ACT
Government

URBAN FOREST
STRATEGY

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MINISTER FOR CITY SERVICES, CHRIS STEEL

MINISTER'S FOREWORD

Canberra's urban forest is a key part of what makes our city the most liveable in Australia. The urban forest, made up of all trees, vegetation and systems that support them, is part of our identity as the bush capital: a city within a landscape.

The urban forest we enjoy today was established through four main planting events over the past nine decades. Alongside this strategy the ACT Government has commenced the fifth major planting, replacing trees that have come to the end of their natural life in established suburbs and extensive planting in newer suburbs to ensure they have the same benefits as the established areas of our city.

Canberrans enjoy the shade and amenity of an established urban forest that supports critical ecosystems, builds resilience against a changing climate and pollution, and adds to our wellbeing; its canopy covers around 21% of our urban area in 2020. Canopy cover varies from suburb to suburb with some older established suburbs enjoying close to 40% canopy cover while some newer suburbs have below 10%. The ACT Government has set an ambitious target in the Climate Change Strategy[1] and Canberra's Living Infrastructure Plan[2] to increase the total canopy cover to 30% by 2045. We do this in the context of the legacy of our first major plantings meaning that much of the urban forest will reach the end of its natural life in the coming decades.

We know that to achieve our target of 30% canopy cover, we will need to plant over 450, 000 trees over the next 25 years. This is based on recent modelling undertaken by the CSIRO in 2019[3] using estimates on the useful life expectancy of public trees generated by previous tree condition audits to estimate annual tree losses. i-Tree software was used to model the number of tree plantings needed to reach 30% tree canopy cover by 2045.

As well as investing in more trees on public land to increase our urban forest canopy cover, we need our legal framework to help us to grow and manage a living urban forest. The complexity of our legislative framework means that three trees within five metres of each other may be subject to different laws and different requirements. At times the same tree can be protected under one law and removed under another. We need to reform our system to a more integrated living infrastructure planning approach.

There is a unique set of challenges facing our urban forest. Changing climate, a lack of species diversity and an ageing forest are all significant challenges that we need to address over the coming decades. So, we are planting a broader variety of tree species that are likely to be better adapted to climate change and are starting the work now to ensure we conserve our biodiversity and eco-cultural values while reversing the decline caused by forest ageing.

OUR VISION

For all Canberrans to enjoy the benefits of streets lined with healthy trees. An urban forest that is resilient and sustainable and contributes to the wellbeing of the community in a changing climate.
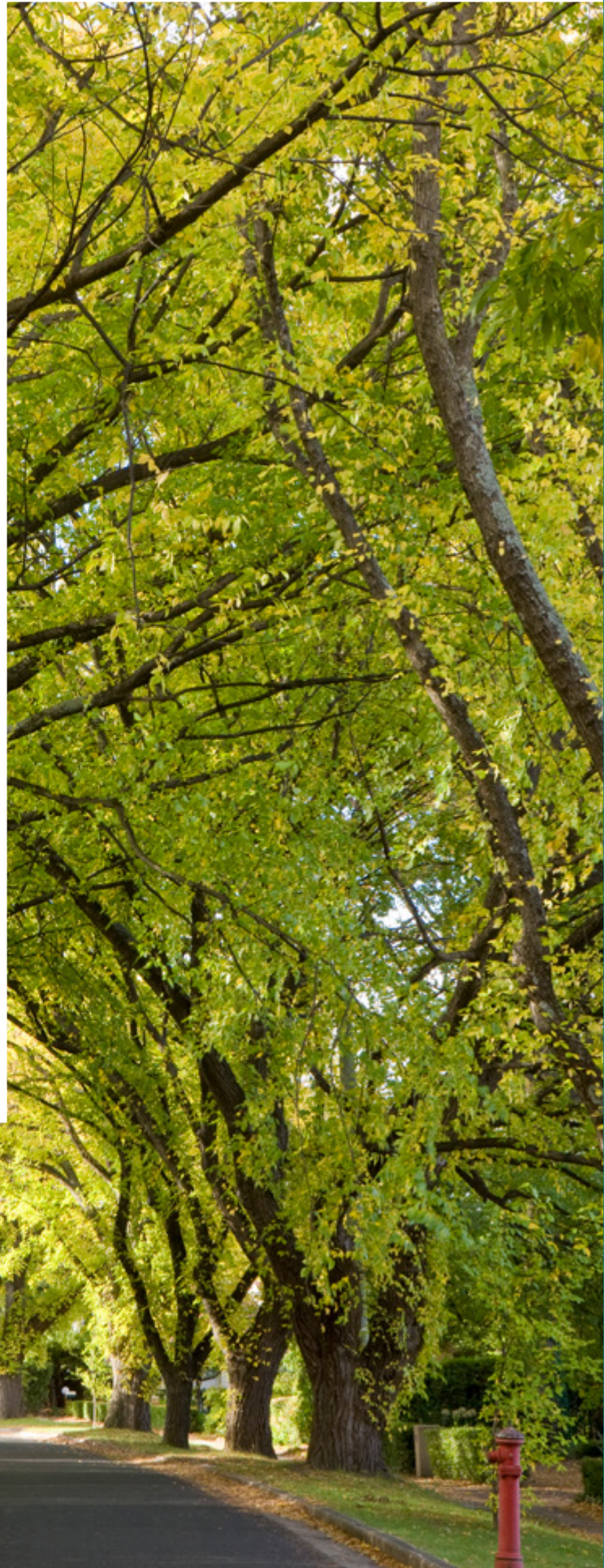
CANBERRA'S URBAN FOREST STRATEGY

Planting 25,000 trees by 2023.

Achieve 30% canopy cover by 2045.

Exceptional trees and those with high biodiversity or eco-cultural value have the highest levels of protection.

Trees on public and leased land are protected and the community is encouraged to care for and retain these trees.

Mature and remnant native trees are conserved.

The urban forest contributes to a resilient city in the face of our changing climate.

Canberrans enjoy equitable distribution of canopy coverage.

A diverse urban forest that supports biodiversity, habitat and resources for wildlife.

City infrastructure supports a healthy tree canopy and community wellbeing.

Volunteers help care for the urban forest and identify emerging issues early.

EXECUTIVE SUMMARY

The Urban Forest Strategy 2020–45 sets out the ACT Government's vision for a resilient and sustainable urban forest that supports a liveable city and the natural environment and contributes to the wellbeing of the community in a changing climate.

This Strategy has been developed alongside the Planning Strategy[4], Climate Change Strategy, Canberra's Living Infrastructure Plan and Transport Strategy. This recognises the importance of the urban forest as part of a wider system that contributes to a liveable city and the wellbeing of the community.

The urban forest has always been a key part of Canberra's identity. Established over nine decades, Canberra is known for its tree lined streets and park trees that provide a connection to nature no matter where in the city you are.

The urban forest we enjoy today unfortunately only covers around 21% of our urban area, lacks species diversity and is ageing significantly. We are also facing a new set of challenges as our climate changes and urban heat island effects increase.

A **RESILIENT** AND **SUSTAINABLE** **URBAN FOREST** THAT SUPPORTS A **LIVEABLE CITY**

This Strategy sets out six objectives and the actions needed to overcome these challenges and achieve the vision.

Objective 1:
Protect the urban forest
recognises that in order to begin to meet the vision of this Strategy we must first protect the urban forest that exists today. This means ensuring that we have a legislative framework that genuinely protects trees and ensures that when they are lost, they are replaced. Under this objective we will see exceptional trees and those with high biodiversity and eco-cultural values continue to have the highest level of protection, trees being protected and mature and remnant native trees on public land being conserved effectively.

Objective 2:
Grow a resilient forest recognises the need to grow our tree canopy cover towards 30% while also ensuring our urban forest is resilient. To grow the urban forest, we must invest in sustainable end-of-life removal and replacement programs as well as investing in new plantings across our urban areas. The urban forest will become more resilient through diversification of the urban forest (Objective 3).

Objective 3:
Balance and diversify the urban forest recognises the many benefits that an urban forest provides to the community and aims to ensure as equitable distribution of tree canopy as possible across our suburbs, as well as species diversity. Under this objective we will see all suburbs having as equitable a distribution of canopy cover as possible, no one species making up more than 10% of our urban forest and a balanced age profile of trees that reflects best practice.
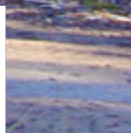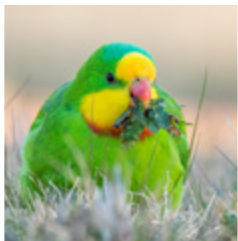
Objective 4:
Take an ecological approach and support biodiversity recognises that the urban forest supports biodiversity across urban areas. Under this objective we will see local ecosystems conserved and managed effectively, with a multi-storied urban forest, and wood by-product from the urban forest being used for ecological and community benefit.

Objective 5:
Develop infrastructure to support the urban forest and liveability recognises that the urban forest cannot be managed in isolation of other living and hard infrastructure. Under this objective we will see an increase in permeable surfaces to support tree growth, soil hydrological processes, maintenance of water quality values across the urban area, and city infrastructure that supports a healthy canopy.

Objective 6:
Partner with the community recognises the important role that community and volunteer groups have in supporting our urban forest. Under this objective we will see volunteer programs that care for the urban forest identify emerging issues early, people incentivised to keep trees on private land, the broader community informed about how to value, care for and avoid damage to the urban forest and interactions with relevant legislation streamlined, transparent and timely.

Together, these objectives and the actions that support them will achieve the vision for a resilient and sustainable urban forest that supports a liveable city and the natural environment and contributes to the wellbeing of the community in a changing climate.

BACKGROUND AND CONTEXT

What is the urban forest?

The urban forest is all the trees and other vegetation, and the soil and water that support them, within the urban landscape. It includes vegetation in streets, parks, front and back gardens, plazas, campuses, river and creek embankments, wetlands, railway corridors, community gardens, green walls, balconies and roofs. While the other vegetation that makes up the urban forest is of critical importance, this Strategy primarily focuses on the trees in the urban forest. A healthy urban forest provides air and water filtration, shade, support to the broader ecosystem, habitat, oxygen, carbon sequestration and nutrient cycling.

The management of urban forests in Australia is often considered a government responsibility. However, responsibility for our urban forest extends to schools, our community, developers, business, industry and the federal government, all of whom have important roles to play. Every part of the city contributes in some way to the urban forest including public and private land.

NEW YORK'S URBAN FOREST REMOVES **1,821 METRIC TONNES** OF **AIR POLLUTION** ANNUALLY[5]

Benefits of the urban forest

Canberra's urban forest is a key part of what makes our city a great place to live, work and play. Past significant investment and a high prioritisation has provided us with the benefits of a healthy urban forest today. These benefits expand far beyond aesthetic and recreational values though – the urban forest impacts almost every part of how we live, move about and enjoy our city.

ENVIRONMENTAL BENEFITS

The urban forest is the 'engine room' for our urban ecosystem and is one of the best means to create resilience against a changing climate. Environmental benefits of the urban forest include:

» Providing shade and cooling our cities – trees and vegetation cool the city and mitigate the urban heat island effect. Canberra's Living Infrastructure Plan recognises this and provides a framework for managing our living infrastructure.

» Reducing stormwater flows and nutrient loads – the tree canopy intercepts and mitigates the impact of heavy rainfall while tree roots reduce nitrogen, phosphorus and heavy metal content in stormwater runoff.

» Reducing air pollution, air-borne particulates and greenhouse gas emissions – through the process of photosynthesis trees remove carbon dioxide, nitrous oxides, sulphur dioxide, carbon monoxide and ground-level ozone from the atmosphere.

» Providing and connecting habitat and enhancing levels of biodiversity – a healthy urban forest contributes to biodiversity conservation and provides essential habitats and movement corridors for wildlife.

» Storing and sequestering of carbon – during photosynthesis, trees convert carbon dioxide and water into sugar and oxygen and store carbon within their biomass.

» A New York study found that its urban forest removed 1,821 metric tonnes of air pollution at an estimated value to society of $9.5 million annually.

SOCIAL BENEFITS

A healthy urban forest provides benefits for both individuals and society, including:

» Creation of local identity – a city's landscape helps define its character. Trees and vegetation can physically define a place, as is the case in Canberra.

» Improving community cohesion – green spaces provide places for events, festivals and celebrations throughout the urban area.

» Encouraging outdoor activity – well-vegetated parks, gardens and streets encourage the use of open spaces, with health benefits like reduced obesity and improved physical and mental wellbeing.

» Reducing sun exposure – Canberra enjoys a high number of sunny days every year, but direct sun exposure can lead to skin cancer. Shade alone can reduce overall exposure to UV radiation by up to 75%[6].

» Reducing heat related illnesses – the shade provided by trees on hot summer days helps to reduce land surface temperatures significantly.

» Improving mental wellbeing – access to, and views of, green spaces, trees and the wildlife they support have positive effects on people's wellbeing.

» Improved human health – tree canopy and urban vegetation can lead to a reduction of a variety of health issues like respiratory disease, skin cancer, depression and heat-related mortality.

» Public wellbeing and safety – well-greened areas can help to reduce crime.

