National Arboretum Canberra

Strategic Forests Review

Prepared by

Mark Richardson
Botanical Consultant

November 2015
Summary of Recommendations of Strategic Review.......................................................... 5

PART 1 Strategic Review ...................................................................................................... 12

1. Introduction ..................................................................................................................... 12

1.1 Purpose of the Strategic Forest Review and Plan ....................................................... 12


2.1 Tree Plantings .............................................................................................................. 14

3. Review of the TCL Plan for the National Arboretum Canberra (Canberra International Arboretum and Gardens - 100 Forests 100 Gardens) ................................................................. 16

3.1 TCL Vision/Mission ................................................................................................... 16

3.2 Other TCL Design Guidelines .................................................................................. 17

4. Review of the ACT Government’s Mission for the Arboretum .................................... 20

5. Forests yet to be Planted .............................................................................................. 22

5.1 Single Species Forests .............................................................................................. 22

5.2 Trial Plantings Forests .............................................................................................. 24

6. Replacement of “Failed” Forests .................................................................................. 27

6.1 Acacia caerulescens (Forest 13) ............................................................................... 27

6.2 Eucalypt sp. (ANU Forest 101) ............................................................................... 28

6.3 Ceiba speciosa (Forest 58) ...................................................................................... 29

6.4 Various Cypress Forests .......................................................................................... 29

6.5 Alternative Species ................................................................................................... 30

7. Relocation of Forest Species ....................................................................................... 34

a) Wollemia nobilis (Forest 32) .................................................................................... 34

8. Completion of First Plantings ....................................................................................... 37

i) Dracaena draco (forest 15) ....................................................................................... 37

ii) Cupressus dupreziana ssp. dupreziana (Forest 40) .................................................. 37

iii) Betula pendula ssp. fontqueri (Forest 44) ................................................................. 37

iv) Lagerstroemia fauriei ‘Fantasy’ (Forest 24) .............................................................. 38
v) Populus euphatica (Forest 74)

vii) Franklinia alatamaha (Forest 93)

9. Replants

9.1 Widdringtonia wallichii (Forest 103)

9.2 Other Forests Requiring a Priority Action for Replanting

10. Boundary Issues (by Stephen Alegria)

10.1 Expansion Areas

10.2 Forest Plantings Within Road Reserves

10.3 Future Impacts from East-West Arterial Road

11. Proposed Establishment of a Federation Forest

Option 1- Conservation Theme

Option 2 – Representative Theme

12. Forest 2 (Locally Indigenous Vegetation)

13. ANU Research Forests (Forests 98 and 99)

a) Experimental design

b) Key research questions

14. Central Valley Spine

14.1 Species Selection

14.2 Spacing of plantings

14.3 Central Valley Gardens

15. The “100 Gardens” Concept

16. Living Collection Database

16.1 Living Collections/Assets Records

16.2 Stocktakes

16.3 Friends Tree Growth Monitoring Project

17. Summary of Stakeholder Consultation

PART 2 General Management of Arboretum Forests

18.1 Pre-Arboretum Plantings
Summary of Recommendations of Strategic Review

Recommendation 1
Consider joining relevant peak bodies as described.

Recommendation 2
Include the role of research in the Arboretum’s mission statement.

Recommendation 3
Prepare an interpretation plan for the Arboretum and consider the possibility to use multi-lingual interpretative material to reflect the diversity of countries that the trees represent.

Recommendation 4
Prepare a conservation plan for the Arboretum to better identify the conservation activities that the Arboretum will undertake.

Recommendation 5
Give a priority to the planting of the most visually prominent forests, i.e. Forest 94 and 91 (See Appendix 1)

Recommendation 6
Replace *Taxodium mucronatum* for Forest 91 to avoid possible problems with cypress canker in the future. Consider using *Sciadopitys verticillata*.

Recommendation 7
Prepare a planting plan and associated full list of species for both the trial forests.

Recommendation 8
Commence the planting of the trial forests after the completion of plantings for the other present forests. This would also give a chance to source propagation material or plants for the trial forests.

Recommendation 9
Make a very serious attempt to ensure that all of the new plantings (and possibly substantial replantings of threatened species) are done so using provenance material.

Recommendation 10
Remove all the *Acacia caerulescens* plantings and replace with another tree species. Replacement species previously approved for consideration are given in Section 6.5.

Recommendation 11
Remove Forest 101 from the ANU Forest (and the Arboretum/ANU’s Memorandum of Understanding). Replacement species previously approved for consideration are given in Section 6.5.
Recommendation 12
Re-assess the survival of forest 58. If the survival of the forest is above 50% consider the replanting of the dead trees. If it is below 50% consider the removal of the remaining *Ceiba speciosa* trees and commence the replacement of the forest. Replacement species for consideration are given in Section 6.5.

Recommendation 13
Continue to regularly check the Cupressaceae forests, keep an accurate record of the location and extent of any infections or possible infections and remove any infected limbs. If there are only occasional losses replace lost trees. However, if any of the species is obviously very susceptible to the cypress canker, replacement should be seriously considered.

Recommendation 14
Re-divide the current Forest 32.

Recommendation 15
Retain the remaining Wollemi pines in Forest 32

Recommendation 16
Create a new forest within current Forest 32 ('102')

Recommendation 17
Establish a new Wollemi planting in Forest 76

Recommendation 18
Delay the final plantings until a much better idea of the *Dracaena draco*’s longer term and unprotected frost survival can be established.

Recommendation 19
Source the propagation material (preferably seed) for the remainder of plantings of *Cupressus dupreziana* ssp. *dupreziana*, identify an obvious part of the unplanted section of the forest and ensure that the provenanced trees are GPSed at planting and recorded in the database.

Recommendation 20
Propagate sufficient trees to complete the plantings for the *Betula pendula* ssp. *fontqueri*. These plants can be propagated from cuttings collected from identified trees on site but more seed should also be sourced from the National Centre for Forest Genetic Resources in Spain.

Recommendation 21
Continue the slow thinning of the *Betula pendula* ssp. *pendula* starting deep within the forest and in numbers directly related to the number of *Betula pendula* ssp. *fontqueri* already propagated for planting.

Recommendation 22
Finish the car park planting in winter 2016. Given the large number still to be planted it will be important to start sourcing plants before 2016. If the carpark will not be prepared by winter 2016,
Recommendation 23
Continue to source propagators for the *Populus euphratica*. Ensure that this is given a priority and is continued until the forest is fully planted.

Recommendation 24
Either buy plants or source seed for the *Franklinia* and supply it to Yarralumla Nursery for propagation, noting the long lead time required.

Recommendation 25
Undertake propagation of the *Widdringtonia* to replace any deaths and fill any unplanted spaces. For the continued propagation it is recommended that provenance seed be sought.

Recommendation 26
Review and if needed update the stocktakes of the Cypressaceae forests, source seed or seedlings as a high priority and program preparation and replanting activities for autumn 2016 onwards.

Recommendation 27
Consider the list of alternative species for selection for expansion of the Arboretum and for replacing of forests 13 and 101.

Recommendation 28
Consult with ACT Roads before undertaking replantings or other significant management actions within the road reserve.

Recommendation 29
The Arboretum continue to liaise with other ACT Government agencies to ensure urban development and road construction has a positive impact on the Arboretum.

Recommendation 30
Set aside an area of Forest 32 for a future Federation forest and confirm the desired species selection.

Recommendation 31
Review the management plan for Forest 2.

Recommendation 32
Consider a stronger connection between Forest 2 and the STEP forest and explore STEP having more input into the management of Forest 2.

Recommendation 33
Remove the remaining *Eucalyptus* and *Corymbia* trees in Forest 101 and replant the area with a new species from the list in section 9.

Recommendation 34
Replant the *Corymbia* trees in Forests 98 and 99.
Recommendation 35
Replant the *Eucalyptus tricarpa* along the Parkway section. These trees will be not be used for the ANU research but will be used for interpretation about the research.

Recommendation 36
Continue to use the zoning system to use the climatic conditions of the central valley and identify suitable species that are known to be readily available and that can be successfully grown on the site.

Recommendation 37
Continue to follow the ceremonial planting policy to have only one planting of any given species.

Recommendation 38
Ensure that the spacing of future plantings is appropriate to prevent trees being overgrown by others.

Recommendation 39
Ensure the future review of the Arboretum Master Plan considers whether the central valley gardens are still a viable and desirable objective, or whether the garden sites could be better utilised for trees.

Recommendation 40
Consider the future of the 100 gardens concept as part of a review of the Master Plan.

Recommendation 41
Continue the development of the GIS-based asset record and mapping system including a capacity to collect and manage information.

Recommendation 42
Utilise the asset record and mapping system to undertake future recording of tree condition and other key factors, including whether plants found to be missing in the last stocktake:
- were part of the planting and need to be replaced
- were never a part of the planting
- are now viewed as no longer a part of the tree locations to be planted

Recommendation 43
Define the class of ‘poor health’ in more detail before the next stocktake to achieve a more consistent appraisal of the trees, and particularly if it is to be again done with volunteer assistance.

Recommendation 44
Promptly remove dead or very poor trees and record the removal.

Recommendation 45
Continue to encourage and support the Tree Growth Monitoring project and ensure that the Arboretum is fully aware of how the project is progressing.
Recommendation 46
Ensure that the information that has been collected over the past 4+ years is incorporated into the Arboretum living collection database.

Recommendation 47
Continue to discuss with NCA the opportunity to link the two trial forests in the Arboretum with the trial plantings at the Lindsay Pryor Arboretum. As a part of this, opportunities to share plant material and undertake cooperative management should be considered.

Recommendation 48
Given the way in which the STEP Forest is now being promoted as a regional botanic garden, consideration should be given to promote it as another component of the Arboretum in the same way as the National Bonsai and Penjing Collection. As a part of this, it should be discussed with STEP how they define ‘regional botanic garden’ and how they plan to effectively develop themselves to achieve that definition.

Recommendation 49
Continue to discuss with NCA the opportunity to link the two trial forests in the Arboretum with the trial plantings at the Lindsay Pryor Arboretum. As a part of this, opportunities to share plant material and undertake cooperative management should be considered.

Recommendation 49
The following tasks are required for the Cork Oak Forest:
- Remove dead trees from within the forest
- Remove weed from along the eastern edge of the forest
- Lift the cork oak trees in Forest 2

Recommendation 50:
Address safety and amenity issues before encouraging visitors to the forest, through:
- Control and remove the blackberry in the SW of the forest
- Remove the dead trees and in particular those that have been felled
- Remove obvious waste and wire from the forest site
- Establish trails to facilitate access.

Recommendation 51
Lift trees on the edge of the forest for fire prevention purposes, and lift trees within the trail corridor for safety reasons, otherwise allow trees to grow naturally.

Recommendation 52
Use the southern third of the forest for Wollemi pines

Recommendation 53
Continue to treat blackberry as the ‘priority weed’ until it is felt to be well under control.

Recommendation 54
Work with neighbouring land managers to establish a weed control zone of at least 50 m for the blackberry occurring in areas adjacent to the Arboretum.
Recommendation 55
Seek to include the Arboretum in any TAMS trialling programs for Blackberry Rust.

Recommendation 56
Address the spread of serrated tussock in the Arboretum with an integrated approach to control that seeks to avoid the loss of any substantial native grass areas that already exist on site.

Recommendation 57
Develop and implement an annual fertilising program.

Recommendation 58
Review the mulching of the forests at least every autumn and ensure that those requiring remulching should be done by late Spring. The order in which the forests are mulched should be partly decided by the species most likely to be effected by drought.

Recommendation 59
Aim to have all of the rock outcrops fit the restoration and management plan before the beginning of the next horticultural contract.

Recommendation 60
Review all of the forests with guards and develop a plan for their removal based on its suitability. Include these removals in the volunteer program.

Recommendation 61
Complete initial formative pruning in the next 12 months

Recommendation 62
Consider the need to maintain views and public access along pathways as a part of the individual forest maintenance plans.

Recommendation 63
Prepare a plan for the planting and management of the water edge for all of the dams.

Recommendation 64
Review and prioritise the proposals to use areas around the dams in Forests 2 and 36 for recreation/barbeque areas.

Recommendation 65
Spray and mulch the basins of dead or badly damaged trees when they are removed so as to keep the location very obvious for replanting and stocktaking and to stop the irrigation system damage.

Recommendation 66
Treat all Cupressaceae forests as if at risk, even if there has been no sign of the Cypress canker to date.
**Recommendation 67**
Suspicious material found on any species not previously infected should be sent to one of the plant disease diagnostic laboratories.

**Recommendation 68**
For the future control of Phytophthora, it is recommended that the following be addressed:
- Continued drenching program for the Wollemi Pines, Ginkgos and Sequoia forest lots
- Commencement of a wider test for Phytophthora across the site to better determine the number and spread of forest lots that will need to be included in any further treatment/management
- Consideration of all drenching of all potted and open rooted plants coming onto the site for planting.
- Sourcing of further expert advice with relation to disease management
- Preparation of an Arboretum management plan for Phytophthora root rot.

**Recommendation 69**
Provide irrigation systems that allow the use of procedures like pulse irrigation to more efficiently use the water.

**Recommendation 70**
Ensure that irrigation in all the forests is checked and repaired before every summer. Those forests that are more dependent on irrigation are shown in Appendix 7.

**Recommendation 71**
Ensure that all of the irrigation system is fully functional at the commencement of the next maintenance contract and that the upkeep of the system is a part of the contract.

**Recommendation 72**
Re-route or bury the irrigation piping that was run across rock outcrops without it being buried.
PART 1 Strategic Review

1. Introduction

In 2003 the bushfire that ravaged Canberra was the catalyst for the creation of an Arboretum originally envisaged by the designer of the city of Canberra, Walter Burley Griffin.

In December 2003 the ACT Government agreed that the burnt-out pine forest area known as Green Hills is to be preserved as an international Arboretum. It has been developed on a 250-hectare site near Lake Burley Griffin about six kilometres from the centre of Canberra. The site incorporated existing stands of Himalayan Cedar (*Cedrus deodara*) and Cork Oak (*Quercus suber*), much of which was planted nearly 100 years ago; some remaining *Pinus radiata* trees that were planted before the fires; stands of eucalypt species planted near the cork oaks in the 1970s, and; a *Pinus radiata* forest planted since the fire.

A national design competition for the National Arboretum Canberra (previously the Canberra International Arboretum and Gardens) commenced in September 2004, and on 31 May 2005 the ACT Chief Minister, Jon Stanhope MLA, announced the landscape architects Taylor Cullity and Lethlean, with the architects Tonkin Zulaikha Greer, as the winners with the “100 Forests 100 Gardens” entry. As the name suggests, the design includes a series of forests instead of the usual Arboretum collections of individual trees or small clumps.

An important aspect of the “100 Forests 100 Gardens” design concept was the designers’ focus on threatened and rare trees. This has provided an excellent theme in terms of the selection of the tree species and provided an opportunity to highlight the fact that many of the world’s trees, often common in cultivation, are in fact threatened in the wild. For some of them, it may also help to protect them through *ex situ* conservation. The Arboretum’s living collection also provides a valuable future resource in Canberra for ongoing education and research programs and will be a place for community recreation. The goal of the plan was to create a place of outstanding beauty, of international standard and interest.

In 2014, Taylor Cullity Lethlean (TCL) and Tonkin Zulaikha Greer (TZG) won the Landscape of the Year award at the World Architecture Festival (WAF) for their design of the National Arboretum. “Rather than a collection of individual trees as specimens, we wanted to create grand forests that offer unique and contrasting visitor experiences and hold a viable population to preserve vulnerable and endangered species,” said TCL Director, Perry Lethlean, of the Arboretum. “It is a strategy, a program and an ongoing event, not a design based chiefly on aesthetics.”

1.1 Purpose of the Strategic Forest Review and Plan

By the end of 2012, 94 forests had been established at the National Arboretum Canberra. Since then the focus of Arboretum management has been on consolidating and bedding down the newly established forests, infrastructure and buildings and meeting the needs of over one million visitors who have attended the Arboretum since it opened to the public in February 2013.

There are a number of factors that have come together to suggest that it is timely to review the plans for completing the establishment of the National Arboretum’s forests. These factors include:

- The end of the initial consolidation phase after the Arboretum’s public opening and an consequent increase in management’s capacity to address strategic issues;
- Increasing public interest in the Arboretum and the timing of establishment of unplanted forest lots;
• Confirmation of urban expansion plans that will affect the southern part of the Arboretum in the medium term;
• Completion of a Forest stocktake
• Initial development of a living collections database

The Strategic Review considers the design intent of the TCL “100 Forest, 100 gardens’ concept and the subsequent Arboretum Master Plan developed by Taylor Cullity Lethlean (TCL) in light of current and anticipated management, stakeholder, development and biophysical conditions, and includes consideration of:
• Arboretum Master Plan as developed by TCL
• General management of Arboretum forests (including those planted before the Arboretum was established)
• Relocation of forests and/or other actions to mitigate the impact of infrastructure required for future urban expansion to the south and west of the Arboretum
• Completion of forests yet to be fully planted
• Issues raised by the recently completed Forest Stocktake including the future of failed forests where losses have exceeded 30%
• Unplanted forest lots including reviewing species selection where warranted
• Proposed establishment of a Federation Forest
• Arboretum-managed land to the west and north that is currently earmarked for “future expansion” (excluding biodiversity offsets sites)

The study has included:
• Consultation
  o TCL
  o The Friends of the National Arboretum
  o Arboretum staff
  o STEP
  o Australian National University
  o National Capital Authority

• Recommendations for issues to be considered in a review of the Master Plan
• Inclusion of nine appendices containing further detailed analysis and information, mostly based on previous reports

In September 2004 the design ideas for the Canberra International Arboretum and Gardens (now National Arboretum Canberra) were released for the design competition. In the overview of the concept, the original intentions for the Arboretum were given as:

- A place of great beauty
- A centre of horticultural excellence
- A national institution of international excellence
- A major tourist destination
- A leisure resource for all Canberrans
- A place of civic uses
- A venue for community and family uses
- A resource for scientific study – where science and education become intertwined.

Although only open for two and a half years the Arboretum has already met a significant number of the original intentions – particularly in terms of its visitation. In addition the Arboretum’s design has received international approval with TCL having received the Landscape of the Year at the World Architecture Festival in 2014.

With regards to its place as a national institution of international excellence, the original design guidelines give the Australian National Botanic Gardens and a number of international arboreta and botanic gardens as the benchmarks. While the Arboretum is already gaining recognition both nationally and internationally, there is ample opportunity to raise its profile through involvement in peak bodies and other organisations with a collaborative and information sharing focus, such as:

- Council of Heads of Australian Botanic Gardens
- Botanic Gardens of Australia and New Zealand
- Australian Network for Plant Conservation (2 Arboretum articles published)
- TreeNet (Conference paper given)
- Botanic gardens Conservation International (Arboretum article published)
- Global Tree Campaign

The ACT representative on the Council of Heads of Australian Botanic Gardens has always been the Australian National Botanic Gardens, however, the decision by the ACT government to have a substantial botanical institute could allow the Arboretum to be the ACT representative and the ANBG to be the national representative.

**Recommendation 1**

Consider joining relevant peak bodies as described.

2.1 Tree Plantings

With regard to the tree plantings themselves, it was viewed that they must be designed in a way that provides for:

_i) Themes that showcase seasonal changes_

**Outcome:**

*With the mix of evergreen and deciduous trees the seasonal changes of the Canberra area are well displayed. They also represent a very wide range of countries from around the world.*

_ii) Collections of acid- and alkaline-loving trees and dry-country species_
Outcome:
An important focus has been put on species that are drought tolerant with many coming naturally from dry areas to assist in future water use. Within the range of different plant families and habitats represented both acid- and alkaline loving trees are present.

iii) Conservation of rare and endangered species
Outcome:
Nearly half the species selected are either rare or threatened.

iv) Representation of Australian species and their cultivars
Outcome:
Both Forest 2 and the STEP forest have a strong representation of naturally occurring species (See section 12)

v) Areas that demonstrate horticultural techniques for trees
Outcome:
All of the forests are effectively providing examples of the arboriculture of the different trees

vi) Trial beds
Outcome:
As well as trialling a number of species in the forest plantings, two of the forest lots have been allocated for the trialling of a wide range of species. (See section 5.2)

vii) Different planting techniques
Outcome:
Given the very large number of trees planted in a relatively short time, what was seen as an effective planting method has been used across the site.

