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FIGURES

Figure 1. Istanbul Historical Peninsula Periodic Development Analysis; right to left First settlement (657 B.C.), Soptimus Severus (190-300), Constantine (330-337), Theodosius (410-442)

Re-visualized from Historical Peninsula Conservation Management Plan by Eisenman & Aytaç Architects

Figure 2. Location of Yenikapı in Istanbul Historical Peninsula, Turkey

Visualized by Eisenman & Aytaç Architects

Figure 3. Yenikapı Excavation Area from the west part, Theodosian Harbour

Photo taken by Eisenman & Aytaç Architects

Figure 4. Simple stone woven branches architectural remains and footprints from Neolithic Period

Photo taken by Eisenman & Aytaç Architects

Figure5. Eisenman-Aytaç Group Project, Analysis of Yenikapı in Istanbul Historical Peninsula

Visualized by Eisenman & Aytaç Architects

Figure6. Eisenman-Aytaç Group Project, Landscape Types

Visualized by Eisenman & Aytaç Architects

30. REVEALING THE CRYPTIC

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ABSTRACT

Invertebrate numbers worldwide are declining, predominantly due a lack of knowledge and detrimental activities on habitat such as urban expansion. "Invertebrates are essential to our natural environment and to humans,"(Department of Conservation, 2006), due to the numerous ecosystem services they provide. Without invertebrates human life as we currently know it would be very different. This research explores how urban landscapes can be designed to provide for invertebrates and uses the highly urbanised Auckland City Centre as a case study.

CBD spatial characteristics were identified using GIS, Auckland Council documents and on site observation. The CBD is a fragmented landscape of patches, which together form an ecological network. At the landscape scale this network is reinforced by designed interventions, and consists of a series of nodes that are used by invertebrates.

Invertebrate information was collected, analysed and categorised into functional groups, which enabled a set of criteria to be established for local design interventions, for both species specific and general habitat types. These interventions are based at each node within the network. Although some interventions will be species specific, it is expected that a range of invertebrate species will take advantage of these interventions, thus increasing biodiversity. An adaptive management strategy will be used to monitor and adjust habitat requirements accordingly.

Invertebrates are cryptic and these small to medium interventions throughout the city are aimed at revealing the presence of invertebrates. Interpretive devices such as QR Codes and projector screens allow the public to better perceive invertebrates as part of their daily environment and to follow mapped habitat routes.

A set of guidelines allows habitat interventions to be retrofitted within most urban sites. Throughout the city these interventions facilitate positive interactions between people and invertebrates through education, increased invertebrate visibility and biodiversity.

INTRODUCTION

'Revealing the Cryptic' was a yearlong research and design project that focused on the lack of designs catering for invertebrates in urban landscapes. The research question that drove the project is: 'How can invertebrate biodiversity be designed for, in highly urban landscapes, to increase conspicuousness for urbanites?' This research explored how Landscape Architects can design for a range of invertebrates in highly urban landscapes, like Auckland city centre, while increasing the public awareness of invertebrates; the importance of them, as well as what they require to survive in urban environments.

Landscape Architect's commonly design for conservation, but the current examples often fail to effectively address the invertebrate layer of the landscape, particularly in urban areas. Bird life is a common consideration through the selection of fruiting plant species, but there is no comparable strategy that is designed to intentionally cater for invertebrates. Some Landscape Architects, Entomologists and other professionals, have started to look at ways to include invertebrates in areas previously designed for human beings, but these are largely within suburban sites. The approaches often tackle the invertebrate topic in a segmented way, rather than providing a holistic guide as to how design for invertebrates in urban landscapes can be achieved.

Invertebrates are a crucial component within the world's ecosystem and as cities continually expand and cover the Earth's surface with urban landscapes that are predominantly impermeable and lacking vegetation, invertebrate ecologies are being destroyed. This is one of the reasons for invertebrate population decline. The research findings show that an increase of city surfaces correlates to the decline of invertebrate populations. As city expansion is inevitable, it is therefore essential that we start providing invertebrate ecologies within our urban landscapes, and in doing so expand our knowledge of invertebrate needs.

