

PEOPLE AND TREES: PROVIDING BENEFITS, OVERCOMING IMPEDIMENTS

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1. INTRODUCTION

The present paper deals with an area that would be familiar to many in the audience on a daily basis, as they manage trees in urban environments with people. Audience members would also be well aware that it is an area fraught with difficulties, as any community includes people with a vast range of attitudes towards trees. Urban tree management involves managing not just the trees, but also the people, particularly their preferences and expectations, regarding the trees in their community.

As our knowledge of tree biology continues to improve, and as we understand more and more about what trees require for establishment and continued healthy growth, we are better placed to know what we should be doing to provide what trees need, even if constraints in the trees' environments often make this difficult. The same cannot be said for our knowledge and understanding of people in relation to trees. Whilst there is an increasing body of research on the benefits to people of 'green environments', including trees and other plants, there has been little research to date on people's perceptions of, and attitudes towards, trees. Yet people have a profound impact on the existence and survival of urban trees, and whether or not we can achieve worthwhile and sustainable urban forests.

Trees and other plants have the potential to make enormous contributions to the economic, environmental and social sustainability of our human settlements. This potential, however, will not be realised unless stronger, personal and meaningful connections are made between people and plants, such that more people are more vocal in demanding green, treed environments in which to live. This, in turn, requires a better understanding of the diversity of people and how this affects their perception of plants – their past experiences, understanding and knowledge, flexibility and enthusiasm, not to mention the more usual descriptors of age, gender, race and socioeconomic backgrounds.

This paper provides an update on 'Trees, Urban Ecology and Community Health' (Tarran, 2006) looking particularly at recent developments, such as our evolving knowledge of benefits to people in regards to their psychological and physical health, as well as business activity in towns and cities. The paper also looks at people's attitudes to trees, including tree appearance and presence at various locations. These findings are discussed in the context of current issues such as continuing population growth (including immigration), increasing densities in cities and towns, responding to climate change and health problems in relation to activity and obesity.

2. THE CONTEXT - URBAN ECOLOGY

Over half the people around the world now live in urban ecosystems and in many western countries the proportion is closer to 80-90%. These ecosystems consist of various components such as the biotic community (humans, as well as locally native and introduced species of flora, fauna and micro-organisms) and the physical environment (both natural features and built infrastructure).

The relatively new field of urban ecology studies the patterns and processes of urban ecosystems, using the theory and methods of both natural and social sciences in an integrated manner (Grimm *et al.*, 2008). It is hoped that this research will lead to ways of making and managing settlements where people live, work and play such that greater attention is given to supporting functional ecosystems that ultimately underpin our survival; as well as strengthening the resilience of communities through attention to social capital. By 2006, ideas in urban ecology were being explored in journal articles (e.g. Niemela, 1999; Pickett *et al.*, 1997; Platt, 2004). Ecological models developed in natural areas were applied to urban areas (Lord *et al.*, 2003), with the city itself being viewed as an ecosystem created by humans specifically for dwelling (McIntyre *et al.*, 2000).

Until about the 1980s, cities and nature were widely viewed as mutually exclusive (Platt, 2004) and this partly explains why urban and suburban landscapes had not been studied by ecologists, who traditionally preferred to research 'pristine' ecosystems, often in remote areas with minimal human impacts. Although there has been an understanding of the interdependence between cities and nature for a long time (Alberti, 2008), the natural sciences of ecology and the social sciences of cities have operated independently of each other until relatively recently. Interest in urban ecology developed in the 1990s, probably as a result of growing awareness of the following phenomena:

- increasing urbanisation and a realisation that urban areas needed to be better understood and made as habitable, safe and pleasant as possible
- recognition by ecologists that disturbed or impacted ecosystems were more common than 'pristine' ecosystems and worthy of study in their own right
- increasing concern about the effects of humans on ecosystems (Wallbridge, 1997), including use of fresh water, transformation of the land surface and loss of biodiversity
- recognition of a sustainability crisis emerging in urban areas
- realisation that 'ecological services' provided by nature to human society (Daily, 1997) could operate in urban areas

More recently, people have realised that urban areas are 'hot spots' that drive environmental change at local, regional and even global scales (Grimm *et al.*, 2008). With increasing urbanisation and increasing populations within cities come increased material demands of production and human consumption. People today are focussing on both global and local changes, and it is becoming apparent that, whilst cities generate problems as regards sustainability, they will also have to provide the solutions. Substantial books on urban ecology have just started to appear (e.g. Marzluff *et al.*, 2008; Alberti, 2008). Similarly, new books on sustainable urbanism, green urbanism and green cities continue to appear (e.g. Farr, 2008; Beatley with Newman, 2009; Birch & Wachter, 2008).

The development of urban ecology has important consequences for urban tree and urban forest management and will hopefully lead to greater recognition of the importance of these components. Trees and other plants, the photosynthetic organisms of our planet, have long been recognised as a critical part of natural ecosystems, since they have the capacity to harness the sun's energy and produce food, both for themselves and for other organisms. The urban forest, and particularly the tree component, is the most conspicuous element of 'nature' in urban ecosystems and has a vital role to play in urban ecology. Urban forest ecology is discussed by Rowntree (2008) who notes that the concept of the urban forest ecosystem enlarges the scope of the urban forest to include humans and requires us to think about urban forest costs and benefits in ecosystems across space and over time. Humans both deforest and afforest land, and both processes change the functioning of whole ecosystems without us knowing the magnitude of both the costs and benefits.

The urban forest provides a range of benefits to people and other organisms, with benefits to people including environmental, aesthetic, social, psychological and economic benefits. It is likely that plants will play an increasingly important role in both mitigation and adaptation strategies for climate change (Tarran, 2009). Well placed trees offering shade and evapotranspirational cooling can reduce electricity requirements, reducing carbon dioxide emissions from power plants, whilst simultaneously absorbing carbon dioxide during photosynthesis. Tree canopies that can capture and hold rain, and then deliver it into the soil will become more valued for this role. As sustainable cities focus more on public transport and walkable streets, the shade provided by trees will become more valued and space will be redistributed away from sealed roads and towards tree-shaded pathways. Whilst water availability is a current focus in towns and cities of southern and south-eastern Australia, it may be that, in the future, local food production will also move into focus, with a role for urban trees in this regard. However, water availability may be so restricted that it may determine species selection for the urban forest, or even whether the existence of an urban forest is possible.

3. BENEFITS TO PEOPLE AND COMMUNITY HEALTH: AN UPDATE

3.1 SOCIAL AND PSYCHOLOGICAL HEALTH AND WELL-BEING AT HOME AND WORK

By 2006, there was already substantial information on the positive roles that urban trees (and urban nature more generally) can play in community health, with a focus on the social and psychological benefits associated with urban 'green'. Much of the early research was carried out in the USA by Rachel and Stephen Kaplan (Kaplan *et al.*, 1998). Later research was carried out by Frances Kuo and

her co-workers at the University of Illinois Landscape and Human Health Laboratory (LHHL) [previously the Human-Environment Research Laboratory (HERL)] (Landscape and Human Health Laboratory (LHHL), 2009). Their research has built upon work carried out by USDA Forest Service researchers, including social scientists (Dwyer *et al.*, 1991 & 1992), and Charles Lewis (Lewis, 1996).