Although the gardens form a significant part of the Design Brief for the Arboretum, there has to date been a limited amount of thinking about gardens in the Arboretum.

Further consideration of the 100 gardens concept is in section 15 (Recommendation 40).
3. Review TCL Plan for the National Arboretum Canberra (Canberra International Arboretum and Gardens - 100 Forests 100 Gardens)

3.1 TCL Vision/Mission

From the TCL Design Criteria:
Selection and location of species shall meet the criteria of being either ‘threatened’ or ‘symbolic’. The term ‘threatened’ refers to tree species that have been nominated by the United Nations ‘red list’ or similarly recognised government or national body from the country of the trees origin or credible research body. The term ‘symbolic’ refers to trees nominated by the national governments of the world as having national symbolic standing in their country of origin based upon cultural identity and unique physiology of the trees.

From the TCL website:
- The 100 forests not only provide a unique experience – the pleasure of being enveloped in a forest of one species – but are also seed banks for the future. Each holds a viable population to preserve vulnerable and endangered species.
- As it develops into the future, the National Arboretum will build links across the world, an exchange of knowledge and actual plant material that will work towards reversing the planet’s loss of biodiversity.

From other comments made by TCL:
- The Arboretum offers a contemporary reinterpretation of the notion of Arboretum by including botanically threatened or ethnobotanically significant tree species from around the world into a repository of biodiversity for the future.
- The vision for the Arboretum anticipates a viable public destination for the next 100 years. The masterplan is centred on creating 100 forests with the world’s most endangered tree species, interspersed with 100 gardens. WAN Awards 2012.
- The result of planting the trees into single-species forest lots containing between 300 and 2000 trees will be a botanically significant collection offering an immersive experience of form, colour and light, augmented by the rustle of leaf-litter, the texture of the bark and the sound of wind moving through the canopies.
- 100 Forests is a living project, it has no completion date, its experiences and messages will continually evolve and adapt; creating experiences of true community within a sublime place that will grow with the people, the city and the nation.
- The ‘mission’ of the National Arboretum is to: “Create grand forests that offer unique and contrasting visitor experiences and hold a viable population to preserve vulnerable and endangered species. It is a strategy, a program and an ongoing event, not a design based chiefly on aesthetics.” (http://worldlandscapearchitect.com/national-Arboretum-canberra-australia-taylor-cullity-lethlean-tonkin-zulaikha-greer/)

Of the above what has been met?

<table>
<thead>
<tr>
<th>TCL design criteria/guideline</th>
<th>Status (achieved, in progress, not achieved)</th>
<th>Comments and notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant the forests with threatened or symbolic trees with plant conservation as the primary theme.</td>
<td>Achieved</td>
<td>Ethnobotanical species were also planted to highlight the importance of conserving trees.</td>
</tr>
</tbody>
</table>
Forests are to be planted with a single species. | Mostly Achieved | Eleven forests have 2 species planted. The second species was planted as a ‘host’ species for the threatened species originally chosen. It is intended that the forests will revert to monocultures of the threatened species over time. Except for the trial forests, the remaining forests should be planted as monocultures.

100 Forests are to be planted | Mostly Achieved | Eight forests including two trial species forests are yet to be planted. A further nine to ten forests could be planted in the reacquired area of the Glenloch property (Patch N).

100 Gardens are to be planted | Not achieved | The relevance of the 100 gardens component of the original forest design concept should be reconsidered. A proposal for a garden in each of the forests is provided in Section 18 of this report.

The collection is to be botanically significant | Achieved | The collection chosen represents evergreen and deciduous trees from 35 families, the flora of every continent and the flora of just over 100 countries.

The Arboretum is to be an evolving project | Achieved | Since the project began it has adapted to what has been learnt.

The arboretum is to develop global links | Partly Achieved | The Arboretum’s primary conservation theme has been recognised by plant conservation organisations in Australia and overseas. There is considerable scope for further promotion and collaboration.

### 3.2 Other TCL Design Guidelines

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Implementation to date</th>
<th>Future Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest species shall be reviewed and located on a specific plot using the following criteria; soil type, ephemeral site conditions, adjacent plantings, cultural meaning, forest experience, preferred growing conditions and mass effect.</td>
<td>Followed throughout the planning of the Arboretum</td>
<td>Continue to take this into account for any new plantings.</td>
</tr>
<tr>
<td>Statement</td>
<td>Followed throughout the planning of the Arboretum</td>
<td>Action</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Tree plantings shall fill the forest lot to the border of the allees and maintain the line created by the adjacent forests</td>
<td>Prioritise the replacement of trees missing along allee borders.</td>
<td></td>
</tr>
<tr>
<td>Forest expression shall be the primary consideration for all lots. Understorey and ground plane planting e.g. shrubs, ground covers and grasses shall be a secondary consideration.</td>
<td>Followed throughout the planning of the Arboretum</td>
<td>Continue to give understorey plantings a very minor role in the forests especially given the maintenance issues.</td>
</tr>
<tr>
<td>Clearings or detailed gardens can be proposed within the forest lots and shall follow these criteria; they shall be generally rectangular in shape, 80m x 20m in size and be located internally in the forest lot. The design and location of any proposed detailed garden or artwork shall be subject to approval.</td>
<td>Not followed throughout the planning of the Arboretum</td>
<td>Revisit the forest plans and identify the areas that were left for garden plantings. Decide whether those gardens will go ahead, be further planted with trees or just become open areas in the forest needs to be made.</td>
</tr>
<tr>
<td>Allees shall be kept clear of trees and shrubs and maintain a cleared appearance.</td>
<td>Followed throughout the planning of the Arboretum</td>
<td>Ensure that this guideline continues to be followed.</td>
</tr>
<tr>
<td>Lot dividers shall be 10m wide and be located between tree lots. They shall run perpendicular to the allees.</td>
<td>Followed throughout the planning of the Arboretum but, similarly to the allees, their impact has been lessened by tree losses along the edges of the forest dividers.</td>
<td>Ensure that the trees that keep the dividers between the forests obvious are replaced if lost.</td>
</tr>
<tr>
<td>The layout, spacing and planting rate of tree species with in the forest lots will be determined for each forest. This will extend to e.g. the planting of forest trees at initially dense rates which will later be thinned, pruned or transplanted for aesthetic, preservation or plant health considerations as determined suitable.</td>
<td>The only forest that has been thinned so far is the <em>Eucalyptus benthamii</em>. A major problem with the other forests is that the design story or rationale for most of the forests is unknown and the effect of tree removal is not easy to determine. Until the full set of designs have been obtained it will be very difficult to address this guideline and not affect the original designs.</td>
<td>Obtain from TCL the story or rationale for the design of the forests. Determine the effect that actions like thinning will have on a design before doing so.</td>
</tr>
<tr>
<td>The continued evolution of the individual forest lots will be directed over time to ensure that a consistent vision is maintained for the forest.</td>
<td>With the majority of the designs still unknown this has not been followed.</td>
<td>Finalise the Forest Management Plan with reference to the original designs to assist the consistent maintenance of the forests.</td>
</tr>
</tbody>
</table>
The forest site preparation specification should achieve the following:

- Site cleaning; removal of logs, rocks, all debris, pines, weeds, etc.
- Deep ripping
- Weed eradication
- Generation of an open and friable growing medium
- Ground smoothing
- Surface treatment
- Sow pastoral or dryland grass e.g. Clover, Sub clover and Rye in the Allees to establish their ultimate location, define the future forest lots and for ease of maintenance
- Fertilizing and mulching
- Weeding and mowing regimes

The majority has been followed throughout the development of the Arboretum.

Review the condition of the forests with regards to the original forest site preparation specification and address the condition of the forests if they fail to meet the specifications. Highlight the forest site preparation specification for the preparation of the remaining unplanted forests (including those in Patch N).
4. Review of the ACT Government’s Mission for the Arboretum

The Arboretum’s current vision statement is being finalised, with proposed wording as follows: “An inspiring living collection embraced by Australians and recognised throughout the world”

The mission proposed is: 
Create and nurture a living collection with outstanding beauty, community amenity and scientific value for recreation, conservation and education

As a part of this it is important to note that a "living collection" is a group of plants grown for a defined purpose and which needs to be supported by a plant recording system. Thus, it moves away from being merely ornamental to being a commodity to be used for various means.

At present, the Arboretum’s collection can be split into four groups:

a) the monocultural forests as proposed in the original plan (including the Central Valley)
b) multi-species plantings of the ACT’s flora, being, Forest 2 which represents the flora of just the immediate vicinity of the Arboretum and Forest 20 (STEP) which represents a broader picture of the ACT regional flora.
c) National Bonsai and Penjing Collection
d) Gardens

Although the different nature of the Bonsai Collection is well promoted and supported, the STEP collection has not been obviously promoted as a specific collection. However, STEP is now promoting Forest 20 as a “regional botanic garden” as is the Arboretum website and its standing in the Arboretum needs to be reviewed (see section 12.1).

Also, given the widely accepted BGCI definition of a botanic garden, which is: “Botanic gardens are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education”, the Arboretum’s mission goes a long way to present it as a functioning botanical institution.

While the current mission statement does not explicitly include scientific research, the Arboretum’s MOU with the Australian National University includes the following statement: “The Arboretum is intended to be a multipurpose facility providing for the conservation of threatened species, a range of scientific and research purposes, a site for practical educational use for such activities as horticulture, botany, forestry, ecology and related uses.”

Recommendation 2
Include the role of research in the Arboretum’s mission statement.

Considering the current Arboretum mission statement, how well has this been met?

a. “Create and nurture a living collection of forests”:
Strengths:
- A living collection of forests has been created
- A living collection policy has been produced
- The majority of the forests have grown well
- Some original records have been kept
- The forests have had a recent and thorough audit
- A database system to assist ongoing auditing and record keeping is being created

Weaknesses:
• Little information about the collection was effectively recorded and several of the original records are likely to have been lost (see section 19)
• The condition of several of the forests has declined since opening (see section 6)

b. “Of International significance”:
Strengths:
• Species have been selected from a wide range of countries
• Many species have an international conservation significance
• Many species have a symbolic or ethnobotanical significance in their countries of origin
• The Arboretum has already been recognised by international organisations
Weaknesses:
• The international definition of a botanic garden (or Arboretum) will not be met until the documentation of the living collection has been achieved (see section 19)
• There has been little actual interaction with other organisations

c. “For recreation, education and conservation”
Achievements:
• Many people already enjoy walking, cycling and horse riding in the forests
• Interesting educational workshops and programs are offered for students of all ages
• Guided tours with the Friends are providing informal education for visitors
• The collection includes a considerable number of threatened species
Failures
• Very little interpretation is in the forests
• Much of the current interpretation is in poor condition
• An interpretation plan has not been prepared
• A conservation plan has not been prepared

Recommendation 3:
Prepare an interpretation plan for the Arboretum and consider the possibility to use multi-lingual interpretative material to reflect the diversity of countries that the trees represent

Recommendation 4:
Prepare a conservation plan for the Arboretum to better identify the conservation activities that the Arboretum will undertake.
5. Forests yet to be Planted

5.1 Single Species Forests:

There are still 6 single species forests yet to be planted. These were not planted so as to ensure that the forests started before opening were completed prior to opening.

It is effectively the Phase 2 of the Arboretum’s first planting. Of the species selected for the forests all but one are still seen to be suitable. See below for the suggested replacement.

The location of the forests is given in Figure 1 below:

The species recommended for the remaining 6 single species are given below.

<table>
<thead>
<tr>
<th>Forest</th>
<th>Species</th>
<th>Theme</th>
<th>Suitable for planting</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td><em>Podocarpus latifolius</em></td>
<td>Ethnobotany</td>
<td>Yes</td>
<td>Possible Source: B&amp;T Seeds</td>
</tr>
<tr>
<td></td>
<td>Broad-leaved Yellowwood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td><em>Brahea edulis</em></td>
<td>Conservation</td>
<td>Yes</td>
<td>Possible Source: B&amp;T Seeds, Palms Online</td>
</tr>
<tr>
<td></td>
<td>Guadalupe Palm</td>
<td>Endangered IUCN</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig 1: Single species forests yet to be planted
<table>
<thead>
<tr>
<th></th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Conservation Status</th>
<th>Possible Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>Pseudolarix amabilis</td>
<td>Chinese Golden Larch</td>
<td>Vulnerable IUCN</td>
<td>Yes</td>
</tr>
<tr>
<td>78</td>
<td>Carpinus orientalis</td>
<td>Oriental Hornbeam</td>
<td>Ethnobotany</td>
<td>Yes</td>
</tr>
<tr>
<td>91</td>
<td>Taxodium mucronatum</td>
<td>Ethnobotany</td>
<td>Consider alternative</td>
<td>Possible cypress canker problems (see section 15.10)</td>
</tr>
<tr>
<td>91</td>
<td>Sciadopitys verticillata</td>
<td>Ethnobotany</td>
<td>Suggested alternative</td>
<td>Possible source: Yamina Rare Plants, B&amp;T Seeds. Needs irrigation.</td>
</tr>
<tr>
<td>94</td>
<td>Quillaja saponaria</td>
<td>Ethnobotany</td>
<td>Yes</td>
<td>Possible Source: Trade Winds Seed</td>
</tr>
</tbody>
</table>

Full descriptions of the above are given in “The Arboretum Book”. A description of the *Sciadopitys verticillata* is given below.

**Sciadopitys verticillata**

*Family:* Sciadopityaceae – not yet represented.

*Conservation Status:* Vulnerable (IUCN)

*Natural Occurrence:* Endemic to Japan

*Description:* Conifer that can grow 15-25m tall

*Tolerances:* Cold tolerant but will need occasional irrigation.

*Possible Source:* Commercial nurseries, B&T

---

**Recommendation 5**

Give a priority to the planting of the most visually prominent forests, i.e. Forest 94 and 91 (See Appendix 1)
**Recommendation 6**

Replace *Taxodium mucronatum* for Forest 91 to avoid possible problems with cypress canker in the future. Consider using *Sciadopitys verticillata*.

### 5.2 Trial Plantings Forests

An important role of the National Arboretum has been to introduce new or rarely planted tree species that may be suitable for planting in Canberra’s urban forest in the future. It is not only an opportunity to learn more about the trees that are already adapted to the Canberra climate but also trees that may be affected by climate change over time.

Several less well known trees are to be trialled in two forests, namely Forests 37 and 63 (see Fig 2). The main aim for these plantings is to grow the trees long enough to determine whether they are in fact suited to the Canberra conditions and what maintenance issues might exist. There will only be 10-12 trees per species and the length of time each of the species is kept on trial will depend very much on the success of the tree. The more successful or very unsuccessful the tree is, the faster will be the turn-over and replacement. It is recommended that those trees that have been successful should then be further trialled in plantings around Canberra. The running of these trials would be of interest to other stakeholder groups including, the Friends of the Arboretum and TAMS City Services.

![Trial Forest (63)](image)

![Trial Forest (37)](image)

**Fig 2.** Trial Forests yet to be planted
Below are given those species that have already been selected to start the trial forests:

i) Conservation Species

1. **Agathis australis** (Forest 63)
   
   **Family:** Araucariaceae  
   **Conservation Status:** Conservation dependant (IUCN)  
   **Natural Occurrence:** New Zealand  
   **Description:** Conifer growing to 30m+  
   **Tolerances:** Would probably need frost protection when young and irrigation during hot dry periods.  
   **Possible Source:** Commercial nurseries

2. **Athrotaxis selaginoides** (Forests 37 & 63)
   
   **Family:** Cupressaceae  
   **Conservation Status:** Vulnerable (IUCN)  
   **Natural Occurrence:** Endemic to Tasmania  
   **Description:** Conifer that can grow from 20-30m tall  
   **Tolerances:** Cold tolerant but will need occasional irrigation  
   **Possible Source:** Wildseed Tasmania, Tasmanian Forestry

3. **Jacaranda mimosifolia** (Forest 63)
   
   **Family:** Bignoniaceae  
   **Conservation Status:** Vulnerable (IUCN)  
   **Natural Occurrence:** Brazil and Argentina  
   **Description:** A deciduous tree growing to 15m  
   **Tolerances:** Can tolerate drought and has been recorded to tolerate frost.  
   **Possible Source:** Commercial nurseries

ii) Ethnobotanical Species

4. **Atalaya hemiglauca** (Forest 37)
   
   **Family:** Sapindaceae  
   **Natural Occurrence:** Australia (central and north)  
   **Description:** Tree to 12m  
   **Tolerances:** Very drought tolerant and tolerant to some frost  
   **Possible Source:** Commercial nurseries

5. **Brachychiton acerifolius** (Forests 37 and 63)
   
   **Family:** Malvaceae  
   **Natural Occurrence:** Australia (subtropical east coast))  
   **Description:** Tree to 20m  
   **Tolerances:** Drought tolerant and known to be tolerant to light frost  
   **Possible Source:** Commercial nurseries

6. **Dais cotinifolia** (Forests 37 & 63)
   
   **Family:** Thymeleaceae  
   **Natural Occurrence:** Southern Africa  
   **Description:** Small tree to 6m  
   **Tolerances:** Drought resistant once established and frost hardy  
   **Possible Source:** Commercial nurseries

7. **Ficus platypoda** (Forest 37)
Family: Bignoniaceae
Natural Occurrence: Australia (northern to central)
Description: Tree to 8-10m
Tolerances: Very drought tolerant and tolerant to some frost
Possible Source: Commercial nurseries

8. *Melaleuca quinquenervia* (Forests 37 and 63)
Family: Myrtaceae
Conservation Status: Nil
Natural Occurrence: NSW and QLD, Australia
Description: Moderate sized, evergreen tree up to 15m
Tolerances: May require occasional watering possibly frost tolerant
Possible Source: possible commercial nursery, NSW national parks

9. *Paulownia tomentosa* (Forest 37 and 63)
Family: Paulowniaceae
Conservation Status: Nil
Natural Occurrence: East Asia
Description: Tree to 15-20m, – fast growing and impressive flower display.
Tolerances: It is frost and drought tolerant.
Possible Source: Commercial nurseries.

10. *Santalum acuminatum* (Forest 37 and 63)
Family: Santalaceae
Natural Occurrence: Australia WA, SA, Vic, NSW
Description: Tree to 7m
Tolerances: Very drought tolerant and tolerant to some frost
Possible Source: Commercial nurseries

11. *Tabebuia chrysotricha* (Forest 37 and 63)
Family: Bignoniaceae
Other selection criteria: Symbolic
Natural Occurrence: Brazil
Description: Tree to 8-12m
Tolerances: Moderately drought tolerant and tolerant to light frost
Possible Source: Commercial nurseries

**Recommendation 7**
Prepare a planting plan and associated full list of species for both the trial forests.

**Recommendation 8**
Commence the planting of the trial forests after the completion of plantings for the other present forests. This would also give a chance to source propagation material or plants for the trial forests.

**Recommendation 9**
Make a very serious attempt to ensure that all of the new plantings (and possibly substantial replantings of threatened species) are done so using provenance material.
6. Replacement of “Failed” Forests

Of the forests planted to date, 3 need to be considered for replanting with a new species in the very near future and 1 may need replacement soon. In addition, several Cypress forests are vulnerable to disease and require special treatment and monitoring. The location of the forests is shown in Fig 3.

6.1 Acacia caerulescens (Forest 13)

This threatened species has been found to be fast growing in Canberra, growing from about 35cm when planted to approximately 2m after the first year. In its early years, it was very obviously affected by northerly winds with many of the trees developing a lean to the southeast of up to 20°. Until 2010, the losses were low but with wet summers in 2010 and 2011 a large area of the forest was lost. The main reason for these losses was viewed as resulting from a very wet area which has since had drainage installed. However, since then many of the trees have been very seriously affected by insect attack. It is likely that this has primarily been done by the jewel beetle *Agrilus hypoleucus*.

