Hort Innovation

Final Report

Global review of incentive schemes for the retention and successful establishment of trees on private urban land

Project leader:

Stephen J. Livesley

Delivery partner:

The University of Melbourne

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Expert Opinion and Case Study Synthesis

In collaboration with:

Author information:

Camilo Ordóñez, Research Fellow, The University of Melbourne
Judy Bush, Lecturer, Urban Planning, The University of Melbourne
Joe Hurley, Associate Professor, Global, Urban and Social Studies, RMIT University
Stephen Livesley, Associate Professor, The University of Melbourne
Marco Amati, Associate Professor, Global, Urban and Social Studies, RMIT University
Alex English, Open Space Planner, City of Moreland Council
Stephen Frank, Principal, TreeLogic
Kelly Hertzog, Team Leader, Urban Forest and Ecology, City of Melbourne
Meg Caffin, Principal, Urban Forest Consulting
Dave Callow, Director of Parks & City Greening, City of Melbourne

Research assistance provided by Christopher Clark, The University of Melbourne

For more information about this report contact:

Camilo Ordóñez
Research Fellow
Ecosystem and Forest Sciences | Faculty of Science
The University of Melbourne
Burnley campus, Main Building
Richmond, Victoria 3121, Australia
camilo.ordonez@unimelb.edu.au | +61 390 356941

Stephen J. Livesley
Associate Professor
Ecosystem and Forest Sciences | Faculty of Science
The University of Melbourne
Burnley campus, Main Building
Richmond, Victoria 3121, Australia
sjlive@unimelb.edu.au | +61 3 90356848

Content

Summary

Trees on private urban land (i.e., land owned and managed by private landowners) are central to the ambitious plans of many global cities to increase urban canopy-cover. This presents many problems and often causes tensions in local and state governments due to the difficulty in controlling and regulating private ownership. To help address this, the University of Melbourne, through funding from Horticultural Innovation Australia, partnered with a reference group of local experts to investigate the mechanisms (regulations and incentives, or "sticks and carrots") that cities have adopted to retain, protect, and plant trees on private lands. These experts included academics, local government, and industry partners.

This report presents expert opinions and a review of case studies on the progressive mechanisms that cities use to retain, protect, and plant trees on private lands. This is the second and final milestone of this project. This report is grounded in the understanding of this topic by Australian local governments, and its goal is to help these cities implement these progressive mechanisms.

Experts, consulted through two workshops held at two international conferences, indicated that urban trees were mostly being lost on private land due to policies that stimulated urban densification and development, and due to ill-defined boundaries between public and private lands. These experts acknowledged the psychological impact of dealing with tree loss. Rather than advocating for stricter regulations, most participants advocated for policy and community-based solutions. They noted that while many global cities have mechanisms to protect trees on private lands, implementing them depends strongly on community support.

We reviewed almost 100 progressive case studies from around the world and found that most cities still relied on sticks, or local laws that require applications for tree removal permits and/or significant tree registries to protect certain trees on private lands. We could not assess the progressiveness of the mechanisms in terms of their efficacy and efficiency, due to the local nature of what these mean and the lack of standardization for evaluating these. Therefore, we assessed each case study in terms of its innovation, specified in terms of going above minimum standards and going beyond business-as-usual. Most carrots were being applied to new developments, so their effectiveness is still unclear and will depend upon longer term monitoring.

While it is difficult to find evidence that stick or carrot approaches work, they can still play an important role. Protecting trees on private lands requires a comprehensive mix of policy, programs, professionalism, values, leadership, and action. Support in local government (governance, decision-making, resources, leadership) and the community (values, preferences, level of trust) are both critical to the success of private tree protections. Carrots can be helpful in a variety of ways, most fundamentally, because they allow for a paradigm shift. This new paradigm means that responsibility can be assigned to private landowners and other stakeholders to promote community stewardship.

Our recommendations for Australian cities include:
- Developing sticks that go above minimum standards by:
    o being specific about private lands,
    o requiring payments up front, and
    o developing specific standards for tree protection or retention in development contexts
- Developing carrots that go beyond business-as-usual practices by:
    o establishing clear minimum standards
    o keeping track of rebates and protected trees

Some of the progressive mechanisms we recommend include:
- combining policies, planning schemes, local laws, and financial rebate programs;
- tree bonds where a payment is required prior to a development commencing; and
- tax rebates for retaining or planting trees in newly developed or re-developed sites and private residences.

We also recommend local governments to incentivize community-based activity and support for protecting private trees by:
- nurturing and supporting social activism aimed at protecting trees, and
- developing a better understanding of the underpinning values and attitudes that their communities have towards trees and towards local government. This can support future decisions and reduce trade-offs and conflicts with, or within, communities.

Local governments and researchers should work together to develop monitor frameworks that allows them to assess the effectiveness and efficiency of sticks and carrots.

Keywords

Hort Innovation – Final Report: Global review of incentive schemes for the retention and successful establishment of trees on private urban land

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Introduction

The sustainability and liveability of cities depends on retaining established trees as long as possible, and on successfully planting and growing new trees. In many world cities, a significant portion of urban trees and tree canopy cover is on private land, defined here as land owned and managed by private landowners, in contrast to land owned and managed by public institutions (e.g., US, Troy et al., 2007; Nowak & Greenfield, 2012; Europe, FAO 2018; Australia, Jacobs et al., 2014; Figure 1). To meet the ambitious canopy cover targets of many forward-looking cities, local governments need to increase the number of trees being planted and help to retain established trees on private land. However, this is challenging because the private ownership of trees contrasts with the accessibility and public nature of their benefits. Communicating and consulting with landowners is resource intensive and potentially difficult for local governments. In addition, many Australian cities have policies promoting urban densification to accommodate increasing urban populations (Infrastructure Australia, 2019), which inadvertently lead to the loss of trees on private lands (City of Melbourne, 2011; Haaland & Konijnendijk, 2015; Jim et al., 2018; Boulton et al., 2018; Ordóñez et al., 2020). These factors in combination are resulting in a shift in urban forest expectations from private land to public land, and greater pressure on local governments to plant more street and parkland trees.

If urban forests are meant to be collectively enjoyed, then local governments have an important role to play in encouraging or regulating what happens to trees on private lands. Many local governments are using a range of mechanisms to influence what happens to trees on private lands. However, no study has yet documented and analysed expert opinion on the subject and/or synthesized case studies from a range of global cities to develop a comprehensive understanding of the advantages and disadvantages of specific mechanisms. This has diminished the ability of cities to learn from each other and to facilitate innovation.

The goal of this project is to understand how local governments can contribute to retaining existing trees on private land and the planting of more trees on private lands. Building from our review of international academic literature (Ordóñez et al., 2019a), this report will:

1) present a framework that helps characterise the issue and develops a framework for assessing the progressiveness of stick and carrot mechanisms
2) garner the opinions of international experts,

3) review and categorise progressive case studies, and

4) synthesise the outcomes of the research by focusing on solutions for Australian cities.

The project will provide a blue-print template for the most promising suite of mechanisms to retain and increase urban tree numbers and canopy cover in global cities.

Figure 1: Illustration of the challenges for privately owned trees in cities (Greater Melbourne Area, Blackburn, Victoria, Australia), including densification driven by increased house sizes (left) and increased number of dwellings in the same area (right) (Source: The Nature Conservancy, 2019)

Framework

Background & Definitions

Tree protection, removal, and planting on private lands is commonly managed by local governments through either land use planning or local laws. Private tree management using land use planning may be achieved through a range of mechanisms. These include using land use zoning, which is the process of dividing land into categories of uses; schedules for each land use zone, which define what is permitted on these zones, such as the size and placement of buildings; and planning overlays, is an area in a map that defines the extent of special features of the land, such as areas prone to flooding, areas with heritage buildings, or areas with vegetation. Overlays also define the type of development that might trigger the need for a planning permit. These mechanisms identify land as requiring specific management of trees to align with strategic objectives, such as environmental significance, neighbourhood character, vegetation protection, and precinct design frameworks. Mechanisms may apply to individual trees, or all

trees/vegetation typically meeting threshold measures, such as vegetation height, cover area, or tree DBH (diameter at breast height). Mechanisms to manage trees on private lands only apply when the land use planning assessment is triggered, and these triggers are usually specified in the planning scheme of local governments. Triggers typically include a development beyond a certain size or scale, or by identified characteristics of the land as defined by a heritage or environmental significance overlay.

Local governments may also establish more detailed local laws to regulate tree removals. These usually involve laws that require application for a tree removal permit, or laws that protect significant trees (i.e., exceptional, heritage, or landmark tree registries). These local laws vary significantly among cities and, besides aiming to reduce tree removals, they can also serve to identify what is to be protected (Clark et al., 2020). Local laws to regulate tree removal are common in cities in the US (Landry & Pu, 2010; Sung, 2012; Bardon & King, 2019), Canada (Conway & Urbani, 2007), New Zealand (Watson, 2015), Europe (Profus & Loeb, 1990; Schmied & Pillmann, 2003), and China (Jim & Liu, 2000).

Land use zones, schedules, overlays, and local laws are examples of regulatory policy mechanisms (Maddison & Denniss, 2013), or "sticks". These sticks set the minimum standards to which all actions must meet, to identify required (permitted) actions and responses (e.g., tree retention, conditions under which tree pruning is allowed) as well as actions that are not permitted (e.g., tree removal). Regulations are often associated with penalties for non-compliance. Their effectiveness is limited by the capacity and resourcing of the regulatory organisation, both on how and when permits are given, and in the enforcement of penalties for breaches (non-compliance) of regulations. Political will for enforcing regulations is a key factor in ensuring their effectiveness (Zuniga-Teran et al. 2020). Political will, which is related to the willingness of elected officials and other local government officials to apply regulations and penalties, is in part influenced by their perceptions of the regulation and the level of public support for enforcing that regulation. An aversion to risky, unpopular decisions related to tree retentions or tree removals is a common aspect of many local governments (Ordóñez et al., 2020). If regulations are rarely enforced, the public perception of these regulations will be weakened.

Promotion programs that encourage the retention of existing trees or the planting of new trees on private lands are examples of incentive mechanisms (Ordóñez & Duinker, 2013; Kelly, 2014;

Watson, 2015), or "carrots". Carrots strive beyond business-as-usual or regulated responses. These incentives may be in the form of grants, rebates, awards and other recognition, or in-kind support such as provision of information or professional arboricultural advice. An overview of all the different types of mechanisms that can be used by local governments to retain, protect, and plant trees on private urban lands, is included in Appendix 1.