Studies of the relationship between people and nature carried out over 25 years (Kaplan *et al.*, 1998) have indicated that natural environments, including ordinary vegetated landscapes experienced close-at-hand on a daily basis, can foster well-being and enhance people's ability to function effectively. Benefits to people go well beyond mere enjoyment. Such landscapes allow people 'time out' to recover from mental fatigue, with its associated impatience, lack of focus and risk-taking, and facilitate restoration so that people are, once again, comfortable, civil and effective.

There are numerous case studies that have been carried out demonstrating the restorative power of nature, often when merely viewed through a window:

- surgical patients recovering after operations (Ulrich, 1984), requiring shorter stays
- prisoners, requiring fewer health service interventions (Moore, 1981)
- people in work environments, having greater job satisfaction and well-being (Kaplan *et al.*, 1988; Kaplan, 1993)
- children moved to greener housing, experiencing improved cognitive functioning (Wells, 2000)
- drivers recovering more quickly from stress and coping better with further stress (Parsons *et al.*, 1998)

Frances Kuo and her co-workers (LHHL, 2009) are studying how residents of inner city areas in Chicago respond to trees and other vegetation and how the physical and psychological health of individuals and communities can improve when nearby nature and natural views are present. As a result of extensive research, Kuo (2001) suggests that nature may be an essential component of a fit human habitat, given the apparent effects of nature on blood pressure, heart rate, mood, day-to-day effectiveness, social behaviour, cognitive functioning and work performance. She goes on to say that "regular contact with nature may be as important to our psychological and social health as the regular consumption of fruit and vegetables is to our physical health."

Practical application of their research has resulted in recommendations that:

- people should spend time in green, natural settings to relax and renew their ability to concentrate
- trees should be planted and maintained near homes, schools, work sites and other places where concentration and mental energy were needed most
- indoors, work places should offer a green view from the window
- green spaces should be created, especially in inner city neighbourhoods

Their research is summarised in the following six themes on their website (LHHL, 2009).

(1) Canopy and Crime: Green Streets, not Mean Streets

In a study of a public housing development, it was found that apartment buildings surrounded by trees and greenery were dramatically safer than buildings without green, with total crimes reduced by 52% (Kuo & Sullivan, 2001a). The greener the surroundings, the fewer were the crimes against people (down by 56%) and property (down by 48%). It is believed that greenery helps by reducing aggression, bringing people together outdoors, which increases surveillance, and indicating that a building is cared for by its residents, who watch over it and each other.

(2) Vegetation and Violence or Cooler in the Shade: Aggression and Violence are Reduced with Nature Nearby

In a study of the relationship between the outdoor environment and family violence in an inner city public housing project it was found that families with trees and greenery in their immediate outdoor surroundings had safer domestic environments than families in buildings barren of nature (Kuo & Sullivan, 2001b). Levels of mental fatigue were higher in buildings without nature, and aggression accompanied this mental fatigue.

(3) Kids and Concentration / Go Out and Play: Nature Adds up for ADD Kids

A study of 96 children, formally diagnosed with Attention Deficit Disorder (ADD), found that their symptoms were relieved after contact with nature and that the greener the setting, the greater was the

relief (Faber Taylor *et al.*, 2001). By comparison, activities indoors such as watching TV, or outdoors in paved, non-green areas, left ADD children functioning worse. The information also applies to Attention Deficit Hyperactive Disorder (ADHD). It was recommended that, before beginning activities that demand attention, like school or homework, children should go out and play in a green yard or park. Furthermore, it was suggested that recess in schools should be taken in green schoolyards.

In a subsequent nationwide survey (Kuo & Faber Taylor, 2004), using parents' ratings of the after effects of 49 common after-school and weekend activities on children's symptoms, green outdoor activities reduced symptoms significantly more than did activities conducted in other settings (e.g. indoors or in a built outdoors setting) even when activities were matched across settings (e.g. reading in each setting). Another study (Faber Taylor & Kuo, 2009) found that children professionally diagnosed with ADHD concentrated better after a 20-minute walk in the park than after a downtown walk or a neighbourhood walk of similar length.

(4) Girls and Greenery: Views of Green Help Girls Succeed

A study of 169 inner city children in a public housing development (Faber Taylor *et al.*, 2002) found that the greener and more natural a girl's view from home, the better she scores on tests of self-discipline (including tests of concentration, impulse inhibition and delay of gratification). The greater a girl's self-discipline, the better she is able to avoid dangerous, unhealthy or problem behaviours and behave in ways that foster life success. It was suggested that the practice of constructing treeless residential developments might have important unintended costs.

(5) Neighbours and Nature or Nice to See You: How Trees Build a Neighbourhood

In an observational study of 59 common outdoor spaces of a large public housing development, it was found that the more trees and grass present, the more those spaces were used by residents (Sullivan *et al.*, 2004), creating more opportunities for informal social interaction. Compared to residents living near barren spaces, residents closer to green spaces enjoyed more social activities, had more visitors, knew more of their neighbours and had stronger feelings of belonging. In another study using interviews with 145 (female) residents of 28 high-rise buildings of a public housing development, it was found that the presence of trees and grass supported common space use and informal social contact amongst neighbours (Kuo *et al.*, 1998).

(6) Plants and Poverty or Green Relief: Trees Ease Poverty in Inner City Neighbourhoods

In a study of 145 urban public housing residents randomly assigned to buildings with and without nearby nature, attentional functioning and effectiveness in managing major life issues were compared (Kuo, 2001). When trees and greenery were immediately outside their apartments, inner city residents coped better with the demands of living in poverty, felt more hopeful about the future, and managed their most important problems more effectively. Kuo noted that 'it is striking that the presence of a few trees and some grass outside a 16-storey apartment building could have any measurable effect on its inhabitants' functioning. It is all the more surprising that such a modest dose of nature could enhance an individual's capacity to manage the most important issues in her life, with an effect size comparable to that of major factors such as health and age.'

3.2 STREETSCAPES, BUSINESS AND CONSUMER ENVIRONMENTS

In 2006, there was little to report in regards to our understanding of economic benefits to business arising from the urban forest. Whilst it was known that residential property values benefited from tree cover or the presence of parks nearby, research had only just begun into the economic benefits to business that flow from urban forests (Wolf, 2003). A substantial study in New York (Bisco Werner *et al.*, undated) found that the urban forest was important for the economics of districts and the stability of nearby communities. Trees made good business sense in terms of market identity, customer preference, lower vacancy rates and providing a competitive edge.