The effects on the Acacia have been splitting of the bark, weeping of sap, weakening and lose of tree limbs and death of trees.

In 2012, 100 trees were replanted at the edge of the area that had had the losses during the wet period. Although they have again grown well when young, losses have been recorded.
Complete removal of the forest is justified based on the outcome of this experimental planting. It will allow replanting of a more suitable species and prevent the need for ongoing actions to manage the forest including removing dead trees. However it will also require installation of an irrigation system, interpretation to explain the removal and updates to various publications. A full copy of the 2013 review of the *Acacia caerulescens* forest is given in Appendix 2.

**Recommendation 10**

Remove all the *Acacia caerulescens* plantings and replace with another tree species. Replacement species previously approved for consideration are given in Section 6.5.

![Acacia caerulescens](Image)

**Fig 4. Acacia caerulescens.** New plantings and earlier plantings in decline (Photo: M. Richardson)

### 6.2 *Eucalypt sp.* (ANU Forest 101)

Forest 101 was initially planted as a part of the ANU research Forest. Not only has it lost a large number of the trees planted, but as they get older it is now obvious that the forest species are not just *Corymbia maculata* and *Eucalyptus tricarpa* but includes other unrelated species (See Fig 5.)

In its current condition, this forest is unusable by the ANU for its research purposes and after consultation with the ANU (Prof. Cris Brack) it is recommended that the forest be removed and used for the planting of another species. Section 10 contains a list of possible alternative species.

**Recommendation 11**

Remove Forest 101 from the ANU Forest (and the Arboretum/ANU’s Memorandum of Understanding). Replacement species previously approved for consideration are given in 6.5
6.3 *Ceiba speciosa* (Forest 58)

The *Ceiba speciosa* planting is one of the few sub-tropical species represented in the Arboretum. It has a record of having survived some frost and was seen as a species that could be a good gauge of climate change in the Canberra region. It was the selection of this species that commenced the thinking about establishing two of the forests as trial plantings. This will allow a far greater degree of the planting of species poorly known in the Canberra region without the possible loss of a forest.

Since planting, the species has been affected by temperatures of \(-5^\circ\text{C}\) and below with a number of trees having been lost. Because of the losses to date, it may be necessary to consider the replacement of the species within the next 2-5 years.

**Recommendation 12**

Re-assess the survival of forest 58. If the survival of the forest is above 50% consider the replanting of the dead trees. If it is below 50% consider the removal of the remaining *Ceiba speciosa* trees and commence the replacement of the forest. Replacement species for consideration are given in Section 9.

6.4 Various Cypress forests

Cypress canker is a disease that has, in last few years, started to seriously affect species of the Cypress family and has already been observed in the Arboretum. The species of the family Cupressaceae that are planted in the Arboretum are listed below. Records of infections either at the Arboretum or elsewhere are noted:

* Austrocedrus chilensis: possible minor host
* Callitris oblonga: not recorded but has been seen on *C. preisii* and *C. rhomboidea*
* Chamaecyparis lawsoniana: known host
* Cupressus duclouxiana: not recorded but is a rare tree and not widespread
* Cupressus dupreziana var. atlantica: known host but moderately resistant
* Cupressus dupreziana var. dupreziana: known host but moderately resistant
**Cupressus sempervirens 'Stricta':** known host - disease seen at the Arboretum.

**Metasequoia glyptostroboides:** not recorded

**Platycladus orientalis:** known host

**Sequoiadendron giganteum:** known host - disease seen at the Arboretum.

**Widdringtonia cedarbergensis:** known host

For location of the forests in the Arboretum see Fig 6 below and for more information about Cypress Canker see Section 17.10

---

**Recommendation 13**

Continue to regularly check the Cupressaceae forests, keep an accurate record of the location and extent of any infections or possible infections and remove any infected limbs. If there are only occasional losses replace lost trees. However, if any of the species is obviously very susceptible to the cypress canker, replacement should be seriously considered.

---

**6.5 Alternative Species**

Below are listed the species that have already been considered as desirable for the Arboretum and that may be considered in any expansion and in replacing forests. The main reasons for selection are highlighted in red.
**Argania spinosa**  
Common name: Argan Tree  
Family: *Sapotaceae* – not yet represented in the Arboretum  
Conservation Status: Nil. However, the populations have been slowly decreasing in terms of density and extent. This is mainly a consequence of the over use of argan trees, for wood or forage production.  
Other selection criteria: Ethnobotany. The main traditional use of argan oil is by far for nutritional purposes. Natives either directly eat the oil on toasts, generally for breakfast, or use it for frying. The oil is traditionally indicated to cure skin conditions.  
Natural Occurrence: Nth Africa - Southwestern Morocco and Algeria  
Description: It is an evergreen tree that grows to 8-10 metres high, is thorny, with gnarled trunks.  
Tolerances: It is very drought tolerant and frost resistant  
Possible Source: B&T – AQIS permit import.

**Combretum erythrophyllum**  
Common Name: River Bushwillow  
Family: *Combretaceae* – not yet represented in the Arboretum  
Conservation Status: Nil  
Other selection criteria: Ethnobotany. The gum produces a non-cracking varnish. Ornaments, cattle troughs and grain mortars are made from the wood. A rich, dark brown dye is extracted from the roots. The dried fruits are often used in flower arrangements.  
Natural Occurrence: southern Africa – not well represented in the Arboretum  
Description: It is a medium to large deciduous tree with reddish autumn colours  
Tolerances: It is both drought and frost resistant  
Possible Source: B&T – AQIS permit import.

**Cussonia paniculata**  
Common name: Mountain cabbage tree  
Family: *Araliaceae* – not yet represented in the Arboretum  
Conservation status: Nil  
Other selection criteria: Ethnobotany. The wood is soft and light and was used for the brake-blocks of wagons. The leaves provide good fodder for stock and the Zulu name refers to this tree as goats' food. The thick root can be peeled and eaten raw as food or as a source of water. Traditional medical uses of Cussonia have been to treat infections, inflammation and malaria.  
Natural Occurrence: Southern Africa – not well represented in the Arboretum  
Description: Evergreen tree to 10m  
Tolerances: Drought and frost tolerant  
Possible Source: Commercial nurseries, B&T  
Suggested location: Small forest

**Dombeya rotundifolia**  
Common Name: Wild Pear  
Family: *Malvaceae*  
Conservation Status: Nil  
Other selection criteria: Ethnobotany. The wild pear has many traditional uses. Strong rope fibre is made from the bark and the plant is used medicinally for various purposes, including a love potion made from the flowers. It is a useful tree on farms and nature reserves as game and stock browse from it. The wood is termite resistant and often used as fence posts. Bee farmers also appreciate the tree for the large amounts of nectar and pollen which it produces.  
Natural Occurrence: southern Africa – not well represented in the Arboretum  
Description: It is a deciduous, very fast growing tree, reaching 6m+ having masses of white blooms which appear before the leaves in early spring.
**Embothrium coccineum**  
Common Name: Chilean Fire Tree  
Family: Proteaceae  
Conservation Status: Nil  
Other selection criteria: Ethnobotany. The wood is very soft but durable and is light pink in colour. It is used for bowls, spoons and other craft articles.  
Natural Occurrence: Chile and Argentina  
Description: Tree from 10 -15m. Spectacular flower display.  
Tolerances: Frost and some drought.  
Possible Source: ChileFlora Seeds – AQIS permit import

**Eucryphia cordifolia**  
Family: Cunoniaceae – not yet represented in the Arboretum  
Conservation Status: Near threatened (IUCN)  
Natural Occurrence: Chile and Argentina  
Description: An evergreen tree growing to over 20m  
Tolerances: Tolerates cold but will need occasional irrigation.  
Possible Source: Commercial nurseries, B&T  
Note: Option may be Eucryphia lucida, non-threatened Tasmanian species.

**Oxydendrum arboreum**  
Family: Ericaceae – not yet represented in the Arboretum  
Conservation Status: Nil  
Other selection criteria: Ethnobotany. The wood is heavy, hard and very close grained. Is been used for panelling and objects like tool handles and wooden bearings. It has also been traditionally used for a range of medical conditions.  
Natural Occurrence: USA  
Description: It is a deciduous tree growing to around 15m with deeply furrowed bark, fragrant white flowers and attractive autumn colour.  
Tolerances: It is frost and drought tolerant.  
Possible Source: Possible commercial nurseries (Bundara), B&T – AQIS permit import.

**Picconia excelsa**  
Family: Oleaceae – not yet represented in the Arboretum  
Conservation Status: Vulnerable (IUCN)  
Natural Occurrence: Portugal and Canary Islands  
Description: Evergreen small tree growing to 10 m tall  
Tolerances: Tolerates both cold and dry conditions  
Possible Source: Known plantings in Australia, including Yass.
Description: It is evergreen tree grows up to 10 m tall with a dense, roundish crown and bell-shaped flowers that are borne singly in summer.
Tolerances: It is both drought and frost resistant
Possible Source: B&T – AQIS permit import.

*Sinojackia xylocarpa*
Family: Styracaceae
Conservation Status: Vulnerable (IUCN)
Natural Occurrence: China
Description: A deciduous small tree growing to 7 m tall
Tolerances: Tolerates both cold and dry conditions
Possible Source: Possible commercial nursery (Yamina), B&T – AQIS permit import

*Trachycarpus fortunei*
Family: Arecaceae
Conservation Status: Nil
Other selection criteria: Ethnobotany. The fibres cloaking the trunk have been traditionally used to make ropes and cloth, as have the fibres from within the leafstalk. The leaves have been woven into hats, rough coats and fans. It has also been traditionally used for a range of medical conditions.
Natural Occurrence: East Asia
Description: Palm growing to about 10m
Tolerances: Both frost and moderately drought tolerant
Possible Source: Commercially available

**Recommendation 27**
Consider the list of alternative species for selection for expansion of the Arboretum and for replacing of forests 13 and 101.
7. Relocation of Forest Species
There is one species that should be considered for relocation within the Arboretum.

a) *Wollemia nobilis* (Forest 32)

The Wollemi Pine forest is one of two forests that have had the greatest loses. An initial inspection of the Wollemi Pine planting in early 2008 revealed that the attrition rate was already much higher than expected. In March 2008, the numbers were recorded as:

<table>
<thead>
<tr>
<th>Status</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead</td>
<td>221</td>
</tr>
<tr>
<td>Unhealthy</td>
<td>57</td>
</tr>
<tr>
<td>Healthy</td>
<td>549</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>827</strong></td>
</tr>
</tbody>
</table>

A recent stock take done by the Friends shows that the number of surviving trees has now fallen to 85, with one tree having been lost since as a result of damage caused by machinery. From the number of plantings/re-plantings done and the number of trees left, there has been a total loss of 94% of trees since the plantings started about 7 years ago.

![Fig. 7 Some of the remaining Wollemi pine on the southerly aspect slope of Forest 32 (Photo: A. Burgess)](image)

From investigations to date it has been concluded that the loss of the plants over the last 7 years could be attributed to three main factors, being: i) exposure to unsuitable growing conditions over a large proportion of the forest; ii) a significant amount of poor original planting stock that was root bound, and; iii) fungal infections during two very atypically wet summers.

Although the loses of Wollemi pines have been very significant, there has been a lot learnt about the cultivation of what is otherwise a poorly known plant and the experience has given the Arboretum an excellent opportunity to greatly improve its display of the rare conifer.

Using the experience gained to date, the space created by the loss of the Wollemi pines and the existence of prime growing conditions elsewhere in the Arboretum, the following actions are recommended.

**Recommendation 14**

Re-divide the current Forest 32.
The re-division of Forest 32 as given in Fig 8 below is recommended. This will allow the original forest layout of the Arboretum to be retained, will provide a section to be used for the Federation plantings (A), will identify an area that can be replanted with another species (B) and allow the remainder of the Wollemi planting to be retained.

Fig 8: Suggested break-up of the current Forest 32
A: Area for Federation Forest, B: Area for new forest, C: Area for remaining Wollemi pines

**Recommendation 15**

*Retain the remaining Wollemi pines in Forest 32*

Given the suitability that area C in the above Fig. 8 has demonstrated, it is recommended that it is retained as a Wollemi planting. As a part of this, the seedlings could be grown from the seed collected from the current planting with the propagation recorded. It is also suggested that the conditions of the site could be further improved with additional species that grow naturally with the Wollemi.

**Recommendation 16**

*Create a new forest within current Forest 32 (‘102’)*

Given the unsuitability for the Wollemi pines that area B in the above Fig. 8 has demonstrated, it is recommended that a new species be selected and planted in that area. Replacement species for consideration are given in Section 10.1

**Recommendation 17**

*Establish a new Wollemi planting in Forest 76*

Using the experience and information that has been gathered at the Arboretum and from the Australian Botanic Garden, Mt Annan it is recommended that a second single species planting of the Wollemi pine be established. The location recommended is an area of 100m² that is the southern one third of the *Pinus radiata* subsp. *radiata* planting and is currently part of Forest 76 (See Fig 9).
Fig. 9: Section of Forest 76 recommended for new Wollemi pine planting.

A more detailed plan for the establishment of the Wollemi pine forest and a listing of possible replacement species for section B in Fig 8 is given in Appendix 2.
8. Completion of First Plantings
The forests for which the first planting is yet to be finished are:

i) Dracaena draco (forest 15)
The planting of the Dracaena draco could not initially be completed because of the development of the central valley. Also, it was in part viewed as a trial planting and its completion was delayed to ensure that the species survived. To assist the trees to survive the winter conditions they have been given frost protection each winter since planting. This has been successful for the majority of the trees and many will outgrow the guards in the next season or two. If the trees continue to survive Canberra winters, the planting below can be commenced using the frost covers from above the road.

Some of the trees do appear to have developed some degree of stem rot and it will be important watch if this is an issue.

Recommendation 18
Delay the final plantings until a much better idea of the Dracaena draco’s longer term and unprotected frost survival can be established.

ii) Cupressus dupreziana ssp. dupreziana (Forest 40)
As a result of both the mixing of plant material by the planters and a number of unrecorded replantings after road works, the exact location of these plants is very difficult to confirm. There is now a need to ensure that the planting of the remaining Cupressus dupreziana ssp. dupreziana is well recorded.

From the Friends’ stocktake about 200 trees are still missing. Plants or seed will now need to be sourced. The trees to be planted should be propagated either from seed collected from the plantation in South Australia (where the first seed came) or as a provenance collection from the natural site. Unless from propagating from cuttings, no material from the Arboretum forest should be used.

Recommendation 19
Source the propagation material (preferably seed) for the remainder of plantings of Cupressus dupreziana ssp. dupreziana, identify an obvious part of the unplanted section of the forest and ensure that the trees are GPSed at planting and recorded in the database.

iii) Betula pendula ssp. fontqueri (Forest 44)
This endangered species is to eventually replace the Betula pendula ssp. pendula. The original plantings were grown from seed obtained from the National Centre for Forest Genetic Resources in Spain and then cuttings were taken from those plants to produce material for the ongoing plantings. The propagation has been successful but no record was kept of where the propagation material was collected.

From the Friends’ stocktake about 130 trees are still to be planted in sites already allocated to the species along the Parkway. If it is done from the former it is vital that a record is kept regarding where the propagation material was collected and where it was planted. For the ongoing replacement plantings it is recommended to start a thinning program for the plantings of B. pendula ssp. pendula as the Betula pendula ssp. fontqueri is propagated.
For the propagation both cuttings from the current planting and seed from the National Centre for Forest Genetic Resources in Spain could be used. If cuttings are used a record of their origin and where they are planted is important.

**Recommendation 20:**

Propagate sufficient trees to complete the plantings for the *Betula pendula* ssp. *fontqueri*. These plants can be propagated from cuttings collected from identified trees on site but more seed should also be sourced from the National Centre for Forest Genetic Resources in Spain.

**Recommendation 21:**

Continue the slow thinning of the *Betula pendula* ssp. *pendula* starting deep within the forest and in numbers directly related to the number of *Betula pendula* ssp. *fontqueri* already propagated for planting.

**iv) Lagerstroemia fauriei ‘Fantasy’ (Forest 24)**

Of the approximately 360 trees only about 60 have been planted so far. This has largely been because the carpark itself is yet to be finished.

**Recommendation 22**

Finish the car park planting in winter 2016. Given the large number still to be planted it will be important to start sourcing plants before 2016. If the carpark will not be prepared by winter 2016, at least prepare the section of the forest at that is outside of the carpark the northern end of Forest 24 and do the planting.

**v) Populus euphratica (Forest 74)**

A large number of the *Populus euphratica* are yet to be planted. Several attempts have been made to get plants propagated. There have been some success but this has not been effectively followed up. These attempts have to be continued to get the forest finished.

**Recommendation 23**

Continue to source propagators for the *Populus euphratica*. Ensure that this is given a priority and is continued until the forest is fully planted.

**vii) Franklinia alatamaha (Forest 93)**

*From the Friend’s stocktake and the Autumn 2015 plantings, between 25 and 30 Franklinia are yet to be planted with the replacement of about 5 others. Like the Populus euphratica the ones planted have done well when established and this has not been easy to source.*

**Recommendation 24**

Either buy plants or source seed for the Franklinia and supply it to Yarralumla Nursery for propagation, noting the long lead time required
9. Replants

From the 2014-15 stocktake done by the Friends, nearly all the forests have a requirement for some replants with some requiring over a hundred trees to be replanted and some requiring less than ten. In the Action Plan table, these forests have been prioritised over the next 3 years.

9.1 Widdringtonia wallichii (Forest 103)

The planting of Forest 103 commenced in 2011 and was done to commemorate almost 1000 Australians who died during the Boer War and the many others who served there. Since the first planting there have a considerable number lost and there has since been a replanting.

Recommendation 25

Undertake propagation of the *Widdringtonia* to replace any deaths and fill any unplanted spaces. For the continued propagation it is recommended that provenance seed be sought.

9.2 Other Forests Requiring a Priority Action for Replanting

From the information provided by the Friends stocktake there could be 9 Forests that require 100 trees or more to be replaced. These forests are:

- Forest 22 – *Eucalyptus argophloia*
- Forest 27 – *Ginkgo biloba*
- Forest 33 – *Sequoiadendron giganteum*
- Forest 48 – *Callitris oblonga*
- Forest 50 – *Arbutus canariensis*
- Forest 65 – *Chamaecyparis lawsoniana*
- Forest 67 – *Styrax japonicas*
- Forest 68 – *Eucalyptus lacrimans*
- Forest 80 – *Fagus sylvatica*

A full list of Forests needing replanting is given in the attached Work Plan with an indication of priorities and likely tasks.

Recommendation 26

Review and if needed update the stocktakes of the Cypressaceae forests, source seed or seedlings as a high priority and program preparation and replanting activities for autumn 2016 onwards.
10. Boundary Issues (by Stephen Alegria)

10.1 Expansion Areas

The area to the north of the Arboretum’s on-ground boundary may be considered for use in the long term for the addition of up to 8 new forests and the expansion of 4 current forests, depending on the area available. Much of this land in the custodianship of the Land Development Agency and may be used for future urban development and so expansion may not be possible if this land is required for urban development. Map 1 shows the land custodianship at the time of writing.

Map 1 Land Custodianship on northern boundary

There is also potential to consider any expansion of the Arboretum in this area as a linking area between the environmental offsets area a shown in green in Map 1 and Forest 2 (see Recommendation 30).

