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Private tree removal, public loss: Valuing and enforcing existing tree protection mechanisms is the key to retaining urban trees on private land

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ABSTRACT

In many cities, private trees dominate urban tree canopy cover, but densification often means fewer private trees and diminishing urban tree canopy cover. Local governments use several mechanisms to protect trees on private land, but their strengths and weaknesses are not well understood. We review private tree protections in six local governments in metropolitan Melbourne, Australia and interview 23 urban planning and urban forest professionals to understand their perspectives on; 1) the causes of private tree removal, 2) the efficacy of significant tree registers, local laws, and planning overlays, and 3) ways to improve the protection of trees on private land. Each local government applies different mechanisms. The professionals interviewed believe these mechanisms are applied too subjectively and are undermined by exemptions, lack of enforcement, and inadequate penalties. They also believe that private landholders exaggerate tree 'risk' and that education programs to improve community support for private trees and their retention are critical to reverse canopy loss. More research might show how private landholders value urban trees, and how tree stewardship, better regulations and incentives could reduce tree losses.

1. Introduction

In many major cities, local governments want to increase tree cover because of the benefits to human health and well-being and doing so on private land is critical to this goal. For example, in the US city of Chicago, over 60 percent of the urban forest canopy is on private land (Nowak, Hoehn, Crane, Stevens, & Leblanc Fisher, 2010). In the Los Angeles Million Trees Initiative more than two-thirds (700,000) of the new trees proposed were for private property (Pincetl, 2010). Local governments (also known as local government authorities – LGAs, municipalities, city councils, or similar) pursue urban tree canopy (UTC) targets by planting and managing trees in public spaces (Croeser et al., 2020). But LGAs struggle to influence the retention or planting of trees on private land (Cooper, 1996), despite its importance in providing urban forest ecosystem services (Nowak et al., 2010).

As Pincetl (2013) observes, not everyone supports tree planting programs and they involve complex changes in the relationship between residents and governments. In North America (Nowak & Greenfield, 2012), as well as in Europe (FAO, 2018), and Australia (Jacobs, Mikhailovich, & Delaney, 2014) a large percentage of UTC is on private land. As cities grow in population and densify, protecting trees on private land becomes more important. Recent surveys corroborate studies showing declines in UTC density (Lin, Meyers, & Barnett, 2015), with some showing losses concentrated on private land (Hurley et al., 2019). It is timely to assess how LGA professionals view the efficacy of private tree protections. Our research is framed by urban forest governance and management concepts and contextualized by reviewing the academic literature on private tree protections.

1.1. Urban forest governance and management

Decisions about trees on private urban land are based on two key concepts: urban forest governance and urban forest management. Governance is defined as the rules and processes of decision-making that allow stakeholders to influence and coordinate their needs in relation to collectively owned resources (Delmas & Young, 2009; Folke, Hahn, Olsson, & Norberg, 2005). Urban forest management derives from the broader concept of ecosystem management (Steenberg, Duinker, & Nitoslawski, 2019), which is the process of how humans work with nature to achieve management objectives (Lackey, 1998). We discuss how these concepts aid understanding of LGA decision-making about private urban trees.

A core aspect of governance is that it encompasses a wide variety of stakeholders and institutions, who together, make decisions about collectively owned resources (Lockwood, Davidson, Curtis, Stratford, & Griffith, 2010), as occurs in urban forests (Lawrence, De Vreese,

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Johnston, Konijnendijk van den Bosch, & Sanesi, 2013). For example, non-governmental greening organizations can influence where and how urban trees are planted (Connolly, Svendsen, Fisher, & Campbell, 2013; Conway, Shakeel, & Atallah, 2011) and how public or private landowners make decisions about trees (Daniel, Morrison, & Phinn, 2016; Meerow & Newell, 2017). However, most of these insights come from studies of public trees.

Another important aspect of governance is how institutions dictate the management of collectively owned resources (Ostrom, 2005). Many institutions make decisions about urban trees, including LGAs and other public land managers, such as the military, private landowners and non-government organizations focused on urban greening (Lawrence et al., 2013; van der Jagt & Lawrence, 2019). These institutions can have different, often conflicting, mandates, discourses, and rules (Morrison & Lane, 2005; Ostrom, 2005). For example, in public infrastructure developments, urban forest managers in LGAs may have less influence than other LGA or state government professionals, such as engineers, architects, or urban planners (Hill, Dorfman, & Kramer, 2010). But again, most of the studies relate to public trees.

Governance is often framed as a non-governmental, multi-level, and multi-stakeholder process of decision-making (Borgström, 2019; Buijs et al., 2019; Muñoz-Erickson et al., 2016; van der Jagt & Lawrence, 2019) but government participation is still vital for governance (Folke et al., 2005; Kenward et al., 2011; Ostrom, 2005). In urban forests, LGAs play an important role in providing resources and establishing rules for citizen-led greening initiatives (Meerow & Newell, 2017; Borgström, 2019 Lawrence et al., 2013). How LGAs govern urban forests can be understood by how they articulate urban forest management. This is usually done through management instruments, such as local tree policies (Daniel et al., 2016), ordinances or bylaws (Conway & Urbani, 2007), and management plans (Gibbons & Ryan, 2015). These can be complemented by planning provisions, including zoning (Hill et al., 2010; Mincey, Schmitt-Harsh, & Thurau, 2013). But many of these management instruments do not explain how LGAs make decisions about private urban trees. To understand the governance and management issues behind this process we must study the perspectives of those who help make the decisions.

1.2. Protection of trees on private urban land: a review

Many LGAs have some control over what happens to trees on private land, and many have local laws that prohibit tree removal without a permit (Conway & Urbani, 2007; Landry & Pu, 2010; Sung, 2012). LGAs also issue permits for building developments and must comply with state or federal objectives of population growth, urban consolidation (infill) and increasing population density. This dual role can create a conflict of interest (Brown et al., 2018; Hill et al., 2010). The challenges and opportunities of this conflict have rarely been investigated through the perspectives of those in LGAs who apply the rules, or of those urban forest professionals whose advice is relied upon. Below is a brief review of the academic literature on this topic.