'Revealing the Cryptic' aims to:

- Design invertebrate habitats and food sources throughout Auckland city centre
- Increase plant biodiversity within the city centre
- Provide for a range of interactions to take place between humans and invertebrates
- Include interpretative media for the public to highlight the importance of the scheme
- Team the design with an adaptive management project that both Landscape Architects and scientists can use to expand their knowledge on invertebrates
- Produce an example of how Auckland Council's 'Indigenous Biodiversity Strategy' could be implemented within the CBD

The overall aim was to design urban landscape interventions that cater for invertebrates whilst revealing them to the public, through engagement and provision of information on the overall scheme. Revealing invertebrates will help to achieve public awareness on their importance and to assist with invertebrate survival.

By designing for the inclusion of invertebrates in urban landscapes, Landscape Architects would be contributing in making a richer city; through provision of increased biodiversity, as well as better aesthetic experiences. It would also add to the sustainable practices that most Landscape Architects are already striving to achieve. The paper provides a new way for Landscape Architects to look at the city, with invertebrates right at the fore.

STUDY AREA

Due to the highly urbanised location and exposure to the public, the design interventions are set within Auckland city centre. Located within New Zealand's largest city; Auckland, the city centre borders the Waitemata Harbour, key motorway infrastructure and a number of urban communities. The city centre alone has over 20,000 residents (Statistics NZ, 2006) and in one-day sees over 160,000 people arrive, for work, education or tourism. (Auckland Council, 2011, p. 37).

As an environment made for humans, the city centre's main land use activities are commercial, residential and education. Towering buildings and grid-roads spread across the city surrounding the six urban parks. Connections between these parks, the city centre and the neighbouring communities are poor; a key problem identified in the Auckland Plan, for both humans and ecology. Auckland city centre is a fragmented landscape, and the constant growth and urbanisation of the area is fuelling this fragmentation.

Left to right: Map showing typography, Aerial highlighting infrastructure coverage vs. open space, Built up nature of Auckland City skyline, Examples of the types of surfaces that can be found in the city centre

METHODOLOGY

Methodologies for the research were primarily based around Landscape Ecology concepts and design and conservation precedents (Figure 1), each helping to form the baseline thinking for the research.

Concepts

'Field of Dreams'

'Spectrum Matrix'

'Patch Corridor Matrix'

'Meta – populations'

'Cues for Care'

Entomology

Species Specific vs. General Designs

Red Admirals, Ambury Farm & One Tree Hill, Auckland, NZ

Bees, Auckland City Town Hall, NZ

'Rise of the Urban Beekeeper', J. Rumble & D. Tikao

vs.

Urban Pollinator Project, United Kingdom

Highline, New York, USA

Conservation

Indigenous Biodiversity Strategy, Auckland Council

Adaptive Management Plan

Figure 1: The Key Influences

The Field of Dreams concept; random arrival of species, suggests that if the conditions are right, wildlife will come and inhabit environments on their own accord. The notion of patches working in a wider network with corridors joining patches, taken from the 'Patch Corridor Matrix', was influential in tackling the issue of the fragmented landscape that is Auckland city centre. The design of nodes with links stemmed from this ecological concept. Discussions with entomologists proved that as invertebrates are such an unknown group in the animal kingdom, it would not be possible to understand everything about invertebrates and what they would need to survive in a highly urban site.

Other important influences and concepts were; the spectrum matrix theory, the 6 intelligences people use when experiencing a landscape; meta-populations, the idea of a network of sub populations within a population, that emerge and disappear sporadically but have at least one viable population at a time; and cues for care, showing signs of being cared for in areas that the general public do not perceive to be tidy or looked after. (In, Meader, 2010).