Trees in business districts traditionally receive a mixed response from the business sector. Some merchants value them as an important amenity for potential customers, providing a more appealing consumer environment, whilst other merchants overlook their contribution to business success and focus on annoyances instead (e.g. reduced signage visibility, seasonal debris and security issues).

Recently, there has been much more research in this area, particularly by Kathleen Wolf (Human Dimensions of Urban Forestry and Urban Greening, 2009). Her research addresses several areas, including nature and consumer environments (especially trees, streetscapes and business districts). Based on her findings, Wolf (2005b) encourages merchants and marketers to look 'beyond the door of

the store' and recognise that streetscape character, like the 'atmospherics' inside a store, can influence shopper response in a positive way, resulting in a return on the green investment. Furthermore, the provision of trees in business districts can assist broader environmental and sustainability outcomes for the city as a whole, ameliorating urban heat islands, reducing energy use, improving air quality, sequestering carbon dioxide and managing stormwater.

Early research (Wolf, 2003) looked into the potential economic contributions of trees to retail settings in revitalising business districts of mid-size cities (population about 100,000). It was found that consumer behaviour was positively correlated with streetscape greening, in that green retail streetscapes were perceived as being higher in visual quality and comfort and were expected to have higher-quality products. Potential shoppers were willing to travel further and longer, to visit more often and for longer, and to pay more for parking when visiting retail places with trees. Higher visual quality ratings of retail streetscapes occurred when a full-canopy forest was present, defining the mood and character of the street (Wolf, 2004a). Even if buildings were well maintained, or of historic character, a lack of trees and dominance of buildings resulted in low streetscape ratings.

A study comparing the values of consumers (residents) and business owners to trees in business districts (Wolf, 2004b) found that both groups gave higher ratings to streets with trees. However, it appears that merchants have significantly less appreciation for trees than do the customers they wish to attract to their shops and that merchants place significantly less value on the benefits provided by trees. Attitudes about tree annoyances were more closely shared by both groups of people but the business respondents were more annoyed by leaf and flower fall than were the residents.

Similar aspects of trees and retail business districts have been investigated in small towns and cities (10-20,000 people) (Wolf, 2005a) and in strip malls (narrow bands of businesses along roads) (Wolf, 2009). In both cases, retention or restoration of a local customer base was an issue and the potential contribution of trees was investigated. For small towns and cities, it was found that the presence of trees in retail settings improved perception of the area, such that it had a better atmosphere, image and comfort level, and was a preferable place to visit and dine out (Wolf, 2005a). People were prepared to travel longer to retail districts with trees, and would stay longer, visit more often, and pay more for parking as well. They were also willing to pay about 9% more for a range of products in treed retail districts, an amount termed an 'amenity margin' (Wolf, 2005a).

In the case of strip malls (Wolf, 2009), trees and associated vegetation enhanced people's judgments of visual quality the most, and were linked to a perception of significantly better business conditions and interactions for the vegetated malls, better patronage and a willingness to pay about 9% more for goods in these malls. Planning and management recommendations were made such as consolidating planting areas, using vegetation 'frames' to identify areas, selecting tree species that have high and open canopies, and moving and consolidating signage to a front location.

3.3 TREES, TRAFFIC SAFETY AND CRASH RISK

Over the past 30 years, as interest in the benefits of the urban forest has increased, those charged with managing the urban forest have realised that urban streetscapes are places where urban forestry meets transportation policy (Wolf & Bratton, 2006). The usual outcome is that transportation officials and policies tend to limit or exclude urban trees because of safety concerns.

Currently there is a greater focus on the sustainability and livability of cities and towns. Crash data in the USA is now being re-examined to understand the circumstances of tree collisions in urban areas so that trees can be designed into streetscapes more safely. Roadside trees can actually protect pedestrians against cars that are out of control and having trees at regular spacings can help drivers establish an appropriate speed and focus on the roadway edge (Centre for Transportation Research and Education (CTRE), 2008). Views of nature while driving can help drivers recover from stress and cope better with further stress (Parsons *et al.*, 1998).

Deterrence and mitigation are the main approaches to improving roadside safety (Wolf & Bratton, 2006). Deterrence emphasises the importance of keeping cars on the road (e.g. by design and engineering), whilst mitigation aims to reduce the severity of the consequences when drivers leave the road ('run-offs'). Mitigation often involves removing, relocating, altering and shielding hazards, such as poles and trees. Tree crashes are severe in that they are more likely to be fatal or incapacitating than other crashes, even though they may occur less frequently than other types of crashes. Tree crashes represented just 2% of all traffic accidents in the USA in 2002, with a fatality rate of 6% (Wolf

& Bratton, 2006). In New South Wales in 2007, tree crashes represented just 4.4% of all crashes, with a fatality rate of 3.1% (Roads and Traffic Authority (RTA) NSW, 2008). However, as a percentage of all *fatal* crashes in NSW in 2007, those associated with tree crashes represented 15.6% and those associated with fences, posts and poles was 12.1% (RTA NSW, 2008). Over 65% of all *fatal* crashes involved no object being hit. To put these numbers into perspective, it is worth noting that alcohol was involved in 20% of the fatal crashes, speeding in 32% and fatigue in 20%. These percentages may actually be much higher, since data is not easily collected for speeding or fatigue, and the alcohol status was unknown in another 19% of the fatal crashes.

To avoid crashes with solid objects, a clear zone of a prescribed width from the road's edge may be specified. For example, on an urban arterial road, at locations where run-offs are likely to occur such as bends, a clear zone of 2.5m from the road's edge is recommended (Traffic Authority of New South Wales (TA NSW), 1987). However, at other locations, and where unobstructed sight distances are not required, trees need only be 1 m from the road's edge. In the USA, clear zone distances vary, based on traffic volumes, speeds and roadside geometry (Wolf & Bratton, 2006). Guidelines are less distinct for urban roads, but 0.5m is the minimum clear zone on urban low speed, local roads with kerbs. Nevertheless, some states have increased their minimum to 3.0m (CTRE, 2008).

Whilst this research is still in its early stages, a clear case has been made to research urban road crash data, as distinct from rural road crash data, so that information is available to better integrate trees into the planning and design of urban roadsides (Wolf & Bratton, 2006). Initial results in the USA (CTRE, 2008) indicated that the fixed object crash frequency in urban areas decreased at a 1.5 m object setback distance, making it the most effective setback distance and that there was no need to adhere to the commonly greater setback distance of 3.0 m.

