# SEEING THE FOREST AND THE TREES IN CANBERRA USING AN AUDIT AND INVENTORY APPROACH

Fleur Flanery
Manager, Urban Forest Renewal (Program), Land Management and Planning,
Territory and Municipal Services, ACT Government

## Overview

Between November 2009 and May 2010 approximately 490,000 of Canberra's urban trees were assessed and the findings recorded, using GPS technology, into the city's Integrated Asset Management (IAMS) database. Of this total number, 460,000 trees were assessed using a 'rapid audit windshield approach' over a ten week period.

This paper will discuss the relative merits and complementary roles that these two assessment approaches play in understanding and developing a strategic plan for the management of Canberra's unique urban forest with consideration to the trees' current and predicted future condition.

## Canberra's urban forest

The ACT Government manages more than 640,000 urban trees in streets and parks, making it one of the largest urban forests managed by a single jurisdiction in the world. The first urban plantings started in the 1920's and continue today, giving an age range for the trees from new to 95 years old. Canberra's urban forest is dynamic and still rapidly expanding. In the past three years alone, 18,000 trees have been planted in the new suburbs.

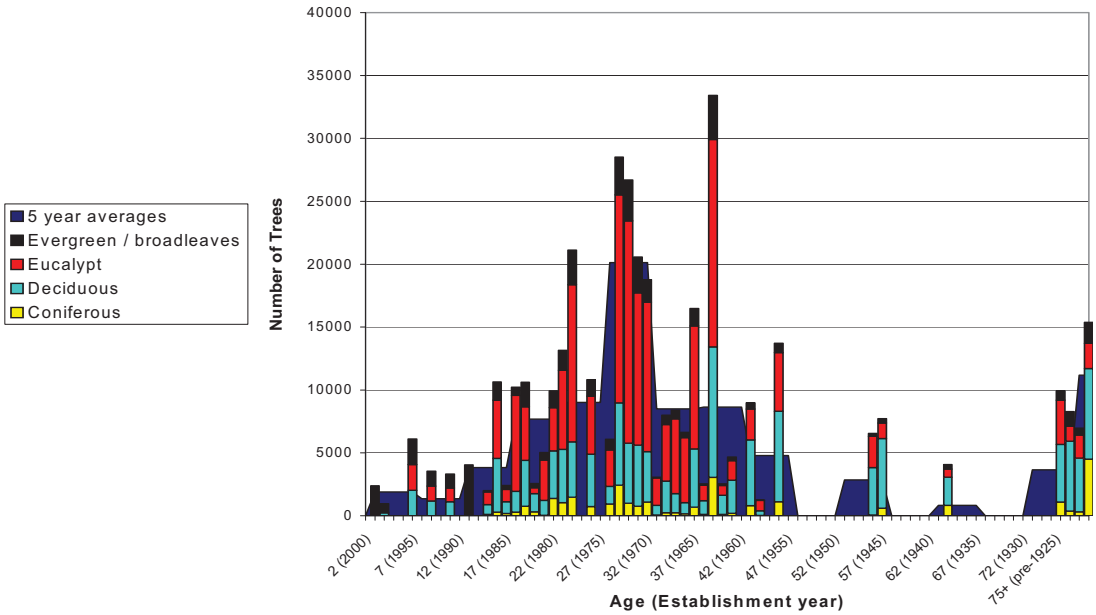
Knowledge of Canberra's social and political development provides a useful context to understanding Canberra's urban forest. In 1901 Joseph Maiden from the Royal Society in NSW proclaimed '*the whole of the Federal territory can be looked upon somewhat in the light of a gigantic park, the streets and buildings to be inserted as details*...'. He went on to say '*we have no grand Arboretum in Australia, and the foundation of the Federal City given us the opportunity of establishing one…*'. There was great idealism with the creation of the 'Federal Capital' and anyone visiting the site may have needed optimism. The site of Canberra was predominantly grassland and in the 1920s it was either cold and windy or dry and dusty. One of the first tree plantings for the new city was in 'Haig Park', which is essentially a parkland of exotic, mainly coniferous trees. It was constructed as a windbreak and marked the formal northern boundary of the city.

