

# TREES, URBAN ECOLOGY AND COMMUNITY HEALTH

## DR JANE TARRAN

This paper looks at the links between trees, urban ecology and the health of urban dwellers. It has two main objectives. Firstly, it seeks to position urban trees and urban forestry within the field of urban ecology, by exploring changes in both our focus on urban trees and our perceptions of their benefits to us, as well as developments that have led to the rise of urban ecology. Secondly, the paper provides an overview of the positive roles that urban trees (and urban nature more generally) can play in community health, with a focus on the social, psychological and spiritual benefits associated with urban "green".

### 1. URBAN TREES - CHANGING FOCUS AND PERCEPTIONS OF THEIR BENEFITS

Over time, it appears that there has been a change in our focus on urban trees from individual trees (or avenues) to the urban forest. The focus on individual trees is associated with issues such as tree species selection, planting, establishment and maintenance through to maturity. Whilst not abandoning the recognition of the importance of individual trees, we have come to focus more on our populations of urban trees, or the urban forest.

The urban forest can be described as all the trees and shrubs in and around urban areas (Miller, 1997) and includes street trees, park and garden trees and shrubs, as well as bushland. The urban forest occurs on both public and private land and includes woody plants that have been planted intentionally as well as trees remaining from previously forested areas, either singly or in small groups, or within a more extensive bushland remnant. The urban forest is managed for the physiological, sociological, economic and aesthetic benefits it provides (Helms, 1998).

At its most basic level, the urban forest is measured by the canopy cover percentage of the total area. With a focus on trees more than on shrubs (Konijnendijk & Randrup, 2002), another measure of the urban forest is the number of trees. More detailed descriptions of the urban forest include information on tree species distribution and composition, community diversity and abundance, distribution of tree sizes and ages, tree health and other parameters.

Urban forestry emerged in the USA in the 1960s from traditional forestry, as foresters sought to engage with urban residents, at a time when traditional forestry was receiving more attention from urban dwellers, including those from the growing environmental movement (Miller, 1997). The political power base had shifted to cities and foresters hoped to use this engagement to contribute to solving urban environmental problems, as well as educating urban residents about sustainable forestry practices. The USDA Forest Service set up a network of research ecologists across the USA in the 1980s and the 1990 Farm Bill provided funds for tree planting, education and research. A significant achievement was the Chicago Urban Forest Climate Project (McPherson *et al.*, 1994) which demonstrated the range and extent of environmental benefits associated with the urban forest and provided a model for research in other cities.

The conceptual shift from a focus on individual trees to the urban forest as a whole appears to occur when trees start to die or need replacement. The disastrous losses of urban elm trees in the Northern Hemisphere as a result of Dutch elm disease undoubtedly hastened the adoption of urban forestry in the USA.

For a range of reasons, people have sought to maintain or introduce vegetation into their cities (Miller, 1997). Whether for food, or ornament, or to improve recreational spaces, we have planted trees in the belief that they make better places in which to live and work.

Our responses to nature and trees probably occur at both subconscious and conscious levels. E.O. Wilson uses the term "biophilia" to describe our subconscious connection to the rest of life and suggests that it has its basis in human evolution (Miller, 1997). Biophilia refers to both positive and

negative responses to elements of the natural world that had survival value to our evolutionary predecessors e.g. our preference for savanna-like parkland (a positive) and our fear of spiders and snakes (a negative).

Benefits of urban forests are found in four main categories -

- \* aesthetic and visual benefits
- \* environmental and ecological benefits
- \* social, psychological and spiritual benefits
- \* economic benefits to business

The aesthetic and visual benefits are the ones familiar to most urban dwellers and were probably the reasons behind early tree planting in cities. The perception of urban trees, however, as merely "ornamental" suggests that they might be non-essential to cities and this has unfortunate implications for their planning and management.

Over the last 20 years, researchers have been exploring the other three categories of benefits. Whilst there are technological alternatives to trees for achieving environmental benefits in cities, benefit:cost analyses indicate the value of trees (McPherson & Simpson, 2002). As regards social and psychological benefits, it may be that our attachment to nature is so deep that urban nature is essential and not easily substituted.

Despite this recognition of the multiple benefits provided by urban trees, a major impediment to effective funding of urban forests derives from the fact that the benefits provided by trees are almost pure public goods (Bisco Werner *et al.*, undated) - that is, trees provide benefits that may be enjoyed by anyone and the cost to produce the benefits is the same no matter how many people receive them. These qualities mean that the economic market will discount or ignore the value of trees. Once a tree is planted, it is virtually impossible to charge people for its environmental, aesthetic or symbolic benefits.