In Australia, tree management on private lands is typically governed by multiple jurisdictions, with federal, state, and local policy provisions in play. As a result, there are different policy approaches across the country. There is no national blanket law for urban tree protection in Australia (Lensink, 2012). The Australian Federal Government has a limited role in land use planning provisions in cities. Urban tree protection on private land is largely governed through land use planning provisions and local laws (Lensink, 2012; Bush, 2017; Phelan et al., 2018). States and territories are the ones who define land use planning, development laws, and planning schemes (Rowley, 2017; VLRC, 2017), while local governments design and administer local laws (VLRC, 2017). Local governments act as planning authorities, applying the state provisions as well as setting and applying local provisions (within the broader directions, priorities and provisions defined by state governments).

Assessing the Progressiveness of Schemes

Tree retention on private land is complex because of the multitude of issues that influence it. This includes policies that promote urban consolidation and densification, the increasing size of houses and shrinking size of gardens, the calculation of premiums for house insurance, and the perception of risk associated with trees, among many others (Ordóñez et al., 2019b). In addition, the effectiveness and efficiency of stick and carrot mechanisms is influenced by a larger governance and socio-political context. This includes a complex combination of policy setting and conflicting policy domains, local government resources, monitoring and enforcement, political will, and community support and public attitudes.

This implies that classifying stick and carrot mechanisms as progressive is a nuanced endeavour and cannot rely on measures of efficacy and efficiency. Monitoring frameworks that allow researchers to assess stick and carrot mechanisms in those terms do not exist in the current literature (Ordóñez et al., 2019a). Moreover, many local governments that have implemented stick and carrot mechanisms have yet to develop such monitoring frameworks (Juhola, 2018). Even if they do exist, such frameworks may be proprietary and therefore, not in the public

domain. But most importantly, if they were to exist, they would only be useful for assessing efficacy and efficiency only in a particular local government context. This means that a prescriptive approach to effectiveness and efficiency, one characterized by global success criteria and a global recipe of solutions, is not only unattainable, but also undesirable, because it may detract from the goal of providing solutions that are specifically tailored to the needs of Australian cities.

Nonetheless, a review of promising stick and carrot mechanisms is not futile if we focus our process on innovation, rather than efficacy and efficiency. As such, we define progressiveness in terms of innovation in two distinct ways. For stick mechanisms to be progressive they must lift the bar of the minimum standards of tree protection on private lands, a standard defined locally or regionally by regulations specified in planning schemes (i.e., zones, schedules, and overlays) and local laws. Complementarily, to classify a carrot mechanism as progressive the mechanism must encourage innovation and best-practice rather than simply rewarding business-as-usual approaches (Figure 2).

Research Opportunities

There are two research gaps that have been previously identified in the literature of tree retention and protection on private urban lands (Ordónez et al., 2019a). First, the lack of understanding about the range of opinions held by urban forest experts about this issue. Second, the lack of knowledge about case studies that have implemented innovative mechanisms.

Most studies of expert opinion with regards to urban forests have focused on what is happening, or what should happen, to trees on public lands (Ordóñez et al., 2019b). As such, there is a limited understanding about expert opinion with regards to trees on private land (Ordóñez et al., 2019a). Garnering and synthesizing the opinions and experiences of international experts with regards to tree protection on private land. This can be useful to understand the spectrum of approaches to and opinions that exist in different geographical and governance contexts around the world (next section).

There is a limited understanding about what and where innovative mechanisms are being used to protect, retain, or plant trees on private urban lands. Most academic literature on urban tree protection is about trees on public lands (e.g., Jim & Liu, 2000; Jim, 2004), and while there are a few guidelines on how to design urban tree protections (e.g., Leff, 2016; VLRC, 2017; ISA,

2018), most studies have only described the type of protections that exist (Ordóñez et al., 2019a), rather than evaluate them in terms of how they push the boundaries beyond business-as-usual (Figure 2). There has never been, that we know of, a comprehensive review and synthesis of progressive case studies that seek to protect, retain or plant trees on private land. This review of case studies seeks to analyse their characteristics as a means to understanding how these ideas can be adopted elsewhere, such as in Australia.
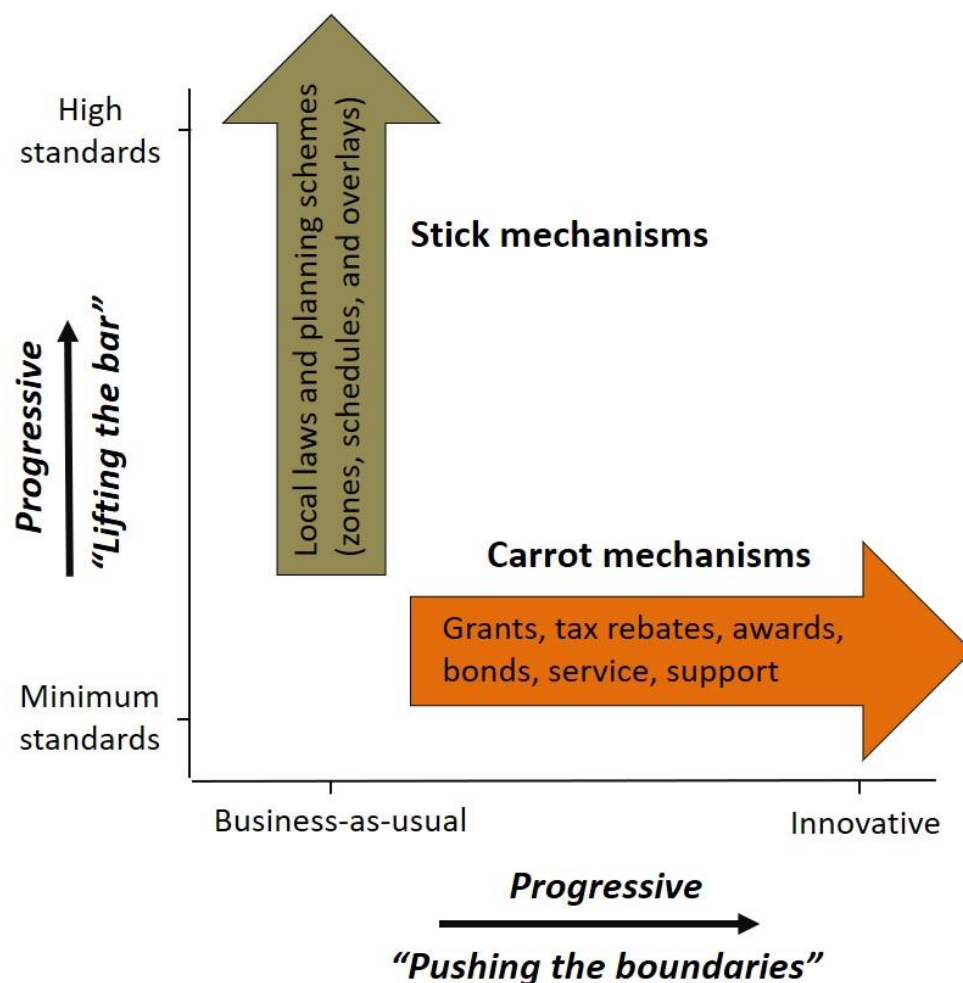

Figure 2: Framework for identifying progressive stick and carrot mechanisms of tree protection on private lands

Methodology

International Expert Opinion

The opinions of international experts were gathered during two conference workshops using an explorative, qualitative approach (Creswell, 2018). This approach means that the insights gained are based directly on the voices of the international expert participants. Two workshops were held, one at the European Forum on Urban Forestry (Cologne, Germany, May 23rd, 2019), and one at the first Nature of Cities Summit (Paris, France, June 4th, 2019). Workshop participants were recruited internally through the conference programs, as well as through a list of contacts of international urban forest leaders compiled prior to the workshops. Participation in the conferences was a pre-requisite to participating in the workshops. Participants could have been representative of any age group, gender, or any other demographic denomination, if they were adults (18 years of age). The workshops were semi-structured discussions based on pre-determined questions (Box 1) that were asked and then monitored by the researcher (Creswell, 2018). Workshop discussions were audio recorded and transcribed. Key ideas, or themes, in these recordings and transcripts were coded for frequency of mention within the discussions (Corbin & Strauss, 2015). Results from the analysis are presented in terms of the frequency of ideas mentioned according to each research question (Box 1).

Box 1: *Questions used in the research study*

We are interested in how why cities retain, protect, or plant trees on private lands. These can include regulations, such as financial penalties for removing trees, or incentives, such as rebates for planting or protecting trees – in short, "stick" or "carrot" approaches.
 	
    1.   What do you think are the causes for local governments to pay attention to private tree protection?
    2.   What are your experiences with tree protection mechanisms, and what is their effectiveness?
    3.   What are some of the new and most innovative opportunities to protect private trees?

Progressive Case Studies

Our review of international case studies on urban tree protection on private urban lands was purposeful rather than systematic, and it sought to be as comprehensive as possible. We gathered information on potential case studies during the workshops we conducted (above), as well as from informal and formal conversations with various international experts. We also conducted online searches and analysed international databases of urban greening projects (Appendix 2). The goals were to gather as many case studies as possible, corroborate them with publicly available information, classify the type of mechanisms used in the case studies, and evaluate

them in terms of their progressiveness, as defined by our framework (Figure 2). The procedure to select case studies is illustrated in Appendix 2, and was based on the following three principles:

1) case study information must be corroborated with publicly available information (e.g., government, non-government, or consulting reports, guideline documents, presentations, and websites);
2) stick mechanisms were considered progressive if they raised minimum standards; and
3) carrot mechanisms were considered progressive if they pushed the boundaries beyond business-as-usual (Figure 2).

Results

International Expert Opinion

A total of 25 experts participated in the workshops from a wide range of backgrounds (Table 1). The conversations at these workshops evolved into three main themes, each theme emanating from each research question. First, participants said that the key reasons local governments were paying attention to trees on private lands was because of tree loss. In fact, workshop participants spent most of their time venting about tree loss on private lands, demonstrating the frustration and despair they feel on the plight of urban trees. Participants said that one of the most important reasons trees were being lost from private lands were government policies that facilitated densification and development of private land. In their opinion this was not only as a result of big development projects, but also as a result of private homeowner removals (note these two aspects of densification are coded as part of the same idea). These government policies ignored or conflicted with existing tree protection mechanisms. The conflicts were exacerbated with ill-defined boundaries of what was public and what was private. Also, these experts suggested that the hierarchical nature of planning schemes meant that planning regulations, such as urban densification policies, 'trumped', or were held above, local tree protection laws. Weak governance of public trees was given as an overarching explanation for why trees in public ownership may be given to private control (Figure 3).