10.2 Forest Plantings Within Road Reserves

A number of forests planted along the Tuggeranong parkway and to the south of the Arboretum were planted within the road reserve. Map 2 shows the road reserve in red lines, with the planned plantings of trees as purple dots. The reason for this planting is not clear, however there are no known plans to utilise the road reserve for development of the Tuggeranong parkway in the foreseeable future.
Recommendation 28
Consult with ACT Roads before undertaking replantings or other significant management actions within the road reserve

Map 2 Road Reserves and Planned Plantings
10.3 Future Impacts from East-West Arterial Road

The growth of the Molonglo urban area to the west and south of the Arboretum is expected to require additional road connections in many areas. The impacts of these road connections on the Arboretum are potentially significant if they are located within the formal road reserves and impact on established forests.

The most recent concept for an East West arterial road connecting John Gorton Drive to Tuggeranong Parkway is shown at Map 3. It has a small impact on Forest 104 (Golden rain tree). However, the existence of this road and other feeder roads in the area is crucially important to the Arboretum as it will provide a much-needed connection that will allow the Arboretum to have a second public vehicle access point. The timing for construction of such a road is not able to be determined, however is likely to be 8-15 years away.

The construction of new suburbs to the south, west and north west of the Arboretum will have a range of impacts that will require careful planning. For example, altered fire risk, weed spread, impacts from after hours visitation and increased use of the forests for local recreation are all key issues.

**Recommendation 29**

The Arboretum continue to liaise with other ACT Government agencies to ensure urban development and road construction has a positive impact on the Arboretum.
11. Proposed Establishment of a Federation Forest

Provision is required for the establishment of a symbolic Federation Forest to represent the States, Territories and Commonwealth of Australia.

With the loss of a large proportion of the Wollemi pines in Forest 32 it is recommended that this forest be divided into sections to include the remainder of the Wollemi planting, another small forest and an area for a Federation planting that will include representation of the flora of every State and Territory in Australia (see Section 7).

Ideally it would be best if an indigenous tree species could be planted that represents all the States and Territories, however, there is not one species that does so. To overcome this, it is suggested that two species be used for the planting. *Eucalyptus camaldulensis* grows in all the States and Territories on the mainland but does not grow naturally in Tasmania. *Eucalyptus viminalis* grows in all States and Territories except the Northern Territory and Western Australia. While this is not perfect, it uses perhaps the best known Australian tree genus and two substantial species. In addition, it effectively connects the ACT with all the other Australian States and Territories and the plants would be readily available.

If this is not acceptable, it could be suggested that each of the States and Territories select a species to represent their flora, based on two options.

The first option is a selection of different species primarily based on the Arboretum’s underlying theme of conservation and the majority of the species represent either threatened species in the State or a species that is part of a threatened ecological community. The selections for the Northern Territory and Western Australia, however, are based on them being a species likely to survive in Canberra but uncommon in cultivation. It is recommended that the WA and NT trees be provided with frost protection for at least the first two years.

### Option 1- Conservation Theme

**Australian Capital Territory**

*Eucalyptus melliodora* (Yellow Box) – a major component of the threatened Yellow Box/Red Gum Grassy Woodland community.

**New South Wales:**

*Eucalyptus benthamii* (Camden white gum) – threatened species

**Northern Territory:**

*Atalaya hemiglauca* (Whitewood)

**Queensland:**

*Eucalyptus scoparia* (Wallangarra white gum) – threatened species

**South Australia:**

*Eucalyptus odorata* (Peppermint box) – from the threatened Peppermint Box grassy woodland of South Australia

*Eucalyptus ovata* (Swamp Gum) – regionally threatened in SA

**Tasmania:**

*Eucalyptus morrisbyi* (Morrisby’s Gum) – threatened species

*Callitris oblonga* (South Esk Pine) – threatened species

**Victoria:**

*Eucalyptus crenulata* (Silver Gum) – threatened species

*Eucalyptus microcarpa* (Grey box) – from the threatened grassland of Victoria

**Western Australia:** *Corymbia aparrerinja* (Ghost Gum)
**Pittosporum angustifolium** (Weeping Pittosporum)
* An Arboretum forest species

The second list is based mainly on species that have been grown in Canberra, that are representative of Australian States and territories. Although *Atalaya hemiglauca* or *Corymbia aparrerinja* are suggested as possible representatives of the Northern Territory, knowledge of their growth in Canberra is very limited. The selection is based on the known conditions in Alice Springs and survival of the Corymbia in the central valley to date.

**Option 2 – Representative Theme**

**Australian Capital Territory:**
*Eucalyptus melliodora* – Yellow Box
*Casuarina cunninghamiana* – She Oak
Eucalyptus bridgesiana – Apple Box

**New South Wales:**
*Eucalyptus benthamii* – Camden white gum
*Casuarina cunninghamiana* – She Oak

**Northern Territory:**
*Atalaya hemiglauca* – Whitewood
*Corymbia aparrerinja* (Ghost Gum)

**Queensland:**
*Grevillea robusta* – Silky Oak
*Araucaria bidwillii* – Bunya Pine

**South Australia:**
*Eucalyptus leucoxylon* – Yellow Gum
*Eucalyptus viminalis* – Ribbon Gum

**Tasmania:**
*Eucalyptus globulus ssp globulus* – Tasmanian Blue Gum
Eucalyptus gunnii – Cider Gum

**Western Australia:**
*Eucalyptus caesia* – Silver Princess or
*Corymbia ficifolia* – Red flowering gum
*Pittosporum angustifolium* – Weeping Pittosporum

**Victoria:**
*Eucalyptus regnans* – Mountain Ash
*Eucalyptus tricarpa* – Red Ironbark
* An Arboretum forest species

The Federation planting would involve 8 ceremonial trees, with a further 8-12 to be planted separately to establish a small forest. With a separation of 10m between the trees it would require an area of at least 1200 square metres as shown in Figure 10.
Fig 10. Suggested Location for a Federation Planting

**Recommendation 30**

Set aside an area of Forest 32 for a future Federation forest and confirm the desired species selection.
12. Forest 2 (Locally indigenous Vegetation)

At the time that the STEP garden was being developed STEP also proposed that what is now Forest 2 (local Eucalypt species) also be not developed as a part of the 100 Forests design. Because of its multi-species nature and strong connection with local trees, it is much more connected with the STEP forest than the rest of the Arboretum. A management plan was written for Forest 2 in 2011 and now needs to be reviewed.

As Forest 2 is not to be developed in the same way as the other Arboretum plantings it is important to ensure that it 1) does not sit uncomfortably within the rest of the Arboretum, and; 2) blends into the surrounding planting areas such as the Cork Oak forest. At the same time it is important that the indigenous flora area has a very natural feel when people are passing through it. As such, it will allow it to also blend in with the surrounding woodlands and nearby Black Mountain dry sclerophyll forest.

The largely planted indigenous flora area is, to some extent, at a cross-over point of: 1) the dry sclerophyll forests of Black Mountain dominated by species including *Eucalyptus mannifera ssp. maculosa*, *Eucalyptus macrorhyncha* and *Eucalyptus rossii*; 2) the eucalypt woodland between Black Mountain and Dairy Farmers Hill dominated by *Eucalyptus melliodora* and *Eucalyptus blakelyi*, and; 3) the forest that occurred alongside the Molonglo River before the flooding of Lake Burley Griffin which had stands of *Eucalyptus viminalis* and has remaining stands of *Eucalyptus bridgesiana*. The lower area near the river and at the base of the mountains is also a frost hollow which has remaining individuals of *Eucalyptus pauciflora*.

An important aspect of the site is also the very strong presence of native grasses. *Themeda australis* is very prominent in the northern and central areas of the site and *Bothriochloa macra* is more prominent in the southern area.

![Fig 11. Open area of Themeda australis between stands of E. viminalis and E. mannifera ssp. maculosa. (Photo: M. Richardson)](image-url)
Given that some of the Australian grasslands are in fact more threatened than the Australian rainforests, the indigenous flora area in Forest 2 could play a strong role in emphasizing the threats that face both grasses and trees and the need to conserve them. It will provide yet another opportunity for the Arboretum to better connect with non-government organisations such as Friends of Grasslands (FoG) and the Canberra Ornithological Group (COG) in addition to Southern Tablelands Ecological Park (STEP).

Forest 2 could provide the National Arboretum Canberra with:

- another section to highlight the importance of local vegetation
- a broader view of plant conservation, with an emphasis on grasslands
- another connection to the ethnobotany of local indigenous people
- an excellent venue for education groups
- a greatly improved section of the Bicentennial National Trail
- another picnic area
- a further connection with ACT non-government organisations

A five year plan was prepared in 2011 (see Appendix 4) but this now needs to be updated.

**Recommendation 31**

Review the management plan for Forest 2.

**Recommendation 32**

Consider a stronger connection between Forest 2 and the STEP forest and explore STEP having more input into the management of Forest 2.
13. ANU Research Forests (Forests 98 and 99)

a) Experimental design
For the ANU research forests, two eucalypt species were selected for their different responses to low rainfall:

a. *Corymbia maculata* (spotted gum), is a “drought avoider” that uses extensive and efficient roots to fully exploit any soil moisture available.

b. *Eucalyptus tricarpa* (red ironbark) is a “drought tolerator” that significantly alters its metabolism to stop growing when in severe moisture stress.

The trees were planted in blocks of single species, with the blocks arranged to allow three watering treatments and replication. Such an arrangement allows researchers to measure the effects of different watering regimes on the growth and survival of the trees, and consequently estimate the effects on many other eucalypt species. The blocks are large enough to allow them to be split to examine other important environmental effects such as competition.

b) Key research questions

i) How will these two different types of eucalypts respond to climate change with a drier climate and longer droughts, as projected to occur in many parts of Australia?

ii) How much carbon do eucalypt forests sequester from the atmosphere?

iii) Will eucalypt trees change their shape or the properties of their wood under different climate extremes?

iv) How do eucalypts respond to moisture stress (tree physiology)?

v) Can we enhance the survival of eucalypts in a more variable climate (genetics)?

All data collected will be available online for research, outreach and educational use.

Since the planting of the Forests there have been three major issues, being:

i) Very large tree loses in Forest 101 along with a number of trees in the planting being the wrong species.

ii) Over 150 Corymbia trees have died since planting in Forest 98 and 99.

iii) About half of the Eucalyptus tricarpa between River Rd and the Parkway have also been lost.

**Recommendation 33**

Remove the remaining *Eucalyptus* and *Corymbia* trees in Forest 101 and replant the area with a new species from the list in section 6.5.

**Recommendation 34**

Replant the *Corymbia* trees in Forests 98 and 99.

**Recommendation 35**

Replant the *Eucalyptus tricarpa* along the Parkway section. These trees will be not be used for the ANU research but will be used for interpretation about the research.
14. Central Valley Spine

The Central Valley has provided a venue for important ceremonial plantings in the Arboretum and there have been 46 plantings up to August 2015. (See Appendix 5).

14.1 Species Selection

Before the Arboretum opened a draft ceremonial planting policy was written for the Arboretum. It included a section on the central valley spine which followed on from the original TCL plans. This includes that the trees are to be planted in micro climatic zones from hot climate trees at the highest point, through temperate to cool/wet climate trees at the lowest point so as to ensure that they can be afforded the best conditions for growth. The proposed climatic zones from the top were:

- **Hot Climate Zones**
  - Hot Mountainous Zone
  - Hot/Arid Desert Zone
  - Subtropical Zone

- **Temperate Climate Zones**
  - Alpine Mediterranean Zone
  - Maritime Mediterranean Zone
  - Temperate Zone

- **Cool Climate Zones**
  - Cool Mountainous Zone
  - Cool Wet Zone

The area that has been planted most to date is the highest area which was to be for the hot climate species (see Fig. 12)

From the planting list in Appendix 5, the species selected have often not matched the original TCL zones. To date there have been 23 plantings in hot zone and, only 12 of the 23 species match the ‘zone’ in which they are planted. However, the top area would always have been the hardest to match and it is likely that the lower zones will be much more frequently matched.
**Recommendation 36**
Continue to use the zoning system to use the climatic conditions of the central valley and identify suitable species that are known to be readily available and that can be successfully grown on the site.

**Recommendation 37**
Continue to follow the ceremonial planting policy to have only one planting of any given species.

14.2 Spacing of plantings

From the TCL plans (see Figures 15 and 16) the spacing of the plantings was to create a closed canopy but not result in trees overgrowing others. However, from the mapping of the central valley plantings by BurHor and looking at the potential canopy diameters of the trees planted so far in the hot climate zone, several plantings could be a problem in the future (See Figure 13)

![Diagram of current plantings at the top of the central valley showing likely future canopies.](image)

**Recommendation 38**
Ensure that the spacing of future plantings is appropriate to prevent trees being overgrown by others.

14.3 Central Valley Gardens

When the plans for the central valley were being drawn up there were two possible ways in which it would be planted. It could be all trees or half trees and half gardens (See Figures 14 and 15). Of the two, the half gardens option was preferred.
However, since the Arboretum started development no gardens have been planted and none have been proposed. While the gardens could assist to make the walk down the central valley attractive there are three issues that have to be seriously considered:

- The maintenance of the gardens will require a much larger staff number or horticultural contract.
- Having a quite dense stands of trees next to the gardens may also have a considerable affect on the plants due to both shade and roots.
- The irrigation of the gardens would have to be addressed.

**Recommendation 39**

Ensure the future review of the Arboretum Master Plan considers whether the central valley gardens are still a viable and desirable objective, or whether the garden sites could be better utilised for trees.

**15. The “100 Gardens” Concept**

A number of gardens are being developed around the Events terrace including the Gallery of Gardens along the western side of the Event Terrace.

Although the 100 Gardens concept was a significant component of the original “100 Forests, 100 Gardens” concept design, the focus to date has been on the 100 forests and there have been no gardens developed within the Arboretum other than the native plant-based garden within the Himalayan Cedar forest, the Discovery Garden on the Events Terrace and the STEP Forest).

The future of the 100 gardens concept needs careful consideration as part of a review of the Master Plan. Possible considerations include:

- If the 100 Gardens are to be developed it will be extremely important to appreciate the significant amount of work they will generate in maintenance and ensure that sufficient provision is made for ongoing maintenance.

- Consider developing a garden in each of the Forests which has a strong relationship with the tree species in each of the forests.
• Invite local embassies to have more involvement with the Arboretum – including plantings and interpretation. Widespread species could involve a number of embassies coming together to do the garden (see Appendix 1 for possible countries to be involved).

• In the same way as an embassy is seen as ‘foreign soil’, the forest and the garden could become a piece of another country or continent. For guides and education groups it could be a chance to take people into another place. Here the interpretation in the different languages would strengthen that feeling of being in a foreign land.

• The variety of plants displayed would solely depend on what is available or what can be imported. This could include other relevant tree species, shrubs or grasses. Threatened species other than trees could be involved. Weedy species would have to be avoided – but they may be something that could still be included in the interpretation if they are important parts of flora or have particularly interesting stories.

• Develop species lists for each of the forests with emphasis on species with interesting stories (for interpretation and guides) and a relevance to school courses.

**Recommendation 40**

Consider the future of the 100 gardens concept as part of a review of the Master Plan.
16. Living Collection Database

16.1 Living Collections/Assets Records

Since the commencement of the Arboretum it has been holding its living collection records in a variety of formats including spreadsheets, word documents and hardcopies making it quite a challenge to retrieve data, generate information and supply up to date data.

However, the importance of record keeping has been acknowledged and a decision was made in 2014 to utilise the existing TAMS Geographic Information System (GIS) and other asset management systems as the basis for accessioning and plant record keeping of the Living Collection (excluding NBPCA). This guarantees that the system will be compatible and consistent with other TAMS management systems and processes will have the required level of corporate support and thus will be sustainable in to the future. A collection records app has already been produced and is being used by staff to update forest maps. In addition, maintenance information is being recorded and this is to be incorporated in the collections records that are being developed.

Good progress has been made in 2015 through the Asset Integration and Data section within Parks and Territory Services to develop and implement an asset mapping app, including data sharing arrangements with the maintenance contractor and ANU. This progress has been enabled by the allocation of a qualified staff member to undertake the development of the app, along with allocation of staff from the Arboretum to populate the database.

The importance of having staff resources allocated to this function cannot be overestimated. A capacity for collecting, maintaining and interpreting records will be required on an ongoing basis to ensure record keeping is maintained and enhanced for the benefit of collection management and supporting research activities.

Recommendation 41

Continue the development of the GIS-based asset record and mapping system including a capacity to collect and manage information.

16.2 Stocktakes

The Forest Stocktake was conducted over a period of nearly 12 months and was coordinated by the Friends of the Arboretum. Volunteers led by Dr Roger Hnatiuk spent thousands of hours on this project. The stocktake excluded a number of forests including the ANU research forests (Forests 98 and 99), the established Pinus radiata forest (Forest 76) and the remnant Eucalypt woodland in Forest 2.

The stocktake provides very useful and accurate data that replaces previous data that was of patchy and sometimes questionable quality. The stocktake data enables sound management decisions to be made, for example:

- there is now an opportunity to examine missing trees on the ground to determine why they are missing (for example, they may have been removed, or may have appeared on planting plans but never actually been planted) and thus decide whether they should be replaced or not.
- The stocktake has identified over 1000 standing dead trees that require replacement, and a further 1800 that are in poor condition and require attention.
The stocktake data provides an accurate baseline for monitoring future changes.

Future stocktakes will be undertaken far more rapidly and easily using the GIS based system described in 17.1. The technology will enable a continuous checking, recording and actioning process to be undertaken as part of normal management duties.

Additional forests that were not counted in the 2014-15 stocktake will be included in future years and so some movement in overall tree numbers can be expected as data quality improves. In managing a forest as large and diverse as the Arboretum, the precise number of trees will always be a number in flux. What is vital to the good management is not the precise number of trees, but rather that we regularly audit the actual forest condition and know what changes are occurring and why so that appropriate actions are taken in the maintenance of the Arboretum’s forests.

Recommendation 42

Utilise the asset record and mapping system to undertake future recording of tree condition and other key factors, including whether plants found to be missing in the last stocktake:

- were part of the planting and need to be replaced
- were never a part of the planting
- are now viewed as no longer a part of the tree locations to be planted

Recommendation 43

Define the class of ‘poor health’ in more detail before the next stocktake to achieve a more consistent appraisal of the trees, and particularly if it is to be again done with volunteer assistance.

Recommendation 44

Promptly remove dead or very poor trees and record the removal.

16.3 Friends Tree Growth Monitoring Project

Another important project that has been run by Roger Hnatiuk and the Friends for over 4 years is the Tree Growth Monitoring project. It aims to “provide a quantitative, long term record of tree growth as measured by height and diameter measurements, done on about an annual cycle for the first five years, and possibly less often in later years”.

The aims of the project are primarily to monitor the growth of the trees in the planted forests at the National Arboretum:

- to determine the heights and diameters of the forest trees as they develop and to track their rate of growth
- to determine if, and to what extent, tree growth is affected by local landscape position (slope, aspect)
- to determine the degree of genetic variability in the population of trees in each forest.

An attribute for monitoring trees has been added in the tree database that is being developed and it will be possible to link it with related tables to the database. The database will be able to capture the measurements and catalogue them by date so the Arboretum can have historic data captured with the ability to display and query it spatially.
**Recommendation 45**
Continue to encourage and support the Tree Growth Monitoring project and ensure that the Arboretum is fully aware of how the project is progressing.

**Recommendation 46**
Ensure that the information that has been collected over the past 4+ years is incorporated into the Arboretum living collection database.
17. Summary of Stakeholder Consultation

During this forest review, discussions were held with a number of stakeholders:

They were:
- Jocelyn Plovits, Ex Chair, Friends of the National Arboretum Canberra
- Dr David Shorthouse, Southern Tablelands Ecological Park
- Dr Cris Brack, Australian National University
- Duncan MacLennan, Lindsay Pryor Arboretum (National Capital Authority)

Below are brief summaries of those discussions and any recommendations that have come from them.

Friends of the Arboretum
Jocelyn Plovits

From the involvement they have had at the Arboretum to date, the Friends feel that it is very important to continue to recognise the Arboretum’s role as a plant collection that has an involvement in education, conservation and research as well as recreation. It is also important that it is never viewed as just a park for recreation purposes alone.

