Improving functional connectivity in Wellington City’s urban ecological network

“New models of urban ecological networks should respect, conserve and enhance natural processes. They will improve biodiversity, aesthetics, and cultural identity and be an important framework for creating sustainable cities” (Ignatieva et al., 2011).

Introduction

The proposed Green Network Plan “identifies the key connections, projects and methods of implementation to achieve a legible green network that delivers outcomes for people and the environment.” The proposal will have four main branches: biodiversity, amenity, movement and resilience. The scope of this report covers the issues and opportunities relating to biodiversity in Wellington City.

The biggest challenge urban wildlife faces is habitat fragmentation. Through its development Wellington City transformed from a settlement amid forests of rimu, tawa and kamahi to become a bustling city with pockets of trees. The once continuous habitat is now in fragments, which are much decreased in size, proximity and diversity. The green network plan aims to address this fragmentation. New skills are needed to connect the fragments of green space, using methods which include tree lined streets, parks, gardens, community gardens, cemeteries, and green roofs to produce a functioning system; in other words achieve functional connectivity. Many of these elements of a green network already exist, however, the value of such a system lies in its being networked (CABE, 2009). Creating this network will require a comprehensive plan that contains site specific recommendations on locations, dimensions, ingredients and intended functions of green spaces (Jim, 2004).

As well as connectivity, important aspects of a green network are the quantity, quality and distribution of patches of green spaces (Van Herzele and Weideman, 2003). Quantity concerns the total area of green space. The relationship between amount of green space and population dynamics is commonly analysed through a green space ratio expressed as green space area per capita. Some countries have recommendations for the provision of green space, such as Britain where it is advised that there be a minimum of one hectare per thousand people (see appendix A for more examples). The quality of green space will depend on the needs and desires of its human and non-human users. The social quality will depend on what is locally valued (Balram and Dragicevic, 2005). The ecological quality of green space is measured on its ability to provide food roosting sites and shelter for native species and carry out ecosystem processes. The distribution of green spaces is essential to the accessibility of the network for people and non-human users. How humans, non-humans and plants move through an environment will depend on the distribution and connectivity of green spaces. The more proximate and connected the green spaces are, the more permeable the urban landscape will be. Again, sometimes standards are set on the maximum distance to the closest green space from places of residence.
Definitions and study site

Scale and area of implementation

Ideally a green network should be trans-regional and unbounded, as natural systems do not obey territorial borders. However, WCC must define a strategic scale and area within which they can implement this network. Scale affects many aspects of the functioning of the green network. For example, the Wellington region has a high green space ratio of 207 m² per person, yet the distribution of this land is such that the ratio will change depending on the study scale chosen. At the scale of the inner city, this ratio would not be maintained. The study area for the green network should focus on the central city, which includes the CBD, inner residential and commercial areas where green space ratio is lowest.

The significance of the green network at the scale of the Wellington CBD is quite different to a network at regional scale. For example the Greater Wellington Regional Council is looking at an ecological network for the Wellington region which will be important for survival of metapopulations, species distribution and migration and large scale dynamic processes. The importance of the inner city biodiversity network may be lost at this regional scale. However, as much of the Wellington population lives in the city, the network becomes integral for the connection of urban residents to nature, and to ensure that the urban environment is liveable and more sustainable. Sawyer (2005) lists three aspects of urban landscapes that make them important for biodiversity. First, there are intrinsic biological values. Secondly, these landscapes influence our understanding and appreciation of nature and our local biodiversity. Thirdly, there are the many resources available for biodiversity management (Sawyer, 2005).

Green Network

Green networks go by many names: ecological networks, green infrastructure systems, green structures, and open space networks. The direction that the plan will take will in part be influenced by the name that it is given. If the plan is solely aimed at greening Wellington City, i.e. including more vegetation, then the name “green network” is appropriate. City greening is one feature of a more sustainable city yet alone it is not enough (Jim, 2004). The biodiversity facet of the green network plan may more appropriately be called an Urban Ecological Network. This will be more attuned to the special conditions of an urban ecosystem. Actions can then be based on the knowledge gained from the growing field of urban ecology which investigates the social and environmental factors of urban settings.

It is then important to define exactly what is meant by an urban ecological network and green network. This definition will inform the function and design of the system. It will determine what principles are adopted and what models are used. At the most basic level, the green network will be a “spatial planning tool for the purpose of balancing and integrating land uses” (Bennett, 2004). This is also a description of the Estonian Green Network, which was developed over 30 years ago (Ibid) . A description of an urban ecological network might be built on that given by Ignatieva et al. (2001); “urban ecological networks, from urban planning and design angles, establish physical, visual and ecological connectivity between built-up areas of the city and surrounding natural areas and green space.”
Aspects of the Model

Green networks are constructed out of two types of green space, corridors and patches, which are embedded in a matrix of other land uses, as demonstrated in figure 1 (Forman and Godron, 1986).