Tree planting took place on an industrial scale which coincided with the construction of the city. In the six suburbs that make up the original part of the region known as the Inner North, over a million trees and tall shrubs were planted in a four year period in the 1920s[1]. Canberra has experienced three planting phases on this industrial scale. The first was at the inception of the city in the 1920s, the second started in the Menzies era in the 1950s with the construction of Lake Burley Griffin and the third in the 1970s with the expansion of the city and construction of two satellite regions, Woden-Weston and Belconnen. These two regions alone contain 230,763 trees.

In 1996 the ACT Government commissioned the Fenner School of Environment and Society, led by Associate Professor Cris Brack, to survey Canberra's trees and develop a modelling system for their management. The output of this research was the Decision Information System for Modelling Urban Trees (DISMUT). This research estimated that up to two-thirds of Canberra's urban trees would decline in the coming 20-30 years.

The following chart shows the numbers of trees planted since the 1920s. You will note the scale of the tree planting from the 1950s to the 1980s. The majority of these trees were *Eucalyptus sp*, some of which are not performing well as street trees as a combination of species choice, growing conditions and/or maintenance practices.

[1] Taylor, K, Canberra, City in the Landscape, 2006,




One of the primary reasons for this decline is the simultaneous ageing of the trees from the two earlier planting periods, the 1920s and the 1950s and a drying climate. Trees in the original plantings under the direction of Charles Weston, Officer-in-Charge Afforestation 1913-1926, were predominantly exotic and trees from this group have an expected safe and useful life of 80 plus years. The tree species from the 1950s to the 70s were predominantly native and have a shorter 'safe and useful' life. These two large groups of trees are maturing simultaneously. Following on from the ANU's work, the ACT Government recognised that a plan was needed to manage the issue of declining trees with consideration to social, economic and environmental issues. This resulted in 2008 with the establishment of the Urban Forest Renewal Program (UFRP).

The UFRP aimed to '*sustain and enhance Canberra's urban forest for future generations*.'

Its strategic plan identified five guiding principles for urban forest management, namely:

- Maintenance of the contribution of the urban forest to Canberra's distinctive landscape setting and character.
- Reduction of risks to people and property from declining and failing trees.
- Optimisation of the use and care of trees, with tree selection based on survival prospects under climate change scenarios and on avoidance of species with the potential to become pest plants.
- Improvement and maintenance of environmental, social and economic benefits.
- A flexible approach should be taken to tree renewal.

The first phase, 2009-2013, the UFRP had the following four key outputs[*]:

- A condition assessment of Canberra's urban forest.
- Introduction of a programmed preventative maintenance (cyclical) program.
- Strategic replanting and review into trees suitable for Canberra.
- An informed and supportive community.

[*] The Urban Forest Renewal Program has been under Review by the Commissioner of Sustainability and the Environment for the ACT since November 2009. The outcome of this review should be completed in September 2010. Until this review is complete, the program has been suspended. Some activities such as the tree audit have been allowed to continue.

In order to develop the public's understanding of and facilitate their participation in the program's planning and implementation, communications and community engagement were identified as priority investment areas.

## Development of the forest audit and tree inventory approach

In April 2009 an individual condition assessment of 18,000 trees was undertaken across four Canberra suburbs, Narrabundah, Higgins, Duffy and Deakin, in which 60 individual attributes were collected. These suburbs were selected as they were geographically separate and managed by different Operational Teams within the ACT Government with a range of gazettal dates, with Deakin being one of the oldest and Duffy a middle aged suburb. Duffy was partly razed in the Canberra bushfires of 2003. The suburbs also contained a good range of demographic groups.

Results from this condition assessment project showed that although the quality of the data was excellent, the approach was unfeasible in terms of cost and time that would be required to replicate this type of audit across the city. This method also had the potential to become a "Sydney Harbour Bridge" scenario in that the job would never be complete. In addition, this level of detail wasn't suited to the development of a holistic perspective of Canberra's urban forest and thus key objectives of the UFRP might be compromised, as the data collection process could take so long and be at considerable financial cost.

The table below provides indicative calculations on the length of time to undertake a single tree assessment against the number of days in a year available for assessments.

