Urban Forestry & Urban Greening 82 (2023) 127870

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Community perceptions of ecosystem services and disservices linked to urban tree plantings

Jessi J. Drew-Smythe [a], Yvonne C. Davila [a], Christopher M. McLean [b], Matthew C. Hingee [b], Megan L. Murray [a], Jonathan K. Webb [a], Daniel W. Krix [a], Brad R. Murray [a,*]

[a] Faculty of Science, School of Life Sciences, University of Technology Sydney, PO Box 123, Ultimo, NSW 2007, Australia
[b] Strategic Planning Projects, Central Coast Council, PO Box 21, Gosford, NSW 2250, Australia

ARTICLE INFO

Handling Editor: Cecil Konijnendijk van den Bosch

Keywords:
Climate change
Native trees
UHI
Urban forestry
Wildfires
Wildlife

ABSTRACT

The planting of trees in streets and parks is critical for urban greening efforts that seek to improve climate-change resilience in cities around the world. Ecosystem services provided by urban trees range from mitigating urban heat island effects to enhancing human well-being and conserving native biodiversity. At the same time, such tree services trade off with disservices that include risk to human safety from falling branches and infrastructure damage from root growth. Here, we performed a survey of residents of a sub-tropical region in eastern Australia to determine community perceptions of the ecosystem services and disservices linked to urban tree plantings. Our aim was to better understand the diverse perceptions of the community, prior to on-the-ground implementation of urban greening, to help guide planting programs in streets and parklands that are vulnerable to UHI effects in the region. We found strong evidence for a high level of public awareness about the beneficial ecosystem services that urban trees can provide. A broad spectrum of beneficial tree services were valued highly by the community in their urban environment including the planting of native trees that can attract and provide food for preferred wildlife; provide shade and reduce heat; allow for a strong connection with nature; have the potential to store carbon to mitigate climate change; provide a level of protection from bushfires; have aesthetically pleasing properties; and produce food for people. At the same time, however, community concerns about tree disservices were concentrated primarily on root damage to infrastructure as well as property damage and injury from falling branches. Our elicitation of community attitudes to tree services and disservices will allow for residents' most important values and strongest concerns about trees to be explicitly taken into account when establishing a community-inclusive approach to urban tree planting.

1. Introduction

Urban greening seeks to introduce, conserve and maintain outdoor vegetation in urban areas (Eisenman et al., 2019). Building on a long history of incorporating trees in urban design and landscape architecture (Arnold, 1980; Lawrence, 2006; Massengale and Dover, 2014), urban greening strategies are being implemented in many cities around the world with the specific aim of increasing urban tree canopy cover (Pincetl et al., 2013; Nguyen et al., 2017; FAO, 2018; Campbell et al., 2022; Sousa-Silva et al., 2023). Such strategies are predicated on the idea that urban tree plantings can provide communities with a wealth of benefits in the form of ecosystem services (Salmond et al., 2016; Willis and Petrokofsky, 2017; Dorst et al., 2019). Expansion of urban tree coverage, for instance, can help to mitigate urban heat island (UHI) effects with temperature reductions in cities ranging from 6.5° to 22.8°C (Cheela et al., 2021). Trees intercept large amounts of solar radiation, providing shade and preventing heat from being captured by the built environment (Gage and Cooper, 2017; Ziter et al., 2019; Helletsgruber et al., 2020; Wang et al., 2020). Furthermore, evapotranspiration by trees (i.e. the release of water vapour from leaves) can markedly lower surrounding air temperatures (Qiu et al., 2013; Li et al., 2018). Urban tree plantings also have positive impacts on the mental and physical health of the community (Kirkpatrick et al., 2012; Turner-Skoff and Cavender, 2019; Saldarriaga et al., 2020; Javadi and Nasrollahi, 2021) and can provide opportunities for urban permaculture, or 'street gardens', which contribute to sustainability and strengthening community ties (Holmgren, 2006; Fadaee, 2019). Additionally, urban trees and greenspace contribute to the conservation of biodiversity by providing

* Corresponding author.
E-mail address: brad.murray@uts.edu.au (B.R. Murray).

https://doi.org/10.1016/j.ufug.2023.127870
Received 25 May 2022; Received in revised form 26 January 2023; Accepted 7 February 2023
Available online 13 February 2023
1618-8667/

food, shelter and habitat interconnectivity for native fauna (Vergnes et al., 2012; Ossola et al., 2019; Bodnaruk et al., 2017; Turner-Skoff and Cavender, 2019).

At the same time, however, the beneficial services provided to communities by urban tree plantings are offset by a range of tree disservices (Roman et al., 2021). These include, among others, the risks that trees pose to safety and infrastructure (e.g. from falling branches) as well as an increased likelihood of attracting unwelcome wildlife (Kirkpatrick et al., 2012; Camacho-cervantes et al., 2014; Saldarriaga et al., 2020). This trade-off can lead to difficulties in the implementation of urban tree plantings (Head and Muir, 2005, 2006; Delshammar et al., 2015; Fernanda Zimmermann et al., 2019; Kronenberg et al., 2021; Barron et al., 2021). Indeed, despite increasing interest from local government bodies to implement urban greening strategies to provide communities with beneficial tree services (Sousa-Silva et al. 2023), there is recent evidence for declines in tree cover in urban regions (Nowak and Greenfield 2018a), in part due to perceived tree disservices (Conway and Yip, 2016). At the wildland-urban interface of fire-prone regions, for example in New South Wales, eastern Australia, recent legislation has been passed allowing residents to clear trees and vegetation near their homes without prior approval from authorities, in response to the perceived disservice that trees present as propagators of wildfires into urban areas (e.g. the 10/50 Code of Practice; Salgo and Gillespie, 2018). Such legislation, which is a response to potential tree disservices, highlights the difficult trade-off between tree planting and tree removal in urban regions.

Given the opposing services and disservices of urban tree plantings, for urban greening initiatives to have a better chance of succeeding, it is essential to determine those services that are perceived as most important to the community, and at the same time, those disservices that are of most concern prior to implementing tree planting programs (Olivero-Lora et al., 2020). Indeed, decisions about urban forestry that fail to account for ecosystem disservices can have unintended negative consequences for communities (Roman et al., 2021). While much of urban forest management activity is focused primarily on technical expertise (e.g. plant physiology and function), there is a need for broader and concurrent consideration of the diverse needs of the community when establishing plans for urban tree plantings (Barona et al., 2022; Campbell et al., 2022). In this context, community consultation must occur before the commencement of full-scale tree planting to ensure that community perceptions of tree ecosystem services and disservices can be appropriately integrated into management plans, so as to encourage longer lasting support for the program from residents and increase the likelihood of successful and enduring revegetation outcomes (Van Herzele, 2004; Janse and Konijnendijk, 2007; Shackleton and Njwaxu, 2021).

In the present study, we performed a survey of residents of a subtropical region in eastern Australia to determine community perceptions of the ecosystem services and disservices linked to urban tree plantings. The aim of our survey was to better understand the diverse perceptions of the community to help guide planting programs in streets and parklands that are vulnerable to UHI effects in the region. The responses to the survey were designed at the outset to provide information that could be used in the design of a maximum benefit framework for urban tree planting. This framework seeks to concurrently reduce the levels of UHI effects, provide a range of other ecosystem services for the community, minimise the potential problems associated with tree disservices, while also encourage the conservation of native biodiversity. The findings of our study will be useful not only in eastern Australia, but also in other parts of the world for informing local climate resilience strategies in urban environments and developing programs concerned with community engagement and education in urban greening efforts.

2. Materials and methods

2.1. Study region

The Central Coast local government area (LGA) in New South Wales (NSW) is one of eastern Australia's largest urban population centres (33°31'55"S, 151°10'51"E). The region spans over 1681 km^2 with a population of 346,596 people (Australian Bureau of Statistics, 2021), forecast to reach 400,000 by the year 2036 (Central Coast Council, 2020). Based on the national system of Socio-Economic Indexes for Areas (SEIFA), which ranks areas in Australia according to relative socio-economic advantage and disadvantage, the Central Coast region has an Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) of 975, placing it in the fourth quintile (the 1st quintile being the most disadvantaged and the 5th quintile being the most advantaged) (Australian Bureau of Statistics, 2018). With respect to the racial diversity of the population within the region, the top six countries of birth of residents spans Australia (79 %), England (4.6 %), New Zealand (1.7 %), Philippines (0.7 %), India (0.7 %) and South Africa (0.6 %) (Australian Bureau of Statistics, 2021).