The matrix “is a component of the landscape, altered from its original state by human land use, which may vary in cover from human-dominated to semi-natural and in which corridors and habitat patches are embedded” (Centre for Large Landscape Conservation, 2010). Matrix lands have the potential to function as habitat as well as the capacity to act as barriers to movement. Whether the matrix acquires a facilitating or impeding role will depend on its composition and the behaviours of the species under consideration. For example, a residential matrix may provide habitat for tui, whilst being too exposed for kakariki.

A patch is an area surrounded by matrix, and may be connected to other patches by corridors. From an ecological perspective, patches represent relatively discrete areas of relatively homogeneous environmental conditions. The patch boundaries are distinguished by changes in environmental character that are relevant to the organism under consideration (Wiens, 1976). In this report a patch will be synonymous with an area of green space.

Corridors are elongated patches that connect other patches together. Forman and Godron (1986) define corridors as “narrow strips of land which differ from the matrix on either side. Corridors may be isolated strips, but are usually attached to a patch of somewhat similar vegetation.”

Functional connectivity is the ability of the landscape to support “flow of individuals and their genes among habitats and populations” (Beier and Noss, 1998).

Figure 1: A hypothetical diagram displaying the network model including patches and corridors embedded in a matrix.
### Setting goals

Goals must be set so progress can be assessed, and so that the design method is driven by specific values. The goals of the green network that pertain to the biodiversity/ecology component will be influenced by two higher level council documents: the Central City Framework and the Open Spaces and Recreation Framework (Table 1).

<table>
<thead>
<tr>
<th>Central City Framework</th>
<th>Green Network</th>
<th>Open Spaces and Recreation Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make our streets green</td>
<td>- Establish functional connectivity of energy flows, people, wildlife and water.</td>
<td>Nature thrives in and around Wellington and show-cases our Ecocity</td>
</tr>
<tr>
<td>- new and upgraded inner city parks</td>
<td>- Create a stronger sense of place recognising the multiple identities of Wellington City.</td>
<td>- Our open spaces support nature and provide places for us to experience nature</td>
</tr>
<tr>
<td>- Some major routes will become tree-lined boulevards.</td>
<td>- Foster a relationship between people and nature.</td>
<td>- Wellington has a connected and integrated ecological network (aquatic and terrestrial)</td>
</tr>
<tr>
<td>- development of urban wetlands</td>
<td>- Increase habitat for wildlife, especially in the form of large, native, food providing trees</td>
<td>- Threats are managed</td>
</tr>
<tr>
<td>- the development of ‘stream streets’</td>
<td>- Promote Wellington as a liveable and more sustainable city</td>
<td>- Our open spaces and natural areas are seen as a key part of the city’s liveability and attractiveness</td>
</tr>
</tbody>
</table>

Create an eco inner city
- -sustainable transport choices,
- buildings will also reflect an eco-city ethos
- innovations such as solar energy, rainwater harvesting and green walls and roofs will be supported

Create a street tree plan
- - End functional connectivity of energy flows, people, wildlife and water. |

Table 1: shows green network bracketed by the two influential higher level plans.

The corporation of North Vancouver are implementing a Green Network plan (The Corporation of the City of North Vancouver, 2003). In their plan they outline objectives which Wellington City Council could use these for direction and influence. Listed below is a selection of these objectives that are at an appropriate level for the WCC plan.

- To create a comprehensive trails and recreational greenway system that links major parks and public destinations throughout the City.
  - Undertake a “greenway street” demonstration project, to show how traffic calming, bicycle and pedestrian enhancements, and possibly a green buffer and wider sidewalks may be incorporated into a street reconstruction or retrofit;
  - Incorporate greenway street locations and design objectives into the City’s transportation traffic calming and street improvement programs, so that street improvements incorporate the greenway street concepts;

- To conserve, protect and improve wildlife habitat values in City Parks.
  - Trail alignments that are causing extensive damage may be closed;
  - Consideration will be given to designated, low impact sites for dog off-leash use and for mountain bike challenge riding;
Habitat restoration efforts will continue;

The City will initiate management of invasive non-native species;

Naturescape approaches that emphasize plantings that support a diversity of bird and other wildlife use will be continued;

No-mow zones may be considered to create meadows, wetlands and marshes that support increased habitat values; and

- Develop a system of greenway streets to increase pedestrian and cycle access to existing open-play park spaces;

- To refine the role that City streets and boulevards can play in a sustainable community the City
  
  - Close selected street segments to vehicular traffic;
  
  - Partially close certain street segments to traffic;
  
  - Provide traffic calming and bike/pedestrian amenities on designated greenway streets;
  
  - Provide additional street tree planting and wider sidewalks on designated greenway streets;
  
  - Designate bike lanes for commuters on major streets;
  
  - Conduct demonstration projects for innovative stormwater management and low impact landscape maintenance on greenway streets; and
  
  - Integrate “naturescape” principles to increase habitat for small mammal and bird species and look for opportunities to connect habitat along greenways.