**Table 1 – Indicative calculations to assess 450,000 trees**

| Average minutes to assess a tree | 1 min | 2 mins | 3 mins | 4 mins | 5 mins | 6 mins |
|---|---|---|---|---|---|---|
| Average trees assessed per day | 480 | 240 | 160 | 120 | 96 | 80 |
| No. of days to survey 450,000 trees | 937.5 | 1875 | 2812.5 | 3750 | 4687.5 | 5625 |
| Years to complete for one person based on estimated survey window | 7.07 | 14.14 | 21.21 | 28.28 | 35.35 | 42.42 |

Working days per year = 221 days

Estimated survey window actual survey days (days with trees in full leaf) = 132.6 days

**Note:** Average number of trees collected per day does not provide for breaks or travel and assumes 40hr week.

Having regard to the size, number of trees, aims and objectives of the UFRP, two assessment approaches were then developed in consultation with TreeLogic[2]. This resulted in the creation of two distinct tree assessment methods:

- **a rapid audit approach – an audit process for** the public tree resource that allows assessment of the urban forest at a strategic level ; and
- **an inventory approach** - designed for **assessment of individual** trees that allows for more specific management activities to be recorded and developed. The inventory is used in larger parks, high use areas, main arterial roads and when needed to assess the condition of a tree.

[2] TreeLogic Pty Ltd is a Melbourne based arboricultural consulting company. Part of the tender for the tree assessment in the four suburbs involved recommendations about a future approach to assessing Canberra's trees. Tree Logic recommended an audit style approach be developed. Recommendations were made to the Expert Working Group for the Program to proceed using this method.

These methods were developed as complementary activities, with the audit providing an overview of the public urban forest to enable broader management issues such as sustainability and strategic replanting programs to be developed, whereas the inventory system provides detailed information on an individual tree and its specific management requirements. The inventory approach can also be used to assess tree condition across a larger landscape unit such as a park or arterial road when more detailed information is required than that which the audit can provide.

Both approaches are based on:

- The use of spatial mapping technology such as ArcPad.
- Experienced and qualified inspectors for quality control.
- All assessments be undertaken at ground level by a qualified assessor either in a car or on foot doing visual inspections. (If further inspection is required it is noted as 'recommended works' and given a priority rating for the timing of the detailed assessment.)

## The rapid audit

The rapid audit is a population-based assessment method that collects information on street or park units and ranks them in order of *risk, maintenance and renewal priority*. It relies on a scoring system that values certain characteristics over others to determine a 'Renewal Score'. The ten attributes that were scored include risk, landscape quality, planting style, age, life expectancy, species diversity, tree health, structure, site constraints and the number of planting opportunities in each assessed unit.

Each scoring field is rated from 0-5. Street tree renewal scores can range from 0 to 50, with a higher score indicating a greater priority for renewal. The following ten attributes are included in the Renewal score**.**

### Audit field within the renewal score – streets (maximum of 50)

| Field | Description | Comments |
|---|---|---|
| Borrowed landscape quality | Condition of surrounding landscape. | Contribution rating from landscape adjoining unit being assessed. A good borrowed landscape receives a higher renewal score than a poor borrowed landscape. |
| Street planting style | Style of street planting. | Rating assigned to different planting styles in streetscape with homogeneous avenues receiving lower renewal scores and mixed plantings or "no theme" receiving higher renewal scores. |
| Risk zone | Level of potential risk based on frequency of people or property. | Included in renewal score or risk score. Higher risk zones receive a higher renewal score than lower risk zones. |
| Estimated age of planting | Average age in years of dominant tree planting species. | Age related score with older trees receiving higher renewal scores than more recently planted trees. |
| Useful life expectancy | Remaining life in years for dominant planting. | Life expectancy score with longer useful life expectancy receiving lower scores than shorter useful life expectancy. |

| | | |
|---|---|---|
| Total no. of species in the unit (count) | Species count for the unit. | Street audit field where fewer species receive lower scores and multiple species receive higher scores. |
| Dominant tree health | Health class rating. | Score assigned for tree health with better health receiving lower scores and poorer health receiving higher scores. |
| Dominant tree structure | Structure class rating (of the dominant species). | Score assigned for tree structure with better structure receiving lower score and poorer structure receiving higher scores. |
| Site constraints | Level of site constraints in relation to the dominant species. | Score assigned with limited constraints to tree growth and development receiving lower scores than sites with more constraints. |
| No. of vacant sites (count) | Planting sites in unit. | Street audit field – score assigned with fewer vacant sites in a unit receiving lower score than units that have a higher percentage of vacant sites. |