## 2. URBAN ECOLOGY - WHAT IS IT?

Urban ecology involves ecological research carried out in cities and towns (Niemela, 1999; Pickett *et al.*, 1997), as ecological models developed in natural areas are applied to urban areas (Lord *et al.*, 2003).

The city itself is viewed as an ecosystem - a new type of ecosystem, the urban ecosystem, created by humans specifically for dwelling (McIntyre *et al.*, 2000). Since urbanisation is both an ecological and social phenomenon, integrating both natural and social sciences in the study of urban ecosystems is crucial - urban ecology is an interdisciplinary field (McIntyre *et al.*, 2000).

In considering ways in which cities need to adjust in the future, the functioning of the cities, both ecologically and socially, rather than their appearance is believed to be of prime importance (Platt, 2004). This implies a stronger appreciation of the role of nature and its functions in urban areas, the establishment of links between humans and nature in urban areas and the development of new strategies to restore ecological services in urban areas.

Ecology is concerned with the relationships and interactions between organisms and their environments (McIntyre *et al.*, 2000; Walbridge, 1997). Patterns of interaction include energy flows and food webs. The aim is to develop an holistic understanding of natural processes within a defined system i.e. a "patch" of the planet or a natural community. Studies can be carried out at different scales, such as a catchment around a river, a forest or a single pool of water.

Traditionally, ecology has been studied in "pristine" ecosystems, often in remote areas with minimal human impacts. Some ecologists do study natural areas within urban and suburban landscapes (e.g.

bushland, wetlands and rivers) but the focus has tended to be on the area itself, rather than the area as part of the broader urban setting.

The term "urban" is a geographical term characterising the land use of an area (Niemela, 1999). It refers to a fairly large, densely populated area with industrial, business and residential districts. In Australia, an Urban Centre is defined as a population cluster of 1000 people or more (Australian Bureau of Statistics, 2004), with a Major Urban Centre being a cluster of 100,000 people or more. In 1996, about 88% of people in NSW and in Victoria lived in Urban Centres, while 67-68% in both states lived in Major Urban Centres (Australian Bureau of Statistics, 2004).

### **3. WHY URBAN ECOLOGY HAS BEEN OVERLOOKED IN THE PAST**

There is widespread recognition that urban and suburban landscapes have been understudied and underutilised by ecologists throughout the world (McDonnell, 1997; Niemela, 1999).

Ecologists appear to be reluctant to study urban ecosystems, or to work in areas dominated by humans. Historically, ecological training has involved addressing ecological questions in the most "natural" context i.e. without humans. It is also possible that urban ecosystems have been regarded as inferior to less disturbed ecosystems (Niemela, 1999).

It appears that, until about the 1980s, cities and nature were widely viewed as mutually exclusive (Platt, 2004). Covering the natural site with an artificial environment emphasised human dominance in the city and gave the illusion of independence from nature.

A survey of research papers in the foremost ecological journals between 1993 and 1997 revealed that only 25 of 6157 papers (0.4%) dealt specifically with urban species or were carried out in an urban setting (McIntyre *et al.*, 2000). Similarly, a prominent book on Biodiversity from 1988 devoted only 7 out of 520 pages (0.01%) to urban biodiversity (Platt, 2004).

This separation between urban ecosystems and natural ecosystems, or between "humans" and "environment" has been traced back to the earliest naturalists, such as Charles Darwin, who left their urban environments to study the natural world in places like South America (Walbridge, 1997). Possibly the view that nature exists only beyond the urban fringe or in exotic and distant places is perpetuated today by some scientists, ecotourism and television nature documentaries (Platt, 2004).

### **4. GROWING INTEREST IN URBAN ECOLOGY**

The growing interest in urban ecology has occurred at a time when we have come to realise that urban areas are essentially inescapable and hence need to be as habitable, safe and pleasant as possible (Platt, 2004).

As well, the increasing urbanisation that has occurred throughout the world over time (McIntyre *et al.*, 2000) suggests that urban areas are becoming more significant. Levels of urbanisation in the world were 9% in 1900, 40% in 1980, 50% in 2000 and are projected to be over 66% in 2025.

Some of the growing interest in urban ecology is a reflection of the changing perspectives of ecologists themselves.

There is increasing recognition amongst ecologists that the "natural" state is more an ideal than reality, given our better appreciation of the wide extent of human impacts on the globe. Global connectivity means that actions at local scales (e.g. chemicals used in air-conditioners) can produce effects that are felt worldwide (e.g. high UV radiation levels because of a decline in stratospheric ozone) (Walbridge, 1997).

Recently, there has been more ecological interest in "disturbance" and how it can determine ecosystem structure. Disturbance includes fire, floods, hurricanes and human activities.