There has been little academic assessment of LGAs' efforts to protect private trees, with most focus on the public realm. In the United States, Coughlin, Mendes, and Strong (1988) found that on private land tree protections were poorly enforced, covered a narrow range of trees, and often exempted major land uses. In Europe, Profous and Loeb (1990) showed that protection of urban trees relied heavily on the skills and motivations of the LGA staff or urban tree professionals involved. Finally, Hill et al. (2010) investigated views on canopy cover protection, mostly on public land, and confirmed that protection was possible by combining tree protection permits with the necessary people to review them. These few studies have all argued that tree removal permits for private land are not effective because permission for removal is almost always granted.

An effective tree protection mechanism is one which increases or maintains the number of trees and the extent of tree canopy cover in a city (Landry & Pu, 2010; Sung, 2012), but evaluating and comparing protection mechanisms is difficult. Some empirical studies have assessed the effectiveness of tree protection laws by assessing UTC across two periods (i.e., before and after laws were implemented) and comparing at least two cities (i.e., cities with laws and those without). Some of these studies, mostly from the US, concluded that permit regulations helped retain canopy cover (Sung, 2012). However, the studies are limited because they focus on patterns of UTC rather on the causal processes that determine these patterns. In addition, no two cities are the same in land use, socio-economic characteristics, or protection mechanisms, so comparison requires an in-depth understanding of the LGAs. Finally, no study has discussed internal LGA factors, particularly whether the professionals making decisions about private trees believe the rules are effective.

These professionals are identified in the literature and include officers working for LGAs; arborists, urban foresters, and urban planners, as well as others outside LGAs who consult or are consulted by them, including arborists and other contractors (Kirkpatrick, Davison, & Daniels, 2013a; Chishaleshale, Shackleton, Gambiza, & Gumbo, 2015). Almost no studies on the views of LGA urban forest managers deals specifically with decisions related to private trees (Ordóñez et al., 2019). While some have identified urban densification and expansion, the lack of municipal coordination, and a culture of risk aversion as factors making it difficult for LGAs to implement their urban forest strategies (Ordóñez et al., 2020), it is still unclear how these findings apply to decisions about trees on private land.

1.3. Objectives of the study

Given the gaps in the literature and that many cities are considering how best to protect private trees (City of Seattle, 2017; Australia, 2019; Pincetl, 2013) there is value in understanding whether LGA staff and associated professionals believe private tree protections are effective. This project responds by:

1. reviewing current protections for urban trees in a selection of LGAs in the context of recent planning permit history, and
2. interviewing urban planning and urban forest professionals, to understand their experiences and perspectives on current protections and processes, and by offering ideas to improve tree retention.

We use qualitative research to provide an understanding of social phenomena directly from the perspective of those involved, where current theory does not provide enough guidance (Creswell, 2017). We present our methods, our findings, and discuss the views of these urban planning and urban forest professionals, considering relevant urban forest governance and management research.

2. Methods

Our approach was based on; 1) collecting data on private tree protections from selected LGAs in Melbourne, Australia; and 2) collecting social science data on the opinions of urban planning and urban forest professionals working in or for the selected LGAs. Human ethics approval and individual consent was obtained from the university involved in the study (Ethics ID Number: 1954571).

2.1. Context

The study was conducted in LGAs belonging to the Greater Metropolitan Area of Melbourne, also known as Greater Melbourne, which covers 9,992.5 km^2 and is the second biggest (approximately 4.5 million) and fastest growing urban population in Australia (2.5% growth from 2017 to 2018) (ABS, 2016, 2019).

UTC in Greater Melbourne varies across LGAs as well as suburbs and has been associated with variations in age, income, and education

(Dobbs, Kendal, & Nitschke, 2013; Kendal, Williams, & Williams, 2012). The most recent Greater Melbourne Area study found that between 2014 and 2018, residential tree cover declined in 18 of the 31 local governments surveyed (Hurley et al., 2019). Some Melbourne LGAs have made their own estimates of the impact of densification on canopy loss. The City of Boroondara found that between 2006 and 2016, all significant declines in canopy cover occurred on private land (City of Boroondara, 2017). The City of Moreland estimated that private tree canopy declined by 28% between 1989 and 2016 (City of Moreland, 2017).

The following section summarises the key points on development, planning and vegetation protection for this study area. Further detail is provided in Supplementary Table 1. In the state of Victoria, Australia, vegetation protection powers on private land are delegated to LGAs. Similar systems apply in other Australian states but there are significant variations (Lensink, 2012). The 32 LGAs of Greater Melbourne must comply with state-wide planning provisions which encourage increased residential density designed to consolidate urban areas. The provisions encourage retention of existing vegetation and space in design to accommodate it, but they are guidelines only. LGAs control land use through planning permits which must conform to the state planning provisions but can be tailored by individual LGAs. LGAs in Victoria use three mechanisms for protecting trees on private land; 1) planning overlays, 2) local laws, and 3) significant or exceptional tree registers.

2.1.1. Planning overlays

Planning overlays define landscape features, such as areas prone to flooding, heritage buildings or vegetation. They exist elsewhere under different names (e.g., zoning in the US; see Mincey et al., 2013). In Australia, planning overlays can limit the built form, for example, to help maintain views, to protect buildings or to protect trees. LGAs publish written overlays with maps, showing relevant areas and features within. The common overlays for protecting trees differ in the balance struck between protection and development. So, LGAs will use one type of overlay where they want to allow development but minimise tree loss and another type where they effectively reverse this emphasis and development comes second to tree protection. Overlays can apply to individual trees (e.g., Significant Tree Registers), groups of trees, specific properties or areas, and tree retention or replacement can be a condition of a development permit. LGAs must have state government approval to introduce planning overlays and that can be a lengthy process, but their integration with the local planning process and the state-wide planning provisions is considered a strength.

2.1.2. Local laws

By contrast, local laws are not part of an LGAs planning controls. LGAs typically make local laws to protect trees on public and private land by setting size thresholds which trigger a permit requirement. Some LGAs exempt the local law permit requirement where a planning permit for development is needed, leaving tree protection solely as a planning matter (and so, protected only if there is a relevant planning overlay) but some require both. Local laws are commonly seen as a weaker protection than planning overlays because of their legal status as subordinate legislation. Local laws have international equivalents, like tree protection ordinances in US cities (Cooper, 1996), private tree by-laws in Canada (Conway & Urbani, 2007), and similar protections in European cities (Profous & Loeb, 1990; Schmied & Pillmann, 2003).