Table 1: Characteristics of workshop participants

Characteristic	Categories	Number of cases *
Type of organization where participants worked	Academic	10
	Business, consultancy	5
	Local government	9
	National or regional government	2
	Non-Government Organization (NGO)	3
Countries where participants worked	Belgium	1
	Brazil	1
	Canada	2
	Colombia	1
	France	4
	Germany	1
	India	2
	Malaysia	1
	Netherlands	1
	Switzerland	1
	United Kingdom	6
	United States	5
Gender	Female	13
	Male	12

* May not add up to 25 due to overlap

Second, many participants commented on what made tree protection mechanisms effective. The two main factors influencing this were the resources available to a local government, including budget and personnel, for reviewing tree removal permit applications. Budget concerns were always mentioned in the context of the human resources that they facilitated (i.e., budgets to cover costs of personnel), so they were coded as a single idea. The ability of local governments to review tree removal permits was the defining factor in the approval rate of such permits. Other suggestions of what made tree protection mechanisms effective included the variation in regulations by council, districts, municipalities, or boroughs in metropolitan areas. This variation in regulation resulted in a fragmented effort to protect trees across metropolitan urban regions, such as in Lima, London, Melbourne, and Toronto. A culture of risk aversion, which is related to political will (see Framework above), was suggested as another reason for ineffective private tree protection, since local governments may avoid implementing a tree-protection law in order to avoid taking a decision that is risky and may result in the loss of community support. Given that

urban development policies also allow private homeowners to develop and expand the footprint of their houses, community attitudes towards trees also influenced the effectiveness of tree protection mechanisms (Figure 3).

Finally, the conversation about opportunities to protect private trees was not focused on advocating for stricter laws, but rather on a more comprehensive policy adjustment that could respond to urban densification, development, and growth. In mentioning this, a few participants noted the importance of differentiating transitional lands. Transitional lands can be defined in this instance as lands between formally recognized land units, including sidewalks, rights of way, curbs, and other areas that are clearly differentiated in public policy or local laws. An example of this is how public areas, such as sidewalks and rights of way, are not well defined in new developments, and this causes conflicts with private landowners because they believe these areas are privately owned. The lack of zoning of these lands in newly developed areas was a big reason why trees were not being protected in many cities. Community stewardship was an important issue to explain why some cities succeed in protecting trees and others do not. For many participants, it was not so much that the mechanisms to protect trees did not exist, but rather that local government officers were not able to defend the action politically. One participant said: "*If the people stand up for the trees, then cities will find it less politically expensive to trigger the protections they have*" (participant code PW18, June 2019). Other opportunities identified by the workshop participants included getting businesses involved in tree planting and tree protection, strengthening tree-giveaway programs, and allowing cities to compete to incentivize recognition and community support (Figure 3).

Progressive Case Studies

We reviewed 97 case studies of mechanisms being used in almost as many cities, of which 75 could be corroborated with publicly available information. Of these 75, according to our definition 62 were deemed 'progressive' (for the process of case study selection, see Appendix 2; for a full list of case studies and sources of information, see Appendix 3).
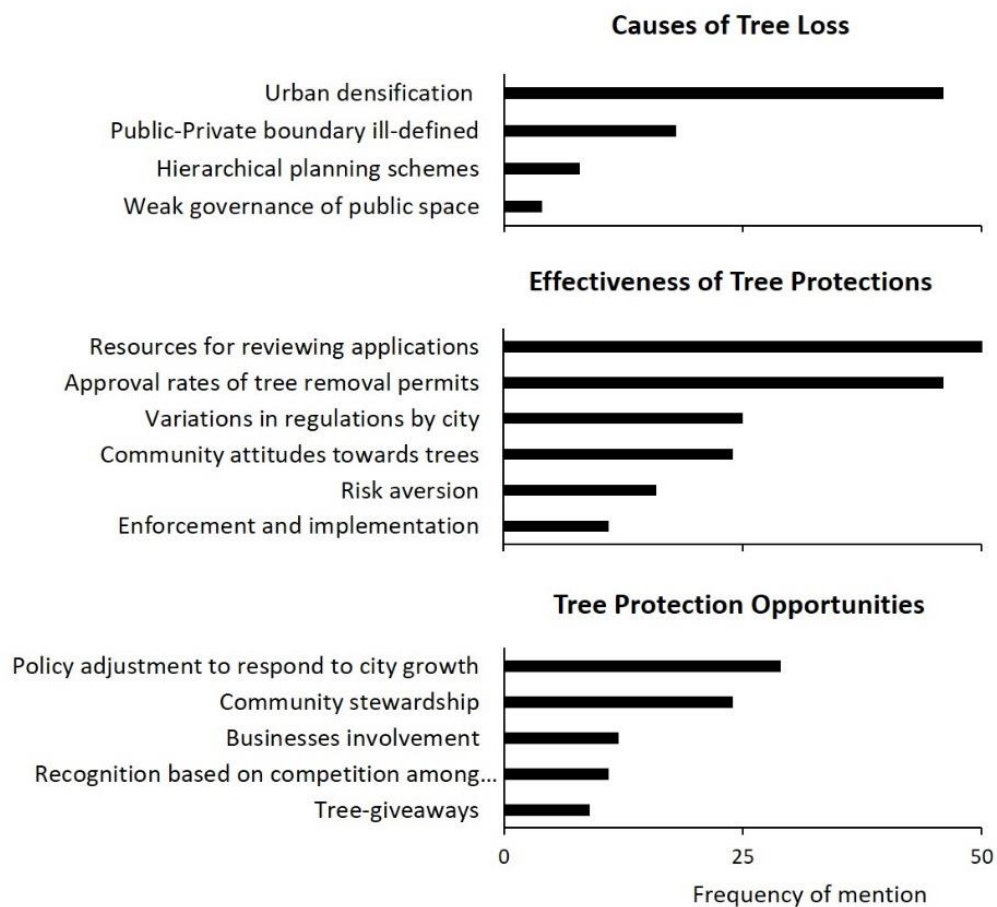
Figure 3: Frequency of mention of themes related to causes of tree loss, effectiveness of tree protections, and tree protection opportunities on private urban lands based on the social data collected through workshops at the two conferences

The stick mechanisms in these case studies referred mostly to local laws and significant tree registries. What made these traditional mechanisms progressive was that they specifically covered trees on private land, considering that many of the local laws and significant tree registries reviewed were only applicable to trees on public land. Another factor that made some case studies progressive was the combination of several tree protections mechanisms at different levels of government (see Outputs, *Showcase of Stick Mechanisms*). Other types of progressive stick mechanisms included tree protection standards, such as advanced tree valuation formulas or standards for the retention of trees in the context of development (Figures 4 and 5; for details, see Appendix 3). One notably innovative and progressive stick mechanism was the use of tree bonds (see Outputs, *Showcase of Stick Mechanisms*) (Figures 4 and 5; for details, see Appendix 3).

The most progressive carrot mechanisms being used in these case studies were tax rebates for

retaining or planting trees in newly developed or re-developed sites. The focus of these tax rebate mechanisms varied, with some being focused on retaining existing trees as an end in themselves, while others were focused on reducing stormwater runoff through the retention of trees (Fitzko, 2014; see also Outputs, *Showcase of Carrot Mechanisms*).

Some sources of case study information did not yield any significant insights, such as the international databases of urban greening projects (Appendix 2), most of which only provided case studies of tree planting on public lands. The only mention of "private" in these databases was to describe the public-private partnerships that were established to fund these planting programs. While we found compilations that described where local tree protections existed (e.g., Canada, University of Toronto, 2017), these were not explicit about the type of protection that existed.
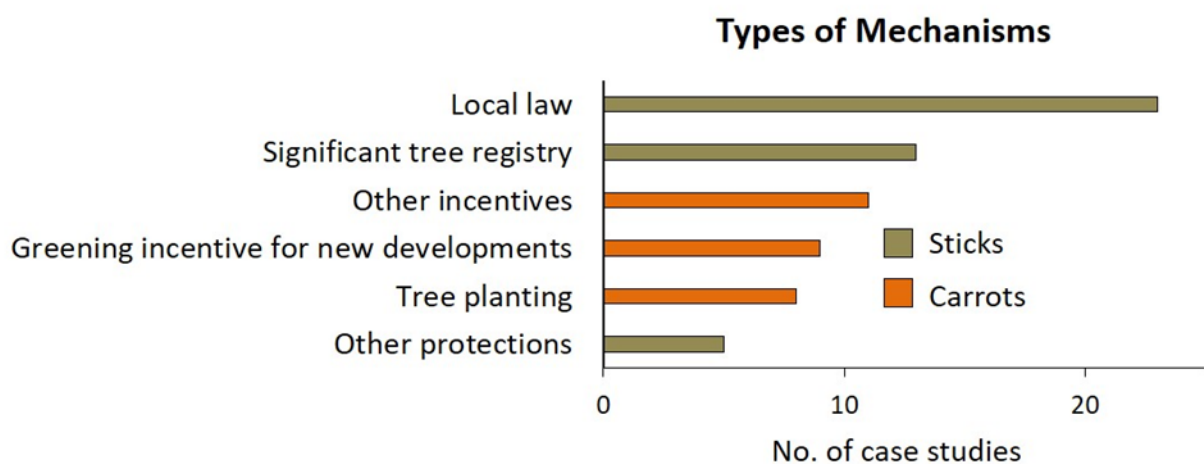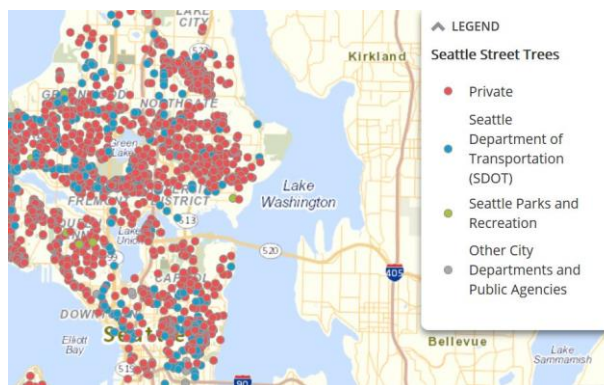

Figure 4: Types of stick and carrot mechanisms for tree protection, retention, and planting on private lands conveyed in the case studies reviewed (see Appendix 3)

Outputs

Showcase of Progressive Stick Mechanisms

TREE PROTECTION FROM ALL DIRECTIONS IN SEATTLE, USA

Seattle relies on two traditional methods to protect its private trees: a local law that defines that all trees of a certain size are to be protected, regardless of ownership or location; and a registry of significant trees, compiled by nomination from residents, based on the size of the tree, and its biodiversity and cultural importance. At first glance, these are just the traditional tree protection measures that most cities in the world use. However, what is unique about Seattle is that, after recently changing the rule about the responsibility for maintaining street trees from private to public (i.e., homeowners living in front a tree were previously responsible for it, but not anymore), Seattle has combined these traditional tree protections with zoning mechanisms that define landscapes types where these protections are to be applied. Any development

A caption of the street tree registry from the City of Seattle; note the distinction between public and private trees (source: https://www.seattle.gov/trees/planting-and-care/trees-for-neighborhoods)

carried out in specific zones will trigger tree protection mechanisms due to the zoning. In addition, Seattle also has strict standards for building setbacks, defined by the percentage (%) of land cover or area that trees need to survive It is one of the most complete local legislations for trees in the US, and the world (for details and sources, see Appendix 3).