3.4 PHYSICAL ACTIVITY AND HEALTH: BENEFITS IN MANAGING DISEASE

Recently, there has been a greater focus on physical activity and health, particularly amongst the elderly and the young, given the aging populations in western countries and problems amongst the young (and others) as regards being overweight or obese. Since these issues are occurring at a time of increased urbanisation, people are looking towards increases in physical activity in towns and cities as potential solutions. With the psychological and social benefits of 'green environments' already well established (section 3.1), more attention is being directed towards physical activity in urban green environments. Yet urbanisation itself threatens the maintenance of these areas. Whilst trees are not the only components of green environments, they are a significant part, given their size and longevity.

Human health is defined as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (WHO (1948) in Tzoulas *et al.*, 2007). Recent epidemiological studies are beginning to provide evidence of the positive relationship between well-being, health and green places (de Vries *et al.*, 2003), including the importance of walkable green spaces to senior citizens (Takano *et al.*, 2002). Integrating our understanding of the role of trees and other vegetation, also known as 'green infrastructure', with our understanding of human health will advance this area of research and provide better land use planning and management outcomes (e.g. Tzoulas *et al.*, 2007).

Green infrastructure performs multiple roles in towns and cities i.e. recreation, maintenance of biodiversity, city structure, cultural identity, environmental quality and biological solutions to technical problems (Sandstrom, 2002). It comprises all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales (Sandstrom, 2002; Tzoulas *et al.*, 2007). A component of 'green infrastructure' is the urban forest which includes all the woody vegetation in and around urban areas, on both public and private property, whether deliberately planted or as a remnant of vegetation pre-dating urbanisation.

Whereas 'green infrastructure' includes more plant types (such as grasses and herbs, as well as trees and shrubs), the main distinction between 'green infrastructure' and the urban forest lies in their basis. Green infrastructure emphasises the multiple purposes of green areas and takes an ecological systems approach in identifying these areas, whereas the urban forest takes a structural approach, focussing on relatively long-lived woody plant material. This is not to say that the urban forest does not perform as an ecological system, providing ecological services and environmental benefits to people; we are increasingly recognising that this is, indeed, the case.

Another term for urban green environments is 'green space' or 'open space', but since these tend to emphasise the recreational role of these areas, and have unfortunate connotations of 'emptiness'

(space), the term 'green infrastructure' is preferred. Another benefit of the term 'green infrastructure' is that it is seen to afford the same significance to these areas as 'technological infrastructure' has traditionally had in urban planning (Sandstrom, 2002).

In Australia, our cities and towns usually have the full range of ecosystem types comprising 'green infrastructure'. The street and park tree components of the urban forest would usually be considered as part of the artificial ecosystems of Green Infrastructure, whereas trees and shrubs (along with herbs and grasses) in a park revegetated with locally indigenous plants might be considered a semi-natural ecosystem, and an area of remnant bushland would be considered a natural ecosystem.

Evidence for the importance of 'green infrastructure' to human health comes from studies in three main areas (Tzoulas *et al.*, 2007): epidemiological studies, experimental studies and survey studies. Experimental studies (section 3.1) indicate that natural views and green places restore attention fatigue, quicken recovery of cognitive performance, provide relaxation, increase positive emotions, allow recovery from stress, reduce symptoms in children with ADD, increase the effectiveness of people in facing major crises and lessen aggression by reducing mental fatigue (Tzoulas *et al.*, 2007).

The epidemiological studies are particularly interesting because they have brought public health and medical researchers into the ecological area. De Vries *et al.* (2003) explored the relationship between green areas and health in over 10,000 people in the Netherlands using two different datasets, one on self-reported health and one on the amount of greenspace in their living environment. The study was controlled for socioeconomic and demographic characteristics, as well as for the level of urban-ness. People living in a greener environment were significantly healthier on all three health indicators (number of symptoms experienced, perceived general health and a score indicating propensity to mental health problems). The level of urban-ness influenced health in that people in highly urban areas had more symptoms and a higher risk of mental illness; however, the amount of greenspace was more strongly related to the health indicators, and in a way that gave better health outcomes.

The positive link between greenspace and health was found to be most apparent among the elderly, housewives and people from lower socioeconomic groups. Whilst the mechanism linking greenness to health was not studied, suggested possibilities included less polluted environments, greater contact with greenspace, or more physical activity. It was also suggested that, if it was ultimately found that greenspace in people's living environments actually *made* people healthier, rather than just being related to perceived health, then the densification of cities, which can remove greenspace, may turn out to have unexpected negative health consequences.

A follow up study, along similar lines and involving over 250,000 people (Maas *et al.*, 2006), studied the strength of the relationship between the amount of greenspace in people's living environments and the perceived general health for different socioeconomic, age, and locational (i.e. urban or rural) groups. The percentage of greenspace inside a 1km and a 3km radius had a significant relationship to perceived general health. The relationship was generally present at all degrees of urban-ness, from very strong to non-urban. The overall relationship was somewhat stronger for lower socioeconomic groups. The groups that seem to benefit more from the presence of green areas in their living environment are the elderly, youth and people with lower levels of education. The study emphasised that greenspace should not be considered a luxury, but rather as having a central position in spatial planning policy, especially for the groups identified above.

Other epidemiological studies on mortality rates (Takano *et al.*, 2002; Tanaka *et al.*, 1996), and controlled for age, sex, marital and socioeconomic status, found that people with access to green places had greater longevity. Increased survival of senior citizens was significantly linked to having parks and tree lined streets near their residence; having walkable green streets and spaces nearby was a significant predictor for survival over the following five years (Takano *et al.*, 2002).

There is an increasing body of literature on physical activity, particularly walking, in residential environments and links with health, including reducing obesity. For example, it has been shown that high levels of greenery in residential environments are associated with being physically active and not being overweight or obese (Ellaway *et al.*, 2005). Whilst parks have long been perceived as important sites of physical activity, contributing to human health (Maller *et al.*, 2002), there is a more recent focus on streets as sites for walking to maintain health, especially for elderly people. Green elements, such as trees along the street, front gardens and parks, have been found to be important aspects in making streets attractive for walking (Borst *et al.*, 2008).

A framework linking 'green infrastructure', ecosystem function and services, and human health has been suggested by Tzoulas *et al.* (2007), whereby green infrastructure, through its provision of ecosystem functions and services, creates the environmental settings for health of both individuals and communities. Health in this context is considered in its broadest meaning, including socioeconomic health (e.g. income, employment, education, housing, services etc.), community health (e.g. community identity and empowerment, social capital and culture), physical health (e.g. cardiovascular, endocrine, bone tissue etc.) and psychological health (e.g. relaxation, attention and cognitive capacity, positive emotions etc.). There are potential economic implications of 'green infrastructure' for health effects and health service budgets, and these need to be researched.

