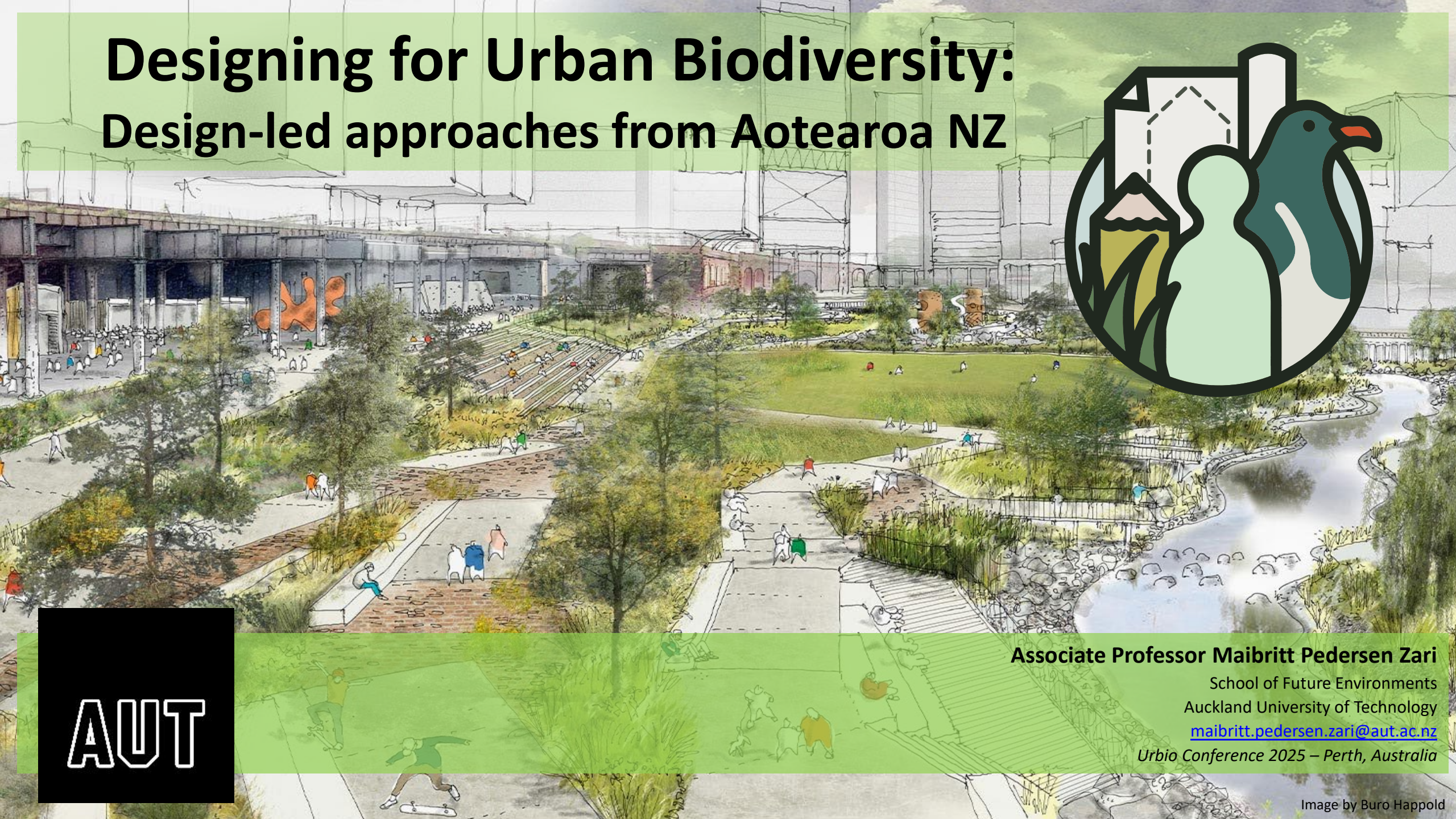
Designing for Urban Biodiversity:

Design-led approaches from Aotearoa NZ



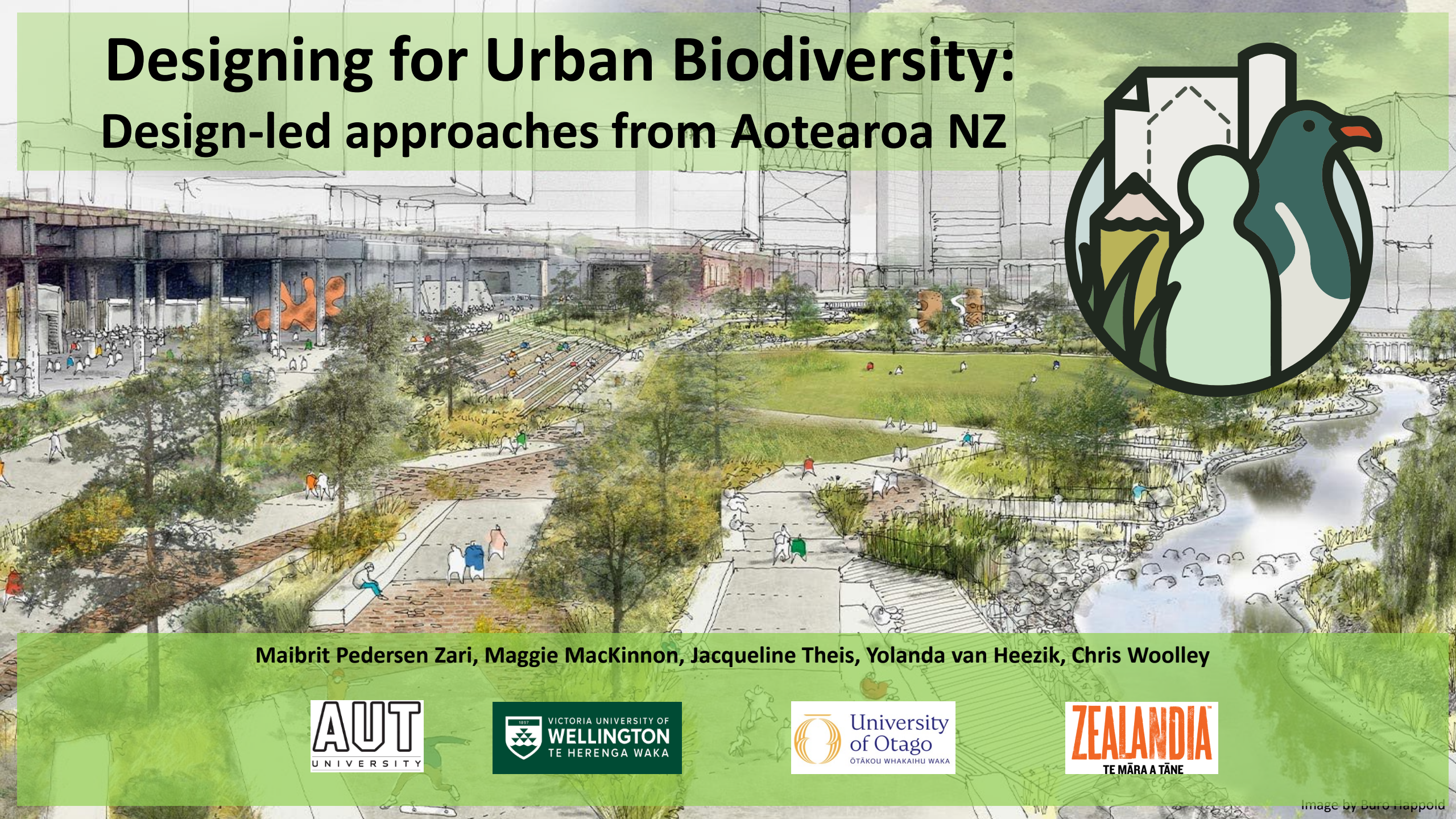
Associate Professor Maibritt Pedersen Zari
School of Future Environments
Auckland University of Technology
maibritt.pedersen.zari@aut.ac.nz

Urbio Conference 2025 – Perth, Australia

Image by Buro Happold

Designing for Urban Biodiversity:

Design-led approaches from Aotearoa NZ



Maibrit Pedersen Zari, Maggie MacKinnon, Jacqueline Theis, Yolanda van Heezik, Chris Woolley

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University of Otago ŌTĀKOU WHAKAIHU WAKA

ZEALANDIA™ TE MĀRA A TĀNE

Image by Buro Happold

People, Cities, & Nature

AOTEAROA BIODIVERCITY: BIODIVERSE MEDIUM DENSITY DEVELOPMENT

www.peoplecitiesnature.co.nz

Residential developments have huge potential to contribute to urban biodiversity through improved and innovative design. We are devising means and goals for optimal biodiversity to be applied to urban greenspace, architecture and built infrastructure.

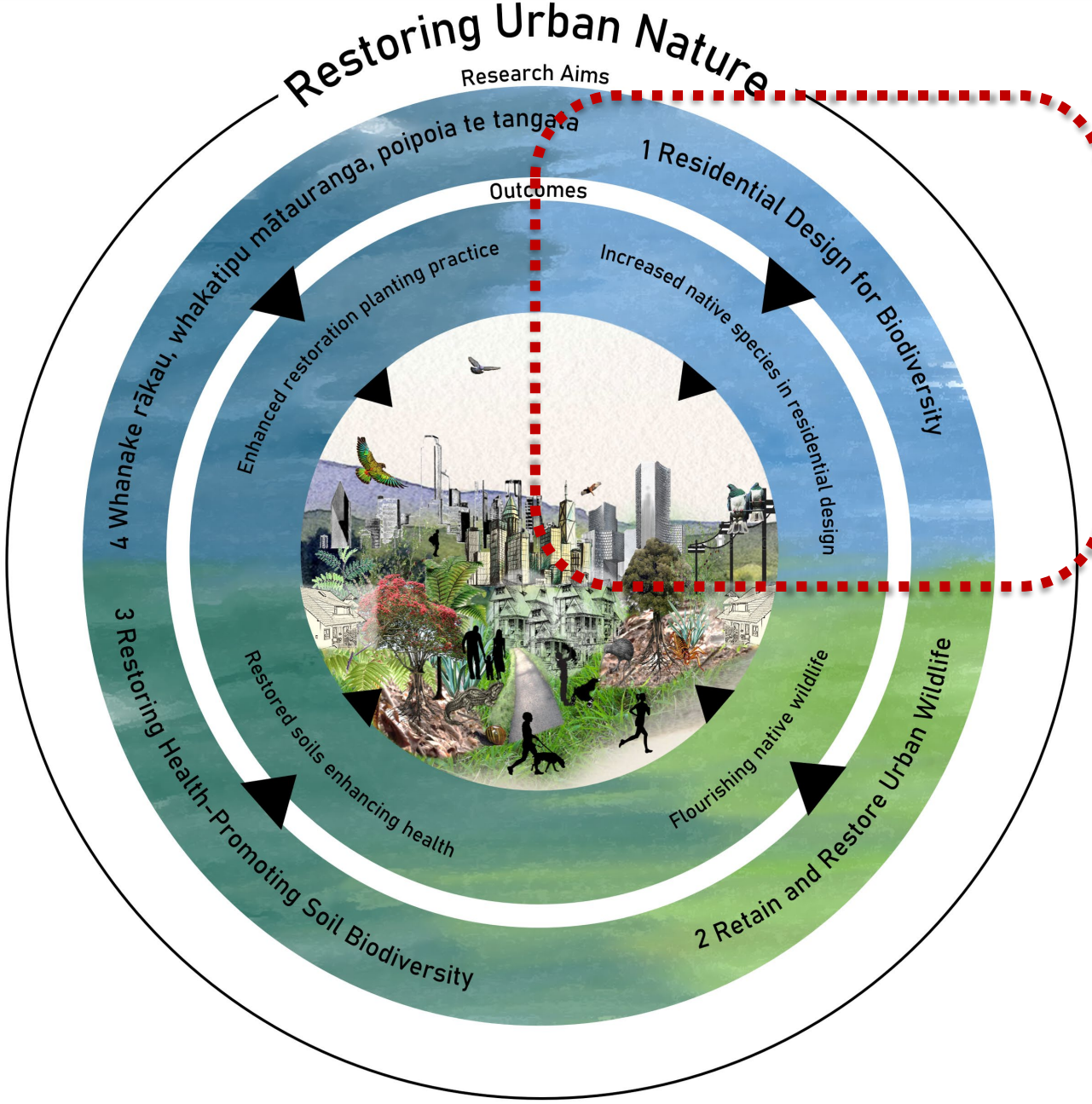
MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

University of Otago
ŌTĀKOU WHAKAIHU WAKA

ZEALANDIA
TE MĀRA A TĀNE

AUT UNIVERSITY

VICTORIA UNIVERSITY OF WELLINGTON
TE HERENGA WAKA



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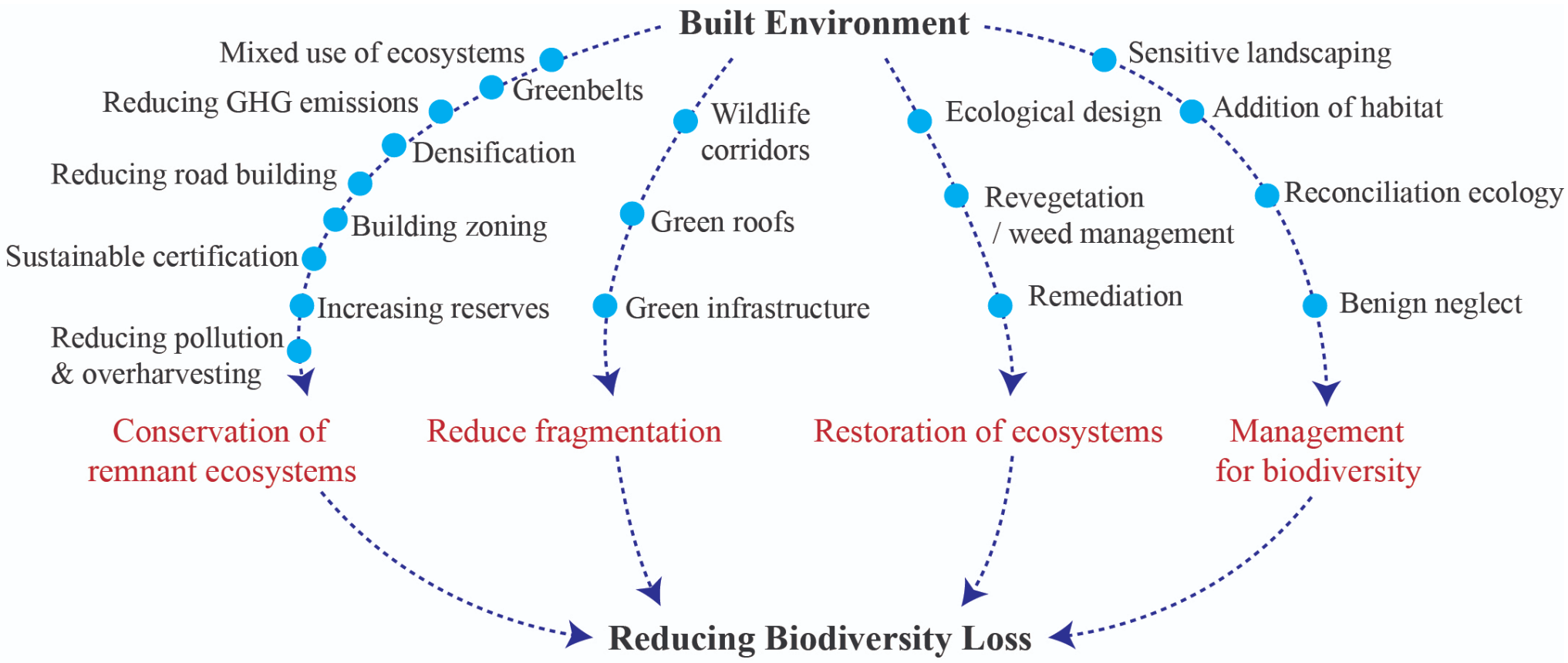
Bosco Verticale.
Boeri Studio, Milan

How can the built environment increase urban biodiversity?