The LGA contains a blended landscape of 153 urban and peri-urban suburbs weaved between bushland and coastal beaches. The built environment is characterised by separate houses (76.4 % of all dwellings), medium density dwellings (18.1 %) and a much smaller percentage of high density dwellings (4.5 %), compared with 70.3 %, 17.3 %, and 11.0 % in Australia respectively (Central Coast NSW Community Profile, 2022). The region hosts abundant biodiversity within the native vegetation that covers 70 % of the land surface area, where National Parks occupy more than half of the LGA (Central Coast Council, 2019). The region is classified as a humid, sub-tropical climate (Cfa) under the Köppen-Geiger classification scheme and is bounded at the coast by the Tasman Sea. Mean annual rainfall on the Central Coast ranges between 1000 mm and 1500 mm, mean annual temperatures range from 15 °C to 18 °C, and relative humidity lies between 70 % and 90 % throughout the year (Australian Bureau of Meteorology, 2020). The region has a six-month fire season over spring and summer, and many areas of the LGA are considered at high risk of bushfires due to the local climate, proximity to surrounding bushland, and the occasional dry lightning storm (Central Coast Bushfire Management Committee, 2020).

2.2. Survey questionnaire

We designed our survey questionnaire to better understand which urban tree services are most important to residents and which disservices are of most concern. A copy of the questionnaire is provided in Appendix 1. We first set out to determine residents' familiarity with foundational knowledge of pertinent urban greening issues including the ability of tree canopies to lower ambient temperatures (Cheela et al., 2021); the potential to store carbon from the air (Nowak, and Greenfield, 2018b; but see Pataki et al., (2011,2021)); provide food and habitat for native wildlife (Ossola et al., 2019); provide food for local residents (Fadaee, 2019); improve people's mental health (Javadi and Nasrollahi, 2021); and provide wildfire protection through the use of fire-retardant (low-flammability) plants (Murray et al., 2018). We also sought to determine residents' understanding of the problems that the use of non-native trees can have on native biodiversity. A three-point Likert-type scale was used to determine familiarity as either (a) unfamiliar, (b) somewhat familiar or (c) extremely familiar. We then used a series of dichotomous questions (yes/no) to ask residents about their experience of uncomfortably hot weather in their neighbourhood and at local parks and whether they were concerned about a reduction of trees in this context. With these introductory questions, we were able to gauge residents' existing awareness of urban greening concepts as well as their personal experiences of urban heating prior to identifying emergent community perceptions of tree ecosystem services and disservices.

We used a five-point rating scale to identify residents' perceptions of tree ecosystem services in urban settings with respect to the ability of trees to provide cooling shade; the potential for carbon storage to offset climate change; attract and provide food and habitat for wildlife; enable human connection with nature; provide food for people; and provide protection from wildfires through the use of fire-retardant species. This rating scale was also used to determine residents' attitudes to the use of native (as opposed to non-native) trees in urban greening. Respondents reported on the level of importance they placed on each of the above along a scale of (a) not at all important, (b) somewhat unimportant, (c) somewhat important, (d) extremely important or (e) I do not mind either way. We included the fifth option as a more specific substitute for a neutral response as the latter often complicates attitudinal measurements through adding ambiguity and reducing honest responses (Johns, 2005). We used a dichotomous (yes/no) question to identify clearly residents' attitudes toward tree disservices with respect to impacts on personal safety (e.g. injury, allergies); damage (e.g. to property, infrastructure, real estate values); aesthetic features of the environment (e.g. trees are ugly, reduce sunlight, too large, take too long and require too many resources to grow, messy); and attract undesirable wildlife. Residents were provided with the opportunity to state which wildlife, if any, they consider most undesirable to attract within urban areas. We also sought to determine whether the free provision and delivery of trees might help to overcome any disincentives associated with tree disservices. Using a five-point Likert scale we explored residents' level of willingness to obtain a tree, free-of-charge, for planting on their property.

The survey questionnaire was pilot tested by a handful of layperson reviewers to ensure it was legible and simple to understand prior to its distribution to residents within the Central Coast LGA. To ensure responses were only received from within the study region, a screening question was employed at the beginning of questionnaire that prompted participants to confirm their current residential status within the Central Coast LGA. Our screening question successfully intercepted three responses from individuals living outside of the study area who were subsequently excluded from further analyses. Survey responses were from a wide range of age groups in the LGA (Fig. 1).

2.3. Survey recruitment

A total of 1190 unique responses were obtained across the survey period. The survey was open to all residents of the Central Coast LGA aged 18 years and over and was executed primarily online via Microsoft forms (1186 respondents). Paper surveys with pre-paid return envelopes were also made available upon request to maximise survey spread, and to ensure that those with limited computer access were able to participate (4 respondents). We distributed our survey through an integrated strategy of purposive and snowball sampling methods. Due to limitations regarding physical access to the study area because of the COVID-19 pandemic we utilised social media, predominantly region-specific networks, and contacted local schools, businesses and volunteer organisations to distribute the questionnaire to their constituents and patrons. The survey introduction further encouraged participants and non-participants (those who attempted to participate but lived outside of the study area) to refer the survey onto those they know living in the study region. Purposive and snowball sampling techniques are understood to increase the probability of bias in responses due to the nature of such methods relying on respondents' social networks (Atkinson and Flint, 2003). However, due to the social distancing requirements imposed during the pandemic these techniques were utilised as a safe, cost- and time-effective means to boost survey reach throughout the study area.

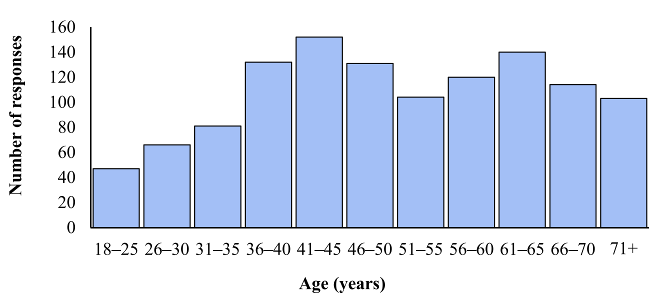

Fig. 1. Frequency histogram of the age range of respondents completing the questionnaire survey (n = 1190).

2.4. Statistical analyses

Responses to survey questions that used a Likert scale were tabulated and G-tests were conducted separately for each question (Sokal and Rohlf, 1981). Pearson residuals for each G-test were used to determine which response groups in the Likert scale most diverged from a result expected if numbers of responses in each group were randomly distributed. This allowed us, for instance, to identify which tree services were perceived to be more valuable by residents more highly than would be expected by chance. In figures portraying responses to Likert-scale questions (Figs. 2, 3 and 5), response groups with unbroken lines indicated either that the number of responses in these groups was greater than (i.e. larger-sized box) or smaller than (i.e. smaller-sized box) the number of responses by residents in those groups that would be expected by chance ($P < 0.0001$). Response groups with broken borders represented response groups in which the number of responses was equivalent to numbers predicted to arise by chance. All analyses and visualisations were performed in R 4.1.0 (R Core Team, 2021) using the package AMR.

3. Results

3.1. Knowledge of urban tree ecosystem services and experiences of urban heating

We found strong evidence for a high level of familiarity among residents with respect to foundational knowledge underpinning urban greening and tree plantings (Fig. 2). For all seven issues described in the survey question, significantly more people than expected by chance (all $P < 0.0001$) were 'extremely familiar' with the ability of trees to provide food and habitat for native wildlife (94 % of responses), improve people's mental health (84 %), have the potential to store carbon (80 %), lower ambient temperatures (73 %), provide food for local residents (57 %), impact negatively on native wildlife if exotic trees are present (47 %), and provide wildfire protection (41 %) through the use of low-flammability plants (Fig. 2). In addition, the majority of residents indicated that they have experienced uncomfortable levels of heat during summer in their neighbourhoods (68 %) and local parklands (71 %) and most residents (96 %) expressed concern about a reduction of trees in their neighbourhoods and a reduction of trees in parklands (91 %).