4. ATTITUDES TOWARDS TREES: PERCEPTIONS, PREFERENCES AND RESPONSES

Understanding the social attitudes of urban dwellers towards nature, including attitudes towards trees, is important in managing urban forests. In 2006, a continuum of values was provided (Tarran, 2006) involving both subconscious and conscious components (Miller, 1997) via five groups of people:

- those with a love of and dependency on nature e.g. wilderness dwellers
- those who seek renewal in nature e.g. weekend bushwalkers
- those who prefer tamed nature e.g. people enjoying backyard or motorised outdoor recreation
- 'nature neutrals' e.g. people who are not interested in nature and are comfortable without nature
- 'nature haters' e.g. people who see nature as messy, threatening and in need of control

As well, the condition known as 'plant blindness' (Moss Warner, 2004) was mentioned: that is, the inability of some people to even notice plants, let alone to recognise their importance to people and the biosphere, or to appreciate their aesthetic and biological features. This could be an increasing group, in view of urbanisation, changes in housing types, and reduced contact with nature in daily life.

This information was based on observation rather than any serious study. Yet the importance of humans, as the dominant influence on urban ecosystems and urban forests, is undeniable. More recently, it appears that people's attitudes towards nature, and towards trees (to some extent), are being researched. This is being driven, in part, by the necessity of bringing about changes in people's environmental behaviour as we attempt to move towards more sustainable cities. As urban environmental managers seek to introduce programs such as recycling and water conservation, they are finding they need to understand better the attitudes of urban dwellers towards nature.

Studies on perceptions of, responses to and preferences for trees and urban forests fall into several categories, such as the:

- shape and appearance of trees and their canopies
- presence of trees in front and back yards
- presence of trees near workplaces, in streets and in cities

4.1 SHAPE AND APPEARANCE OF TREES AND THEIR CANOPIES

There are some studies dealing with people's perceptions of trees and their canopies, in an attempt to understand landscape preferences. The findings of these studies may assist with species selection that will meet with approval by urban dwellers, particularly on a visual basis.

Spreading and globe tree shapes, and comparable species examples such as acacia and oak, are preferred over conical (and conifer) and columnar forms by people from a range of countries including the United States, Canada, Australia, Brazil, Israel and Japan (Sommer & Summit, 1996). Whilst there was also a preference for trees most common in early experience (e.g. people who grew up with conifers tended to rate them more highly), the characteristics of the spreading and globe shapes in themselves played a greater role in the common preferences for these shapes across different nationalities. A similar study (Sommer, 1997) including countries with other environments (South Africa, Zimbabwe, Estonia, Italy, Switzerland and the US-Mexico border) confirmed the previous findings. It is suggested that preference for tree shape is related to early human evolution and derives from landscape features of the East African savannah in which areas were selected as habitat based on their provision of features that contributed to human survival. Spreading trees offered both refuge (shelter) and prospect (the ability to climb up and see into the distance) (Summit & Sommer, 1999). The preference for a spreading tree form was confirmed by Lohr and Pearson-Mims (2006) who also

found that people reported feeling happier, friendlier and more attentive, but less angry, sad and fearful, when looking at urban scenes with trees than the same scenes with inanimate objects.

Williams (2002) studied resident preferences for street trees in Melbourne, Australia, via a photo-questionnaire involving trees photographed in local streets. This study thus evaluated multiple tree characteristics, such as form, size and foliage texture, within the context of the street, including overhead wires, roads and footpaths. A preference was found for trees with a spreading, oval or globe form, but unlike previous studies (e.g. Sommer & Summit, 1996; Sommer, 1997; Summit & Sommer, 1999) the globe forms were more preferred than the spreading forms. Williams' study did however confirm previous findings of the relatively low preference for conical and columnar forms. The most preferred trees tended to be those in the category of introduced, deciduous trees, which were medium to large and with relatively large and coarse foliage; it was not possible, however, to relate the preference to any single character of these trees. There was also a preference for medium-sized trees over both smaller and larger trees, for trees with coarser foliage (broadleaved trees) compared with finer foliage (conifers and Australian trees with needle-like foliage), and for trees with balanced canopies compared with irregular canopies. It appeared that older respondents had lower preference for large trees, whilst more highly educated respondents had significantly higher preference for large, primarily native, trees. There were no significant differences in average preference for 'native Australian' trees (from the local area or elsewhere in Australia) or 'introduced' trees (trees from countries overseas).

4.2 PRESENCE OF TREES IN FRONT AND BACK YARDS

People may have different attitudes to trees, depending on the location of the trees, whether it be a distant forest of natural bush, a plantation of exotic pines, or trees in an urban bushland remnant, a public street or park, or in their own yards. People's attitudes to trees can be explored by investigating how they engage with trees on their own properties, where they have a greater level of control over tree planting, pruning and removal. Of interest are whether people choose to include trees in or exclude trees from their front and back yards, and the reasons for their decisions.

Using a large study of 226 backyards and backyarders in Sydney and Wollongong, Head and Muir (2005) extracted data from 21 participants looking at attitudes towards trees, both positive and negative, that reflect ownership, association and attachment. This sample included differences in educational level, ethnicity, age, gender, occupancy time and size of backyard. Not surprisingly, diverse sets of attitudes were found. Trees were variously seen as powerful, dangerous and beloved. The most frequently cited reason for tree removal related to danger, disease or size, whilst the most important reasons for planting trees related to aesthetics and creating habitat for birds, with provision of shade cited less often. People used the word 'love' to describe their attachments to particular trees in their backyards and then explained this love, via social value, aesthetics or bird attraction. Dangerous trees were identified as such because of disease, age, angle, shedding large branches, planted too close together, wind affected, fire hazard or a threat to plumbing. Although some people did not view large trees in their backyard as a threat to security, others stated a general belief that gum trees didn't belong in suburban back yards.

Head and Muir (2005) made some interesting suggestions about attitudes to trees based on people's perceptions of trees as occupying a zone where "nature" and "home" overlapped. Whilst some people seemed to be aware that native plants might be appropriate for environmental reasons, their own needs and personal sense of aesthetics took precedence, albeit with some sense of guilt. Removal of trees aroused more guilt than removal of shrubs and ground cover, even though all layers are important for habitat and biodiversity. Other people, who were strongly committed to restoring locally indigenous trees to their area, were highly critical of neighbours' choices of (exotic) trees for planting or reasons given for removing locally native trees. The study suggests that some people exclude trees from their backyard when they perceive nature and the environment as something 'out there', beyond the home. On the other hand, when people have a view of nature that is more fluid and can move into the 'home' zone, they are more comfortable with including trees in their backyard. A third group of people, who expressed a strong sense of connectedness to nature, had a strong commitment to including trees in their backyards, including restoring the indigenous tree layer.

A few studies on western cities with extensive suburbs, particularly in the USA, have examined the relationship between socioeconomic status and characteristics of urban vegetation (e.g. see Kirkpatrick *et al.*, 2007). The general finding is that tree cover is greater in areas with higher socioeconomic status (higher levels of income and/or education). Garden size plays an overwhelming

role in determining garden composition as well (Smith *et al.*, 2005), with larger gardens being more likely to contain trees taller than 2-3m. The reasons why tree presence could be directly related to socioeconomic status have not been determined, but could include (Kirkpatrick *et al.*, 2007) the fact that the rich have larger gardens or better land for growing trees; other factors could include ethnicity, home ownership, imitation, education, age of owners and age of suburb.