Parks were also assessed using this method. The renewal scoring was modified to be a maximum of 30 or a minimum of 0. Each scoring field is rated from 0-5. The following 6 fields are included in the Renewal score:

## Park unit renewal scored maximum of 30

| Field | Description | Comments |
|---|---|---|
| Borrowed landscape quality | Condition of surrounding landscape. | Contribution rating from landscape adjoining unit being assessed. A good borrowed landscape receives a higher renewal score than a poor borrowed landscape. |
| Risk zone | Level of potential risk based on frequency of people or property. | Included in renewal score or risk score. Higher risk zones receive a higher renewal score than lower risk zones. |
| Estimated age of planting | Average age in years of dominant tree planting species. | Age related score with older trees receiving higher renewal scores than more recently planted trees. |
| Useful life expectancy | Remaining life in years for dominant planting. | Life expectancy score with longer useful life expectancy receiving lower scores than shorter useful life expectancy. |
| Dominant tree health | Health class rating. | Score assigned for tree health with better health receiving lower scores and poorer health receiving higher scores. |
| Dominant tree structure | Structure class rating (of the dominant species). | Score assigned for tree structure with better structure receiving lower score and poorer structure receiving higher scores. |

Vacant sites and planting theme isn't included in the renewal score for parks.

An additional scoring system was also included to calculate a risk ranking score. The score is calculated by adding three fields together. Two of these fields are also included in the 'Renewal Score' calculation (risk zone and dominant tree structure). The addition of tree size provided a risk ranking score with a maximum score of 15.

## Audit fields within risk score system

| Field | Description | Comments |
|---|---|---|
| Risk zone | Level of potential risk based on frequency of damage to people or property. | Included in renewal and risk score. Higher risk zones receive a higher renewal score than lower risk zones. |
| Dominant tree structure | Structure class rating. | Score assigned for tree structure with better structure receiving lower scores compared with poorer structure. |
| Tree size | Size class. | Risk rating field not used in renewal score. |

To maximise efficiency in the field a number of GIS layers were incorporated into the ArcPad including:

- Aerial images for all suburbs.
- Suburb layer.
- Property layer.
- Street address layer.
- Kerb layer.
- Road layer.
- Urban open space layer.

**Other data sources were also made available**

- DISMUT data (street by specie DISMUT 2009.xls)
- Pryor L.D and Banks J.CC 2001. Trees and Shrubs in Canberra, ACT Government, Little Hills Press, NSW
- Gazettal dates for suburbs and roads of Canberra

Prior to its roll out across Canberra the 'rapid population audit' was piloted in December 2009 in two Canberra suburbs, Higgins[3] and Hackett. The pilot study demonstrated that the audit approach was methodical, replicable and an efficient way to strategically analyse a large tree population. It also showed that individual units could be identified if they were more degraded than other units. This was an important issue to help provide some guidance in prioritising one region, suburb or street over another to help determine where the ACT Government needs to focus its efforts.

The pilot of the audit also provided an opportunity to make minor modifications prior to it being conducted throughout the city. Scoring modifications were needed when a landscape unit had few or no trees (although this wasn't a frequent occurrence).

## Canberra individual tree inventory

Canberra's urban trees are predominantly managed in-house by four Operations Teams located throughout the city. These teams are managed by the Urban Tree Unit within the ACT Government Department of Territory and Municipal Services. The individual tree inventory assessment was initially developed to provide the Tree Operations Teams and Urban Tree Unit with a consistent approach to tree condition assessments across the city. The Department had experienced considerable criticism from the public about the inconsistencies of tree assessments in respect to tree removal or retention. Without a consistent set of criteria it was very difficult to compare decisions as to why a tree should be removed, retained for habitat or pruned. A consistent assessment method was also essential to useful data capture on the Territories' integrated database (IAMS). The assessment approach once again needed to be designed for the scale (number) of trees within the urban forest and used as a starting point in the future management of the tree.

The individual tree condition assessment uses GPS technology and an electronic form, with drop-down menus to maximise efficiency, and reduce the opportunity for error. The computer version of the form has a scoring system which is linked to the Territory's risk rating matrix. The form is loaded onto robust laptops for field use and the information, once recorded, is downloaded into the city's **Integrated Asset Management System (IAMS).**[4] Digital images accompany the assessment.

[3] Higgins was assessed using both the rapid audit approach and the individual inventory system to check the quality of the data and tree counts etc.