- To recognize the importance of, and examine opportunities for, protected public viewpoints to major regional attractions including views of the ocean, mountains and the Vancouver skyline, the City will:
  
  - Identify existing viewpoints from public parks and streets; and
  
  - Create a strategy to designate viewpoints that will be maintained as the City grows, and methods to protect these views and enhance the viewpoint.

Key uses:

Key uses of the green network should be identified and used as a lens to view design decisions (Hellmund and Smith, 2006). Whilst the green network will have multiple uses, it is important that each key use is functional in isolation. In a house, the plumbing and the electricity need to be designed as separate, unbroken systems, but together they deliver hot water. In the same way the components of the green network need to be function both on their own and in unison.

- Wildlife movement corridor
- Aesthetic garden
- Stormwater retention site
- Walking tracks
- Community garden
- Traffic calming planting
- Pocket park
- Historic site
Assess what we already have

Due to the unique geography of Wellington and the constricting embrace of the town belt, Wellington City is very compact and its green space has been hard won. This is in contrast to the vast open spaces of the surrounding hills, sea and sky. As development pressure will only increase in the city centre and the amount of green space per capita is exceptionally high at the Wellington region scale, it is unlikely that the green network will have a strong role in adding more green space to the total. The role of the network then is to utilize the existing spaces by increasing their functionality and connectivity.

To achieve this functional connectivity it is critical to assess the existing green infrastructure and create a detailed land use map. Once identified, the actual and potential patches should be graded according to their landscape and ecological values (Jim, 2004). This should include indices such as patch type, size, perimeter/area ratios, diversity, isolation (Cook, 2002) and their quality for plant growth and human enjoyment (Jim, 2004). Other ecological indices should help identify the areas of greatest ecological significance (Weber, Sloan and Wolf, 2006) such as density, tree age, locations of birds and habitat diversity (Oh, Lee and Park, 2011). The risk of development that each site faces should also be assessed.

Before creating an open space strategy in Dunedin, Freeman and Buck (2007) thought it important to create a comprehensive data base of green space of all types. This approach is relevant to the proposed green network for Wellington City as a comprehensive database would better enable the Wellington City Council to:

- Guide the future development of green space through the identification of focus areas
- Facilitate the identification of ecological corridors, linkages and gaps in green networks
- Identify areas with low percentage coverage of “green”
- Inform decision making regarding development proposals
- Identify both short term and longer term changes in the green network
- Facilitate identification and comparison of the range of urban habitat types and the relationship between natural, indigenous and modified habitats
- Develop urban amenity indicators such as patch accessibility, and distribution of patch type.
Vegetation Considerations

The importance of urban trees as green infrastructure

Due to the benefits that they provide (see table 2), trees should be mandated as an essential urban infrastructure. They have benefits over other vegetation forms as they have longer life spans, larger biomass and more notable environmental functions (Jim, 2004). However, like other city infrastructure, trees require rigorous lifetime maintenance. There are exemplar tree plans demonstrating how to care for this green infrastructure such as the Hutt City Council Urban Forest Plan. Factors that act against city greening include tree-unfriendly development modes, excessive density, high site coverage, lack of setback, and inertia (Jim, 2000).

<table>
<thead>
<tr>
<th>Social Benefits</th>
<th>Economic benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Making the urban environment more pleasant to live, work, and spend leisure time in</td>
<td>- Providing potential for future carbon offsetting trade</td>
</tr>
<tr>
<td>- Providing nature in the city</td>
<td>- Avoiding investment in new power supplies</td>
</tr>
<tr>
<td>- Enhancing quality of urban life</td>
<td>- Savings on electricity costs</td>
</tr>
<tr>
<td>- Providing significant outdoor leisure/recreation opportunities</td>
<td>- Saving annual cooling and heating costs</td>
</tr>
<tr>
<td></td>
<td>- Providing annual returns on municipal investment</td>
</tr>
<tr>
<td>Health benefits</td>
<td>- Reducing expenditure on air pollution removal</td>
</tr>
<tr>
<td>- Creating relaxed psychological states</td>
<td>- Reducing expenditure on stormwater infrastructure</td>
</tr>
<tr>
<td>- Averting premature death</td>
<td>- Reducing “time on market” for selling property</td>
</tr>
<tr>
<td>- Averting respiratory hospital admissions</td>
<td>- Increasing land value</td>
</tr>
<tr>
<td>Visual and aesthetic benefits</td>
<td>- Increasing property value</td>
</tr>
<tr>
<td>- Providing a sense of place and identity</td>
<td>- Increasing rental price</td>
</tr>
<tr>
<td>- Creating seasonal interest by highlighting seasonal changes</td>
<td></td>
</tr>
<tr>
<td>- Improving scenic quality</td>
<td></td>
</tr>
<tr>
<td>- Providing privacy</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Demonstrated benefits of urban trees. Source: Roy et al., 2012