REQUESTING TREE BONDS FROM PRIVATE LAND DEVELOPMENTS IN THE CITY OF STONNINGTON, MELBOURNE, AUSTRALIA

An example of adapted tree development for tree retention in the City of Banyule, Victoria, Australia, with the shaded, blue area indicating the extent of the tree canopy, which spreads over several property boundaries, delineated by the white lines (compiled by C Clark, 2019; source: Nearmap®)

The City of Stonnington, in the Melbourne area, is implementing tree bonds on private lands as a mechanism for protecting trees. While tree bonds are used by many cities, including Bendigo, Stirling, and Sydney (see Appendix 3), only Stonnington has applied them to private land. A tree bond requires a land developer to deposit a certain amount of money with the local authority prior to commencing a development. These bonds apply to any tree deemed significant by the city. If the identified tree or trees are not present and healthy after the development, the funds are forfeited. The system is a bank guarantee system, as the city council does not hold the money itself. The size of the bond is based on estimated tree valuation, and/or set at a level that is likely to achieve compliance (likely to be thousands or tens of thousands of dollars) (Hurley et al. 2018). Tree bonds are usually used in major development contexts, such as in the case of multi-dwelling commercial or residential building developments. The only caveat is that the mechanism is still new, and it is still unclear if or how is being implemented (for details and sources, see Appendix 3).

TREE PROTECTION BASED ON HERITAGE IN LONDON, UK
All cities in the United Kingdom, including London, are covered by a nation-wide tree protection regulation (Section 198 of the TCPA, 1990) to protect and retain trees. While implementing the regulation has not been easy – some UK participants in our workshops documented an increase of tree removals in the 1990s and 2000s due to intensified development – this nation-wide protection embedded in the planning standards of the country is one of the only ones in the world. This is compensated with national legislation on the preservation of English Oaks. Recent policies to protect public parks from terrorist attacks and increase safety have required the installation of concrete walls and containments around the walls. This has put many mature trees located at the verges of the park under risk of root damage. Yet, the protection regulation has meant that a lot of these trees are being actively protected from root damage (for details and sources, see Appendix 3).

Showcase of Progressive Carrot Mechanisms

FINANCIAL INCENTIVES FOR GREENING NEW DEVELOPMENTS ACROSS THE USA AND EUROPE
Cities like Seattle, Portland, Washington DC, Berlin, Helsinki, and Malmö have all implemented a similar program for incentivizing greening in new developments. The program has different names in each city, but it is based on a similar premise: newly developed or re-developed building sites can obtain tax rebates by calculating the amount of greening they are retaining or creating in these sites (Juhola, 2018). The goal of each individual program varies, from managing stormwater runoff to simply greening the site. For instance, the TreeBate Program in Portland focuses on reducing impervious surface or volume for stormwater runoff. Trees with a significant canopy cover that are retained during development get a higher greening score than simply having grass. Planting new trees also gets a high score. In Seattle, the Urban Greening Factor program simply calculates the potential of greening of a new development area. As with the Portland program, the calculation is not specific to trees, but trees get a higher score than simply grass. Finally, the Green Area Ratio Index program in Washington DC is aimed at giving a certain value to tree retention to stimulate stormwater runoff in new developments. Like the Portland program, is based on the reduction of impervious surfaces. Programs across European cities are very similar (for details and sources, see Appendix 3).

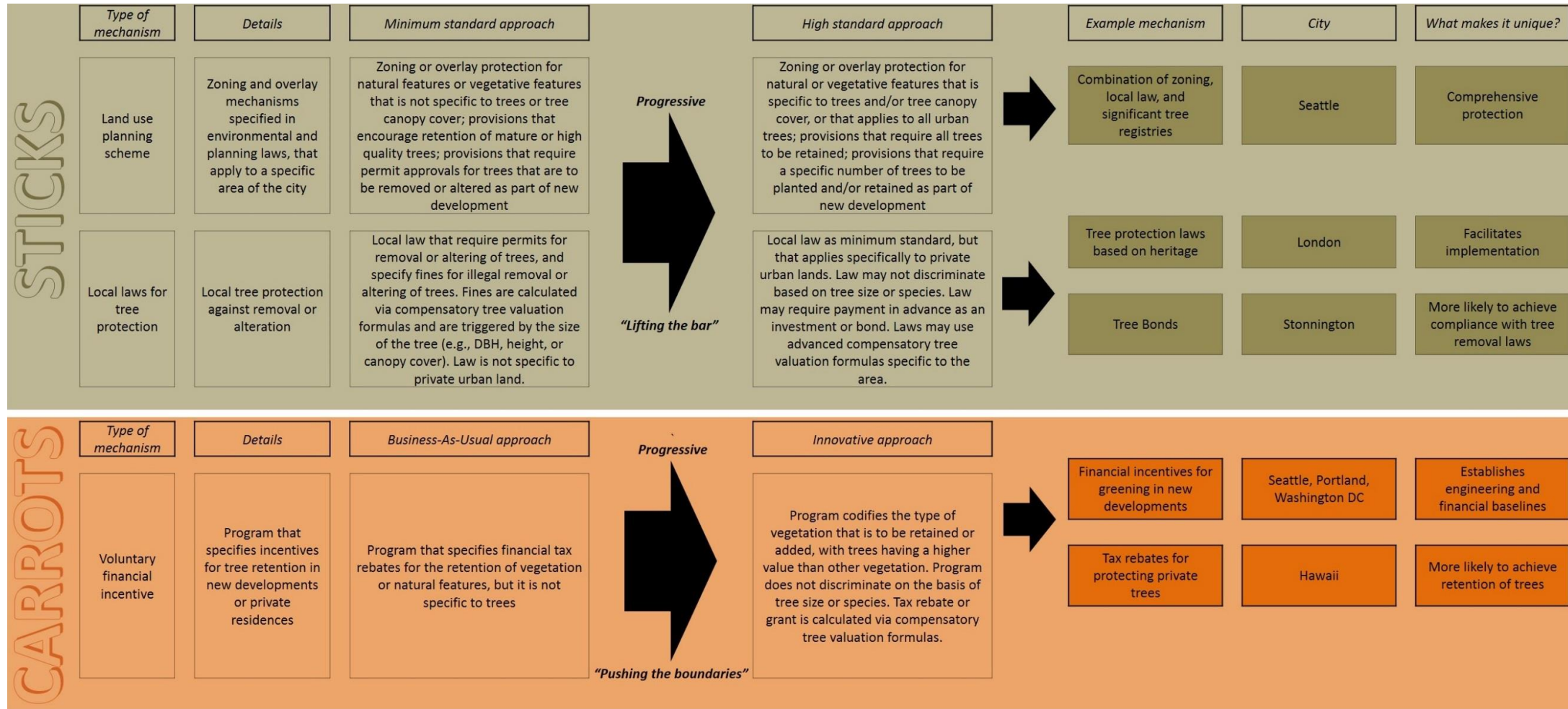| RESIDENTS GETTING TAX BENEFITS FOR PROTECTING THEIR PRIVATE TREES IN HAWAII, USA |
| --- |
| Besides being an interesting case study of strict vegetation protection, Hawaii is an interesting case study for tree retention incentives. The state has implemented a greening incentive for private residents, establishing a new system to pay for residents to protect their private trees. This so-called "tree-retention incentive" is basically a tax rebate, where residents can claim up to $3,000 from their tax returns per tree every year if they happen to have an exceptional tree on their property. To apply for this tax rebate, residents need to be able to demonstrate that they have spent money on tree maintenance, ranging from pruning or lopping the tree, to mulching it. One caveat about this system is that there is not a lot of information as to how many people are claiming this incentive from their taxes (for details and sources, see Appendix 3). |

Type of mechanism	Details	Minimum standard approach		High standard approach	Example mechanism	City	What makes it unique?
STICKS							
Land use planning scheme	Zoning and overlay mechanisms specified in environmental and planning laws, that apply to a specific area of the city	Zoning or overlay protection for natural features or vegetative features that is not specific to trees or tree canopy cover; provisions that encourage retention of mature or high quality trees; provisions that require permit approvals for trees that are to be removed or altered as part of new development	**Progressive**	Zoning or overlay protection for natural or vegetative features that is specific to trees and/or tree canopy cover, or that applies to all urban trees; provisions that require all trees to be retained; provisions that require a specific number of trees to be planted and/or retained as part of new development	Combination of zoning, local law, and significant tree registries	Seattle	Comprehensive protection
Local laws for tree protection	Local tree protection against removal or alteration	Local law that require permits for removal or altering of trees, and specify fines for illegal removal or altering of trees. Fines are calculated via compensatory tree valuation formulas and are triggered by the size of the tree (e.g., DBH, height, or canopy cover). Law is not specific to private urban land.	"Lifting the bar"	Local law as minimum standard, but that applies specifically to private urban lands. Law may not discriminate based on tree size or species. Law may require payment in advance as an investment or bond. Laws may use advanced compensatory tree valuation formulas specific to the area.	Tree protection laws based on heritage / Tree Bonds	London / Stonnington	Facilitates implementation / More likely to achieve compliance with tree removal laws

