way may then be used as propagation material to be taken back into the natural environment, once the habitat has been protected or restored (Lucas, 1978). Identification of key sites and at-risk species has long been recognised as a crucial conservation role for botanic gardens to be involved with internationally (Lucas, 1978). Careful collection, identification, recording of species data and plant management practices, such as weed control are essential in this type of *ex situ* conservation, to ensure population maintainance (Given, 1994; Hawksworth, 1995).

Plant collections and botanic gardens are key tools in plant conservation, and are discussed in the next section.