Furthermore, ecologists are now more aware of and concerned about the effects of humans on ecosystems (Walbridge, 1997). Some of these effects (Vitousek *et al.*, 1997) include the observations that -

- \* more than half the earth's fresh water is used by humans
- \* nearly half of the land surface has been transformed by human action
- \* more atmospheric nitrogen is fixed by human activities than by all natural terrestrial processes combined
- \* human activities are leading to significant losses of biodiversity

The recognition of environmental problems and the sustainability crisis in many urban areas has also encouraged a focus on urban ecology. The urban sprawl associated with urbanisation in Australia and the USA has created a range of environmental, social and economic problems (Platt, 2004).

Over the same period, the concept of "ecological services" provided by nature to human society was developed by the biologists Paul Ehrlich and Gretchen Daily (Daily, 1997). These services are provided in both rural and urban settings and have helped to reinforce the idea that cities and nature are not mutually exclusive.

## 5. URBAN ECOSYSTEMS IN THE SPOTLIGHT – Long Term Ecological Research sites (LTERs)

**The LTER Network** (The US Long Term Ecological Research Network, 2004) was established in 1980 by the National Science Foundation to support research on long-term ecological phenomena over broad spatial scales, mostly in the USA. The network consists of 26 sites and involves more than 1800 scientists and students. It aims to provide the scientific community, policy makers and society with the knowledge and predictive understanding necessary to conserve, protect, and manage the nation's ecosystems, their biodiversity, and the services they provide.

In late 1997, two new LTERs were established - one in Baltimore, Maryland and one in Phoenix, Arizona (Walbridge, 1998). What was significant about these two LTERs was that they were both in densely populated urban areas and, in fact, the first urban LTERs in the network. These LTERs ushered in a new era of institutional recognition for urban ecology (Parris, 2004).

The Baltimore Ecosystem Study (BES) aims to understand metropolitan Baltimore as an ecological system - how both the ecological and engineered systems work, and how the ecosystems change over long time periods. The Central Arizona-Phoenix Urban LTER (CAP) aims to monitor human-induced ecological transformations, resulting from rapid land-use transformations, in Phoenix, Arizona; Arizona is the second fastest growing state in recent years, and the population of the Phoenix metropolitan area has doubled twice in the past 35 years.

Other groups with interests in urban ecology can be found in a range of countries and sectors. There are research institutes with university affiliations, including the following - the Institute of Urban Ecology (IUE) within Douglas College, Canada; the Urban Ecology Institute (UEI) within Boston College, USA; the Hixon Centre for Urban Ecology within Yale University, USA; and the Australian Research Centre for Urban Ecology (ARCUE) in Melbourne involving the Botanic Gardens and University of Melbourne.

There are also government agencies, such as the USDA Forest Service's Urban Forest Research Unit (with groups in Syracuse, Chicago, San Francisco and Davis) and the National Park Service Centre for Urban Ecology (CUE) based in Washington, DC.

The range of non-profit organisations includes Urban Ecology in San Francisco, USA (dating from 1975), the Trust for Urban Ecology (TRUE) in London, UK (1976) and Urban Ecology Australia in Adelaide, Australia (1991).

## 6. URBAN ECOSYSTEMS - KEY FEATURES

In urban ecosystems, *Homo sapiens* is the keystone species controlling ecosystem structure and function (Walbridge, 1997). The biotic community includes humans, as well as both locally native and introduced species of both flora and fauna. The physical environment includes natural features (e.g. rivers, mountains) as well as built structures or infrastructure (e.g. buildings, roads). The natural component is often hidden by the strong human domination of the landscape.

The main difference between urban and "natural" ecosystems is the degree of human influence, as it affects both the biotic and physical environment e.g. the presence of exotic flora and fauna and pollution in air, water and soil (McIntyre *et al.*, 2000). Introduced species can add to the diversity of urban species richness, but may depress populations of native species (Niemela, 1999); nevertheless, it has often been observed that species richness is higher in intermediately disturbed sites than in heavily disturbed sites (city centres) or undisturbed sites (natural forests).

The physical and social characteristics of urban ecosystems are dynamic and heterogeneous (McIntyre *et al.*, 2000). Urban ecosystems have small habitat "patches" and these are often isolated from each other by a matrix of built environment (Niemela, 1999).

