

# **THE 2003 BANKS MEMORIAL LECTURE**

## **Cities are cultural and ecological keys to biodiversity futures**

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### **A reality check**

Biodiversity is declining throughout the world at an alarming rate. But the loss of natural and semi-natural habitat in New Zealand lowlands undermines not only our 'clean green' pretensions, but the very fabric of our natural landscape, even our nationhood. Native plants and wildlife may continue to survive in remote mountain parks. However, the overwhelming impression of the New Zealand urban environment to its residents and visitors alike is that of an imitation Europe, North America, Asia, Australia and Africa, that is, almost any part of the world other than our own. Perhaps the final irony is that since the enactment of the widely lauded Resource Management Act (1991) the rate of loss of lowland natural habitat appears to have accelerated. This cannot have been the intention of the architects of this visionary legislation. Case law, dominated by the views of financially and legally powerful development lobbies, has subverted the spirit and intent of the Act (Memon and Selsky, in press). Biodiversity has been more conspicuous in the fine words of legislation, local government plans, and policies than in the hands-on practice.

Nevertheless, there are positive signs and apparent paradoxes. For example, waterfowl are increasing in Christchurch because of a decade's construction of open water bodies (retention ponds and reversals of estuary poldering and filling) and planting or managing for denser riparian vegetation (Andrew Crossland, pers. comm.). Bellbirds

and kereru also seem to be more widespread in this city. This might be because of greater interest in observing and recording them, but primarily because the expansion and maturing of the city has meant an increase in extent and stature of woodland. This supports a wide range of fruit, nectar and nesting resources, even though 70% of the species are exotic and many are weedy. We have to be aware, however, that infilling of the leafier suburbs may reverse this trend unless there is compensatory development of public open space. Human presence may have another indirect benefit for native wildlife, by disturbing introduced predators such as mustelids, rats and possums, while domestic cats and dogs prey on some of these pests (and unfortunately, some of the native birdlife).

Overall, primary land-based vegetation continues to decline along with its co-adapted invertebrates, reptiles and birds. To overcome the twin crises of biodiversity decline and weakening national and regional identities, all avenues for recovery must be explored. The role of people, as part of the solution as well as initially being part of the problem, has to be emphasised. To this end, cities and individual citizen decisions and behaviours will be vital to the success of the solutions.

Thus, cities can be forces for 'good' or 'evil' as far as nature and biodiversity are concerned. I shall review the state and causes of this, the history of urban ecology, the international contrasts and similarities, the controlling ecological and social factors, and the opportunities for

recovery at the property, neighbourhood, and wider landscape or catchment scale.

### **Cities are people centres**

Urban-dwellers make up 48% of the world population, and this proportion is growing steadily (McDonnell, 2004). In the OECD countries the figure is 77% and in New Zealand it is 86%. This represents large captive labour, and economic and political forces that more often than not cause major physical and biological impacts on the environment. People propagate weeds and pets! It seems clear, therefore, that citizen attitudes and behaviours will have a major bearing on the future of the planet.

Despite the massive urban footprint, new work on environmental remedies, such as low impact urban design and development (a Landcare Research public good science programme; Eason *et al.*, 2003a, b), have the potential to improve the physical and biological environment and raise citizens' quality of life.

However, the balance of impacts and remedies will depend on a commitment to knowledge-based application of Triple Bottom Line principles at the highest decision-making levels, in the socio-political context, and considering population trends, wealth distribution, and ultimately the individual will. The rise of self-centred materialism, alienation, intolerance and anarchic or vandalistic attitudes in urban areas

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An industrial park in Duisburg, Germany, with 'riverbed' successions on the railway line and deciduous woodland in the 'ravines' among the buildings

is having alarming effects on social and ecological integrity. A fortress mentality ensues, with the wealthy able to retreat into gated communities. These trends are all influencing city patterns and dynamics. The causes and solutions to these problems of the human condition are complex and only weakly understood, let alone acted upon. There is as yet no consensus on how to overcome these destructive tendencies. But perhaps a more humane civilisation depends on rediscovering the social contract and a human relationship with nature!

## Cities are biodiversity centres, full of life

There are about as many wild native plants in New Zealand cities (350-550 species or 14-22% of the flora) as in National Parks (440-660 spp.

or 17-26%). Bird numbers are also high and increasing in Christchurch (Andrew Crossland, pers. comm.). There are 12 spp. of terrestrial/bush birds (35% of extant New Zealand birds in this category), 29 spp. (45%) of wetland birds, 12 spp. (50%) of coastal birds, and 20 spp. (67%) of exotic birds. And then there are the countless invertebrates and microbes. Yet Christchurch is often seen as the most modified of all the New Zealand cities, as a result of its flat terrain, so easily developed.