Type of mechanism	Details	Business-As-Usual approach		Innovative approach	Example mechanism	City	What makes it unique?
CARROTS							
Voluntary financial incentive	Program that specifies incentives for tree retention in new developments or private residences	Program that specifies financial tax rebates for the retention of vegetation or natural features, but it is not specific to trees	**Progressive** / "Pushing the boundaries"	Program codifies the type of vegetation that is to be retained or added, with trees having a higher value than other vegetation. Program does not discriminate on the basis of tree size or species. Tax rebate or grant is calculated via compensatory tree valuation formulas.	Financial incentives for greening in new developments / Tax rebates for protecting private trees	Seattle, Portland, Washington DC / Hawaii	Establishes engineering and financial baselines / More likely to achieve retention of trees

Figure 5: A blueprint for identifying and selecting progressive stick and carrot mechanisms, based on our framework for identifying progressive mechanisms (Figure 2) and indicating details of types of mechanisms, minimum standards or business-as-usual approaches, and innovative or best practice approaches, as well as examples of mechanisms and the cities where they are being implemented, as based on the information elicited from the case studies reviewed (see Appendix 3)

Discussion & Reflections

Local governments play a significant role in encouraging or regulating what happens to trees on private land, particularly if they want to meet current policy targets based on increasing urban tree numbers and canopy cover (Australian Government, 2018). A comprehensive mix of policy, programs, professionalism, education, resourcing, values, leadership, and action can protect and enhance trees on private land while still catering for city redevelopment. But there is no simple way to achieve this. Private tree protection is a relatively immature area of government policy when compared to, for example, built form heritage, or even flood risk management. While we have identified progressive case studies in terms of their innovation, these do not necessarily represent successful or effective, and efficient mechanisms. Even amongst the most active and progressive government settings, the situation is still characterized by an ongoing process of tree removal from private lands. Due to the local nature of what makes a mechanism effective or and efficient, such as implementation costs of a program, or the cost of labour for reviewing tree removal permits, this information may be available only in terms of personnel expenses and budgetary allocations. As such, this financial information may be proprietary to local governments and not in the public domain. Most importantly, the standards of efficacy and efficiency of one city may not be applicable in another city. A prescriptive approach to tree protection on private urban lands is undesirable, as it detracts from the goal of providing solutions that will work for Australian cities. While there is little sense that there is a single, effective local government policy or program in place to respond to ongoing private tree loss, be that made up of carrots or sticks, the efficacy and efficiency of sticks and carrot approaches, in broad terms, may depend on a complex combination of policies, programs, decision-making process, monitoring and enforcement, political will and public attitudes.

Throughout this project, we have found many arguments against stick mechanisms (see Ordóñez et al., 2019a; see also Coughlin et al., 1988; Profus & Loeb, 1990; Cooper, 1996; Schmied & Pillmann, 2003; City of Melbourne, 2011; Mincey et al., 2013; Kelly, 2014; Watson, 2015; Wyse et al., 2015; Brown et al., 2018; Clark et al., 2020; see also Seattle sources in Appendix 3), including:

- There are too many exemptions to the law, either because the land use zone is exempted, there is no definitive standard about what constitutes a protected tree (e.g., variable standards for significant trees), and/or the law is subjectively applied, either because of lack of standards or aversion to risk (e.g., loss of community support). These exemptions increase tree removal approval rates and make the laws ineffective.
- Regulatory approaches, such as requiring tree removal permits, or managing a registry of significant trees, are resource intensive, and some cities simply do not have the capacity (budgets and/or personnel) to enforce them, or they slow down the planning application process, resulting in less attention to other applications.

The minimization of risk associated with urban trees (i.e., risks related to limb fall, windthrow, infrastructure damage caused by roots or branches, among others; see Klein et al., 2019), is a big driver behind decisions to retain or remove trees on private land. Many professionals (e.g., civil engineers) and homeowners seek to minimize all possible risks, real or perceived. This results in an institutional bias towards recommending tree removal as a solution to reduce risk. Risk reduction and aversion is a big player in decisions taken by urban forest managers (see Kirkpatrick et al., 2013; Koeser et al., 2016; Roy et al., 2017; Klein et al., 2019; Ordóñez et al., 2020) and private landowners (see Kirkpatrick et al., 2012; Dilley & Wolf, 2013; Conway, 2016; Avolio et al., 2018)

As a result, urban forest experts suffer the psychological impact of dealing with loss. In our conversations, experts were always looking for opportunities to vent their discontent, frustration, and despair regarding the loss of trees on private lands. Despite this emotional impact, instead of advocating for stricter regulations, experts advocate for policy and community-based solutions. It is still unclear if other urban forest stakeholders, such as residents, or non-governmental organizations, share these ideas as there is almost no research on this topic in the literature.

While it is difficult to find evidence that stick approaches are effective or efficient, they can still play an important role, especially if they are combined with carrots. Regulations give structure to policies, help identify what is to be protected, and, in some cases, can be the main instrument to

retain trees. While there are no silver bullets, the most progressive stick mechanisms we found are described in the *Solutions & Recommendations for Australian Cities* section below (for other mechanisms, see Appendix 3).

Furthermore, while many have argued for having more carrot mechanisms (Ordóñez et al., 2019a; see also Coughlin et al., 1988; Cooper, 1996; City of Melbourne, 2011; Kelly, 2014; Watson, 2015; Wyse et al., 2015; Atkinson, 2016; Nguyen et al., 2017; Brown et al., 2018; FAO, 2018; Juhola, 2018; Clark et al., 2020; Roman et al., 2018; see mechanisms in Appendix 1; see case studies in Appendix 3), these mechanism also have problems, including:

- financial incentives, such as tax rebates, lack baselines or change existing baselines frequently;
- since they mostly apply to new developments, their effectiveness is still unclear and depends on longer term monitoring;
- incentives are sometimes hindered by existing contradictory regulations; and
- most public information about traditional carrot mechanisms, such as free arboricultural services, tree giveaways, and tree planting programs, are anecdotal, and this is not enough to corroborate their existence or evaluate their efficacy.

Nonetheless, while it is difficult to find evidence that carrot approaches work, they can still play an important role. Incentive programs can be helpful in a variety of ways, most fundamentally, because they allow for a paradigm shift. This new paradigm can assign responsibility to private landowners and other stakeholders to promote community stewardship (see Boulton et al., 2018; Brown et al., 2018; Ordóñez et al., 2019b; 2020). While there are no silver bullets, the most progressive carrot mechanisms that we identified are described in the *Solutions & Recommendations for Australian Cities* section below (for other mechanisms, see Appendix 3).

Because the community context (people's values, preferences, etc.) is also critical to the success of private tree protections (Kirkpatrick et al., 2012; Dilley & Wolf, 2013; Conway, 2016; Avolio et al., 2018; Ordóñez et al., 2019a; 2020), we have also recognized ways that local governments can incentivize community-based activity for protecting private trees in the *Solutions &*

Recommendations for Australian Cities section below. This information is solely based on our own opinion. One of the biggest limitations is that information about how local governments are incentivizing community-based activity is not publicly available.

Finally, rapid population growth, rapid development, climate change, and changes in the characteristics of communities (e.g., more education; more cultural diversity), play a role in creating new, not previously considered, opportunities as well as liabilities for cities. These changes include, for example, changing design standards that stipulate minimum areas and soil volumes for the provision of trees, or an increase in the perceived level of risk associated with trees given the impacts of storms and drought on trees in the future. Successful stick or carrot mechanisms to retain, protect, and plant trees on private land will be the ones that take some of these future changes into consideration.

Solutions & Recommendations for Australian Cities

We recognise that many local governments across the world are trialling their own mechanisms to protect and retain trees on private and that these mechanisms have not yet been evaluated for their efficiency or efficacy. Despite this lack of evidence, we know that significant empirical research data have been utilised to formulate these solutions. As such, we recommend Australian cities to take a proactive approach to this issue by following the lead of the local governments covered in this review (see *Progressive Case Studies* section, Figure 5; see also Appendix 3). The following are a set of guidelines that we have developed to assist Australian cities develop an approach to private trees that is suitable for their own use.

Regulations that go above minimum standards are those that:
- are specific about private lands, instead of leaving ownership open to interpretation;
- rely on state- or nation-wide regulations that are tree-specific, rather than generic descriptions of vegetation or natural environments;
- develop specific standards for the protection of trees in development contexts to avoid the subjective application of local laws;
- require payment for removing trees up front; and
- keep track of the permit applications and approvals provided (e.g., permits to remove trees) and the number of protected trees through comprehensive, continuously updated databases

Incentives that go beyond business-as-usual practices are those that:
- are specific about private lands, instead of leaving ownership open to interpretation;
- establish clear and reliable minimum standards for the maintenance and growth of trees; and
- keep track of the financial incentives provided (e.g., tax rebates) and the number

of protected trees via comprehensive, continuously updated databases

Examples of progressive mechanisms, in terms of their innovation, include:

- regulations based on a comprehensive combination of policies, planning schemes, local laws, and financial rebate programs,

- tree bonds that developers are required to pay prior to commencing a development, and

- tax rebates for retaining or planting trees in newly developed or re-developed sites and private homeowners.

Local governments and researchers should work together to develop monitoring and evaluation frameworks that allow them to assess the effectiveness and efficiency of regulatory and incentive mechanisms.

Local governments can incentivize community-based activity and/or obtain support for implementing tree-protection regulations and incentives for protecting private trees by:

- Nurturing and systematically supporting social activism (non-governmental, community-based work) for protecting, retaining, or planting trees on private lands.

- Establishing a monitoring system for programs based on free tree services or free tree giveaways, to ensure that the trees survive and do well.

- Developing a better understanding of the underpinning values and attitudes of communities by doing empirical, social-based work, including, but not limited to, consultations, open houses, and engagement activities. This work provides the empirical evidence of what communities want, and this information, in turn, can serve to support decisions and reduce trade-offs and conflicts with communities.

Local governments should make information about how they incentivize community-based activity publicly available. Also, local governments and researchers should work together to develop evaluation monitoring and frameworks that allow them to assess the effectiveness and efficiency of these programs.

