Urban Ecosystems (2025) 28:201
https://doi.org/10.1007/s11252-025-01801-8

# Priorities, concerns, and potential compromises amongst urban forest stakeholders: international lessons from Aotearoa New Zealand

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Received: 11 February 2025 / Accepted: 12 August 2025 / Published online: 27 September 2025


## Abstract

Urban forests provide numerous benefits including habitat for wildlife, improving human health, purifying air and water, and preventing and mitigating the effects of climate change. The need to protect and improve our urban forests will only increase as populations increase and cities densify and expand over time. However, urban forest establishment and maintenance is challenging due to a lack of effective policies, delays, lack of communication, inappropriate targets, and lack of recognition, disunity, or resourcing amongst stakeholders. Here we present the results from a joint urban forest symposium-workshop that sought to determine the priorities and challenges of different stakeholder groups in New Zealand, including arborists, ecologists, non-ecologist researchers, indigenous peoples, and planners. We synthesise these lessons as recommendations to improve urban forest planning, design, establishment, and minimise conflicts between stakeholder groups. While the highest priorities of each stakeholder group are fairly distinct, there are high levels of overlap in the general priorities and challenges they face in working towards advancing those priorities. We suggest a 3-phase framework to deliver progress that broadly considers (1) data collection, (2) policy development, and (3) resource development. We suggest this framework should be supported by continual monitoring and data sharing, an increased investment in green employment and education, and further recognition of urban foresters, indigenous communities, and ecologists. We suggest that an inclusive approach based on a shared understanding of forest values and removing barriers is most likely to result in long-term success.

**Keywords** Ecosystem services · Green jobs · Mātauranga māori · Native biodiversity · Tree governance · Collaborative decision-making

## Introduction

Urban forests provide myriad benefits such as mental and physical health improvements (Ulmer et al. 2016; Turner-Skoff and Cavender 2019; Wolf et al. 2020; Pataki et al. 2021), refugia for wildlife (Hutto Jr and Barrett 2021; Gentili et al. 2024), and help to mitigate the effects of climate change (Roy et al. 2012; Teo et al. 2021). While trees are the dominant component, urban forests also include understory communities and other woody vegetation across both public and private urban land (Konijnendijk et al. 2006). The benefits provided by urban forests become increasingly important where intensification increases impervious cover and where urban sprawl erodes the natural environment (Seto et al. 2012; van Vliet 2019). Urban forest disservices include providing habitat for pests, triggering allergens, causing winter shading, and damaging above- and below-ground infrastructure (Roman et al. 2021); however, the benefits invariably outweigh these detriments (Schroeder et al. 2006; Roy et al. 2012; Song et al. 2018).

There is broad consensus on the net benefits of urban forests, yet significant challenges remain in establishing and

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maintaining them (Oldfield et al. 2013; Ordóñez et al. 2020; Upton 2023). Efforts to establish urban trees may fail before planting due to a lack of funding (Hauer and Johnson 2008; Van Der Jagt and Lawrence 2019), unfavourable policies, opposition, or nimbyism (Riedman et al. 2022). Urban planners can struggle to allocate adequate green space in the face of densification pressures (Haaland and van Den Bosch 2015; Jim et al. 2018), especially within road corridors where underground and above-ground linear infrastructure is concentrated (Brown et al. 2001). Some canopy cover targets may even be impossible in areas without significant land use reform (Lund and Nordh 2024). After planting, tree mortality rates can be high due to improper species-site matching, inadequate maintenance, or vandalism (Hilbert et al. 2019). It can also be difficult to retain established trees as urban development projects commonly lead to tree removal, particularly when trees are close to buildings (Morgenroth et al. 2017; Guo et al. 2019; Croeser et al. 2020). Healthy trees can be removed due to fears of storm-related risk (Conway and Yip 2016), nuisance leaf litter (Moore 2014), unwanted shading or screening (Roman et al. 2021), or pest animals using trees to access roof space (Chen et al. 2020). Furthermore, management plans from local governments are often reactive rather than proactive, leading to tree removals when complaints occur instead of careful retention (Davies et al. 2017). Unfortunately, once urban forests are established their benefits tend to be unevenly distributed across society, often with the most vulnerable or deprived areas missing out (Schwarz et al. 2015; Sousa-Silva et al. 2023). Some attempts to correct for this can inadvertently out-price local residents by gentrifying the area (Wolch et al. 2014), so careful planning and implementation is required.

A wide array of stakeholders are involved in urban forest decision-making, including urban planners, landscape architects, arborists, local business owners, local and national government representatives, researchers, indigenous peoples, the general public, private landowners, land developers, and other relevant civil servants. Difficulties can quickly arise when different stakeholders have opposing ideas (Kozová et al. 2018; Mensah 2021; Wilson 2023), or when stakeholders cannot decide on the best course of action within their own group (Kirkpatrick et al. 2013). Without effective collaboration processes are often disjointed leading to confusion and difficulties in establishing urban forests (Cobbinah and Nyame 2021; Mensah 2021). However, when collaboration occurs between stakeholder groups (such as between planners, NGOs, and researchers), processes are more efficient and lead to more favourable outcomes (Muñoz Sanz et al. 2022; Doucet et al. 2024).

In Aotearoa New Zealand (A–NZ) urban forestry is an emerging discipline, yet arboriculture is a well-established profession. Over the last 10 years several cities have developed specific, local, urban forest plans (e.g., Auckland Council 2019; Christchurch City Council 2023), recognising the benefits of urban forests and signalling their intentions to develop specific expertise in urban forestry. However, there has been little attention at the national level despite recommendations from the New Zealand Parliamentary Commissioner for the Environment to strengthen national and local powers around urban green spaces (Upton 2023, 2024). As the population of A–NZ is estimated to increase by 10%—53% between 2022 and 2073 (Stats 2022), with many of these new residents expected to live in urban areas, developing effective urban forest plans now can maximise their benefits while mitigating the pressures of urban expansion. The effective integration of urban forests is likely to be most successful if established in conjunction with urban growth rather than as an afterthought. These considerations are similar to those of other growing cities around the world.

Here we present the perspectives from a multi-stakeholder urban forest symposium-workshop investigating the priorities, perceived challenges, and future plans of different stakeholder groups in A–NZ. The *Urban Forest Futures New Zealand* event was held on 10–11 April 2024 in Christchurch, organised by local researchers and city council employees to progress discussions of urban forests in A–NZ. The workshop asked 4 key questions of each stakeholder group:

1 What are your main priorities regarding the future of urban forests in A–NZ?
2 How would you define "success" in urban forestry in A–NZ?
3 What challenges do you currently deal with, or foresee, in achieving this "success"?
4 What steps are required over the next 5 (or more) years in order to achieve this "success"?

Aotearoa New Zealand represents a valuable case study for emerging urban forestry policy because it combines a diverse range of urban environments, including six cities with populations over 100,000 (Stats 2021), spanning from subtropical to temperate climates. Its small national population enables coordination among key stakeholders, making it well-suited to developing nationally coherent yet ecologically adaptable urban forest strategies. To maintain the high levels of endemism and biodiversity that exist in A–NZ we must consider an alternative suite of plant species compared to the traditional colonial urban forest plantings (Stanley and Galbraith 2024). Additionally, the unique island biodiversity of A–NZ and the bicultural relationship between the government and indigenous Māori population require additional considerations for effective urban forest establishment.