The main reason that cities are surprisingly so biologically rich is that they are often situated at ecosystem junctions, for example between hills, dry and wet plains, rivers and coasts. Species of coastal or lowland cities are not generally protected in national parks and reserves. Furthermore, these species may be naturally absent from these protected areas. There is thus a responsibility to protect urban biodiversity because of its intrinsic importance, the

resource capabilities of the cities, and as a model or catalyst for biodiversity awareness and protection in the wider nation.

## Worldwide experience

New Zealand has lagged behind in urban studies and recognition of biodiversity values and critical opportunities in cities. England, Germany and the Netherlands are centres of knowledge, experience and practice in urban ecology. Professionals and amateurs have been collecting natural history information for at least a couple of centuries and quite detailed distribution maps of most groups of plants and animals have been produced. Despite the high density of people and large numbers of introduced species in cities, and the cultural landscape at large, indigenous nature is prevalent even



A greenway of marshes and swampy woodland along a canal in urban Rotterdam, The Netherlands

in the largest of these European cities. This is probably because of the hard winter climate that suppresses rampant growth, the largely continental (robust) origins of the indigenous flora and its long history of adaptation to human disturbance. Both London and Berlin are regarded as green cities. The old polluted industrial town of Duisburg has been converted into an industrial park using the old buildings for social and musical events or 'rock' climbing. Natural vegetation succession is being allowed to occur in old cooling ponds (artificial wetlands), on railway tracks (surrogate riverbeds), and along edges of buildings (simulating riparian forest). The Netherlands originated the notion of ecological parks, which are prevalent in several large cities, such as Rotterdam. In contrast, some New Zealanders are fixated on the danger of densely vegetated parks, despite most human assaults occurring in homes and in open places, such as car parks, bus stops and open parks. Knee-jerk vegetation

clearances are inevitably detrimental to nature in the city.

As mentioned above, many European cities have been mapped in great detail in terms of buildings, services and vegetation (biotopes) to allow for equally detailed planning and management. Similar initiatives have been undertaken in South Africa and in some of the wealthier Asian countries, such as Singapore. In poorer lands with burgeoning populations, biodiversity inevitably has to be integrated with the production of basic foods and fibre. Hence, Sarel Cillier's concept of low-tech 'eco-circles' in South Africa. These are ca. 1m diameter, hollow, recycled, porous rubber rings supplied by gravity-fed water from raised water barrels. The rings are placed on the ground and the internal space is cultivated and planted in vegetables and herbs. The intervening ground is intended to retain native grassland, but is often cultivated regardless because it is the African tradition to keep ground

around houses clear of vegetation to deter dangerous pests. So, that idea will have to be rethought!

Ecologists in the United States have brought modern developments in science to bear on the ecology of urban environments. For example, impacts of urbanisation on forest have been evaluated by sampling trees and soil/litter processes along an urban-rural gradient in New York State (McDonnell and Pickett, 1990). Baltimore is the subject of a long-term urban monitoring project, and this longitudinal investigation encompasses social as well as biophysical dimensions. The gradient studies show that urban aerial pollutants interfere with the nitrogen economy, fertility and decompositional processes of forests, and, in turn, affect species composition of microbes and plants.

One of the architects of these gradient studies, Mark McDonnell, brought this approach to the Australian Research Centre for Urban Ecology

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# ***Manifesto for a heritage garden city in Christchurch, and broader implications***

We now have a good handle on the scope of biodiversity problems and how urban environments can play an important role in recovery. There are some specific lessons from Christchurch, where the council is about to launch its Biodiversity Strategy for the city, and some of these lessons can be generalised to urban environments elsewhere. The fundamental need is an action plan with timelines that reflect both urgency and practicality. Some key elements of such a plan are outlined below.

## **The first proposition: protection is the first priority**

With so little left, protection of remnant primary habitats is crucial. These are vegetation-soil systems that have a continuous, maybe tenuous, history back to the pristine ecosystems. I have already made the point that cities retain important natural remnant environments. Although we know a lot about restoration, we still cannot restore the unique complex relationships between mature soils, microbes, vegetation and the food webs of invertebrates and higher animals. The true replacement cost, of just the juvenile, structural elements of a forest, is conservatively estimated as \$100,000 per ha. These primary habitats are sources of biological material and benchmarks for other restoration projects on completely denuded or weed-infested land. So protection must come first, followed by mending, restoring and extending degraded habitat.