[4] The individual assessment method was initially trialled using a paper based assessment form. It is currently being rolled out across the Operational Teams

The individual assessment can be used as a strategic planning tool when applied across larger landscape units such as parks, when the rapid assessment approach is less informative and also as a tool to inform specific management of a tree flowing from resident requests and when a tree requires removal.

It is not anticipated that this individual assessment approach will be applied across Canberra's urban forest in the near future. Work is however being undertaken to capture information about new trees at the time of planting and after work has been undertaken as a starting point to a more proactive cyclic management regime.

The Tree Condition Inventory form is designed to meet criteria of the IAMS which uses a parent – child relationship for attribution of assets. A list of attributes is provided in the tables below.

## Attributes of the parent asset

| Field | Type | Description |
|---|---|---|
| IAMS asset ID | Auto | Identification number auto-generated when entered into IAMS |
| Contractor tree ID | Auto | Identification number supplied by contractor |
| Suburb | List | List of all suburbs |
| Location type | List | Street tree or Open Space tree |
| Location number | Text | House number if applicable |
| Location street name | List | Asset name of street |
| Location UOS name | List | Name of town park or Urban Open Space type (used in relation to road name) |
| X coordinates | Auto | GPS, GIS/aerial photo or referenced survey |
| Y coordinates | Auto | GPS, GIS/aerial photo or referenced survey |
| Heritage status | Auto | No, Provisional Registration, Full Registration (Appears on form, but not collected in field) |
| Registered tree | Auto | No, Provisional Registration, Full Registration (link to Register page / tree management plan – PDF) (Appears on form, but not collected in field) |
| Tree of interest | List | No / Yes – Tree to be considered for heritage or registration protection |
| Designated land | Auto | No / Yes (Appears on form, but not collected in field) |
| Genus species | List | List of commonly found species in Canberra (IAMS format) |
| Provenance | Text | Record nursery and seed source if known |
| Planting date | Year | If known, or estimated to mid decade, e.g. 1965 |
| WAE / Project Number | Text | Reference number from 'Works as Executed' plans, Capital Works projects or program name, e.g. Million Trees |
| Collector name | Text | Staff name or contracting company name |
| Collection date | Auto | Date the tree is inspected and data recorded |

## Tree condition assessment fields - child

| Field | Description | | | | | |
|---|---|---|---|---|---|---|
| DBH | Number | Diameter of largest stem measured at 1.3 m above ground. Estimate to nearest 5 cm.<br>If multiple stems, record additional stems (up to 5) in comments field. If branch union at<br>1.3 m adjust measurement higher or lower. | | | | |
| Tree Height<br>(Scored) | Very Large (5)<br>>20 m | Large (4)<br>12-20 m | Medium (3)<br>6-12 m | Small (2)<br>3-6 m | Very Small (1)<br><3 m | Vacant (0) |
| Health<br>(Scored) | Dead (5)<br>Trunk, primary branches and twigs dead; no leaves or dead leaves | Very Poor (4)<br>Irreversible decline; 30-50% dieback; severe foliage deficiencies; 30-50% foliage density; 30-50% leaf health; severe pests / diseases | Poor (3)<br>Minimal vigour; substantial decline; 20-30% dieback; considerable foliage deficiencies; 50-70% foliage density; 50-70% leaf health; pest / diseases exceed thresholds | Fair-Poor (2)<br>Below average vigour; more than average decline; 10-20% dieback; foliage deficiencies; 70-90% foliage density; 70-90% leaf health; pests / disease at thresholds | Fair (1)<br>Average vigour; average decline; <10% dieback; >90% foliage density; >90% leaf health; pests / diseases within thresholds.<br>The typical condition of the species. | Good (0)<br>Above average vigour; no decline; 0% dieback; better than average foliage density; better than average leaf health; no pest / diseases.<br>An exceptional specimen. |
| Structure<br>(Scored) | Failed (5)<br>Failure of root plate, trunk or primary branch; active split between branch unions; severe damage to primary tree structure | Very Poor (4)<br>Excessive damage or decay to root plate, trunk, primary branches or branch unions; fungal fruiting bodies; excessive decay or hollows compromising structural integrity; unstable in ground; excessive branch end-weight; severe included-bark unions; exceeding thresholds – failure probable | Poor (3)<br>Major damage or decay to root plate, trunk or primary branches; no observable basal flare; acute branch unions starting to include bark; major branch end-weight / over-extension; at or exceeding thresholds | Fair-Poor (2)<br>Moderate damage or decay in root plate, trunk or primary branches; minimal basal flare; acute branch unions; past branch failure; moderate branch end-weight / over extension; approaching thresholds | Fair (1)<br>Minor damage or decay to root plate, trunk or primary branches; typically formed branch unions; minor end-weight / over-extension; within thresholds.<br>Standard tree – no observable major defects to suggest that there is an increased likelihood of tree failure. | Good (0)<br>No damage or decay; visible basal flare; stable in ground; well tapered branches with sound open unions.<br>An exceptional specimen. |