- Multiple pathways
- Greenspaces + buildings + infrastructure
- Synergistic benefits
- Connectivity
- Process + strategies

How can the built environment increase biodiversity?



PEDERSEN ZARI, M. 2018. **The importance of urban biodiversity – an ecosystem services approach.** *Biodiversity International Journal. Vol. 2, No. 4 pages 375-360.* https://medcraveonline.com/medcrave.org/index.php/BIJ/article/view/3481/6806

Aotearoa BiodiverCITY

- Focus on medium density development
- Policy analysis
- Barriers to increasing urban biodiversity
- Future scenarios
- A suite of tools
  - Aotearoa Design for Biodiversity Guide
  - Garden Star
  - New Zealand Biodiversity Factor tools
- Approach: scientific + design-led, interdisciplinary, place-based

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Aotearoa BiodiverCITY – the team

Yolanda van Heezik

Urban ecologist

Otago University

Danielle Shanahan

Restoration ecologist

Socio-ecological systems

Zealandia Eco-sanctuary

Claire Freeman

Planning for the natural environment & diversity

Victoria University

Maibritt Pedersen Zari

Regenerative architecture & urban design

Auckland University of Technology

Chris Woolley

Urban restoration ecologist

Zealandia Eco-sanctuary

Jacquie Theis
PhD candidate, Otago

Maggie MacKinnon
Urban biodiversity, Victoria University

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Canary Wharf Group and Eden Project, London

What is urban biodiversity?

- Biogeographic and anthropogenic factors
- Humans as inseparable from the living world

Maureen Lander Kit-Set Whanaungatanga / Flat-pack whakapapa. 2017. Harakeke, teri dyes.

Cultural and relational value; social justice

- Whakapapa
- Identity
- Te Tiriti

Rodgers, M., Mercier, O.R., Kiddle, R., & Pedersen Zari, M. (2023). **Plants of place: justice through (re) planting Aotearoa New Zealand's urban natural heritage**. *Architecture_MPS*, *25*(1).

'In the context of Aotearoa New Zealand where Indigenous human-nature-biodiversity relationships are unique, meaningful, spiritual, and often political, reflecting a worldview aligned with a concept of interconnected relational living ecologies that bind human and non-human life into an interdependent whole, there is additional reason to ensure that biodiversity is more adequately considered at urban development policy levels as part of partnership obligations under Te Tiriti'

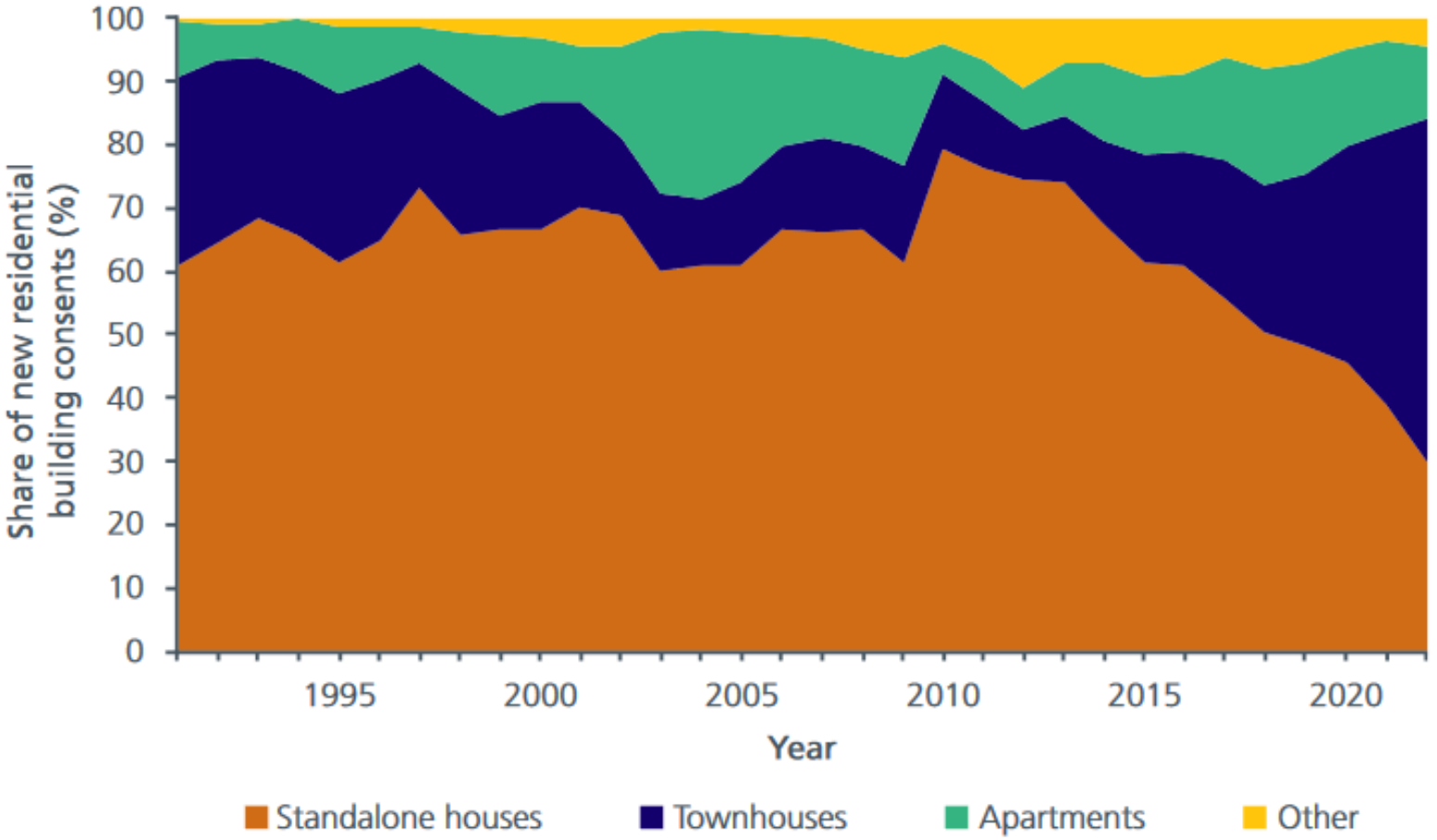
Varshney, K., MacKinnon, M., Zari, M. P., Shanahan, D., Woolley, C., Freeman, C., & van Heezik, Y. (2024). **Biodiverse residential development: A review of New Zealand policies and strategies for urban biodiversity.** *Urban forestry & urban greening*, 128276.

Aotearoa urban green space - overview

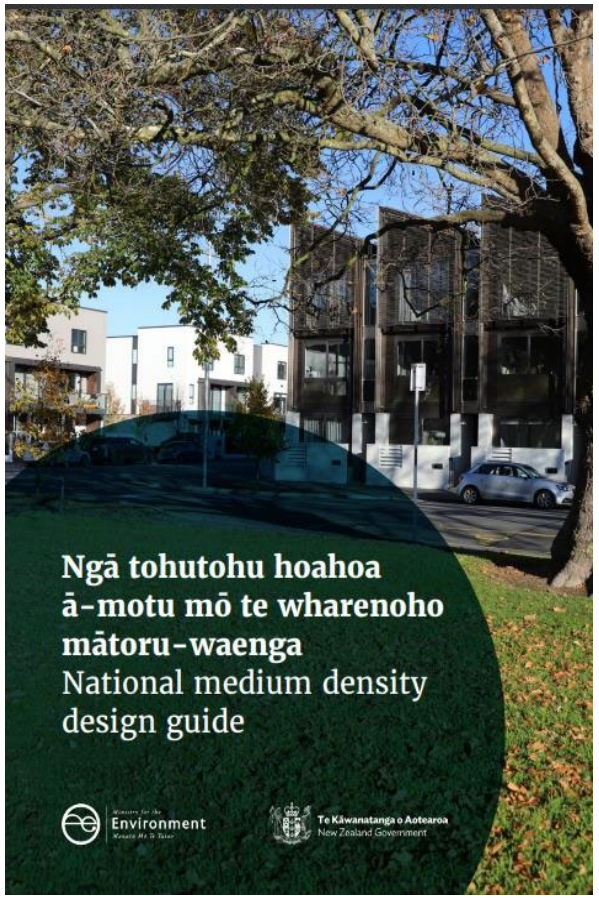
- 86% of NZers live in urban settings
- NZ cities have a lot of urban green space, but this is not evenly distributed and is dropping in total
- Greenspace PER PERSON is dropping in some areas
- Most New Zealanders have good access to coastline/ beaches

Blaschke, P. et al. (2024). **Multiple roles of green space in the resilience, sustainability and equity of Aotearoa New Zealand's cities.** *Land*, *13*(7), 1022.

Why medium-density development?



Source: Data from Stats NZ (2022a)



- Medium-density housing is accelerating across NZ cities

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Medium-density development – the context

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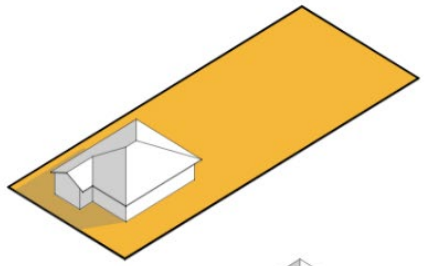
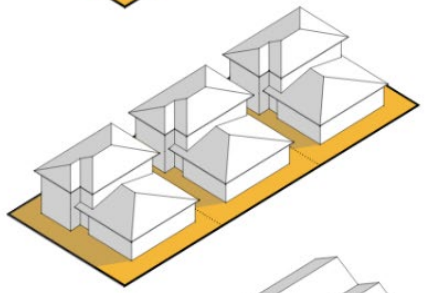
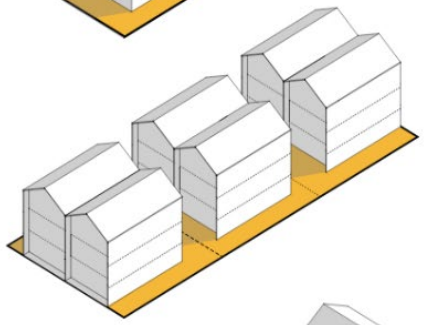
Medium-density development – the context



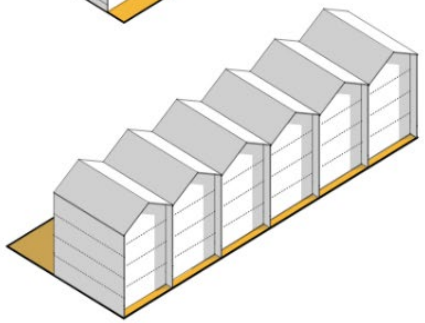
Past: 1012m^2, ¼ acre
Density: 10 dwelling units/ha