3.2. Community perceptions of urban tree ecosystem services

Residents not only considered nine of the 10 beneficial tree services as 'extremely important', but they did so in a manner that was significantly higher than expected by chance ($P < 0.0001$; Fig. 3). The only exception to this pattern was that about the same proportion of residents as expected by chance rated the ability of urban trees to produce food for people as 'extremely important'. More importantly, combining the response groups 'somewhat important' and 'extremely important' revealed highly positive attitudes of residents to all urban tree services in priority order of providing food for wildlife (98 %), attracting wildlife (98 %), providing shade (97 %), reducing heat (97 %), providing connection with nature (97 %), storing carbon (95 %), providing protection from bushfires (94 %), are aesthetically pleasing (80 %) and produce food for people (74 %). A significantly high response was received on the issue of urban trees being native plant species (94 %).

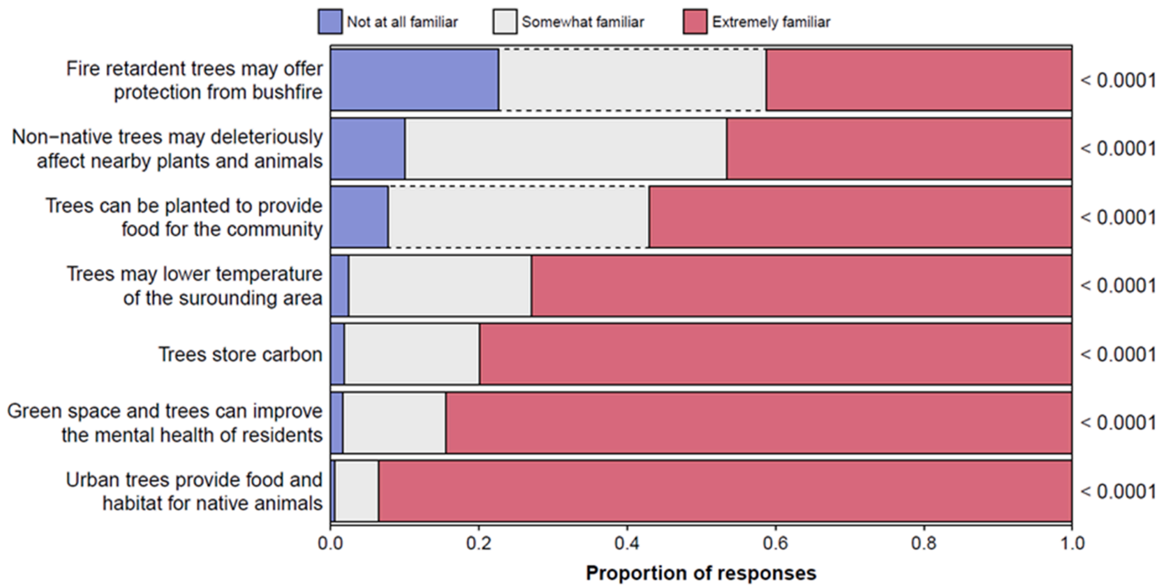

Fig. 2. Proportions of survey responses to questions asking residents about their familiarity with foundational knowledge underpinning urban tree plantings. Response groups with unbroken lines indicated either that the number of responses in these groups was greater than (i.e. larger-sized box) or smaller than (i.e. smaller-sized box) the number of responses by residents in those groups that would be expected by chance (P < 0.0001). Response groups with broken borders represented response groups in which the number of responses was equivalent to numbers predicted to arise by chance.

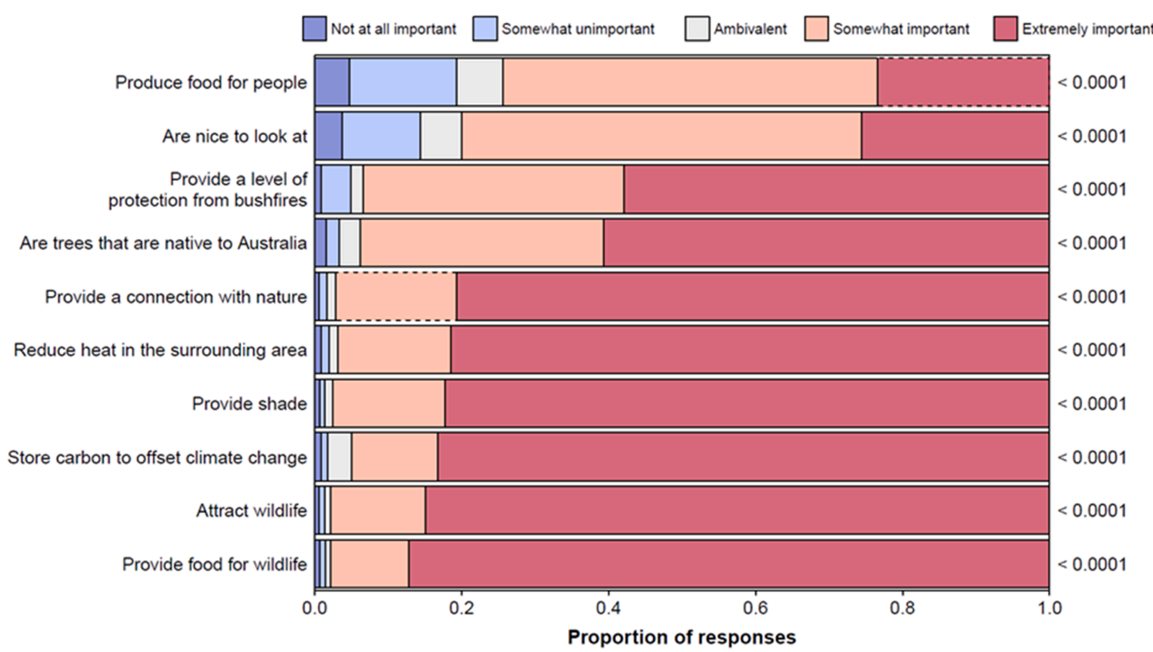

Fig. 3. Proportions of survey responses to questions asking residents about their perceptions of urban tree ecosystem services. Response groups with unbroken lines indicated either that the number of responses in these groups was greater than (i.e. larger-sized box) or smaller than (i.e. smaller-sized box) the number of responses by residents in those groups that would be expected by chance (P < 0.0001). Response groups with broken borders represented response groups in which the number of responses was equivalent to numbers predicted to arise by chance.

3.3. Community perceptions of urban tree ecosystem disservices

Residents demonstrated varying levels of concern about the range of potential disservices provided by urban trees (Fig. 4). The most concerning issues for residents were damage to infrastructure from roots (71 % of respondents answered 'yes' to this question) and property damage from falling branches (60 %). Health risks to people through injury from falling branches (50 %) and allergen production (44 %) were also considered important concerns (Fig. 4). Of somewhat least concern were time taken for trees to mature (10 %), growth of trees to the height of a one-storey house (8 %), attracting wildlife (6 %) and the need for too many resources to grow trees (5 %).