» Child health and well-being – access to nature and green space can have a significant impact on children's life-long development[7]

The ACT Wellbeing Framework will provide high-level indicator outcomes for Canberra through twelve domains of wellbeing, reflecting key factors that impact on the quality of life of Canberrans. Within the Environment and Climate domain, indicators will include Healthy and resilient natural environment, Connection to nature, and Climate resilient environment and community.

ECONOMIC BENEFITS

A healthy urban forest contributes to a healthy economy and can result in cost savings. Some economic benefits of the urban forest include:

» Reducing energy costs – buildings that are shaded in summer have a reduced need for air conditioning, which in turn reduces energy costs.

» Increasing property values – trees in streets enhance neighbourhood aesthetics and increase property values.

» Avoiding costs of infrastructure damage and renewal – urban forests that provide significant canopy coverage improve the lifespan of certain assets like asphalt by shading them from harmful UV rays – potentially by 30%[8].

» Decreasing health costs – research suggests that a healthy green city helps alleviate the burden on national health systems. While it is difficult to create a direct link and quantify dollar savings, it is likely that urban forests may reduce health costs associated with sedentary behaviour, obesity and mental illness.

» Increased retail activity – shoppers spend longer in retail areas that are well-treed and landscaped.

» Every dollar spent on tree planting and maintenance in cities returns between one and three dollars in benefits[9].

CHILDHOOD ASTHMA
RATES REDUCED
BY **25%** FOR EVERY
EXTRA **340 TREES**
PER SQUARE KILOMETRE[8]

Legislative Frameworks

Canberra's urban forest is impacted by a number of legislative frameworks including the Tree Protection Act 2003 (TPA), Public Unleased Land Act 2013 (PULA), Heritage Act 2004 and the Planning and Development Act 2007 (the planning system). These are also complemented by the Nature Conservation Act 2014, which serves to protect, conserve and enhance the biodiversity of the ACT.

The TPA provides a framework for managing trees, primarily on leased land. The TPA protects trees in the urban forest under two categories: registered trees and regulated trees.

REGISTERED TREES

Registered trees have the highest level of protection and cannot be removed or damaged. Registered trees are protected because of their exceptional natural or cultural heritage, landscape and aesthetic or scientific value. Trees on both public and leased land can be registered.

Registered trees can only be removed if the registration is cancelled and this can only be done in limited circumstances.

REGULATED TREES

Regulated trees include any trees (excluding pest trees) that meet a set of criteria. The criteria for regulation currently is a tree that is 12m or taller, with a canopy 12m or wider, trunk circumference of 1.5m (measured 1m from natural ground level) or if there are multiple trunks the total circumference is 1.5m (also measured 1m from natural ground level).

Regulated trees can be removed if they meet a set of criteria as set out in a disallowable instrument.

In 2018-19 the unit responsible for administering the TPA received 2320 tree removal requests (some applications included a request to remove multiple trees). 1731 (representing 74.6%) were approved for removal because they met the required criteria.

The criteria for regulated trees in the ACT are not consistent with other Australian jurisdictions. The difference primarily relates to the minimum height and canopy span required for protection, which in the ACT is 12m.

A cross-jurisdictional analysis of tree protection measures revealed that a height and canopy span of 12m is one of the highest thresholds for protection in Australia. The lowest threshold is 3m with the average being a little over 5m.

The Heritage Act 2004 provides some protection for urban trees, where a tree forms part of a place that has been entered in the ACT Heritage Register by the ACT Heritage Council. Individual trees are, however, registered under the Tree Protection Act 2004.

The PULA provides limited protections for trees on public land. Under the PULA, trees are considered assets and, if they are damaged, the ACT Government can give directions for repair. This is a fairly 'light touch' way of regulating public trees and does not provide for their proactive protection.

In Canberra trees can also be removed via the planning system. A development application can include a request for a tree removal that may be approved if the planning authority is satisfied that all other design options considered are not suitable. Removals can be allowed by the planning authority even if the tree would not meet the criteria for removal under the TPA (except for registered trees).

Importantly, of the current legislative frameworks that apply to trees in Canberra, only the Heritage Act 2004 requires replacement trees to be planted when they are removed, and this applies only to defined areas. The lack of an appropriate framework for replacing removed trees is contributing to overall tree canopy loss and is inconsistent with ACT Government targets to increase tree canopy cover to 30%. The ACT could consider introducing a canopy contribution framework to ensure that when trees are removed, they are replaced. This framework could work in a similar way to environmental offsets and provide flexible options for replacing trees either on the block or on public land via a financial contribution.

CASE STUDY: CITY OF MELBOURNE

The city of Melbourne has developed a process to compensate for trees that are removed from public land due to development. Where a public tree removal is approved by Melbourne Council in relation to a development, the associated cost of the tree and its removal is paid by the property owner or representative prior to the removal of the tree.

Melbourne Council uses a calculation that considers the removal costs incurred by the Council for removing the tree, the reinstatement cost to replace the tree and the amenity and ecological value the tree has in the landscape. Melbourne has developed a formula for calculating the amenity value and ecological service value. The way the value is calculated is below:

A – REMOVAL COSTS
Amounting to the fees incurred by Council for physically removing the tree.

B – AMENITY VALUE
Calculated in accordance with Council's Amenity Formula.

C – ECOLOGICAL SERVICES VALUE Calculated in accordance with the i-Tree valuation tool.

D – REINSTATEMENT COST
Calculated in accordance with the greening required to replace the loss to the landscape incurred by the removal.

The basic monetary value of a tree is determined by matching the trunk diameter at breast height (DBH) with its corresponding base value.
The additional components of the formula are determined by the corresponding total score of the assessment criteria.

Value (V) = Basic Value ($) x Species (S) x Aesthetics (A) x Locality (L) x Condition (C)

An important part of Melbourne's compensation process is that it recognises trees have a greater value than their cost of removal and replacement. The calculation specifically considers both the amenity the tree provides, as well as the ecological value the tree has in its landscape. This is a more holistic approach that should be considered for the ACT's urban forest[10].

Policy Context

The urban forest is part of a broader system that contributes to creating a liveable city that is resilient to our changing climate. This Strategy sets a vision for our urban forest and specific objectives and actions to achieve the vision. However, this Strategy does not operate in isolation of other ACT Government strategies and priorities – it must complement, be consistent with and support the Government's vision for planning, transport, biodiversity conservation and climate change.

The urban forest of the future will:

» support people to live in green areas with high levels of canopy cover as set out in the ACT's Planning Strategy

» support our strategic transport links and active travel routes as set out in the ACT's Transport Strategy

» ensure that the urban forest provides for habitat and resources for wildlife (flora and fauna) including threatened species and ecosystems, mature native trees, and culturally significant trees; and

» be a key tool in keeping the city resilient against climate change as set out in the ACT's Climate Change Strategy and Canberra's Living Infrastructure Plan.

PLANNING

In 2018, the ACT Government released the Planning Strategy. This document sets a vision for Canberra to be a sustainable, competitive and equitable city that respects Canberra as a city in the landscape and the national capital, while being responsive to the future and resilient to change. Importantly, the Planning Strategy continues the original vision of Walter and Marion Mahoney Griffin of Canberra being a city within the landscape that celebrates its bushland setting.

The Planning Strategy sets five key themes to respond to the challenges facing Canberra today: for Canberra to be compact and efficient, diverse, sustainable and resilient, liveable and accessible. Three themes, in particular, are of relevance to this Strategy:

» **Compact and efficient**
A significant proportion (70%) of new housing will be built within our existing footprint in dense places like town and group centres and along major transport routes, limiting urban spread.

» **Sustainable and resilient**
The City will become more sustainable and resilient to climate change through protecting and expanding our living infrastructure, managing waterways, reducing emissions, increasing connectivity and habitat values for wildlife, reducing our ecological footprint and conserving our parks and reserves.

Of particular relevance, is a goal to integrate living infrastructure and sustainable design to make Canberra a resilient city within the landscape.

» **Liveable**
Creating a liveable city by developing social infrastructure, open spaces, public spaces, strong activity hubs and housing choice.

CLIMATE CHANGE

In 2019, the ACT Government released the Climate Change Strategy which outlines current and future challenges that the ACT will face from a changing climate. These changes continue to impact the health and viability of Canberra's urban forest.

The Climate Change Strategy sets several goals and actions to 2025 to position the ACT has a leader in net zero emissions. This Strategy supports several goals and actions of the Climate Change Strategy including:

» **Goal 4I – reduce urban heat and improve liveability.**
Action 4.23 – implement Canberra's Living Infrastructure Plan to achieve 30% urban canopy cover, increase surface permeability, account for the value of living infrastructure and assess local needs for managing heat.

» **Goal 7B – sequester carbon in the landscape.**
Action 7.3 – identify suitable sites in the ACT for 'carbon sinks' and develop a plan for planting trees or using soil carbon in these areas to sequester carbon with consideration of biodiversity outcomes and competing land uses.

» **Goal 7A – protect local species and habitats.**
Action 7.1 – identify opportunities to increase resilience of terrestrial and aquatic habitats at risk from climate change and implement land management changes and relevant on-ground works with delivery partners.

LIVING INFRASTRUCTURE

Released alongside the Climate Change Strategy, Canberra's Living Infrastructure Plan recognises the critical role of living infrastructure in urban resilience and liveability in a time of climate change, urban densification and urban heat island effect. Key commitments in the plan are to grow Canberra's tree canopy cover from 21% to 30% by 2045 (Action 2) and develop an urban forest strategy (Action 9).

This Strategy provides a pathway to deliver on Action 9: Develop an Urban Forest Strategy of Canberra's Living Infrastructure Plan over the next 25 years.
In implementing this Strategy, a number of other actions from Canberra's Living Infrastructure Plan will also be supported and actioned including:

» Action 1 – Expand the existing asset management system.

» Action 2 – Living infrastructure targets (30% canopy cover and 30% permeable surfaces).

» Action 8 – Tree Protection Act Review.

» Action 5 – Climate-wise landscape guide.

» Action 10 – City cooling program.

» Action 11 – 'Oasis' program.

» Action 12 – Shadeways program.

TRANSPORT

The Transport Strategy 2020 will help ensure Canberra remains one of the world's most liveable cities well into the future. It addresses triple objectives of managing future congestion, reducing carbon emissions and supporting urban intensification. The Transport Strategy identifies local, central and orbital transport links.
The local transport links are primarily in town and group centres and align with the Planning Strategy's areas for urban intensification. It is in these key areas where people will live and use active travel routes that the urban forest should provide amenity and support transport choices.
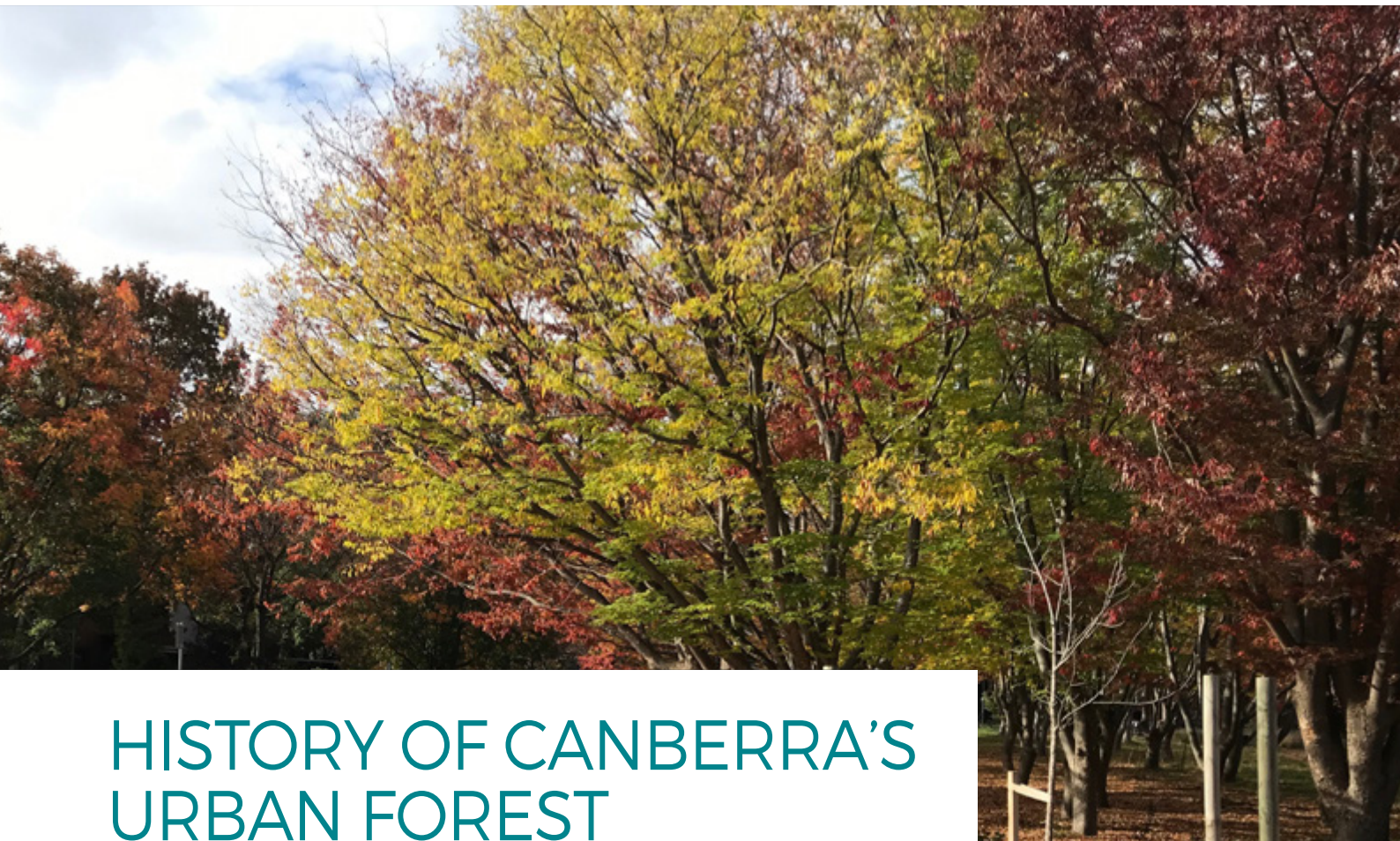
HISTORY OF CANBERRA'S URBAN FOREST

The Canberra region has a rich history of caring for the urban forest. The ACT Government acknowledges the Ngunnawal people as traditional custodians of the Canberra region, and their ongoing deep and spiritual connection with the land here including the trees that were on the land prior to European settlement. Aboriginal heritage places and objects attest to the relationship between Ngunnawal people and the ACT landscape for at least 25,000 years.