## 7. URBAN ECOLOGY STUDIES

Five types of ecological studies involving urban environments have been recognised (McIntyre *et al.*, 2000) -

- (1) comparison of different land-use types within an urban setting - studies are needed to calculate structural variables like % vegetative cover, % canopy cover, average building height or housing density
- (2) comparison of an urban area with a nearby "natural" area - this assumes that "urban" areas are characterised by the presence of humans and "natural" areas by their absence (i.e. at opposite ends of the spectrum); such studies could include species comparisons between an urban bushland remnant and "natural" bushland in a nearby National Park
- (3) gradient analysis - ecological effects of urbanisation are assessed along a gradient, usually simply the distance from a city's geographic centre; biotic, physical and social variables (e.g. human population density, housing density, traffic volume, air quality and species richness) are then correlated with position along this gradient
- (4) urban succession - studies of urban development dynamics are undertaken by monitoring a single area over time
- (5) ecological "footprint" analysis - calculations are made of the land / ecosystem area needed to supply the material and energy flows to sustain humans and industry in the urban area

## 8. URBAN ECOLOGY - WHERE DOES THE URBAN FOREST FIT IN?

The urban forest is the most conspicuous element of "nature" in urban ecosystems and has a vital role to play in urban ecology. Urban trees have come to symbolise green, healthy cities and are

recognised as a key contributor to high quality urban environments. They also support other elements of nature, such as urban fauna.

The urban forest is often regarded as a city's natural capital, or the principal of an investment that keeps providing interest over time as benefits to humans.

Urban and community forests are also windows into the souls of our cities (McPherson, 1998). They reflect the values, lifestyle preferences and aspirations of current and past residents. By understanding a city's vegetation resource, we can better understand to what degree and how private and public institutions wish to invest in the future. Also, understanding an urban forest's structure is prerequisite to quantifying its function and value.

Unfortunately, however, urban forests are often taken for granted, overlooked, or under threat, despite the fact that they are quietly working full-time to make cities more livable (McPherson & Simpson, 2003).

Considering ecological principles in relation to urban environments can, however, lead to some interesting debates; for example, cities located in arid environments might question whether the planting of vegetation should be encouraged or discouraged and what types of vegetation might be appropriate (Walbridge, 1997).

Integrative studies in urban ecology, with a focus on vegetation and trees (natural aspects), but with links to urban dwellers (socio-cultural aspects), are beginning to appear. For example, one such study found that, after accounting for variations in population density, there was a positive relationship between the likelihood of a community to contain areas with trees and grass and its level of income and education (Grove & Burch, 1997).

## 9. CURRENT SOCIAL ATTITUDES TOWARDS NATURE

Current social attitudes held by an urban society towards nature are seen as a continuum of values, involving both subconscious and conscious components (Miller, 1997). They are reflected in the following five groups -

- \* people with a love of and dependency on nature - people in this group must live in nature and draw subsistence from it; this group includes remaining hunter-gatherer societies and individuals who seek to live in wilderness areas
- \* people who seek renewal in nature - many city dwellers reflect this attitude, by renewing themselves spiritually through periodic contact with nature, whilst spending most of their lives in urban areas at urban tasks
- \* people who prefer tamed nature - this group includes people who are satisfied by occasional contact with nature, but prefer the tamed nature of yards, high density camping grounds, or motorised outdoor recreation
- \* nature neutrals - people in this group are those who have no interest in nature and are quite comfortable in areas devoid of nature; nature does not matter to them
- \* nature haters - this group includes people who see nature as messy or threatening or in conflict with their lifestyle and in need of control by humans

Another aspect of our relationship with nature, and a rather disturbing one, is a recently recognised condition known as "plant blindness" (Moss Warner, 2004), with the symptoms of -

- \* the inability to see or notice plants in one's environment
- \* the inability to recognise the importance of plants in the biosphere and in human affairs
- \* the inability to appreciate the aesthetic and biological features of plants
- \* the anthropocentric ranking of plants as inferior to animals, so that plants are believed to be not worthy of human consideration

People with "plant blindness" are probably "nature neutrals". It is possible that this is a growing group of people, as societies become more urbanised, housing types change and people have less and less contact with nature in their daily lives.

## **10. SOCIAL AND PSYCHOLOGICAL BENEFITS OF THE URBAN FOREST: The restorative power of nature**

Rachel and Stephen Kaplan have been studying the relationship between people and nature (in its broadest sense) for over 25 years (Kaplan *et al.*, 1998). In particular, they have studied the way the natural environment can foster well-being and can enhance people's ability to function effectively.

Nature, in their research, includes a variety of outdoor settings, often nearby, that are encountered everyday and that have substantial amounts of vegetation e.g. parks, open spaces, street trees and backyard gardens. They can be small or large, visible through the window or more distant, and carefully managed or neglected.