To understand the role that indigenous Māori communities may have in urban forestry, we must consider that they traditionally have a different worldview and perspective compared to non-Māori populations (Mercier et al. 2012). Moreover, until recently perspectives and priorities of Māori communities have been largely ignored in urban developments (Awatere et al. 2013; Rodgers et al. 2023). Māori hold a unique cultural and constitutional position, with relationships to the land rooted in whakapapa (genealogy) and responsibilities of kaitiakitanga (guardianship). Urban environmental planning in A–NZ is increasingly shaped by obligations under Te Tiriti o Waitangi (A–NZs founding document), shifting expectations toward co-design and power-sharing (Berke et al. 2002; Raerino et al. 2021). A better understanding and integration of indigenous perspectives not only improves the success of urban forest plan implementation in A–NZ but also enriches urban ecological and cultural resilience in ways that have international relevance (Rodgers et al. 2023; Walker et al. 2025).

## Methods

The workshop was conducted on day 2 of the *Urban Forest Futures 2024* event, allowing for participants to receive equivalent and broad background information from various stakeholder perspectives before the workshop commenced. The workshop was framed by three overriding indigenous Māori principles to foster a collaborative atmosphere and emphasise that all viewpoints were valid for discussion: (1) tika (accuracy), (2) pono (integrity), and (3) aroha (respect). While we offer approximate translations of these principles, we acknowledge their deeper significance as cornerstones of the Māori worldview and emphasise that their meanings are interwoven and not fully separable (Stewart et al. 2021). The workshop embodied these principles through multiple aspects, including ensuring all participants had time to provide individualised feedback during and after the workshop to prevent dominant voices disproportionately shaping group responses.

The 28 workshop participants (the authors) represent expertise across a range of disciplines relevant to urban forestry, and were affiliated with scientific institutions, environmental consultancies, private arboricultural businesses, urban planning and design firms, and local or regional councils. Based on the job roles of the participants, we designated nine initial participant groups. Attendees were instructed to self-organise into the group they most strongly affiliated with (Fig. 1), bearing in mind that attendees may have multiple affiliations or specialties. These initial groups were arborists, civil servants, ecologists, foresters, geographers, landscape architects, silviculturists, tangata whenua (the original inhabitants of A–NZ), and urban planners. To ensure balanced discussions these nine groups were consolidated into the five final groups: arborists, ecologists, tangata whenua, planners, and researchers. Here the "planners" group included urban planners, civil servants, and landscape architects, and the "researchers" group included foresters, silviculturists, and geographers.

We provided a long list of priorities to each group to seed ideas and help structure discussion; however, groups were not limited to these suggestions and could include their own (Fig. 1). The long list of suggested priorities was an amalgamation of keywords extracted from (1) workshop organiser suggestions, (2) questions and comments from attendees of the *Urban Forest Futures New Zealand* symposium, and (3) a modified 'Political, Economic, Sociological, Technological, Legal and Environmental' (PESTLE) analysis conducted with ChatGPT on 5 April 2024 (Nandonde 2019; OpenAI 2023). The PESTLE analysis was modified to additionally include spiritual, regulatory, cultural, and general considerations of urban forests in A–NZ. For each component ChatGPT was prompted to return an unbiased, comprehensive list of considerations affecting urban forests in A–NZ. Suggested priorities from all three workstreams were curated to ensure relevance, and had their keywords extracted to produce the final long list of priorities presented to workshop attendees. By iteratively ranking these initial priorities, groups were ultimately asked to identify their top 3 priorities in urban forestry. These priorities were then used to help define what "success" in urban forestry means to their stakeholder group. We specifically requested that indicators of success and any goals should be specific, measurable, achievable, realistic, and timebound (SMART; Doran 1981).

Bearing in mind their group's definition of success, participants identified potential challenges in establishing, maintaining, or improving urban forests. Groups then developed 5-year plans on how to achieve their desired successful outcome whilst circumventing or addressing potential challenges. Finally, we rearranged participants to create mixed stakeholder groups based on the participants' specific cities or regions and allowed time to discuss their results before reporting back to the main group. These discussions helped establish a shared understanding of the key steps needed to advance urban forests in A–NZ, while addressing each stakeholder group's priorities. The outcomes were then synthesised into an actionable framework.

While we recognise that the views expressed by workshop participants do not necessarily reflect those of wider stakeholder groups, we aimed to ensure representation of a range of stakeholders while keeping group sizes manageable. In particular, we acknowledge that some indigenous people in attendance were expressing viewpoints on a