British explorers called Canberra The Limestone Plains, after the geology in the area and the sparsely treed grassland plains. Early settlers started to appear in this region in the early 1800s, and by 1900 there were farming properties and small towns dotted around the region.

The government interest in the Canberra landscape was apparent even before the naming of the capital in 1913. T.C.F. (Charles) Weston (1866-1935), a Sydney horticulturalist, visited the federal capital site in April 1911 to advise on the establishment of a government nursery to raise plants in preparation for afforestation.

Today Canberra is an exceptionally well-planned city as the idea of the city existing within a landscape has always been a key part of its character, dating back to Walter and Marion Mahoney Griffin's vision vision for the city. Over 100 years of extensive planting and regeneration has transformed Canberra from a virtually bare rural landscape to a city rich with green open spaces and tree lined streets. Our urban forest has been established through four main planting events starting in the late 1920s.

Pre-1928

Prior to 1928, Canberra sat in a very different landscape. Widespread land clearing and degradation resulted from agriculture and the development of the city and suburbs and as a result Canberra was windy and dusty. Charles Weston was largely responsible for implementing a significant planting program and broadened plantings beyond just trees on the side of the road, including to create Haig and Telopea Parks. Weston also implemented policies to provide trees and shrubs to Canberra residents at no cost.

1944 to 1958

In 1944, Canberra's second significant planting episode began with a large-scale planting program implemented by Lindsay Pryor. Pryor continued the widespread use of exotic species in the urban landscape with a focus on informal style amenity plantings and the infill of vacant planting sites in public spaces. Pryor also prioritised the introduction of new exotic species and continued the practice of issuing free plants to new Canberra residents.

Woden from Mt Taylor 1963

1969 to 1989

By the mid-1960s the planting palette on public land began to change in response to shifting public tastes. From the late 1960s there was less incentive to trial exotic trees in streets and the focus switched to native species, primarily eucalypts. Many of the streetscapes established during 1969-1989 are characterised by irregular plantings of mixed eucalypt species planted in an informal and naturalistic landscape style. Today native street trees are still prevalent throughout suburbs in Woden, Belconnen, Weston Creek and Tuggeranong.

1989 to today

Following the establishment of self-government in the ACT, the Government inherited an extensive urban forest. Due to the varying species' lifespans and planting dates by region, many of the trees throughout the city were reaching maturity, and requiring maintenance and replacement. The last 30 years have seen a more even balance of natives and exotics planted, as planting efforts have focused on maintaining and enhancing the original character of each unique area of the city.

During this time the list of tree species appropriate for planting on public unleased land[11] has been progressively updated so that weed species and species no longer tolerant to Canberra's changing climate are removed and new species which are suitable for urban plantings are added.

From 1989 onwards there was a loss of trees on private land due to the growth of the city.

Woden from Mt Taylor 1970

Woden from Mt Taylor 2020

THE URBAN FOREST TODAY

The urban forest we enjoy today is the result of a century of care and investment in Canberra as the bush capital and a city within its landscape. However, the urban forest of today is facing a set of new challenges including its age, changing climate conditions and urban densification.

Tree Canopy Cover

One of the most common measures of an urban forest is the amount of coverage the tree canopy provides. Measuring and understanding canopy cover helps us understand how much shade is provided and how much carbon dioxide is absorbed by our urban forest.

In the ACT, tree canopy cover is measured by using LiDAR data. Data from 2015 recorded Canberra's overall tree canopy cover at 21%. This includes all trees above three metres, on both public and leased land. However, tree canopy cover is not equal across all areas, with the cover by suburb ranging from 5% up to 40%. The proportion of tree canopy coverage is shown for each suburb in Figure 1.

LiDAR is a surveying method that involves a plane that takes measurements of the surface of the ground by laser and measures the reflected light with a sensor. Differences in laser return times and wavelengths can then be used to make digital 3D representations of the target surface and can map things like trees.

The term LiDAR is an acronym for light detection and ranging. In practice, the use of LiDAR enables rapid and detailed measurement of the urban forest canopy that enables key data on canopy cover to be analysed and compared over time.
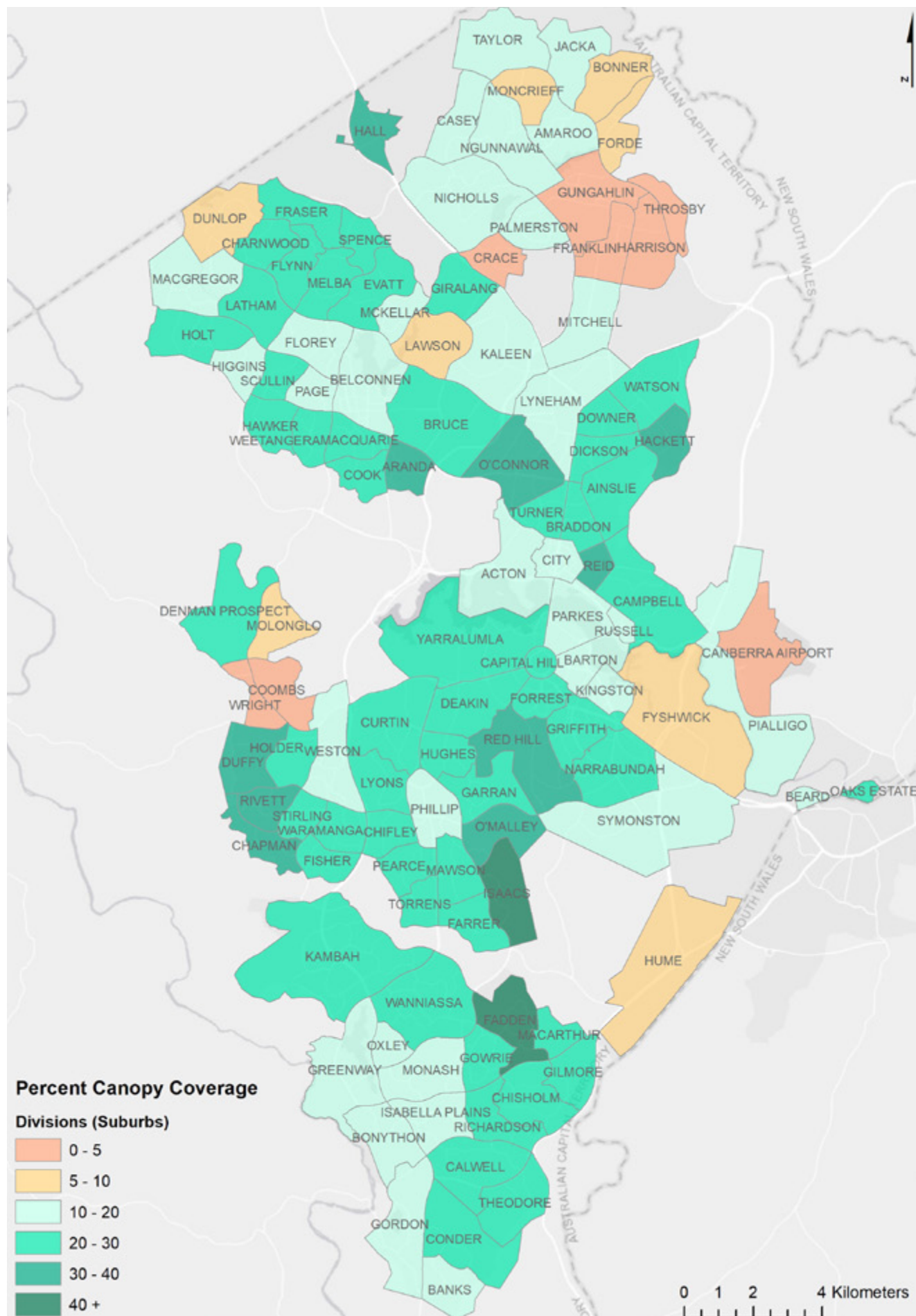
The reasons for differing levels of canopy cover vary by region. Newer suburbs like Wright, Coombs and Throsby have very low levels of canopy cover as they are still being developed and the trees in this area are being established. Older suburbs are more likely to have higher canopy cover as the blocks and road verges are larger and the trees more established.

Alternative location-specific solutions such as green infrastructure and permeable surfaces from grass and ground cover beds can achieve equivalent benefits in higher density areas, as outlined in Canberra's Living Infrastructure Plan. The Draft Variation to the Territory Plan DV369: Living Infrastructure in Residential Zones will also significantly contribute to achieving 30% tree canopy cover by requiring approximately 15% canopy cover on private land in residential zones, as there was previously no requirement to provide a tree on a residential block.

It is also important to consider the presence of grassland reserves, prevalent in the northern suburbs. While these native grasslands affect the canopy cover of the area, they provide critical habitat for several species of threatened plants and animals and are inappropriate for trees.

Figure 1: Percentage Tree Canopy Cover for each Division over urban Canberra. (Source: ACT Government, 2020)

Percent Canopy Coverage

Divisions (Suburbs)

- 0 - 5
- 5 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 +

0 1 2   4 Kilometers

Species Diversity

It is estimated that there are over 370 tree species found within Canberra's urban tree population. Results from a 2010 audit indicate that the majority of our tree population consists of only a relatively small number of species. The 10 most frequently recorded species accounted for almost 60% of assessed trees. The most common trees and the proportion of the total tree population they represent is shown in Table 1.

The most common species recorded in the audit was Red Spotted Gum (*Eucalyptus mannifera*) that made up over 20% of the tree population, resulting in it being an over-dominant species in the urban forest. Generally, experts suggest that no one species should represent more than 5 to 10% of an urban tree population. A high level of diversity among tree species helps build resilience against things like disease, pests and climate change.

The 2010 audit showed a heavy reliance on native species, with eucalyptus accounting for approximately 40% of all trees. Of particular note, in Canberra, is the large number of streets that have multiple species of trees over single species avenues. This contributes differently to the overall landscape character within many residential neighbourhoods.

However, recent trends show that species diversity is decreasing in newer greenfield developments compared to early plantings, reducing the overall diversity and creating pockets of dominant species.

Some tree species, like Nettle tree (*Celtis australis*) and False acacia (*Robinia pseudoacacia*), which were planted in the past are no longer used because of the weed risk they pose.

The ACT Government has worked with the Fenner School of Environment and Society at the Australian National University to research the tree species that are likely to be the most resilient in our future climate conditions. The resulting report makes recommendations about the ideal trees for certain conditions including high pedestrian traffic pavement areas, irrigated areas, local streets and arterial roads. This information is vital to ensure our future plantings are diverse and appropriate for emerging conditions.

A lack of species diversity in our urban forest increases vulnerability to risks such as disease and climate change. A key objective of this Strategy is to balance and diversify the urban forest to create resilience and support habitat for biodiversity.