Design precedents internationally seem to focus on suburban areas. Precedents were split into two types; species specific and general, depending on what invertebrate type the design was giving consideration to (Figure 1). Although the precedents did not provide a holistic approach, each highlighted an important point. Collectively these were:

- Borrowing existing infrastructure and utilising surfaces in a more productive way
- Providing information via technology (online websites)
- Monitoring and analysis – Adaptive management plans
- Providing plant biodiversity – native and exotic mix, wide seasonal variety, and thought given to plant life cycles
- Support for the 'cues for care' concept and validation of the Field of Dreams concept
- Idea of public interaction and enlisting in their help

The release of the 'Indigenous Biodiversity Strategy', by Auckland Council, late in 2012, and the conservation concept of adaptive management plans were two important conservation precedents that were investigated. The Indigenous Biodiversity Strategy strives to cover Auckland Councils "obligations to maintain and sustainably manage biodiversity." The strategy highlights the importance of New Zealand's biodiversity; visible or invisible, as well as the pressures that our ever expanding cities are placing on our natural environments. It was made known that the council did not yet know how to implement their goals. Key concepts from the release that provided a sound backing to the project include:

- The importance of having visible biodiversity at local scales, and as a part of everyday life
- Development of habitat nodes, and other components of ecosystems is crucial
- Education and understanding are key
- Engagement with communities is important in changing their perspectives
- Interventions need to have adaptive capabilities

Adaptive management plans link into this last point of having adaptive capabilities. Adaptive management works as an iterative process of learning by doing, in which monitoring, analysis, and adjustment phases work in a circular motion, until the best solution is found. This concept is important in conservation and within this project.

Invertebrates

Invertebrates are one of the six basic animal groups and are the largest. They house the most diverse of all animal groups, the Arthropods; also know as insects. There is an estimated 200 million insects for every human alive, with only 1 million insect species identified to date. A vast contrast to the 30 million species thought to be alive today. (Klappenbach, n.d.).

Due to the variation of invertebrates, their cryptic nature and inadequate information it is difficult to know what invertebrates would be attracted to, and thrive in the design interventions. However some broad information is known such as, each invertebrate species have different food and habitat needs, which can change depending on their life cycle stage. For example the Red Admiral larvae needs to live on and eat nettles, while the adult butterfly feeds on nectar. (Monarch Butterfly NZ Trust, 2012). Colours and fragrances are also important.

Distances travelled by invertebrates differ between species, some moving in order to locate food sources and ideal habitats, others involuntarily by wind dispersal. Their movement across the landscape and colonisation of new sites, links into the Field of Dreams concept. Entomologists often use broad generalisations to map the distances invertebrate groups will travel. As a general assumption a crawling insect will travel meters to tens of meters, while for flying insects it is reasonable to assume distances of hundreds of meters. (Winders, 2012).

People

As the design interventions would be bringing invertebrates into everyday life, it was important to understand how people react to invertebrates. Human senses particularly sight and hearing, inform people when invertebrates are around. Movement, colour differentiation, and noise all refocus attention. Depending on the proximity, and movement type people's responses will differ.

In order for the interventions to be accepted and used by the public, Gobster et al (2007) suggest three possible factors to consider in the paper, 'The shared landscape: what does aesthetics have to do with ecology'. These are, increasing acquaintance; familiarity is essential, increasing the immediate aesthetical value, or scientifically justifying why the interventions are in a highly humanised environment. A mixture of all three would be best suited to a highly urbanised site, like Auckland city centre. This mix would help to reduce urbanites potential anxieties around certain invertebrate species and the potential harm that could be caused by human interest.

Research on invertebrates, humans and plants, was undertaken alongside analysis, site visits, mapping, layering, testing and critiquing. This trial and critique process lead to the use the Landscape Ecology concepts and apply them to the fragmented landscape of Auckland city centre. Reflection occurred throughout the course of the project.

Working at different scales, information was layered, identifying habitat islands, zones and nodes in an overarching ecological network. A network slither was then used to show how the network functions at the local scale. As a result of site analysis a variety of hard and soft surface and space types were distinguished. These seven space types were; road infrastructure, shared space, civic space, urban parks, walls, overhangs, and roof tops. The space types were used to provide a variety of locations for node interventions to be placed. Within each type there is climatic and human use variation depending on the physical location of the node.