| Useful Life Expectancy (ULE) (Scored) | 0-10 Years (5) | 10-20 Years (4.5) | 20-30 Years (4) | 30-40 Years (3.5) | 40-50 Years (3) | 50-60 Years (2.5) | 60-70 Years (2) | 70-80 Years (1.5) | 80-90 Years (1) | 90-100 Years (0.5) | 100+ Years (0) |
|---|---|---|---|---|---|---|---|---|---|---|---|

| Risk Zone (Scored) | Prominent (5) Highway / arterial road; 40km/hr school zones; adjacent to retail premises; shopping centres; 10 m buffer from edge of BBQs, seats, shelters, toilet blocks, car parks, picnic tables, cycleways and paths in UOS | Major (4) Major collector roads; Category A Maintenance Areas – High Use; Town park | Moderate (3) Minor collector roads; Category A Maintenance Areas – Medium Use; District park | Minor (2) Access roads; Category A Maintenance Areas – Low Use; Pedestrian Parkland; Laneway; neighbourhood park | Minimal (1) Category B Maintenance Areas | N/A (0) |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Risk Score | Calculated | The sum of the individual scores for: Tree Height, Health, Structure, SULE and Risk Zone – maximum 25 | | | | |
| TAMS – Risk Level | Auto | TAMS Management Actions and Responses to Risk Assessment Levels – automatically determined by risk score – see attached Table – Extreme, Very High, High, Medium, Low, Very Low | | | | |
| Utility Lines (In close proximity to tree) | High Voltage – HV | Low Voltage – LV | Domestic / Service | Telco | Aerial Bundle Cable – ABC | None |
| Footpath Conflict | Tick box | Observable damage to footpath that may reasonably be attributed to the tree, including vertical deflection, lips or cracks. Add comments if required. | | | | |
| Verge Crossing Conflict | Tick Box | Observable damage to verge crossing that may reasonably be attributed to the tree, including vertical deflection, lips or cracks. Add comments if required. | | | | |
| Road Conflict | Tick Box | Observable damage to road surface that may reasonably be attributed to the tree, including vertical deflection, root patterns, lips or cracks. Add comments if required. | | | | |
| Kerb & Channel Conflict | Tick Box | Observable damage to kerb & channel that may reasonably be attributed to the tree, including deflection, lips, cracks or roots growing over. Add comments if required. | | | | |
| Utility Line Conflict | Tick Box | Direct or potential crown interference with utility lines. Add comments if required. | | | | |
| Street Furniture Conflict | Tick Box | Crown or root conflict with street signs, light poles, utility poles, bus shelters, service pits, seats, etc. Add comments if required. | | | | |
| Line-of-Sight Conflict | Tick Box | Part of the crown is obscuring an important sight line. Add comments if required. | | | | |
| Utility Box/Stn Conflict | Tick Box | Access to Utility/electrical box on nature strip or electrical/sewage pumps stn obstructed by vegetation pipe. Add comments if required. | | | | |