2.1.3. Significant tree registers

In Victoria, significant tree registers are not a legal protection in themselves, but a list of what is to be protected. Known in other places as heritage, notable, exceptional, or landmark tree registers (see Jim, 2005; City of Portland, 2017; City of Honolulu, 2019; City of Auckland, 2019), they describe trees according to aesthetics, landscape, cultural or heritage context and other values, including size. In Victoria, a significant tree register is given legal protection by a planning overlay or a local law.

2.1.4. Enforcement and penalties

LGAs enforce planning overlays and local laws. They can issue maximum fines of 2,000 AUD per offence for illegal tree removal under local law; 1,652 AUD for breaches of planning permits by a body corporate and half that amount for an individual. LGAs must prosecute through the courts for higher penalties. Crucially, the application of planning overlays and local laws relies on the advice of staff and external consultants. This means that arborists, planners, and urban foresters play a central role within an LGA in deciding whether a tree should be retained or removed.

2.2. Data collection & analysis

2.2.1. Data on current tree protections and planning permit allocations

We chose specific LGAs in the Melbourne region by applying an adapted urban–rural gradient lens, commonly used in urban socio-ecological studies to understand the unique experience of a city or urban centre (Hahs & McDonnell, 2006). We classified them using the planning guidelines of the VPN (2018). Accordingly, LGAs in Melbourne usually vary from areas of high development and population density (central and inner LGAs), to areas of low density and high population growth (outer LGAs), and everything in between. We do not generalize results for all LGAs in Melbourne, or for all LGAs represented by these characteristics. We researched LGAs that shared similar characteristics to gain comparable insights about private tree protection.

The 32 LGAs in the Greater Melbourne area were assessed for their private tree protection mechanisms. More detailed data on tree protections and planning activity were collected from six LGAs using publicly available documents supplemented by email and telephone conversations with LGA staff to confirm material and obtain unpublished data on figures relating to significant tree registers and private tree removals. The six LGAs were concentrated in the centre and inner parts of Greater Melbourne (Fig. 1) and were selected for their location within areas of acknowledged urban densification, to illustrate a range of protection mechanisms and because they were actively setting UTC targets and attempting to regulate private trees (Table 1).

2.2.2. Opinions of urban planning and urban forest professionals

The lead author conducted semi-structured interviews in August 2019 with 23 urban planning and urban forest professionals involved in LGA decisions on private trees. The qualitative and exploratory social-science approach was based on grounded theory, which aims to understand social phenomena through participants' views (i.e. 'grounded' in the social data generated; Corbin & Strauss, 2015). Rather than presenting results in the form of a narrative, grounded theory allows researchers to focus directly on the frequency, hierarchy, and structure of participants' ideas collected through interviews, workshops, or other mechanisms.

Interviewees were recruited using snowball sampling techniques, built from a list of pre-identified participants to achieve a mix of professions and LGAs. The cohort of 23 comprised nine consulting arborists, seven LGA arborists, four LGA planners and three LGA urban foresters. They were drawn from seven LGAs and seven consultancies. Of the total, 13 were employed directly by LGAs; 10 from five of the six LGAs featured in Table 5 and three from two additional LGAs. Of the 10 consultants, several were former LGA staff and most described LGAs as being their main clients. Two consulting arborists worked mostly for developers or other private clients. Two urban foresters were LGA staff and one was a self-employed consultant. All interviews were conducted separately, in English, in person by the researcher, and each ran for 30–45 min. The identities of LGAs and consultants have been excluded to protect participants' anonymity. All interviewees were asked the same 9 guiding questions (Table 2).

All interviews were recorded and imported into NVivo 12 Pro

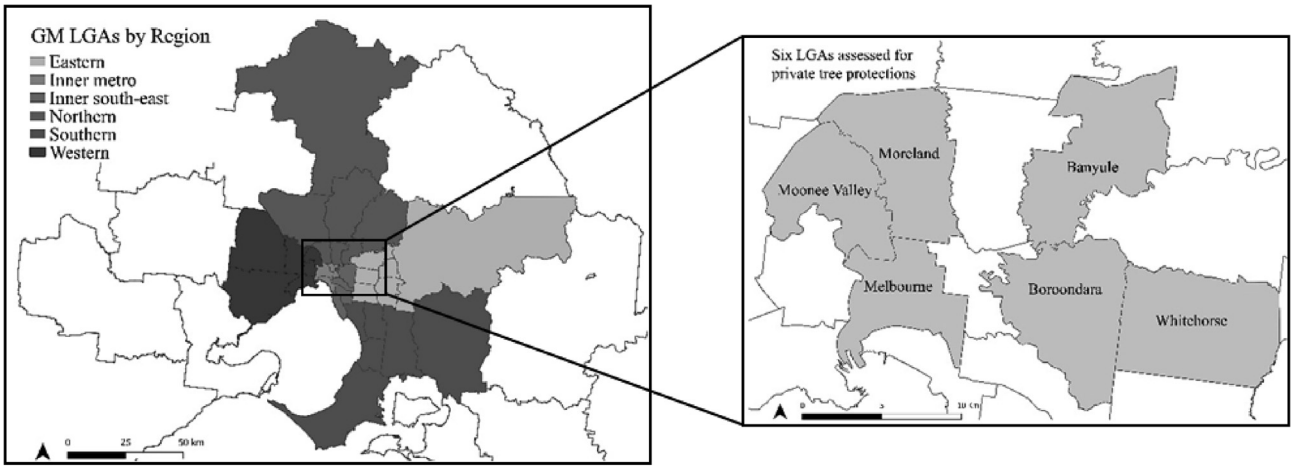


Fig. 1. The 32 LGAs in Greater Melbourne (GM) by region and location of the six assessed in detail for private tree protections. Source: www.data.vic.gov.au.

(developed by QSR International, 2019) and transcribed. Data were analysed using interpretative, inductive coding techniques. Verbatim responses were assigned codes which conveyed ideas that were then grouped into broader themes (Corbin & Strauss, 2015); see Table 3. All coding was completed solely by the lead author, who lives in Melbourne, has studied urban horticulture for four years, worked in the arboriculture industry in a tree assessment and inventory role and who previously had a long career as a researcher and writer. In cases of coding by an individual, the role of the researcher's interpretation is heightened to reveal nuanced experiences and views (see Creswell, 2013).