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Appendices

Appendix 1

Table 2: Types of urban tree protections on private urban land (updated from Ordóñez et al., 2019a)

Category	Subcategory	Mechanism	General Description	Examples in Australia	Type
Legal or Regulatory	National or state/provincial regulations	Environmental or natural resource acts and legislations	Direct or indirect regulations about trees or that include trees	Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Tree protection acts (e.g., ACT 2005, Australia's only tree-specific blanket law) Threatened species conservation acts (e.g., NSW 1995) Conservation, forests and land acts (e.g., VIC 1987) Most planning and environmental acts (e.g., Environmental Planning and Assessment Act 1979 No 203) for all Australian states and territories that give provisions (e.g., Environmental Planning Instruments, EPIs) to local governments to implement tree protections Specific acts or policies for each state/province	Stick
	Protected sites	Parks & natural areas Historical or heritage sites Scenic or special landscapes Educational, commercial, or scientific sites	Planning overlays	Environmental Significance Overlay (ESO) Vegetation Protection Overlays (VPO) Significant Landscape Overlay (SLO) Heritage Overlay Neighbourhood Character Overlay (NCO) Bushfire Management Overlay (BMO) Erosion Management Overlay (EMO) Salinity Management Overlay (SMO) Specific for each local landholder (e.g., hospitals, schools, military bases)	Stick
		Protection of area where tree grows	If tree in imminent danger, e.g., soil volumes Depends on site and type of activity	Local overlays (as above) Specific for each local landholder (e.g., hospitals, schools, military bases)	Stick

Table 2: Types of urban tree protections on private urban land (cont.)

Category	Subcategory	Mechanism	General Description	Examples in Australia	Type
Legal or Regulatory	Protected species or specimens	Rare or large specimens	Depends on type of tree	Local overlays (as above) CITES acts Specific for each local landholder (e.g., hospitals, schools, military bases)	Stick
		Protected Species	Trigger usually species		
		Protected types of trees	Depends on type of tree e.g., fruit trees, conifers or deciduous or native species		
		By community or public demand	Specific to local area	Specific to local area	Stick
	Tree protections	Permits or licenses requirements for removing trees	Trigger usually size (DBH or height or canopy-cover), minimum or maximum, or species/specimen Applies to both public and private trees Could be calculated via compensatory value formulas (see below) Requires or complemented by arborist report (see below)	Local tree-protection laws (e.g., Tree Preservation Orders – TPOs in NSW; Local Environment Plans – LEPs) Tree bonds Specific for each local landholder (e.g., hospitals, schools, military bases)	Stick
		Significant, exceptional, or heritage tree registries			
		Fines for illegal tree removals			
		Compensatory value formulas	Also known as valuation formulas Based on tree characteristics (usually size, species, etc.) Usually based on amenity value, not environmental services value Some examples include the Council of Tree and Landscaper Appraisers (CTLA) in US, and the Capital Assets Value Amenity Trees, (CAVAT), in UK Could be calculated based on tree characteristics of as a single price for any tree	Local tree-protection law Specific for each local landholder (e.g., hospitals, schools, military bases)	Stick

Table 2: Types of urban tree protections on private urban land (cont.)

Category	Subcategory	Mechanism	General Description	Examples in Australia	Type
Legal or Regulatory	Tree management requirements for new constructions or developments	Arborist report	Could be specified in local building requirements Trigger usually size (DBH or height or canopy-cover), minimum or maximum, or species/specimen Applies to both public and private trees Could specify type of effect: • to remove • to destroy totally or partially • to damage totally or partially • to cut, to truncate totally or partially • to modify • to enhance decay Could be calculated via compensatory value formulas (see below), or single price for any tree Uses compensatory value formulas (a.k.a. valuation formulas) (e.g., Council of Tree and Landscaper Appraisers (CTLA) in US; Capital Assets Value Amenity Trees, (CAVAT), in UK)	Local tree-protection law Building Code of Australia (BCA) Specific for each local landholder (e.g., hospitals, schools, military bases)	Stick
		Building requirements			Stick
	Strategic policy guidelines	Resource continuity	Definition of the urban forest as a continuous resource regardless of ownership across public and private lands	National, State, or Local policy or strategic documents (e.g., biodiversity plans, sustainability plans, development plans, building plans, heritage plans) Specific for each local landholder (e.g., hospitals, schools, military bases)	Both
		Inclusion of urban forest strategies or themes in other policies/strategies	Overseen by state or national planning regulations Applies to both public and private trees Specifics depend on context: National documents/policies State policies/documents Local laws or documents/policies		
		Guidelines for legal personhood of urban forest or trees	To allow legal representation of the urban forest as a natural resource or entity None for urban forests yet, only theoretical, but similar examples exist (e.g., New Zealand, Whanganui river)		

Table 2: Types of urban tree protections on private urban land (cont.)

Category	Subcategory	Mechanism	General Description	Examples in Australia	Type
Voluntary standards or guidelines	Tree management guidelines for new constructions or developments	Tree management standards	Could be specified in national, regional, local building standards, or standards that are part of a third-party certification Could specify type of incentive: • to minimize tree removal • to reduce tree removal • to increase tree retention • to maximize greenspace Triggers vary Applies to private trees only Could be calculated via compensatory value formulas, or single price for any tree Could require third-party arborist report (see above) Could be done via tax breaks or credits (e.g., carbon credits)	Australian Standards for tree pruning (AS 4373-2007) and trees on development sites (AS 4970-2009) Green Factor calculations or indexes for new developments Specific to consulting or certification companies (e.g., International Standards Organization; Standards Australia) Specific for each local landholder (e.g., hospitals, schools, military bases)	Both
		Building standards			
	Planting incentives	Tree planting, retention, or replacement incentives for new constructions or developments Sponsored or financed tree planting			
Education & Awareness	Raise awareness	Material for communication & outreach	Websites, flyers and brochures	National, State, or Local policy or strategic documents (e.g., biodiversity plans, sustainability plans, development plans, building plans, heritage plans, urban forest strategies, urban forest management plans, communications plans) Local tree-protection laws Specific for each local landholder (e.g., hospitals, schools, military bases)	Carrot
		Public information centres	Info centres in arboreta; interpretation sites in natural areas		
		Site interpretation			
	Free services	Free arboricultural services	Free pruning or removal and re-planting		
		Free tree resources	Seed or seedling giveaway program		
	Education	Educational programs	Information workshops; partnerships with universities to do research or undertake urban forest courses; walking tours (e.g., Nature Stewards program)		
		Educational centres	Centres with information or educational programs (e.g., arboreta)		

Table 2: Types of urban tree protections on private urban land (cont.)

Category	Subcategory	Mechanism	General Description	Examples in Australia	Type
Participation, Stewardship, & Engagement	Promoting Private Stewardship	Private stewardship	Celebrations or competitions of private tree stewardship Tree days and tree competitions (e.g., ArborDay, Tree Week) Adopt-a-tree/greenway programs (e.g., New York's tree-adoption program)	National, State, or Local policy or strategic documents (e.g., biodiversity plans, sustainability plans, development plans, building plans, heritage plans, urban forest strategies, urban forest management plans, communications plans) Local tree-protection laws Specific for each local landholder (e.g., hospitals, schools, military bases)	Carrot
	Participation & Engagement	Volunteering	Tree-planting volunteers Includes celebration of volunteer activities		
		Public/community input requirements for activities	Public input on trees to be removed or altered by new development projects		
		Community partnerships and leadership	Steering communities or working groups on urban-tree decisions Creation of community-led organizations (e.g., tree-planting groups in neighborhood) Supporting local activism programs or activities (e.g., tree retention activities)		
		Citizen science	Citizen-led programs for collection of tree data, such as an inventory (e.g., Citizen Forester program)		

Appendix 2

Table 3: Case study review procedures, including search techniques and selection criteria

Review stage	Procedure	Details
Data collection	Case study databases search using keywords. Databases used: *ICLEI's C40 program, https://www.c40.org* *100 Resilient Cities, http://www.100resilientcities.org* *Oppla – EU repository of Nature-Based Solutions, https://oppla.eu* *Urban Biodiversity Hub – Case studies map, http://ubhub.org/map* *Naturvation – Urban Nature Atlas, https://naturvation.eu/atlas* *Scopus (academic database)*	*Keywords used:* [1] *Group 1:* — Private, Private areas, Private lands, Private property *Group 2* — forest, forestation, greening, green infrastructure, street trees, trees, vegetation, woodland *Group 3* — planting, protection, retention, removal
	Search of specific case study websites & publicly accessibly information	Purposeful search by case study, following suggestions from workshops and interviews
Data screening & eligibility	Screen case studies using selection criteria Extract more information about case study	*Selection Criteria* 1. Focuses on private urban lands 2. Includes information about tree-dominated systems (including urban wooded area, treed or forested urban area, or single trees) 3. Focuses on planting, protection, retention, or removal of trees 4. Information can be corroborated with publicly available documents
	Select final list of case studies for classification and synthesis	Select data based on the following criteria: *Selection Criteria (Figure 1)* 1. Raises minimum standard 2. Pushes for innovation
Data analysis	Classify and synthesize data	Build database of all case studies, classify content to create synthesis tables and diagrams

1. Bolean operators such as AND OR were used in between groups to include or exclude words in the search

Figure 6: Case study review procedures, including selection and exclusion criteria for selected and reviewed case studies (see Table A2)

Appendix 3

Synthesis of progressive case studies regarding urban tree protections on private urban land

Types of Mechanisms	Code
Local law	LL
Significant, Heritage, or Exceptional tree registry	ST
Greening incentive for new developments	GI
Tree planting programs	TP
Other incentives (see case-study details)	OI
Other protections (see case-study details)	OP