Kirkpatrick *et al.* (2007), studying 1550 front gardens randomly selected across Hobart suburbs (50 gardens from each of the 31 suburbs), covering socioeconomic and environmental variation, found that household income was the best predictor of the percentage frequency of trees (taller than 8m) in front gardens. Gardens that had more clayey soils and those at a higher altitude also had more trees. Overall however, most front gardens were medium-sized and most (70%) had no trees. Of the 13 garden types identified, trees were most often present in the types described as 'shrubs with bush trees' (including retained native trees) and 'complex native' (which included planted locally native and other Australian plants); these were also the categories containing the most large gardens. However, garden size in itself was not a significant predictor of tree presence. Trees were also often present in 'productive', 'woodland' and 'simple native' gardens, but notably absent in 'non-gardens' (lawn and/or artificial surfaces), 'complex flower' gardens and 'exotic shrub' gardens.

In speculating as to why there were fewer or no trees in the gardens of lower socioeconomic areas, Kirkpatrick *et al.* (2007) suggested, based on ideas of Seddon (1997), that people of lower socioeconomic status may find that the garden is one of the few places where they can exercise control in their lives and that such control is more readily achievable in the absence of trees. These findings for Hobart, where the poorer suburbs had mostly Australian-born people, may not apply to Melbourne and Sydney, where comparable areas have substantial recent immigrant populations.

Another line of research has looked at the cultural background and landscape history of different groups of people to determine whether these factors affect the perception of the urban forest.

Toronto, Canada, is a multicultural city, in which four culturally distinct populations (British, Chinese, Italian and Portuguese) were identified and studied, using a random selection of 50 households of each population, controlled for income and housing type (Fraser & Kenney, 2000). Vegetation inventories were conducted on each property and face-to-face interviews gathered information on:

- (a) the changes they had made or would make to their gardens
- (b) what kind of tree they would plant on their property (large shade, small ornamental, fruit or none)
- (c) their order of preference for images of five front yards (lawn, vegetable/fruit, two shade trees, ornamental shrubs or brick patio)
- (d) their order of preference for four different park types (playing field, flower garden, playground and hiking path) and whether the city would be improved or degraded by more of each type
- (e) demographics (home ownership, years at house, age and time in Canada)

Fraser and Kenney (2000) found that there was a clear difference between the populations in terms of the type of tree each group would prefer to plant: the British preferred shade trees, the Italians preferred fruit trees, the Portuguese preferred either fruit or ornamental trees, and the Chinese preferred no tree at all. Whilst all communities preferred shrub front gardens, the British had the strongest preference for shrub and shade tree gardens, whilst the Chinese reacted more favourably to lawn and brick patio. In relation to the park types, only the British reacted favourably to the hiking trail, with the other three communities preferring flower gardens. In their own back yards, the British had the most shade and ornamental trees, while the Italians and Portuguese had the most fruit trees. It was felt that these differences could be linked to both cultural background and landscape history.

It is apparent that, in the case of the urban forest on private land, cultural differences can create another layer of complexity in developing an urban forest strategy. Given that different cultural perceptions exist, managers can try to work with these differences, recognising that ecological and climatological benefits may be sub-optimal, or they can ignore these differences, and face resistance or sabotage from some parts of the community, or they can attempt to educate diverse communities about the benefits of larger trees in urban areas.

There have been some studies of the gardens of different migrant cultural groups in Australia (e.g. Armstrong, 1999; Head *et al.*, 2004), but these have tended to focus less on the tree aspect *per se* and more on the experience of migration and the links between people and plants in their new environments. These links often involve food production, as a way of sustaining their cuisine and

other aspects of their culture. Trees that are mentioned as important are, for example, figs, lemons and olives in the Greek community (Armstrong, 1999), stone fruit, lemon, mango and nut trees in the Macedonian community (Head *et al.*, 2004) and tropical fruit (mango, pawpaw, loquat and longan) and citrus (grapefruit, mandarin and lemon) trees in the Vietnamese community (Head *et al.*, 2004). Other trees were not common in these back yards. The gardens of British migrants, on the other hand, contained tree-and-shrub layers combining 'native' Australian plants and exotic plants, but little in the way of food trees, most often just a single lemon tree (Head *et al.*, 2004). Intensive back yard food production seemed to break down amongst the next generation in suburban Australia, with aspects retained as part of heritage alongside increasing use of 'native' shrub-and-tree layers.

Although there is anecdotal evidence of a desire for residents to remove trees from their properties after severe events, such as bushfires or major storms, there is little documented research into this phenomenon. Studying (non-development) tree removal request data in Canberra, both before and after the major bushfires of January 2003, Gilbert and Brack (2007) found that there was a substantial increase in requests lodged in February 2003, but by February 2004 the number of requests had returned to February 2002 levels, indicating a response that declines relatively quickly. Since the approval rate remained the same during the increase in requests to remove trees, it appears that the reasons for requesting tree removal were justified and that the bushfires may have just provided an incentive for people to request tree removal for reasons that pre-dated the fires.

4.3 PRESENCE OF TREES NEAR WORKPLACES, IN STREETS AND IN CITIES

Reasons given for the inadequate funding of the urban forest are often that the benefits are pure public goods (Bisco Werner *et al.*, undated), widely dispersed and not priced (Vesely, 2007), with further complications arising from the fact that the urban forest is in multiple ownerships. Quantitative information on urban forest benefits and residents' valuations of the urban forest are both needed to facilitate better funding, either through better public awareness of potential values that may be lost or through management decisions based on cost-benefit analyses (Tyrvaainen & Miettinen, 2000).

Quantitative information on urban forest benefits has been steadily increasing (e.g. see Dwyer *et al.*, 1992; McPherson *et al.*, 1999; McPherson & Simpson, 2002; Brack, 2002) and has been facilitated by specialised software packages such as CITYGreen (undated) and i-Tree (undated). There is, however, less information about residents' valuations of the urban forest.

Using contingent valuation methodology (since market data does not exist), Vesely (2007) measured the perceived monetary value of avoiding a 20% decrease in the urban tree estate on the public and private land of 15 cities in New Zealand (mainly in Auckland and Wellington). On average, households were willing to pay about NZ\$184/yr for 3 years to avoid a 20% reduction in their local tree estate. When volunteer work was used as an alternative to monetary measure, it was found that 66% of the sample agreed to contribute 4 hours per year.