Current:
Density: 36 dwelling units/ha



Current:
Density: 50 dwelling units/ha



6 sites – 168 m^2 each, 1/24th acre
Density: 250 dwelling units/ha

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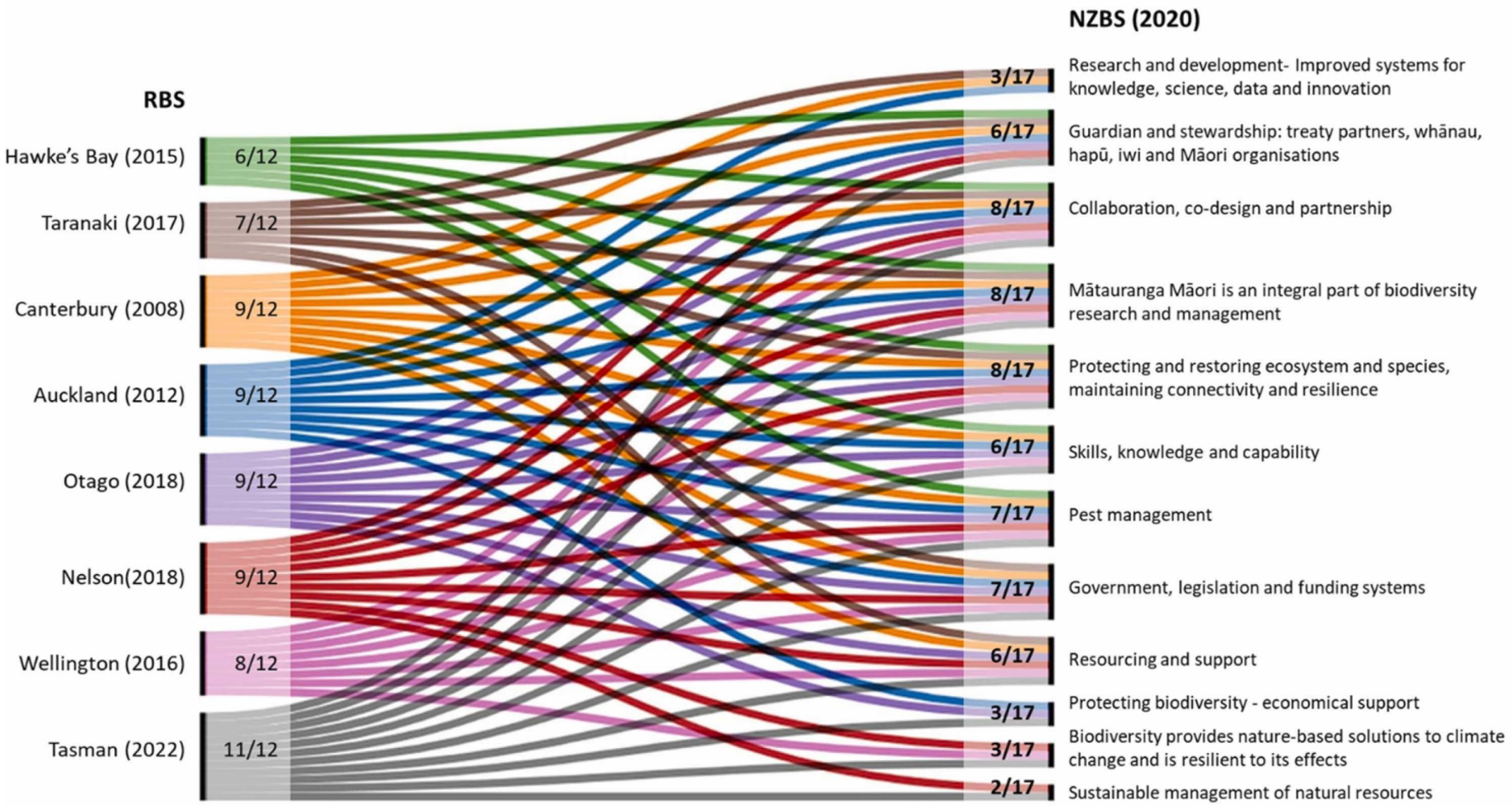
Development and biodiversity - Policy



Correlation between regional biodiversity strategies (RBS) and the New Zealand Biodiversity Strategy (NZBS). (image by K. Varshney)

Varshney, K., MacKinnon, M., Pedersen Zari, M., Shanahan, D., Woolley, C., Freeman, C., & van Heezik, Y. (2024).
Biodiverse residential development: A review of New Zealand policies and strategies for urban biodiversity. *Urban forestry & urban greening*, 128276.

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- Biodiversity is not explicitly considered in medium-density residential development in NZ.
- Current policies, strategies & planning for residential developments are inadequate.
- District plans & design guidelines should identify explicit biodiversity outcomes.
- Residential design guidelines should include measures & monitoring of biodiversity.
- Policy and design precedents exist.
- **Designers need to know HOW to increase biodiversity**

Hammerby Sjöstad, Stockholm, Sweden


Earthsong, Auckland, Aotearoa

Varshney, K., MacKinnon, M., Pedersen Zari, M., Shanahan, D., Woolley, C., Freeman, C., & van Heezik, Y. (2024). **Biodiverse residential development: A review of New Zealand policies and strategies for urban biodiversity.** *Urban forestry & urban greening*, 128276.

Opportunity:

- Embed ecological regeneration into intensified urban form and architecture itself through design

The Aotearoa BiodiverCITY Toolbox

- Aotearoa Design for Biodiversity Guide: Process + strategies - creative & spatial focus
  - CONCEPTUAL DESIGN STAGE
- Suite of tools to support biodiversity-positive built environment evaluations: NZ Biodiversity Factor
  - DEVELOPED DESIGN STAGE and BUILT

NZBF-R NZBF-B NZBF-CS

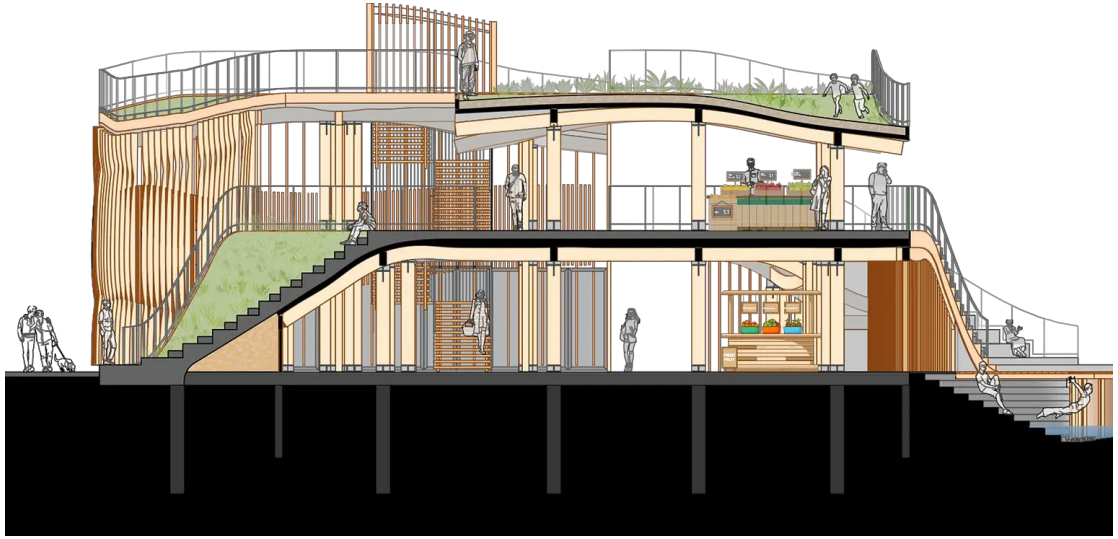
Aotearoa Design for Biodiversity Guide: Purpose

- Support architects, urban designers, planners, developers to integrate biodiversity into the beginning of projects.

- Provide clear, practical process guidance and a set of strategies for increasing urban biodiversity through built environment design at various scales.

Research Methods Approach

- Grounded in Aotearoa ecologies, cultures, contexts
- Co-developed with ecologists & designers
- **Design-led research**
- **Process (HOW) + Strategies (WHAT)**
- Case study analysis
- Literature analysis - existing biodiversity strategies (eg BSUD) and processes
- Categorisation of strategies (grounded theory)
- Interactive online platform



Images by Thomas Westend and Micheala Thomson

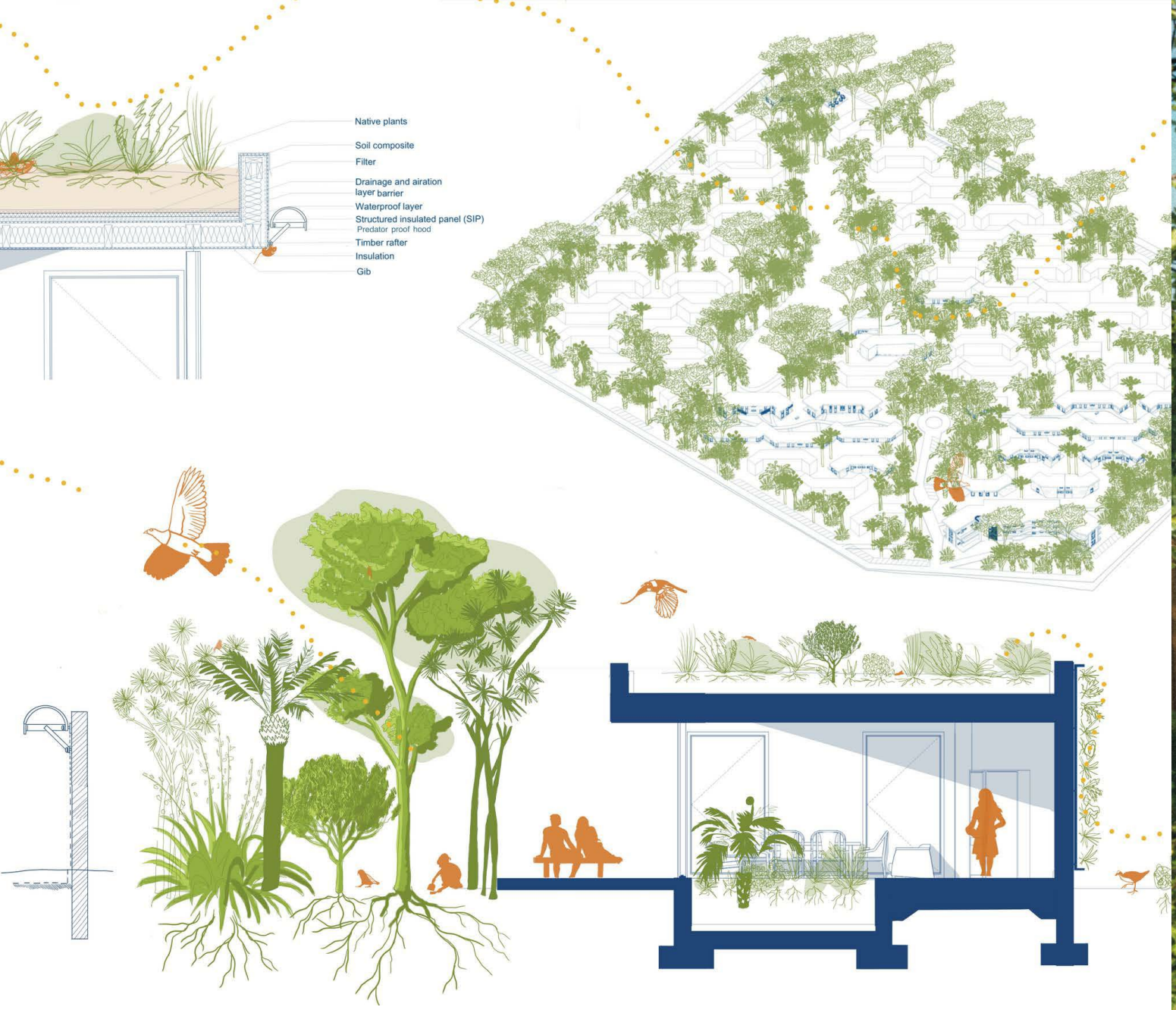
Image by George Tamati

Design-led research approaches:

REDLab

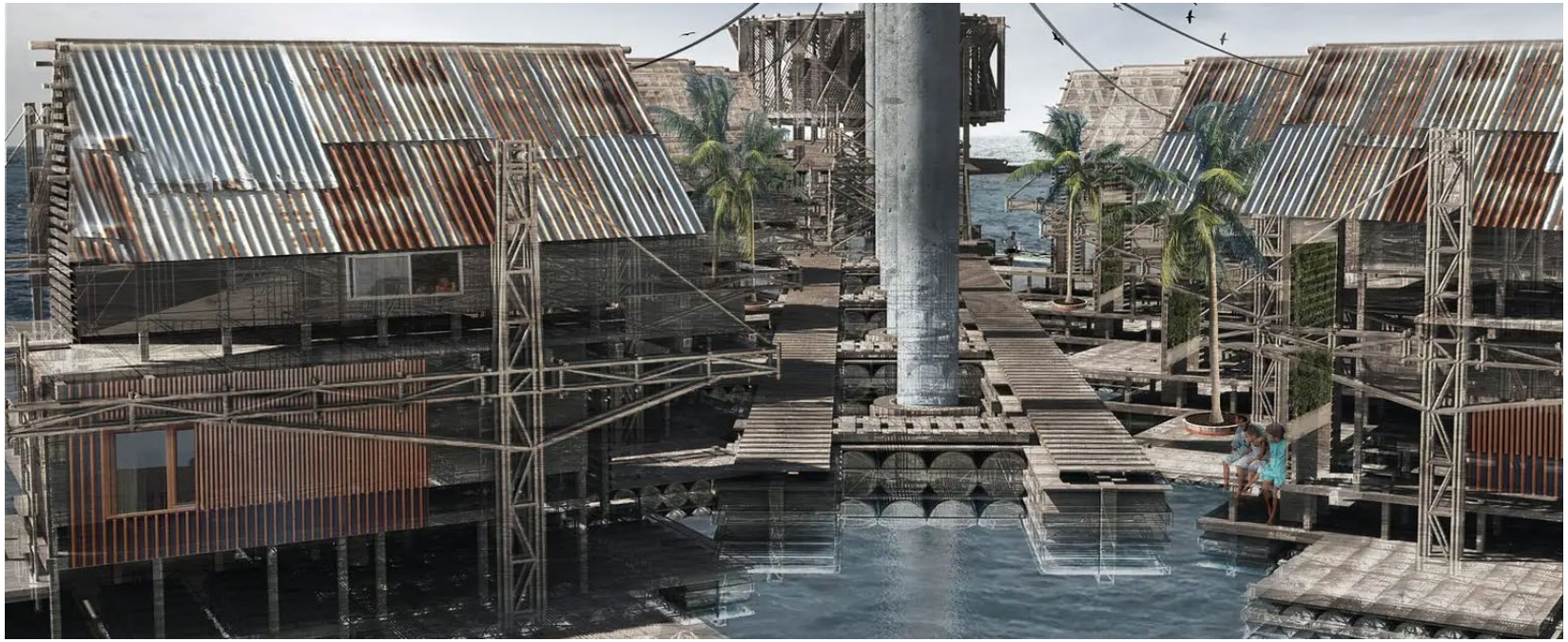
Regenerative Ecologies Design

https://regenerativeecologies.com/



Du Preez, R. K. (2024). ***Medium-density housing designed to conserve and regenerate native biodiversity in Auckland, Aotearoa New Zealand*** (Master of Architecture – prof thesis). Auckland University of Technology.