3.4. Delivery of trees and their source of origin

We found strong evidence that the free delivery of trees, collected from within the local neighbourhood rather than from outside a resident's suburb, would help to overcome potential disincentives to planting urban trees (Fig. 5). Significantly more people than expected by chance (P < 0.0001) responded with either 'strongly agree' or 'agree' to

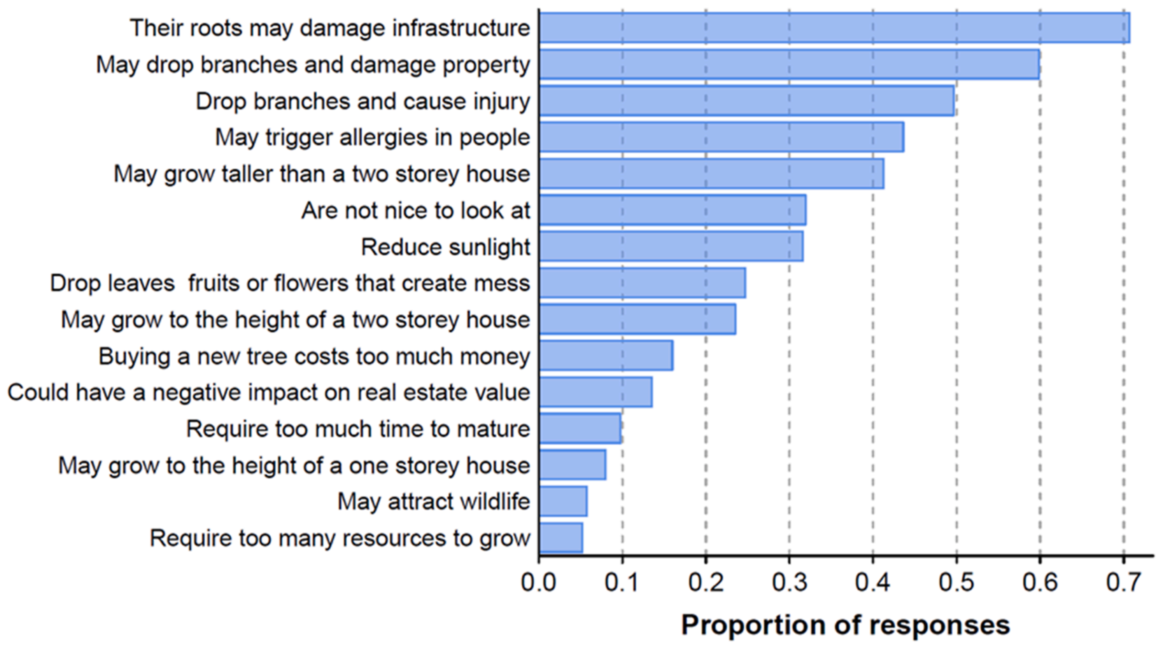

Fig. 4. Proportions of survey responses to questions asking residents about their perceptions of urban tree ecosystem disservices. Proportions shown represent a 'yes' response to concerns about impacts on (a) community well-being (e.g. injury, allergies), (b) damage (e.g. to property, infrastructure, real estate values), (c) aesthetic features of the environment (e.g. trees are ugly, reduce sunlight, too large, take too long and require too many resources to grow, messy) and (d) attract undesirable wildlife.

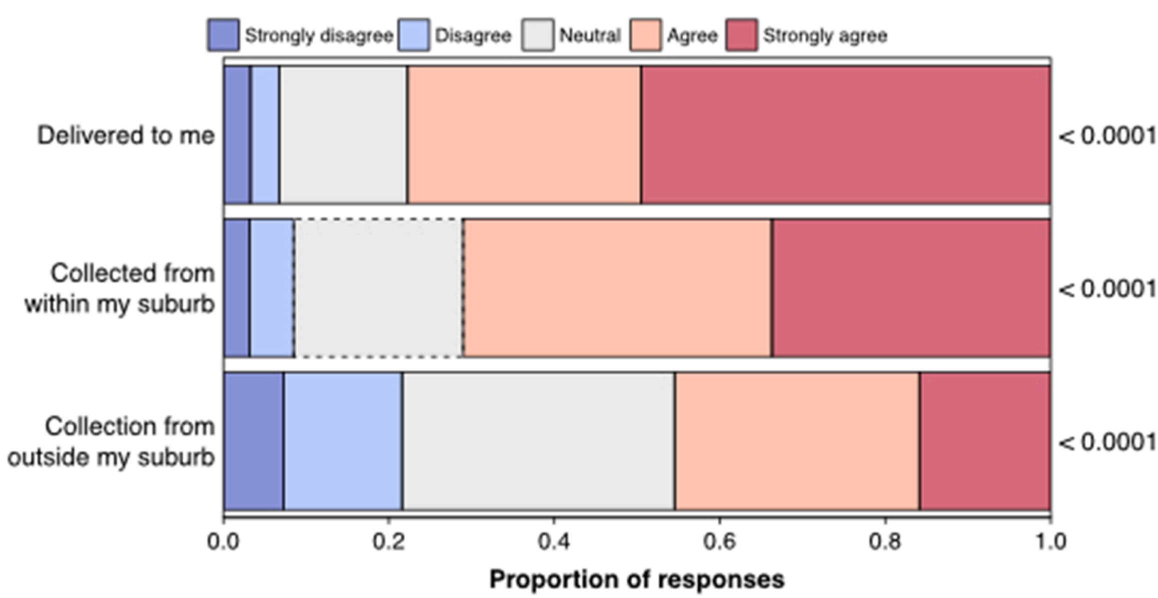

Fig. 5. Proportions of survey responses to questions asking residents about their attitudes to the free delivery of trees and whether they would prefer trees from within or from outside their suburb. Response groups with unbroken lines indicated either that the number of responses in these groups was greater than (i.e. larger-sized box) or smaller than (i.e. smaller-sized box) the number of responses by residents in those groups that would be expected by chance ($P < 0.0001$). Response groups with broken borders represented response groups in which the number of responses was equivalent to numbers predicted to arise by chance.

both the free provision of trees (78 % of responses) and to the collection of trees from within their suburb (72 %).

3.5. Human-wildlife dynamics

A total of 589 residents answered this optional question with 44 faunal groups listed as being of concern. These groups were not necessarily unique, with some broad animal groups (e.g. invasive species) described by some respondents also including fauna (e.g. feral goats, pigs) described by other respondents. The three highest ranking animal groups across all responses were introduced species and included cats (15 %), foxes (12 %) and non-native animals in general (8 %) (Table 1). Considered together, responses that included exotic species as identifiable taxa accounted for 58 % of all responses. The three native species of most concern to residents included the brush turkey (7 %), noisy miner (4 %) and possums (4 %). Explanations provided by residents for listing animal groups were centred on the negative impacts that exotic species would have on native fauna as well as damage, mess and health problems that might arise from either native or exotic fauna (Table 1).

Table 1
Resident responses describing native and introduced wildlife that they consider should not be encouraged in their neighbourhood as a result of urban tree planting (X = native or introduced status not specified). Wildlife with >20 mentions in the survey are ordered from the highest to the lowest number of mentions. Numbers in parentheses under reasons for nomination show the frequency of each explanation provided by residents for discouraging each taxon.

Wildlife	Status	Number of mentions	Reasons for nomination
Domestic cat (*Felis catus*)	Introduced	102	Negatively affect native wildlife (29); prey on domestic chickens (1); are at risk due to road traffic (1)
European fox (*Vulpes vulpes*)	Introduced	80	Negatively affect native wildlife (13); prey on domestic chickens (1)
Non-native animals	Introduced	56	Impact habitat for other organisms (2); negatively affect native wildlife (3)
Brush turkey (*Alectura lathami*)	Native	47	Are destructive and cause mess in gardens (19); are overpopulated (6); carry parasites (1); create fire hazards through nesting behaviour (1)
European rabbit (*Orichtolagus cuniculus*)	Introduced	38	Negatively affect native wildlife (6); create burrows that are hazards for people (1)
Common myna (*Acridotheres tristis*)	Introduced	37	Negatively affect native bird species (13); carry disease (1)
Snakes	X	37	May injure or envenomate people (16); are at risk of injury or death from people (3); are 'creepy' (1)
Rats	X	36	Carry diseases (3); cause property damage (1)
Feral animals	Introduced	24	Negatively affect native wildlife (2)
Noisy miner (*Manorina melanocephala*)	Native	24	Negatively affect other native birds (9); are aggressive (1)
Possums	Native	24	Nest in roof cavities (9); cause property/garden damage and mess (6); are noisy (2); are overpopulated (1)
Bats	Native	23	Smell (5); are noisy (4); are messy (4); carry diseases (3)