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|---|---|---|---|---|---|---|
| Underground Services Conflict | Tick Box | Observable damage to underground services that may reasonably be attributed to the tree, such as roots removed from drain, or deflection of pipe. Add comments if required. | | | | |
| Private Infrastructure Conflict | Tick Box | Observable damage to private infrastructure that may reasonably be attributed to the tree, such as lifting fences / walls, deflection of driveways, cracking in house wall. Add comments if required. | | | | |
| Recommended Work Type | Hazard Tree Assessment<br><br>More detailed assessment required – aerial inspection / probe; unclear evidence of decay, termites, bird damage, etc. | Removal<br><br>Tree condition cannot be alleviated by contemporary arboricultural practices | Utility Line Clearance<br><br>Pruning around or over utility lines to create suitable clearance | General Maintenance – Mature<br><br>Mature / large trees – dead wood removal (>50mm ∅/ 2m length); crown thinning; crown lifting; reduction pruning; selective or structural pruning | General Maintenance – Juvenile<br><br>Young and semi-mature trees – dead wood removal; crown lifting; formative pruning | None<br><br>No obvious works required |
| Work Priority | Urgent<br>48hrs | High<br>2 Weeks | Medium<br>3 Months | Low<br>6 Months | Very Low<br>12 Months | None<br>N/A |
| Comments | Text | General comments if required or if removal recommended (use codes). | | | | |
| Marked for Removal | List | No; Pink Cross; Pink Dot; Yellow Cross; Yellow Dot; Blue Cross; Blue Dot; Green Cross; Green Dot. A consistent colour will be used across Canberra to indicate removals; the colour will change each year and specified by Program Manager Urban Trees; dots indicate removals by contractors; crosses indicate removal by PCL staff. | | | | |
| Assessment Date | Auto | Date the tree is assessed and data recorded. | | | | |

**Note:** The assessment included descriptions for health assessment definitions such as useful life expectancy and risk zone ratings from prominent (5) to minor (–2).

## Results

From March to May 2010, the rapid audit was used to assess tree condition across 460,000 trees - approximately 80%[5] of Canberra's urban forest. Preliminary results are provided in the table below.

| | |
|---|---|
| Total trees in audit | 460,000 |
| Total street trees | 263,000 |
| Total planting opportunities in streets | 20,300 (streets) |

**Count of top 20 combined dominant, secondary & tertiary species name and count**

(Accounts for 61% of all trees)

| Species | Count | % |
|---|---|---|
| *Eucalyptus mannifera* | 79538 | 29.07% |
| *Casuarina cunninghamia* | 36615 | 13.38% |
| *Pinus radiata* | 17406 | 6.36% |
| *Eucalyptus polyanthemos* | 17056 | 6.23% |
| *Eucalyptus sp.* | 16032 | 5.86% |
| *Eucalyptus melliodora* | 15659 | 5.72% |
| *Eucalyptus spp.* | 11668 | 4.26% |
| *Eucalyptus cinerea* | 9685 | 3.54% |
| *Quercus palustris* | 8468 | 3.09% |
| *Eucalyptus blakelyi* | 8377 | 3.06% |
| *Populus alba* | 7549 | 2.76% |
| *Eucalyptus sideroxylon* | 7024 | 2.57% |
| *Fraxinus oxycarpa* | 5334 | 1.95% |
| *Fraxinus raywood* | 5254 | 1.92% |
| *Eucalyptus bicostata* | 5233 | 1.91% |
| *Pyrus calleryana* | 5143 | 1.88% |
| *Eucalyptus nicholii* | 5054 | 1.85% |
| *Ulmus parvifolia* | 4938 | 1.80% |
| *Liquidambar styraciflua* | 3898 | 1.42% |
| *Platanus x acerifolia* | 3698 | 1.35% |
| | 273, 629 | |

| | |
|---|---|
| Dominant species as a percentage of total trees in each unit | Average = 61% |
| Secondary species name | MIXED sp. dominant by small percentage over Eucalyptus spp |
| Species 1 as a percentage of total trees | Average = 18.7% |
| Count of very poor or dead trees | Park 7890 |

[5] It was intended to complete all suburbs but seasonal conditions prevented completion of the audit in the timeframe. It is hoped to complete the audit in 2011.

| | |
|---|---|
| | Street 8930<br>**16, 820**<br>3.74% of assessed trees |
| Count of young trees | Total 21,839 or 4.86% of total trees |

| | | | |
|---|---|---|---|
| General recommendation on how to manage unit | Infill | 860 | 10.9% |
| | Maintain | 4919 | 62.5% |
| | No planting opportunity | 749 | 9.5% |
| | Other - comment | 41 | 0.5% |
| | Partial renewal | 632 | 8.0% |
| | Planting opportunity | 464 | 5.9% |
| | Renewal | 211 | 2.7% |

It is interesting to observe that in terms of sustainability, the current (and predicted future) age or size class distribution for Canberra's urban trees does not meet McPherson's[6](1998) features of a sustainable urban forest. His research suggests adequate species and age diversity. Common prescriptions include having no single species accounting for more than 5-10% of the entire population and a good age/size diversity with 40% of trees at less than 20 cm dbh, 30% at 20-40 cm dbh and 20% at 40-60 dbh and 10% older. The Eucalyptus genus dominated the planting in Canberra making up 56% of all trees in parks and streets. Replanting should therefore not necessarily replace like with like in order to reduce the overall number of Eucalypt.