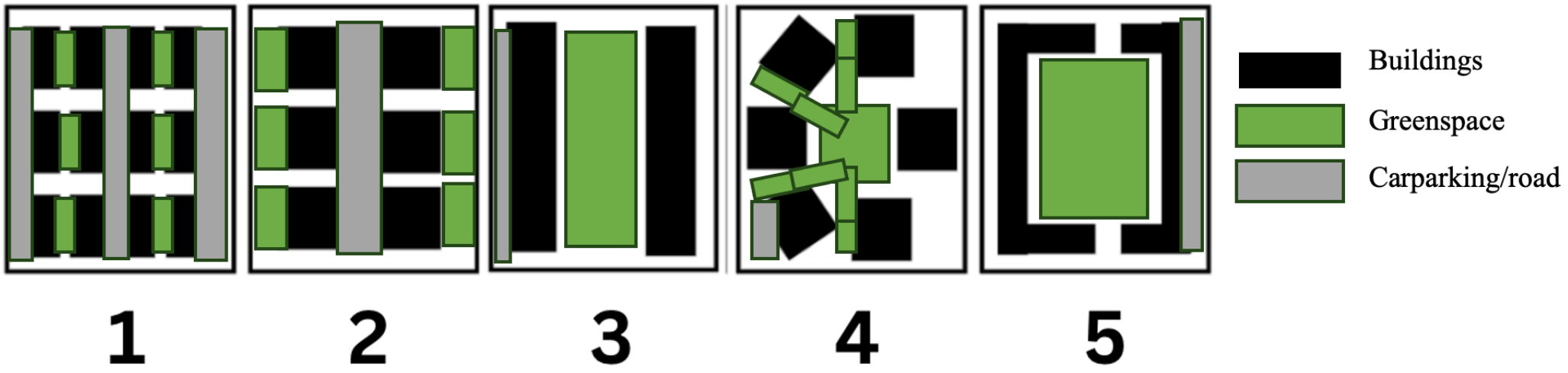
Jenkins, K. (2024). ***BiodiverCity: The integration of biodiversity with medium-density housing*** (Master of Landscape Architecture thesis) Victoria University of Wellington).



Michaela Thomson, VUW
Master of Landscape Architecture 2019
http://researcharchive.vuw.ac.nz/xmlui/handle/10063/8870

Planning for biodiversity

Alternative spatial forms & layouts to enhance biodiversity and community resilience



Sarah Copeland (2024). **Socio-Ecological 'In-Between' Spaces within Residential Developments in Aotearoa.** Master of Planning thesis, University of Otago

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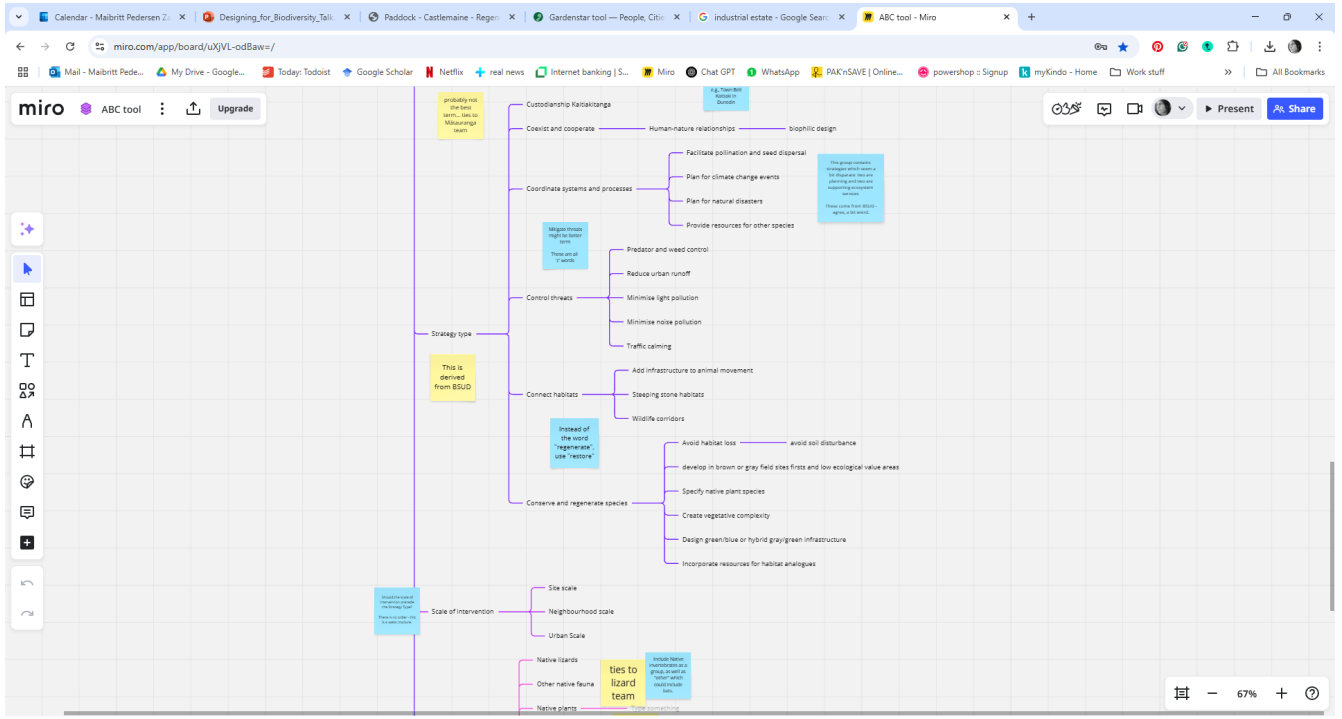
Process + Strategies:

Aotearoa Design for Biodiversity Guide

Aotearoa Design for Biodiversity Guide



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Design for Biodiversity: Process

Aotearoa BiodiverCity

1. Prioritise ways of understanding and valuing biodiversity that reflect interwoven cultural and ecological knowledges as a foundation for the project at the conceptual design stage.
2. Assess past, existing, and future site and climate conditions to determine keystone / indicator species to design for.
3. Analyse the site's wider catchment to potentially connect with nearby habitats.
4. Conserve, remediate, and restore soil and native vegetation wherever possible.
5. Design to site hydrology. Use water flows to design for green corridors and pathways.
6. Minimise roads and car access. Reclaim space for vegetation, pedestrians, and safer, quieter places.
7. Cluster and orient buildings to maximise green space and social connection.
8. **Integrate NbS, water-sensitive design, and biodiversity strategies at block and neighbourhood scales.**
9. **Design buildings as living systems. Vegetation-integrated buildings and sanctuary spaces for flora and fauna.**
10. **Foster meaningful reciprocal human–nature relationships that enrich wellbeing and are grounded in te ao Māori values.**
11. **Use NZBF tools to refine designs and evaluate built projects**

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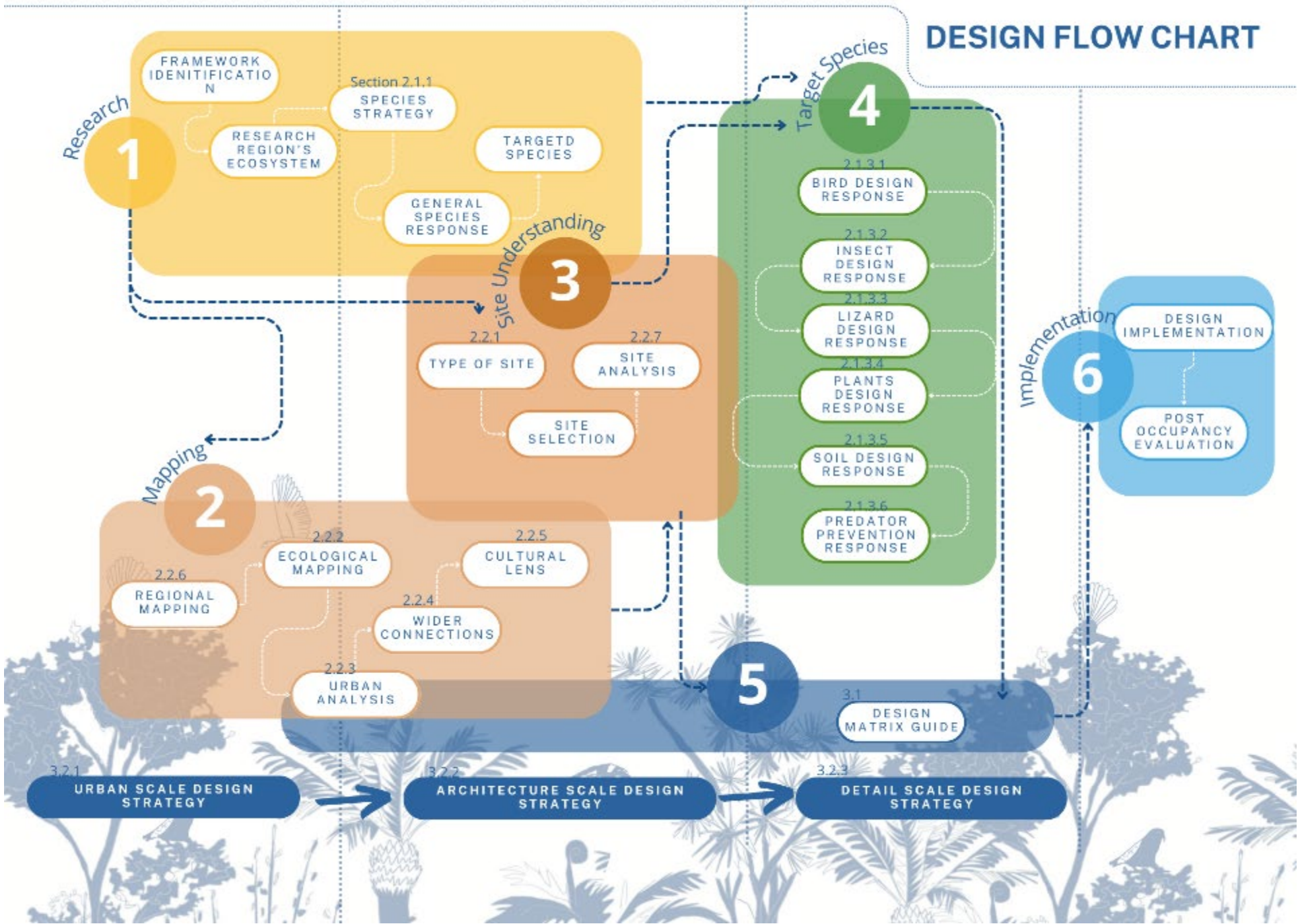


Key design moves.

Selected site.

01. Create a **planting buffer** around the border of the site to put the habitat at the forefront of the design.

02. Place multiple **social gathering spaces** around the site.

03. Design with different scaled interventions to contribute to the **native biodiversity** of the area at different stages.

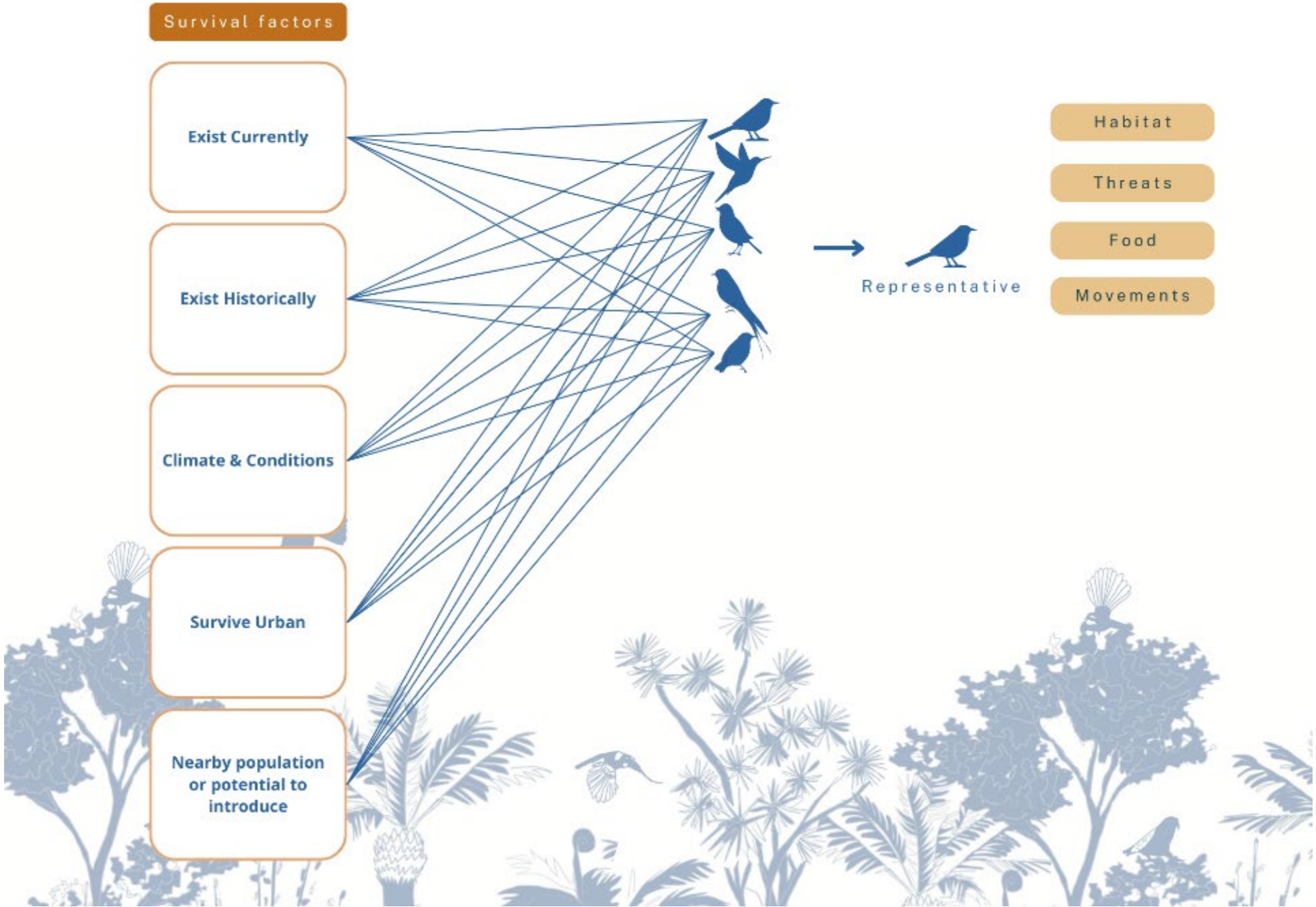
04. The native planting is selected to respond to the specific requirements of the area within Wellington and the **keystone species habitat needs** within an urban environment.

05. A **pedestrian only** site to contribute towards the exploration around the site through multiple pathways.

06. Integration of green walls on the southern side and green roofs that include isolated and interactive designs.

07. **Hidden predator traps** that are monitored through the residents to educate everyone on the importance of our native species.

Aotearoa BiodiverCity



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Keystone species.