Functional invertebrate categories were formed to overcome the difficulty of obtaining information, and to ensure a wide range of invertebrate needs were provided for within each intervention. Based on what invertebrate survival needs, the functional categories of Habitat, Eating Habit, and Travel Method emerged. This led to developing invertebrate types; Species specific, Group specific, and general. Two comparatively well-documented invertebrates were used as case studies to represent two of these. These were the native New Zealand bee for species specific, and butterflies as group specific. The general species covers all other species that would inhabit or use the intervention nodes.

A range of ways that the public can interact and experience the site needs to be provided, to cater for the numerous ways individuals like to engage. Visual – spatial and naturalistic intelligences, which are predominantly catered for, are 2 of the 8 ways that people perceive and interact, principles of the spectrum matrix theory.

DESIGN OUTCOME/ RESULTS

The design model for 'urban invertebrate landscapes' works over two scales, with the first at a landscape ecology scale and the second at a local scale. Each scale has been designed with five main parts in mind, the network, the interventions, the invertebrates, the site, and the people. The segments within these overlap and ultimately, when combined, work as a unit, dealing with the urban invertebrate ecology holistically.

Landscape Ecology Scale

At the Landscape Ecology scale an overarching network exists. The network is made up of habitat islands; the existing urban parks that are unintentionally catering for invertebrates, the 100 to 300m zones; in which the Field of Dreams concept can legitimately occur, and the nodes; which are potential intervention sites. Each habitat island within Auckland city centre is relatively disconnected from another; so 100m - 300m zones have been placed around the peripheral edges of each. Within these zones a network of nodes occur, ultimately enhancing the connections between habitat islands in the overall network. (Figure 2, Image 1).

The Field of Dreams concept suggests that invertebrate populations will move into these designed nodes on their own accord. Overtime, as populations grow, more nodes would be developed at 500 - 1000m distances out from the habitat islands, until a full network exists across the city. From here the network could overflow into the surrounding communities of Auckland city centre. This network is a solution to the fragmented landscape that is Auckland city centre, and is based on the principles of the landscape ecology concept; Patch Corridor Matrix.

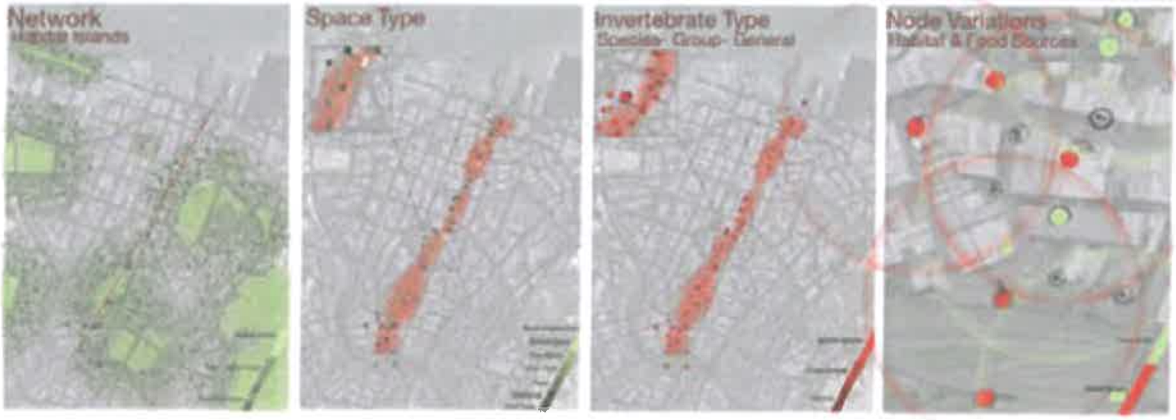


Figure 2: Left to right Habitat Islands, Space Type and Invertebrate Type (both over the Network Slither) and Node Variations

Local scale

At the local scale the same principles of Patch Corridor Matrix apply, however there is a focus on the nodes and the interventions within them. A slither of the network was used to demonstrate how the network would function at the local scale. The slither was chosen due to its positioning within Auckland city centre; it runs through the CBD centre, and because of the positioning of the potential nodes that sit within the 300m zones around habitat islands. On closer inspection the network slither demonstrates a wide range of the space and surface types that can be found within the city. (Figure 2)

Nine nodes, from within the network slither, were chosen to undertake detailed design. These exemplar nodes needed to be unique, varying in spatial, invertebrate and interaction type. To ensure this occurred, and that all types were catered for, a table of criteria was produced to work off. A range of food, habitat, and space types; including environmental variance, must be provided for, to best accommodate invertebrates. For example, full sun, sheltered, exposed, shaded, long grass, tight habits, open habits, nectar, and pollen.