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
Adelaide	Australia	LL	Blanket or general law (all trees). Defined by size of tree. Min penalty for private trees: $75; max penalty for public trees: $60,000	Lenskin 2012
Atlanta	US	LL	Combination of tree ordinances (blanket or general law) and zoning ordinances, smart-growth projects, designation of key management person, existence of tree board.	Hill et al. 2010; Merry et al. 2014
Auckland	New Zealand	ST	Significant tree registry. Protection based on cultural not biodiversity reasons.	Wyse et al. 2015
Austin	US	ST	Heritage tree registry, 33,000 trees, 95% of all heritage trees adequately protected	Lavy & Hagelman 2017; Mars, K. (2014) Heritage tree report. Austin, TX, USA. Retrieved from http://www.austintexas.gov/edims/document.cfm?id=227900, Oct 2019; City of Austin (2017) State of our Environment Report. Austin, TX, USA. Retrieved from https://data.austintexas.gov/stories/s/2017-State-of-Our-Environment-Report-Urban-Forest-/mquz-kyrj/, Oct 2019
		TP	Tree planting program on private and public urban lands to obtain carbon credits for the city to meet carbon goals.	
Baltimore	US	TP	Tree-planting programs on private lands	Nguyen et al. 2017
Bangalore	India	LL	Financial penalties for removing trees	[Not progressive or no publicly available information to corroborate information]
Banyule	Australia	ST	Significant tree registry. Protected by combined local law and Vegetation Protection Overlay (VPO). Alteration/removal requires planning permit	City of Banyule (2017). Significant Trees. Banyule, VIC, Australia. Retrieved from https://www.banyule.vic.gov.au/Waste-environment/Environment-sustainability/Significant-trees, Oct 2019
Bayside	Australia	LL	Blanket or general law (all trees). Specifies private trees	City of Bayside (2012). Consolidated local Law No. 2 - Neighbourhood Amenity. Bayside, VIC, Australia. Retrieved from https://www.bayside.vic.gov.au/sites/default/files/bcc_local_laws_no_2_neighbourhood_amenity_2015.pdf, Oct 2019
Bayswater	Australia	LL	Tree requirements for every 350m^2 of private urban land	[Not progressive or no publicly available information to corroborate information]
		ST	Significant tree register guidelines	

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
Bendigo	Australia	OP	Tree bonds	City of Bendigo (2017) Urban Tree Management Policy. Retrieved from: https://www.bendigo.vic.gov.au/About/Document-Library/urban-tree-management-policy, Oct 2019
Bogotá	Colombia	OI	Public-private partnerships for tree protection and planting on private urban lands	[Not progressive or no publicly available information to corroborate information]
Bolzano	Italy	OI	Tree-giveaway programs to plant trees on private urban lands	[Not progressive or no publicly available information to corroborate information]
Boone	US	OI	Tax credits defined by size of tree to preserve trees in local properties	Bardon & King 2019
Boroondara	Australia	LL	Blanket or general law (all trees). Specifies private trees	City of Borrondara (2016) Tree Protection Local Law. Borrondara, VIC, Australia. Retrieved from https://www.boroondara.vic.gov.au/sites/default/files/2017-05/Tree-Protection-Local-Law.pdf, Oct 2019
Brisbane	Australia	LL	Blanket or general law (all trees)	[Not progressive or no publicly available information to corroborate information]
Canberra	Australia	LL	Blanket or general law (all trees). Specifies private trees	Australian Capital Territory (2015) Tree Protection act - 2005. ACT, Australia. Retrieved from https://www.legislation.act.gov.au/a/2005-51, Oct 2019; Lenskin 2012; Australian Capital Territory (2017) Tree Reistry. ACT, Australia. Retrieved from https://www.tccs.act.gov.au/city-living/trees/act_tree_register, Oct 2019
		ST	Significant tree registry. Protected by combined capital territory planning scheme. Currently facing legal challenges over the validity of tree protection over economic reasons.	
Dresden	Germany	LL	Blanket or general law (all trees). Strict protections even for private trees	[Not progressive or no publicly available information to corroborate information]
Hawaii (all cities, state-wide)	US	LL	Blanket or general law (all trees). Specifies private trees. Protected state-wide through legislation on tree (all trees in the state), nature-conservation, and invasive species protections.	Hawaii State Legislature (2015) Environmental Quality and Tree Protections. Hawaii, US. Retrieved from https://www.capitol.hawaii.gov/SessionLaws/isysquery/42ad6a14-bf99-4247-a79d-a1b4dd1397d3/2/doc/, Oct 2019

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
Hawaii (all cities, state-wide)	US	ST	Significant tree registry. Most trees are exceptional even if there is another landowner.	City of Honolulu (2019) Exceptional Tree Progam. Honolulu, Hawaii, US. Retrieved from http://www.honolulu.gov/parks/hbg/exceptional-tree-program.html, Oct 2019
		OI	Tree-retention incentive: tax cut for private residents to maintain their exceptional trees. Maximum of $3,000 per tree per year for maintenance (pruning, mulching, etc.)	The Tax Foundation (2006) Exceptional tree deductions. Hawaii, US. Retrieved from https://taxfoundation.org/exceptional-tree-deduction/, Oct 2019
Helsinki	Finland	GI	Green factor tool as a greening incentive for new developments	Juhola 2018
Hornsby Shire	Australia	LL	Blanket or general law (all trees)	[Not progressive or no publicly available information to corroborate information]
Indianapolis	US	GI	Tree retention index calculated via water runoff benefits for new developments, based on reduction of impervious surface or volume	Fitzko 2014; City of Indiannapolis (2009). Stormwater design and specification manual. Indiannapolis, IN, US. Retrieved from http://www.indy.gov/eGov/City/DPW/SustainIndy/WaterLand/Documents/Final.pdf, Oct 2019
Jacksonville	US	LL	Blanket or general law (all trees). Permit required to remove trees from private lands	[Not progressive or no publicly available information to corroborate information]
Kingston	Australia	LL	Blanket or general law (all trees). Specifies private trees.	City of Kingston (2017). Community local law (Consolidated). Kingston, VIC, Australia. Retrieved from https://www.kingston.vic.gov.au/About-Us/Local-Laws-and-Health/Local-Laws, Oct 2019
Kuala Lumpur	Malaysia	LL	Blanket or general law (all trees). All trees above DBH 15cm protected. $1,000 to cut down trees	[Not progressive or no publicly available information to corroborate information]
Lakeway	US	LL	Blanket or general law (all trees). Specifies private trees.	Sung 2012

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
London	UK	GI	Urban greening factor as an incentive to retain trees via tree valuation. Calculates the potential of greening of a new development area. Existing trees get a higher score than simply grass.	Greater London Authorioty (2017) Green Infrastructure. London, UK. Retrieved from https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/draft-new-london-plan/chapter-8-green-infrastructure-and-natural-environment/policy-g5, Oct 2019; Juhola 2018; City of London (2018) Urban greening factor study. London, UK. Retrieved from https://www.cityoflondon.gov.uk/services/environment-and-planning/planning/planning-policy/local-plan/Documents/urban-greening-factor-study.pdf, Oct 2019
Los Angeles	US	LL	Blanket or general law (all trees). Specifies private trees. Specifies species (quercus genus, oak trees)	Los Angeles City (2006). Los Angeles Tree ordinance report. Los Angeles, CA, US. Retrieved from https://cityplanning.lacity.org/Code_Studies/Other/ProtectedTreeOrd.pdf, Oct 2019; County of Los Angeles (2011) Urban Forestry Program Manual. Los Angeles, CA, US. Retrieved from http://file.lacounty.gov/SDSInter/dpr/184720_UFPMANUAL080211.pdf, Oct 2019
Louisville	US	LL	Blanket or general law (all trees)	[Not progressive or no publicly available information to corroborate information]
Maroondah	Australia	GI	Blanket or general law (all trees). Protected by combined local law and Vegetation Protection Overlay (VPO).	City of Maroondah (2019) Vegetation policy review. Maroondah, VIC, Australia. Retrieved from https://yoursay.maroondah.vic.gov.au/40256/documents/97895, Oct 2019
Madrid	Spain	OI	Tree-giveaway programs to plant trees on private urban lands	[Not progressive or no publicly available information to corroborate information]
Malaysia (all cities, country-wide)	Malaysia	LL	Blanket or general law (all trees)	[Not progressive or no publicly available information to corroborate information]
Malmö	Sweden	OI	Tree-retention incentive for private residents. Swedish building act protects trees and stimulates their replacement	Juhola 2018
Mandurah	Australia	ST	Significant tree registry	[Not progressive or no publicly available information to corroborate information]

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
Melbourne	Australia	ST	Significant tree registry. Most trees on private lands. Protected by combined local law and Environmental Significance Overlay (ESO). Any alteration/removal requires a planning permit	City of Melbourne (2018) Exceptional tree registry. Melbourne, VIC, Australia. Retrieved from https://www.melbourne.vic.gov.au/community/greening-the-city/tree-protection-management/Pages/exceptional-tree-register.aspx, Oct 2019
		OP	Tree replacement standards: advanced tree valuation compensatory formula	City of Melbourne (2018) Tree Retention and Removal policy. Melbourne, VIC, Australia. Retrieved from https://www.melbourne.vic.gov.au/community/greening-the-city/tree-protection-management/Pages/tree-protection-policy.aspx, Oct 2019
Mississauga	Canada	GI	Tree retention index calculated via water runoff benefits for new developments, based on reduction of impervious surface or volume	[Not progressive or no publicly available information to corroborate information]
Monee Valley	Australia	ST	Significant tree registry. Protected by combined local law and Environmental Significance Overlay (ESO). Any alteration/removal requires a planning permit	City of Monee Valley (2015) Significant Tree Registry Fact Sheet. Monee Valley, VIC, Australia. Retrieved from https://www.mvcc.vic.gov.au/planning-and-building/long-term-planning-in-moonee-valley/significant-trees.aspx, Oct 2019
Montreal	Canada	LL	Blanket or general law (all trees). Specifies private trees. Application varies across boroughs.	Ville de Montreal (2005) Tree Policy. Montreal, QC, Canada. Retrieved from http://servicesenligne.ville.montreal.qc.ca/sel/publications/PorteAccesTelechargement?lng=En&systemName=7761598&client=Serv_corp, Oct 2019
Moreland	Australia	LL	Blanket or general law (all trees). Specifies private trees.	City of Moreland (2018) Planning Scheme Review Report. Moreland, VIC, Australia. Retrieved from https://www.moreland.vic.gov.au/globalassets/areas/strategic-planning/planning-scheme-review-report-2018---adopted.pdf, Oct 2019. City of Moreland (2018). General Local Law. Moreland, VIC, Australia. Retrieved from https://www.moreland.vic.gov.au/globalassets/areas/local-laws/moreland-city-council-general-local-law-2018.pdf, Oct 2019
New South Wales (all cities, state-wide)	Australia	LL	Blanket or general law (all trees; Tree Preservation Orders; Local Environment Plans). Defined by size of tree.	Lenskin 2012; Kelly 2014; Watson 2015