## **The second proposition: habitat restoration fills the local gaps**

Habitats needing special attention are riparian, coastal, dryland, and lowland woodland and forest. Planting up the residential matrix with indigenous species is something that everyone can do. No matter how small the property, its planting can still make an important contribution to biodiversity sustainability in the landscape. A single bush is a habitat, and I have seen tiny (~5m<sup>2</sup>) backyards in Milton Keynes, UK, with several habitats: vines on fences for bird nesting, lax lawn with wildflowers and butterflies, a pond for snails, crustacea and amphibians, rocks for reptiles, and a bird table.

At the site level, it is all about what is the right plant in the right soil, the right compositional mixtures and times to plant. The New Zealand Ecological Restoration Network (NZERN) has a website with an interactive key to choose plants for each project or garden, based on the soil type within the relevant ecological region

[[www.bush.org.nz/planterguide](http://www.bush.org.nz/planterguide)]. For microenvironments within broad soil mapping units, the tool includes a soil key, Canterbury and Waikato restoration guides for wetlands, streamsides and gullies, and species lists for biodiverse lawns and rock gardens.

In the public domain of streets and parks, territorial authorities need to increase the proportion of indigenous noble trees to >10%. These include the iconic podocarps, elaeocarps and kowhai. And they need to recognise the formation of recombinant plant communities, new associations of indigenous and 'safe' or 'useful' exotics, e.g. non-invasive nectar-bearers. Native sedges, rushes and New Zealand flax are also being used for swale filters along suburban roads, and rain gardens are being promoted to cleanse rain runoff from buildings.

Home gardeners are making a difference with increasing numbers adopting a nature heritage garden genre, incorporating and celebrating indigenous plants (Gabites and Lucas, 1998). The various styles within this genre are bush (representation of rainforest with tree ferns), parkland (scattered large trees), hedges, ferneries, streams and ponds (although often a source of wetland weeds), herbaceous borders, rock gardens, and biodiverse lawns. There is great scope, diversity and character amongst the native flora for all gardening tastes, both formal and 'wild', and all can play their part in the functional and visual relationship between remnant semi-natural habitat patches and the urban matrix. A watch-out needs to be kept for the male fern and other native look-alikes. Even the native section of plant nurseries may have phebalium, choisya, and various introduced grasses, lilies and ferns.

There are also many substrates in urban environments that may look inhospitable, and are frequently drenched in herbicide. But these built or artificial surfaces have counterparts in nature with shallow soil or frequent



A tiny backyard in Milton Keynes, southern England, full of habitats

disturbance. Stone or brick walls can be surrogates of rock ledges, cracks and gorges; footpaths act as 'riverbeds'; polluted or eutrophied open sites may have similarities to exposed coasts; biodiverse lawns are like grazed meadows; and rock gardens represent shallow or stony soils.



A lawn with native plants or close relatives: *Oxalis exilis* in flower, *Dichondra* sp. (kidney leaf) and *Cotula australis*, with the lichen *Pseudoparmelia pseudosorediosa* on the footpath

### The third proposition: facilitating landscape dynamics restores landscape function

Habitats and species populations may be enhanced, but their long-term viability will depend on linkages through the wider landscape. Empirical data shows us how forest plants are dispersed and establish. Receptive surfaces and overhead cover are needed for successful seedling establishment, and grass is a killer for native tree seedling establishment. Most tree seed is carried by birds or falls within 200m of a source, but there is a long tail of rare dispersal out to and beyond 2.5km. Predictive models that combine the dispersal and forest succession functions show how trees can gradually spread through a landscape (Meurk and Hall, 2000).

Using this dispersal-succession model, together with knowledge of forest reserve design, we have a basis for configuring urban or cultural landscapes that support optimal arrangements of forest patches. This provides for a critical mass of habitat and species populations, genetic exchange, saturation of all potential regeneration sites with native propagules and seedbanks, and wildlife continuity through stepping-stones and corridors. This formula applies to both rural and urban landscapes.

The ideal urban world, suffused with natural character and landscape integrity, would retain or develop sanctuaries (core forest habitats >5ha) no more than 5km apart (<1% of total area), 1-2ha habitat patches no more than 2km apart (<2%), groves of 'noble trees' less than 200m apart (2%), a matrix of urban garden and street trees (35% of trees; 10% of area), and linkages or corridors along rivers (400km in Christchurch), streets (2,000km in Canterbury towns), hedgerows (300,000km of shelter plantings in Canterbury) and railway lines

(about 1% of area). Whereas a medium-term target of 10% of major trees is proposed, an ultimate target of 40% density of indigenous trees and shrubs, covering 20% of the urban area, is not unrealistic.