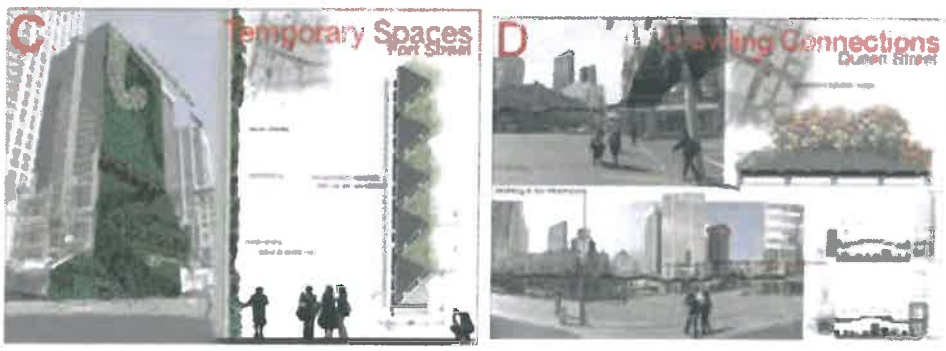
Using entomologist assumptions the nodes are distanced at 100 meters to ensure that invertebrate connections are viable, with the occasional 50-meter node in between. (Figure 2, Image 4). Interactions between people and invertebrates take place within each node and in the surrounding links. The proximity between nodes means that although one node might not offer the key factors for a certain invertebrate species, there will be another node within a 100-meter radius that does.

Each intervention caters for a variety of invertebrate, space, and interaction types to allow for the wide range of unknown possibilities and aims to increase biodiversity and invertebrate populations while evoking urbanites to accept them in the city. Posters 'A' through to 'I' (Figure 3) show how the nodes, within the network, are the intervention sites.

A key aim of these interventions was to ensure that they all varied slightly, because of the unknown preferences of each invertebrate species. 'A', 'D', and 'F', immediately show this biodiversity, through the variation of components needed for the invertebrate, space and interaction types.

Figure 3: The posters A Through B are a combination of perspectives, sections and close up details depicting the interventions that occur at each exemplar node.

The three functional categories; in which biodiversity is essential, are designed for in the following ways. Habitats have been designed to cater for the various invertebrate types and the nodes they are in differ environmentally. The species-specific clay walls in design intervention 'A' are positioned in full sunlight, to maximize warmth, and provide habitats of the native NZ bees. While masses of nettles provide shelter on a sunny overhang in design intervention 'F', as well as a habitat for the group specific species - butterflies. General invertebrate habitats can be seen in the rock wall components and logs within 'H'. These nook and cranny habitats provide a range of climatic conditions. Habitats are provided in the range of plant habits, also seen in 'H', with variation between open and closed plant structures, such as Echinacea versus Muehlenbeckia species. 'A', 'F' and 'H' are examples of the climatic variations needed in habitats as well as the range of habitats that can be provided for the various invertebrate groups.



Eating habits for the invertebrate types and stages are catered for through the broad use of plants. Providing for the range of life cycle stages within a species is crucial in supporting the ongoing population within a node. The native nettles are an example of how, alongside a mixture of flowers, food sources for the various stages of the Red Admiral lifecycle can be accommodated for. Colour blocking plants in design intervention 'E' looks at the importance of massing colours to allow invertebrates to easily detect a food source. Butterflies easily spot red, orange, yellow, and purple flowers; while bees are better suited to yellow, blue, blue green and ultraviolet.