Table 1: Top 10 most recorded species within streets and reserves of urban Canberra[13]

Species	Common Name	Percentage of audited population (2010)
Eucalyptus mannifera	Red Spotted Gum	25.00%
Casuarina cunninghamiana	River She Oak	4.55%
Eucalyptus polyanthemos	Red Box	4.02%
Eucalyptus melliodora	Yellow Box	3.48%
Quercus palustris	Pin Oak	2.35%
Eucalyptus cinerea	Argyle Apple	2.27%
Eucalyptus sideroxylon	Red Ironbark	2.12%
Eucalyptus nicholi	Narrow–leafed Peppermint	2.12%
Fraxinus oxycarpa	Claret Ash	2.05%
Eucalyptus blakelyi	Blakely's Red Gum	1.89%
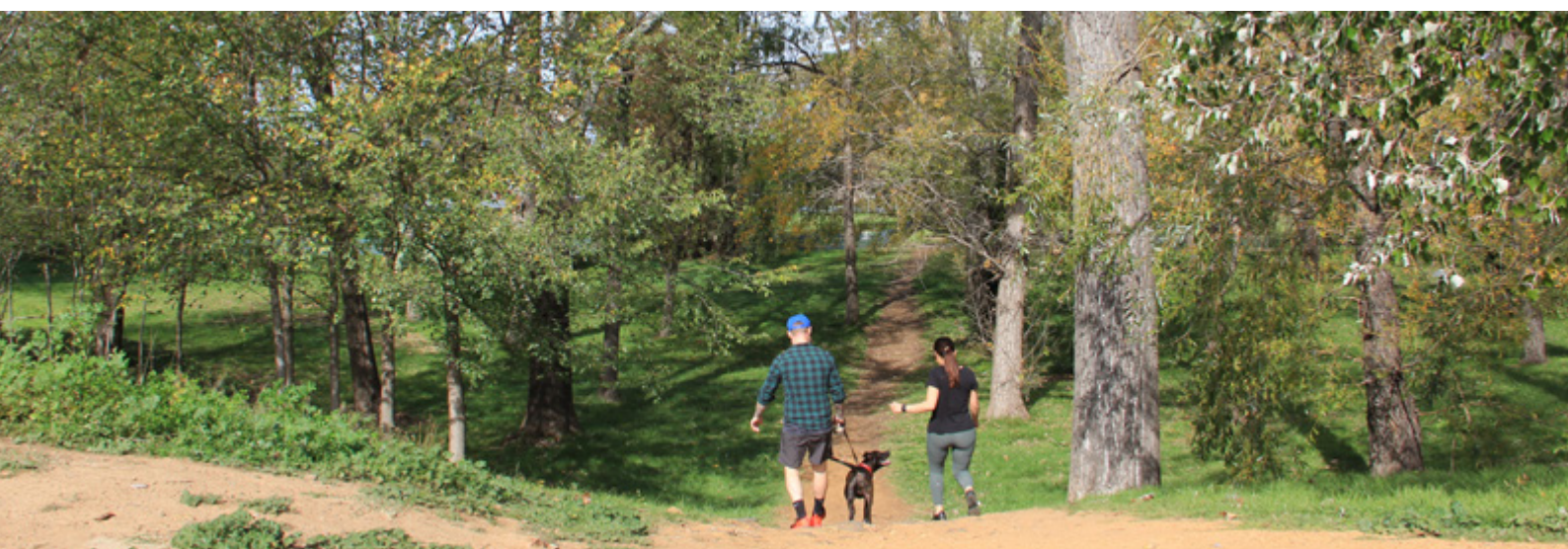
An Ageing Urban Forest

Canberra's urban forest was established through three main planting phases which means a significant number of trees will come to the end of their useful life expectancy (ULE) in the coming decades. The ULE of a tree is the estimated length of time a tree can live in a landscape before needing to be removed. Tree age, health, structure and the surrounding location are all factors that are considered when determining ULE.

The age profile of our public urban forest (**Table 2**) shows that the distribution of trees in Canberra is weighted towards ageing trees. In 2010, over half of our public trees were classed as mature or over-mature. This means that over 55% of trees in streets and parks are likely to reach the end of their life over the next two or three decades. Just as importantly, the number of young trees in Canberra's public urban forest in 2010 is less than one-third of the industry standard for an optimal age profile. The low number of young trees means that we have insufficient young trees in place to maintain existing canopy cover as our ageing trees decline and are removed.

The age cohort data from 2010, while needing to be updated, shows some strong trends and makes it clear that action is needed in the short, medium and long term to address the ageing forest and ensure we take action for the benefit of future generations who should inherit a liveable and sustainable city.

While the age profile of trees on leased land in Canberra is not known, it is fair to assume that the age profile follows a similar pattern to trees on public (unleased) land. This is because trees are often planted on private land around the same time that new suburbs are established.

Table 2: Public urban forest 2010 age class profile for short, medium and long-lived species in Canberra against an industry standard

| Lifecycle Stage	Age class categories of Canberra's public urban trees according to species longevity	Optimum age class %	Canberra's public urban trees age class % (from 2010 audit)
Young	Age Class (0) Long lived species 0-20, Medium 0-15, Short 0-10	40%	12.8%
Early functional	Age Class (1) Long lived 20-40, Medium 15-30, Short 10-20	30%	31.2%
Functionally mature	Age Class (2) Long lived 40-60, Medium 30-45, Short 20-30 Age Class (3) Long lived 60-80, Medium 45-60, Short 30-40	20%	52.8%
Over mature/ senescent	Age Class (4) Long lived 80-100, Medium 60-75, Short 40-50 Age Class (5) Long lived >100, Medium >75, Short >50	10%	3.20%

Community Coordination and Education

The ACT community is passionate about our urban forest. The Better Suburbs Statement 2030, a statement developed in 2017 through a community co-design process ranked street and park trees as their second highest priority to create better suburbs. The ACT has numerous community groups filled with volunteers who dedicate a significant proportion of their time and effort to our urban forest as well as an engaged community with an interest in and appreciation of urban trees.

We know from lessons around the world that these community groups provide an invaluable service. Our Canberran volunteer groups have made a significant contribution to our urban forest on their own initiative. However, with our changing conditions and the need to support the vision of this Strategy it is important to now take a coordinated approach to supporting our volunteers and ensuring they are provided with the resources and tools needed to maximise the impact of their efforts.

When a community is informed about the benefits of the urban forest as well as how trees need to be cared for the urban forest thrives. For example, many Canberrans may not be aware that parking on street verges is prohibited as it damages the root systems of trees and shortens their lifespan.

An essential part of this Strategy is ensuring that the community is educated and informed about the urban forest and that volunteers are empowered to make the most valuable contribution possible.
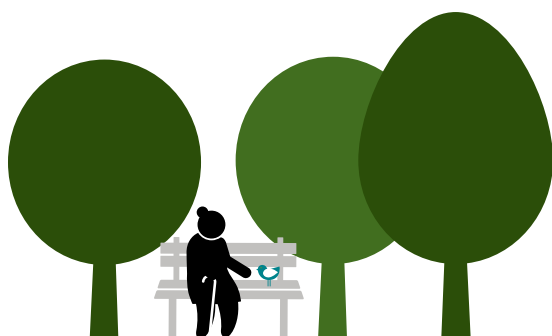
CASE STUDY: COMMUNITY ENGAGEMENT IN PORTLAND, USA

Portland authorities manage Portland's urban forest of 218,000 street trees and 1.2 million park trees through an array of community engagement programs that both invigorates community interest and care of the urban forest and enables work programs to be undertaken by volunteers.

Tree Inventory

Beginning with a pilot neighbourhood street tree inventory in 2010, the Tree Inventory project has captured data on each one of Portland's 218,000 street trees and created action-oriented neighbourhood tree management plans.

Pruning program

The Portland Pruners Program helps volunteers interested in pruning young street trees to take direct action to promote proper tree structure, tree health and clearance from the streets and sidewalks. The Program enables volunteers to use their pruning and leadership skills to make an impact in their neighbourhoods through independent, self-organised street tree pruning events.

Neighbourhood Tree teams

Tree Teams are groups of dedicated volunteers who care for their neighbourhood's trees, working to plan tree events in neighbourhoods, such as educational workshops and tree stewardship activities like pruning or planting. Tree Teams represent and advocate for trees at neighbourhood meetings and serve as a connection between authorities and neighbours.

Neighbourhood Tree Stewards

Neighbourhood Tree Stewards gain knowledge, skills, and confidence through training in Trees in the urban environment, Park tree planting and pruning, tree planting techniques, community outreach training and the City of Portland Tree Code. Stewards put their new skills to use by planting trees, organising, advocating, and greening their neighbourhoods and commit to volunteering 40 hours in their neighbourhood after graduation.

Learning Landscapes

The Learning Landscapes program empowers students to plant trees at their schools. School yard trees are identified and mapped, providing learning opportunities about different species of trees. Developing a school arboretum gives students a hands-on learning experience that continues to grow along with the trees[14].

CHALLENGES

Climate Change

Across the ACT, maximum, minimum and average temperatures are increasing and are projected to continue to rise. The ACT Government has set a clear way forward in the Climate Change Strategy. This Urban Forest Strategy supports several actions from the Climate Change Strategy and together they set a clear path for a resilient city.

Projections show that the ACT region will face an increasingly extreme and unpredictable climate into the future. Summers will become hotter and longer and extreme heat will become more common, with the number of hot days (above 35°C) also increasing in spring and autumn. Heatwaves will become hotter, longer and more frequent, and droughts will become more frequent and prolonged. As a result, severe fire weather is likely to become more common.

Rainfall is expected to become seasonally more variable, decreasing in spring and winter while summer storms become more frequent and are more severe, bringing flash flooding and violent winds.

As the climate changes, an increase in extreme weather patterns will place pressure on Canberra's urban forest and increase the importance of the role trees play in making our city more liveable for the community. It will become increasingly more challenging to establish young trees in a hotter and drier climate and ongoing management of mature trees will become increasingly important as we adapt to more frequent and intense heatwaves and thunderstorms.

Urban Heat Island Effect

The urban heat island effect is created by the built environment (buildings and paving) absorbing and trapping daytime heat and then releasing heat at night. This leads to increased temperatures and prevents night-time cooling.

Urban trees provide shade throughout the day which prevents the built environment from heating to the most extreme levels. **Figure 2** shows a thermal image of a street in Tuggeranong and the difference in temperature between the areas shaded by trees and those exposed to the sun directly.

In 2017, the CSIRO conducted a study which mapped surface urban heat in Canberra and showed that the locations which experience the highest urban heat in Canberra are where green vegetation cover is at its lowest and impervious surface proportions are high. Impacted areas logically include town and group centres, industrial suburbs and newly developed areas ('greenfield estates'). The study found that in built-up areas, the surface urban heat island at night was around 8°C warmer in summer than in surrounding rural areas.

The residents who live or work in areas that are suffering from the heat island effect are not just suffering higher summer temperature and therefore subject to higher energy costs due to a greater need for air conditioning, they are missing out on the many benefits that a healthy urban forest provides as outlined previously.

Figure 2: Heat map of a 32.5 degree day in Tuggeranong in February 2015
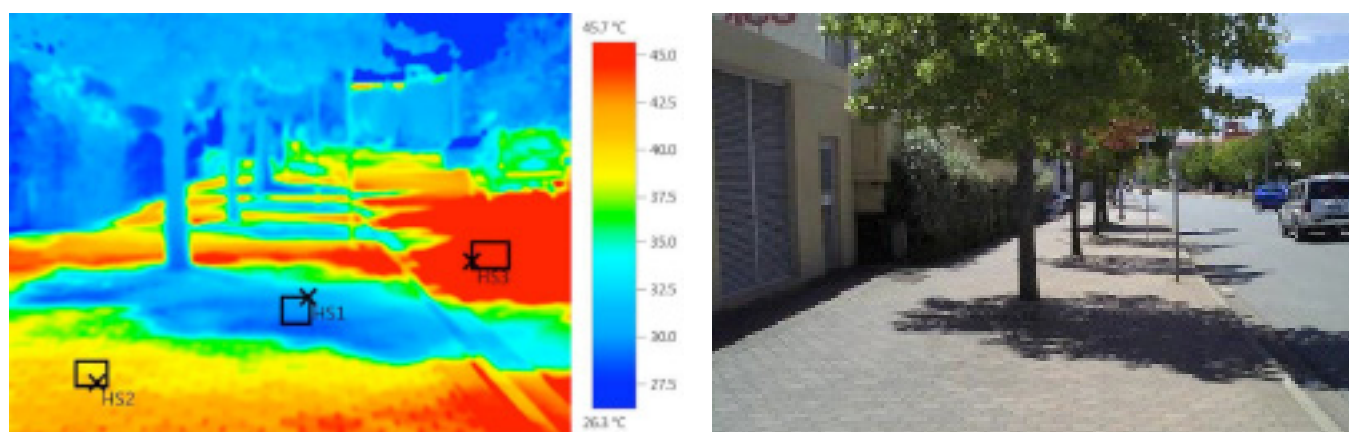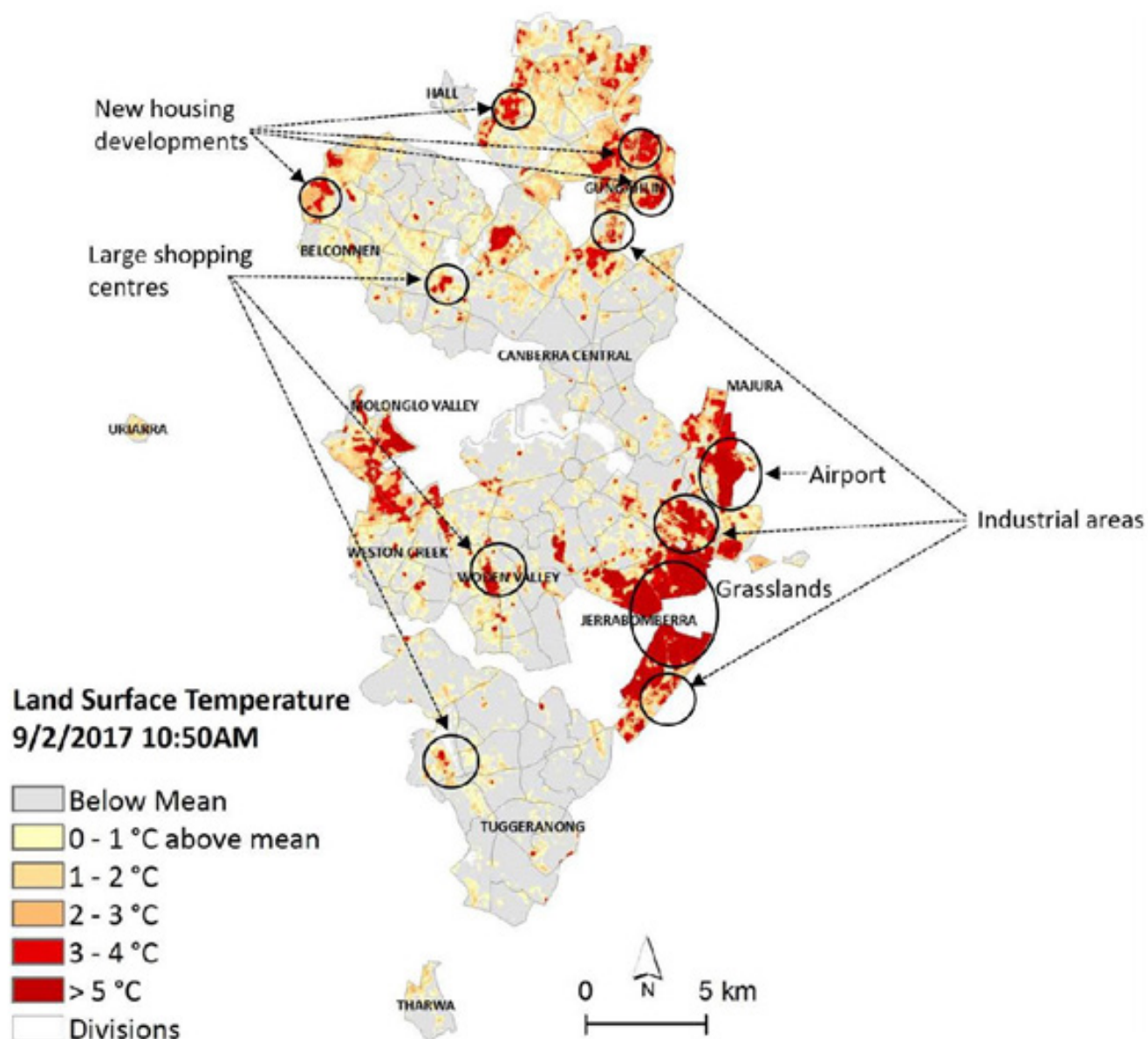