Coding consistency and accuracy were achieved by applying the grounded theory techniques of densification and constant comparison (see Glaser & Strauss, 1967). The densification technique consolidates the number of times an idea (or code) is mentioned in answers to questions. For example, the response "there's a lot of tree removal happening just because people are afraid of trees" would be coded as "negative perception of trees" and it would be counted as a single 'mention' of that code for this interviewee, even if mentioned again in response to the question. If in later questions, the interviewee again refers to this idea (code), it would be an additional 'mention'. The constant comparison technique consolidates the number of times an idea (code) is mentioned by examining its representation overall. For example, the comments 'there's a lot of tree removal happening just because people are afraid of trees' and 'they don't actually understand that trees are actually low risk', were both coded as 'negative perception of trees'. Codes were grouped into hierarchies headed by themes (e.g. 'Causes of Canopy Loss'), and coding continued until data interpretation was exhausted (i.e., coding saturation; see Corbin & Strauss, 2015). Only codes mentioned more than twice and in more than two interviews were included in the results. The data contains 43 coded ideas, and 723 'mentions' of those codes. The approach allowed the researcher to generate an in-depth understanding of private tree protection from the participants' perspectives. The frequency of mention, hierarchy, and coding patterns demonstrate the weight participants attach to issues.

3. Results

3.1. Current tree protections and planning permit allocations

Of the 32 LGAs in Greater Melbourne, LGAs on the urban fringe tend to have fewer and less extensive protections, the exceptions being outer LGAs in the east and north-east, where land use history and topography have led to large stands of remnant and planted trees remaining (Table 4). Tree protections were most extensive in LGAs within the inner east and north-east, where established suburbs with mature trees are undergoing densification. Importantly, some LGAs provide strong tree protection using only one mechanism, so the presence of multiple mechanisms is only a general guide to protection.

Tree protection measures in the six LGAs selected for detailed assessment fell into three distinct groups: planning overlays, local laws, and significant tree registers (Table 5).

Over the decade 2007–2018 there were stark differences in the number of planning permits allocated for multi-dwelling, single-dwelling, or extension developments in these six LGAs (Fig. 2). Many of these planning permits are likely to directly contribute to the removal of trees from private urban land.

Table 1
Characteristics of the six local governments in Greater Melbourne selected for this study.

Characteristic	Banyule	Boroondara	Melbourne	Moonee Valley	Moreland	Whitehorse
Location	Suburban north-east	Suburban east	Inner city centre	Inner north-west	Inner north	Suburban east
Total area of city (hectares) [1]	6,254	6,018	3,735	4,314	5,095	6,428
UTC (% of total city area) [2]	21%	21%	11%	10%	10%	18%
UTC target (% @ year)	•	•	40% @ 2040 (public only)	30% @ 2040	29% @ 2050	30% @ 2030
UTC % change (2014–18)[2]	−1.1	−1.9	+0.8	−0.1	+0.1	−2.8
Area of city classified as public land (hectares)	625.4	601.8	< 373.5	1294.2	1885.1	642.8
UTC of public land (% of area)[2]	22.1%	26.3%	17.4%	11.2%	14.4%	22.3%
Area of city classified as private land (hectares)	5628.6	5416.2	> 2614.5	3019.8	3209.8	5785.2
UTC of private land (% of area) [2]	20.0%	17.5%	5.0%	8.8%	7.7%	16.5%
Pop. Density (n/km^2) [3]	2,082	3,013	4,550	2,965	3,567	2,741

[1] Based on ABS (2018).
[2] Based on Hurley et al. (2019).
[3] Based on ABS (2019).

Table 2
Research questions asked of every participant in the semi-structured interviews.

Question No.	Interview question
1.	Are trees being lost from private land in your area?
2.	What are the main reasons for tree removal?
3.	What does your LGA do (or what can local governments do) to prevent tree losses on private land?
4.	If your LGA has a Significant Tree Register, or you have been involved in compiling one, how does it function?
5.	How do Significant Tree Registers work?
6.	Does your LGA have other mechanisms to protect and retain trees on private land?
7.	How did your LGA decide on the mechanisms of tree protection on private land?
8.	How are trees on private land considered during a planning application?
9.	What do you think could help tree retention on private land?

Table 3
Examples of interpretative coding, indicating verbatim responses, codes, and themes used in this study.

Type of Participant (participant ID number)	Verbatim text from interviews	Code(s)	Theme(s)
Consulting Arborist (8)	"The loss is increasing and it's not just because of urban development where we're cutting blocks in half. The perception of people out there, the risk of trees, their misperception of it."	• Densification • Negative view of trees	• Causes of canopy loss
Urban Planner (1)	"So, as well as policy controls for infill developments, a close second would be education."	• Tougher fines, regulation, and enforcement • Education	• Ideas for retention
Consulting Arborist (7)	"The maximum fine is $2000 and a recent one was a fine of $1100 for removing 6 cypress trees. That's less than the bill to cut down the trees. Whereas under a planning overlay the potential fine is massive, so that's the essential difference, I think. Apart from that, all you've really got is education programs."	• Penalties inadequate • Higher penalty available • Education	• Local law limits • Planning overlay advantages • Ideas for retention

Table 4
The 32 LGAs of Greater Melbourne and their methods of private tree protection.

Greater Melbourne Region	Local Government Authority (LGA)	Planning Overlay	Local Law	Significant Tree Register
Eastern	Knox	✓		
Eastern	Manningham	✓		
Eastern	Maroondah	✓		
Eastern	Monash	✓		
Eastern	Whitehorse	✓		
Eastern	Yarra Ranges	✓		
Inner Metro	Melbourne	✓		✓
Inner Metro	Port Phillip	✓	✓	
Inner Metro	Yarra	✓	✓	✓
Inner SE	Bayside	✓	✓	✓
Inner SE	Boroondara	✓	✓	✓
Inner SE	Glen Eira	✓		
Inner SE	Stonnington	✓	✓	
Northern	Banyule	✓		✓
Northern	Darebin	✓	✓	
Northern	Hume	✓		
Northern	Mitchell	✓		
Northern	Moreland	✓	✓	
Northern	Nillumbik	✓		
Northern	Whittlesea	✓		
Southern	Cardinia	✓		
Southern	Casey	✓		✓
Southern	Frankston	✓	✓	
Southern	Greater Dandenong	✓		
Southern	Kingston	✓	✓	✓
Southern	Mornington Peninsula	✓		
Western	Brimbank	✓		
Western	Hobsons Bay	✓		
Western	Maribyrnong	✓		✓
Western	Melton	✓		
Western	Moonee Valley	✓		✓
Western	Wyndham	✓		

Some tree removal data was obtained from two of the six LGAs. From June 2013 to May 2019, one LGA approved the removal of 6,184 trees on private land, a permit approval rate of 72%. Only 4,574 trees were ordered as replacements, less than three quarters of the number removed. Another LGA estimated that in five years (2013–18), 27% of the trees on private land being considered for a significant tree register were removed.