It is also important that the Arboretum continues to maintain a strong community engagement and continues to recognise the role of the Friends as supporters. As a part of this, it will be worthwhile for the Friends to continue to provide assistance in the ongoing maintenance of the forests.

(Also see sections 16.2 and 16.3 with regards to the Friends involvement in the forest stocktake and tree growth monitoring project)

Some other essential points raise that were relevant to the forests were:
- For the forests: healthy trees, facilitate international standard research, plantings to be finalized.
- For gardens/other landscaping: attractive, ever changing (seasonal) and developing
- For visitors: a variety of experiences and reasons to come more than once.
- For staff: a positive place to work and sufficient resources to deliver the tasks
- For Friends: a collaborative approach with staff and provision of passionate supportive members, donations and volunteers
- For education: focus on the most productive markets – e.g. education tours of the forests for schools

STEP Forest
David Shorthouse

The Southern Tableland Ecosystems Park is an important site partner with the National Arboretum Canberra. It views itself as managing a regional botanic garden, education and conservation centre demonstrating southern tablelands species within the Arboretum. It has its own Strategic Plan and by promoting itself as a regional botanic garden, could be considered in a similar way to the National Bonsai and Penjing Collection. Although it is similar to the National Bonsai Collection in that it has an identity of its own, it does not seem to receive the same recognition or financial support for its personnel from the Arboretum.
STEP also has a Memorandum of Understanding with the Arboretum. As a part of the MOU it is agreed “that labour to maintain and to develop the STEP garden will be provided by STEP members and voluntary conservation groups”. As a part of this, it is also agreed “STEP will undertake to maintain the STEP Garden and education space to an aesthetic standard appropriate to its location in a nationally significant institution”.

**Recommendation 47**

Given the way in which the STEP Forest is now being promoted as a regional botanic garden, consideration should be given to promote it as another component of the Arboretum in the same way as the National Bonsai and Penjing Collection. As a part of this, it should be discussed with STEP how they define ‘regional botanic garden’ and how they plan to effectively develop themselves to achieve that definition.

**Research at the National Arboretum Canberra**  
**Dr Cris Brack**

One of the Arboretum’s most important roles is to generate research and new knowledge about its trees and forests and their ecology. With assistance from the Friends of the Arboretum and the Australian National University, baseline data is being collected through monitoring and analysing the relationship between the growth and condition of the trees and the environmental conditions including season, weather, soil condition, moisture, nutrition, aspect, pests and diseases.

This, and other data including provenance information, is being collated into what will become a long-term database and reference resource.

The trees planted at the Arboretum have faced droughts, floods, hot winds and severe frosts. These extreme conditions offer opportunities to see how the trees respond - some trees thrive while others struggle. This is a rich vein for research and learning about the cultivation, adaptation and possible preservation of some of the rarest trees in the world.

In the Arboretum/ANU MOU it was noted that: “The Arboretum is intended to be a multipurpose facility providing for the conservation of threatened species, a range of scientific and research purposes, a site for practical educational use for such activities as horticulture, botany, forestry, ecology and related uses.” Also, the “ANU has an interest in establishing a facility on the Arboretum site and in accessing other areas of the Arboretum from time to time.”  
(See also Section 13 ANU Research Forests)

**The Research Coordination Committee**

As a part of the Arboretum’s establishment of a forest research program, a Research Coordination Committee has been established. The role of the Research Coordination Committee is to promote research opportunities and the role of the Arboretum as a site for collaborative research, assess and coordinate research proposals to ensure they are consistent with the Arboretum’s vision and research priorities, and provide advice including input to annual reviews of the Research Policy.

**National Capital Authority**  
**Duncan Maclennan**
The National Capital Authority has commenced works “to renew and upgrade the Lindsay Pryor Arboretum to a place for recreation, scientific research and education in recognition of the great importance of trees and forests to Australia.”

From their Master plan it is envisaged that the Arboretum will:
• provide adequate recreational facilities;
• provide tree interpretation to emphasise the role and importance of trees to Australia in the 21st century;
• provide the opportunity for a progressive expansion of the tree collection which in the years ahead will yield useful performance information for an expanded range of tree species.

As a part of this, it is proposed that one of the Lindsay Pryor Arboretum’s main roles will be to trial trees that haven’t been grown in Canberra before. Given the Arboretum’s planned trial plots, this is an excellent opportunity to link the two arboreta, especially given the very different conditions next to the Lake in the Lindsay Pryor Arboretum.

Recommendation 48
Continue to discuss with NCA the opportunity to link the two trial forests in the Arboretum with the trial plantings at the Lindsay Pryor Arboretum. As a part of this, opportunities to share plant material and undertake cooperative management should be considered.
PART 2 General Management of Arboretum Forests

18.1 Pre-Arboretum Plantings

a) Cork Oak Forest
It was planted between 1917 and 1920. Many of the trees were grown from acorns provided by Griffin. A number of cork oaks have also been planted in what is now Forest 2. Consideration should be given to removing these trees or at least lifting them.

The majority of the oaks are in good condition and the understorey is generally in good condition. There are a few dead trees that should be removed and some weed control required – especially along the road on the eastern side. The condition of the entry to the Arboretum from the north has been poor condition since the commencement of the project but is to be upgraded before the end of June 2015.

Recommendation 49
The following tasks are required for the Cork oak Forest:
- Remove dead trees from within the forest
- Remove weed from along the eastern edge of the forest
- Lift the cork oak trees in Forest 2

b) Himalayan Cedar Forest
It was planted in 1917-1930 and 2010.

As with the cork oaks the majority of the cedars are in good condition, as is the understorey within the forest including the ‘garden area’ near the barbeque area. All of the trees in the more public areas have already been lifted, with any fallen branches on site removed.

c) Radiata Pine Forest (Forest 76)
The Pinus radiata subsp radiata was planted after the 2003 fires but before the planting commenced in the Arboretum.

Since the trees were planted, there appears to have been some minor tidying of the area around the forest (with heaps remaining at the edge) and some lifting of trees. However, the forest has only been lifted once (around 2007) and many of the trees were not lifted. It now needs to be decided whether the remainder of the trees should be lifted or if dead limbs should just be removed. If the latter is done, there may be an opportunity to show how the trees grow in their natural forest.

Across the forest the ground surface is unlike all the other forests. It is typical of a commercial-style pine forest that has been ripped and mounded as part the site preparation for the establishment of the trees. Like most pine forests, it contains its share of blackberry and other woody weeds as well as rocky sections. Providing visitor access will need to consider the safety aspects presented and the use of a structured trail network is likely to be the most appropriate means of allowing access.

A suggestion is made in this review to establish the Wollemi planting in the southern section of the Radiata forest (see Section 7.2).

Recommendation 50:
Address safety and amenity issues before encouraging visitors to the forest, through:
- Control and remove the blackberry in the SW of the forest
- Remove the dead trees and in particular those that have been felled
- Remove obvious waste and wire from the forest site
- Establish trails to facilitate access.

**Recommendation 51**
Lift trees on the edge of the forest for fire prevention purposes, and lift trees within the trail corridor for safety reasons, otherwise allow trees to grow naturally.

**Recommendation 52**
Use the southern third of the forest for Wollemi pines

**18.2 Removal of problem weeds across the Arboretum**

*a) Woody weeds*
The problem woody weed most obviously seen during this review was blackberry, as it had been for the past year and a half. It has definitely become significantly worse over the last 2-3 years.
Examples of some of one of bad areas that had developed is given in Figure but most of these have been since sprayed. Although the control of the weed has been undertaken this year, it is important to ensure that it is checked regularly and that the control program continues until it is a rare occurrence.

Fig 17. Black berry in Forest 82 *Quercus robur* (on rock outcrop)

**Recommendation 53**
Continue to treat blackberry as the ‘priority weed’ until it is felt to be well under control.
The ongoing problem of blackberry on the National Arboretum site is probably being made much harder by large patches in the *Pinus radiata* stands to the west of the Arboretum (see below).

![Image of blackberry outside of Arboretum’s western boundary](image)

**Fig 18:** Blackberry outside of Arboretum’s western boundary (M. Richardson)

With the announcement of the proposed use of *Phragmidium violaceum* (Blackberry Rust) by TAMS, the Arboretum and the surrounding area could also provide an excellent site for part of the trials. This would fit well with the Arboretum’s mission to be involved in research and conservation.

**Recommendation 54**

Work with neighbouring land managers to establish a weed control zone of at least 50 m for the blackberry occurring in areas adjacent to the Arboretum.

**Recommendation 55**

Seek to include the Arboretum in any TAMS trialling programs for Blackberry Rust.

**b) Non-woody weeds**

The most obvious non-woody weed at present is the Serrated Tussock which is a a proclaimed noxious weed in the Australian Capital Territory, New South Wales, Victoria, South Australia and Tasmania. It is a weed of national significance because of its serious agricultural impacts. However, for the Arboretum it appears that the major concern would be the removal of the opportunity for locally native grasses to take over the forest floors as had been intended – and also the invasion of native grass areas that already exist in the Arboretum, e.g. Forest2 and the Patch GG.

Although it responds to a small number of herbicides it is recommended that a mixture of the following are used:
- chemical control—use of broad-acre and spot spraying with strategic rotation of herbicide groups
- cultural control— mowing, chipping, hoeing, cultivation and mulching
• competition—cropping, grassland rehabilitation, agro-forestry and native revegetation, and strategic cell grazing of stock to promote pasture competition
• seed spread—strategic use of fire and slashing to prevent seeding
• vehicle and machinery hygiene to prevent N. trichotoma seed spread
• most importantly, monitoring and follow-up control (chipping out) of any regrowing serrated tussock plants.

**Recommendation 56**
Address the spread of serrated tussock in the Arboretum with an integrated approach to control that seeks to avoid the loss of any substantial native grass areas that already exist on site.

**18.3 Fertilising program**
Since the plantings began there has been some fertilising of trees, however a planned program could help greatly to assist some of the slower growing species to become well established.

**Recommendation 57**
Develop and implement an annual fertilising program.

**18.4 Remulching of tree basins**
With the intention of the Arboretum to reduce its water usage over time and to keep mowing machinery away from tree trunks, it has been desirable to continue to regularly mulch the basins of the young trees. However, the re-mulching of the trees in the Arboretum has not been consistent, with several forests going into summers over the last 4-5 years with poorly mulched basins. While at least one remulching of most has eventually been done, the mulching of particular forests does not seem to have been prioritised.

The re-mulching of the tree basins has continued over winter 2015 and a large number of the forests have been remulched, however, there are still a few forests yet to be done. The Forests yet to be done need to be reviewed and a decision made about which forests to do first before next summer, preferably based on the water requirements of the different species (see Appendix 7).

**Recommendation 58**
Review the mulching of the forests at least every autumn and ensure that those requiring remulching should be done by late Spring. The order in which the forests are mulched should be partly decided by the species most likely to be effected by drought.

**18.5 Rock outcrops**
Before mid 2015, the number of rock outcrops to be slashed and cleared of woody weeds was a very significant issue, with a significant number becoming major problem sites for blackberry (see Point 16.2). Although a start had been made about 3 years ago in more obvious forests such as the Ginkgo forest, the progress was lost with the regrowth of both the grasses and woody weeds. The slashing of the outcrops has never seemed to be an important part for the horticultural contracts and the contractor has never really been given an idea of the maintenance condition required.

However, this problem is now being addressed, with the preparation of a restoration and management plan (See Appendix 6) and with the use of outside labour to start clearing the outcrops. A valuable outcome of the clearing is that it will be possible to actually see what areas are rocky and what are just unmown. It will also greatly assist the removal of woody weeds and rock that has been left on site after clearance.
One guide to use for selecting which rock outcrops to prioritise, could be based on those that have part of the forest actually planted within them. There are now several of these that are very overgrown. The attached plan shows those outcrops that have plantings in them. (See Fig 20)
Recommendation 59
Aim to have all of the rock outcrops fit the restoration and management plan before the beginning of the next horticultural contract.

18.6 Removal of Tree Guards
A large number of the forests still have tree guards and these are going to require removal over the next year to eighteen months to ensure minimal impact on the trees. Major downsides for not removing the guards are that they are starting to damage some trunks, weed growth is hidden within them and they make re-mulching much harder.

Fig 21: Forest 83 – Branches on *Notofagus macrocarpa* growing through tree guards (M. Richardson)

Fig 22: *Forest 59* – Unseen good growth of *Butia capitata* hidden in tree guards (M.Richardson)

The assistance provided by the Friends volunteers has been important and should be continued.

Recommendation 60
Review all of the forests with guards and develop a plan for their removal based on its suitability. Include these removals in the volunteer program.

18.7 Pruning
Formative pruning has been undertaken on significant number of forests to date. The Forest Management Advisory Group has recommended that a pruning regime for each forest be developed, which takes into account not only tree health and visitor safety, but also the design intent of the forest plantings and thus ensures that pruning regimes contribute to the long term realisation of the design intent.

As recommended earlier there is a need to obtain the rationale or story behind all the TCL designs. Where the design intent is not known or is not significant, formative pruning should consider tree health and visitor safety as guiding principles.

In addition to the ongoing need for formative pruning, consideration is required for pruning of trees that are impacting on visitor access or safety. An obvious example is given below and with the creation of more pedestrian paths this will possibly become more frequent. In addition, the need to preserve views from focal points such as bench seats needs to be considered.

**Fig 23: Forest 10 – Washingtonia filifera growing over the path (M. Richardson)**

**Recommendation 61**
Complete initial formative pruning in the next 12 months

**Recommendation 62**
Consider the need to maintain views and public access along pathways as a part of the individual forest maintenance plans.

**18.8 Dam Plantings**
The Arboretum now has had three dams constructed but only the main dam in Forest 27 has been planted around its waters edge. The dam that is mainly in Forest 36 still requires the completion of the planting of the *Larix decidua* and a decision regarding plantings for the water edge. The newest dam is in Forest 91 and it is in an unplanted forest (see section 5.1). In addition there are two dams in Forest 2 (Indigenous Flora), one on the edge of Forest 20 STEP and one in Forest 59 (see Fig. 24).

As a part of the earlier planning, barbeque areas have been suggested for both the dam in Forest 36 and the larger dam near the cork oaks in Forest 2 and these need to reviewed.
**Recommendation 63**

Prepare a plan for the planting and management of the water edge for all of the dams.

**Recommendation 64**

Review and prioritise the proposals to use areas around the dams in Forests 2 and 36 for recreation/barbeque areas.

**18.9 Maintaining the basins of missing trees**

As large a number of trees are yet to be planted or replaced after death some time ago, the planting basins of many of the missing trees are now grassy/weedy, are much harder to see and are being mown. As a result, this has affected the recent stocktaking with many of the basins having completely disappeared and making it very difficult to tell if they were ever planted.

In many of the basins that are not easy to see, the mowing has damaged the remaining irrigation piping and again has added to hiding the original locations of plantings.

**Recommendation 65**

Spray and mulch the basins of dead or badly damaged trees when they are removed so as to keep the location very obvious for replanting and stocktaking and to stop the irrigation system damage.

**18.10 Treatment of Serious Diseases**
a) Cypress Canker

The greatest current potential risk to forest health in the Arboretum is probably the fungal Cypress Canker. Cypress canker is regarded as one of the most serious threats to the survival of Cupressaceae trees worldwide. It has already been identified in at least 2 Arboretum forests and could become a serious problem in up to 10 forests, with many of those having been planted as a part of the conservation theme. The disease could even require complete replacement of several of those forests in the future.

Because of this it is important that Arboretum management, horticultural staff and contractors are well aware of the problem and what needs to be done to reduce its impact. Being a collection of single species forests rather than individuals or small groups it is extremely important to try to avoid the development of any outbreaks.

i) Background

Cypress canker was first described in California and is currently reported in all continents. The Monterey Cypress (Cupressus macrocarpa) and Leyland Cypress (x Cupressocyparis leylandii) are particularly susceptible, although more than 25 other conifer species are now known to be affected.

Cypress canker may be caused by one of three Seiridium species (Seiridium cardinale, S. unicorne or S. cupressi). Seiridium cardinale is thought to be the most aggressive and widespread among the three and Cypress deaths can also be caused by Botryosphaeria, Phomopsis and Pestalotiopsis species.

The fungus Seiridium, is essentially a weak pathogen requiring some defect by which to enter a host plant. Spores may enter the tree through fine bark cracks which develop naturally in branch and twig crotches or through other wounds in the bark such as those made by borers or sap sucking insects. Pruning or mower wounds and other injuries can also provide a point of entry. New local infections can also develop when spores are washed down the tree or splashed from tree to tree by rain or overhead irrigation. The fungus interferes with the sap-conducting system, eventually causing death of the branch or main trunk above the wound. When branches become infected the fungus effectively ringbarks the limb so the foliage yellows and dies from the tips back. Typically, branches scattered throughout the tree may be affected. Commonly the disease starts at the top of the tree. Branches die rapidly, yellowing almost overnight as the foliage is starved of sap. If untreated, the disease will eventually lead to death of the whole plant within a few months to a couple of years.

Spores are carried on the wind, in water droplets or by insects and birds. New infections develop when spores are washed down the tree or splashed from tree to tree by rain or overhead irrigation. They can also be transferred from plant to plant on pruning tools, or through the transport of infected cuttings or plants.

ii) Arboretum trees threatened

The species in the Arboretum that are in the plant family Cupressaceae are:

- Austrocedrus chilensis: possible minor host
- Callitris oblonga: not recorded but has been seen on C. preisii and C. rhomboidea
- Chamaecyparis lawsoniana: known host
- Cupressus duclouxiana: not recorded but is a rare tree
- Cupressus dupreziana var. atlantica: known host but moderately resistant
- Cupressus dupreziana var. dupreziana: known host but moderately resistant
- Cupressus sempervirens ‘Stricta’: known host
Metasequoia glyptostroboides: not recorded
Platycladus orientalis: known host
Sequoiadendron giganteum: known host
Widdringtonia cedarbergensis: known host

Fig 25: Cypress Canker
- **Red**: Species infected
- **Purple**: Possible infection
- **Yellow**: Species susceptible
iii) Control

No fungicides are currently registered for the control of *Seiridium* on conifers, however a copper based fungicide e.g. active ingredient copper hydroxide has proven to help with other fungi.

Preventative measures such as regular feeding and watering and reducing the chances of wounding, are required.

Any infected branches can be pruned 10 cm below the canker to prevent infection spreading to the main stems. All tools should be sterilised before and after use with alcohol or dilute bleach. Severely diseased plants should be removed and destroyed. No fungicides are effective in controlling the disease once infection has occurred. Remove apparently infected branches well below the last obvious sign of canker (infection). Clean pruning tools between cuts or at least between trees to minimise the risk of infection transfer (use alcohol such as methylated spirits or domestic bleach) is recommended. Remove and destroy trees that are severely infected.

Prunings or trees should be carefully bagged and transferred for burning. Staff assigned to do this should be shown what to do and and have the reason explained.

Older trees are usually more prone to this disease but any tree is susceptible if stressed, for example, by drought or poor nutrient status

**Recommendation 66**

All of the Cupressaceae forests in the Arboretum should treated as if at risk, even if there has been no sign of the disease to date. This need for treating them as being at risk is even more important, given that once the plants are infected and weakened with *Seiridium*, they may be more susceptible to other pests and diseases, including borers.

**Recommendation 67**

Suspicious material found on any species not previously infected should be sent to one of the plant disease diagnostic laboratories.
b) Phytophthora Root Rot

Another potentially damaging disease that has already affected trees in the ARBORETUM is Phytophthora root rot. Caused by the soil fungus *Phytophthora cinnamomi*, it grows through the root system (and sometimes the stem) of a plant, destroying it and preventing the plant from absorbing water and nutrients. The fungus was probably introduced into Australia through European settlement, and has now spread to affect hundreds of thousands of hectares.

i) Phytophthora on the National Arboretum Site

Following an atypical wet season in late 2010 a considerable number of Wollemi Pines showed poor health. Tests on a sample of these showed the presence of Phytophthora root rot. Since then further tests from some of the trees in the Ginkgo and Giant Sequoia lots also revealed evidence of Phytophthora root rot. A diagnostic test kit has been used on several other forests but there has not been evidence that the disease has spread or is a problem in other forests.

ii) Control

We continue to monitor and use the diagnostic test kits, we checked the araucarias last week and had a negative result. We have programmed to remove the wash pits from the forests this week. So far no more reports of a positive reading. I believe good management, and the use of beneficial mycorrhizal fungi treatments along with drenching with phosphorus acid have had positive results.