Figure 3: Thermal heat mapping for the City of Canberra showing hotspots in red (Source: Meyers et al, 2017. CSIRO)
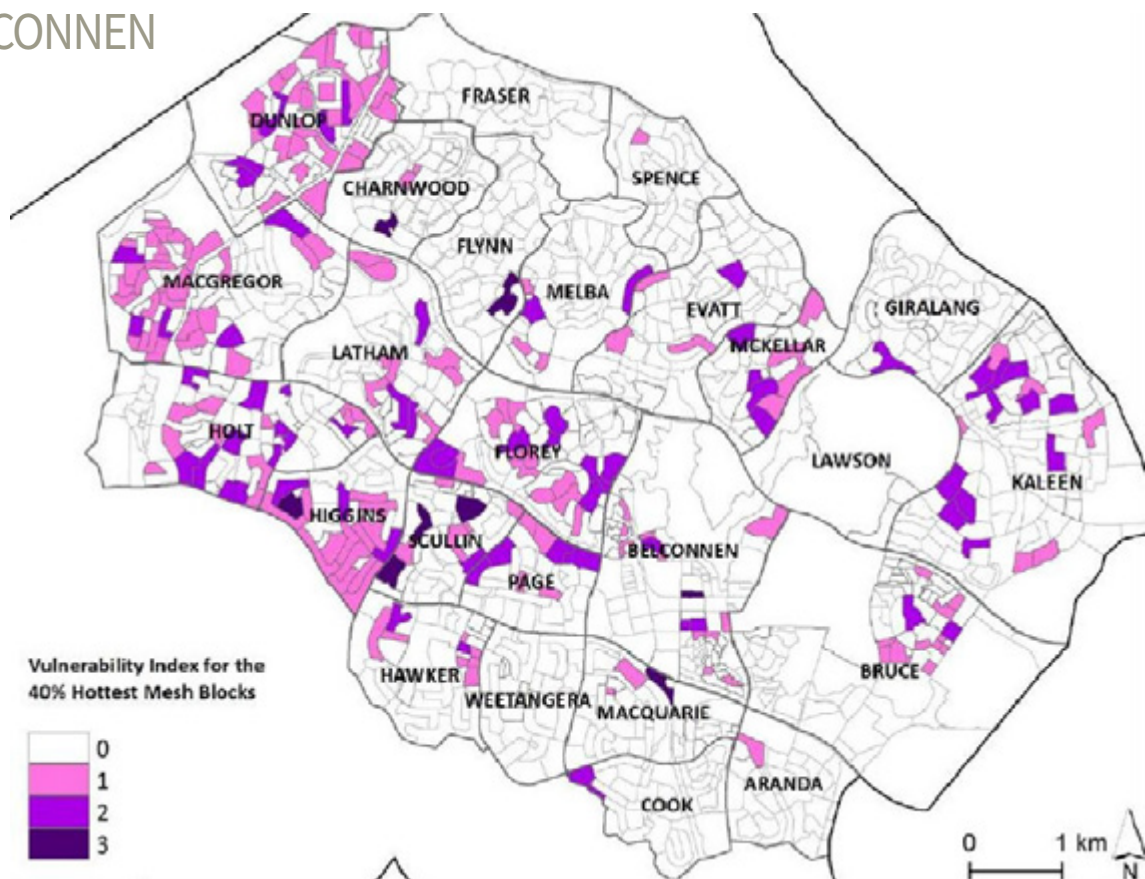
Social Vulnerability

There are some areas within Canberra where residents are more vulnerable to heat, and especially extended heatwaves. **Figure 3** is sourced from a 2017 CSIRO study and shows areas where heat impacts are high. The following maps are overlaid with a Vulnerability Index based on socio-economic and age data, with the most vulnerable areas to heat marked in dark purple.

It is now well recognised that a healthy urban forest and tree canopy has economic benefits, as well as measurable benefits on health and wellbeing. As the section on tree canopy cover above highlights, not all Canberra suburbs have equal canopy cover.

A key goal of this Strategy is to support equitable distribution of the urban forest so that all can benefit from it. In the case of Canberra, it will not be possible for complete equitable distribution across all suburbs due to the different ways suburbs were designed. Some suburbs, like Issacs, are able to comfortably accommodate 40% canopy cover and should continue to maintain this. However, some newer suburbs, like Throsby, are unlikely to ever surpass 20% canopy cover.

For this Strategy, equitable distribution of the urban forest means ensuring planting efforts are prioritised in the areas where canopy cover is lowest and where residents are most vulnerable.

BELCONNEN

Vulnerability Index for the 40% Hottest Mesh Blocks

0
1
2
3

CENTRAL CANBERRA

Vulnerability Index for the
40% Hottest Mesh Blocks

0
1
2
3

0   1 km

N

GUNGAHLIN

Vulnerability Index for the
40% Hottest Mesh Blocks

0
1
2
3

0   1 km

N

MOLONGLO

DENMAN PROSPECT

MOLONGLO

COOMBS

WRIGHT

Vulnerability Index for the 40% Hottest Mesh Blocks

- 0
- 1
- 2

0　1 km

N

TUGGERANONG

KAMBAH

WANNIASSA

FADDEN

MACARTHUR

OXLEY

GREENWAY

MONASH

GOWRIE

GILMORE

CHISHOLM

ISABELLA PLAINS RICHARDSON

BONYTHON

CALWELL

GORDON

CONDER

THEODORE

BANKS

Vulnerability Index for the 40% Hottest Mesh Blocks

- 0
- 1
- 2

0　1 km

N

WESTON CREEK

Vulnerability Index for the
40% Hottest Mesh Blocks

0
1
2
3

WODEN VALLEY

Vulnerability Index for the
40% Hottest Mesh Blocks

0
1
2
3

Urban Densification

The Planning Strategy sets a target for 70% of all new dwellings to be within our existing urban footprint. This means that key town centres and transport routes are being targeted for urban intensification.

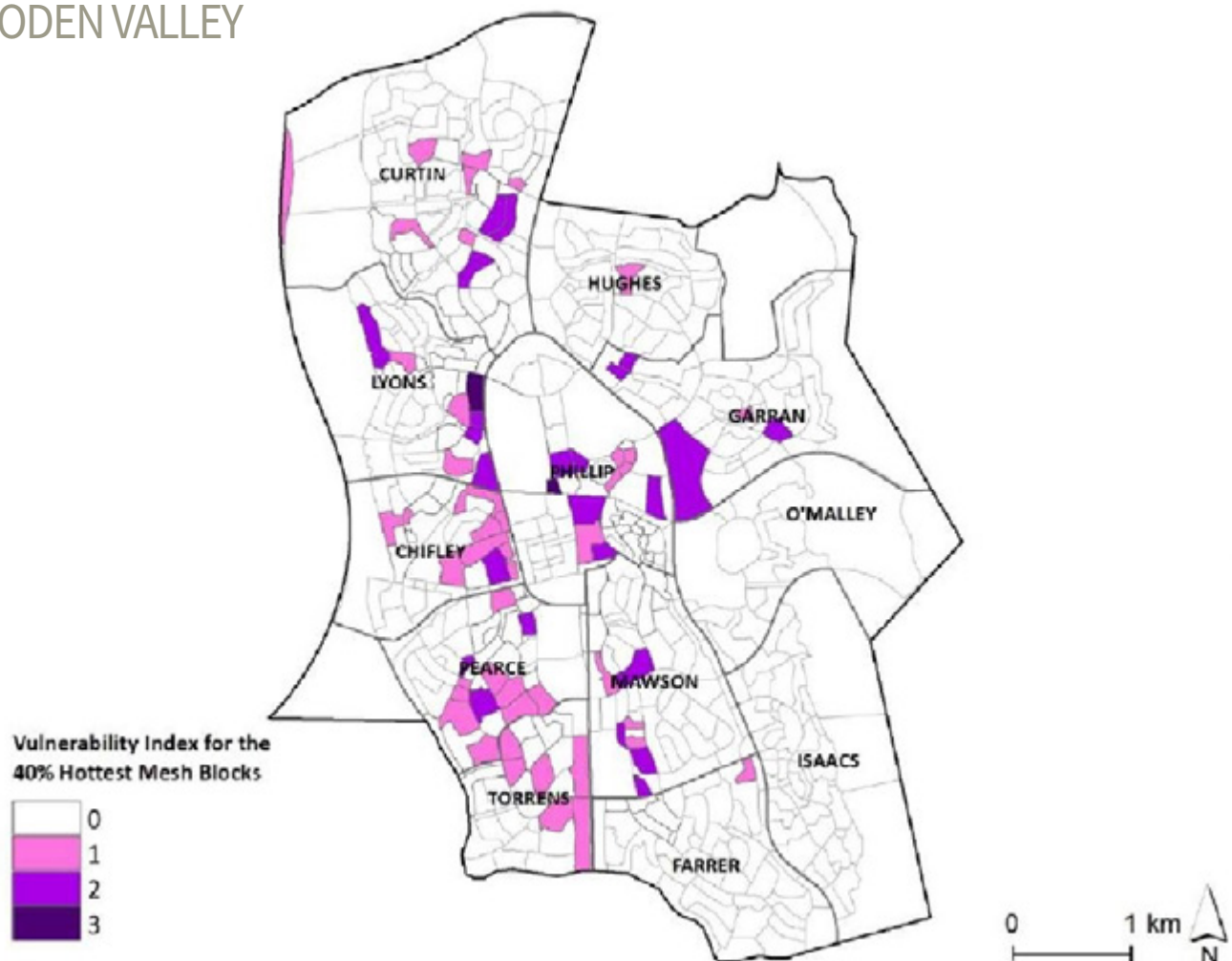Urban intensification comes with its own challenges in terms of less space for green infrastructure and trees.

However, a healthy urban forest with significant canopy cover can be compatible with urban intensification. Canberra's Living Infrastructure Plan sets a target for 30% permeable surfaces which is important for providing the space to grow trees and allow for water and nutrient infiltration into root systems. Reducing urban run-off and retaining stormwater to hydrate the ground will both sustain vegetation and reduce pollution in our waterways.

Loss of Habitat

Canberra's urban forest and network of nature reserves and green spaces provide important areas of habitat for the conservation of biodiversity, as well as opportunities for people to enjoy contact with nature. Urban densification and expanding urban land use can pose a significant threat to our biodiversity. As a result of urban development, flora and fauna can face increased threats, such as lack and fragmentation of suitable habitat, resulting in reduced habitat connectivity to allow movement and dispersal and increased competition and/ or predation from exotic species.

The Conservator of Flora and Fauna prepared the Nature Conservation Strategy 2013–23, made under the Nature Conservation Act 1980. This strategy helps guide future planning of the Territory's open spaces, rural areas, urban areas, riverine corridors, and nature reserves, and guide investment of funding and resources in nature conservation.

The "Loss of mature native trees (including hollow-bearing trees) and lack of recruitment" was listed as a Key Threatening Process (KTP) under the Nature Conservation Act 2014 in September 2018. The Conservation Advice, prepared by the ACT Scientific Committee and released at the time of listing, outlined how large mature trees, including hollow-bearing trees and standing dead trees, play an important role in woodland ecology and threatened species conservation.