Their research and that of others has shown that people generally do indeed prefer natural environments to other settings and that people experience benefits other than the mere fact of enjoyment. In particular, they have found that nature has the power to be restorative and calming, to allow people to recover from mental fatigue which results from our attempts to manage vast amounts of information. Symptoms of mental fatigue include difficulty in focusing, risk-taking activity, impatience and irritability. Nature allows people to become comfortable, civil and effective once again.

They note that it is not just the sensational or extraordinary landscapes that are important and deserve respect and protection. They recognise the importance of ordinary, close-at-hand landscapes. Whilst these landscapes may not be famous or spectacular, they are the places that nourish people on a daily basis.

## **11. CASE STUDIES INVOLVING THE RESTORATIVE POWER OF NATURE**

Some specific examples of the restorative power of nature include the following.

One of the best known studies into the restorative power of nature was described by Roger Ulrich (1984) who examined the restorative effect of natural views (trees) on surgical patients in a hospital. He found that patients recovering after abdominal surgery had different recovery experiences, depending on whether they were in a room with a window view of a natural setting or of a brick building wall. Those who looked out on a small stand of deciduous trees -

- \* had shorter post-operative hospital stays
- \* received fewer negative evaluative comments in nurses' notes
- \* took fewer potent analgesics

If window views of plants could shorten postoperative hospital stays by the 8.5% reported in Ulrich's study, the annual health cost savings in the USA would total several hundred million dollars (Ulrich, 1986).

Moore (1981) found that the use of health services by prisoners was significantly lower if the prisoners had views of nature (farmland) from their cells, rather than views of the prison interior.

Rachel Kaplan and Steven Kaplan carried out studies on nearby nature and the workplace (Kaplan *et al.*, 1988; Kaplan, 1993), in recognition of the fact that most daytime hours for many people are spent at work. They found that nearby nature, even when only viewed from the window, had a substantial beneficial effect in the work setting, affecting job satisfaction and well-being.

There are now many studies indicating that vegetation aids in the recovery from mental fatigue (see Kuo & Sullivan, 2001a, p.347), providing enhanced cognitive functioning as measured by both self-

report and performance on objective tests. Vegetation in these studies is represented by contact with nature in a variety of forms - community parks, window views and interior plants, as well as more natural areas.

Steven Kaplan (1995) proposed, in his Attention Restoration Theory, that contact with nature can renew the resource underlying our capacity to direct attention by providing elements that are effortlessly engaging or involve our involuntary attention. It is believed that this gives our directed attention (or voluntary attention) a chance to rest and helps overcome the mental fatigue associated with continued directed attention.

In residential settings, views of nature have been linked to (see Faber Taylor *et al.*, 2002) -

- \* residential satisfaction (Kaplan, 1985)
- \* enhanced well-being (Kaplan, 2001)
- \* more effective patterns of coping (Kuo, 2001)
- \* greater day-to-day effectiveness (Tennessen & Cimprich, 1995)

In a study of the well-being of children in poor urban environments, Wells (2000) found that the nearby natural environment plays a far more significant role than had previously been recognised. By examining the cognitive functioning (i.e. attentional capacities) of 17 children initially in poor housing and the same children after they moved to better housing with more natural resources, Wells found that children whose homes improved the most in terms of greenness following relocation also tended to have the highest levels of cognitive functioning following the move.

Urban forests and parks have been found to be areas that serve as refuges for privacy, away from home and work environments (Hammit, 2002). People visiting these areas for privacy stated that the most important benefit they obtained was the opportunity for "reflective thought". The most important reasons for visiting these urban forest and park areas were to be away from crowded places and daily routines of work and home, as well as to go to a place of peace and quiet.

## **12. SOCIAL AND PSYCHOLOGICAL BENEFITS OF THE URBAN FOREST – The research of Frances Kuo, William Sullivan and others**

At the University of Illinois Human-Environment Research Laboratory (HERL), Frances Kuo, William Sullivan and others are studying how residents of inner city areas 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 (Human-Environment Research Laboratory, 2002). Their research has built upon other work carried out by USDA Forest Service researchers, including social scientists (Dwyer *et al.*, 1991 & 1992), and Charles Lewis (Lewis, 1996).

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 revive the ability to concentrate on challenging tasks
- \* trees should be planted and maintained near homes, schools, work sites and other places where concentration and mental energy were needed most
- \* indoors, time should be spent in places where there is a green view from the window and desks at work and school should be arranged to provide a green view
- \* green spaces should be created, especially in inner city neighbourhoods

The research supporting these recommendations is summarised in the following six themes.