Kereru
NZ Pigeon

Piwakawaka
Fantail

Northern Grass skink

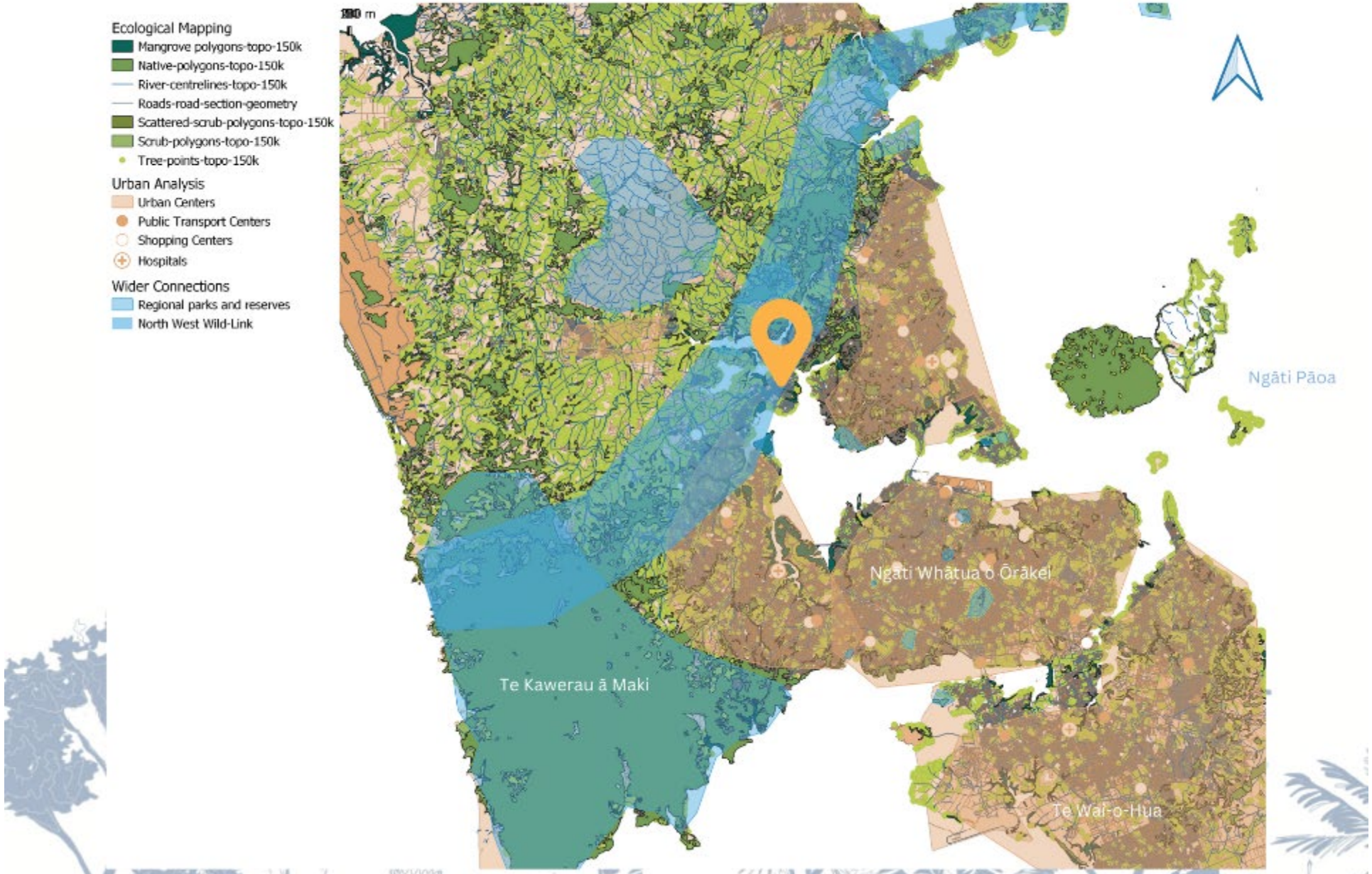
Kaka

Korimako
Bellbird

Titipounamu
Rifleman

Katie Jenkins, Master of Landscape Architecture, VUW, 2023. The Integration of Biodiversity within Medium-density Housing

Aotearoa BiodiverCity

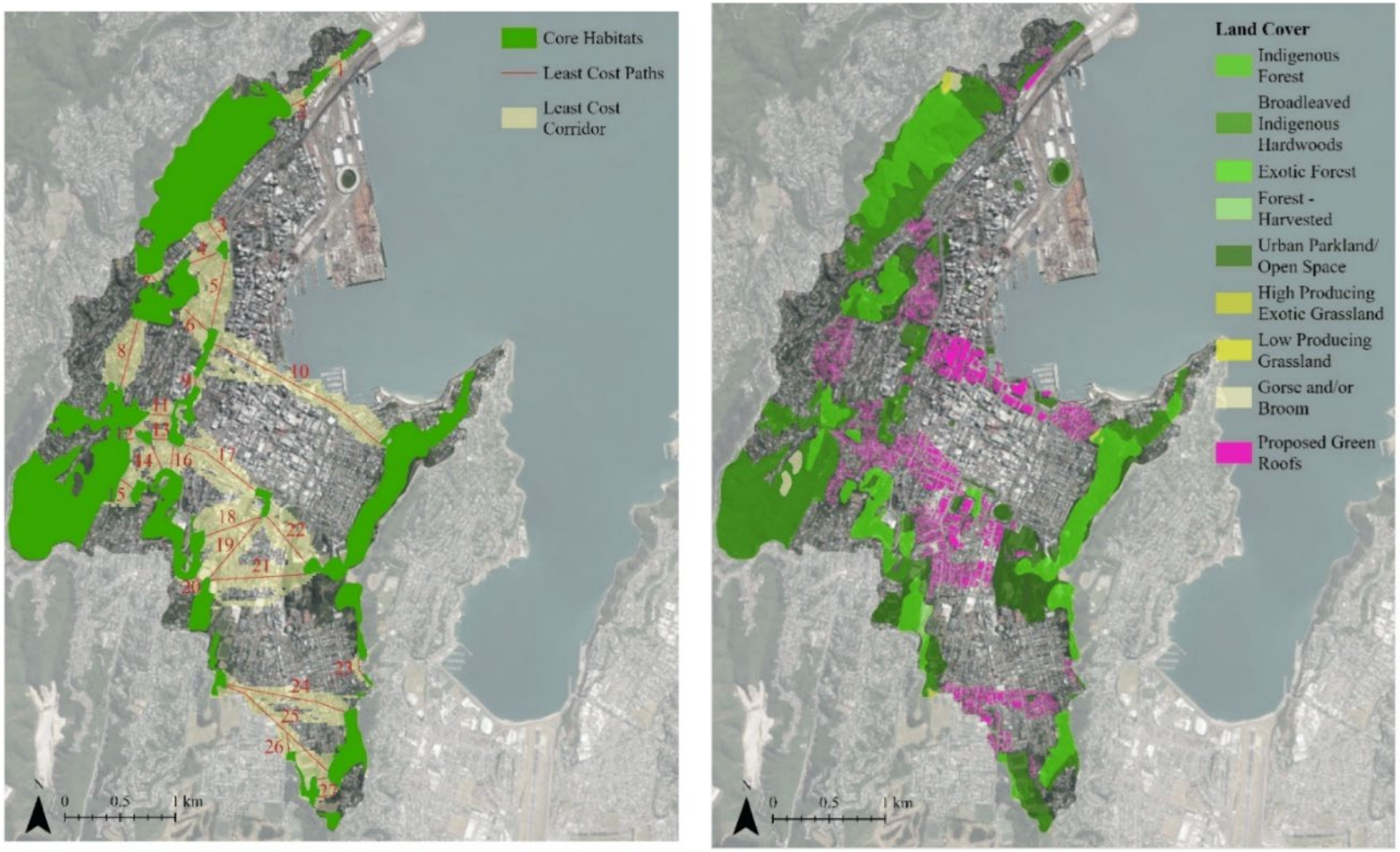


Green connection.

+ Zealandia

+ The Botanical gardens

+ Mount Victoria



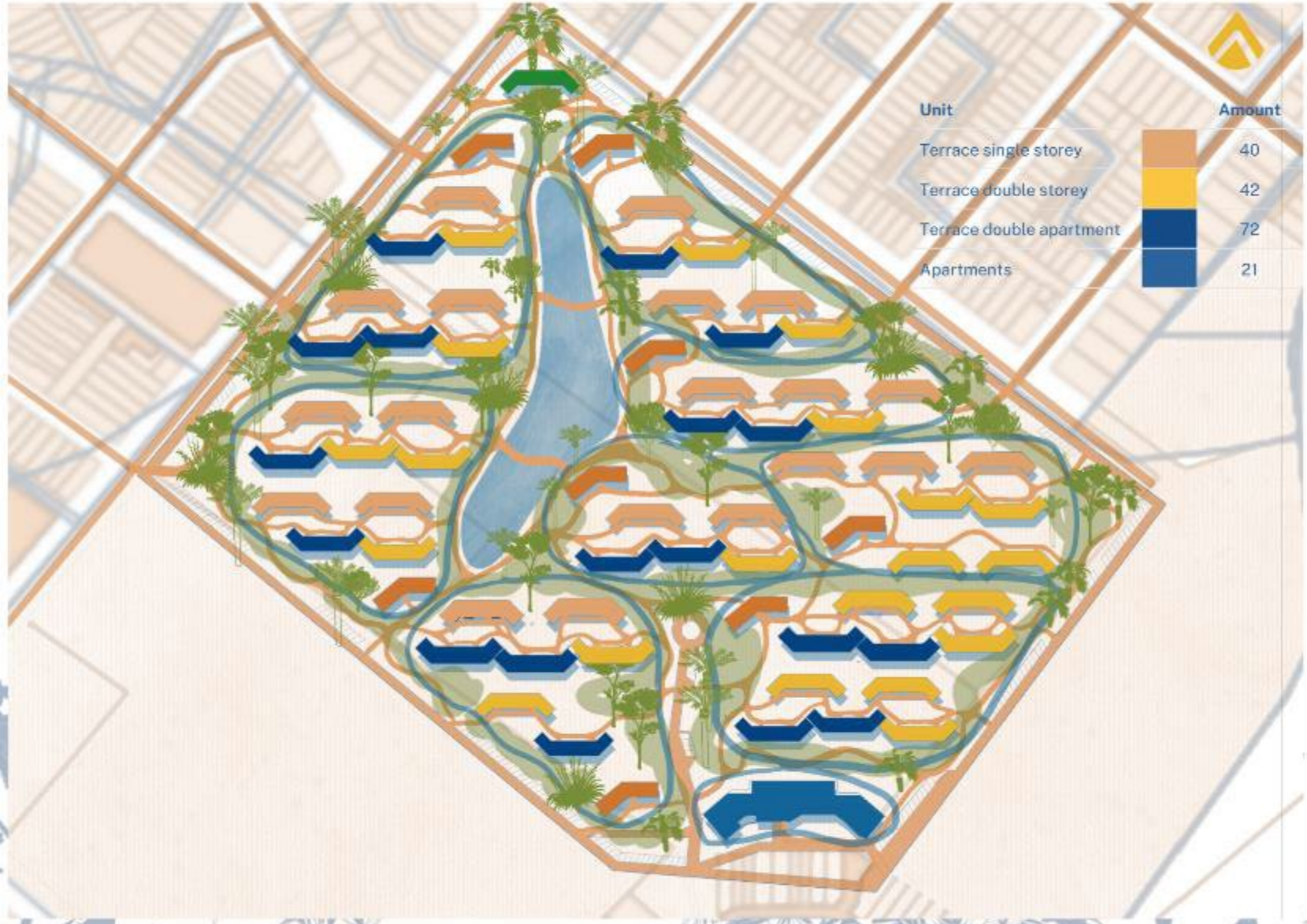
Urban green infrastructure design using outputs from the Linkage Pathways tool: (**a**) consolidated least-cost paths connecting core habitats for the four study species; (**b**) proposed locations for green roofs to supplement the existing green space network.

MacKinnon, M., Pedersen Zari, M., & Brown, D.K. (2023). Improving urban habitat connectivity for native birds: using least-cost path analyses to design urban green infrastructure networks. *Land*, *12*(7), 1456.

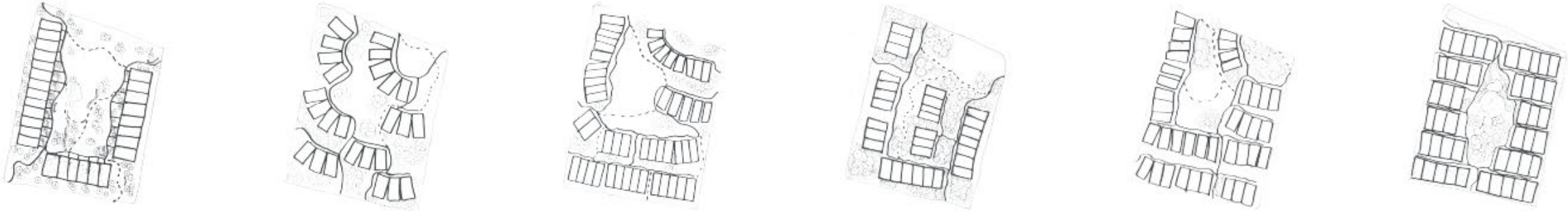
Robyn Kay duPreez, Master of Architecture, AUT, 2024. Medium-density Housing Designed to Conserve and Regenerate Native Biodiversity

Aotearoa BiodiverCity

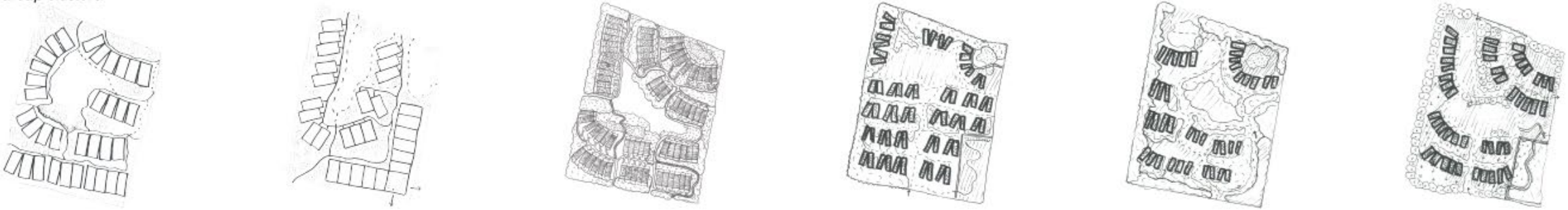
Aotearoa BiodiverCity



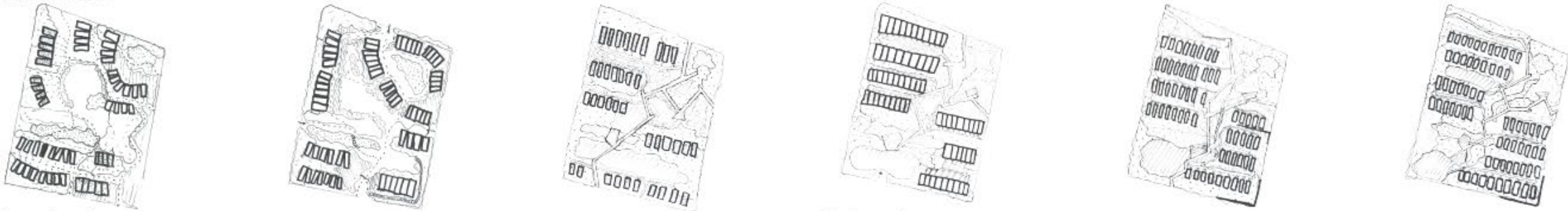
Changing orientation of homes.