The Conservation Advice recommended retention of standing dead trees wherever possible and encouraged retention of non-mature native trees across urban and rural landscapes to ensure a future supply of mature trees and avoid lag times. An Action Plan (threat abatement plan) will be prepared to outline measures to prevent further fragmentation and, where feasible, to improve connectivity between habitat fragments.

By planning for the development of Canberra as a compact and efficient city with increased prioritisation of urban infill to support future growth, we can reduce pressure on valued natural resources and improve the sustainability of our urban land use.

To protect our habitats and ecosystems from the future effects of climate change, we will need to include consideration of maintaining and enhancing our living infrastructure and biodiversity assets, and improving landscape connectivity and resilience, as part of urban planning and development processes. Canberra's Living Infrastructure Plan sets out policy and actions to ensure urban development is supportive of a healthy, liveable and biodiverse urban environment.

OBJECTIVES

Our vision is for a resilient and sustainable urban forest that supports a liveable city and the natural environment and contributes to the wellbeing of the community in a changing climate.

This means that we consider the urban forest as the asset that it is and prioritise creating an urban forest that Canberrans can continue to enjoy and benefit from for generations to come. The vision will be achieved through the following six objectives and actions to support these:

1   Protect the urban forest

2   Grow a resilient forest

3   Balance and diversify the urban forest

4   Take an ecological approach and support biodiversity

5   Develop infrastructure to support the urban forest and liveability

6   Partner with the community

The objectives in this Strategy do not exist in isolation of one another. Each are intrinsically linked and the actions supporting one objective will also support another. A holistic approach must be taken when implementing the actions of this Strategy to ensure these objectives are achieved.

These objectives provide a clear direction to achieve our vision for the urban forest and support a truly vibrant and liveable city. Each objective is supported by tangible outcomes and actions. The timeframes for actions are outlined below:

Ongoing: Ongoing for the duration of the Strategy

Immediate: Within 2 years

Short: Within 5 years

Medium: Within 10 years

Long: Within 20 years

Objective 1: Protect the Urban Forest

The first objective towards achieving the vision of the Strategy is to protect the urban forest. The urban forest that we all benefit from today is the result of considerable investment and protection by those previously responsible for the urban forest.

Our urban forest is facing a number of challenges from changing climate, urban development, ageing trees and inadequate species diversity. The vision of this Strategy is for a resilient and sustainable forest and to achieve this we must first protect the forest that we have.

It is essential that our legislative framework is protecting the right trees. As discussed above, the TPA only applies to regulated trees on private (leased) land once they have met a set of criteria that is currently set at an insufficient threshold. This must be reviewed to ensure we are protecting the right trees for our future urban forest, as well as ensuring the criteria for removal are appropriate and in line with community expectations. The Canberra community were invited to provide feedback on the TPA in late 2019 and all comments will be considered in finalising the review of the Act.

Trees on public land (other than a registered tree under the TPA) have limited protection under the PULA.

The PULA recognises trees as 'assets' and as such requires their protection, but does not provide a regulatory framework that acknowledges that trees are alive and have specific needs to ensure their health.

Often trees on public land, particularly street trees, suffer damage from cars being parked over their roots and inadequate protections from construction damage. PULA must also be reviewed to ensure our public trees are appropriately valued and protected, with particular consideration given to requiring financial bonds against trees and requirements for fencing trees to protect them from construction damage.

Protecting our urban forest extends beyond just the legislative framework that applies to them. The challenges that our urban trees are facing require regular assessment of the needs of trees and pro-active management. Around half our urban forest exists on leased land and is the responsibility of the lessee, while the ACT Government is responsible for the maintenance of over 700,000 trees on public (unleased) land. To achieve this objective the actions of Objective 6: Partner with the Community will also be essential.

In achieving this objective, the following outcomes are expected:

1.1 Exceptional trees and those with high biodiversity and eco-cultural values continue to have the highest levels of protection.

1.2 Trees on unleased public land and leased land are protected.

1.3 Mature and remnant trees are conserved effectively.

1.4 Community interactions with the Tree Protection Act are streamlined, transparent and timely.

To achieve these outcomes, the following actions must be taken:

No	Actions	Status
1.1.1	Maintain and promote the Tree Register (under the TPA)	Ongoing
1.2.1	Review the TPA to ensure the threshold for protecting trees is appropriate	Short
1.2.2	Review the TPA criteria for removal of protected trees to ensure it aligns with community values and expectations	Short
1.2.3	Review the TPA and PULA to ensure appropriate compliance mechanisms exist to deter illegal tree removals or damage to trees on leased and unleased land, and respond appropriately when they occur	Short
1.3.1	Develop a program to ensure the health of mature and remnant trees on unleased land	Immediate
1.3.2	Require all developers to erect prescribed fencing to protect existing trees on public land from damage during construction on adjacent block/s through a review of PULA	Short
1.3.3	Investigate incentives and programs to better provide for the protection, maintenance and care of registered and remnant trees on leased land	Short
1.4.1	Investigate and implement administrative and technological reforms to systems and processes for administration of the Tree Protection Act to ensure they are streamlined, transparent and efficient	Immediate

Objective 2: Grow a Resilient Forest

Current tree canopy cover is estimated to be around 21%. A significant proportion of the urban forest is ageing and will require renewal in the life of this Strategy. The ACT Government has set a clear goal of 30% canopy cover by 2045. To do this we need to not only protect the urban forest, but also invest in increasing overall canopy cover. This will require contributions through public funding but must also consider ways to leverage private and business contribution in a sustainable way that recognises the broad range of public and private benefits that accrue from a healthy and diverse urban forest.

The challenges our city and urban forest are facing mean that we not only need to grow the canopy, we need to grow a resilient forest. Our changing climate means that the species we have traditionally planted may not be suitable to withstand future conditions.

A resilient forest means, not only having significant diversity among our species of trees, it means developing the urban forest in a way that responds to the challenges being faced now and into the future. Traditionally, the ACT Government plants new trees on public land in two main tranches a year, in spring and autumn. However, in our changing climate, we can no longer rely on climatic conditions conducive to tree planting occurring as they have in the past. As our understanding of the climate improves, changes will be required to tree planting to ensure it aligns with climatic conditions and rainfall patterns rather than only aligning with traditional seasons.

At the time this Strategy was drafted in 2019-2020, the ACT experienced a turbulent summer with prolonged drought conditions impacting on the health and vigour of the urban forest.
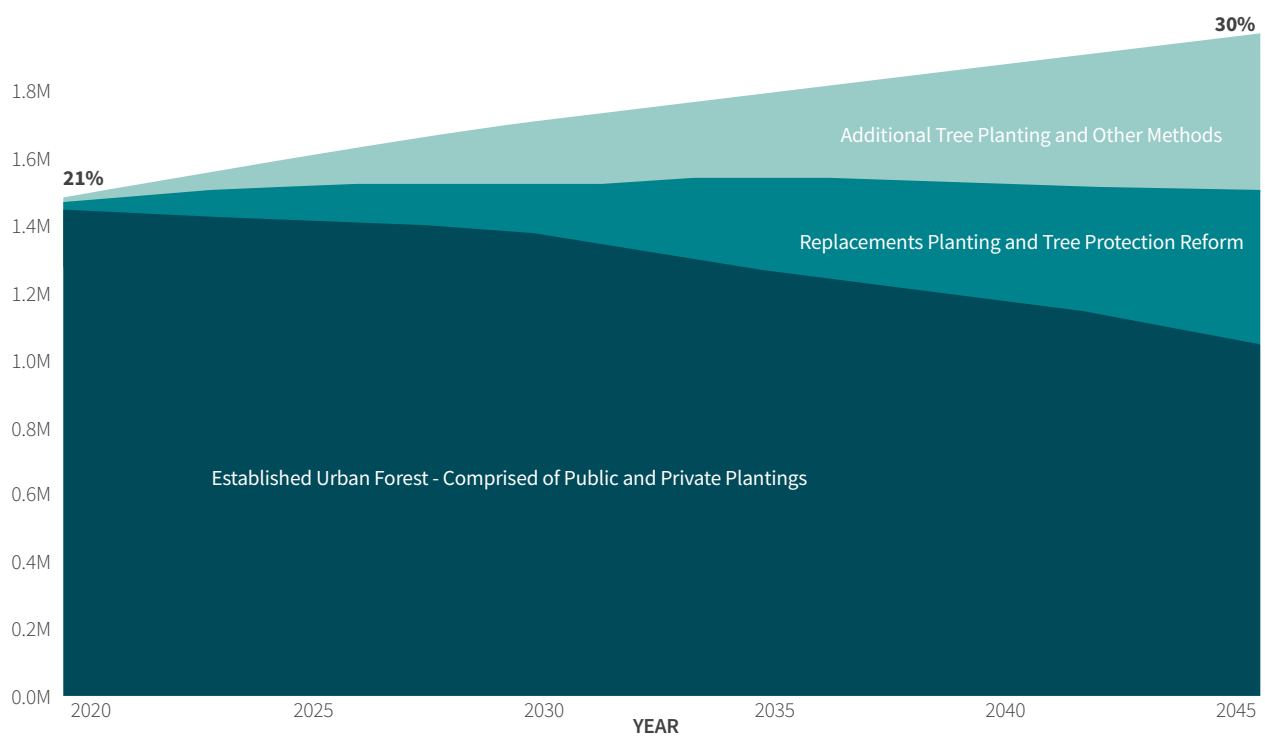
The ACT's planting programs must be flexible and responsive to conditions. They must also recognise the need for adequate resources to enable long periods of post-planting care. This includes watering, formative pruning and other necessary actions for five years or more after plantings, to ensure the benefit of investment in establishing new trees is realised.

A key part of meeting the canopy cover target will be planting of trees - not only filling existing known planting gaps and replacing ageing trees as they reach end of life, but also planting many thousands of additional trees across the city. This work is already underway with over 4,000 trees planted in the Autumn 2020 program and a commitment to plant 25,000 trees by 2023, but a sustained effort is required for decades to come. It is estimated that achieving an increase in canopy cover to meet the 30% target will require over 450,000 additional trees over 25 years.
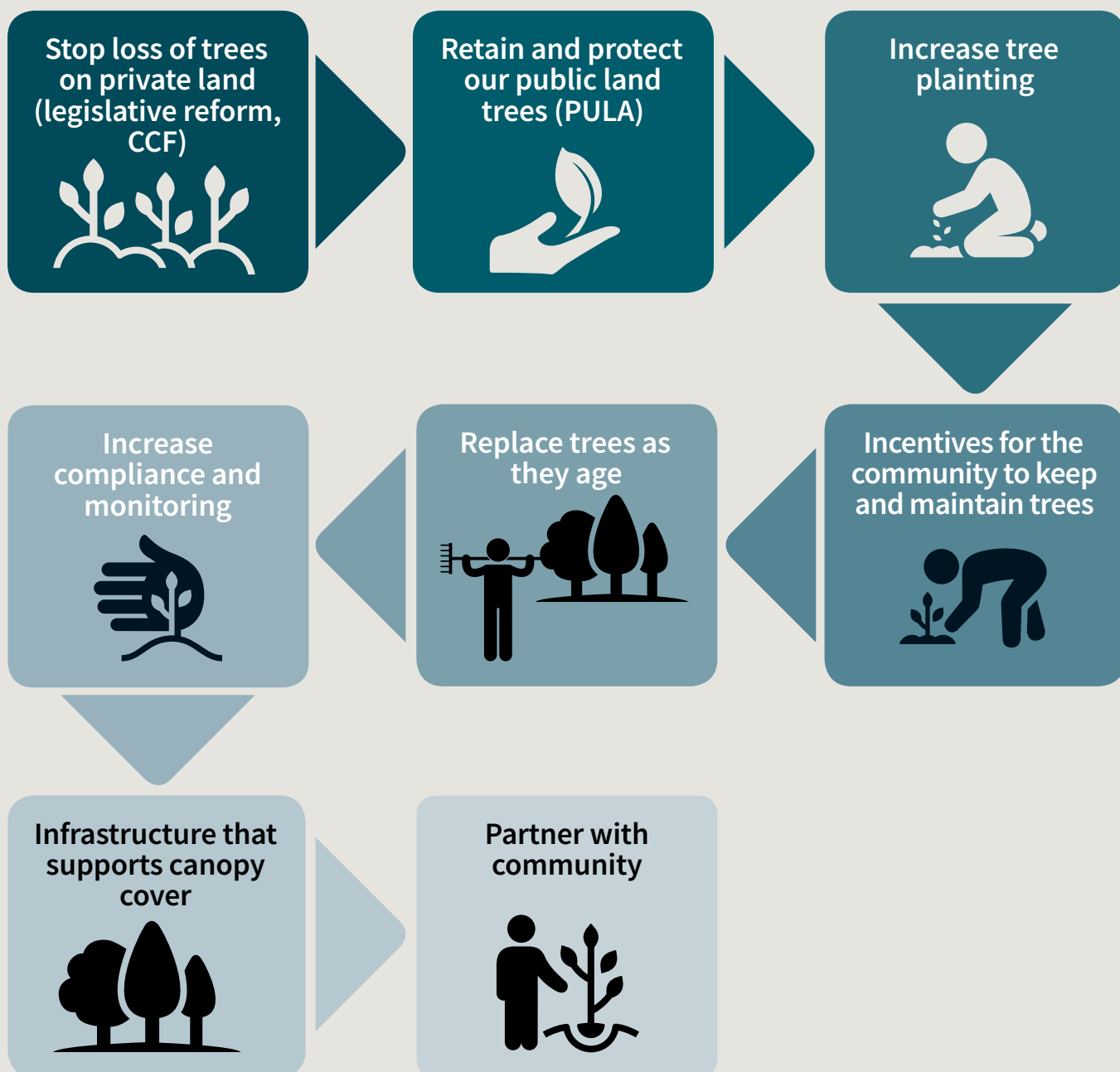
However we know that, while critical, planting new trees alone will not achieve 30% canopy cover. To acheive this will require a holistic and sustained effort in line with this Strategy including looking at our legislative frameworks, compliance, incentivisation and partnerships with the community. The graph below illustrates the path included in the 30% canopy cover by 2045. The graph considers the entire urban forest and shows overall tree numbers if we do nothing, if we replace trees as they are removed at end of life and implement tree protection reforms, and if we plant additional trees and undertake other actions, in line with this Strategy.