In late December 2009 to February 2010, the inventory approach was used in two of Canberra's oldest parks, Corroboree and Glebe Parks and along Northbourne Avenue, the major arterial into Canberra from Sydney. Data from these inventories is being used to develop specific management plans for these locations in conjunction with community groups and residents adjacent to the sites.

## Comments and recommendations

An audit is an audit and should be used as a management tool for planning at a strategic level. Its strength is that it can efficiently provide information on tree condition and is considerably less costly and quicker than other assessment methods. It relies on a scoring system that is linked to the dominant tree type and therefore may not be as helpful in park situations where it may be difficult to determine the dominant tree species. An individual inventory assessment approach provides the detail that may be needed to manage these sites.

The audit cannot gauge peoples' opinions about trees and thus it does not provide a context to peoples' desire for or angst about trees. For example, a trial exercise was recently undertaken, where information from the audit on a street with a high number of vacant sites was aligned with a resident enquiry for tree replanting. Approximately 30 residents were notified via letter box drop advising them that trees would be (re)planted in their street. Within two days of receiving the notice, five residents responded requesting that a tree not be (re)planted. In management terms, the Government then needs to consider value in (re)planting trees when residents have requested otherwise.

The audit provides useful observations about the actions of residents when trees are either planted that they don't like or not replanted after removal or failure (death) when newly planted. The audit results show that a high number of streets have highly variable and inconsistent street trees.

[6] **Brack, C.L.** (2005) Environmental, amenity and Habitat Values of an Urban Forest: How to determine and manage for them in Canberra. *Proceedings of the 9th Annual ISAAC National Conference*. Launceston, Tasmania. September 30th - October 5th, 2005. P 19.

Reviewing records for these sites shows that (re)planting may not have been undertaken since the original plantings. It can therefore be assumed the resident has planted their own tree, many of which are now mature. Issues around the management of privately planted trees can be problematic as work can be difficult to schedule as these trees may have different needs, the resident often has considerable ownership and may resent pruning work being undertaken as well as the siting and ongoing safety issues. However it may not be a prudent decision to remove these trees just because they were not official streets trees.

The audit initially highlighted considerable vacant sites where trees could be planted in laneways. These areas were of less importance in overall terms for replanting than streets and arterial roads. Given the scale of the issue in Canberra, decisions will need to be made on the tree management priorities in terms of location and replacement species.

## Some conclusions

Information from the audit and inventory are starting points for future management plans of the urban tree estate. Community interests and government responsibilities and priorities are equally important components in the success of future management plans.

An understanding of the detail that can be provided by an audit to that of an inventory is essential. The audit relies on averages to provide efficiencies and allows for data collection at a broad scale which can be used in a strategic planning sense. Information from the inventory however is also essential to more specific management of urban trees.

The scoring fields used in the audit have been designed to rank streets and parks according to ten attributes. The results show there is sufficient variation in the quality of the units to establish a rank or order based on these scoring fields. This scoring system allows the condition of trees at a regional, suburb or street level to be compared although in some cases there may not be great variations between results.

The audit approach provides a snapshot of a landscape unit's condition in time. The accuracy of the information will deteriorate unless updated. Consideration needs to be given to the timeframe and process for updating the information.

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Associate Professor Cris Brack, Chair of Forestry, Waiariki Institute of Technology
Private Bag 3028, Rotorua 3046. New Zealand.

Emeritus Professor Ken Taylor, Australian National University

**Rapid audit undertaken by:**

- DSB Landscape Architects - Jim Laity and Steve Taylor
- GHD Consulting - Melinda Mylek and Tim Brown
- Homewood Consulting Pty Ltd - Ben Kenyon, Cameron Ryder, Aaron Provis, Blake Clancy
- TreeLogic Pty Ltd - Dean Simonsen, Michael Tracy, Bruce Callander, Greg Pollard

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