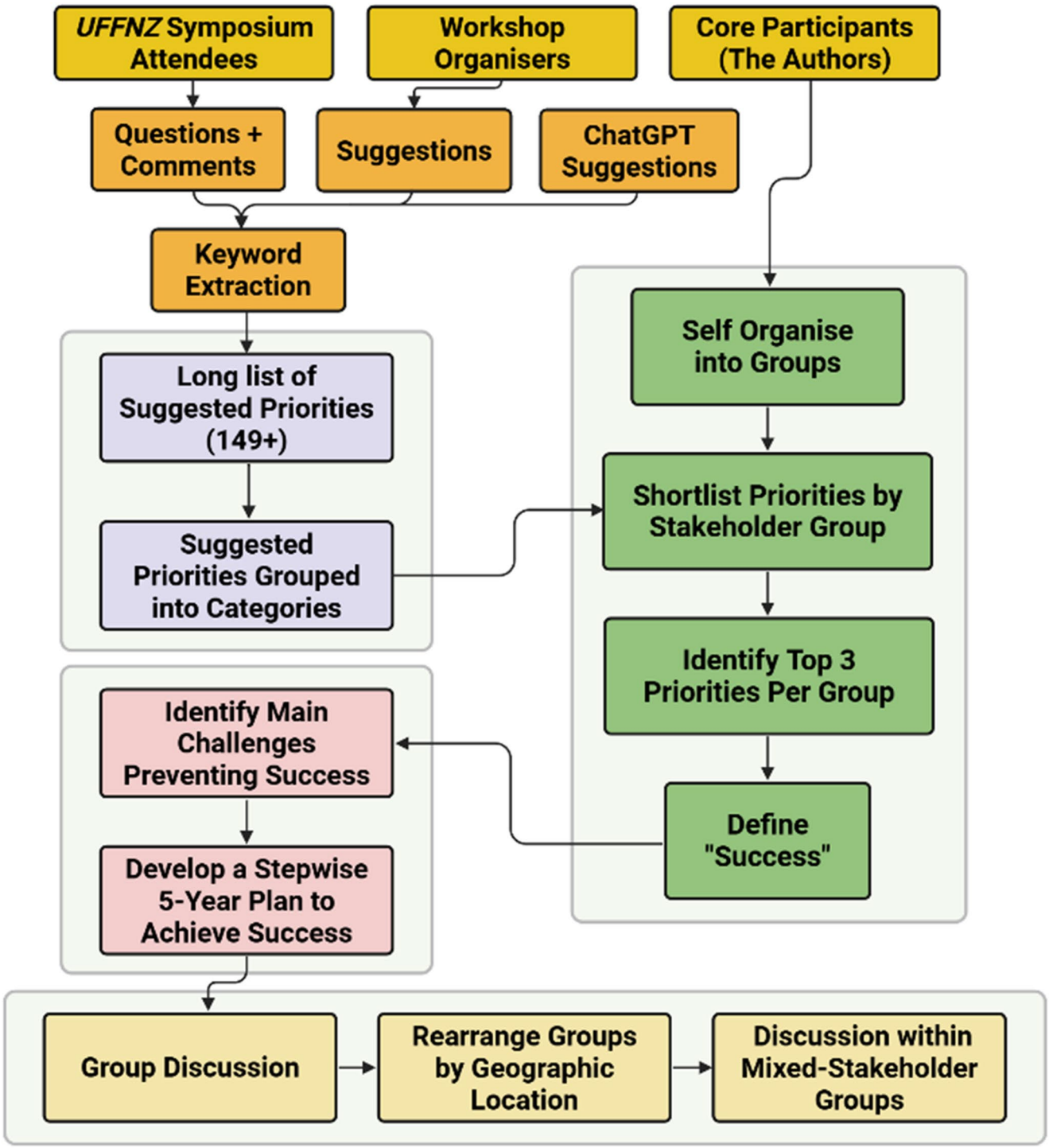


**Fig. 1** Schematic diagram summarising the process used to identify stakeholder priorities, challenges, and future plans. Broad suggestions of priorities were collected prior to, and during, the *Urban Forest Futures New Zealand* 2024 event (*UFFNZ*; orange boxes). A subset of *UFFNZ* attendees (the authors) then undertook a series of conversations and group activities to prioritise urban forest initiatives. See text for further methodological details

national perspective as mātāwaka (visitors to an area), while others were expressing viewpoints on a local perspective as mana whenua (the original inhabitants of an area with a relationship to their land). If mana whenua groups were consulted across the country their viewpoints would likely differ based on the specific context of their lands. Although

estimates vary between sources, A–NZ includes hundreds of distinct iwi and hapū (tribal community) groups which have diverse histories and priorities, of which only a few were represented (Te Kahui Mangai 2024).

## Stakeholder priorities & challenges

### Arborists

The group of arborists identified their 3 highest priorities as: (1) enhancing and protecting human health; (2) ensuring the availability and advancement of green jobs; and (3) promoting trees as critical infrastructure within cities (Fig. 2). Lower ranked priorities included developing a sense of community and providing ecosystem services (Table S1). Urban forest "success" was summed up in three statements by the arborists as: (1) urban forests are full of healthy trees that the public can easily access and enjoy; (2) trees are actively wanted by the general public on their streets, roadsides, and properties; and (3) green jobs are considered essential and receive increased attention and investment.

The most pressing challenge identified is the lack of investment to simultaneously maintain existing trees let alone establish new areas of urban forest (Table 1). As many of the arborist participants are either directly employed by city councils, or hold contracts with city councils, a particular concern was that councils have a number of under-resourced projects and that investment in trees may be deemed a low priority. One participant expressed frustrations regarding bureaucratic inefficiencies that commonly exist between civil service departments which can stifle both everyday progress and the establishment or development of green jobs (silo effects; Arborist, City Council). A common complaint among the arborist group was that engagement of arborists and urban foresters often occurs late in projects, and typically when existing tree health is declining or plans for new inappropriate plantings are already firm.

While we have already highlighted the benefits to human health, the values delivered by green job creation centred on arboriculture and treating trees as critical infrastructure are new. Viewing trees as critical infrastructure can infer a number of benefits, including favouring tree planting for ecosystem services such as stormwater mitigation over other structural solutions (Carlyle-Moses et al. 2020), thereby helping to prevent tree removal. Likewise, it can help support the development of other forms of infrastructure (such as power lines and pipes) in ways that minimise adverse effects on existing urban forests (Most and Weissman 2012). In the US, the economic benefits provided by urban forests are estimated to be USD$65B, creating over 500,000 jobs (Thompson et al. 2021). The jobs created by urban forests are sustainable and ongoing, ensuring sustained purchasing power and economic prosperity for communities (Klaus et al. 2015; Sulich and Sołoducho-Pelc 2022).

Many of the challenges highlighted by the arborist group are commonplace in the international urban forest community. Wirtz et al. (2021) found that adequate investment

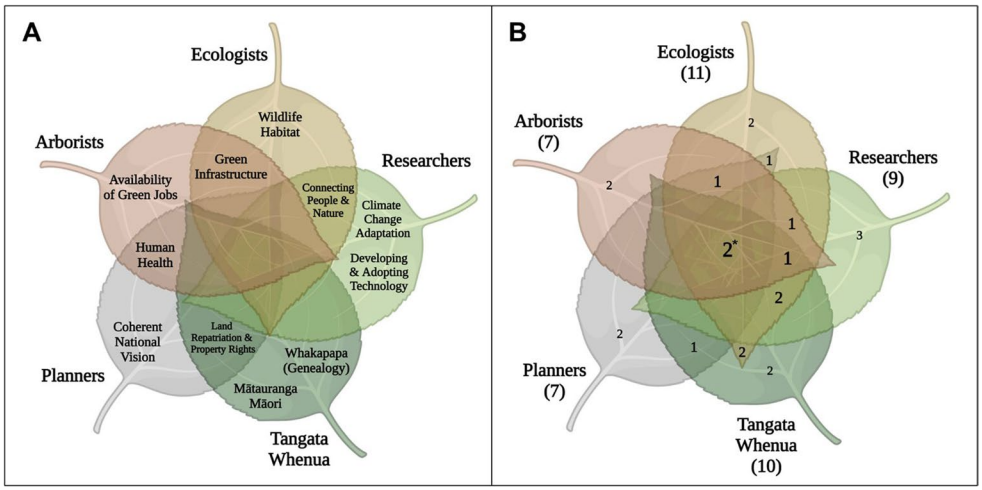


**Fig. 2** The overlap between priorities of each stakeholder group when considering urban forest success. **A**) The 3 highest ranked priorities from each stakeholder group, showing that every group shared at least one of their top priorities with another group. **B**) The total number of priorities listed by each stakeholder group is displayed in parentheses, with values within the Venn diagram showing how many priorities were shared by each group. The font size of values in **B** is proportional to the number of groups in each segment. Tangata Whenua is a term used to describe the indigenous population of Aotearoa New Zealand. Mātauranga Māori is a term relating to the traditional knowledge of the indigenous Māori peoples. Whakapapa loosely translates to genealogy, and in this context refers to the strong relationship that the original inhabitants and their descendants have with the land, compared to the rights of Māori and non-Māori who moved there.* The two priorities shared by all groups were enhancing human health outcomes and enhancing ecosystem services from urban forests