Street trees and other urban trees will differ in their attractiveness to birds. Few studies have looked into the relationship between street tree characteristics and tree use by urban birds. One study of this relationship found there was a positive relationship between height of tree and use by birds and it also identified tree species that were most frequently used by birds (Tzilkowski, Wakley and Morris, 1986). An equivalent Wellington based study would provide useful information for the WCC to incorporate into the network.
Recommendations

- A tree plan should be formulated for planting and maintenance planning
- Unplanted green spaces should be targeted to raise the tree cover (Jim, 2004)
- Promote buildings with lower site coverage, potentially allowing taller buildings so that tree coverage can be provided for
- Studies should be undertaken to assess what viable street tree species are most attractive to native birds.

**Green Roofs and Walls**

In some dense urban settings it will be unfeasible to introduce street trees. In these situations green roofs and/or walls could be viable greening options. International research has demonstrated the personal, social and environmental benefits of installing green roofs (see table 3).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Increased market value of the greened building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Increased usable open space</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Green roofs provide a layer of insulation, owners experience improved temperature control and thus reduced energy consumption and noise reduction</td>
<td>Saiz et al., 2006; Kosario and Ries, 2006; Clark et al., 2008</td>
<td></td>
</tr>
<tr>
<td>- This insulation layer also provides weather protection which extends the lifespan of the roofing material</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Public benefits

- Air pollution reduction
- Storm water quality and quantity management
- Green roofs aid in adaptation to climate change by storing carbon and reducing energy use

Ecological benefits

- Provide largely predator free habitat

Table 3: Demonstrated benefits of green roofs.

With these demonstrated benefits it seems sensible to install green roof technology on New Zealand buildings wherever possible. However this is not being done. Simcock (2007) suggests the barriers to widespread adoption include lack of knowledge on appropriate plant species and soil substrates, the youth of the green roofing industry, and the lack of a contextual environmental and cost benefit analysis. As retrofitting green roofs can be resource intensive a full life cycle assessment would be needed to clarify whether there is an overall environmental gain from the implementation of green roof technology. Table 4 shows that different forms of green roofs have different costs and benefits. A further barrier is the limited number of exemplar buildings (Simcock and Fassman, 2008).
The potential benefit of green roofs to biodiversity in the green network is unclear. The study of green roofs in New Zealand has focused on the value of green roofs as habitat for invertebrates and endangered skinks (Davies, Simcock and Toft, 2010; Davies et al., 2010). There is no information on the use of green roofs by native birds. Green roofs may be stronger as a component of stormwater management, where the New Zealand research is strongest (Voyde et al., 2009; Voyde, Fassman and Simcock, 2009; Voyde, Fassman and Simcock, 2010; Voyde et al., 2010).

### Table 4: A comparison of the advantages and disadvantage of the two main types of green roofs: intensive and extensive.

<table>
<thead>
<tr>
<th>Intensive green roofs - deep soils</th>
<th>Extensive green roofs – shallow soils</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Can hold more water</strong></td>
<td><strong>Hold less water</strong></td>
</tr>
<tr>
<td>o Can improve the quality of a large quantity of water</td>
<td>o Improve the quality of a smaller amount of water</td>
</tr>
<tr>
<td>o Can retain a large amount of water, significantly reducing peak flows</td>
<td>o Reduce peak flows less significantly</td>
</tr>
<tr>
<td>o Need a lot of structural support therefore are resource and cost</td>
<td>o Less resource intensive and financially less costly</td>
</tr>
<tr>
<td>intensive</td>
<td></td>
</tr>
<tr>
<td><strong>Support larger trees</strong></td>
<td><strong>Do not support trees</strong></td>
</tr>
<tr>
<td>o provides more structurally complex habitat which will increase</td>
<td>o Simple habitat will lack high biodiversity potential</td>
</tr>
<tr>
<td>biodiversity</td>
<td>o Grasses and shrubs less likely to be danger risks</td>
</tr>
<tr>
<td>o will potentially provide more food</td>
<td></td>
</tr>
<tr>
<td>o large trees more dangerous in high winds</td>
<td></td>
</tr>
</tbody>
</table>

Setting Goals

*Lead by example*. The species choices made by the WCC influence the attitudes of the public towards their environment. This makes these public plantings immensely valuable in shaping ecological awareness in urban dwellers.