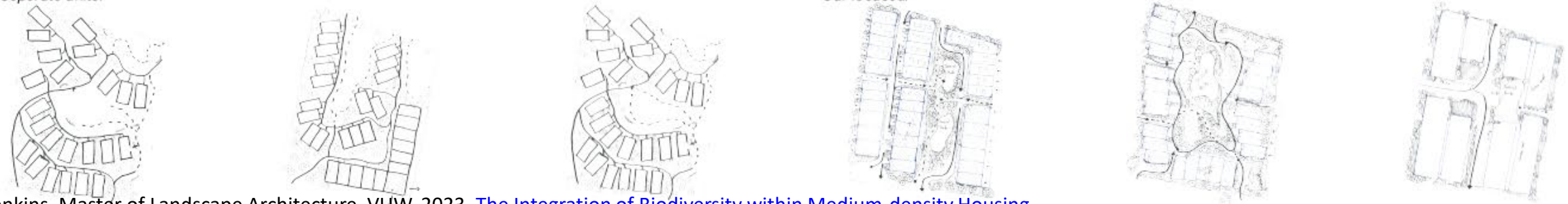
Group clusters.



Site movement.



Seperate units.



Car focused.

Katie Jenkins, Master of Landscape Architecture, VUW, 2023. The Integration of Biodiversity within Medium-density Housing

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Refining the design.

Houses: 86 Lots (1806m2) 13%
Green space: 11,846m2 87%
Approx: 516 people

Houses: 97 Lots (2037m2) 15%
Green space: 11,846m2 85%
approx: 582 people

Houses: 130 Lots (2730m2) 20%
Green space: 10,922m2 80%
approx: 780 people

Houses: 195 lots (4095.6m2) 30%
Green space: 9556.4m2 70%
approx: 1170 people

Houses: 260 lots (5460.8m2) 40%
Green space: 8191.2m2 60%
approx: 1560 people

Houses: 325 lots (6826m2) 50%
Green space: (6826m2) 50%
approx: 1950 people

Katie Jenkins, Master of Landscape Architecture, VUW, 2023. The Integration of Biodiversity within Medium-density Housing

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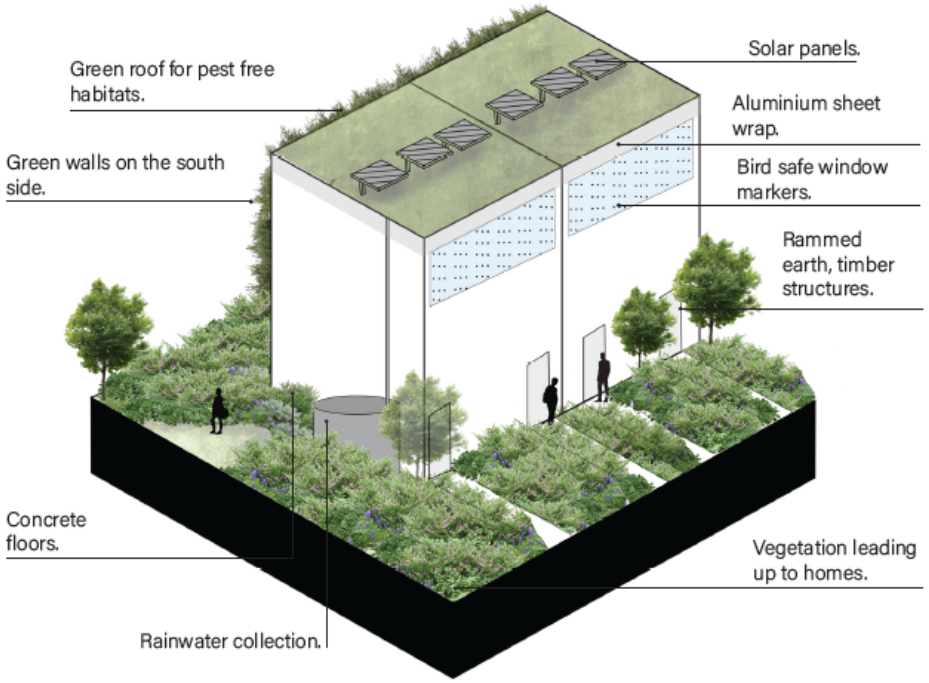
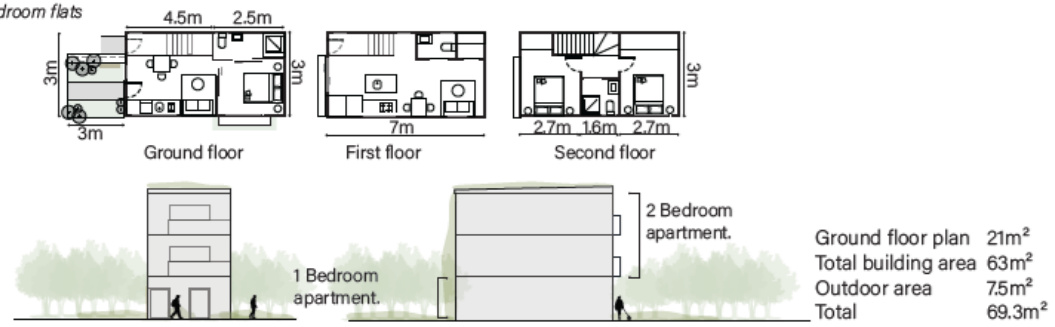
Housing.



Type 1.

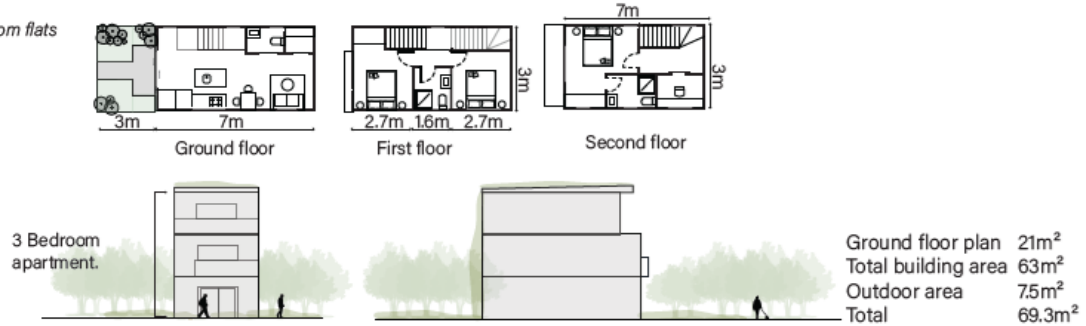
One and two bedroom flats



Ground floor plan	21m²
Total building area	63m²
Outdoor area	7.5m²
Total	69.3m²

Type 2.

Three bedroom flats



Ground floor plan	21m²
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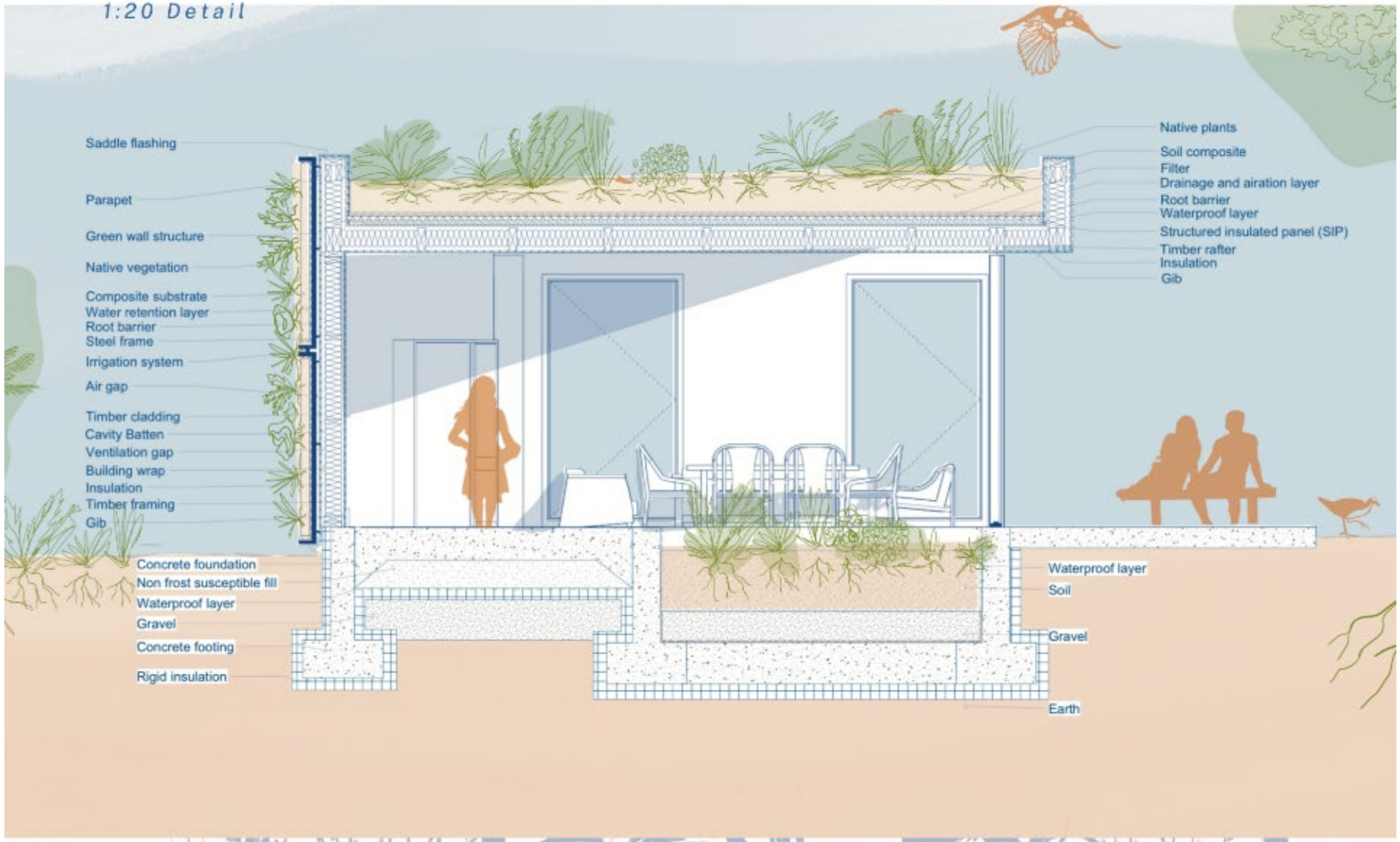
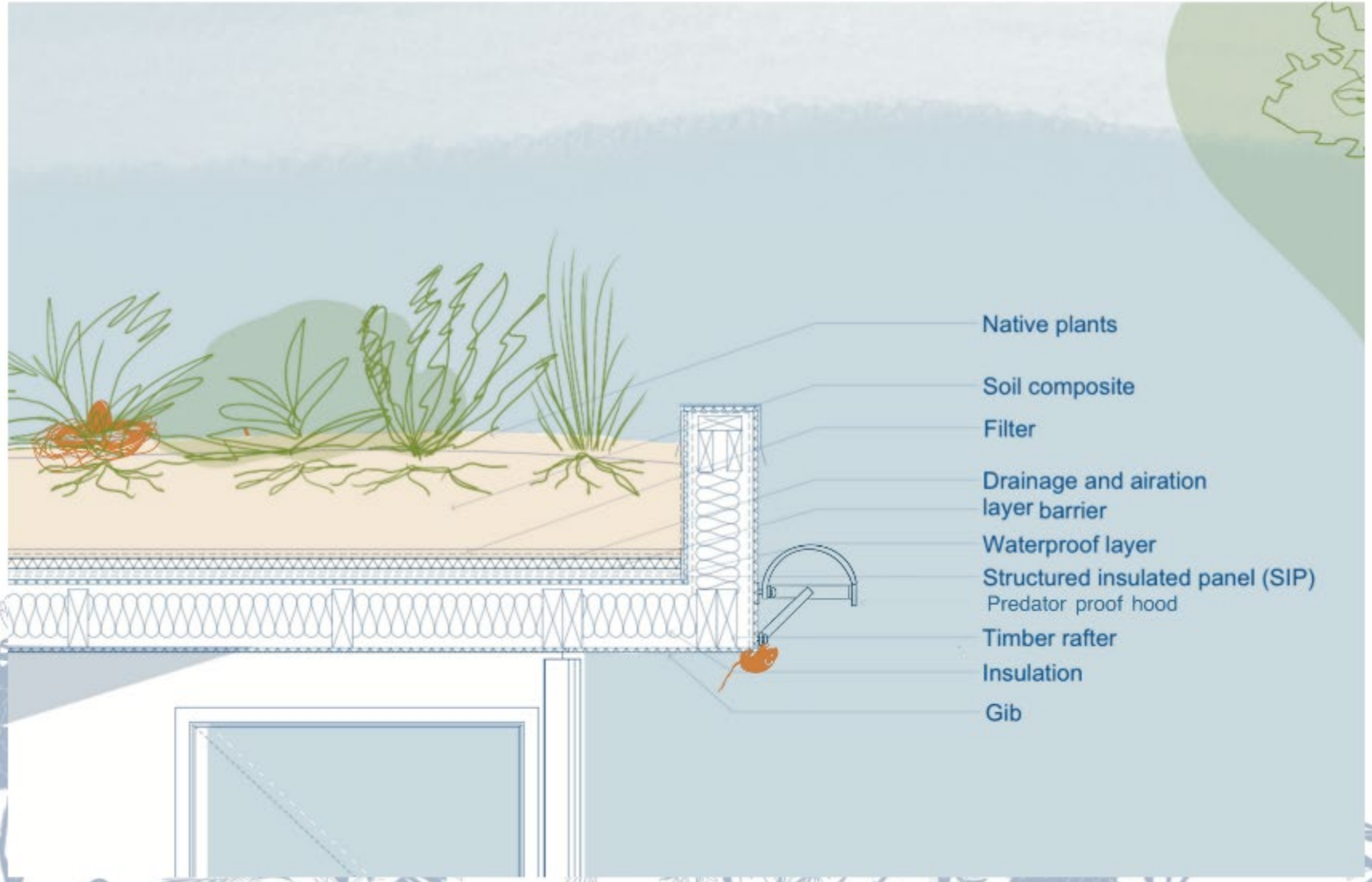
Aotearoa BiodiverCity