**Table 1** The challenges in achieving their urban forestry priorities identified by each of 5 urban forest stakeholder groups that they are currently facing or foresee in the near future. All groups share at least 1 challenge with every other stakeholder group; however, the context of that challenge May vary. Tangata Whenua is a term used to describe the Indigenous population of Aotearoa New Zealand. Challenges are sorted from top to bottom by the number of stakeholder groups that highlighted it as strongly affecting them

| Identified challenge | Arborists | Ecologists | Researchers | Tangata Whenua | Planners |
|---|---|---|---|---|---|
| Lack of Investment | ✓ | ✓ | ✓ | ✓ | ✓ |
| Lack of Political Will | | ✓ | | ✓ | ✓ |
| Missing Data/Information | | ✓ | ✓ | ✓ | |
| Other Priorities Considered Higher than Urban Forests | ✓ | | | | ✓ |
| Lack of Education on the Benefits of Urban Forests | ✓ | ✓ | | | |
| Lack of Visibility as a Profession | ✓ | ✓ | | | |
| Communal Participation is not Encouraged | ✓ | ✓ | | | |
| Conflicts with Property Owners | | ✓ | | | ✓ |
| Lack of National Collaboration | | | ✓ | | ✓ |
| Engaged in Projects too Late | ✓ | | | | |
| Complex or Slow Bureaucratic Processes | ✓ | | | | |
| Overwhelmed School Curriculum | | ✓ | | | |
| Lack of Efficient Policies | | ✓ | | | |
| Extinction of Experience | | ✓ | | | |
| Changing Environment/Climate | | ✓ | | | |
| Differences Between Stakeholder Priorities | | | ✓ | | |
| Connecting Research with Practise | | | ✓ | | |
| Determining Who/How Environmental Standards are Set | | | ✓ | | |
| Lack of Consideration for Future Generations | | | | ✓ | |
| Lack of time | | | | ✓ | |
| Respecting Cultural Boundaries and Considerations | | | | ✓ | |
| Graylings Law (Costly Policies Unlikely to Succeed) | | | | | ✓ |
| De-Centralisation of Policy Strategies | | | | | ✓ |

was the greatest factor driving successful urban forest governance in Canada, and is consistent across other regions (e.g., Ordóñez et al. 2019). Contesting for resources at local councils is similarly widespread. Although councils are responsible for serving residents' interests within their district, a lack of awareness about the ecosystem services provided by trees (Kim 2021) can result in pressure to prioritise other areas for investment over urban forestry. Silo effects, or organisational clustering, are an inevitable outcome in large organisations or councils (Bento et al. 2020) and may be particularly troublesome where clusters are competing internally for investment. Strategies for counteracting silo effects include improving information sharing and presenting a coherent organisational vision (Popęda 2025)—both of which can be improved with the development of long-term urban forest strategies. Late engagement of tree experts in projects has been noted elsewhere, and could relate to a misunderstanding of tree expert job capabilities or simply reflect budget and time constraints which lead to reactive rather than proactive tree care (Bardekjian 2016). Compounding these issues in A–NZ, recent governments have eroded council liberties regarding urban trees—first by removing the ability to codify blanket tree protections in 2013 (Morgenroth 2024) and recently by introducing a controversial fast-track approvals bill (Bishop 2024) which critics suggest will lead to negative environmental outcomes including the rapid removal of trees (Carr 2024; Stevenson and Schlaepfer 2024).

## Ecologists

The top 3 priorities for ecologists related to: (1) the promotion of trees as critical infrastructure within cities; (2) the development of urban forests to provide essential wildlife habitat; and (3) increasing people's connection to nature through enhanced ecological literacy (Fig. 2). The ecologist group highlighted numerous other priorities (Table S1), but the two additional priorities unique to their group were facilitating slow tourism and enabling ecosystem functionality. When considering what urban forest "success" would

look like, the ecologist group suggested: (1) national and local minimum standards for vegetated, permeable areas are established and abided by; (2) native species dominate a complex canopy, supporting indigenous biodiversity; and (3) natural history is embedded in the education system—for both children and adults.

Alongside a lack of investment, which all stakeholders stated they struggle with, the group of ecologists identified a lack of political will as the major impediment to achieving their vision of success (Table 1). Where political will exists to enact positive change, concern remains among ecologists that bureaucratic processes can stifle progress. In addition to budgetary and political challenges, the ecologists noted that decision-making is further complicated by significant gaps in our current data and understanding of urban species' life histories. The ecologists also recognised the large potential that private land has in reducing fragmentation of vegetation across cities, and that conflicts with property owners and developers can reduce wildlife habitat.

Urbanization in the face of a growing human population is recognised as one of the leading causes of biodiversity decline (Kondratyeva et al. 2020). However, cities can expand in ways which support wildlife populations. While increasing overall levels of vegetation in urban areas would benefit biodiversity (McDonald et al. 2020), even forest fragments can also be highly beneficial—particularly in less managed 'wild' areas where understory plants are abundant (van Heezik and Ludwig 2012; Müller et al. 2018; Gerolemou et al. 2024), and provide stop-over habitat for migratory birds heading to larger forests (Buron et al. 2022). However, the inclusion of habitat patches large enough to support breeding populations (Ignatieva et al. 2011; Nguyen et al. 2021) along with biodiversity corridors between them is necessary to support a broader variety of ground-dwelling species (Amburgey et al. 2021). The establishment, maintenance, appreciation, and acceptance of urban green space can subsequently be improved by bettering ecological education of communities (Vieira et al. 2022), and by including education on mātauranga Māori principles to better understand how these spaces, and native species, are valued by indigenous communities (Mercier 2018; Rodgers et al. 2023).

The paramount challenge for ecologists was the current perceived absence of political will to focus on environmental issues (e.g., Taylor 2023, 2024), leading to both a lack of investment and willingness to act. This absence of political will was partly attributed to a lack of understanding of the many ecosystem services that urban forests provide, which frequently offer positive benefit-to-cost ratios alongside their environmental benefits (Hunter et al. 2022; Morgenroth 2023). Although urban forest education programmes have proven effective for children and communities (Kim 2021; Vieira et al. 2022), limited space in an already overcrowded school curriculum and a lack of political will to prioritise natural history education remain as barriers. Furthermore, it is more challenging to undertake extensive education amongst the adult population, who are not subject to a formal curriculum.

When urban forests are successfully planned or established, additional ecological challenges can arise via conflicts with property owners and developers (Dorst et al. 2022). From an ecological perspective, increasing overall levels of native vegetation, reducing habitat fragmentation, increasing buffering of remnant forest patches, and connecting fragments via habitat corridors are optimal for reducing human–wildlife conflicts and promoting biodiversity (Ignatieva et al. 2011; Müller et al. 2018; Amburgey et al. 2021). However, this can risk reliance on long-term collaboration with private property owners who may choose to renege on commitments or sell their property to less cooperative owners. Additionally, uncertainty exists about which native species can thrive in highly modified urban habitats, which species will adapt to the effects of climate change, and how the provisioning of urban ecosystem services may change under different conditions (Ahrens et al. 2020; Esperon-Rodriguez et al. 2022; Anderegg 2023). This is of particular concern in A–NZ where the climatic tolerances of indigenous species are relatively understudied (Macinnis-Ng et al. 2021).