4. Discussion

The planting of trees in streets and parks as part of urban greening strategies can create dynamic public spaces that provide positive outcomes for local communities (de Vries et al., 2003; Tzoulas et al., 2007; Dronova, 2019; Turner-Skoff and Cavender, 2019). Urban tree plantings have a long history spanning hundreds of years in the design of cities, providing beautification, ornamentation and environmental benefits (Lawrence, 2006; Massengale and Dover, 2014). Building on this long history, urban design over the last several decades has seen an increased focus on the assessment of ecosystem service provision by trees (Silvera Seamans, 2013). The results of our study indicate that this design focus has been matched by a high level of public awareness of the benefits of trees in relation to urban greening. For example, the greater majority of residents were extremely familiar with the ability of trees to lower ambient temperatures to mitigate UHI effects, the potential of trees to store carbon, and at the same time provide food and habitat for native wildlife. In addition, residents were keenly aware of the strong connectivity between positive mental health and the presence of green spaces (Dwyer et al., 1991; Sheets and Manzer, 1991; Wolf, 2005; Ellis et al., 2006). We suggest that residents' robust understanding of these urban greening concepts underscores the reliability of their survey responses in terms of their perceptions of tree ecosystem services and disservices in urban environments. As a consequence, we are confident that residents' responses to our survey can provide a reliable initial guide for the implementation of a tree planting program in streets and parklands in the region that are vulnerable to UHI effects.

How might the results of our study be of practical use for tree planting strategies in urban regions? First, our findings can be used to ensure that tree planting programs work towards meeting the values of residents, which include the planting of native trees that can attract and provide food for preferred wildlife; provide shade and reduce heat; allow for a strong connection with nature; have the potential to store carbon to mitigate climate change; provide a level of protection from bushfires; have aesthetically pleasing properties; and produce food for people. Second, the empirical basis of these community preferences for tree ecosystem services elicited in our study can be used in community and school education programs to disseminate the benefits of urban forests. Third, information from our survey can be used to ensure that residents' concerns about tree disservices are explicitly taken into account, which means planting trees that minimise damage to buildings from roots and falling branches, and that minimise health risks to people through injury and allergies. Consideration of community perceptions of ecosystem disservices in this way will be critical to avoid unintended negative consequences for communities (Roman et al., 2021). Fourth, our work can be used to direct research efforts into identifying tree species that address most if not all of the service and disservice issues described above. For example, very little is known about which tree species used in urban plantings possess low-flammability properties. Research efforts need to be directed towards identifying low-flammability tree species which can help to slow or prevent the spread of wildfires in urban areas (Murray et al. 2018).

Concerns regarding personal and property damage associated with trees were noted in survey responses, which included property damage and personal injury from falling branches. Whole tree and branch failure receive very little attention in a scientific context but are often considered within risk management and insurance frameworks. Whole tree failure is relatively uncommon but can have lethal consequences, even after a previous visual tree inspection by a trained arborist (Timbs v Shoalhaven Council, 2004). In one example, a large Spotted Gum fell on a house during a storm, killing a man (Timbs v Shoalhaven Council, 2004). The tree had been visually inspected around two years previously by a Council arborist who had deemed the tree to be structurally sound and the court also determined that prior to the storm that caused the tree to fail, no visual evidence would have been available to determine the tree posed a risk of failure. Cases like this create a sense of uneasiness among residents, despite the risk of tree failure being very low. In this context, van Haaften et al. (2021) undertook a systematic literature review of 161 studies and found 142 different factors that could explain tree failure, which were largely related to tree size and age, which ultimately could translate to any mature tree being at a risk of failure. Tree branch failure is more common than whole tree failure, however, van Haaften et al. (2021) found no significant relationship to explain branch failure. Others have proposed that tree branch weight is potentially the most realistic measure of impact potential in assessing tree failure risk. The relationship between branch diameter and mass may provide a measurable estimate of this risk which may increase during storms and wind events. Certain species are more susceptible to summer branch drop, which increases during periods of hot, dry weather, times when members of the community are likely to seek shade (Lonsdale, 1999). Engagement with the community to educate residents about the possibility of removing dead or other high risk branches by trained arborists may be a mechanism to reduce the risk of branch shear.

Residents also reported concerns of damage to infrastructure from roots. As a general trend, tree root systems in urban spaces tend to be shallow and widespread. Day et al. (2010) reviewed published data on root spread of trees and concluded that the radius of the root system is approximately equal to tree height which is often greater than the radius of the branches. Given the close proximity of trees to structures, pavements, and utilities in most urban and suburban settings, tree roots can be easily injured by soil excavation (Watson et al., 2014) which may seriously compromise the health and longevity of the tree. The Australian Standard for the protection of trees on development sites (Standards Australia, 2009) considers that a tree root zone that requires protection during works is 12 times larger than the tree's diameter at breast height and that excavation in this area may reduce the longevity of the tree.

Large trees in restricted planting spaces are most associated with pavement damage (Wagar and Barker, 1983; D'Amato et al., 2002). However, dilapidated pavements may degrade irrespective of whether trees are present nearby (Sydnor et al., 2000; D'Amato et al., 2002). Importantly, trees require space to achieve their optimal growing conditions, where suboptimal conditions can translate to reduced tree size (Sanders et al., 2013) and premature death (Nowak et al., 2004). Urban soils often limit rooting space, due to being over-compacted, having poor drainage and low organic content (Day and Bassuck, 1994). Thus, urban trees may not reach their optimal size which may translate to a reduced effectiveness at reducing UHI and providing for other ecosystem services. Subsequently, re-establishment should aim to ensure sufficient space and optimal soil conditions are provided for new plantings.

It may be difficult to capture all of the tree services and disservices that we have documented as being of importance for a community in the process of urban tree planting. As with many solutions to environmental issues, there may need to be trade-offs in the implementation of greening programs. Roman et al. (2021) make the excellent point that a key consideration with such trade-offs is the management costs associated not only with maintaining the beneficial ecosystem services, but also in mitigating the disservices. To better understand how these costs might effectively be offset, future studies are needed to explore ways to balance out trade-offs and to understand what compromises are most agreeable to communities (Roman et al., 2021). For example, in mitigating UHI effects, the shading of house roofs is important, but this also requires larger trees with larger root systems and greater height. A way forward may need to be through achieving a compromise, for example through planting of smaller species, which have a smaller canopy and may be less effective at mitigating UHI but that cause less infrastructure damage from falling branches. Importantly, in replanting smaller species, larger trees may be lost, but this is still a superior outcome when compared to no replacement planting at all. This strategy may lead to a loss in overall canopy cover for urban regions, however, it may be a particularly fruitful way to manage the trade-off between tree services and disservices.

A total of 44 faunal groups associated with urban greening were listed as being of concern to residents. These groups included invasive species in general, with more specific concerns primarily surrounding introduced cats and foxes, as well as a mix of native species including brush turkeys, possums, snakes and bats/flying foxes. Concerns from residents included increased predation by introduced species on native species (chiefly from cats and foxes) and aggression from the overabundant native bird species *Manorina melanocephala* (noisy miner) towards other native species. For the undesirable native species, concerns were largely anthropocentric and related to causing mess, noise, smell and disease transfer from many animal groups. Conflict between residents and wildlife has been studied for a number of the faunal groups mentioned by respondents in this study, including the Australian brush turkey (Göth et al., 2006), possums (Hill et al., 2007) and flying foxes (Currey et al., 2018). Previous studies have advocated for stakeholder engagement in reducing conflict and ensuring accurate perceptions of risk and damage caused by undesirable native species, which may also be suitable in this area, given the high value placed on other elements of the natural environment by respondents. Urban habitats are important for a range of native species, including flying foxes (Tait et al., 2014, Timmiss et al., 2021) and a range of small birds, such as the silvereye and eastern yellow robin (Parsons and Major, 2004), however human behaviour can threaten the longevity of native species. For example, a single domestic cat in Perth, Australia killed the majority of a population of large skinks within a few months (Bamford and Calver, 2012). The awareness among our survey respondents of the ecological impacts caused by certain animals, including domestic cats, is encouraging and may contribute to reducing human impacts on urban wildlife populations.