*Don’t plant/remove weedy species*. Exotic species that are potentially weedy should not be considered as an option, as council use may encourage the public to use them (Sawyer, 2005). For example, agapanthus, a noxious weed in New Zealand, can be found intentionally planted in council gardens (see image 1). These should be removed and replaced with a similar native species such as rengarenga.

Image 1: Google street view image of agapanthus planted in Frank Kitts Park.
Promote the planting of threatened vulnerable native species. Traffic islands and road reserves are far more abundant in urban areas than anywhere else. These areas provide space to demonstrate, promote and protect plants. Wellington’s roadside plantings already host some vulnerable species such as *Euphorbia glauca* and *Muehlenbeckia astonii*, see image 2. This action can be further promoted and encouraged.

![Image 2: The endangered shrub *Muehlenbeckia astonii* growing in a traffic island in Upper Hutt. Source: http://mp.natlib.govt.nz/detail/?id=65850&l=mi.](image2.png)

Select native species that fit with good design practice. One example of good design practice is the use of deciduous trees in narrow, light restricted roadways as the trees will add shade in summer but let in light in winter. There are only 11 native species that are fully, or almost fully leafless in winter. They are listed below (Source: http://www.nzpcn.org.nz/page.aspx?flora_vascular_flowering_plants_deciduous_plants):

<table>
<thead>
<tr>
<th>Discaria toumatou</th>
<th>Muehlenbeckia astonii</th>
<th>Olearia odorata</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Fuchsia excorticata</em></td>
<td><em>Olearia fragantissima</em></td>
<td><em>Plagianthus divaricatus</em></td>
</tr>
<tr>
<td><em>Hoheria glabrata</em></td>
<td><em>Olearia gardneri</em></td>
<td><em>Plagianthus regius</em></td>
</tr>
<tr>
<td><em>Hoheria lyallii</em></td>
<td><em>Olearia hectori</em></td>
<td></td>
</tr>
</tbody>
</table>

Choose vegetation that provides food for people and/or birds. The more abundant the food source provided for native birds, the more probable it becomes that they will be present in the city centre. New Zealand native birds are adapted to a high proportion (c. 75%) of woody plants that bear fleshy fruits or nectar (Meurk and Hall, 2006). This nectar and fruit provide essential dietary components for many of the species that have already been sighted in Wellington city centre.

Urban agriculture is an increasingly touted sustainability strategy (Birch and Wachter, 2008). WCC could lead by example showing that people can easily grow their own produce either on their private land or in community gardens, with health and environmental benefits. Edible fruit trees are planted on public land in Marlborough as part of the Council’s commitment to providing resources for the community good (Marlborough District Council, n.d.).
Increase structural diversity of plantings. New Zealand birds are adapted to vegetation with high structural diversity. Under planting should occur where large trees stand alone. This fits in with the naturescape approach, which aims to make landscapes that are closer to those that are not man made.

![Figure 2](image_url)

Figure 2: As structural diversity increases, so too does biodiversity.

Select vegetation that reflects cultural and historical identities. Species choice should optimally reflect the multiple cultural histories of the area. Species locally exotic, yet significant to Maori, include puriri, karaka and pohutukawa. Exotic tree species significant to European colonisation include Norfolk Island pine, oak and poplar. Pre-human arrival the study area historically would have supported the following native tree species (Boffa Miskell, 2002):

<table>
<thead>
<tr>
<th>North Aspect:</th>
<th>South Aspect:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree and climbing rata</td>
<td>Manuka</td>
</tr>
<tr>
<td>Rimu</td>
<td>Kohuhu</td>
</tr>
<tr>
<td>Kahikatea</td>
<td>Hinau</td>
</tr>
<tr>
<td>Cabbage tree</td>
<td>Mapou</td>
</tr>
<tr>
<td>Lancewood</td>
<td>Ponga</td>
</tr>
<tr>
<td>Maire</td>
<td>Five finger</td>
</tr>
<tr>
<td>Raewa raewa</td>
<td>Rangiora</td>
</tr>
<tr>
<td>Mahoe</td>
<td>Lemonwood</td>
</tr>
<tr>
<td>Koromiko</td>
<td></td>
</tr>
<tr>
<td>Kamahi</td>
<td></td>
</tr>
<tr>
<td>Wineberry</td>
<td></td>
</tr>
<tr>
<td>Karamu</td>
<td></td>
</tr>
<tr>
<td>Mamaku</td>
<td></td>
</tr>
<tr>
<td>Narrow leaved lacebark</td>
<td></td>
</tr>
</tbody>
</table>

Continue engagement with public about the benefits of planting native species. Continue successful measures to engage the public with planting native vegetation such as restoration projects, providing free native plants and distributing the brochure *Planting Natives in Wellington*. More information may need to be targeted at apartment dwellers, demonstrating the joys and benefits of balcony and container gardening. Ecologically based vegetation choices can be encouraged by providing online resources showing which native species are adapted to specific locations. Some examples are given below:

**Monitoring**

A full, detailed, easily accessible record of what is planted on council land is not kept. This makes it difficult to assess the balance of native and exotic species represented. There appears to be a good representation of native flora, and it could be good promotion for the council to have data on the amounts and ratios of this.