## Researchers

Researchers were the only group to share only one of their top 3 priorities with another stakeholder group (Ecologists; Fig. 2). Their top 3 priorities were to: (1) develop urban resilience to climate change effects through appropriate tree establishment; (2) trial, develop, and adopt novel technologies to enhance and monitor urban forests; and (3) connect urban populations with nature to foster a sense of caring for the urban environment. Additional priorities uniquely suggested by researchers were improving liveability of cities under densification and using urban forests as biosecurity indicators (Table S1). Urban forest "success" for the researcher group was summed up as: (1) urban forests are seen as critical infrastructure and are equitably accessible across the city; (2) urban forests are thriving thanks to active monitoring and data sharing advances; and (3) the impacts of climate change within cities are mitigated, such as maintaining temperatures within cities below an unhealthy and uncomfortable threshold.

Similar to other groups, the researchers highlighted a lack of investment as a key impediment to the progression of urban forest research (Table 1), and that key knowledge gaps exist in urban species' life history information. In

addition, the researcher group indicated a large knowledge gap in which technologies would be most effective to implement, as well as a lack of national collaboration for existing data including satellite imagery and LiDAR. Finally, the researcher group identified the importance of setting thresholds in policy, particularly around temperatures within cities, however this poses the question of how these limits are determined. Realistic thresholds will likely need to be determined through collaboration between stakeholders and politicians which risks compromising the original intent in order to appease all parties. This process is also vulnerable to challenges such as limited national collaboration and a lack of political will.

While it is well established that urban forests can help cities adapt to climate change (Roy et al. 2012; Teo et al. 2021), work is needed to determine which tree species can adapt to future climates to provide these benefits (Ahrens et al. 2020; Janowiak et al. 2021; Esperon-Rodriguez et al. 2022; Anderegg 2023) combined with moderating the harsh urban environment (Pavao-Zuckerman 2008; Ward et al. 2021). If native species cannot fulfil all of our required ecosystem services or harsh urban environments are unable to be moderated, non-invasive exotic species may be needed (Sjöman et al. 2016). Novel technologies can support these goals and are already being utilised across the world in multiple ways including rapid and automated data collection (Nitoslawski et al. 2021), incorporating big data and machine learning into urban forest management (Beery et al. 2022) and monitoring (Zhao et al. 2023), and utilising predictions from artificial intelligence to improve planning and management (de Lima Araujo et al. 2021). Novel technologies can also aid in developing 'smart forests' that are attractive to the general public (Prebble et al. 2021), helping to increase their use and promoting cooperation in citizen science efforts (Cappa et al. 2022). However, it is worth noting that these technologies may be less desirable to some stakeholders, such as indigenous peoples. As previously noted, initiatives to better connect children and communities with nature can lead to favourable preservation and appreciation outcomes (Chawla 2020; Vieira et al. 2022). Unfortunately, A–NZ lags behind in the consideration and adoption of novel technologies, such as artificial intelligence (de Lima Araujo et al. 2021).

Regarding existing datasets, a lack of national collaboration has been noted in other regions such as Europe (Dorst et al. 2022)—in particular when stakeholders have a wide diversity in values and desired outcomes. This stakeholder isolation can make it more difficult to establish the collaborative partnerships needed to effectively share research findings.

## Tangata Whenua

Three of the top priorities for the tangata whenua group related to: (1) respecting whakapapa (genealogy); (2) land repatriation; and (3) utilising mātauranga Māori (indigenous knowledge) approaches in urban forestry (Fig. 2). Tangata whenua were also the only group to indicate that inspiring creativity via urban nature was a priority (Table S1). When considering what urban forest "success" would look like, the tangata whenua group summarised 4 statements: (1) significant tracts of land are repatriated to Māori communities, allowing mana whenua to dictate stewardship of urban forests; (2) power-sharing in decision-making between Māori and non-Māori in lands not repatriated; (3) ecosystems are healthy enough for native birdsong to be heard across all areas of cities; and (4) there is an increased capability among non-Māori on Māori related matters, including an understanding of where Māori consultation is required.

The tangata whenua group identified a number of challenges preventing the success of urban forests, including both a lack of investment and political will (Table 1). Similar to other groups, the tangata whenua group identified significant gaps in our current information around the state of urban forests and associated biodiversity, the effects of an urban environment on the planted species, and how to better design urban forests with children in mind. Part of this knowledge gap includes how urban forests viewpoints vary between different iwi and hapū groups. Although the tangata whenua group expressed interest in filling these information gaps, they recognise this as a challenge as their time and resources are often overutilised in numerous and varied requests for consultation. In addition, they identified that effective collaboration with mana whenua requires time and resources to develop and maintain relationships, yet projects are often run on tight timeframes. This lack of time, particularly time devoted to genuine consultation, threatens to prevent true collaboration with mana whenua groups in urban forest projects. When collaboration or consultation is sought, they emphasised that it is important to respect cultural boundaries and considerations that may otherwise seem unimportant to non-Māori.

Whakapapa is the foundation of Māori identity, language, culture and social structure that connects people, their spirituality, and the environment (Harmsworth and Roskruge 2014; Ngata and Ngata 2019). Whakapapa underpins the relationship mana whenua have with the land, and respecting whakapapa requires mana whenua to be included in decision making on their lands (Mercier et al. 2012). The repatriation of land to Māori is a central and enduring issue with significant implications for urban forestry. One participant (Urban

Designer) highlighted that even if intentions are positive, for example utilising mātauranga Māori when establishing and managing urban forests, these efforts can appear tokenistic if the more fundamental issues of land rights are not addressed. Approximately 5.7% of land in A–NZ is currently designated as Māori land, with this located predominantly in the central and eastern regions of the North Island (Kingi 2008; Te Kooti Whenua Māori 2022). Notably the areas designated as Māori land tend to be areas of lower productivity and roughly 30% are landlocked, meaning that owners are unable to access them easily and often have no other option except to lease it to neighbours. Very little Māori land is present in urban areas, meaning mana whenua currently have little direct authority over urban forests. Although limited, examples of areas that have been returned to Māori communities (e.g., Pourewa Reserve returned to Ngāti Whātua Orākei) have shown promising restoration success (Pourewa Valley Project 2022). The respectful incorporation of mātauranga Māori, which relates to the indigenous knowledge collected and shared by Māori communities through history (Mercier 2018), into appropriate projects can significantly increase the wellbeing impact of those projects (Michel et al. 2019; Saunders et al. 2024; Walker et al. 2024). By including mātauranga Māori in urban forest projects, we may be able to maximise the benefits of urban forests—in particular in deprived areas (Schwarz et al. 2015; Sousa-Silva et al. 2023).