3.1.1. Significant tree registers

Even in an LGA with relatively high canopy cover and extensive overlays (Banyule), or one with a local law (Boroondara), (Table 1), significant tree registers do not protect large numbers of trees (Table 5) and most of these trees are on public land. Methods of selecting significant trees varied. Banyule, Boroondara and Melbourne used a combination of public nominations and expert recommendations. Moonee Valley relied on external consultants to update and extend its significant tree register because few nominations were received from the public. In Moonee Valley, most public comment came from private landowners objecting to the nomination of a tree on their property, fearing it might limit development. One LGA (Whitehorse) did not have an 'official' significant tree register but listed approximately 1,000 properties with trees judged significant and protected them with planning overlays. LGAs typically updated their significant tree registers every five years, except Moonee Valley where this has been extended to ten years.

3.1.2. Planning overlays

Only two LGAs, Banyule and Whitehorse, use planning overlays as their main tree protection. They apply them widely to reflect planning priorities in different areas, covering thousands of private properties and potentially tens of thousands of trees. Whitehorse has five types of planning overlays resulting in some measure of tree protection on all residential property. Banyule's protection level is similarly broad; tree removal is permitted in some cases if it seriously compromises development and greatest protection is given to trees on its Significant Tree Register. Melbourne and Moonee Valley, by contrast, use planning overlays to protect only their significant (exceptional) tree registers

Table 5
Main private tree protection mechanisms used by the six LGAs in Greater Melbourne selected for this study.

	Banyule	Boroondara	Melbourne	Moonee Valley	Moreland	Whitehorse
Significant tree registers	✓	✓	✓	✓		
Total trees	614	1041	167	1475		
Private trees	138	74	167	225		
Private trees lost (2014–18)	5	7	2	5		
Planning overlays	✓		✓			✓
Local laws		✓		✓	✓	
Exemptions for:						
Multi-dwelling				✓	✓	
Single				✓		
Extension				✓		

which cover 167 and 225 trees, respectively. Boroondara and Moreland have limited planning overlays covering few trees and do not rely on this method (Table 5).

3.1.3. Local laws

Local laws are often exempt from the planning process. Moonee Valley does not require a local law tree removal permit where a planning application is made, and Moreland exempts all multi-dwelling applications (the largest category). For these two LGAs, the main tree protection mechanism lies outside planning. Importantly, most interviewees believe the critical decisions about tree loss are made within the planning process (see Fig. 3). In Boroondara, granting a removal permit relies on the balance between arborists applying the tree protection local law and planners considering the development applications. Internal administration and the balance of views between arborists and planners ultimately determines tree protection.

3.2. Opinions of urban planning and urban forest professionals

3.2.1. Causes of urban tree and canopy loss

The 23 interviewees identified some common beliefs about the causes of UTC loss in Greater Melbourne (Fig. 3). They believed densification through multi-dwelling development was the main contributor but also blamed larger house footprints. Many thought people overstated the risk of injury or damage from trees and few believed private tree owners were well informed about tree health and maintenance. Lack of protections and enforcement included inadequate laws, regulations, and penalties, plus a lack of will and resources to apply them. Local government culture covered competing interests and opinions on the value of trees, while resourcing refers mainly to the time pressure on planners to process applications quickly.

3.2.2. Tree considerations in planning

The common view was that consideration of trees in the planning process depended on an individual's motivation to protect them (Fig. 4A). Nearly as many identified a strong emphasis on considering trees. Arborists and urban foresters questioned whether planners were interested in protecting trees, while planners stressed the difficulty of retaining a tree where it seriously constrained financial yield from development. As many who believed trees were being given greater consideration than previously also thought they were a low priority.

Significant tree registers were considered effective but limited, because of the narrow range covered and the costs of establishing and updating them (Fig. 4B). Planning overlays were preferred because of their greater legal weight and easier enforcement (Fig. 4C). Their main limitations were the reliance on motivated staff and the impact of