5. Conclusion

Our findings highlight that the majority of surveyed residents not only understand, but also value a wide range of ecosystem services that trees provide in the urban environment. At the same time, residents have legitimate concerns centred on some of the potential tree disservices linked to urban tree plantings. Importantly, our study has elicited community perceptions to tree services and disservices prior to on-the-ground implementation of urban tree planting. It should be noted that our study was designed to capture in the first instance a broad overview of community perceptions of services and disservices associated with urban tree plantings. Recent studies have demonstrated the importance of examining the influence of a range of socio-economic factors on community attitudes towards urban tree planting (e.g. Barona et al., 2022; Campbell et al., 2022). For example, Riedman et al. (2022) showed that there can be barriers to participation in urban tree planting programs within low-income and minority neighbourhoods. On the basis of such critical previous research in this area, future surveys in the Central Coast region that target a socio-economic analysis of community patterns would be a valuable next step to further and deepen our understanding of community perceptions to urban tree plantings.

CRediT authorship contribution statement

Jessi J. Drew-Smythe: Conceptualization, Methodology, Survey Administration, Writing and Editing **Yvonne C. Davila:** Conceptualization, Methodology, Reviewing and Editing, Supervision **Christopher M. McLean:** Conceptualization, Reviewing **Matthew C. Hingee:** Conceptualization, Reviewing **Megan L. Murray:** Conceptualization, Reviewing **Jonathan K. Webb:** Conceptualization, Reviewing **Daniel W. Krix:** Statistical Analysis, Graphical Outputs **Brad R. Murray:** Conceptualization, Methodology, Supervision, Writing and Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was supported by the Local Government NSW Research and Innovation Fund, awarded to Central Coast Council, NSW, Australia. We thank Birding NSW, Blue Haven Public School, Budgewoi Beach Dune Care Inc., Central Coast Community Environmental Network, Central Coast Express Advocate, Central Coast Library, Central Coast Sports College, Gosford Regional Community Services and Umina Community Group for kindly assisting in the dissemination of the survey. We thank two anonymous reviewers and Sylvia Trench for helpful comments that improved the manuscript. The anonymous and voluntary survey met the requirements of the Australian National Statement on Ethical Conduct in Human Research (UTS HREC Ref No. ETH21–6374), and informed consent was confirmed by each respondent prior to submitting their response.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2023.127870.

References

Arnold, H.F., 1980. Trees in Urban Design. Van Nostrand Reinhold, New York, USA.

Atkinson, R., Flint, J., 2003. Sampling, snowball: accessing hidden and hard-to-reach populations. In: Miller, R.L., Brewer, J. (Eds.), The A-Z of Social Research. SAGE Publications, Ltd. https://doi.org/10.4135/9780857020024.

Australian Bureau of Statistics, 2018. Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia, 2016. Australian Bureau of Statistics. Accessed January 9, 2023. ⟨https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/2033.0.55.0012016⟩.

Australian Bureau of Statistics, 2021. Census QuickStats: Central Coast NSW. Australian Bureau of Statistics. Accessed January 11, 2023. ⟨https://www.abs.gov.au/census/find-census-data/quickstats/2021/LGA11650⟩.

Bamford, M., Calver, M.C., 2012. Cat predation and suburban lizards: a 22 year study at a suburban Australian property. Open Conserv. Biol. J. 6, 25–29. ⟨https://benthamopen.com/ABSTRACT/TOCONSBJ-6-25⟩.

Barona, C.O., Wolf, K., Kowalski, J.M., Kendal, D., Byrne, J.A., Conway, T.M., 2022. Diversity in public perceptions of urban forests and urban trees: a critical review. Landsc. Urban Plan. 226, 104466 https://doi.org/10.1016/j.landurbplan.2022.104466.

Barron, S., Sheppard, S., Kozak, R., Dunster, K., Dave, K., Sun, D., Rayner, J., 2021. What do they like about trees? Adding local voices to urban forest design and planning. Trees For. People 5, 100116. https://doi.org/10.1016/j.tfp.2021.100116.

Bodnaruk, E.W., Kroll, C.N., Yang, Y., Hirabayashi, S., Nowak, D.J., Endreny, T.A., 2017. Where to plant urban trees? A spatially explicit methodology to explore ecosystem service tradeoffs. Landsc. Urban Plan. 157, 457–467. https://doi.org/10.1016/j.landurbplan.2016.08.016.

Camacho-cervantes, M., Schondube, J.E., Castillo, A., Macgregor-fors, I., 2014. How do people perceive urban trees? Assessing likes and dislikes in relation to the trees of a city. Urban Ecosyst. 17, 761–773. https://doi.org/10.1007/s11252-014-0343-6.

Campbell, L.K., Svendsen, E.S., Johnson, M.L., Plitt, S., 2022. Not by trees alone: centering community in urban forestry. Landsc. Urban Plan. 224, 104445 https://doi.org/10.1016/j.landurbplan.2022.104445.

Day, S.D., Bassuck, N.L., 1994. A review of the effects of soil compaction and amelioration techniques on landscape trees. J. Arboric. 20, 9–17. https://doi.org/10.48044/jauf.1994.003.

Day, S.D., Wiseman, P.E., Dickinson, S.B., Harris, J.R., 2010. Contemporary concepts of root system architecture or urban trees. Arboric. Urban For. 36, 149–159. https://doi.org/10.48044/jauf.2010.020.

Delshammar, T., Östberg, J., Öxell, C., 2015. Urban trees and ecosystem disservices: a pilot study using complaints records from three Swedish cities. Arboric. Urban For. 41, 187–193. https://doi.org/10.48044/jauf.2015.018.

Dorst, H., van der Jagt, A., Raven, R., Runhaar, H., 2019. Urban greening through nature-based solutions: key characteristics of an emerging concept. Sustain. Cities Soc. 49, 101620 https://doi.org/10.1016/j.scs.2019.101620.

Dronova, I., 2019. Landscape beauty: a wicked problem in sustainable ecosystem management? Sci. Total Environ. 688, 584–591. https://doi.org/10.1016/j.scitotenv.2019.06.248.

Dwyer, J.F., Schroeder, H.W., Gobster, P.H., 1991. The significance of urban trees and forests: toward a deeper understanding of values. J. Arboric. 17, 276–284. https://doi.org/10.48044/jauf.1991.062.

Eisenman, T.S., Churkina, G., Jariwala, S.P., Kumar, P., Lovasi, G.S., Pataki, D.E., Weinberger, K.R., Whitlow, T.H., 2019. Urban trees, air quality, and asthma: an interdisciplinary review. Landsc. Urban Plan. 187, 47–59. https://doi.org/10.1016/j.landurbplan.2019.02.010.

FAO, 2018. Forests and sustainability cities – inspiring stories from around the world. FAO, UN, Rome, Italy. December 2022. ⟨http://www.fao.org/3/I8838EN/i8838en.pdf⟩.

Roman, L.A., Conway, M., Eisenman, T.S., Koeser, A.K., Barona, C.O., Locke, D.H., Jenerette, G.D., Östberg, J., Vogt, J., 2021. Beyond 'trees are good': disservices, management costs, and tradeoffs in urban forestry. Ambio 50, 615–630. https://doi.org/10.1007/s13280-020-01396-8.

Shackleton, C.M., Njwaxu, A., 2021. Does the absence of community involvement underpin the demise of urban neighbourhood parks in the Eastern Cape, South Africa? Landsc. Urban Plan. 207, 104006 https://doi.org/10.1016/j.landurbplan.2020.104006.

Sheets, V.L., Manzer, C.D., 1991. Affect, cognition, and urban vegetation: some effects of adding trees along city streets. Environ. Behav. 23, 285–304 doi.org/10.1177%2F0013916591233002.

Sokal, R.R., Rohlf, F.J., 1981. Biometry: The Principles and Practice of Statistics in Biological Research, Second ed. Freeman, New York.