The study also revealed other information about the residents' perceptions of the urban forest, since they were first encouraged to think about the beneficial and negative effects of city trees. A pre-study indicated that, on average, city residents named only three benefits of having trees in the city, so the questionnaire was designed to ensure that they had a broader understanding of the benefits. The main findings were that -

- (a) of nine benefits listed for the urban forest, aesthetics was considered most important, followed by having nature in the city, habitat for wildlife and fresh air
- (b) of seven listed negative effects of the urban forest, only one (causing drainage problems) was more important than the lowest ranked benefit; leaf drop was considered the least problematic
- (c) about half the city residents felt that there were the right number of city trees, while slightly less than half felt that there were not enough; only 2% felt that there were too many trees
- (d) people were motivated to take care of trees mainly by the benefits provided by the trees to them, but also to some extent by having benefits available for future generations
- (e) in relation to the seriousness of a possible 20% reduction in the urban forest, about half the residents considered it to be either 'extremely serious' or 'very serious'

Very little research has been carried out addressing landscapes near workplaces and employees' reactions to them. Kaplan (2007), using a survey and photo-questionnaire, assessed employees' attitudes to their nearby natural setting. She found that having a view of large trees was consistently related to greater satisfaction with the nearby natural environment, but that a great number of large trees were not required - even a few large trees can make a substantial difference. In terms of desired

changes to the landscape, having more trees and more landscaping were strongly endorsed, but having more flowers received the strongest endorsement. The presence of mowed grass around the workplace had no bearing on participants' satisfaction with any aspect of the natural environment.

5.OVERCOMING IMPEDIMENTS

In 2006, impediments to realising the potential of urban forest benefits to assist the health of urban dwellers were only briefly mentioned in two areas:

- firstly, given that the benefits provided by urban trees could be enjoyed by anyone free of charge once planted, it was likely that the economic market would discount or ignore their value
- secondly, that trees would also be ignored by some groups in society i.e. people who have no interest in nature (or trees), who actively hate trees, or who are 'blind' to their importance

Ways of overcoming these impediments were also only mentioned in passing:

- firstly, that we needed to market the importance of the urban forest more widely to other decision-makers and the public, and in more creative ways
- secondly, that we needed to position urban trees as a normal part of city infrastructure, so that quality space and adequate resources would be automatically provided for them
- thirdly, that we needed much more local research in Australia, to guide the development of urban forestry and urban ecology here

Whilst it would be possible to compile an extensive list of impediments to establishing worthwhile and sustainable urban forests, the present paper will focus on just a few of the key impediments and then suggest some possible ways forward, particularly those that can address multiple impediments simultaneously.

5.1 LACK OF RECOGNITION OF VALUE OF URBAN TREES AND FORESTS

Lack of widespread recognition of the value of urban trees and forests, especially for the extensive and multiple benefits they provide to people, remains one of the major problems. This lack of recognition includes a failure to understand or appreciate the benefits in a qualitative way, as well as a failure to place an economic value on these benefits. Whilst there is increasing recognition of these benefits within a small group of professionals whose work involves trees or interacts with them, many other professionals, and the general public, have little idea of these benefits. People who work and are immersed in a particular area often find it difficult to fully understand how little other people know of the area. The case of the New Zealand study, where pre-testing revealed that members of the general public were aware of only three benefits of trees, comes to mind (Vesely, 2007).

This lack of recognition and value is probably just a subset of a general lack of understanding of urban areas, sustainability, urban ecosystems and the like. Just as people have been slow to appreciate the benefits of urban trees and forests, so have they been slow to understand and value the ecosystem services provided by nature to us.

Of particular significance is the lack of recognition of the value of urban trees and forests at a national level, let alone a state level. At present, the vast majority of the work in promoting urban trees and forests is done at the local government and community level. This has many advantages in building support for sustainable communities and helping people engage with their local ecosystems. However, national recognition of issues is an important landmark. It provides focus and elevates issues to a prominence that can never be otherwise achieved. National recognition facilitates broad scale strategic planning, with long term research and action plans. It can coordinate research and technology transfer programs across the country to minimise duplication and allow all towns and cities to benefit from available information. Central to all this activity, and flowing on from national recognition, is national funding at a level that can achieve significant advances.

One aspect of the environment that has received national attention, and where understanding has grown, is water use and sustainability, including urban water. This, however, has been achieved through reaching a crisis situation, with a prolonged dry period in eastern and southern Australia, much publicity as regards water storage (dam) levels, water restrictions in many cities and towns, and decisions to build energy-intensive water infrastructure, such as desalination plants. It appears that a serious and immediate crisis is needed to bring about awareness of environmental issues.

Our challenge in urban trees and forests is to achieve recognition and support before a crisis emerges. It doesn't do to dwell on how much of our existing urban forests would need to be lost before the perception of a crisis brought about awareness of their value.

5.2 LACK OF PROVISION OF QUALITY SPACE AND OTHER RESOURCES

Lack of quality space remains an impediment to establishing trees and other vegetation in towns and cities. Large trees are needed to maximise environmental benefits, since large canopy size increases the value of benefits like shading, evaporative cooling, and air pollutant and water interception. For health benefits, 'green' is needed, but there has been less research into the importance of the type of green; it may well be that some level of tree canopy is also needed in this regard. Trees need both below ground and above ground space, for root, trunk and canopy growth, yet they are unable to make a primary claim on space in our cities and towns.

Added to this is the increasing problem of densification of towns and cities, as people seek to make cities more concentrated, to make use of existing built infrastructure, and to reduce urban sprawl. Densification will reduce the availability of quality space for trees and the urban forest even more, and, more worryingly, in a way that is permanent and not easily reversible.

One area where this is all too evident is in the proliferation of suburbs of 'McMansions', also known as too-big houses, monster houses, starter castles and garage Mahals (Nasar & Stamps, 2009). Many of these suburbs are being created without an urban forest or, indeed, much green. We simply do not know how these suburbs will fare in the future, when energy may be too expensive for continuous air-conditioning (in the absence of trees and well-designed houses) and children may lack green places to restore their concentration capacities or undertake physical exercise.

5.3 FRAGMENTATION WITHIN GREEN INFRASTRUCTURE

It is possible that, in focussing on trees, just one component of green infrastructure, we are hindering the greater acceptance of the concept of green infrastructure as fundamental to cities and towns. The same comment applies to all the other groups who are concerned with their own particular aspects of 'green' in cities and towns: those concerned with revegetating degraded rivers and creeks, pocket parks, home gardens, community food gardens, bushland remnants, roof gardens, playing fields, recreating locally indigenous landscapes etc.

It may be that the fragmentation itself, and inter-group debates and disagreements, weakens the case for green infrastructure or, at the very least, causes some important main messages to be lost in the detail of the debates.