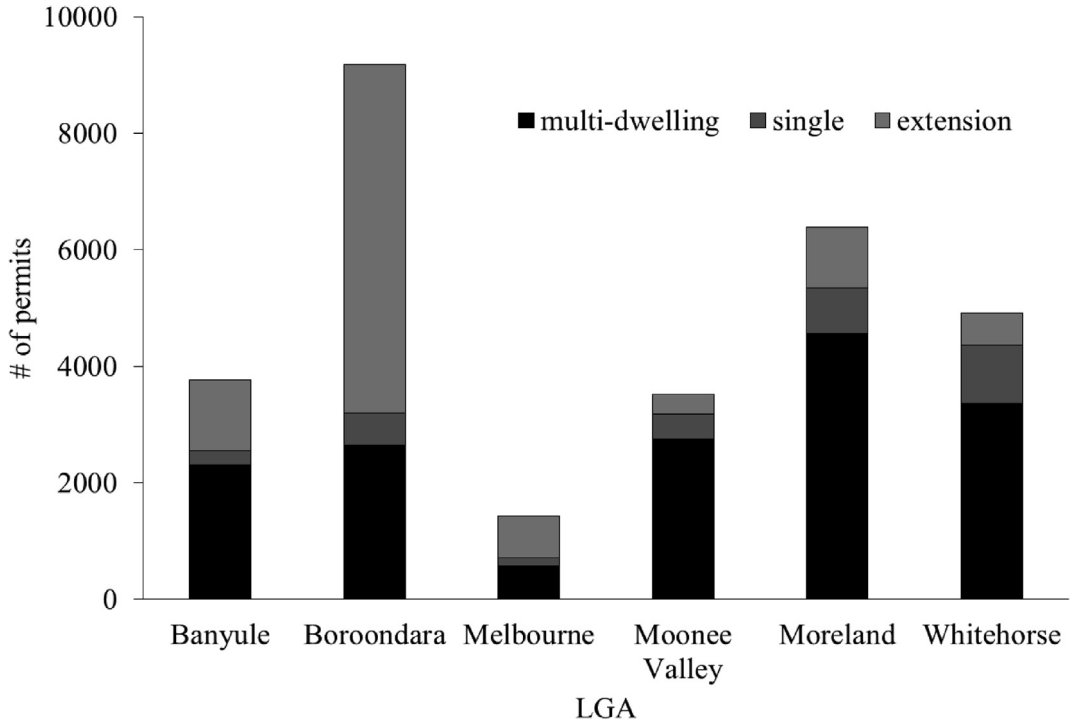


Fig. 2. Planning permits by type issued by six LGAs in Greater Melbourne. Source: (DELWP, 2019), data from 2007 to 08 to 2017–18; 2014–15 data unavailable).

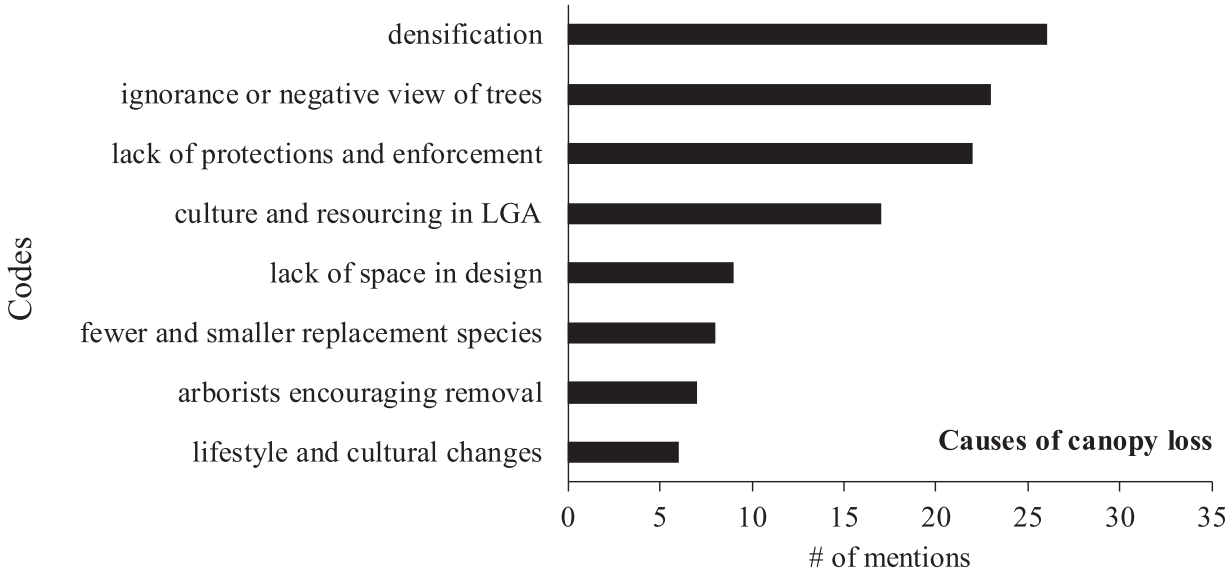


Fig. 3. Frequency of codes associated with themes when participants discussed the causes of canopy loss; based on the social data from interviews in this study.

lobbying from elected councillors. A few believed local laws could be effective, but their advantages were heavily outweighed by limitations, in particular, enforcement difficulties and low penalties. (Fig. 4D).

3.2.3. Ideas for improving tree retention

Providing more physical space for trees was considered key (Fig. 5). Interviewees recommended mandating minimum space in private developments rather than relying on guidelines or general rules. Support for tougher tree protection measures and better enforcement was qualified by a view that regulation was unlikely to have much impact without greater community support for trees, and that financial incentives might help. It is interesting that when questioned about causes of canopy loss, many mentioned ignorance or negative views of trees, and when asked for ideas to retain trees, education was ranked highly; in other words, the need to correct common misconceptions about trees (Figs. 3 and 5).

4. Discussion

4.1. Urban tree and canopy loss

This study supports others linking urban densification to declining UTC (Lin et al., 2015) and the loss of urban trees (Lavy & Hagelman, 2019). Inadequate penalties and enforcement as significant factors accord with studies in Canada and the United States (Conway & Urbani, 2007; Coughlin et al., 1988).

There is a strong belief among urban planning and tree professionals that private landowners hold negative perceptions of trees, including an unrealistic view of risk, and that this is a key reason for continued canopy decline. Australian studies of resident's attitudes towards their trees have linked negative perceptions with risk, although it is less of a factor in removal than aesthetic preferences for garden and house style (Kirkpatrick, Davison, & Harwood, 2013b). There are few studies of residents' perceptions of trees focusing on private tree risk and most of them explore the multi-stakeholder aspect of urban forest decisions that consider their opinions in the context of public trees (e.g., Conway et al., 2011; Connolly et al., 2013; Meerow & Newell, 2017; Ordóñez et al., 2020).

4.2. Tree protection mechanisms

Many participants believed the time and expense of updating significant tree registers weakened their effectiveness. This supports other studies, such as Currell (2012) in the UK. Because most academic work on significant tree registers relates to public land (e.g., Wyse, Beggs, Burns, & Stanley, 2015), it is unclear how insights gained so far apply to private trees. Our study suggests significant tree registers provide reasonable protection (between 2% and 10%), which accords with other studies that show canopy cover associated with the presence of heritage tree ordinances in Florida (Hilbert et al., 2019), and only a 5% rate of tree loss for significant trees registers in Austin (City of Austin, 2014) and Honolulu (State of Hawaii, 2020), in the United States. On reflection, these concerns about updating registers might be related to the financial benefits obtained from development in rapidly densifying cities such as Greater Melbourne.