Sousa-Silva, R., Duflos, M., Barona, C.O., Paquette, A., 2023. Keys to better planning and integrating urban tree planting initiatives. Landsc. Urban Plan. 231, 104649 https://doi.org/10.1016/j.landurbplan.2022.104649.

Standards Australia, 2009. The Protection of Trees on Development Sites AS-4970-2009. Standards Australia, Sydney.

Central Coast Bush Fire Management Committee, 2020. Bush Fire Risk Management Plan 2020–2025. ⟨https://ccbfmc.org/wp-content/uploads/2021/02/Central-Coast-Bushfire-Risk-Management-Plan-2020-v2-Doc-only.pdf⟩.

Central Coast Council, 2019. Flora and Fauna Guidelines. ⟨https://cdn.centralcoast.nsw.gov.au/sites/default/files/Central_Coast_Council_Flora_and_Fauna_Guidelines_July_2019.pdf⟩.

Central Coast Council, 2020. About Council. Accessed September 29, 2021. ⟨https://www.centralcoast.nsw.gov.au/council/about-council⟩.

Central Coast NSW Community Profile, 2022. Central Coast Council area: Dwelling type. Accessed January 11, 2023. ⟨https://profile.id.com.au/central-coast-nsw/dwellings?WebID=10&BMID=50⟩.

Cheela, V.R.S., John, M., Biswas, W., Sarker, P., 2021. Combating urban heat island effect: a review of reflective pavements and tree shading strategies. Buildings 11, 1–21. https://doi.org/10.3390/buildings11030093.

Conway, T.M., Yip, V., 2016. Assessing residents' reactions to urban forest disservices: a case study of a major storm event. Landsc. Urban Plan. 153, 1–10. https://doi.org/10.1016/j.landurbplan.2016.04.016.

Currey, K., Kendal, D., Van der Ree, R., Lentini, P.E., 2018. Land manager perspectives on conflict mitigation strategies for urban flying-fox camps. Diversity 10, 39. https://doi.org/10.3390/d10020039.

D'Amato, N.E., Sydnor, T.D., Knee, M., Hunt, R., Bishop, B., 2002. Which comes first, the root or the crack? J. Arboric. 28, 277–282. https://doi.org/10.48044/jauf.2002.041.

Ellis, C.D., Lee, S.W., Kweon, B.S., 2006. Retail land use, neighborhood satisfaction and the urban forest: an investigation into the moderating and mediating effects of trees and shrubs. Landsc. Urban Plan. 74, 70–78. https://doi.org/10.1016/j.landurbplan.2004.10.004.

Fadaee, S., 2019. The permaculture movement in India: a social movement with Southern characteristics. Soc. Mov. Stud. 18, 720–734. https://doi.org/10.1080/14742837.2019.1628732.

Fernanda Zimmermann, T., Bachi, L., Blanco, J., Zimmermann, I., Welle, I., Carvalho-Ribeiro, S.M., 2019. Perceived ecosystem services (ES) and ecosystem disservices (EDS) from trees: insights from three case studies in Brazil and France. Landsc. Ecol. 34, 1583–1600. https://doi.org/10.1007/s10980-019-00778-y.

Gage, E.A., Cooper, D.J., 2017. Relationships between landscape pattern metrics, vertical structure and surface urban Heat Island formation in a Colorado suburb. Urban Ecosyst. 20, 1229–1238. https://doi.org/10.1007/s11252-017-0675-0.

Göth, A., Nicol, K.P., Ross, G., Shields, J.J., 2006. Present and past distribution of Australian Brush-turkeys *Alectura lathami* in New South Wales? Implications for management. Pac. Conserv. Biol. 12, 22–30. https://doi.org/10.1071/PC060022.

Head, L., Muir, P., 2006. Edges of connection: reconceptualising the human role in urban biogeography. Aust. Geogr. 37, 87–101. https://doi.org/10.1080/00049180500511996.

Head, L.M., Muir, P., 2005. Living with trees – perspectives from the suburbs. In: Calver, M., Bigler-Cole, H., Bolton, G., Dargavel, J., Gaynor, A., Mills, J.H., Wardell-Johnson, G. (Eds.), Proceedings of the 6th National Conference of the Australian Forest History Society Inc. Millpress. Rotterdam, pp. 85–94.

Helletsgruber, C., Gillner, S., Gulyás, Á., Junker, R.R., Tanács, E., Hof, A., 2020. Identifying tree traits for cooling urban heat island: a cross-city empirical analysis. Forests 11, 1–14. https://doi.org/10.3390/f11101064.

Hill, N.J., Carbery, K.A., Deane, E.M., 2007. Human–possum conflict in urban Sydney, Australia: public perceptions and implications for species management. Hum. Dimens. Wildl. 12, 101–113. https://doi.org/10.1080/10871200701195928.

Holmgren, D., 2006. Permaculture: Principles & Pathways Beyond Sustainability. Holmgren Design Services, Hepburn, Victoria.

Janse, G., Konijnendijk, C.C., 2007. Communication between science, policy and citizens in public participation in urban forestry – experiences from the Neighbourwoods project. Urban For. Urban Green. 6, 23–40. https://doi.org/10.1016/j.ufug.2006.09.005.

Javadi, R., Nasrollahi, N., 2021. Urban green space and health: the role of thermal comfort on the health benefits from the urban green space; a review study. Build. Environ. 202, 108039 https://doi.org/10.1016/j.buildenv.2021.108039.

Johns, R., 2005. One size doesn't fit all: selecting response scales for attitude items. J. Élect. Public Opin. Parties 15, 237–264. https://doi.org/10.1080/13689880500178849.

Kirkpatrick, J.B., Davison, A., Daniels, G.D., 2012. Resident attitudes towards trees influence the planting and removal of different types of trees in eastern Australian cities. Landsc. Urban Plan. 107, 147–158. https://doi.org/10.1016/j.landurbplan.2012.05.015.

Kronenberg, J., Łaszkiewicz, E., Sziło, J., 2021. Voting with one's chainsaw: what happens when people are given the opportunity to freely remove urban trees? Landsc. Urban Plan. 209, 104041 https://doi.org/10.1016/j.landurbplan.2021.104041.

Lawrence, H.W., 2006. City Trees: A Historical Geography from the Renaissance Through the Nineteenth Century. University of Virginia Press, Charlottesville, Virginia, USA.

Li, Z., Chen, D., Cai, S., Che, S., 2018. The ecological services of plant communities in parks for climate control and recreation: a case study in Shanghai, China. PLoS One 13, e0196445. https://doi.org/10.1371/journal.pone.0196445.

Lonsdale, D., 1999. Principles of Tree Hazard Assessment. HMSO, London, UK, p. 388.

Massengale, J., Dover, V., 2014. Street Design: The Secret to Great Cities and Towns. John Wiley & Sons, Hoboken, New Jersey, USA.

Murray, B.R., Martin, L.J., Brown, C., Krix, D.W., Phillips, M.L., 2018. Selecting low-flammability plants as green firebreaks within sustainable urban garden design. Fire 1, 15. https://doi.org/10.3390/fire1010015.

Nguyen, V.D., Roman, L.A., Locke, D.H., Mincey, S.K., Sanders, J.R., Smith Fichman, E., Duran-Mitchell, M., Lumban Tobing, S., 2017. Branching out to residential lands: Missions and strategies of five tree distribution programs in the US. Urban For. Urban Green. 22, 24–35. https://doi.org/10.1016/j.ufug.2017.01.007.

Nowak, D.J., Greenfield, E.J., 2018a. Declining urban and community tree cover in the United States. Urban For. Urban Green. 32, 32–55. https://doi.org/10.1016/j.ufug.2018.03.006.

Nowak, D.J., Greenfield, E.J., 2018b. US urban forest statistics, values, and projections. J. For. 116, 164–177. https://doi.org/10.1093/jofore/fvx004.

Nowak, D.J., Kuroda, M., Crane, D.E., 2004. Tree mortality rates and tree population projections in Baltimore, Maryland, USA. Urban For. Urban Green. 2, 139–147. https://doi.org/10.1078/1618-8667-00030.