**Recommendation 68**

- For the future control of Phytophthora, it is recommended that the following be addressed:
  - Continued drenching program for the Wollemi Pines, Ginkgos and Sequoia forest lots
  - Commencement of a wider test for Phytophthora across the site to better determine the number and spread of forest lots that will need to be included in any further treatment/management
  - Consideration of all drenching of all potted and open rooted plants coming onto the site for planting.
  - Sourcing of further expert advice with relation to disease management
  - Preparation of an Arboretum management plan for Phytophthora root rot.

18.11 Irrigation

Irrigation maintenance across the Forests has also been patchy. This is partly because of 2 wet summers during which the systems were not frequently used. The extreme dry conditions in summer 2013/14 demonstrated the need for more irrigation system maintenance.

In addition to the irrigation systems generally there is also a need to start re-routing the irrigation piping that was laid across rock outcrops and not buried.

**Recommendation 69**

Provide irrigation systems that allow the use of procedures like pulse irrigation to more efficiently use the water.

**Recommendation 70**

Ensure that irrigation in all the forests is checked and repaired before every summer. Those forests that are more dependent on irrigation are shown in Appendix 7.
Recommendation 71
Ensure that all of the irrigation system is fully functional at the commencement of the next maintenance contract and that the upkeep of the system is a part of the contract.

Recommendation 72
Re-route or bury the irrigation piping that was run across rock outcrops without it being buried.
19. **Suggested Work Program over the Next 5 years**

Appendix 9 is a suggested work program over the next 5 years. The table in Appendix 9 also provides the chapter in this review that is directly related to the forest and issues concerned.
## Appendix 1: List of Forests

<table>
<thead>
<tr>
<th>Forest</th>
<th>Species</th>
<th>Common Name</th>
<th>Family</th>
<th>Continent</th>
<th>Countries</th>
<th>Conservation Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quercus suber</td>
<td>Cork Oak</td>
<td>Fagaceae</td>
<td>Europe</td>
<td>Italy, France, Spain, Portugal, Morocco, Algeria, Tunisia</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Local Eucalypts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ficus carica</td>
<td>Fruiting Fig</td>
<td>Moraceae</td>
<td>Europe</td>
<td>Europe and Asia</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Aesculus hippocastanum</td>
<td>Horse Chestnut</td>
<td>Sapindaceae</td>
<td>Europe</td>
<td>Greece, Albania, the Republic of Macedonia, Serbia, and Bulgaria</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Melia azedarach</td>
<td>White Cedar</td>
<td>Meliaceae</td>
<td>Asia SE</td>
<td>Australia, Indonesia, China, India</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Albizia julibrissin</td>
<td>Silk Tree</td>
<td>Fabaceae</td>
<td>Asia C</td>
<td>Iran to China and Korea</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Magnolia delavayi</td>
<td>Chinese Evergreen Magnolia</td>
<td>Magnoliaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Magnolia grandiflora</td>
<td>Southern Magnolia</td>
<td>Magnoliaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Cornus kousa</td>
<td>Japanese Flowering Dogwood</td>
<td>Cornaceae</td>
<td>Asia E</td>
<td>Japan, China</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Liriodendron chinense</td>
<td>Chinese Tulip Tree</td>
<td>Magnoliaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Washingtonia filifera</td>
<td>Fan Palm</td>
<td>Arecaceae</td>
<td>America N</td>
<td>USA, Near Threatened</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Cedrus deodara</td>
<td>Deodar Cedar</td>
<td>Pinaceae</td>
<td>Asia S</td>
<td>Pakistan, India, Afghanistan</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Araucaria araucana</td>
<td>Monkey Puzzle</td>
<td>Araucariaceae</td>
<td>America S</td>
<td>Chile, Argentina, Endangered</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Acacia caerulescens</td>
<td>Buchan Blue Wattle</td>
<td>Mimosaceae</td>
<td>Australia W</td>
<td>Australia - Victoria, Vulnerable</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Parrotia persica</td>
<td>Persian Ironwood</td>
<td>Hamamelidaceae</td>
<td>Iran</td>
<td>Turkey, Georgia</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Dracaena draco</td>
<td>Dragon Tree</td>
<td>Ruscaceae</td>
<td>Africa N</td>
<td>Canary Islands, Vulnerable</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Acer saccharum</td>
<td>Sugar Maple</td>
<td>Aceraceae</td>
<td>America N</td>
<td>USA, Canada</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Prunus x yedoensis</td>
<td>Yoshino Cherry</td>
<td>Rosaceae</td>
<td>Asia E</td>
<td>Japan, is a natural hybrid</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Quercus macrocarpa</td>
<td>Bur Oak</td>
<td>Fagaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Eucalyptus argophloia</td>
<td>Western Qld White Gum</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Australia, QLD, Vulnerable</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Eucalypt species STEP</td>
<td>Gum Trees</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Australia, Southern Tablelands NSW</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Quercus engelmannii</td>
<td>Mesa Oak</td>
<td>Fagaceae</td>
<td>America N</td>
<td>USA, Vulnerable</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Araucaria angustifolia</td>
<td>Parana Pine</td>
<td>Araucariaceae</td>
<td>America S</td>
<td>Brazil, Argentina, Paraguay, Critically Endangered</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Lagerstroemia fauriei 'Fantasy'</td>
<td>Japanese Crepe Myrtle</td>
<td>Lythraceae</td>
<td>Asia E</td>
<td>Japan</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>not planted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Jubaea chilensis</td>
<td>Chilean Wine Palm</td>
<td>Arecaceae</td>
<td>America S</td>
<td>Chile</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Ginkgo biloba</td>
<td>Maidenhair Tree</td>
<td>Ginkgoaceae</td>
<td>Asia E</td>
<td>China, Endangered</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td><strong>Schotia brachypetala</strong></td>
<td>Weeping Schotia</td>
<td>Fabaceae</td>
<td>Africa S</td>
<td>Zimbabwe, South Africa</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td><strong>Podocarpus latifolius</strong></td>
<td>Broad-leaved Yellowwood</td>
<td>Podocarpaceae</td>
<td>Africa S</td>
<td>South Africa</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td><strong>Eucalyptus benthami</strong></td>
<td>Camden White Gum</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Camden district, NSW, Australia</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td><strong>Cercis siliquastrum</strong></td>
<td>Judas Tree</td>
<td>Fabaceae</td>
<td>Asia W</td>
<td>Iran, Iraq, Israel, Jordan, Lebanon, Syria Albania, Bulgaria, France, Greece, Italy, Turkey and Yugoslavia</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td><strong>Wollemia nobilis</strong></td>
<td>Wollemi Pine</td>
<td>Araucariaceae</td>
<td>Australasia</td>
<td>Australia, NSW</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td><strong>Sequoiadendron giganteum</strong></td>
<td>Giant Sequoia</td>
<td>Cupressaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td><strong>Cupressus sempervirens 'Stricta'</strong></td>
<td>Pencil Pine</td>
<td>Cupressaceae</td>
<td>Europe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td><strong>Betula nigra</strong></td>
<td>River Birch</td>
<td>Betulaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td><strong>Larix decidua</strong></td>
<td>European Larch</td>
<td>Pinaceae</td>
<td>Europe</td>
<td>France, Switzerland, Italy, Germany, Austria, Czechoslovakia, Yugoslavia</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td><strong>Tilia cordata</strong></td>
<td>Small-leaved Lime</td>
<td>Malvaceae</td>
<td>Europe</td>
<td>Great Britain, Scandinavia, Russia, Spain, Italy, Bulgaria, Turkey, the Caucasus</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td><strong>Cedrus libani</strong></td>
<td>Lebanese Cedar</td>
<td>Pinaceae</td>
<td>Asia W</td>
<td>Lebanon, Syria, Turkey</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td><strong>Cupressus dupreziana var. atlantica</strong></td>
<td>Moroccan Cypress</td>
<td>Cupressaceae</td>
<td>Africa N</td>
<td>Morocco</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td><strong>Cupressus dupreziana var. dupreziana</strong></td>
<td>Saharan Cypress</td>
<td>Cupressaceae</td>
<td>Africa N</td>
<td>Algeria</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td><strong>Quercus palustris 'Freefall'</strong></td>
<td>Pin Oak</td>
<td>Fagaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td><strong>Eucommia ulmoides</strong></td>
<td>Chinese Rubber Tree</td>
<td>Eucommiaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td><strong>Nyssa sylvatica</strong></td>
<td>Black Tupelo</td>
<td>Nyssaceae</td>
<td>America N</td>
<td>North America</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td><strong>Betula pendula ssp. fontqueri</strong></td>
<td>Spanish Birch</td>
<td>Betulaceae</td>
<td>Europe</td>
<td>Spain</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td><strong>Betula pendula ssp. pendula</strong></td>
<td>Silver Birch</td>
<td>Betulaceae</td>
<td>Europe</td>
<td>All Europe, including Scandinavia, Turkey and the British Isles</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td><strong>Luma apiculata</strong></td>
<td>Chilean Myrtle</td>
<td>Myrtaceae</td>
<td>America S</td>
<td>Chile, Argentina</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td><strong>Pinus radiata var. binata</strong> (Cedros Is)</td>
<td>Cedros Island Pine</td>
<td>Pinaceae</td>
<td>America C</td>
<td>Mexico, Cedros Island</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td><strong>Brahea edulis</strong></td>
<td>Guadalupe Palm</td>
<td>Arecaceae</td>
<td>America C</td>
<td>Guadalupe Island Mexico</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td><strong>Callitris oblonga</strong></td>
<td>South Esk Pine</td>
<td>Cupressaceae</td>
<td>Australasia</td>
<td>Australia, Tasmania</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td><strong>Cotinus 'Grace' (Hybrid)</strong></td>
<td></td>
<td>Anacardiaceae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td><strong>Arbutus canariensis</strong></td>
<td>Canary Madrone</td>
<td>Ericaceae</td>
<td>Africa N</td>
<td>Canary Islands, Spain</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Family</td>
<td>Region</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------</td>
<td>---------------------</td>
<td>--------------------</td>
<td>-------------------------</td>
<td>--------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>Grevillea robusta</td>
<td>Silky Oak</td>
<td>Proteaceae</td>
<td>Australasia</td>
<td>Australia: Qld, NSW</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>Picea abies</td>
<td>Norway Spruce</td>
<td>Pinaceae</td>
<td>Europe</td>
<td>Norway, Poland, central Europe, the Alps, the Carpathians and Balkans to Greece</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>Platanus orientalis</td>
<td>Plane Tree</td>
<td>Platanaceae</td>
<td>Asia W</td>
<td>Balkans to Iran</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Metasequoia glyptostroboides</td>
<td>Dawn Redwood</td>
<td>Cupressaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>Eucalyptus michaeliana</td>
<td>Hillgrove Spotted Gum</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Australia, NSW</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Pinus pinea</td>
<td>Stone Pine</td>
<td>Pinaceae</td>
<td>Europe</td>
<td>Southern Europe, North Africa and parts of the Mediterranean</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>Austrocedrus chilensis</td>
<td>Chilean Cedar</td>
<td>Cupressaceae</td>
<td>America S</td>
<td>Chile and Argentina</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Ceiba speciosa</td>
<td>White Silk Floss Tree</td>
<td>Malvaceae</td>
<td>America S</td>
<td>Brazil, Argentina, Paraguay</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>Butia capitata</td>
<td>Jelly Palm</td>
<td>Arecaceae</td>
<td>America S</td>
<td>Brazil, Uruguay</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Pinus halapensis</td>
<td>Aleppo Pine</td>
<td>Pinaceae</td>
<td>Europe/Asia W</td>
<td>Morocco, Spain, France, Italy, Croatia, Greece, Malta, Tunisia, Syria, Lebanon, Turkey, Jordan, Israel &amp; Palestine</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Pinus radiata ssp. radiata</td>
<td>Radiata Pine</td>
<td>Pinaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>Pinus brutia</td>
<td>Lone Pine</td>
<td>Pinaceae</td>
<td>Asia W</td>
<td>Turkey, Greece, Crimea, Iran, Georgia, Azerbaijain, Iraq, Syria, Lebanon, Cyprus</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Davidia involucrata</td>
<td>Dove Tree</td>
<td>Nyssaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Podocarpus totara</td>
<td>Totara</td>
<td>Podocarpaceae</td>
<td>Australasia</td>
<td>New Zealand</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Sophora microphylla</td>
<td>Kowhai</td>
<td>Fabaceae</td>
<td>Australasia</td>
<td>New Zealand</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>Chamaecyparis lawsoniana</td>
<td>Lawsons Cypress</td>
<td>Cupressaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>Platycladus orientalis</td>
<td>Chinese arborvitae</td>
<td>Cupressaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>Styrax japonica</td>
<td>Japanese Snowbell</td>
<td>Styracaceae</td>
<td>Asia E</td>
<td>Japan</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>Eucalyptus lacrimans</td>
<td>Weeping Snow Gum</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Australia, NSW</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>Pseudolarix amabilis</td>
<td>Golden Larch</td>
<td>Pinaceae</td>
<td>Asia E</td>
<td>Eastern China</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>Cercis canadensis</td>
<td>Eastern Red Bud</td>
<td>Fabaceae</td>
<td>America N</td>
<td>USA, Canada</td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>Araucaria bidwillii</td>
<td>Bunya Pine</td>
<td>Araucariaceae</td>
<td>Australasia</td>
<td>Australia</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>Liquidambar orientalis</td>
<td>Oriental Sweet Gum</td>
<td>Hamamelidaceae</td>
<td>Europe</td>
<td>Turkey</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Acer buergerianum ssp. buergerianum</td>
<td>Chinese Trident Maple</td>
<td>Aceraceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Acer buergerianum ssp. formosanum</td>
<td>Taiwan Trident Maple</td>
<td>Aceraceae</td>
<td>Asia E</td>
<td>Taiwan</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>not planted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Family</td>
<td>Subdivision</td>
<td>Countries/Regions</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------</td>
<td>------------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Populus euphatica</td>
<td>Euphrates Poplar</td>
<td>Salicaceae</td>
<td></td>
<td>Algeria, China, Egypt, India, Iran, Iraq, Israel, Libya, Pakistan, Syria, Turkey, Turkmenistan</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Populus yunnanensis</td>
<td>Yunnan Poplar</td>
<td>Salicaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Toona sinensis</td>
<td>Chinese Mahogany</td>
<td>Meliaceae</td>
<td>Asia SE</td>
<td>North Korea, China, Nepal, India, Myanmar, Thailand, Malaysia, Indonesia</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>Pinus radiata ssp. radiata</td>
<td>Radiata Pine</td>
<td>Pinaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Sophora toromiro</td>
<td>Toromiro</td>
<td>Fabaceae</td>
<td>Pacific</td>
<td>Easter Island</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Styphnolobium japonicum</td>
<td>Japanese Pagoda Tree</td>
<td>Fabaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>not planted Carpinus orientalis</td>
<td>Oriental Hornbeam</td>
<td>Betulaceae</td>
<td>Europe</td>
<td>Southeastern Europe to Northern Iran</td>
<td></td>
</tr>
<tr>
<td>79</td>
<td>Brachychiton populneus</td>
<td>Kurrajong</td>
<td>Malvaceae</td>
<td>Australasia</td>
<td>Australia - Victoria, NSW and QLD</td>
<td></td>
</tr>
<tr>
<td>79</td>
<td>Brachychiton rupestris</td>
<td>Queensland Bottle Tree</td>
<td>Malvaceae</td>
<td>Australasia</td>
<td>Australia - QLD</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>Fagus sylvatica</td>
<td>European Beech</td>
<td>Fagaceae</td>
<td>Europe</td>
<td>All Europe, including Scandinavia, Turkey and the British Isles</td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>Eucalyptus parvula</td>
<td>Small Leaved Gum</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Australia, NSW</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>Quercus robur</td>
<td>English Oak</td>
<td>Fagaceae</td>
<td>Europe</td>
<td>Europe, Asia Minor and North Africa</td>
<td></td>
</tr>
<tr>
<td>83</td>
<td>Nothofagus obliqua</td>
<td>Roble Beech</td>
<td>Nothofagaceae</td>
<td>America S</td>
<td>Chile and Argentina</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>Zelkova serrata</td>
<td>Japanese Zelkova</td>
<td>Ulmaceae</td>
<td>Asia E</td>
<td>Japan, Korea, China, Taiwan</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>Eucalyptus morrysvyi</td>
<td>Morrisby's Gum</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Australia, Tasmania</td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>Diospyros lotus</td>
<td>Wild Persimon</td>
<td>Ebenaceae</td>
<td>Asia W</td>
<td>Iran, Uzbekistan</td>
<td></td>
</tr>
<tr>
<td>87</td>
<td>Pyrus calleryana</td>
<td>Callery Pear</td>
<td>Rosaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>88</td>
<td>Juglans regia</td>
<td>Persian Walnut</td>
<td>Juglandaceae</td>
<td>Asia W</td>
<td>Afghanistan, China, Kyrgyzstan; Pakistan, Tajikistan, Turkmenistan, Uzbekistan</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td>Pseudopanax ferox</td>
<td>Fierce Lancewood</td>
<td>Araliaceae</td>
<td>Pacific</td>
<td>New Zealand</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>Pinus radiata var. binata (Guadalupe Is)</td>
<td>Guadalupe Pine</td>
<td>Pinaceae</td>
<td>America C</td>
<td>Mexico, Guadalupe Island</td>
<td></td>
</tr>
<tr>
<td>91</td>
<td>not planted Taxodium mucronatum</td>
<td>Montezuma Cypress</td>
<td>Taxodiaceae</td>
<td>America C</td>
<td>Mexico, USA</td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>Eucalyptus scoparia</td>
<td>Wallangarra White Gum</td>
<td>Myrtaceae</td>
<td>Australia</td>
<td>Australia, QLD &amp; NSW</td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>Carya illinoinsensis</td>
<td>Pecan</td>
<td>Juglandaceae</td>
<td>America C</td>
<td>USA, Mexico</td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>Franklinia alatamaha</td>
<td>Franklin Tree</td>
<td>Theaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>94</td>
<td>not planted Quillaja saponaria</td>
<td>Soapbark Tree</td>
<td>Quillajaceae</td>
<td>America S</td>
<td>Chile</td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>Cupressus duclouxiana</td>
<td>Chinese Cypress</td>
<td>Cupressaceae</td>
<td>Asia E</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>Catalpa bignonioides</td>
<td>Southern Catalpa</td>
<td>Bignoniaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>97</td>
<td><em>Cladastris kentukea</em></td>
<td>American Yellowwood</td>
<td>Fabaceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----------------------</td>
<td>---------------------</td>
<td>----------</td>
<td>-----------</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>98/99</td>
<td><em>Corymbia maculata</em></td>
<td>Spotted Gum</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Australia,</td>
<td></td>
</tr>
<tr>
<td>98/99</td>
<td><em>Eucalyptus tricarpa</em></td>
<td>Red Ironbark</td>
<td>Myrtaceae</td>
<td>Australasia</td>
<td>Australia, Victoria, NSW</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td><em>Allocasuarina verticillata</em></td>
<td>Drooping She Oak</td>
<td>Casuarinaceae</td>
<td>Australasia</td>
<td>Australia - Victoria, NSW, Tas, SA</td>
<td></td>
</tr>
<tr>
<td>101</td>
<td><em>TBD</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>102</td>
<td><em>Maclura pomifera</em></td>
<td>Osage Orange</td>
<td>Moraceae</td>
<td>America N</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>103</td>
<td><em>Widdringtonia cedarbergensis</em></td>
<td>Clanwilliam Cypress</td>
<td>Cupressaceae</td>
<td>Africa S</td>
<td>South Africa</td>
<td></td>
</tr>
<tr>
<td>104</td>
<td><em>Koelreuteria paniculata</em></td>
<td>Golden Rain Tree</td>
<td>Sapindaceae</td>
<td>Asia E</td>
<td>China, Korea</td>
<td></td>
</tr>
</tbody>
</table>

- **Critically Endangered**
Appendix 2: Proposal for a new Wollemi pine Planting and Management of Forests 32 and 76

1. Introduction

The Wollemi pine is still extremely new to horticulture. Discovered in the Blue Mountains in 1994, it was first planted at the Royal Botanic Gardens, Sydney in 1998. Although it has been planted in many places around Australia and the world, its growth has been monitored for only a limited period of time. It was first planted at the Arboretum in 2007.