The local laws used by LGAs here often do not apply to development applications, and, as Lavy and Hagelman (2019) have observed in the context of public trees, this limits their effectiveness. Just as tree protection laws differ among countries (Profous & Loeb, 1990), the local laws discussed here vary greatly among LGAs. This is evidence of the institutional diversity (Ostrom, 2005) of urban forest contexts, with different institutions having fragmented, and often conflicting, debates and rules about the same collectively owned resource. In our study, the variation could be related to differences in socio-economic factors, such as average income and levels of education (Dickerson, Groninger, & Mangun, 2001). More broadly, it might be related to the different discourses that define the management of urban forests in each city (e.g., Gibbons & Ryan, 2015; Steenberg et al., 2019; van der Jagt & Lawrence, 2019). These discourses can vary: some may focus on providing ecosystem services, such as shade or pollution control; others on ecological issues, including species diversity and climate change; or on social equity, particularly, ensuring an equal distribution of tree numbers and canopy cover (e.g., Gibbons & Ryan, 2015; Steenberg et al., 2019; van der Jagt & Lawrence, 2019).

While interviewees in this study preferred planning overlays, overlays do not guarantee protection. Decisions to remove or retain trees on private land in urban Australia can be challenged by the landowner, interested neighbours and others. Planning overlays are context specific, so comparisons with similar protections elsewhere are difficult. For example, the City of Seattle allows private tree removal if a developer cannot achieve the building footprint allowed for that land-use zone (City of Seattle, 2020). This is a more standardized approach than the discretion given planning officers in LGAs in this study. Nonetheless, the City of Seattle regarded its protections as inadequate and introduced new penalties for unauthorized private tree removal (City of Seattle, 2017).

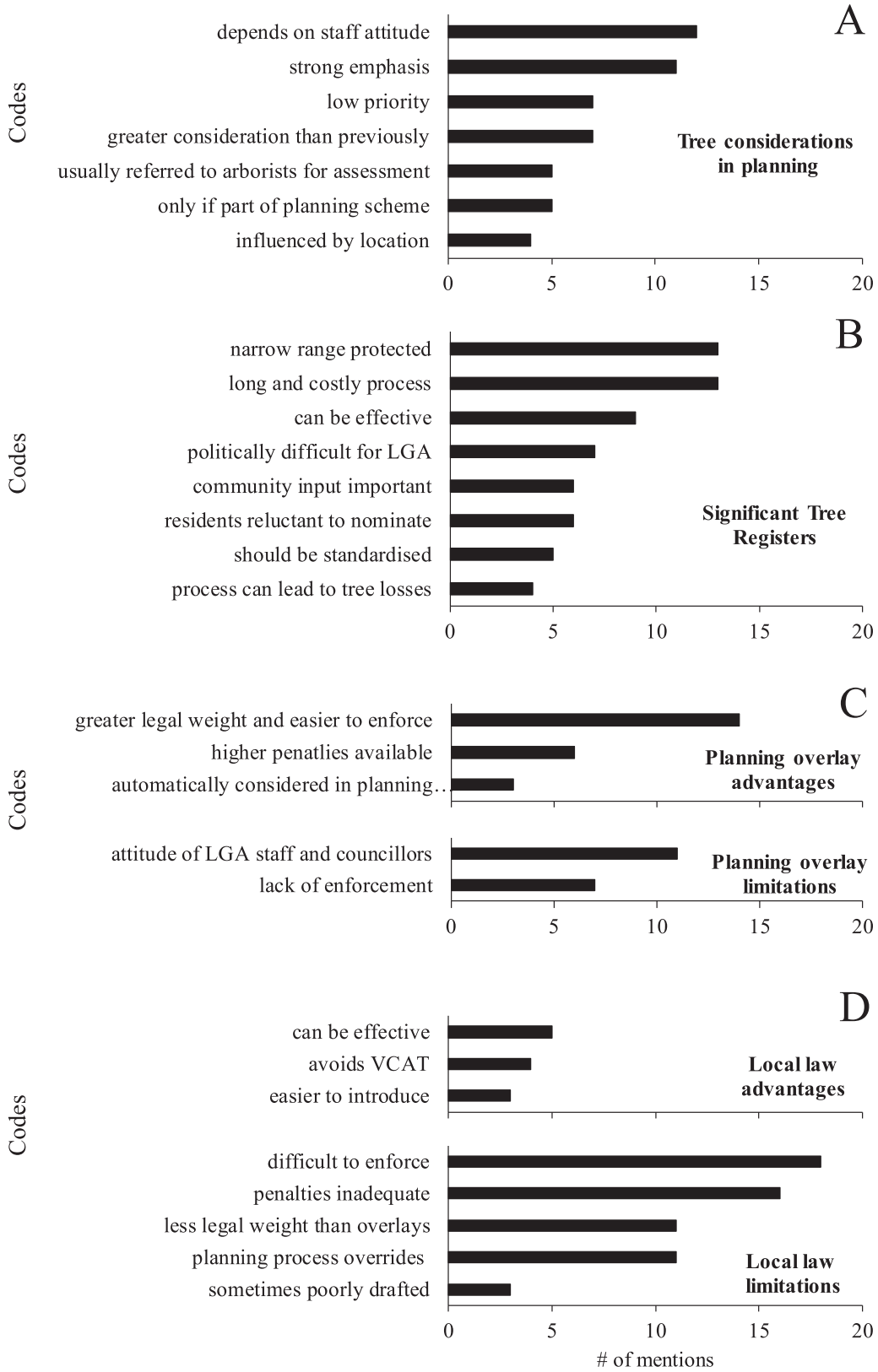


Fig. 4. Frequency of codes associated with themes when participants discussed protection mechanisms and the planning process, including tree considerations in planning (A), significant tree registers (B), planning overlays (C), and local laws (D), based on the social data from interviews in this study.