### Planners

The top 3 priorities of the planning group were: (1) the health and wellbeing of humans and the environment; (2) developing a coherent national vision for urban forests; and (3) respecting property rights, including those of mana whenua (Fig. 2). Planners were also the only group to prioritise achieving balance in urban environments (Table S1). When considering what urban forest "success" would look like, the planning group suggested: (1) city-specific urban forest strategies, under a broader national strategy, are set and met; (2) human populations are co-existing with nature; and (3) better integration of urban forests into cities, with forest distributed equitably across communities.

The planning group similarly identified that lack of investment and political will to achieve meaningful changes as key challenges preventing the success of urban forest development (Table 1). However, they suggested the biggest challenge related to the lack of national collaboration of urban forest policy development, and that de-centralisation of policies and strategies would lead to inconsistent lessons and outcomes. Compounding this, they identified that trees are often placed lower on the priority list when planning urban areas due to pressure imposed by competition for valuable space both above and below-ground. One participant (Urban Planning Consultant) identified that Grayling's Law dictated that other priorities are often favoured due to having more immediate profitability (Grayling 2022). The group also suggested that individualism dictates that not all property owners want to live near trees and even individuals that recognise the benefits of trees can have nimbyistic tendencies and may lobby against stronger tree establishment or protection policies.

It is important to also acknowledge the benefits of a coherent national vision. Given that governments are dynamic, with elections every 3 years in A–NZ, setting long-term bipartisan national goals for urban tree inclusion in development plans can provide consistent investment and political support (Lawrence et al. 2013; Sousa-Silva et al. 2023). Progressing urban forest goals on private land is similarly difficult and possibly may worsen as homeownership rates decrease in favour of private rentals (Stats 2020). In these instances, private rental owners may favour lower maintenance options, such as artificial lawns, hard surfaces or plastic greenery, despite occupant and public dissatisfaction (Barnes and Watkins 2022), which do not provide essential ecosystem services (Francis 2018; Simpson and Francis 2021).

Addressing the primary concern of planners, i.e. the lack of national urban forest policy, is difficult but can be progressively improved upon. The Resource Management Act governs the management of all natural and built environments across A–NZ; however, it does not currently define "urban forests" leading to inconsistency in how urban trees and vegetation are recognised and managed across jurisdictions (Morgenroth 2024). Defining a nationally consistent concept of urban forests would provide local councils and planning agencies with a shared baseline for decision-making—clarifying scope, supporting regulatory and funding mechanisms, and enabling more consistent monitoring. Importantly, a national definition would still allow municipalities to expand on it or utilise alternative terms that reflect specific ecological and cultural priorities.

## Framework for Long-Term success

Achieving successful and equitable urban forests requires us to consider what success in urban forestry means for each stakeholder group and attempt to overcome the challenges hampering this success. We propose a 3-phase framework to address the concerns of each stakeholder group and improve urban forests in A–NZ: (1) collect and share information nationally across stakeholder groups, as well as identifying appropriate partners and co-developing national standards for urban forest monitoring; (2) develop informed and inclusive policies at both the local and national levels to guide urban forest development; and (3) produce and share resources and technologies to aid in urban forest

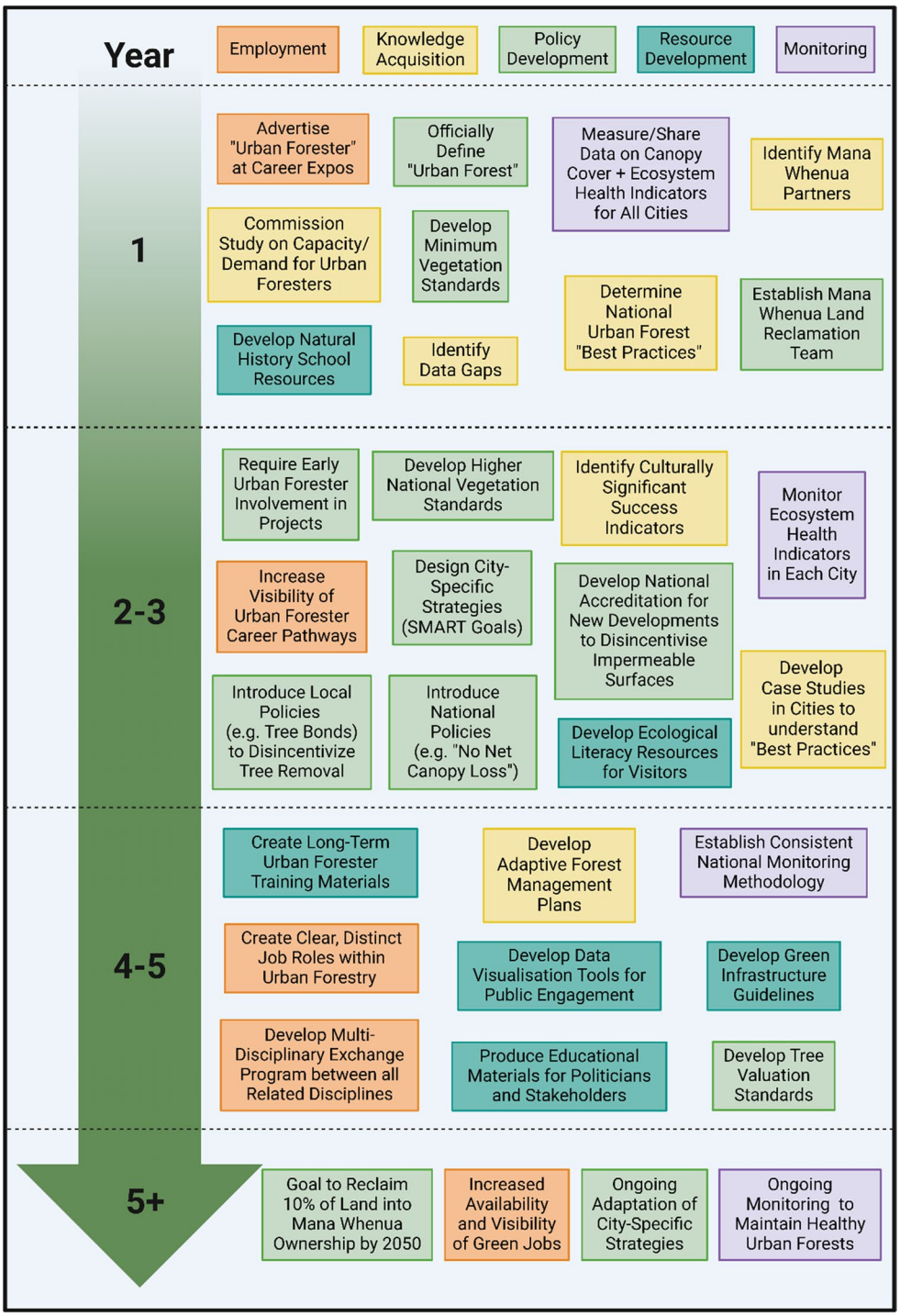


**Fig. 3** A five-year framework of agreed-upon activities developed through consensus among urban forest stakeholders in Aotearoa New Zealand, aimed at improving urban forest outcomes. Activities are grouped into five thematic areas: Employment, Knowledge Acquisition, Policy Development, Resource Development, and Monitoring. Stakeholders identified knowledge acquisition as a critical short-term priority, forming the basis for informed policy development, followed by investment in resources and employment opportunities. Monitoring is required throughout and will evolve alongside emerging knowledge. While grounded in the New Zealand context, these strategies are broadly applicable to urban forest planning worldwide

maintenance and future establishment including sustained investment in green employment opportunities. Sustained monitoring will be needed to continually improve urban forest maintenance, ensure benefits are equitably distributed throughout populations, and to better quantify ongoing ecosystem services. This framework is mapped onto a potential 5-year plan (Fig. 3), although we acknowledge these phases may require more time to fully implement. This framework represents the agreed upon consensus of all stakeholder groups and demonstrates a high level of recognition of the importance of other stakeholder priorities.