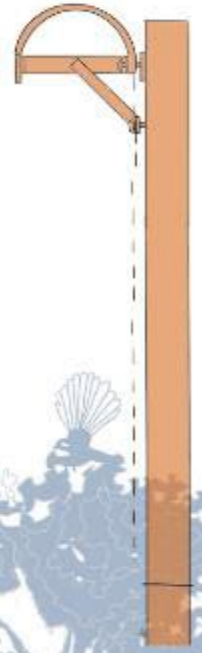


Aotearoa BiodiverCity



Robyn Kay duPreez, Master of Architecture, AUT, 2024. Medium-density Housing Designed to Conserve and Regenerate Native Biodiversity

Aotearoa BiodiverCity



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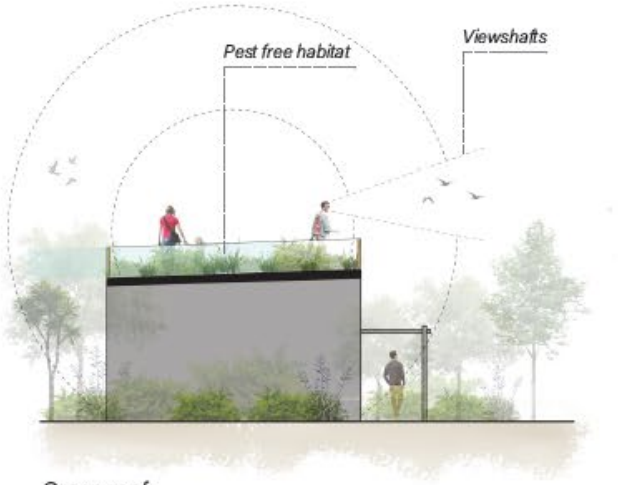
Forms of biodiversity interaction.

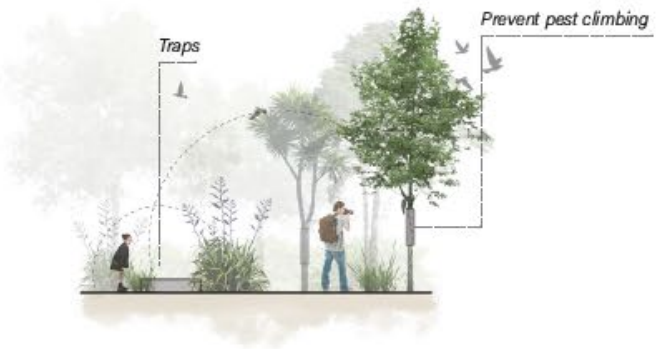


Green roof.

Boardwalks + interactive pathways.

Seating.

Nesting posts.

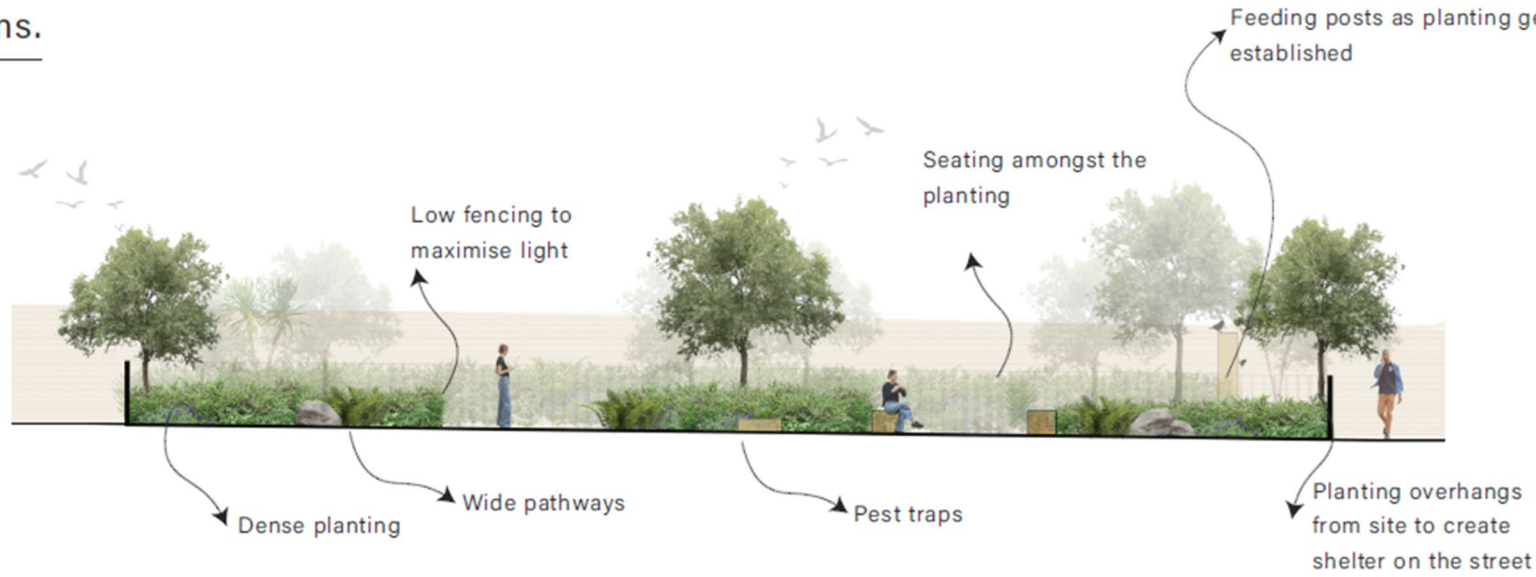


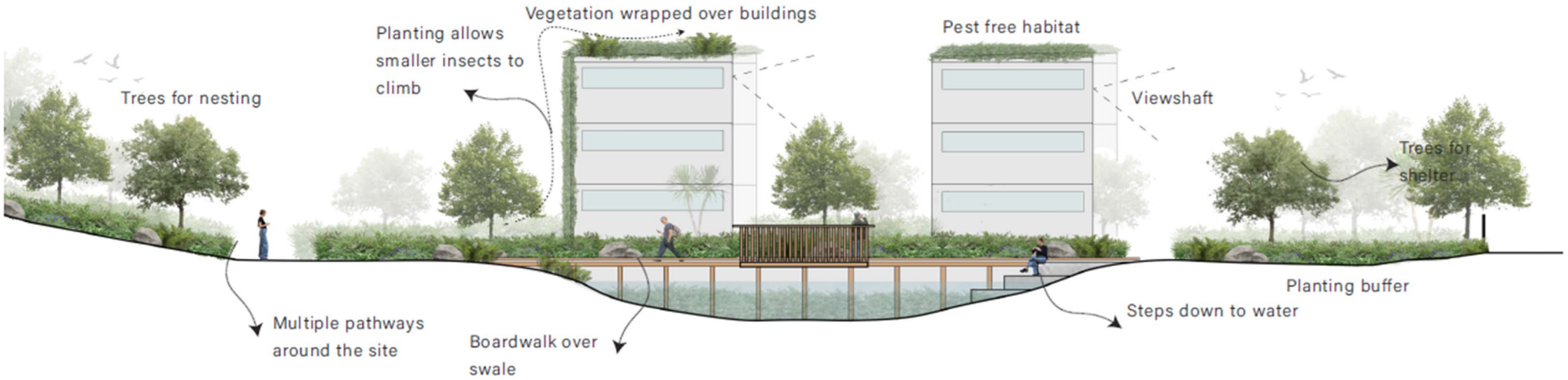
Pest traps.

Katie Jenkins, Master of Landscape Architecture, VUW, 2023. The Integration of Biodiversity within Medium-density Housing

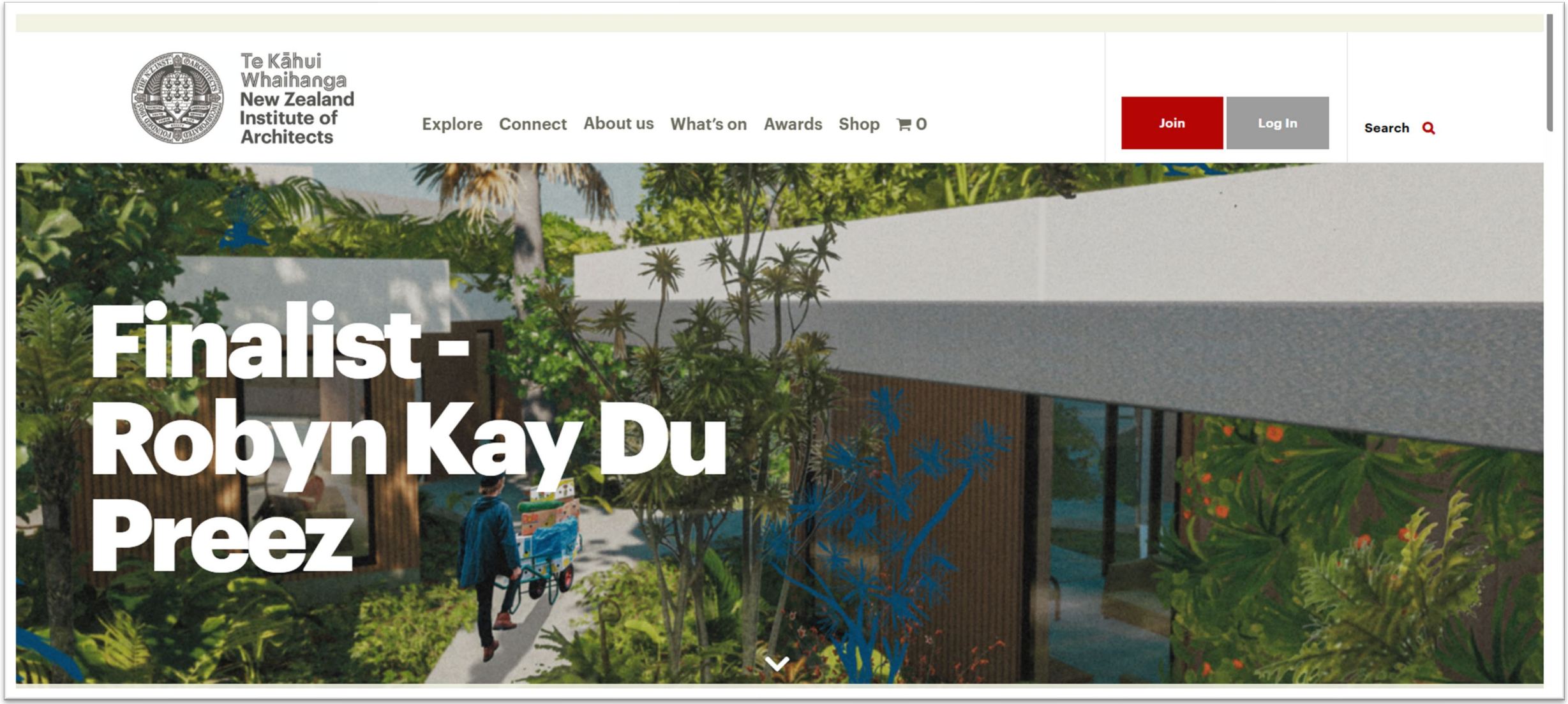
Aotearoa BiodiverCity

Functionality diagrams.





Katie Jenkins, Master of Landscape Architecture, VUW, 2023. [The Integration of Biodiversity within Medium-density Housing]



https://www.nzia.co.nz/awards/student-design-awards/2024-student-design-awards/finalist-robyn-kay-du-preez/


hapori
Medium-density housing designed to conserve and regenerate native biodiversity in Auckland, Aotearoa New Zealand.