An accessible record of what grows well in Wellington from outcomes of species trials and characteristics of planting sites should be established to ensure that the huge amount of information that has built up over the years (mostly in worker’s heads and shared verbally [Greening Central Wellington, Boffa Miskell, February 2002]) is used effectively. There is the need to “monitor to manage” as feedback and reflections guide future choices for constant improvement (Hostetler, Allen and Meurk, 2011).

**Research**

A barrier to the wider use of native tree species in roadside planting is the lack of knowledge on the suitability of species to the task. Roadside plantings are expensive undertakings, thus it is important to ensure that they successful. The species that are usually chosen are hardy and low maintenance. For this reason species selection is heavily influenced by the known success in other locations. The result in Wellington is that exotic species are used along with a small selection of natives, including a high proportion of the locally exotic pohutukawa. If the variety of these plantings is ever to increase, and hopefully move towards an increasing presence of local natives, different species need be trialled.

One way to do this would be to designate an area of roadside planting to trialling. This would provide information on the usability of different native species, and would also act as a unique attractive and informative feature like an urban arboretum. Information could be displayed about each species which would add to the public educational experience, possibly involving the public further by asking them their aesthetic preferences. This would be a long term process, however, if trials are not undertaken it is possible that roadside plantings will remain the same ad infinitum.
Animal Species Considerations

The importance of birds as indicators

Birds are useful target species as they are the most mobile group of animals in New Zealand. Bird species are effective in engaging the public with nature and WCC have been monitoring the abundance of birds in the areas surrounding the city centre for 10 years so have good contextual data. Connectivity into urban environments may never be a reality for species such as lizards.

What bird species should be targeted?

One of the desired outcomes of the urban ecological network is a higher presence of native birds in the city centre. To achieve this, it is important to meet the specific needs of species that WCC wish to attract. An abundance of food is the most likely draw for birds, although providing a safe place on the way to a larger food source is also important. As each species has individual needs, it is important to decide which will be likely candidates for the network. Table 6 shows the species which are present in the city centre or the surrounding town belt (also displayed in figure 3). As community reporting is unreliable, the number of sightings is not expected to be a true representation of their relative abundance.

<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Number of Sightings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tui</td>
<td>Endemic</td>
<td>42</td>
</tr>
<tr>
<td>Kākā</td>
<td>Endemic</td>
<td>28</td>
</tr>
<tr>
<td>Fantail (piwakawaka)</td>
<td>Native</td>
<td>21</td>
</tr>
<tr>
<td>Silver eye (tauhau)</td>
<td>Native</td>
<td>20</td>
</tr>
<tr>
<td>Riroriro (grey warbler)</td>
<td>Endemic</td>
<td>14</td>
</tr>
<tr>
<td>Kererū (wood pigeon)</td>
<td>Endemic</td>
<td>11</td>
</tr>
<tr>
<td>Welcome Swallow</td>
<td>Native</td>
<td>7</td>
</tr>
<tr>
<td>Shining Cuckoo (pīwharauroa)</td>
<td>Native/migratory</td>
<td>7</td>
</tr>
<tr>
<td>Bellbird (korimako)</td>
<td>Endemic</td>
<td>6</td>
</tr>
<tr>
<td>Kārearea (NZ falcon)</td>
<td>Endemic</td>
<td>5</td>
</tr>
<tr>
<td>Morepork (ruru)</td>
<td>Native</td>
<td>3</td>
</tr>
<tr>
<td>Kingfisher (kotare)</td>
<td>Native</td>
<td>3</td>
</tr>
<tr>
<td>Tomtit (miromiro)</td>
<td>Endemic</td>
<td>1</td>
</tr>
<tr>
<td>Kākāriki (parakeet)</td>
<td>Endemic</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6: Birds sighted in the study area. Source: global biodiversity information forum webpage [http://www.gbif.org/](http://www.gbif.org/).
A flagship species approach could be taken with tui. Samways et al. (1995: 491) define flagship species as “known charismatic species that serve as a symbol or focus point to raise environmental consciousness”. Human interest in the green network could be gained through a connection with tui as tui have many characteristics which make them suitable advocates:

- Tui have a local success story (population recovery from only a few breeding pairs)
- Habitat and food can be provided easily
- Tui venture into gardens and urban areas
- Tui are easily recognised by sight and sound
- Tui are iconic.