Wetlands operate on a different scale. We know that aquatic and wetland plants are dispersed many tens of kilometres by birds. Both native species such as the mudwort (*Limosella lineata*) and naturalised aquatic weeds, like curly pondweed, have arrived at most of Christchurch's constructed ponds within 2 or 3 years of excavation. We also know that viable wetlands can be restored or created by buffering them from surrounding drainage, by discouraging cats with protective moats and island complexes for the sake of waterfowl, and by trapping rats, mustellids and other predators. To support a mosaic of different habitats along moisture and fertility gradients, wetlands should be >100ha, but can be further than 10km apart, although connected through a fine network of waterways and ponds. This, then, is the basis for a sustainable wetland patch configuration in the cultural landscape.

### The fourth proposition: cultural depth

Our land has layers of history, many of which have been obscured by development, exploitation and modification of the environment. These layers may be recognised as a window on *The Fires of Tamatea* by natural landforms, geological features, soil profiles and trees, or bracken fern along the railway ballast. Legibility is a landscape architecture term to do with reading stories in the land. In New Zealand, one might recognise signatures of Gondwanic, Tertiary (geological period of subtropical warmth and low topographic relief), Glacial-Post Glacial, Polynesian, Colonial-Industrial, Techno-Modern, Multicultural-Post Modern, and emerging Pluralistic-Holistic layers of history.

We have to stop homogenising the land by levelling hills, dips and sand dunes just because we have the bulldozers to do it! The way we treat the land is a metaphor for how we treat each other. Rather, we should preserve and join these nature stories and ecological linkages into a city narrative that boldly says where we are from, where we are going, and that there is a good chance that the journey will be enjoyable, interesting, informative and sustainable.

To acknowledge and progress through all of the above eight historical layers or stages, the ecological and cultural sustainability of nature in cities has to come together. Ecologically viable configurations of nature create visual cues. Nature then becomes culturally viable, hence the importance of conspicuous indigenous nature (Meurk and Swaffield, 2000). 'Doing' nature is important! Seeing and experiencing life processes, and being involved with planting and nurturing in community restoration projects acts as a source of social, even spiritual restoration.

in Melbourne. The initial focus has been on collecting and collating environmental data from this city (and beyond). Research students have been investigating the impacts of fragmentation on natural grasslands in the greater Melbourne region and documenting the decline of native mammals and birds in the region.

They have also experimented with high frequency sound to scare flying foxes away to prevent them from building up in artificially large numbers in local parks. The point here is that cities, far from being barren wastelands, are in fact filled with diverse life, some of it indigenous, some of it regionally rare, but all of it living in places that resemble wild habitats. Some of this biodiversity is useful to people. There are natural processes operating, and all of these elements are legitimate objects of study for the lay person and the professional who is trying to provide ecological knowledge for urban planners and managers.

## Influences on nature in cities

As Mark McDonnell has pointed out, the ecological processes and principles operating in cities are no different to those in natural ecosystems. In this sense urban ecology is not a fundamentally new branch of science. The usual physical factors operate, including stress and especially high levels of disturbance. Fragmentation and degradation of habitats are also a common consequence of urbanisation. The one factor that does set the urban landscape apart from the wild is the specifically human causes of the stresses, disturbances and alien competition. While this mimics or exaggerates natural processes, it also adds a social dimension that must be considered in any management of urban nature. In the urban context, sustainability has not only an ecological meaning but a cultural one as well, in which experience, values, aesthetics,

economics, and destructive behaviour all have a determining influence on the survival, protection and restoration of nature.

## Weeds galore

Because cities are magnets for international travellers, and disembarkation points for returning soldiers; and because gardening (with walking) is the number one recreation in New Zealand, and fascination with exotica goes with the territory, cities here support huge numbers of introduced plants and animals. Garden weeds get dumped on country roadsides or on edges of reserves, or they get passed on to other gardening enthusiasts, or are dug out, divided and sold at the school fête. Wandering willy (*Tradescantia*) and male fern (*Dryopteris filix-mas*) are two weedy species whose main mode of dispersal in New Zealand is the fête or garage sale. In other (continental) countries such intruders generally merge into the background amongst a strong indigenous biota.