Design for Biodiversity: Process

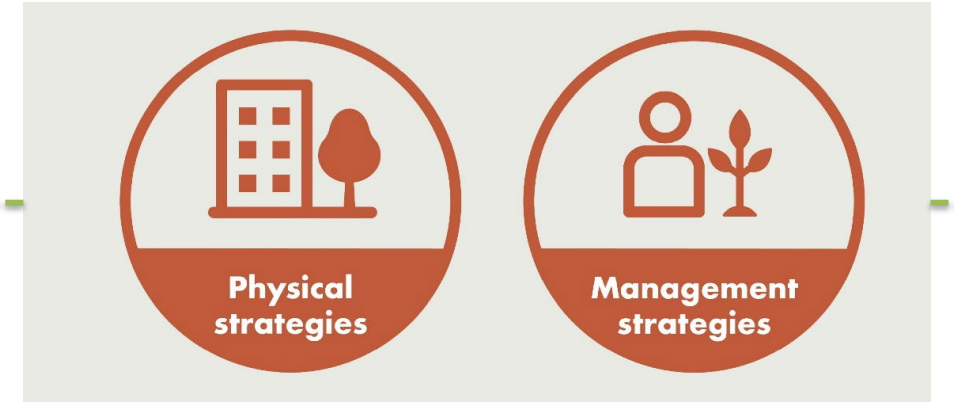
Aotearoa BiodiverCity

1. Prioritise ways of understanding and valuing biodiversity that reflect **interwoven cultural and ecological knowledges** as a foundation for the project at the conceptual design stage.
2. Assess past, existing, and future site and climate conditions to **determine keystone / indicator species to design for**.
3. Analyse the site's wider catchment to potentially **connect with nearby habitats**.
4. Conserve, remediate, and restore **soil and native vegetation** wherever possible.
5. Design to site hydrology. **Use water flows** to design for green corridors and pathways.
6. Minimise roads and car access. **Reclaim space for vegetation, pedestrians**, and safer, quieter places.
7. **Cluster and orient buildings** to maximise green space and social connection.
8. **Integrate NbS, water-sensitive design, and biodiversity strategies at site and neighbourhood scales.**
9. **Design buildings as living systems. Vegetation-integrated buildings and sanctuary spaces for flora and fauna.**
10. **Foster meaningful reciprocal human–nature relationships that enrich wellbeing and are grounded in te ao Māori values.**
11. Use NZBF tools to refine designs and evaluate built projects

100 design for biodiversity strategies

Animal movement infrastructure, backyard gardens, basking area, biofilters, bioremediation/phytoremediation, bioswales, building-created microhabitats, clean construction, climate adapted plantings, clustering of housing, community education ad stewardship, community gardens and mahinga kai, compact high yield urban agriculture, constructed wetlands, container gardens, cue to care strategies, design aligned with maramataka (seasonal calendars, detention ponds, diverse ground cover, erosion prevention, façades for bird safety, faced integrated nesting, perching, fauna shelter, fish passage strategies, floating wetlands, fungi inoculation, gabion structures, green/wildlife corridors, habitat heterogeneity, increase pervious surfaces, insect/wētā hotels, invasive species management, lighting for biodiversity, living crib walls, living machines, living seawalls / biodiversity tiles, minimise disturbance, mulch, mycorrhizal companion planting, natural playgrounds, nesting boxes, noise pollution control, nature-based storm water management, no-mow zones, local seed banking, pet containment….

Animal movement infrastructure
Backyard gardens
Bare soil areas
Basking areas (sunny, open, warm: rocks, concrete)
Biodiversity sensitive landscaping (reduced chemicals)
Biofilters
Bioremediation/phytoremediation of water or soil
Bioshading
Bioswales
Brown or grey-field development (AVOID GREENFIELD)
Buffers
Building colour and reflectivity strategies
Building-created microhabitats
Citizen science biodiversity monitoring - built environment integrated
Clean construction
Climate adapted plantings
Clustering of housing
Community education and active stewardship
Community gardens and Mahinga kai
Compact high yield urban agriculture techniques
Constructed wetlands
Container gardens
Cue to care strategies
Cultural keystone species prioritisation
Design aligned with maramataka / seasonal calendars
Design to support customary harvest or cultural use
Detention ponds
Diverse ground cover
Ecosystem-services integrated design
Erosion prevention (wind and water caused)
Facades for bird safety
Façade-integrated nesting, perching, roosting, shelter structures
Fauna shelter (dense vegetation, logs, crevices, rock piles etc)
Fish passage strategies
Floating wetlands or pontoons in urban water bodies
Fungi innoculation
Gabion structures
Green/wildlife corridors bridges and belts
Habitat heterogeneity and diverse planting
Increase pervious surfaces
Introduce desirable or rare species
Insect/wētā hotels
Invasive species management (pests)
Lighting for biodiversity
Living crib walls / brush mattresses
Living machines
Living seawalls / biodiversity tiles
Living shorelines
Matauranga Māori values driven management
Minimise disturbance (benign neglect)
Mulch
Mycorrhizal companion planting
Natural playgrounds
Nature-based stormwater management / sponge cities
Nesting boxes
Noise pollution reduction
No-mow or reduced mow zones
Local seed banking / eco-sourcing nurseries
Permeable paving
Pet containment (cats)
Planting for biodiversity
Pollinator pathways / flora plantings
Predator proof fencing or green roof edging
Provision of roosting and perching sites and cavities
Rainwater gardens
Raised boardwalks through green space
Soil sensitive construction
Restoration / preservation of wetlands
Retain or provide large old trees or ephiphytes
Retain or provide leaf / vegetation / log fall / detritus for microhabitats
Revegetation
River daylighting / culvert naturalisation
Rongoā / medicinal planting
Smart habitat sensors - building integrated
Soil decompaction using biological methods
Soil microbiota innoculation
Sonic restoration
Stepping stone habitats
Stormwater planters
Traffic calming techniques
Transport corridors for biodiversity
Urban composting
Urban forests
Urban green-blue spaces
Urban riparian restoration and shading
Urban street trees
Urban water features
Urban wildlife sancturies / ecological islands
Uwhi (aquatic weed suppresion)
Vegetated retaining walls or engineered slopes
Building-integrated vegetation: Green roofs, green walls, biodiverse balconies



E.g: Cat patio

E.g: Contain cats

Search 100 strategies for design for biodiversity by:

- Te Ao Māori Lens

Engagement opportunities matrix & case studies

- Strategy Type

- Scale of Intervention

- Species to Target

- Synergies & Co-benefits

Strategy Type

1. Embed human–nature relationships
2. Foster biophilic experiences
3. Design for ecosystem services
4. Provide cues to care and stewardship
5. Manage human–nature conflict

1. Manage invasive species
2. Protect biodiversity from urban hazards
3. Design for resilience to urban stressors
4. Increase resilience to disturbance events

1.Enable the emulation of ecological flows and cycles
2.Support seasonal cycles
3.Design for natural disturbance
4.Cultivate ecological feedback loops & relationships
5.Plan for ecological adaptation and change

1.Enable species' movement through urban areas
2.Plan for climate-responsive connectivity
3.Restore and create buffers and habitat edges
4.Connect human spaces with ecological ones

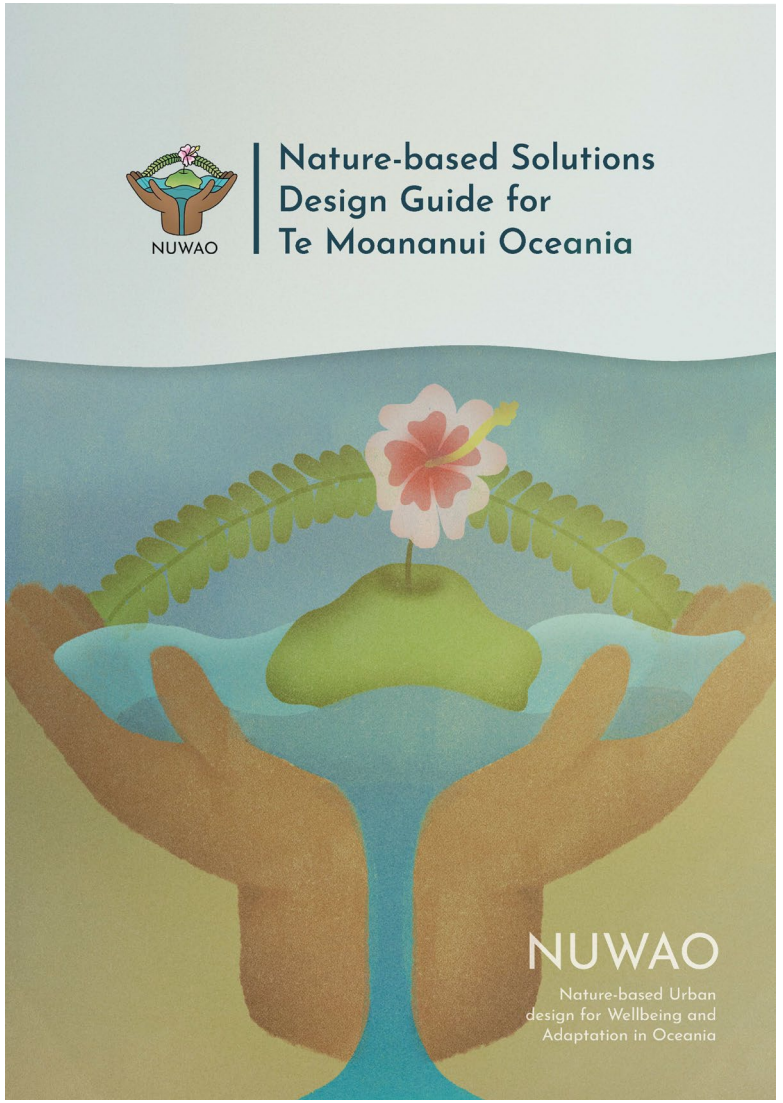
1. Protect existing habitats
2. Restore degraded habitats
3. Create new urban habitats
4. Support habitat complexity
5. Design for habitat resilience

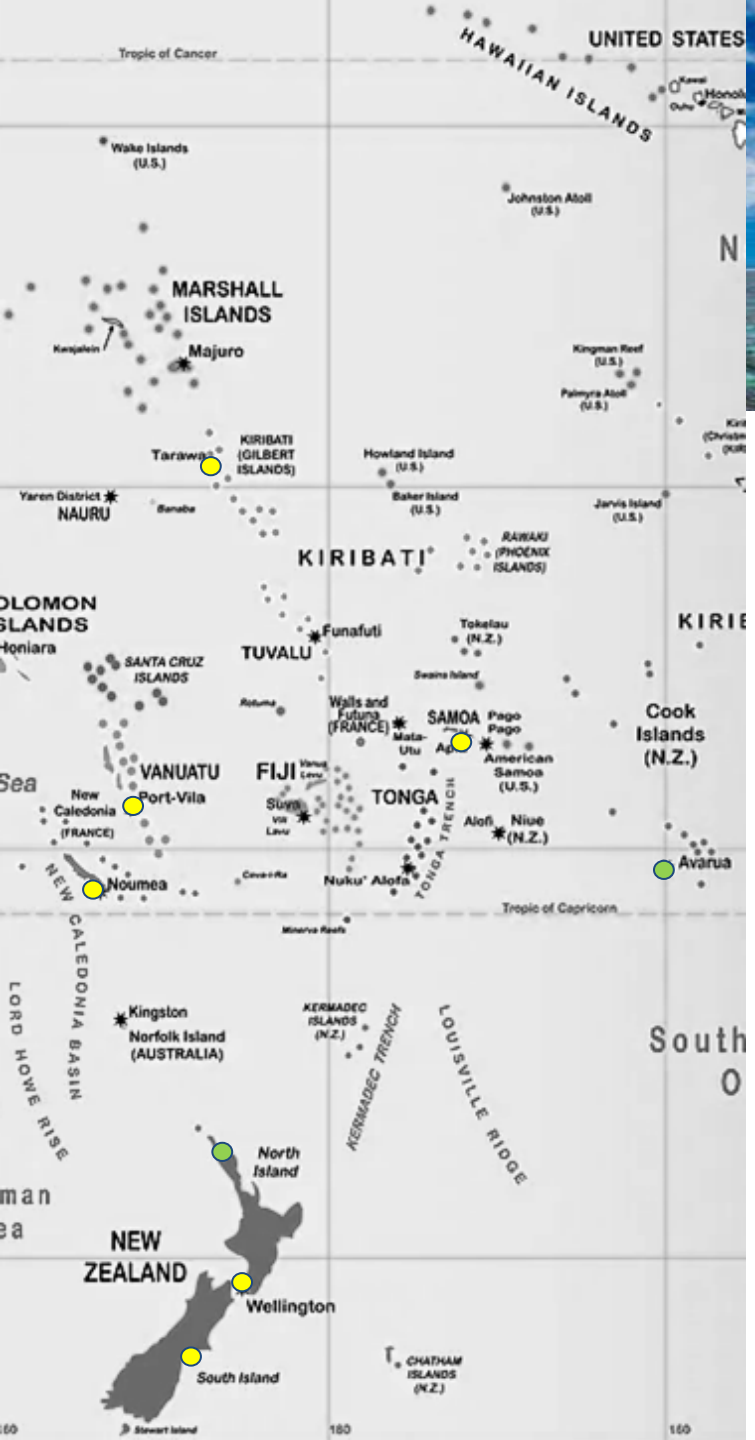
Garrard, G. E., Williams, N. S., Mata, L., Thomas, J., & Bekessy, S. A. (2018). **Biodiversity sensitive urban design**. Conservation Letters, 11(2), e12411.

NUWAO Nature-based solutions design guide for Moananui Oceania

- Make the NbS concept more contextualised and effective in Oceania
- Highlight unique human-nature relationships in Oceania and the knowledge that stems from that
- Prioritise local and Indigenous wellbeing in Oceania through just climate adaptation
- Showcase local case studies
- Provide links to evidence and technical requirements for NbS

https://nuwao.org.nz/nbs-guide/





NUWAO

NATURE-BASED URBAN DESIGN FOR WELLBEING AND ADAPTATION IN OCEANIA

www.nuwao.org.nz

The overall aim of NUWAO is to develop nature-based urban design solutions, rooted in Indigenous knowledges that support climate change adaptation and wellbeing in different contexts across Oceania.

NUWAO

MARSDEN FUND
TE PŪTEA RANGAHAU A MARSDEN

ROYAL SOCIETY TE APĀRANGI

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Aotearoa BiodiverCity Tools

New Zealand Biodiversity Factor

Jacquie Theis, PhD candidate, Otago

- Developed design or as built
- Rapidly assess urban biodiversity
- Suggest strategies to enhance impact
- Based on BSUD

NZBF-R NZBF-B NZBF-CS NZBF-T

Theis, J., Woolley, C. K., Seddon, P. J., Shanahan, D. F., Freeman, C., Pedersen Zari, M., & van Heezik, Y. (2025). **The New Zealand Biodiversity Factor—Residential (NZBF-R): A Tool to Rapidly Score the Relative Biodiversity Value of Urban Residential Developments.** *Land*, *14*(3), 526.

Aotearoa BiodiverCity

Moving towards regenerative ecological urbanism

- Use design as inquiry and innovation, positioning the built environment as an agent in ecological restoration.
- Apply biodiversity design guides and tools.
- Ground approaches in ecology and culture.
- Link biodiversity design to Indigenous priorities, wellbeing, & climate adaptation.
- Expand urban greenspace at all scales.
- Connect greenspace to ecosystem services and habitats.


Image by Irina Macovei

Regenerative, biodiverse, living cities are critical to biodiversity health, human health, and climate change adaptation. Buildings must be part of this equation.

Aotearoa BiodiverCity

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The knowledge exists - we need the conditions to activate it.