Figure 4: Urban Forest Renewal - Roadmap for 30% Canopy Coverage

The roadmap to 30% tree canopy cover

Stop loss of trees on private land (legislative reform, CCF) → **Retain and protect our public land trees (PULA)** → **Increase tree plainting**

↓

Increase compliance and monitoring ← **Replace trees as they age** ← **Incentives for the community to keep and maintain trees**

↓

Infrastructure that supports canopy cover → **Partner with community**

In achieving this objective, the following outcomes are expected:

2.1   Achieve 30% canopy cover by 2045.

2.2   Trees that have reached the end of their useful life will be removed and replaced with one or more new trees.

2.3   Species that are planted are suitable for a changing climate.

To achieve these outcomes, the following actions must be taken:

No	Actions	Status
2.1.1	With reference to the 2010 audit, obtain updated data on the current canopy cover of the public urban forest to inform a replacement program	Immediate
2.1.2	Develop a sustainable program of end-of-life tree removals and replacements for removed trees and existing planting gaps to maintain the urban forest, including best-practice after-care for new plantings	Immediate
2.1.3	Develop a sustainable planting program to increase canopy cover by establishing sufficient additional trees to meet the canopy cover target over the life of the Strategy	Short/ Ongoing
2.2.1	Consider introducing a canopy contribution framework that ensures that when trees must be removed, they are replaced based on the value of the tree at its current maturity	Short
2.2.2	Review PULA to consider a tree bond scheme for trees on public (unleased) land that discourages tree removal and damage through development	Short
2.3.1	Promote the preferred species planting guide[15] to assist the community in understanding what trees to plant on leased land	Immediate
2.3.2	Publish and regularly review a list of climate resilient trees	Immediate

Objective 3: Balance and Diversify the Urban Forest

The urban forest provides many benefits to the community and residents, but these benefits are not currently enjoyed equally by everyone in Canberra. An objective of this Strategy is to balance the urban forest and have as equitable a distribution as possible of canopy cover across our suburbs. Canberra suburbs are diverse and have significantly variable verge and block sizes. This means that it will not be possible to achieve an ideal equal distribution of the urban forest – some suburbs can comfortably accommodate 40% canopy cover while others are not likely to ever reach beyond 20%.

For this Strategy, balancing the canopy means initially prioritising new planting efforts in areas that either have the lowest current canopy cover, highest impact of the heat island effect or are otherwise socially vulnerable. In practice, this means focusing on existing planting gaps where trees have previously been removed or are not present, particularly in locations where social vulnerability is high. Once this is achieved, the focus can turn to augmenting canopy cover in other locations and renewal of areas where canopy trees have reached the end of their useful life and need to be replaced in a staged approach to avoid loss of landscape character.

To meet the vision of a resilient forest our future urban forest must have a diverse range of species. Diversity is a key element of what creates a resilient urban forest.

The greater the diversity of species, size, age and growth rates of trees the lower the risk of losing significant parts of the urban forest to disease or climate change. Our current forest is at risk from over-dominant species including Red spotted gums which constitute over 20% of our public urban trees. To overcome this, it is essential that future plantings focus on a diverse range of species that are appropriate for our climate.

Many parts of the existing urban forest have been planted to create a cohesive theme, for example, using the same species for a street or suburb to give a sense of continuity and consistency. Likewise, suburbs and regions have been established with exotic or native species dominating depending on the circumstances and preferences at the time of development. However, where possible the future approach will be a more flexible, site specific approach that ensures the right trees are planted in each location, with a view to maximising diversity and canopy cover.

The age class distribution should be appropriate for a mixed age forest where the net forest canopy remains relatively stable, ensuring a dynamic population. This is also relevant on an economic level, as diversity of age delivers a more evenly paced process in maintaining the urban forest.

In achieving this objective, the following outcomes are expected:

3.1   The distribution of tree canopy coverage is as equitable as possible across all suburbs.

3.2   No one species of tree represents more than 10% of the urban forest.

3.3   The age profile of trees in public spaces reflects industry best practice.

To achieve these outcomes, the following actions must be taken:

No	Actions	Status
3.1.1	Direct initial prioritisation for new plantings to existing planting gaps and addressing the most vulnerable communities	Short/ Ongoing
3.1.2	Progressively map suburbs at risk of losing canopy due to ageing trees to inform a planned removal and replanting program	Short/ Ongoing
3.1.3	Undertake additional plantings to increase overall canopy cover	Ongoing
3.2.1	Use spatial mapping and citizen science programs to help identify areas with low species diversity and inform future plantings	Medium
3.3.1	Plan planting programs to achieve a best practice age profile of the urban forest by 2045	Ongoing
3.3.2	Ensure yearly maintenance programs involve adequate removal and replacement of end of life trees to develop a balanced age distribution	Ongoing
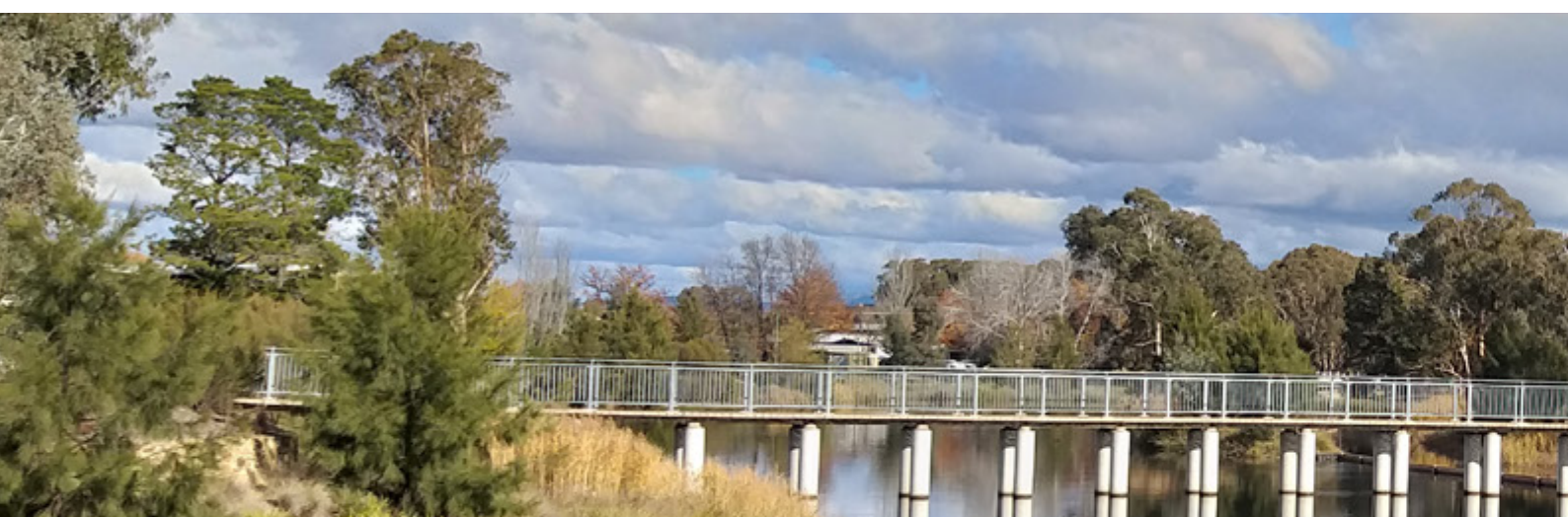
Objective 4: Take an Ecological Approach and Support Biodiversity

The presence of urban trees supports increased biodiversity of a wide range of plants, animals and microorganisms, by providing foraging, shelter, shade, roosting, nesting and movement opportunities. Where possible, retention of fallen wood from remnant or mature trees in parks and reserves also provides valuable habitat for birds, reptiles and invertebrates.

Remnant trees located in the urban environment, make a significant contribution to local ecological, landscape and cultural values. Remnant trees are those which were present before urban development and have been retained for their biodiversity, habitat and amenity value. Native hollow-bearing trees are a critical habitat and breeding resource for native, hollow-using fauna and are important for ecological connectivity. Remnant trees are also an important genetic resource and recruitment in urban environments should be encouraged to help maintain diverse, local gene pools. Identifying the location, species and condition of the remnant tree population on unleased Territory land will allow for improved monitoring and scheduling of regular inspections necessary to inform improved tree management practices, improve public safety and prevent unnecessary tree removals.

Significant benefits can also be realised where the existing dryland grass surrounding remnant trees are replaced with native understorey plants, large rocks and branches to improve tree health, increase wildlife habitat and attract more birds, increase localised cooling and amenity and reduce maintenance routines.

'No mow' zones can be excluded from mowing to allow natural regeneration, supported by additional volunteer planting and maintenance activities. This is especially appropriate in open space areas providing connectivity to nature reserves.

Renewal of the urban forest provides an opportunity to enhance a diversity of habitat and resources for insects, bees and wildlife through considering flowering times and nectar/pollen/fruit and forage characteristics of different tree species. This approach can be expanded for use by residents and developers as they undertake plantings on private land.

The reuse of urban forest material (by-product) at end of life is currently receiving attention from industry, academics and urban forest managers in jurisdictions in Australia and internationally. This widespread interest represents an opportunity to tap into local and international expertise to efficiently and economically develop systems that will transform what is currently a 'waste stream' for the Territory into a 'value stream'. Models such as the Sacramento Urban Wood Rescue may be suitable, with locally-based industries processing sawn timber from salvaged wood. This may be utilised for local school wood-working departments or to sustainably produce value added products such as furniture with the benefit of retaining local timber for use by the local community and businesses. This approach may be distinguished from low value-added timber products such as soft fall mulch, bio-char and wood pellets, though these may also have a role in the sustainable use of urban forest timber.
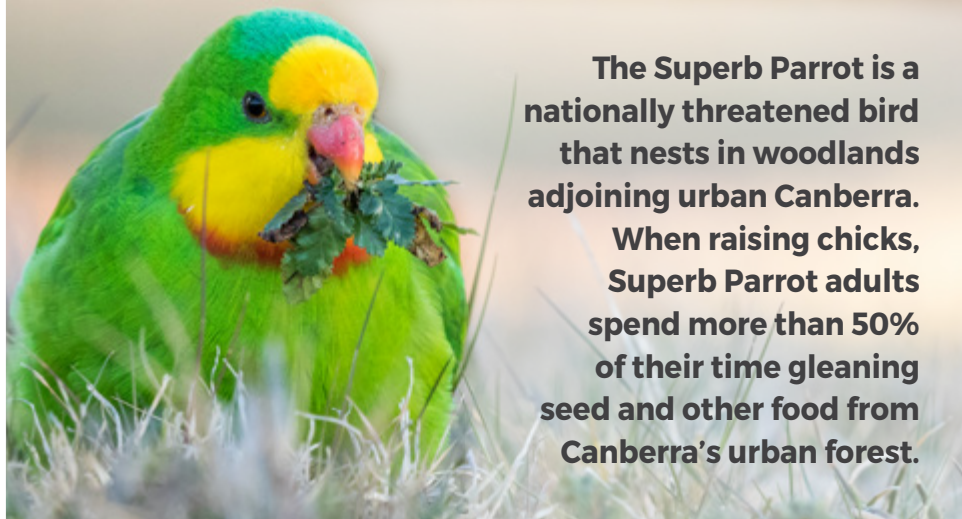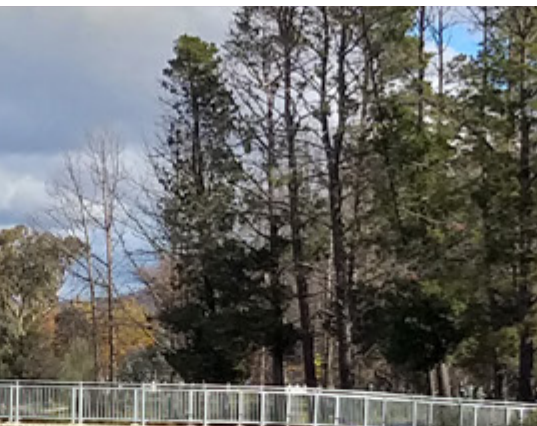
The Superb Parrot is a nationally threatened bird that nests in woodlands adjoining urban Canberra. When raising chicks, Superb Parrot adults spend more than 50% of their time gleaning seed and other food from Canberra's urban forest.
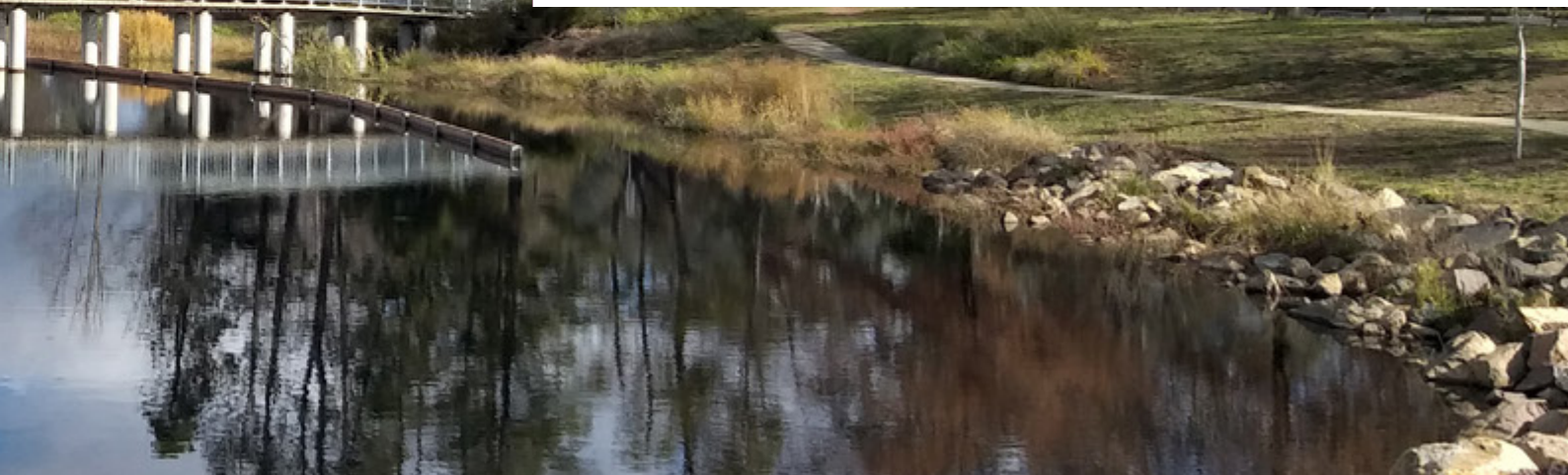
In achieving this objective, the following outcomes are expected:

4.1   The biodiversity and eco-cultural values of the urban ecosystem are conserved and managed effectively.

4.2   Urban forest renewal provides habitat and resources for wildlife.

4.3   Wood from the urban forest is used for habitat and community benefits.

To achieve these outcomes, the following actions must be taken:

No	Actions	Status
4.1.1	Map remnant trees in the urban area	Short
4.1.2	Assess senescent and ageing native trees for retention as habitat in preference to being removed	Ongoing
4.1.3	Collaborate with EPSDD to enhance and conserve biodiversity and eco-cultural values of urban areas (Nature Conservation Strategy – Strategy 4)	Medium
4.1.4	Identify opportunities to protect young seedlings growing from mature remnant trees on unleased public land where it is appropriate	Ongoing
4.2.1	Implement strategic planting to support wildlife and enhance movement and foraging opportunities across the city and wider landscape	Medium
4.2.2	Collaborate with EPSDD to undertake fine scale planning for habitat connectivity (Nature Conservation Strategy - Action 1.2)	Medium
4.3.1	Develop an urban wood reuse plan for trees removed from public land	Medium
4.3.2	Ensure by-product from maintenance of the urban forest is used to support tree health and biodiversity conservation including in habitat restoration programs and nature-based park features	Ongoing

Objective 5: Develop Infrastructure to Support the Urban Forest and Liveability

This Strategy sets out a clear vision for our urban forest. To achieve this the urban forest needs to be supported by infrastructure that allows it to thrive. The urban forest cannot be managed in isolation of the other living infrastructure in our city or without consideration of the impacts and opportunities presented by urban densification. Achieving a liveable city and ensuring community wellbeing requires contributions from both built and living infrastructure components.

For example, permeable surfaces in nature strips enable water infiltration which supports tree growth and health and reduces run-off into the storm water system. Unauthorised use or development of nature strips (such as with hard paving for storage of vehicles) impacts directly on permeability and other aspects of tree health through compaction and prevention of water infiltration. Understory plantings can contribute significantly to biodiversity and amenity outcomes while also promoting canopy tree health.

Planning for the installation of new underground services in new suburbs and densification zones is a key determinant of the amount of space available for tree roots to establish. In some areas, the space left for tree roots after services are installed severely limits the growth potential of any trees planted. Careful selection of tree species for such areas is required.

City infrastructure should also consider use of dead trees for other purposes to support their reuse and a natural environment. For example, the use of dead trees in nature play spaces in 2019 and 2020 has created fun learning environments for children, provided a valuable use for dead trees and saved resources that would have otherwise been used to make artificial play equipment.

JAMISON CENTRE

A water sensitive urban design trial will be undertaken in 2020-21 in a segment of the Jamison Group Centre carpark to improve tree survival and growth rates and provide improved canopy cover. The trial will use the propriety Strataflow modular soil cell system that is designed to support tree health by providing a growing medium with good soil structure that protects tree roots, captures and stores surface runoff, and provides localised water quality treatment while reducing the need for watering from potable water supplies. This system will also allow collection of statistically significant data assessing the environmental value of this system and will inform future potential investments in similar systems in other locations where improved tree canopy cover can be improved, along with better water quality outcomes.

Trials like this have significant benefits for our community and environment from improving tree health and extending the life of the tree, increasing the shade and cooling provided by tree canopies to achieving best practice pollutant reduction. Pollutants are reduced by intercepting and filtering stormwater that is reused during the passive irrigation of trees. This innovative method will allow the work the Government does in tree protection to also play a key role in contributing to Canberra's climate change resilience in harsh environments like carparks.

TUGGERANONG TOWN SQUARE

Rain gardens and other measures have been incorporated into the Tuggeranong Town Square upgrade design for climate change mitigation, including Water Sensitive Urban Design. These features include rain gardens, directing surface rainwater flows to shrub planter beds and trees to reduce flows into the urban stormwater network, water permeable pavers surrounding trees to enable maximum rainfall penetration, a selection of hardy deciduous trees proposed for seasonal sun or shade, and improved soil conditions to promote rapid tree growth and health.

In achieving this objective, the following outcomes are expected:

5.1   Increase the area of permeable surfaces to support tree growth.

5.2   City infrastructure supports a healthy tree canopy.

To achieve these outcomes, the following actions must be taken:

No	Actions	Status
5.1.1	Investigate and promote use of permeable infrastructure (e.g. shared and bike paths, paving and car-parks) in target areas	Short/ Ongoing
5.1.2	Continue to promote positive community behaviour in relation to managing and protecting nature strips and other public areas	Ongoing
5.2.1	Collaborate with EPSDD to increase tree numbers in priority areas (Action 11 of the LIP)	Long
5.2.2	Focus public tree plantings to support active travel routes (Action 12 of the LIP)	Short
5.2.3	Where possible, seek to widen road verges in areas where densification is occurring and along key active travel routes to accommodate additional tree planting	Long
5.2.4	Collaborate with EPSDD and other land development authorities on changes to the planning system that will properly provide for protection of existing trees and the establishment of new trees when planning infrastructure in new suburbs and in urban densification areas	Short
5.2.5	Collaborate with EPSDD on the Planning Review and TPA review to ensure consistent and appropriate decision making for protected trees	Short
5.2.6	Where appropriate, install rain gardens and swales for urban water run-off in tree and understorey planting areas in urban streetscape upgrades and new estate developments	Medium/ Ongoing
5.2.7	Review municipal design standards to include specifications on urban rain gardens or urban stormwater swales as planting locations on verges and other locations	Short

Objective 6: Partner with the Community

The Canberra community cares deeply for the urban forest with park and street trees ranked as the second highest priority in the Better Suburbs Statement 2030. There are numerous community and volunteer groups around Canberra dedicated to caring for their section of the urban forest. While it is currently difficult to measure the impact these groups have on our urban forest, there is potential for the community to make a significant contribution to maintenance of our existing trees.

With the challenges that our urban forest is facing now, and will face in the coming decades, it is more important than ever that the significant resource base of volunteers is empowered and able to contribute in the most effective way possible. In our changing climate, data on the condition of the urban forest is essential to provide informed and appropriate maintenance and care. The community will be empowered to collect this data.

When a community is engaged and informed about the benefits of the urban forest and the care that trees need to survive, they are more likely to act in a responsible way towards the urban forest and to support planting programs. While many people in the community value the urban forest and the benefits it brings, they are unaware of actions that can cause damage and unsure of how they can help care for the urban forest. A sustained program of educational activities is essential to ensuring that our community is informed about how to play a role in protecting and supporting this important asset. In this, young people will play a major role as they increasingly seek tangible ways to overcome the challenges of climate change and help create a sustainable future.

ADOPT A PARK

The Adopt-a-Park initiative encourages community participation in the management of our public trees by strengthening the capacity of local communities to care for our beautiful local neighbourhood parks. Up to $20,000 was available to empower community groups to make a real difference. The 2019-2020 Adopt-A-Park Community Grants Program received 56 applications, with 33 successful projects sharing in $183,989 in grants that will contribute to the amenity and improvement of the ACT's neighbourhood parks and places. With co-contributions from the successful applicants factored in, the program will result in a $390,572 investment in community stewardship of public green space by the Canberra community.

Project activities included weed and erosion control, tree-planting, volunteer training and community events.

In achieving this objective, the following outcomes are expected:

6.1   Volunteer programs help care for the urban forest and identify emerging issues early.

6.2   Lessees are incentivised to retain trees on private land.

6.3   The broader ACT community is well informed about how to care for and avoid damage to the urban forest.

To achieve these outcomes, the following actions must be taken:

No	Actions	Status
6.1.1	Expand and support community / volunteer programs to encompass a wider range of contributions to maintenance of the urban forest	Ongoing
6.1.2	Develop and make available to volunteers a citizen science data collection program	Immediate
6.2.1	Investigate incentives for retention of trees on private land including through collaboration with planning authorities	Medium
6.3.1	Develop community education material to convey the benefits of trees	Short
6.3.2	Build indigenous engagement in caring for the urban forest	Medium
6.3.3	Consider ways to educate young people and how they can contribute to the urban forest	Short

IMPLEMENTATION AND MEASURING SUCCESS

This Strategy sets a clear vision for Canberra's urban forest and six objectives, with associated outcomes and actions, to achieve it with timeframes attached to all actions.

This Strategy is currently in draft for community and stakeholder consultation. The finalised Strategy will include an implementation and evaluation plan to ensure that the actions are being taken and assess the results. Reporting against each action will be required every five years over the life of the 25 year Strategy.

Endnotes

1   ACT Government (2019). Climate Change Strategy 2019 – 2025, https://www.planning.act.gov.au/act-planning-strategy/home

2   ACT Government (2019). Canberra's Living Infrastructure Plan, https://www.environment.act.gov.au/cc/act-climate-change-strategy/keeping-our-city-cool

3   Meyers J, Devereux D, Van Niel T and Barnett G. (2017). Mapping surface urban heat in Canberra. CSIRO, Australia

4   ACT Government (2018). ACT Planning Strategy 2018, https://www.planning.act.gov.au/act-planning-strategy/home

5   Nowak, D., J. (2002), The Effects of Urban Trees on Air Quality

6   Cancer Council. (2015). All about shade. Retrieved from https://www.cancercouncil.com.au/127370/cancer-prevention/sun-protection/tips-for-being-be-sunsmart/tips-for-sun-protection/all-about-shade/

7   Iowa Department of Natural Resources. (undated). Community Benefits from Public Trees in Iowa.

8   Melbourne City Council. (2012). Urban Forest Strategy Making a Great City Greener 2012-2032.

9   https://www.fs.fed.us/psw/publications/mcpherson/psw_2005_mcpherson003.pdf

10 City of Melbourne. (2012). Urban forest strategy: making a great city greener 2012-2032

11 Transport Canberra and City Services. (2019). Municipal Infrastructure Standards 25: Plant Species for Urban Landscape Projects. ACT Government, Canberra, ACT. Retrieved from https://www.cityservices.act.gov.au/__data/assets/pdf_file/0004/1378543/MIS25-Plant-Species-for-Urban-Landscape-Projects.pdf

12 Amati, M., Boruff, B., Caccetta, P., Devereux, D., Kasper, J., Phelan, K. and Saunders, A. (2017). Where should all the trees go? Investigating the impact of tree canopy cover on socio-economic status and wellbeing in LGA's. In Prepared for Horticulture Innovation Australia Limited. Centre for Urban Research, RMIT University.

13 Tapsuwan, S., Marcos-Martinez, R., and Schandl, H. (2019). An environmental-economic accounting of services provided by the living infrastructure in the ACT: public urban forests and irrigated open spaces, CSIRO Land & Water, Canberra, ACT

14 https://www.portlandoregon.gov/parks/38304