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

In a study of a Chicago public housing development, involving 98 apartment buildings over two years, it was found that apartment buildings surrounded by trees and greenery were dramatically safer than buildings without green. Higher levels of greenery reduced total crimes 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, since people feel more relaxed
- \* bringing people together outdoors, which increases surveillance
- \* indicating that a building is cared for by its residents, and that they watch over it and each other

Tall trees and open, grassy areas with low shrubs and flowers that preserve visibility are recommended as potential crime deterrents. It was recognised by the authors that criminals can use dense vegetation like shrubs to conceal their activities and that such vegetation that blocks views can sometimes evoke fear and fear of crimes (Talbot & Kaplan, 1984). However, not all greenery blocks views.

(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, involving 145 residents, 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 also higher in buildings devoid of nature, and aggression accompanied this mental fatigue.

It appears that exposure to trees and greenery reduces mental fatigue and associated feelings of irritability, thereby helping people to concentrate and become both more able and willing to deal with problems thoughtfully and less aggressively.

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

A study of 96 children in the 7-12 age group, formally diagnosed with ADD or ADHD, has found that the symptoms of children with Attention Deficit Disorder (ADD) are relieved after contact with nature and that the greener the setting, the greater is the relief (Faber Taylor *et al.*, 2001). By comparison, activities indoors such as watching TV, or outdoors in paved, non-green areas, leave ADD children functioning worse. Children with ADD have chronic difficulty paying attention and focusing on tasks. They are impulsive, prone to outbursts and sometimes aggressive. Often their behaviour results in family conflict, peer rejection and academic failure. The information also applies to ADHD which is a broader diagnostic term under which a child can be diagnosed as predominantly inattentive (attention deficit), or inattentive *and* hyperactive/impulsive; only inattention was examined in this study, not hyperactivity.

It is thought that children, like adults, become fatigued from concentration on schoolwork and structured activities; to refresh and renew their voluntary attention, the use of involuntary attention helps, such as by contact with nature.

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.

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

A study of 169 inner city children in a Chicago 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 recommended that girls should be encouraged to study or play in rooms with a view of nature, and also to play outdoors in green spaces and have recess in green schoolyards, which may be especially helpful for renewing children's concentration. It was also suggested that the practice of constructing treeless residential developments might have important unintended costs (Faber Taylor *et al.*, 2002).

(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 in Chicago, Illinois, it was found that the more trees and grass present, the more those spaces were used by residents (Sullivan *et al.*, 2004). This created 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.

It was suggested that the results from this study of a profoundly poor neighbourhood could be generalised to other neighbourhoods that are not poor - that strong social ties are important for a variety of reasons (e.g. building consensus on values and norms, monitoring neighbourhood activity and intervening if problem behaviours occur and defending their neighbourhoods against crime). It was also thought to be worth investigating in otherwise barren, new housing developments.

In another study using interviews with 145 (female) residents of 28 high-rise buildings of a large public housing development in Chicago, Illinois, it was found that the presence of trees and grass supported common space use and informal social contact among 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 (via attentional testing) and effectiveness in managing major life issues (via self-reporting in structured interviews) 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 made the comment - "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 comparable to that of major factors such as health and age."

### 13. OTHER URBAN GREEN

Although the focus of the TREENET Symposium is on urban trees and forests, it is important to consider other places for plants in urban ecosystems. Such plants can be found growing not in the natural ground or soil, but rather in creative adaptations with built infrastructure.

The importance of other urban green is that it may help overcome "plant blindness" in urban dwellers and cause them to reflect on the role of plants, including trees, in urban ecosystems.

Opportunities for other urban green are likely to be explored in the future in the following ways -

- \* roof gardens, which may or may not have human access - such gardens can offer multiple environmental benefits
- \* vertical gardens and wall gardens - these gardens offer the opportunity for green, when space is limited
- \* interior plantscapes - the use of a few or many indoor plants can improve indoor air quality by removing volatile organic compounds (VOCs) (Wood *et al.*, 2006); this, in turn, has implications for improved human health and productivity
- \* community gardens - these gardens can help establish links between people in a community as well as re-establishing links between people and nature
- \* hydroponics - food production using hydroponic systems is common at the fringes of urban areas, and may well increase within urban areas in the future

#### 14. CONCLUDING COMMENTS: MAXIMISING THE BENEFITS FROM URBAN FORESTS

The wide range of benefits associated with the urban forest makes it clear that urban trees belong in cities, alongside people, buildings, roads and other infrastructure. Whilst aesthetic and visual benefits are important, recent research has revealed a wealth of environmental, social, psychological and economic benefits associated with the urban forest.

The environmental and social benefits of the urban forest are highly relevant to the emerging area of research into urban ecology, which brings together the natural sciences (or biologically based ecology) and the social sciences (or social aspects of humans). Sustainable cities of the future will have, at their core, a healthy environment and a healthy community of urban dwellers. Urban ecology has emerged at a critical time in the process of global urbanisation.