The species grows to 40m high in its natural habitat with a trunk of up to one metre in diameter, however, it is not expected that it will grow higher than about 20m in cultivation in Canberra. Although it does not grow in overly cold conditions in the Blue Mountains, trials in the US and Japan indicate that it can possibly survive conditions down to as low as -12 degrees C and so survive Canberra’s climate. It is generally considered to be a fast growing species that responds to light well and favours acidic soil conditions.

The Arboretum planting is both nationally and internationally important as it has been probably the largest single Wollemi planting in the world. Although since the planting started a very high percentage of trees have been lost, a lot has been learnt about the cultivation of the plant. Using the experience gained already there is now an excellent opportunity to continue this study and not only provide further information but also produce an impressive display.

2. Loss of plants since the initial planting

An initial inspection of the Wollemi Pine planting in early 2008 revealed that the attrition rate was already much higher than expected. In March 2008, the numbers were recorded as:

<table>
<thead>
<tr>
<th>Status</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead</td>
<td>221</td>
</tr>
<tr>
<td>Unhealthy</td>
<td>57</td>
</tr>
<tr>
<td>Healthy</td>
<td>549</td>
</tr>
<tr>
<td>Total</td>
<td>827</td>
</tr>
</tbody>
</table>

After the above count and after the first removal of dead trees, the remainder were assessed and scored from 0 to 5, i.e. from dead to growing well. The results are below:

**Over the entire site (606 trees):**
0  23%  1  7%  3  25%  3  16%  4  18%  5  11%

**On the steep southern facing slope (70 trees):**
0  19%  1  2%  2  7%  3  13%  4  24%  5  36%

**On eastern facing slope (117 trees):**
0  7%  1  4%  2  16%  3  34%  4  26%  5  11%

As can be seen, it was already obvious that the trees on the southerly and, to a lesser extent, easterly slopes were surviving considerably better than average. Since the time of the first count in 2008, there have been 410 re-plantings with the majority being lost.
A recent stock take done by the Friends shows that the number of surviving trees has now fallen to 85 (see Fig 1), with one tree having been lost since as a result of damage caused by machinery. From the number of plantings/re-plantings done and the number of trees left, there has been a total loss of 94% of trees since the plantings started about 7 years ago.

![Wollemia nobilis Forest 32 (Lot 16) planted 2007/08](image)

**Fig 1. Remainder of the Wollemi forest in 2014 (Hnatiuk 2015)**

As was recorded in 2008, the best survival in 2014 is still on the slope with the southerly aspect with some of the best plants on the edge of the rocky outcrop. However, most of the trees that survived up to 2008 on the easterly aspect have since been lost. The condition of the remaining trees was re-scored from 0 to 5, (i.e. from dead to growing well) in September, 2014 with the following results:

<table>
<thead>
<tr>
<th>Score</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>4</td>
<td>39%</td>
</tr>
<tr>
<td>5</td>
<td>45%</td>
</tr>
</tbody>
</table>

### 3. Suggested reasons for tree losses

Since the deaths of the Wollemi Pines started soon after planting in 2007, there have been numerous reasons proposed. The major suggestions include:

1. Wollemi pine is poorly adapted to the open conditions of Forest 32 and planting on more extreme aspects added to this problem.

   This is strongly supported by the results of the surveys above.

   Both Dan Bishop from the Australian Botanic Garden, Mt Annan and Phil Hurle from the Australian National Botanic Gardens agreed that aspect and protection are important for the growth of young trees – but there is as yet no experience with older specimens.

2. Plants used were root bound when potted up and had not grown out sufficiently into the larger pots before planting.
From when the first plantings had started to be removed in early 2008, the tightly bound nature of the root balls was observed. At the time of planting it had been noted that several of the plants had not grown out into the surrounding potting mix after repotting. This problem was, however, most likely associated with only the first plantings.

**iii) Some short periods of extreme weather stressed the plants.**
Most days during October 2007 recorded above average maximum temperatures and there were also 2 days where the maximum temperature was greater than 30 °C (Bureau of Meteorology, 2007). While these could have cause some loses on the early plantings, the extreme conditions in Canberra during the summer of 2014 did not cause the loses that could have been expected.

**iv) Insufficient irrigation water.**
It was felt that poor irrigation equipment contributed to the death of some of the earlier plantings but Dan Bishop from the Australian Botanic Garden, Mt Annan noted that the trees there have coped well with a very wide range of soil moisture conditions.

**v) Fungal infections**
Specialist advice from Edward Liew at the Royal Botanic Gardens, Sydney indicated that the fungus *Botryosphaeria* was definitely present, indicating that it could potentially become pathogenic and produce symptoms when the plants get severely stressed. A *Pythium* sp. was also detected and although it was unlikely to cause disease problems it does exacerbate stresses caused by climate or other diseases. *Phytophthora* was also detected and although it was probably not *P. cinnamomi* it should still be considered pathogenic.

Dan Bishop noted that where *Phytophthora* has arisen at Mt Annan previously, it does not appear to be a major concern for the tree if other conditions were satisfactory. This also appears to be the situation at the Arboretum.

**Conclusion:**
The main findings to date suggest that the loss of the plants over the last 7 years could be attributed to three main factors, being: i) exposure to unsuitable growing conditions over a large proportion of the forest; ii) a significant amount of poor original planting stock that was root bound, and; iii) fungal infections during two very atypically wet summers.

Although the loses of Wollemi pines have been very significant, there has been a lot learnt about the cultivation of what is otherwise a poorly known plant and the experience has given the Arboretum an excellent opportunity to greatly improve its display of the rare conifer.

**4. Recommended Actions**
Using the experience gained to date, the space created by the loss of the Wollemi pines and the existence of prime growing conditions elsewhere in the Arboretum, the following actions are recommended.

**4.1 Re-division of the current Forest 32.**
The re-division of Forest 32 as given in Fig 3 below is recommended. This will allow the original forest layout of the Arboretum to be retained, will provide a section to be used for the Federation plantings (A), will identify an area that can be replanted with another species (B) and allow the remainder of the Wollemi planting to be retained. Further recommendations with regards to the new forest and the management of the remaining Wollemi ‘forest’ are given in sections 4.2 and 4.3.
4.2 Creation of a new forest within current Forest 32
Given the unsuitability for the Wollemi pines that area B in the above Fig. 3 has demonstrated, it is recommended that a new species be selected and planted in that area. Suggested species for the planting are given in Appendix xx.

4.3 Management of the remaining Wollemi pines in Forest 32
Given the suitability that area C in the above Fig. 3 has demonstrated, it is recommended that it is retained as a Wollemi planting but it is also recommended that the conditions of the site be further improved with additional species that grow naturally with the Wollemi. Two species for consideration are *Angophora floribunda* and *Acmena smithii*. This would also effectively separate the purpose of the current and proposed Wollemi plantings, with the former being a habitat planting like Forest 2 and Forest 20.

4.4 Establishment of a new Wollemi planting in Forest 76
Using the experience and information that has been gathered at the Arboretum and from the Australian Botanic Garden, Mt Annan it is recommended that a second planting of the Wollemi pine be established. The location recommended is an area of 100m² that is the southern one third of the *Pinus radiata* subsp. *radiata* planting and is currently part of Forest 76 (See Fig 4). This site has a strong southerly aspect and was a part of a large rocky outcrop. Using this area would still leave a large planting of *P. radiata* that could be further developed (see Section 4.5). The planting of the entire 100m² will not be done in one go and the first plantings will not be obvious from the outside of Forest 76. As a result, if it is decided after the first or second planting that it has not been successful, it will still be very simple to re-establish the *P. radiata* planting without it being obvious.
The suggested staging of the planting is partly because the Wollemi plantings are still effectively a part of the Arboretum’s research and its success is yet to be fully gauged. The following phasing is recommended:

i) Clear five 20m$^2$ areas for the first planting in the southern section of Forest 76 (see Fig 5).

ii) Plant the areas with both seed grown and cutting grown specimens. A planting design to provide a good number of plantings while still allowing space between them is given in Fig 6. It also will give an impression of a less formal planting pattern.

iii) Water the plants regularly over at least the first growing season.

iv) Further expand the P. radiata plantings at the southern end of the windbreak (see Fig 5).

Given the findings by Edward Liew regarding Phytophthora on site, it is also recommended that some consideration to the fungus’ possible presence in Forest 76 is necessary. The most common way of treating new plantings is to dip or soak the root ball of new plants in phosphonate before planting into the ground. The chemical, phosphonate, triggers the host defence mechanism and an enhanced host resistance is generated.

Assuming that the first plantings have grown well in the first two years:

i) Clear the P. radiata from the second area and replant with Wollemi pines (see Fig 5).

Assuming the first two plantings have continued to grow well in the first 3-4 years:

i) Clear the P. radiata from the third area and replant with Wollemi pines (see Fig 5).

ii) Leave the wind break of P. radiata on the western side

iii) Clear an area between Forest 76 and the new Wollemi pine planting.
Fig 5: Suggested Wollemi plantings in the southern section of Forest 76

- First planting
- Second planting
- Third planting

Fig. 6: Suggested planting pattern of new Wollemi planting
4.5 Management and use of the remainder of Forest 76

Whether the southern section of Forest 76 is used for the forest planting of the Wollemi pine, the following actions are recommended for Forest 76.

i) **Review the current stand of *Pinus radiata* in terms of:**
   - Proposed long term density and associated thinning
   - Proposed lifting and formative pruning.
   - Needs for replanting both around the edge and within the forest
   - Need for weed removal, especially blackberry
   - Need for rubbish removal, including fence wire

ii) **Determine the suitability of Forest 76 for a bike path.**

5. Ongoing research

Given the involvement that the Australian Botanic Garden, Mt Annan has had with the Wollemi pine since its discovery, it is suggested that the Arboretum establishes a link with them to collaborate in developing the cultivation of the Wollemi pine. This could involve a MOU like the one with ANU. Possible contacts include Cathy Offord, the Manager of Horticultural Research at the Australian Botanic Gardens, Mt Annan.

Some of the remaining Wollemi pine on the southerly aspect slope of Forest 32 (A. Burgess)
Appendix 3: Review of the *Acacia caerulescens* Planting and Options for Replacing a Forest Species (written in March 2013)

**Forest 13**

Date First Planted: November 2008  
Number Planted: 1082  
Number Replanted in 2012: 100 super tubes from same provenance  
Current Number: About 700 (Another count is to be done soon)

1. **Species Information:**

   **Natural Distribution**
   
The species is native to a small area in the Gippsland region of Victoria, Australia.

   **General Description**
   
   It is a small evergreen tree which has a pyramidal shape. The bark on young trees is smooth but becomes dark and fissured as the trees age. It has blue green foliage and an attractive, fragrant, pale-yellow flower. The fruit is an oblong pod. Where they occur naturally the species is apparently long-lived, with no evidence of any senescing trees present in surveys done in 2002.

   Height 12m Spread 6m

   **Conservation Status**
   
   It is classified as a threatened species.

2. **Performance at the Arboretum:**

   **Growth rate**
   
The species has been found to be fast growing in Canberra, growing from about 35cm when planted to approximately 2m after the first year. The mean height of the trees, as recorded by the Friends Tree Monitoring Group, increased from 2.22 m in February 2010 to 6.35m in April 2012 (1.95m/yr). In the same time the stem diameter increased by over 400% with the mean stem diameter growing from 1.63cm to 8.63cm. For more information see Table 1.

   Table 1: Heights and stem diameters of *Acacia caerulescens* recorded by the Friends Tree Monitoring Group.

<table>
<thead>
<tr>
<th>Diameter (cm)</th>
<th>Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Mean</td>
</tr>
<tr>
<td>21/2/2010</td>
<td>1.63</td>
</tr>
</tbody>
</table>
It was also very obviously affected by northerly winds in its early years with many of the trees developing a lean to the southeast of up to 20°. And this lean has continued to develop over the past 4 years with a significant number of the trees falling over.

**Health**

Up until the wet summer of 2010, the losses were low. However, with both the 2010 and 2011 summers a large area of the forest was lost. See Fig 1 below.

![Fig 1. Area of forest planting lost since early 2011.](image)

The main reason for these losses was viewed as resulting from a very wet area which has since been addressed with drainage. However, since then, the pests described below have continued to cause a serious loss of trees throughout the entire forest.

**Pests**

In addition to the leaning, many of the trees have been very seriously affected by insect attack. It is likely that this has primarily been done by the jewel beetle *Agrilus hypoleucus* which has been identified by the CSIRO Division of Entomology from insects collected by Phillip Unger for BurHor. Another species is present but is yet to be identified.

The beetle is a member of the family Busprestidaceae and the larvae bore through roots, logs, stems, and leaves of various types of plants, ranging from trees to grasses. Some of the wood boring types like *Agrilus hypoleucus* attack green wood and are capable of killing trees.
Agrilus hypoleucus is among the most abundant species of Buprestid beetle in temperate southern half of Australia, and is common on several species of Acacia. One of the recorded species is Acacia mearnsii, Black Wattle, which is highly likely to be native to areas close to or on the Arboretum site.

The effects of the insect attacks in the Arboretum have been splitting of the bark, weeping of sap, weakening and lose of tree limbs and death of trees. Interestingly, a similar level of insect attack is not recorded as a threat to the species where it grows naturally in Victoria.

Again, the problem of tree death appears to have been significantly worse in the particularly wet areas. Those trees growing on a slight rise that is much better drained, have done considerably better.

3. Actions to date

When a large number of trees were lost during and following the wet summer of 2010, drainage in the area of total loss was greatly improved. However, by the time that the drainage was completed the deaths from insect attack had already commenced and until there was a better understanding of the insects causing the damage no further plantings were done. In 2012, as there were still plants at the Yarralumla Nursery, it was decided to plant 100 trees at the edge of the area that had had the losses during the wet period to gauge their response.
Fig 3. New plantings and earlier plantings in decline

This was seen as a test for growth in both drier and less wind exposed conditions. All of these trees have shown excellent early growth, as did the first plantings. They are not yet large enough to see whether the issues of leaning or insect attack will be repeated.

However, since this last planting several trees of the first planting have either died or have been removed because of poor health as a result of the beetle attacks, and no further plantings have been done.

4. Options for Discussion

Given the current condition of the forest, the main options for discussion are as follows:

**Option 1** Continue to remove the dying trees without replacing them for at least the next year to determine whether the death rate will continue at the same level or will dramatically decline and allow the possibility of replanting.

**Pros**

- No need to do regular plantings until a decision about replanting/replacement is made
- No need to spend time on hand watering or upgrading the irrigation until a decision is made
- Possibility of decline in deaths and improvement in health
- Continuation of the same species, particularly in terms of interpretation

**Cons**

- Likely increase in the obvious gaps in the forest
- Ongoing need to frequently explain the poor tree health and tree removals
- Ongoing need to explain the missing plantings in the forest
• Need to again address the problem if the trees continue to decline

Option 2 Replace all lost trees with *Acacia caerulescens* seedlings and monitor whether the tree deaths will be an ongoing problem.

**Pros**

• Continuation of the same species, particularly in terms of interpretation
• No obvious gaps in the forest
• Variation in the size of trees across the forest.
• No need to justify change in species

**Cons**

• Likely need to frequently remove trees
• Likely need to continue to buy replacement trees
• Likely need to frequently replant trees
• Need to repair/upgrade irrigation system or hand water replants
• Possible ongoing need to frequently explain tree removals

Option 3 Remove all the *Acacia caerulescens* plantings and replace with another tree species.

**Pros**

• Improve the appearance of the forest in one action
• Stop the need for regular removals

**Cons**

• Need to select species that suits current planting layout or redesign irrigation system
• Need to reinstall irrigation system or hand water.
• Need to wait until new species can be propagated/sourced before planting commences
• Need to explain the removal of the *Acacia caerulescens* and the planting of another tree species
• Need to change all interpretation to include new tree species

Option 4 Continue to remove the *Acacia caerulescens* as they decline or die and start replacing them with another tree species selected to eventually fill the forest.

**Pros**

• No need to remove all of the *Acacia caerulescens* at one time
• No obvious gaps in the forest
• No need to explain the obvious removal of the whole forest
• Improve the appearance of the forest over time

**Cons**

• Need to select tree species that suits current planting layout
• Need to repair/upgrade irrigation system or hand water replants
- Need to wait until new species can be propagated/sourced before replacement planting commences
- Ongoing need to explain the poor tree health and tree removals
- Need to explain the planting of another species
- Need to change all interpretation to include both species until all the *Acacia caerulescens* is gone and only then include only the new species
Appendix 4: Five Year Operational Plan for Forest 2

Year 1 (2011)

Natural areas of *Themeda australis*
- Mowing of previously unmown areas before Spring.
- Woody weed control.

Planted indigenous trees
- General forest site clearance to allow mowing/whipper snipping.
- Mowing or whipper-sipping of areas not previously mown.
- Mulching of *E. mannifera* and *E. viminalis* stands.

Naturally occurring indigenous trees
- Mowing or whipper-snipping of areas not previously mown.
- Woody weed control.

Planted exotic trees
- *Quercus* removal.
- Woody weed removal.

Grasses and water plants in drainage areas
- Rubbish clearance from any drainage lines.
- Mowing of all drainage areas.
- Woody weed control.

Fences
- Removal of cork oak fence.
- Relocation of boundary fence alongside William Hovell Drive.
- Mowing and rubbish removal along old fence lines.

*Flora survey to determine range and distribution of grasses and other ground cover. This will extend into 2012 as the plants re-grow after mowing.*

Year 2 (2012)

Natural areas of *Themeda australis*
- Mowing any unmown areas within newly fenced areas.
- Testing use of fire for weed control and *Themeda* management.
- Commencement of grass and broadleaf weed control.
- Commencement of re-establishment of *Themeda* areas.

Planted indigenous trees
1) Stands dominated by *Eucalyptus mannifera* ssp. *maculosa*
- Continued mulching.
- Removal and chipping of inappropriate trees.
- Plantings to connect small groups.
- Plantings to introduce new dry sclerophyll forest
species.
• Plantings of woodland species on the edge of stands to connect with surrounding Themeda grassland.
• Plantings of grasses/forbs from dry sclerophyll forests.
2) Stand dominated by *Eucalyptus viminalis*
• Re-mulching.
• Removal and chipping of any inappropriate tree species.
• Planting of more *E. viminalis* and *E. pauciflora* to fill spaces.
3) Stand dominated by *Eucalyptus bridgesiana*
• Removal of inappropriate species of trees.
• Thinning of *Eucalyptus bridgesiana* to create woodland.
• Commencement of grass and broadleaf weed control.
• Re-establishment/expansion of different grass stands under the trees.

*Naturally occurring indigenous trees*
• Weed control.
• Re-seeding and planting of selected grass (and *Cyperaceae* species in drainage areas).

*Naturally occurring individuals of natives species and associated seedlings*
• Weed control.
• Re-seeding and planting of selected grass (and *Cyperaceae* species in drainage areas).

*Woody weeds*
• 3 monthly site inspection and weed removal.

*Rushes growing near the dams*
• Development of the dam and picnic area.
• Planting of trees as selected as a part of the plan.
• Planting of water plants which naturally occur in the area.