The range of native and exotic planting in design intervention 'I' depicts how a variety of food sources can be provided for all invertebrate types at one node. 'F', 'E' and 'I' highlight the way food sources can be provided to the various types of invertebrates, as well as some of the things that need to be considered, like life cycle stage, colour, and native or exotic preference.

The elevated connections between nodes in design intervention 'D', demonstrates some of the thinking that needs to be done around providing for the various travel methods and distances travelled by invertebrates. Crawling invertebrates would otherwise be disconnected from the surrounding nodes if the bridges were removed.

The way surfaces are utilised differs, with the new bridge infrastructure and existing overhangs in design intervention 'D', showing how a mixture of retrofitted and newly built elements can be designed. However nodes sport interventions that are retrofitted over the existing surfaces and spaces. The upper car park level and adjacent rooftops in design intervention 'I' emphasise how unused surfaces and spaces throughout the city centre, offer so much potential.

Interventions vary in the degree in which they make urbanites interact. Magnification of invertebrate movements on screens is a blatant intervention, requiring little interaction. While QR Codes; Quick Response codes used to download information to a smart phone after a two-dimensional barcode has been scanned, and hands on elements are subtler and require active investigation or discovery. ("QR code", 2013). Old and new technologies will be utilised, with some listed below:

- QR Codes [to give relevant information on interventions - the information that the code links to highlights the overall network]
- On site signs [for brief information]
- Screens [to magnify and reveal invertebrate movements]
- Hands on interventions such as logs and lids that can be lifted [to get up close with invertebrate species]
- Data observation and collection [helping to measure the success and with adaptive management]
- Traversable routes

Utilising main road spaces, as in design interventions 'B', 'D' and 'E', show how the interventions could become a part of everyday life for urbanites. This principle comes from Auckland Council's 'Indigenous Biodiversity Strategy', and is backed up further by Gobster et. Al. The logs and lift boxes, in design interventions 'H' and 'F', provide close up discovery and interaction. As people accumulate singular interactions, they can start to make up their own connections and formulate their own personalised experiential network.

QR codes on city structures like traffic lights in design intervention 'E' reveal the overall network through connecting straight into it. This allows the person to decide the level of interaction that they want to further have, as it connects them into the surrounding node interventions, and wider network. It provides them with the invisible connections between nodes. Data can also be given through the QR codes, and other interpretive devices, such as signs.

However it is not only about interacting with the invertebrates, but with the spaces and connections. Using a selection of nodes, traversable links can be formed, allowing an interaction with the network at a personal level. In the Butterfly Trail (Figure 4) interventions can be revealed to the public. The nodal links become traversable for people, and create a series of routes that spreading over the city. Different elements are showcased within each route, e.g. the Butterfly Trail would showcase a variety of group specific food and habitat nodes on a range of surfaces. Alongside this are the physical attributes that the route may have. Such as avoiding main roads, sticking to quieter streets and pedestrian only areas.

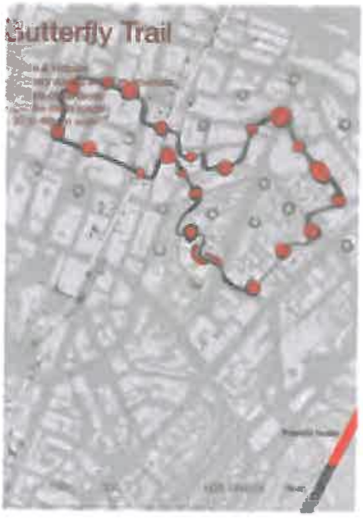


Figure 4: Butterfly Trail

The routes provide another way for the public to gain understanding and give a detectable network for people to interact with. The routes in Figure 4 are approximately a 30-minute walk and could be used on lunch breaks by urbanites, as well as by families and tourists coming into Auckland city centre. The routes could be extended to become parts of other walking networks within the CBD, such as historic walks.

Adaptive management plans would be used to address current practices of pesticide and other chemical use within Auckland city centre, particularly areas where interventions are located.