In phase 1 (year 1) of the framework an emphasis on knowledge acquisition is required, including collating current information (Upton 2023). From an employment perspective, this includes an investigation into the perceptions of green jobs as a career path as well as workforce capacity,

training capacity, and demand for future work. Some simple policies should be introduced, paramount of which is officially defining "urban forest" in A–NZ policy and clarifying the boundaries between urban, peri-urban, and rural forestry. Similarly, national minimum acceptable and optimum vegetation standards for existing urban areas and new developments are needed to support urban forest development. In the interest of respecting mana whenua, a team of experts should be established to identify areas where land can be returned to Māori ownership, or other areas where their management is prioritised and practiced by mana whenua, and secure appropriate resourcing for land restoration. Where land is returned to mana whenua together with adequate resourcing, we would predict increases in the visibility and engagement of mana whenua in urban forest restoration, maintenance, and policy development.

In phase 2 of the framework (years 2–3) an emphasis on informed policy development is required – capitalising on the newly acquired knowledge from phase 1. Here, informed national policy can be introduced including a commitment to tree protection and higher standards for vegetation around schools and all modified habitats including ecological corridors, fragments, and buffers to support biodiversity and minimise effects from urban infrastructure (e.g., artificial light, noise, emissions, heat). Likewise, the development of local, city-specific urban forest strategies (e.g., Auckland Council 2019; Christchurch City Council 2023) that acknowledge space and resource requirements is essential to improving the success of urban forest initiatives. Additional local policies should be considered by local authorities that have proven successful in other territories, such as introducing bonds as a financial disincentive to removing trees during developments (Clark et al. 2020), with bonds tied to land value of space occupied by trees at maturity (not the tree itself) being particularly effective. Similarly, to reduce instances of improper establishment or poor planning, species-specific planting policies should be designed and implemented only with the involvement of urban foresters (or other specialised tree-care professionals) and urban ecologists from project fruition. Likewise, consultation should occur with iwi partners to determine what "success" would look like in their specific areas given local mana whenua priorities may vary from broader Māori priorities.

In phase 3 of the framework (years 4–5) an emphasis on developing tools, technologies, and educational resources is required – providing guidance on how to rapidly collect and disseminate information through networks established in phases 1 and 2. Here, a number of educational resources for urban foresters, the general public, politicians, and urban developers are needed to ensure a minimum understanding of urban forest benefits. More complex policies, such as tree valuation standards, should be introduced and utilised to update existing policies (such as tree bonds). After increasing the visibility and investment in urban forestry career pathways, new and distinct roles can be developed to ensure tree care agencies have multifaceted approaches to retaining and restoring urban forests.

While this framework should be adapted following new information in future years, there are some long-term stakeholder goals that A–NZ can work towards. City-specific strategies (e.g., Auckland Council 2019; Christchurch City Council 2023) are inherently timebound and should be regularly updated with new information – particularly given a changing climate (Macinnis-Ng et al. 2021; Keegan et al. 2022). Likewise, monitoring efforts based off of nationally standardised methods should continue into the future to provide long-term information on urban forest health and benefits. We hope that with increased investment, visibility, and demand, green jobs will be viewed positively as an engaging, rewarding, and respected career path. And finally, a goal to increase the proportion of Māori Land in New Zealand (e.g., 10% by 2050) to better engage and respect mana whenua inputs in urban forest management. This includes respecting the aspirations of mana whenua for their land and acknowledging that developing urban forests may not always be their priority.

## Synthesis

There is a large amount of overlap in both the priorities (Fig. 2B) and challenges (Table 1) across diverse stakeholder groups, despite little overlap in the highest priorities of each group (Fig. 2A). Furthermore, when the priorities and challenges were shared verbally between the groups, there was strong agreement that all issues were important. Given the general overlap in priorities and challenges, particularly around enhancing ecosystem services provided by urban trees and securing adequate investment, there is considerable potential for mutual benefit by cross-stakeholder collaboration (e.g., Wallace and Clarkson 2019; Doucet et al. 2024). We suggest a pathway to simultaneously fulfil the interests of a range of stakeholders should initially focus on knowledge acquisition, then policy development, and finally resource creation (Fig. 3).

### Valuing people

In order to effectively establish and manage urban forests, arborists, tangata whenua, and ecologists require increased recognition of their value and earlier engagement in projects (Bardekjian 2016; Saunders et al. 2024). Early engagement of arborists or urban foresters in projects can increase

success and also enforce the demand for urban foresters to help boost their recruitment and visibility as a profession. Currently, very few tree-care professionals in A–NZ identify as urban foresters. This trend has also been observed in the United States (O'Herrin et al. 2020), which is partly due to differing qualification requirements, but may also reflect the ongoing challenge of recognising urban forestry as a distinct career path.

Early engagement with mana whenua can bolster success in projects, however effective and equitable long-term collaboration with mana whenua may be contingent on both the meaningful return of mana whenua lands and an effective power-sharing collaboration with Māori communities. While it is easy to simply assume overlap between traditional tangata whenua values such as kaitiakitanga (guardianship of the land, sea, and sky) and priorities of other stakeholders, acting upon this assumption undermines the authority of mana whenua to manage their ancestral lands. This is exacerbated when mana whenua are excluded in the establishment or tenure of projects that affect them.

Urban ecology is a relatively young field (Mcdonnel 2011), however can offer considerable insight to ensure urban forests are healthy ecosystems that maximise the ecosystem services they provide—to humans, wildlife, and the planet (Alberti et al. 2003; Wu 2014; McPhearson et al. 2016). Urban forest plans often focus on canopy cover or tree establishment targets, but less frequently on the composition of the urban forest (native vs. exotic) or the quality of the planting substrate (Barona et al. 2024). Involvement of ecologists at all stages of urban development and tree establishment could develop urban forests that are healthier, more biodiverse, and are more resistant to disease (Te Tana et al. 2024; Varshney et al. 2024).