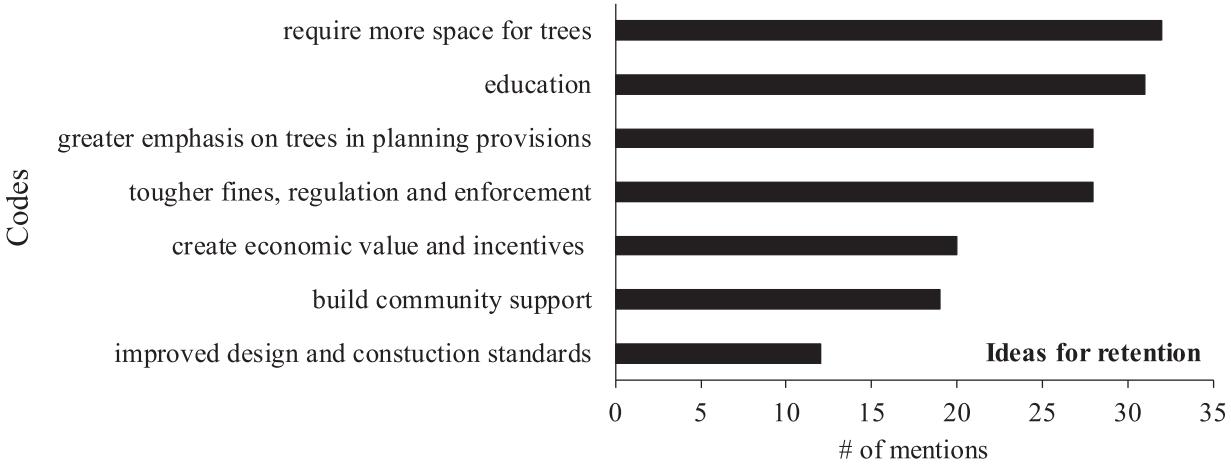


Fig. 5. Frequency of codes associated with themes when participants discussed ideas for improving tree retention on private lands; based on the social data from interviews in this study.

4.3. Improving private tree retention

The urban planning and forest professionals in this study identified three key ideas for improving retention; 1) more space for trees, 2) improved private tree stewardship, 3) better enforcement and tougher penalties. They believed that while development applications often complied with regulations on minimum garden size, this frequently meant less space for trees. While these insights might be related to the rapid densification of some areas of Greater Melbourne, other cities, such as Portland, are also limiting building footprints, instead of specifying a minimum garden size (City of Portland, 2019).

In their review of studies on urban forest managers' views, Ordóñez et al. (2019) found that many believed urban forest success was as simple as having good resources and strict rules. But success can also be determined by the level of public support for protecting and retaining urban trees (Frantzeskaki, Kabisch, & McPhearson, 2016; Boulton, Dedekorkut-Howes, & Byrne, 2018; Buijs et al., 2019; Lawrence et al., 2013). Stricter regulations can even be counter-productive if residents decide to remove trees before they reach a protection threshold (Conway & Lue, 2018; ISA, 2018). Moreover, LGAs enforcing higher penalties for private tree removal face associated costs. Enforcement requires more than increasing the human resources and budgets to better detect violations and collect fines (Burby, May, & Paterson, 1998). It also depends on proactive leadership, adequate legal and public support, and incentives that increase voluntary compliance (Conway & Lue, 2018; McKay, Berry, & McGreal, 2003). Providing incentives, including creating economic value for trees, is an understudied and immature area of urban planning and something LGAs should explore in greater depth. For years, authors have argued that putting a monetary value on trees will encourage tree-friendly designs by linking planning outcomes to financial rebates (Nowak, 2006). But applying an economic value to trees has been difficult in practice. Guidelines on tree ordinances (e.g., ISA, 2018) suggest incentive programs for cost-sharing, and grants or loans for planting and maintenance, but do not evaluate case study success. Local governments are ideally placed to develop financial incentives aimed at increasing private tree stewardship (Cerra, 2017). Many cities now offer tax rebates for greening new developments, including: Portland, which offers rebates for tree retention and planting (City of Portland, 2020); Sacramento, which offers free shade trees per customer for new developments (SMUD, 2020); Washington DC, which subsidizes tree planting for private homeowners (District of Columbia, 2020); and many European cities, such as Berlin and Helsinki, which offer tax rebates for greening new or re-developed sites (Juhola, 2018). One LGA in Greater Melbourne now requires a bond before work can start on a site with high value trees. The bond, typically thousands or tens of thousands of dollars, is forfeited to the LGA unless the tree is protected (City of Stonnington, 2018). The scheme is recently introduced, and only further research will determine its effectiveness.

Finally, urban forest professionals need to do more than promote the practical benefits of trees if they are to reduce private tree losses (Kirkpatrick et al., 2013b). Community engagement is essential for understanding and responding to private landholders' motivations for removing trees (Conway & Lue, 2018; Gulsrud, Hertzog, & Shears, 2018). The goal is not just to reduce the barriers for public acceptance of urban trees (Kirkpatrick et al., 2013b), but to increase urban tree stewardship (Dai, 2011; Roman et al., 2015). This means building a sense of collective responsibility for the urban forest (Roman et al., 2015). While stewardship is complex, reflecting culture, income, and education (Conway, 2016), empirical research on residents' opinions shows that many are willing to recognise the benefits of private trees (Conway, 2016; Dilley & Wolf, 2013) and to accept some of the risks (Kirkpatrick et al., 2013b). Still, peoples' opinions are expressed in many ways; through attitudes and preferences toward specific trees, and by deeper values and beliefs related to urban nature (Kirkpatrick et al., 2013b; Ordóñez, Beckley, Duinker, & Sinclair, 2017). Understanding this hierarchy of opinion is the key to community engagement aimed at promoting stewardship (Ordóñez et al., 2017). To achieve this, LGAs will need to train staff to monitor and evaluate the impact of programs (Gulsrud et al., 2018; Herriman, 2011).

5. Conclusions

Without public support, rules and regulations to protect trees on private property are unlikely to be effective, so LGAs need to implement existing programs or discover new ways of engaging people in the stewardship of private trees – probably both. Further research could focus on better understanding people's beliefs about trees in specific instances of private tree decision-making, as well as investigating what factors, financial or otherwise, might influence their views. Ultimately, behavioural change is also a responsibility for those professionals who communicate and engage with the public. This probably requires new models of engagement as the basis of managing private trees, in which they are seen as a resource needing a cooperative approach between private landowners and the broader community.

CRediT authorship contribution statement

Chris Clark: onceptualization, data curation, Formal analysis, Investigation, Methodology, Writing. **Camilo Ordóñez:**

Conceptualization, Methodology, Supervision, Writing - review & editing. **Stephen J Livesley:** Conceptualization, Supervision, Writing - review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2020.103899.

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