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
New York	US	LL	Blanket or general law (all trees; Tree Protection Ordinance)	Cooper 1996; Nguyen et al. 2017
		TP	Tree-planting programs on private lands	
Oakland	US	LL	Blanket or general law (all trees; Tree Protection Ordinance)	[Not progressive or no publicly available information to corroborate information]
Ontario (all cities, state-wide)	Canada	ST	Significant tree registry. Protected by combined local law and Provincial-Wide Heritage Tree Registry managed by Forests Ontario, Ontario Heritage Trust, and Urban Forest Council of Ontario.	Ontario Urban Forest Council (2013) Heritage Trees. Retrieved from https://www.oufc.org/heritage-trees/identifying-heritage-trees/; https://www.forestsontario.ca/blog/2013/07/26/trees-ontarios-heritage-tree-program-records-and-celebrates-legacy-tree-landmarks/, Oct 2019
Perth	Australia	LL	Blanket or general law (all trees). Specifies private trees.	Brown et al 2013; 2018; Government of Western Australia (2018). Better urban forest planning. Perth, WA, Australia. Retrieved from https://www.clearwatervic.com.au/resource-library/guidelines-and-strategy/better-urban-forest-planning-a-guide-to-support-the-enhancement-of-urban-forests-in-western-australia.php, Oct 2019
Philadelphia	US	GI	Tree retention index calculated via water runoff benefits for new developments, based on reduction of impervious surface or volume	City of Philadelphia (2013). Stormwater Management Incentives Program Grant Fact Sheet. Philadelphia, PA, US. Retrieved from http://www.phillywatersheds.org/doc/SMIP_Grant_Factsheet_FY13.pdf, Oct 2019; Fitzko 2014; Nguyen et al. 2017; Roman et al. 2018; FAO 2018
		TP	Tree-planting programs on private lands	
		OI	Community stewardship programs "Cool streets" contest.	
Phoenix	US	TP	Tree planting program on private and public urban lands to obtain carbon credits for the city to meet carbon goals. Travel miles program for tree planting (incremental, not replacement trees)	FAO 2018; CityLab (2018) Article. Retrieved from https://www.citylab.com/environment/2018/08/carbon-offsets-for-urban-trees-are-on-the-horizon/568378/, Oct 2019

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
Portland	US	LL	Blanket or general law (all trees). Specifies private trees.	City of Portland (2011) City wide tree policy and review. Portland, OR, US. Retrieved from https://www.portlandoregon.gov/bps/article/331401, Oct 2019
		GI	Tree retention index (TreeBate Program) calculated via water runoff benefits for new developments, based on reduction of impervious surface or volume	City of Portland (2017) TreeBate Program. Portland, OR, US. Retrieved from https://www.portlandoregon.gov/bes/51399, Oct 2019
		OI	Community-based tree monitoring	City of Portland (2017) Tree Program. Portland, OR, US. Retrieved from https://www.portlandoregon.gov/parks/53181, Oct 2019
		OI	Tree giveaways as an incentive to plant trees on private lands. Partnership with Friends of the Trees (https://friendsoftrees.org/)	City of Portland (2017) Tree Program. Portland, OR, US. Retrieved from https://www.portlandoregon.gov/trees/60087, Oct 2019
Providence	US	TP	Tree-planting programs on private lands	Nguyen et al. 2017
Sacramento	US	LL	Blanket or general law (all trees). Specifies private trees.	City of Sacramento (2016) Tree ordinance. Sacramento, CA, US. Retrieved from https://www.cityofsacramento.org/Public-Works/Maintenance-Services/Trees/Permits-Ordinances, Oct 2019
San Francisco	US	LL	Blanket or general law (all trees). Specifies trees as "significant" (private or next to property) and "landmark" (highest protection, defined by size) trees	City of San Francisco (2008) Tree protection legislation. San Francisco, CA, US. Retrieved from http://sfdbi.org/ftp/uploadedfiles/dbi/Key_Information/TreeProtectionLegislation.pdf, Oct 2019
		ST	Significant tree registry	
San Jose	US	LL	Blanket or general law (all trees; Tree Protection Ordinance)	[Not progressive or no publicly available information to corroborate information]
São Paulo	Brazil	OP	Tree protection overlays advanced provisions for a biosphere reserve zone, greenbelt protection	[Not progressive or no publicly available information to corroborate information]

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
Seattle	US	LL	Blanket or general law (all trees). Specifies private trees. Protected by combined local law and zoning mechanisms and setback standards.	City of Seattle (2018). Tree protection regulation review. Seattle, WA, US. Retrieved from https://www.seattle.gov/Documents/Departments/UrbanForestryCommission/Resources/Final%20Report_Tree%20Regulation%20Research%20ProjectPahseII_31MAR2017_final.pdf, Oct 2019; City of Seattle (2015) Seattle Green Factor. Seattle, WA, US. Retrieved from http://www.seattle.gov/sdci/codes/codes-we-enforce-(a-z)/seattle-green-factor, Oct 2019; Juhola 2018; City of Seattle (2019) Trees for Neighbourhoods program. Retrieved from https://www.seattle.gov/ trees/planting-and-care/trees-for-neighbourhoods
		ST	Significant tree registry. Includes trees on private lands	
		GI	Tree retention index calculated via water runoff benefits for new developments, based on reduction of impervious surface or volume	
		GI	Urban Greening Factor formula, calculates the potential of greening of a new development area. Trees get a higher score than simply grass	
		OI	Tree-giveaway programs to plant trees on private urban lands	
Sheffield	UK	OI	Community urban forest program	[Not progressive or no publicly available information to corroborate information]
South Perth	Australia	LL	Significant tree registry. Uses National Trust criteria	Lenskin 2012
Stirling	Australia	LL	Blanket or general law (all trees) to retain existing trees (>4m height) in new developments or plant new tree	City of Stirling (2017) Trees and Development Planning Amendment. Stirling, WA, Australia. Retrieved from https://propertycouncil.com.au/Web/Content/News/WA/2017/City_of_Stirling_introduces_Tress_and_Development_planning_amendment_.aspx, Oct 2019 Western Australian Local Government Association (2019), Policy Advice Document. Retrieved from https://walga.asn.au/getattachment/Policy-Advice-and-Advocacy/Environment/Climate-Change/WALGA-Event-Presentations/Nicole-Mathews-Urban-Forest.pdf.aspx?lang=en-AU, Dec 2019
		OP	Tree bonds	City of Stirling (2019) Trees and Development. Retrieved from https://www.stirling.wa.gov.au/waste-and-environment/trees/trees-and-development, Oct 2019

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
Stonnington (Council)	Australia	OP	Tree bonds	City of Stonnington (2019) Council Tree Maintenance. Retrieved from: https://www.stonnington.vic.gov.au/Live/Trees-in-Stonnington/Trees-on-public-land/Council-Tree-Maintenance, Oct 2019
Sydney	Australia	OP	Tree replacement standards: advanced tree valuation compensatory formula	City of Sydney (2017). Tree Valuation formulas. Retrieved from http://peterthyer.com/City%20of%20Sydney%20Tree%20Valuation%20Dec%202003%20%20Peter%20Thyer.pdf, Oct 2019.
Tampa	US	LL	Blanket or general law (all trees; Tree Protection Ordinance)	[Not progressive or no publicly available information to corroborate information]
Toronto	Canada	LL	Blanket or general law (all trees). Specifies private trees. Anything above 18inches of DBH is protected.	Conway & Bang 2014; City of Toronto (2018) Private tree bylaw. Toronto, ON, Canada. Retrieved from https://www.toronto.ca/legdocs/municode/1184_813.pdf, Oct 2019; Steenberg et al. 2018
Vancouver	Canada	LL	Blanket or general law (all trees). Defined by size of tree. Burnaby and Surrey councils have a tree lawn policy to increase tree numbers in these areas	FAO 2018; City of Vancouver (2018). Urban Forest Strategy - update. Vancouver, BC, Canada. Retrieved from https://vancouver.ca/files/cov/urban-forest-strategy.pdf, Oct 2019
Victoria (state-wide)	Australia	ST	Significant tree registry. Protected by combined local law and state-wide National Trust of Australia's Register of Significant Trees of Victoria	VLRC 2017; National Trust (2017) Significant Tree register. Retrieved from https://www.nationaltrust.org.au/services/significant-tree-register/, Oct 2019
		OP	Tree planting standards: Tree replacement and soil deep zone regulations	
Western Australia (state-wide)	Australia	OP	Tree planting standards: building codes to include trees, established as areas requirements for tree inclusion, by area	DPLH (2019) Residential building codes. Perth, WA, Australia. Retrieved from https://www.dplh.wa.gov.au/getmedia/5926602c-ab14-46f0-be6f-56dc31c45902/SPP-7-3-R-Codes-Apartments, Oct 2019
Washington	US	GI	Tree retention incentive via the Green Area Ratio calculation, calculated via water runoff benefits for new developments, based on reduction of impervious surface or volume	Julhola 2018; City of Washington DC (2019). Green Area Ratio. Washington, DC, US. Retrieved from https://doee.dc.gov//sites/default/files/dc/sites/ddoe/page_content/attach, Oct 2019

City	Country	Code	Description of innovation or details of mechanism	Source (see References for academic sources)
Whitehorse	Australia	LL	Blanket or general law (all trees. Protected by combined local law and Significant Landscape Overlay (SLO)	Whitehorse City Council (2018). Urban forest strategy. Whitehorse, VIC, Australia. Retrieved from https://www.whitehorse.vic.gov.au/ sites/whitehorse.vic.gov.au/files/ass ets/documents/Urban-Forest-Strategy-2018.pdf, Oct 2019; Whitehorse City Council (2019). Municipal wide tree study. Whitehorse, VIC, Australia. Retrieved from https://www.whitehorse.vic.gov.au/ sites/whitehorse.vic.gov.au/files/ass ets/documents/municipal_wide_tree _study_-_part_2.pdf, Oct 2019
Whittlesea (Council)	Australia	OP	Tree replacement standards: advanced tree protection standards in the context of development	City of Whittlesea (2016) Tree Protection standards in developments. Retrieved from https://www.planning.vic.gov.au/res ource-library/incorporated-documents/whittlesea/wsea-C188-Quarry-Hills-Precinct-Structure-Plan,-June-2016_Part13.pdf, Oct 2019.
Worcester	US	TP	Tree-planting programs on private lands	Nguyen et al. 2017