The urban forest has a special role to play in urban ecology, since trees are the most conspicuous element of nature in cities. They are highly symbolic of green, healthy, liveable cities. Whilst they evoke strong responses, both positive and negative, from many people, there may be an increasing number of people who are "blind" to their existence and importance. Yet recent research has indicated that urban trees and other urban green may be essential to our social, psychological and spiritual well-being.

To maximise the benefits from urban trees, we need to market the importance of the urban forest more widely to decision-makers and the public, and in more creative ways, so that urban trees are seen as a normal part of the planning of city infrastructure and quality space is made available for them. Furthermore, resources are needed for their establishment and maintenance, as for any other infrastructure.

To guide the development of urban forestry and urban ecology in Australia, it is essential to undertake much more local research into these areas than has been the case to date.

#### REFERENCES

Australian Bureau of Statistics (2004) *Glossary of statistical geography terminology*.  
<http://www.abs.gov.au/> Website updated 19 March 2004. Website accessed 14 June 2005.

Bisco Werner, J.E., Raser, J., Chandler, T.J. & O'Gorman, M. (undated) *Trees mean business: a study of the economic impacts of trees and forests in the commercial districts of New York City and New Jersey*. Trees New York and Trees New Jersey.

Daily, G.C. (ed.) (1997) *Nature's services: societal dependence on natural ecosystems*. Island Press, Washington, DC, USA.

- Dwyer, J.F., McPherson, E.G., Schroeder, H.W. & Rowntree, R.A. (1992) Assessing the benefits and costs of the urban forest. *Journal of Arboriculture* 18(5): 227-234.
- Dwyer, J.F., Schroeder, H.W. & Gobster, P.H. (1991) The significance of urban trees and forests: toward a deeper understanding of values. *Journal of Arboriculture* 17(10): 276-284.
- Faber Taylor, A., Kuo, F.E. & Sullivan, W.C. (2001) Coping with ADD: the surprising connection to green play settings. *Environment and Behaviour* 33(1): 54-77.
- Faber Taylor, A., Kuo, F.E. & Sullivan, W.C. (2002) Views of nature and self-discipline: evidence from inner city children. *Journal of Environmental Psychology*, Special Issue: Environment and Children 22: 49-63.
- Grove, J.M. & Burch, W.R. Jr. (1997) A social ecology approach and applications of urban ecosystem and landscape analyses: A case study of Baltimore, Maryland. *Urban Ecosystems* 1: 259-275.
- Hammitt, W. (2002) Urban forests and parks as privacy refuges. *Journal of Arboriculture* 28(1): 19-26.
- Helms, J. (ed.) (1998) *Dictionary of forestry*. Society of American Foresters, Bethesda, USA.
- Human-Environment Research Laboratory (2002) *Human-Environment Research Laboratory, Natural Resources and Environmental Sciences, University of Illinois at Urbana Champaign*. [www.herl.uiuc.edu](http://www.herl.uiuc.edu). Date accessed: 17 February 2005.
- Kaplan, R. (1985) Nature at the doorstep: residential satisfaction and the nearby environment. *Journal of Architectural and Planning Research* 2: 115-127.
- Kaplan, R. (1993) Urban forestry and the workplace. In: Gobster, P.H. (ed.) (1993) *Managing urban and high-use recreation settings*. Gen. Tech. Rep. NC-163. US Department of Agriculture, Forest Service, North Central Forest Experiment Station, St Paul, MN, USA. Pp. 41-45.
- Kaplan, R. (2001) The nature of the view from home: psychological benefits. *Environment & Behaviour* 33: 507-542.
- Kaplan, S. (1995) The restorative benefits of nature: Towards an integrative framework. *Journal of Environmental Psychology* 15: 169-182.
- Kaplan, R., Kaplan, S. & Ryan, R.L. (1998) *With people in mind: design and management of everyday nature*. Island Press, Washington, DC, USA.
- Kaplan, S., Talbot, J.F. & Kaplan, R. (1988) *Coping with daily hassles: The impact of nearby nature on the work environment*. Project Report, Cooperative Agreement 23-85-08. US Forest Service, North Central Forest Experiment Station, Chicago, IL, USA.
- Konijnendijk, C.C. & Randrup, T.B. (2002) Editorial. *Urban Forestry & Urban Greening* 1 (2002): 1-4.
- Kuo, F.E. (2001) Coping with poverty: Impacts of environment and attention in the inner city. *Environment and Behaviour* 33(1): 5-34.
- Kuo, F.E. & Sullivan, W.C. (2001a) Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behaviour* 33(3): 343-367.
- Kuo, F.E. & Sullivan, W.C. (2001b) Aggression and violence in the inner city: Effects of environment via mental fatigue. *Environment and Behaviour* 33(4): 543-571.