## Pathways forward

To effectively plan, research, and develop policy to support urban forests new information needs to be collected and shared. We currently lack an understanding of the vitality of our urban tree species, particularly native species, and how their provision of ecosystem services will alter under climate change (Marselle et al. 2021; Esperon-Rodriguez et al. 2022). Despite many urban forest strategies indicating a preference for native species, these policies are often vague, and exotic species are regularly planted instead (Auckland Council 2019; Barona et al. 2024). In some regions, native species may not provide the full range of ecosystem services demanded by urban environments (Sjöman et al. 2016); however, native species offer critical benefits for indigenous biodiversity and cultural connections to nature. This is particularly true in A–NZ, where stronger commitments to native planting are needed to retain local biodiversity and strengthen the human connection with A–NZ's endemic species (Rodgers et al. 2023; Te Tana et al. 2024; Varshney et al. 2024). Research is also required to ensure that our urban ecosystems are resilient to the increasing demand placed upon them and reduce any negative impacts that novel technologies could impose on our urban ecosystems (Stanley et al. 2015; Goddard et al. 2021).

The consulted stakeholders recommend urgent adoption of policies at both the national and local levels to protect our existing urban forests while improving the success of planned future plantings. An official definition of "urban forest" and its limitations is a simple but major step to underscore further policy, and easy to implement. A commitment to tree protection, providing incentives for retaining/planting trees, defining minimum standards for urban vegetation (such as percent cover, diversity, and tree health), and requiring relevant relationships and expertise (e.g., urban foresters and mana whenua) in projects are urgent policies to establish thriving urban forests at the national level (Fig. 3). At the local or regional level, local government and councils should take a more bespoke approach using SMART goals and specify the desired benefits, objectives, targets, and success indicators that are most appropriate for the area (Sousa-Silva et al. 2023). These should include targets not just for canopy and ground cover but also for canopy and understory complexity, as well as targets for soil health (Upton 2024), restoring natural soundscapes, and co-development of culturally relevant biodiversity indicators. Regulations can be effective at reducing urban forest removal and the effectiveness of such policies needs to be tracked to ensure they are implemented appropriately (Brown et al. 2015; Wyse et al. 2015). Notably, policy needs to be well informed and receive bipartisan support to ensure it is not repealed by a successive government. Policy recall can be more damaging than never introducing policy, as people who otherwise would not remove trees may do so through fear of losing that privilege again in the future (Kronenberg et al. 2021). Fortunately, A–NZ can learn from the successes and failures experienced by other regions (Kozová et al. 2018; Clark et al. 2020; Croeser et al. 2020; Ordóñez et al. 2020; Mensah 2021; Ordóñez-Barona et al. 2021; Thompson et al. 2021; Sousa-Silva et al. 2023).

## Further engagement

We recognise that limiting this workshop to stakeholders directly involved in establishing or maintaining urban forests meant some important stakeholder perspectives were excluded, including the general public, artists, and private home- or landowners. While these stakeholders are clearly important, some effort into understanding the perspectives of the general public has already occurred (Vesely 2007; Fernandes et al. 2019; Barona et al. 2022; Drew-Smythe

et al. 2023). Nevertheless, there still remains a research gap on how to enact long-term collaboration with private home- and landowners. Private landowners significantly affect canopy cover *en masse* (Klobucar et al. 2021), but their individual effects are difficult to predict due to the relatively short timeframe of home ownership compared to tree life cycles. In A–NZ, the average length of time owning a home before reselling it is only 5.5 years (Franklin 2023). While each new occupant can easily remove trees, planting and establishing mature trees often takes longer than 5.5 years, meaning trees may be removed prior to the realisation of their ecosystem services. Retaining trees on private land will likely require a combination of policies or incentives (Guo et al. 2019; Clark et al. 2020), and education on the benefits of trees (Moffat 2016) including their positive effect on property values (Pandit et al. 2014). Additionally, further work is required to understand the diversity of urban forest values across Māori communities in A–NZ, given that 84% of Māori live in urban centres (Meredith 2015).

## Lessons for urban forests worldwide

Urban forestry is an emerging discipline in A–NZ and has historically received less attention than in other countries. While many of the priorities and challenges identified through this workshop are grounded in the national context, several align closely with themes in the international urban forestry literature. These include the need for long-term funding, integrated planning, inclusive decision-making, and stronger regulatory support. As such, our findings contribute to a growing body of work seeking to clarify the shared barriers and opportunities in urban forest establishment globally.

More specifically, the emergence of urban forestry in A–NZ may offer lessons for other Pacific island states. Many of these countries share a legacy of colonial plantings and face similar tensions between development, biodiversity protection, and the inclusion of Indigenous worldviews. As home to the largest urban areas in the Pacific, A–NZ is uniquely positioned to lead in this space. More generally, issues surrounding endemic biodiversity are critical for urban forest management in other biodiversity hotspots, and the emergent challenge of urban intensification is similarly pressing in other countries that have historically been land-rich and largely rural. Finally, urban forest governance in many countries must grapple with the historical and ongoing effects of colonisation that have disadvantaged indigenous peoples so they can establish a strong foundation for the inclusion of indigenous perspectives in urban forest development.

This workshop integrated a stakeholder-inclusive approach to assess the perspectives of diverse groups using a standardised methodology. This structured, multi-sectoral process allowed us to develop a stakeholder-informed framework outlining a range of activities to guide progress over the next five years. In contrast to other frameworks recently developed which focus on quantitative measurements (e.g., Galdino et al. 2022; Wang et al. 2024), our approach highlights the social and ecological barriers that must be addressed to ensure that healthy urban forests are not only technically achievable, but also socially supported and valued within urban environments. While this method may be adaptable to other contexts, we acknowledge that urban forestry in Aotearoa New Zealand is still in its early stages, and time is needed to determine whether these recommendations are adopted and lead to lasting outcomes.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s11252-025-01801-8.

**Acknowledgements** We are deeply grateful to all attendees and organisers of the Urban Forest Futures New Zealand (UFFNZ) 2024 symposium. We are grateful to the Oak Springs Garden Foundation for providing T. Carlin an avenue for contemplation, feedback, and quiet writing space. We thank the representatives of Ngāi Tūāhuriri, including Liz Brown from the University of Canterbury, who not only gifted the UFFNZ symposium part of its name but also provided significant consultation on early versions of the symposium concepts. We are grateful to Kimberley Murrell who helped organise UFFNZ. We are grateful to Matthew Scott and Charlotte Armstrong for their comments on an early version of this manuscript, as well as the two anonymous reviewers whose comments helped improve this work. All figures were created using BioRender.com.

**Author contributions** YD, TFC, JM, DRR, & TC acquired the funding. TFC, TB, TC, DRR, JM, ST, & RS developed the concept and methodology, and handled project administration. TFC wrote the original draft. All authors contributed significantly to the investigation, along with manuscript writing, reviewing, and editing. All authors approved the final version.

**Funding** Open Access funding enabled and organized by CAUL and its Member Institutions. This work was funded by the New Zealand Ministry of Business Innovation and Employment through Strategic Science Investment Funding to both Scion and Manaaki Whenua – Landcare Research.

**Data availability** No datasets were generated or analysed during the current study.

## Declarations

**Competing interests** CW and DS each own and operate specialist tree care and maintenance companies. JA and ZA own and operate an urban design consultancy firm. The remaining authors declare that they have no competing interests.

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