**Across town bird movements**

The existing bird sighting data suggest that there is little movement of birds from the west of Wellington to the eastern section of the town belt and the Miramar Peninsula. This will be due in part to the disconnection of forest fragments caused by the urban centre of Wellington. This trend could also be a reinforced historical characteristic, as even pre-human land cover change there was no continuous forest cover connecting the peninsula to the rest of Wellington, excepting a thin band of coastal forest where Cobham Drive now lies (Boffa Miskel, October 2002).

The eastern branch of the town belt is lacking functional connectivity as it has the high density urban area of the suburb of Mt Victoria to the west, the sea to the north and east and the Miramar isthmus to the south. To utilise this large patch of habitat, connections across the city centre should be established. The two most obvious locations for this appear to be the waterfront where a lot of public land is owned, or the point where the arms of the town belt are narrowest near the hospital.

**Monitoring**

As there have been no biodiversity assessments focused on the inner city it is unknown what species are present where, why and in what numbers. Work resulting from the 2007 WCC Biodiversity Action Plan focused specifically on threatened species and habitats, which are largely absent from the CBD and inner suburbs. Monitoring the changes in presence and abundance of species is essential so biodiversity actions can be based on current knowledge, and to discover whether actions are effective.
Recommendations

- Ongoing bird counts should begin in the CBD and the inner city suburbs or Thorndon, Mt Victoria, Mt Cook, Aro Valley and Te Aro.

- Investigate the role that citizen science can play in obtaining central city bird presence data. A ‘report a bird’ website or app could provide useful information. This could be coordinated with Zealandia.

- Assess the biodiversity of street trees to discover whether native birds are using them.

Figure 3: Native bird sightings in Wellington City and the surrounding town belt. Sources: Kaka information from Kerry Charles and Zealandia, other bird sightings are from the Global Biodiversity Forum website (www.gbif.org).
Social Considerations

Vegetation, Values and Identity

Wellington can promote its uniqueness and enforce its identity through its plant signature. A plant signature is a composition of vegetation that will offer some essence of the place (Robinson, 1993). Indigenous nature in particular is an important element in identity and sense of place (Hough, 1990).

The role of the council in promoting native vegetation is described elegantly by Meurk and Swaffield (2007): “Cities are [...] complex systems of symbols. They physically represent the values embodied within urban society and culture, both past and present (Rossi, 1982) and these messages are ‘read’ by the inhabitants and by visitors. City leaders [...] consciously shape city form to reinforce values which they seek to maintain or impose. Inevitably this effort is focused upon the public realm – the shared spaces of the city, such as streets and parks, and the public buildings [...] Hence the decisions made about the design and management of these areas are central to the evolution of public values concerning indigenous biodiversity. These public actions can become transformative, with the potential to stimulate actions on adjoining private land, further reinforcing a deepening public awareness and understanding of nature and natural processes.”

Awareness and pride in greening

Part of progressing Wellington as an Ecocity, could be the greater acknowledgements of the successes that are currently being achieved. WCC could provide “cues to care” which Joan Nassauer (1995) describes as obvious indicators that humans (i.e. the council) are being effective stewards of the landscape. A simple example of this could be placing labels where endangered plants are located on pedestrian routes. Without this many people will walk past unaware of the native planting and of the council’s efforts.

Public awareness of environmental issues will be the foundation for acceptance of the green network plan. The council may not obtain public support for a green network if the public feel there is enough or too much green space already, or if they are satisfied with the state of affairs. Currently residents are over 80% satisfied with the quality and maintenance of roadside vegetation, town belts and walkways and residents rate the ease of access to green open spaces at 94% (Wellington City Council, 2011).
**Future Growth**

As Wellington City has grown, the CBD and inner residential areas have densified. Wellington City will continue to grow and areas of un-built land may come under pressure for development resulting in further losses of private and/or public green space. With an increase in dense housing styles that provide little in the way of private green space, public space becomes especially important. It will be essential to plan this development carefully so it is in tune with a green network plan to ensure that patches are able to provide ecological and social functions.

<table>
<thead>
<tr>
<th>Area</th>
<th>2006 to 2026</th>
<th></th>
<th>2026 to 2051</th>
<th></th>
<th>2006 to 2051</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>people</td>
<td>dwellings</td>
<td>people</td>
<td>dwellings</td>
<td>people</td>
<td>dwellings</td>
</tr>
<tr>
<td>Central Area</td>
<td>5,582</td>
<td>3,137</td>
<td>4,370</td>
<td>2,996</td>
<td>9,952</td>
<td>6,132</td>
</tr>
<tr>
<td>Inner Residential</td>
<td>629</td>
<td>353</td>
<td>492</td>
<td>337</td>
<td>1,121</td>
<td>691</td>
</tr>
</tbody>
</table>

Table 7: Predicted growth rates for central and inner residential areas. Source: McSweeney, n.d.