Kuo, F.E., Sullivan, W.C., Coley, R.L. & Brunson, L. (1998) Fertile ground for community: Inner-city neighbourhood common spaces. *American Journal of Community Psychology* 26(6): 823-851.

Lewis, C.A. (1996) *Green nature / human nature: the meaning of plants in our lives*. University of Illinois Press, Urbana, IL, USA.

Lord, C.P., Strauss, E. & Toffler, A. (2003) Natural cities: urban ecology and the restoration of urban ecosystems. *Virginia Environmental Law Journal* 21: 317-350.

McDonnell, M.J. (1997) A paradigm shift. *Urban Ecosystems* 1: 85-86.

McIntyre, N.E., Knowles-Yanez, K. & Hope, D. (2000) Urban ecology as an interdisciplinary field: differences in the use of "urban" between the social and natural sciences. *Urban Ecosystems* 4: 5-24.

McPherson, E.G. (1998) Structure and sustainability of Sacramento's urban forest. *Journal of Arboriculture* 24(4): 174-190.

McPherson, E.G., Nowak, D.J. & Rowntree, R.A. (eds) (1994) *Chicago's urban forest ecosystem: results of the Chicago Urban Forest Climate Project*. Gen. Tech. Rep. NE-186. US Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Radnor, PA, USA. 201 pp.

McPherson, E.G. & Simpson, J.R. (2002) A comparison of municipal forest benefits and costs in Modesto and Santa Monica, California, USA. *Urban Forestry & Urban Greening* 1: 61-74.

McPherson, E.G. & Simpson, J.R. (2003) Potential energy savings in buildings by an urban tree planting program in California. *Urban Forestry & Urban Greening* 2: 73-86.

Miller, R.W. (1997) *Urban forestry: planning and managing urban greenspaces*. 2nd edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Moore, E.O. (1981) A prison environment's effect on health care service demands. *Journal of Environmental Systems* 11: 17-34.

Moss Warner, K. (2004) Showcasing and treasuring horticulture in public spaces. *Acta Horticulturae* 642: 101-107. (Proceedings of the XXVI International Horticultural Congress, Horticulture: art and science for life, Toronto, Canada, 11-17 August, 2002.)

Niemela, J. (1999) Is there a need for a theory of urban ecology? *Urban Ecosystems* 3: 57-65.

Parris, T.M. (2004) Urban ecology. *Environment* 46(5): 3.

Pickett, S.T.A., Burch, W.R. Jr., Dalton, S.E., Foresman, T.W., Grove, J.M. & Rowntree, R. (1997) A conceptual framework for the study of human ecosystems in urban areas. *Urban Ecosystems* 1: 185-199.

Platt, R.H. (2004) Toward ecological cities: adapting to the 21st century metropolis. *Environment* 46(5): 11-27.

Sullivan, W.C., Kuo, F.E. & DePooter, S.F. (2004) The fruit of urban nature: vital neighbourhood spaces. *Environment and Behaviour* 36(5): 678-700.

Talbot, J.F. & Kaplan, R. (1984) Needs and fears: the response to trees and nature in the inner city. *Journal of Arboriculture* 10(8): 222-228.

Tennessen, C.M. & Cimprich, B. (1995) View to nature: Effects on attention. *Journal of Environmental Psychology* 15: 77-85.

The US Long Term Ecological Network (2004) *LTER Network*. <http://lternet.edu> Website updated 2004. Website accessed 14 June 2005.

Ulrich, R.S. (1984) View through a window may influence recovery from surgery. *Science* 224: 420-421.

Ulrich, R.S. (1986) Human responses to vegetation and landscapes. *Landscape and Urban Planning* 13: 29-44.

Vitousek, P.M., Mooney, H.A., Lubchenco, J. & Melillo, J.M. (1997) Human domination of Earth's ecosystems. *Science* 277: 494-499.

Walbridge, M. (1997) Urban ecosystems. *Urban Ecosystems* 1: 1-2.

Walbridge, M. (1998) Growing interest in urban ecosystems. *Urban Ecosystems* 2: 3.

Wells, N.M. (2000) At home with nature: effects of "greenness" on children's cognitive functioning. *Environment and Behaviour* 32(6): 775-795.

Wood, R.A., Burchett, M.D., Alquezar, R., Orwell, R.L., Tarran, J. & Torpy, F. (2006) The potted-plant microcosm substantially reduces indoor air VOC pollution: I. Office field-study. *Water, Air and Soil Pollution* 175: 163-180.