PLANT LIST

Accompanying the majority of the interventions is planting. A 'Top 40 Plant List' was developed through collating plants that were constantly recommended in various literatures as providing food and habitat for invertebrates. The list is made up of a fairly equal mix of native and exotic plants, seasonal variety and a wide range of plant habits. This list is not definitive and would need to be further tested and trialled.

When selecting plants for interventions it is important to get a wide range to ensure biodiversity, to best suit each invertebrate, and cater for the different stages in their life cycles. Careful consideration needs to be given to plants with a heavier mass when planting them on rooftops or overhangs, as infrastructure may need to be reinforced.

An adaptive management plan would allow us to review the strengths and weaknesses of this plant list.

BOTANICAL NAME	COMMON NAME	NATIVE	BEES	BUTTERFLIES	GENERAL	INTERVENTION TYPE
Arthropodium cirratum	[illegible]	✓	•		[illegible]	[illegible]
[illegible]	Milkweed and Butterfly weed			[illegible]		GRO

Figure 5: Top 40 Plant List

DISCUSSION AND CONCLUSION

Invertebrates are crucial to the survival of mankind yet humans are causing their decline. Through urban design that encompasses the needs of invertebrates, we can start to remedy this, increasing the biodiversity and conspicuousness of invertebrates in highly urbanised areas, like Auckland city centre.

To enable the application of the findings of this research, a set of guidelines were developed (Figure 6) that would allow Landscape Architects to approach the topic of invertebrates in urban landscapes. The guidelines encompass the functional categories, invertebrate types, and surface and space types, to ensure that biodiversity is considered in the design process.

Cater for an unknown range of invertebrates through biodiversity

Wide range of plants - [native, exotic, varied habits]

Variety of spaces - [physical structures e.g. roofs, walls, pavement]

Different environmental factors - [exposed, sheltered, full sun, shade]

Provide food and habitat nodes - [100m spacing] - Additional nodes interspersed randomly - [at <100m spacing]

Provide for life cycle stages of invertebrates - [e.g. habitat & food sources for larvae & adult]

Vary the way public interact with interventions

Provide levels of interaction - [direct vs. indirect e.g. opening log habitats vs. screens]

Range of interventions - [roof tops, clay walls, seating, planting, lift boxes]

Utilise available technology - [QR Codes, green roof & wall technology]

Provide relevant information - [signs, QR Codes]

Place interventions in a range of city spaces - [each space used differently by urbanites e.g. civic space, urban park, main road]

Continue to investigate invertebrate ecology

Species requirements - [plant relationships, food & habitat needs]

Species functionality - [pollinator, carnivore, travel mode]

Adaptive management plan - [monitor, analyse, adjust]

Figure 6: Guidelines

Due to the unknown realm of invertebrates it is important to have alongside these guidelines, a way to visually measure the success of the designs. This can be achieved through the measures below:

- The ability to see the invertebrate species
- Signs of invertebrate species; this includes nest, shed skins, chewed leaves, and invertebrates noises
- Having invertebrate species in the higher ends of the trophic levels – for example spiders
- And evidence of invertebrate species completing full life cycles in the network.

The guidelines, along with the 'Top 40 Native and Exotic' plants list act as a source for other Landscape Architects and professionals to use to create urban invertebrate landscapes of their own. The research lends itself to be utilised within other urban environment policies and environmental issues, addresses Auckland Council's plans to become the world's most liveable city and provides a model for how Auckland Council's Indigenous Biodiversity Strategies can be accomplished.

If this project was to be implemented it could provide an opportunity to expand the available knowledge on invertebrates. An adaptive management plan would also need to be developed.

'Invertebrates in urban landscapes' is a highly relevant topic to the Landscape Architecture profession. It has an important role in enhancing the biodiversity potential of our urban landscapes, enriching them, as well as protecting invertebrate numbers. The interventions are generic and can be easily retrofitted for other sites. They allow meaningful interactions to occur between, people, invertebrates and site. Landscape Architects are in an ideal position to be part of the move to design highly urban landscapes that cater for invertebrates.

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