In New Zealand, exotic species greatly outnumber the indigenous. Our indigenous vascular plant flora numbers about 2,500 species. There is a similar number of naturalised species, but more are being added each year from a pool of in excess of 20,000 exotic plants in the country (Williams and West, 2000; Bill Sykes, pers. comm.). And every time an exotic plant fails (rarely), such as willows being attacked by a sawfly, the reaction is not that we should rejoice at a fortuitous control of one of our many biosecurity risks, but rather that we should import an even more virulent strain of willow! Such attitudes ensure that our country will continue to be overrun by the pick of the world's weed crop, because much of the global flora will grow exceptionally well here in our relatively benign climate. It goes without saying that one of the key actions needed in cities is a serious review of all exotic species to identify, contain and remove major sources of invasive

weeds. We have to change from a reactive 'blitzkrieg' to a 'stitch in time' preventative approach.

## The biodiversity crisis in perspective

While I have outlined many biodiversity problems in the wider cultural landscape and cities, there are also many opportunities and resources for recovery. We must overcome habitat loss and fragmentation, and pressure from pests. Lowland environments in particular are at great risk: dunes, coastal forest, woodlands, grasslands, wetlands and riverbeds. Many, especially herbaceous, species from these habitats are facing regional extinction. This is because of intensification of agriculture on the one hand and the smothering growth of tall, dense grasses in uncontrolled environments or wastelands, on the other.

As we have seen, urban areas are, paradoxically, not always as depleted as the rural hinterland. This is because of peripheral catchments or recharge zones for aquifers being protected for water supplies, and because some wild pests are under better control close to population centres where there are abundant labour and financial resources. There is also much waste ground inadvertently protected in golf courses, cemeteries and airports, and hilly cities always have gullies that are protected from development.

## Cities: a sense of place, or of alienation

The soul and identity of cities stems from authenticity and an organic connection with their history. There are dangers, for cities such as Christchurch, of becoming locked in a colonial time warp or, worse still,

irrelevant in a nation of more grounded, maturing cities. The definition and destiny of the city can appear to be a contrivance of the tourist industry.

It is symbolic of a subconscious racism that some people "like their natives, as long as they are in an appropriate place". Do they mean in their proper place, visually subjugated as controlled shrubberies, obscured by dominating exotic street and park trees, the gums, poplars and oaks? The natives are also tolerable if relegated to the outskirts and do not interfere with the central city mainstream. The kinds of trees that form sentinels at the city portals and line the avenues, drawing residents and visitors into the heart of the city, are critical to the way we define ourselves and the image we project. The imagery of English or New Zealand noble trees is a very powerful statement. We should be striving, in fact, to portray all eight elements of our heritage at these defining loci by preserving landforms, landscaping with ecologically appropriate trees

(regardless of whether they are indigenous or exotic), and using sculpture or other forms of interpretation.

If cities are to be relevant, honest, legible, sustainable and grounded, and if people are to have a sense of place, there are a number of things that we must change. Our culture now evolves consciously rather than spontaneously as in past history. Therefore, if we want a particular cultural mix we have to promote it, otherwise someone else will fill the vacuum with a different world view. Perhaps tinkering with nature and the landscape may seem trivial, but I would argue that there is a connection between people and nature. If this thread is broken, then the pact with nature is lost. The social contract becomes untenable because the relationship is dependent on observation, knowledge, awareness of the miracle of life, compassion and respect between creatures and people. We need vitality. We need to celebrate our diversity and multiple

dimensions, and be sensitive to the intrinsic values of nature and the layers of our culture through legible landscapes that are part of a holistic sustainable city. This is not a proposal to eliminate alien species. Even if it were possible, it would not be desirable. Little mention is made here of the multitude of exotic plants and animals other than the many that pose biosecurity risks. This is not because of dislike of foreign biota (which I depend on and appreciate as much as anyone in this land), but because of a need to promote a new balance. There are plenty of agencies, businesses and media promoting the use and spread of exotic plants. I do not need to do that. I am merely trying to turn the tide a little towards a future in which New Zealanders, who will be overwhelmingly urban, recognise that they live in New Zealand-Aotearoa and will be able to tell their visitors about it with some authority and passion.

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Picture of Mike Peters (New Zealand Ecological Restoration Network, PO Box 9000, Christchurch) of his "front lawn", which is used by the local school for nature study. It has nursery spiders, which show up on misty mornings, two fern species, bidibid, windgrass, divaricating shrubs, wild Spaniard and bush flax amongst the silver tussock (*Poa cita*). There are multiple layers, with a dense layer of bidibid and ferns under the tussocks, then a thick sponge of mulch, full of life. "Apart from a bit of weeding at the beginning, it has been left alone".