Olivero-Lora, S., Meléndez-Ackerman, E., Santiago, L., Santiago-Bartolomei, R., García-Montiel, D., 2020. Attitudes toward residential trees and awareness of tree services and disservices in a tropical city. Sustainability 12, 117. https://doi.org/10.3390/su12010117.

Ossola, A., Locke, D., Lin, B., Minor, E., 2019. Yards increase forest connectivity in urban landscapes. Landsc. Ecol. 34, 2935–2948. https://doi.org/10.1007/s10980-019-00923-7.

Parsons, H.M., Major, R.E., 2004. Bird interactions in Sydney gardens: some initial findings of the Birds in Backyards program (Lunney and Burgin eds). Urban Wildlife: More than Meets the Eye. RZS NSW, pp. 211–215 (Lunney and Burgin eds).

Pataki, D.E., Carreiro, M.M., Cherrier, J., Grulke, N.E., Jennings, V., Pincetl, S., Pouyat, R.V., Whitlow, T.H., Zipperer, W.C., 2011. Coupling biogeochemical cycles in urban environments: Ecosystem services, green solutions, and misconceptions. Front. Ecol. Environ. 9, 27–36. https://doi.org/10.1890/090220.

Pataki, D.E., Alberti, M., Cadenasso, M.L., Felson, A.J., McDonnell, M.J., Pincetl, S., Pouyat, R.V., Setälä, H., Whitlow, T.H., 2021. The benefits and limits of urban tree planting for environmental and human health. Front. Ecol. Evol. 9, 603757 https://doi.org/10.3389/fevo.2021.603757.

Pincetl, S., Gillespie, T., Pataki, D.E., Saatchi, S., Saphores, J.-D., 2013. Urban tree planting programs, function or fashion? Los Angeles and urban tree planting campaigns. GeoJournal 78, 475–493. https://doi.org/10.1007/s10708-012-9446-x.

Qiu, G.-y, Li, H.-y, Zhang, Q.-t, Chen, W., Liang, X.-j, Li, X.-z, 2013. Effects of evapotranspiration on mitigation of urban temperature by vegetation and urban agriculture. J. Integr. Agric. 12, 1307–1315. https://doi.org/10.1016/S2095-3119(13)60543-2.

R Core Team, 2021. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. 〈https://www.R-project.org/〉.

Australian Bureau of Meteorology, 2020. Maps of average conditions. Commonwealth of Australia. Accessed October 18, 2021. 〈http://www.bom.gov.au/climate/averages/maps.shtml〉.

Riedman, E., Roman, L.A., Pearsall, H., Maslin, M., Ifill, T., Dentice, D., 2022. Why don't people plant trees? Uncovering barriers to participation in urban tree planting initiatives. Urban For. Urban Green. 73, 127597 https://doi.org/10.1016/j.ufug.2022.127597.

Saldarriaga, N., Shrestha, K.K., McManus, P., Bajracharya, A., 2020. Greening sydney: attitudes, barriers and opportunities for tree planting. Aust. Geogr. 51, 469–488. https://doi.org/10.1080/00049182.2020.1813948.

Salgo, M., Gillespie, J., 2018. Cracking the Code: a legal geography and political ecological perspective on vegetation clearing regulations. Aust. Geogr. 49, 483–496. https://doi.org/10.1080/00049182.2018.1440688.

Salmond, J.A., Tadaki, M., Vardoulakis, S., Arbuthnott, K., Coutts, A., Demuzere, M., Dirks, K.N., Heaviside, C., Lim, S., Macintyre, H., McInnes, R.N., Benedict, W., Wheeler, B.W., 2016. Health and climate related ecosystem services provided by street trees in the urban environment. Environ. Health 15 (Supplement 1), S36. https://doi.org/10.1186/s12940-016-0103-6.

Sanders, J., Grabosky, J., Cowie, P., 2013. Establishing maximum size expectations for urban trees with regard to designed space. Arboric. Urban For. 39, 68–73. https://doi.org/10.48044/jauf.2013.010.

Silvera Seamans, G., 2013. Mainstreaming the environmental benefits of street trees. Urban For. Urban Green. 12, 2–11. https://doi.org/10.1016/j.ufug.2012.08.004.

Sydnor, T.D., Gamstetter, D., Nichols, J., Bishop, B., Favorite, J., Blazer, C., Turpin, L., 2000. Trees are not the root of sidewalk problems. J. Arboric. 26, 20–29. 〈https://urbanforestrysouth.org/resources/library/citations/trees-are-not-the-root-of-sidewalk-problems-1〉.

Tait, J., Perotto-Baldivieso, H.L., McKeown, A., Westcott, D.A., 2014. Are flying-foxes coming to town? Urbanisation of the spectacled flying-fox (*Pteropus conspicillatus*) in Australia. PLoS One 9, e109810. https://doi.org/10.1371/journal.pone.0109810.

Timbs v Shoalhaven City Council, 2004. NSWCA 81.

Timmiss, L.A., Marti, J.M., Murray, N.J., Welbergen, J.A., Westcott, D., McKeown, A., Kingsford, R.T., 2021. Threatened but not conserved: flying-fox roosting and foraging habitat in Australia. Aust. J. Zool. 68, 226–233. https://doi.org/10.1071/ZO20086.

Turner-Skoff, J.B., Cavender, N., 2019. The benefits of trees for livable and sustainable communities. Plants People Planet 1, 323–335. https://doi.org/10.1002/ppp3.39.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kaźmierczak, A., Niemela, J., James, P., 2007. Promoting ecosystem and human health in urban areas using green infrastructure: a literature review. Landsc. Urban Plan. 81, 167–178. https://doi.org/10.1016/j.landurbplan.2007.02.001.

van Haaften, M., Liu, Y., Wang, Y., Zhang, Y., Gardebroek, C., Heijman, W., Meuwissen, M., 2021. Understanding tree failure: a systematic review and meta-analysis. PLOS ONE 16, e0246805. https://doi.org/10.1371/journal.pone.0246805.

van Herzele, A., 2004. Local knowledge in action: Valuing nonprofessional reasoning in the planning process. J. Plan. Educ. Res. 24, 197–212. https://doi.org/10.1177/0739456X04267723.

Vergnes, A., Viol, I.L., Clergeau, P., 2012. Green corridors in urban landscapes affect the arthropod communities of domestic gardens. Biol. Conserv. 145, 171–178. https://doi.org/10.1016/j.biocon.2011.11.002.

de Vries, S., Verheij, R.A., Groenewegen, P.P., Spreeuwenberg, P., 2003. Natural environments – healthy environments? An exploratory analysis of the relationship between greenspace and health. Environ. Plan. 35, 1717–1731. https://doi.org/10.1068/a35111.

Wagar, J., Barker, P.A., 1983. Tree root damage to sidewalks and curbs. J. Arboric. 9, 177–181.

Wang, J., Zhou, W., Jiao, M., Zheng, Z., Ren, T., Zhang, Q., 2020. Significant effects of ecological context on urban trees' cooling efficiency. ISPRS J. Photogramm. Remote Sens. 159, 78–89. https://doi.org/10.1016/j.isprsjprs.2019.11.001.

Watson, G.W., Hewitt, A.M., Custic, M., Lo, M., 2014. The management of tree root systems in urban and suburban settings II: a review of strategies to mitigate human impacts. Arboric. Urban For. 40, 249–271. https://doi.org/10.48044/jauf.2014.025.

Willis, K.J., Petrokofsky, G., 2017. The natural capital of city trees. Science 356, 374–376. https://doi.org/10.1126/science.aam9724.

Wolf, K.L., 2005. Business district streetscapes, trees, and consumer response. J. For. 103, 396–400. 〈https://www.fs.usda.gov/treesearch/pubs/34952〉.

Ziter, C.D., Pedersen, E.J., Kucharik, C.J., Turner, M.G., 2019. Scale-dependent interactions between tree canopy cover and impervious surfaces reduce daytime urban heat during summer. Proc. Natl. Acad. Sci. 116, 7575–7580. https://doi.org/10.1073/pnas.1817561116.