5.4 COMPETITION FOR WATER AND IMPACTS OF CLIMATE CHANGE

Within urban areas, there is competition for water, both between green infrastructure categories (e.g. trees, grassed areas, floral displays and food production) and between green infrastructure and other uses (e.g. cleaning and provision of water features in the landscape). With decreasing availability of urban water, given climate change and increasing populations, there may be greater impediments to establishing and maintaining urban trees and forests if the species selected require more water than can be provided by the local rainfall, both as regards its extent and variability. Nevertheless, there are locally indigenous trees and exotic trees that can survive in and are suitable for urban areas. The issue of weediness, however, does need to be addressed in the case of introduced species that survive easily in local soils and climates.

Of possible concern in the future, with greater attention being paid to the energy costs of food transport and dwindling supplies of oil, is the potential conflict between food supply and other components of green infrastructure, such as urban trees and forests. It may be that available urban space, water and fertiliser will be increasingly devoted to food production.

5.5 SOME WAYS FORWARD

(1) National recognition of green infrastructure, including urban trees and forests

Ultimately, we need to gain recognition, at a national level, of the importance of green infrastructure, including urban trees and forests in Australia. Significant advances have been made in urban forestry in both the USA (since the 1980s) and the UK (since the early 2000s) by having national bodies making representations at the highest levels and influencing government policies. In these countries,

plant scientists and social scientists worked together within a forestry-related national body to develop research programs in urban and community forestry, reallocating funds to urban areas in the process.

In Australia, we need to identify a 'champion' national body to promote green infrastructure, urban trees and forests. Nevertheless, it is worthwhile noting that The Wentworth Group of Concerned Scientists did much to get water onto the national agenda. As regards Commonwealth departments in Australia (Australian Government, 2009), the most promising ones appear to be:

- Environment, Water, Heritage and the Arts (includes human settlements, plants, biodiversity, water, climate change etc.)
- Innovation, Industry, Science and Research (includes CSIRO and Cooperative Research Centres)
- Health and Ageing is also relevant, via public health and disease prevention, and health of target groups such as indigenous populations, the youth and the elderly

Early research at the US Department of Agriculture (USDA) Forest Service research stations led to a landmark, well-funded study on Chicago's Urban Forest Ecosystem (McPherson *et al.*, 1994) which became the model for subsequent studies throughout the USA. The 1990 Farm Bill (amending the Cooperative Forestry Assistance Act of 1978) led to the creation of the National Urban and Community Forest Advisory Council (NUCFAC) which drafted a National Research Agenda for Urban Forestry in 1991 (Makra & Watson, 2003). Thus, early research was undertaken in a strategic and coordinated way. This Agenda was revised in 2003 (Makra & Watson, 2003). In 2004, an inventory of urban forestry programs throughout the USA was undertaken and the USDA Forest Service Urban and Community Forestry Program was assessed (HortScience, Inc. & The Aslan Group, 2004). Recent documents prepared by NUCFAC include the 'National Research Plan for Urban Forestry: 2005-2015' (Clark *et al.*, 2004) and the 'Ten-year Action Plan 2006-2016' (NUCFAC, 2005).

In the UK, it appears that their version of urban forestry, that is, trees, woodlands and the natural environment, has received a similar boost, via the involvement of the national Forestry Commission of Great Britain (2009), in particular through their Forest Research programs. In the early 2000s, they appear to have expanded into social science research, alongside their traditional scientific research. They now have a strong health and well-being component in their research program. Recently, their research centres were reorganised to include Forestry and Climate Change, Human and Ecological Services as well as the traditional area of Forest Resources and Management.

(2)An Alliance of Green Infrastructure Providers

To achieve national recognition, I believe we need a group with the national, long-term public good at its core, to promote green infrastructure, including urban trees and forests. For urban trees and forests, it may be best to present trees as part of the green infrastructure 'package' that also includes shrubs and grasses, green walls and roof gardens, community food (productive) gardens, pocket parks, revegetated riverbanks, bushland remnants, and recreated indigenous landscapes.

Just as we moved from individual trees, to urban forests, so the next logical step forward may be to green infrastructure in cities and towns. This has the advantage of positioning plants as central to urban ecosystems and hence to the ecosystem functions and services provided to urban areas and urban dwellers. Furthermore, this recognises the role of green infrastructure in creating the environmental settings for the health and well-being of both individuals and communities.

The Alliance of Green Infrastructure Providers needs to include the extensive range of green infrastructure categories in Australia and the special attributes of our 'green', such as our unique biodiversity (resulting from Australia's environmental history), the links between indigenous people and plants, the presence of remnant bushland in and near cities and towns, and the cultural overlays of recent immigration during the last 220 years, including tree planting, garden making, revegetation programs and bush regeneration. Given the diversity of this group, its members would need to work through philosophical differences to arrive at a stage where the greater good is served by recognising the commonality of our commitment to green infrastructure, rather than by debating the relative merits of different types of green.

(3)Continued engagement with people through tree and other "green" stories

People are storytellers; and a powerful way of engagement and awareness-raising is through stories. We need to continue to talk about trees, gardens, parks and bushland, in the past, present and future, and to embed these stories in our culture. We need to engage with other groups, like social scientists,

garden historians, and artists, to learn more about people-plant interactions. Perhaps we need more creativity in the ways we help people to see trees and the links between people and trees.

It is interesting to note that trees have recently appeared as a prominent part of the Sculpture by the Sea (2008) exhibition in Sydney NSW, along the coastal walk between Bondi and Tamarama: family trees with roots that spread far and wide, a tree representing our lifeboat and connection to nature, and a tree suspended between the land and sky. In the USA, an art commission to commemorate the centennial of the Grand Concourse in the Bronx, a tree lined avenue, saw it turned into a long boulevard of talking trees: a tree museum, with trees connecting to oral guides of Bronx history (The New York Times, 2009). Along the Concourse, 100 trees were marked out, giving a phone number and code to listen to short recordings of people speaking about the Bronx, their lives and their work.

6. CONCLUSION

Although the benefits of trees and other vegetation to humans living in cities and towns are being increasingly studied and even quantified, we are yet to achieve full recognition of these benefits by all parties involved in urban planning and management. Benefits of 'green infrastructure' are mostly promoted at the local government and community levels, but are not yet recognised at national or state levels. Furthermore, many people themselves are yet to recognise the diverse benefits provided by trees and other plants and advocate more strongly for their right to live in green cities and towns.

At the same time, we are losing 'green infrastructure' and potential spaces for future 'green infrastructure' as we continue to build and consolidate our cities and towns. In some cases, the loss of space, especially for trees, cannot easily be reversed.

The emerging evidence of powerful health benefits associated with green in urban areas should serve as a wake up call that existing trees and vegetation in cities should not be taken for granted, nor readily removed as we increase urban densities. Furthermore, we need to seriously re-think current development that 'designs out' spaces for significant areas of trees and other vegetation, given the likely future adverse consequences for human health.

It is critical, at this late stage in our process of urbanisation in Australia, that an Alliance of Green Infrastructure Providers engages with both people and their national, representative decision-makers, to position Green Infrastructure as an essential component of liveable, sustainable urban ecosystems.

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