- “Between 2006 and 2031, 12,000 people (or 7,000 new households) are expected to be provided in the central city (in and close to the CBD) where market demand and capacity is most evident. 36% of the total growth for the City will demand high density apartment style housing and most new growth will occur in the central city” (McSweeney, n.d.).
- “The Inner Residential Area will continue to be under pressure for redevelopment, even though the capacity maps shows there to be little infill potential. High land values and proximity to the CBD will likely see these areas continue to redevelop for multi-units rather than single dwelling infill” (Kos and Peeters, 2007).
References


Boffa Miskel (February 2002). Greening Central Wellington: A vision and guideline for the use of plants, trees and green open space in central Wellington. Wellington City Council: Wellington


CABE (2009). Grey to green: How we shift funding and skills to green our cities. Author: London.


Wellington City Council (October 2012). Draft Town Belt Management Plan. Author.


Wellington City Council (September 2007). Biodiversity Action Plan. Author.


**Appendix**

**A) Table of green space regulations**

<table>
<thead>
<tr>
<th>Aspects Related to Urban Green Space</th>
<th>Applied by countries/cities</th>
</tr>
</thead>
</table>
| Maximum distance to nearby Green space | - 280-300 m (English Nature) (Handley et al., 2003); (Harrison, et al., 1995)  
- 500 m (Aarhus, Denmark) (Carmona, Magalhães, Blum, & Hopkins, 2004)  
- 400 m (Zurich, Switzerland) (Carmona, et al., 2004) |
| Walking Time to nearby green space (accessibility)| - 15 minutes (Europe) (Anonymous, 2005)  
- 10-15 minutes (Switzerland) (Carmona, et al., 2004) |
| Provision per 1,000 population | - 1 ha (Handley, et al., 2003); (Harrison, et al., 1995)  
- 0.765 ha (Backer standard in Hidayansyah (2007)) |
| Green space allocation for each urban citizen | - 9 m² by WHO (Singh, et al., 2010)  
- 200 m² in Wellington (Singh, et al., 2010)  
- 104 m² (Europe) (Konijnendijk, 2003)  
- 800 m² (France) (Konijnendijk, 2003)  
- 80 m² (Canberra-Australia) (Singh, et al., 2010)  
- 10 m² (Harrison, et al., 1995)  
- 8 m² (Zurich, Switzerland) (Carmona, et al., 2004)  
- 38 m² (India) (Singh, et al., 2010)  
- 3 m² (Hong Kong) (Singh, et al., 2010)  
- 27.3 m² (China) (Singh, et al., 2010)  
- 1.9 m² (Malaysia) (Purnomohadi, 2006)  
- 5.0 m² (Japan) (Purnomohadi, 2006)  
- 11.5 m² (Lancashire, England) (Purnomohadi, 2006)  
- 60 m² (USA) (Purnomohadi, 2006)  
- 1.5 m² (Jakarta, Indonesia) (Purnomohadi, 2006) |
| Trees/crown coverage | - 27% (USA) (Singh, et al., 2010)  
- 18.6% (average in Europe) (Singh, et al., 2010)  
- 27.85% (India) (Singh, et al., 2010) |
B) Possible Design Objectives

- Connections
  o Use the greenway to provide visual and physical access ("connectedness") to nature.
  o Provide opportunities and aids within the greenway for users to have immediate and vivid experiences with natural processes.
  o Engage future greenway users in the greenway design process. Include in the greenway areas elements such as community gardens and adventure playgrounds that can be manipulated by humans.
  o Create vantage points within and adjacent to the greenway where users can view wildlife, other greenway users, or interesting elements.

- Water
  o Cleanse stormwater and other waste outputs from adjacent land uses before or as they enter the greenway.
  o Expose streams that may have been piped and generally make processes visible

- Cues to care
  o Mark the greenway, and especially all entrances, so it becomes known as a distinct and purposeful place.
  o Create elements along the greenway that remind users they are in the greenway and that give more information about the greenway’s functions.
  o Make obvious human interventions in the greenway, and instead of trying to obscure these, give cues for care.

- Place
  o Use local solutions wherever possible in implementing aspects of the greenway.
  o Use local materials in any construction (paths, bridges, etc.) within the greenway to emphasize what is unique to an area and gives an area a specific sense of place.
  o Align the greenway so that users have views and experiences that give them a sense of the landscapes they are passing through, even including signs and other marks that remind users of previous uses of the land.

- Landscape
  o Make the greenway extensive enough to accommodate natural processes such as erosion, and thereby communicate the complexity of the landscape.
  o Design greenways to sustain their function despite changes in adjacent land uses.
  o Wherever possible or appropriate, extend the greenway functions outward from the greenway to integrate the greenway and its context.
  o Feature significant topography in the greenway.

- People
  o Include obvious places (e.g. trails and viewing blinds) for people in the greenway as appropriate.
 Provide opportunities for recreation and other uses, perhaps community gardens or forests, public gathering spaces, or farmer’s markets.