*Paths*
• Re-routing and upgrading of paths.

*Naturally occurring indigenous trees*
• Continued weed control.

*Grasses and water plants in drainage areas*
• Continued weed control.

*Grasses and water plants near dams*
• Continued establishment of water plants.
• Continued weed control.

*Woody weeds*
• 6 monthly site inspection and weed removal.

**Year 3 (2013)**

*Natural areas of *Themeda australis***
• Burning of site if acceptable.
• Re-mowing of site if not burnt.
• Continued weed control.
• Continued re-establishment of *Themeda* areas.

**Planted indigenous trees**

1) Stands dominated by *Eucalyptus mannifera* ssp. *maculosa*
   • Mulching as required.
   • Continued weed control.
   • Cutting up of any fallen trees.

2) Stand dominated by *Eucalyptus viminalis*
   • Mulching as required.
   • Continued weed control.
   • Cutting up of any fallen trees.

3) Stand dominated by *Eucalyptus bridgesiana*
   • Continued weed control.
   • Continued development of grass stands under the trees.
   • Cutting up of any fallen trees.

**Naturally occurring indigenous trees**

• Continued weed control.

**Grasses and water plants in drainage areas**

• Continued weed control.

**Grasses and water plants near dams**

• Continued establishment of water plants.

• Continued weed control.

**Woody weeds**

• 6 monthly site inspection and weed removal.

**Year 4 (2014)**

**Natural areas of *Themeda australis***

• Continued weed control.

**Planted indigenous trees**

1) Stands dominated by *Eucalyptus mannifera* ssp. *maculosa*
   • Continued weed control.
   • Cutting up of any fallen trees.

2) Stand dominated by *Eucalyptus viminalis*
   • Continued weed control.
   • Cutting up of any fallen trees.

3) Stand dominated by *Eucalyptus bridgesiana*
   • Continued weed control.

**Year 5 (2015)**

**Natural areas of *Themeda australis***

• Mowing of *Themeda* stands.

• Continued weed control.

**Planted indigenous trees**

1) Stands dominated by *Eucalyptus mannifera* ssp. *maculosa*
   • Continued weed control.
   • Cutting up of any fallen trees.

2) Stand dominated by *Eucalyptus viminalis*
   • Continued weed control.
• Cutting up of any fallen trees.
3) Stand dominated by *Eucalyptus bridgesiana*
• Continued weed control.
• Cutting up of any fallen trees.
**Naturally occurring indigenous trees**
• Continued weed control.
**Grasses and water plants in drainage areas**
• Continued weed control.
**Grasses and water plants near dams**
• Continued weed control.
**Woody weeds**
• 6 monthly site inspection and weed removal.
Appendix 5: Plantings in the Central Valley up to August 2015

1. Their Royal Highnesses, The Duke and Duchess of Cambridge
   Qurucus robur "English oak", planted 2014

2. His Excellency Dr. Johannes Hoesch, President of the Republic of Germany
   Zelkova serrata "White oak", planted 2010

3. Mr. Jon Stahnke, former Chief Minister of the ACT
   Shagbark hickory "American hickory", planted 2017

4. The Honourable Peter Garrett MP, Minister for Environment, Heritage and the Arts
   Agathis robusta "Queensland Kauri", planted 2013

5. Crown Prince Frederik and Princess Mary of Denmark
   Astronium fraxinifolium "Field maple", planted 2011

6. Mr. Ban Ki-moon, Secretary-General of the United Nations
   Cercis siliquastrum "Swamp willow", planted 2011

7. The Honourable Ms Julie Gillard MP, Prime Minister of Australia
   Cornus kousa "Snowbell", planted 2014

8. His Excellency Mr. Georgy Parvanov, President of the Republic of Bulgaria
   Pinus halepensis "White pine", planted 2009

9. His Excellency Mr. László Sólyom, President of the Republic of Hungary
   Fagus sylvatica "Hungarian beech", planted 2008

10. The Right Honourable Mr. John Key, Prime Minister of New Zealand
    Acacia auriculiformis "New Zealand silver" planted 2009

11. His Excellency Lieutenant General Sareetaיחari Han Kamra, President of the Republic of Kazakhstan
    Calophyllum inophyllum "Capuche chestnut", planted 2010

12. The Honourable Mr. O'Neill CMG OM, Prime Minister of Papua New Guinea
    Eucalyptus cinnerea "Gum tree", planted 2011

    Eucalyptus cinnerea "Gum tree", planted 2011

14. Her Excellency Ms Yoko Kishiwata, Prime Minister of the Kingdom of Thailand
    Sassafras occidentalis "Red bay", planted 2012

15. The Honourable Mr. Tullulah Lepcha, Member of Parliament, Prime Minister of the Independent State of Samoa
    Araucaria bidwillii "Silky oak", planted 2011

16. Jimmy Barnes, Musician
    Eucalyptus tereticornis "Parrot tree", planted 2011

17. His Excellency Professor Dr. Sodindo, Vice President of the Republic of Indonesia and Madam Harawati Sodindo
    Eucalyptus tereticornis "Silky oak", planted 2013

18. The Honourable Mr. Morgan Tsvangirai, Prime Minister of Zimbabwe
    Scleria longipedata "African walnut", planted 2012

19. His Excellency Mr. Dimitris Christofias, President of the Republic of Cyprus
    Quercus ilex "European oak", planted 2011

20. His Majesty His Highness the Aga Khan, President of the Islamic Community (Wadad La'ah)
    Urtica dioica "Nettle", planted 2011

21. His Excellency Dr. Tony Tan Keng Yam, President of Singapore and his wife, Mrs Mary Tan
    Albizia julibrissin "Silk tree", planted 2014

22. His Excellency Professor Anh Nhac Cao, President of the Republic of Vietnam and Dr. Mai Chi Tho, President of Vietnam
    Qurucus salicifolia "Maidenhair", planted 2012

23. His Excellency General Michel Sleiman, The President of the Republic of Lebanon
    Cedrus libani "Cedar of Lebanon", planted 2012

24. Mr. David Cameron, Prime Minister of the United Kingdom
    Acacia cyncantha "Cymacanth", planted 2011

25. Mr. Rob de Castella, Sporting Champion
    Acacia cyncantha "Cymacanth", planted 2011

26. Ms Laureen Jackson, Sporting Champion
    Acacia cyncantha "Cymacanth", planted 2011

27. Mr. Mal Meninga, Sporting Champion
    Acacia cyncantha "Cymacanth", planted 2011

28. Mr. Thomas Keenleysy, Author
    Acacia cyncantha "Cymacanth", planted 2011

29. His Excellencies Li Gei, The Rt Hon Su, Henry Mateipa and ZNZQ GO, Governor-General of New Zealand, and Lady Dame Janet Mateipa
    Quercus coccifera var. californica "California oak", planted 2015

30. His Excellency Dr. John M. Kikwete, President of the Republic of Tanzania
    Eucalyptus globulus "Eucalyptus", planted 2015

31. His Excellency Mohammed Nafisuddin, President of the Republic of the Maldives
    Wollemia nobilis "Wollemi pine", planted 2010

32. The Honourable Branswyn Bishop MP, The Speaker of the House of Representatives
    Acacia cyncantha "Cymacanth", planted 2014

33. René the Honourable Stéphane Perrin, The President of the Senate
    Acacia cyncantha "Cymacanth", planted 2014

34. M. Romatitso M. Mathafa, Architect
    Acacia cyncantha "Cymacanth", planted 2012

35. Mr. Wolfgang Boas (Wollbachia), Winnemakers
    Acacia cyncantha "Cymacanth", planted 2011

36. His Excellency Mr. José Manuel Barroso, President of the European Commission
    Fagus sylvatica "Tiliae" "European beech", planted 2011

37. Their Excellencies General the Honourable Sir Peter Cosgrove AK MC and Lady Cosgrove
    Davidia involucrata "Snowbell", planted 2015

38. His Excellency Mr. Mark Rutte, Prime Minister of the Kingdom of the Netherlands
    Siebner pendula "Silver birch", planted 2014

39. His Excellency Mr. Nguyen Tan Dung, Prime Minister of the Socialist Republic of Vietnam and his wife, Madame Tran Thanh Kim
    Acacia inquilina "Hollyhock" "Wattle", planted 2016

40. His Excellency Mr. James Alex Michel, President of the Republic of Seychelles
    Diospyros lotus "Date palm", planted 2011

41. His Excellency Mr. Sukhbat Tuvshinbayar, Prime Minister of Mongolia
    Urtica dioica "Nettle", planted 2011

42. His Majesty, Ghaldam Sangay Choeden Wangchuck, Queen Mother of Bhutan
    Cypripedium calceolus "Bhutan orchid", planted 2013

43. The Right Honourable Malcolm Fraser AC CH, Prime Minister of Australia 1975-1983
    Eucalyptus camaldulensis "River red gum", planted 2011

44. Mr. John Schumann and Mr. Hugh McDonnell, Musicians
    Eucalyptus camaldulensis "River red gum", planted 2011

45. The Honourable Gordon Barty, Life, Prime Minister of Solomon Islands
    Crotonos corimbosum "River she oak", planted 2012

46. The Honourable Sir William Dwyer AC KBE, Former Governor-General
    Eucalyptus pseustes "Snow gum", planted 2011
Appendix 6: Rock Outcrops - Restoration and Management Plan

Definition: “Rock outcrops” are natural outcrops of rock within the Arboretum that cannot be removed from the forests or easily mown. They are usually on areas of steep land and vary in size from just a few exposed boulders to small knolls. Many contain some remnant vegetation and most are heavily infested with exotic weeds. They do not include areas of loose rock that has been collected from across the forests and left as heaps.

Purpose
To prepare a management plan for the ecological restoration and ongoing management and rehabilitation of the rocky outcrops in the National Arboretum Canberra.

Management
The rock outcrops will be managed as areas of natural grassland vegetation that can be easily maintained. The principle vegetation will eventually be local native grasses and small herbaceous plants. The rock outcrops should not be treated as gardens.

All outcrops require rehabilitation to some degree and maintenance to manage weeds. The tasks will include:

1. Mapping: All rock outcrops within the Arboretum will be identified and mapped so as to:
   • Assess the ecological condition each rock outcrop including the site condition, aspect, soil condition, context, views, the diversity of remnant native plant species and the degree of infestation with environmental weeds;
   • Identify priorities for restoration based on site specific ecological values, the importance of the site as a link in a wildlife corridor, fauna habitat and the aesthetic significance of individual knolls to the Arboretum landscape as viewed from within the Arboretum itself and from the city;
   • Group the sites into meaningful categories reflecting the primary objective and restoration priority of each site, using the following as a guide:
     o to create habitat for fauna;
     o to restore the site as a wildlife corridor link;
     o to create an aesthetic garden? within a forest environment;
     o to create an opportunity for interpretation and education.

2. Removal of loose rock: Any heaps of loose rock which were created during the construction of the Arboretum (or during earlier forestry work?) will be identified and removed. This includes areas of loose rock that has been dumped on natural rock outcrops.

3. Weed removal: All plants growing on the rock outcrops that are not locally indigenous (including non-local Australian plants such as Acacia baileyana) will be treated as weeds, will be sprayed and removed.

4. Grass maintenance: Grass up to 1m from the edge of the rock outcrop will be kept slashed to 300mm to identify that edge. The remaining area should be slashed to 300mm in October and February. Consideration should be given to burning the rock outcrop area every two years.

5. Plantings: The rock outcrops will not be treated as gardens – low maintenance will be an important feature of their future management. Only local indigenous species of grass or herbaceous flora can be planted amongst the rock outcrops.
6. Ecological restoration and maintenance guidelines
Develop guidelines for each rock outcrop restoration and maintenance category including plant species enrichment, use of fire as a restoration or management tool, weed eradication and control. In developing the guidelines consideration should be given to the:
- long term condition of the site once the forest develops including potential for overshadowing, weed invasion and leaf fall from the forest;
- potential for expansion or reduction of the sites;
- short term watering requirements.

7. Plant Records: To record the development of the natural flora on each of the outcrops, this could be considered as a future task for the Friends’ plant records group. This task could include:
- Field investigations to map sites, identify plant species present and assess ecological condition;
- Identification of weed problems;
- Assistance in the development of restoration and management guidelines.
### Appendix 7: Likely Irrigation Requirements of Forest Species:

<table>
<thead>
<tr>
<th>Species</th>
<th>Forest</th>
<th>Possible irrigation needed</th>
<th>Lowest % of full irrig.</th>
<th>Highest % of full irrig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cedrus deodara</td>
<td>11</td>
<td>zero</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Pinus radiata ssp. radiata</td>
<td>76</td>
<td>zero</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Quercus suber</td>
<td>1</td>
<td>zero</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Albizia julibrissin</td>
<td>3</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Allocasuarina verticillati</td>
<td>100</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Brachychiton populneus</td>
<td>79</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Brachychiton rupestris</td>
<td>79</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Brahea edulis</td>
<td>47</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Cedrus libani</td>
<td>11</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Cupressus dupreziana</td>
<td>40</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Cupressus sempervirens</td>
<td>34</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Dracaena draco</td>
<td>15</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Eucalyptus tricarpa</td>
<td>98,99</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Jubaea chilensis</td>
<td>26</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Pinus brutia</td>
<td>61</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Pinus halepensis</td>
<td>60</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Pinus pinea</td>
<td>56</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Pinus radiata var. binata</td>
<td>46&amp;90</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Populus euphratica</td>
<td>74</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Washingtonia filifera</td>
<td>10</td>
<td>zero - very low</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Acacia caerulescens</td>
<td>13</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Acer buergerianum</td>
<td>73</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Araucaria araucana</td>
<td>12</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Araucaria bidwillii</td>
<td>71</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Austrocedrus chilensis</td>
<td>57</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Butia capitata</td>
<td>59</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Callitris oblonga</td>
<td>48</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Carpinus orientalis</td>
<td>68</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Carya illinoinensis</td>
<td>93</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Cercis canadensis</td>
<td>70</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Cercis siliquastrum</td>
<td>31</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Chamaecyparis lawsoniana</td>
<td>65</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Corymbia maculata</td>
<td>98&amp;99</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Cupressus duclouxiana</td>
<td>95</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Eucalyptus argophloia</td>
<td>19</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Eucalyptus benthami</td>
<td>30</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Eucalyptus lacrimans</td>
<td>68</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Eucalyptus michaeliana</td>
<td>55</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Eucalyptus morrisbyi</td>
<td>85</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Eucalyptus parvula</td>
<td>81</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Eucalyptus scoparia</td>
<td>92</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Ficus carica</td>
<td>3</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Franklinia alatamaha</td>
<td>93</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Grevillea robusta</td>
<td>51</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Juglans regia</td>
<td>88</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Liquidambar orientalis</td>
<td>72</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Liriodendron chinense</td>
<td>9</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Species</td>
<td>Height</td>
<td>Handicap Risk</td>
<td>Spread 1</td>
<td>Spread 2</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------</td>
<td>---------------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>Maclura pomifera</strong></td>
<td>102</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Parrotia persica</strong></td>
<td>14</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Picea abies</strong></td>
<td>52</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Platanus orientalis</strong></td>
<td>53</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Pseudopanax ferox</strong></td>
<td>89</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Quercus engelmannii</strong></td>
<td>21</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Quercus macrocarpa</strong></td>
<td>18</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Quercus palustris 'Freefall'</strong></td>
<td>41</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Quercus robur</strong></td>
<td>82</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Quillaja saponaria</strong></td>
<td>94</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Schotia brachypetala</strong></td>
<td>28</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Styphnolobium japonicum</strong></td>
<td>77</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Widdringtonia wallachii</strong></td>
<td>10</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Zelkova serrata</strong></td>
<td>84</td>
<td>very low - low</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Acer saccharum</strong></td>
<td>16</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Araucaria angustifolia</strong></td>
<td>23</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Arbutus canariensis</strong></td>
<td>50</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Betula pendula ssp. fontqueri</strong></td>
<td>44</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Catalpa bignonioides</strong></td>
<td>96</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Ceiba speciosa</strong></td>
<td>58</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Cladastris kentukea</strong></td>
<td>97</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Cornus kousa</strong></td>
<td>8</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Cotinus 'Grace'</strong></td>
<td>49</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Diospyros lotus</strong></td>
<td>86</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Eucommia ulmoides</strong></td>
<td>42</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Ginkgo biloba</strong></td>
<td>27</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Koelreuteria paniculata</strong></td>
<td>104</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Lagerstroemia fauriei</strong></td>
<td>24</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Larix decidua</strong></td>
<td>36</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Magnolia grandiflora</strong></td>
<td>7</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Nyssa sylvatica</strong></td>
<td>43</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Platycladus orientalis</strong></td>
<td>66</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Podocarpus latifolius</strong></td>
<td>29</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Podocarpus totara</strong></td>
<td>64</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Pseudolarix amabilis</strong></td>
<td>69</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Pyrus calleryana</strong></td>
<td>87</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Sophora microphylla</strong></td>
<td>64</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Sophora tomentosa</strong></td>
<td>77</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Styphnolobium japonicum</strong></td>
<td>67</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Tilia cordata</strong></td>
<td>38</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Toona sinensis</strong></td>
<td>75</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Wollemia nobilis</strong></td>
<td>32</td>
<td>low - moderate</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Aesculus hippocastanum</strong></td>
<td>4</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Betula nigra</strong></td>
<td>35</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Betula pendula pendula</strong></td>
<td>44</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Davidia involucrata</strong></td>
<td>62</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Fagus sylvatica</strong></td>
<td>80</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Luma apiculata</strong></td>
<td>45</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Magnolia delavayi</strong></td>
<td>7</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>Species</td>
<td>Rank</td>
<td>Sunlight Requirement</td>
<td>Minimum Survival</td>
<td>Maximum Survival</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------</td>
<td>----------------------</td>
<td>------------------</td>
<td>------------------</td>
</tr>
<tr>
<td><em>Metasequoia glyptostroboides</em></td>
<td>54</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><em>Nothofagus obliqua</em></td>
<td>83</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><em>Prunus x yedoensis</em></td>
<td>17</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><em>Sequoiadendron giganteum</em></td>
<td>33</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td><em>Taxodium mucronatum</em></td>
<td>91</td>
<td>moderate - full</td>
<td>50%</td>
<td>100%</td>
</tr>
</tbody>
</table>
### Appendix 8: Botanic Gardens Survey (2013)

<table>
<thead>
<tr>
<th>Organisation Name</th>
<th>Anticipated visitation for 2013/14</th>
<th>Size of site</th>
<th>Approximate No. of Accessions in Collection</th>
<th>No. of Field Horticultural staff</th>
<th>No. of Nursery Horticultural Staff</th>
<th>No. of Records Mgt staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adelaide Botanic Garden</td>
<td>1,500,000</td>
<td>24ha</td>
<td>7,875</td>
<td>21</td>
<td>2 shared</td>
<td>1 shared</td>
</tr>
<tr>
<td>Mt Lofty Botanic Garden</td>
<td>176,365</td>
<td>79ha</td>
<td>11,391</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wittunga Botanic Garden</td>
<td>72,000</td>
<td>15ha</td>
<td>3,020</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Royal Botanic Garden, Sydney</td>
<td>3700000 RBG, 4,000,000 Domain</td>
<td>30Ha, RBG 34 Ha Domain</td>
<td>72,000</td>
<td>15 + 20 Hort Apprentices</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Australian Botanic Garden, Mt Annan</td>
<td>350,000</td>
<td>416ha</td>
<td>25,000</td>
<td>27</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Australian National Botanic Gardens</td>
<td>470,000</td>
<td>40 ha</td>
<td>81,000</td>
<td>14</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Blue Mountains Botanic Garden</td>
<td>180,000</td>
<td>252 ha</td>
<td>30,000</td>
<td>23</td>
<td>3 Part-time</td>
<td>1</td>
</tr>
<tr>
<td>Cairns Botanic Gardens</td>
<td>300,000</td>
<td>40 ha</td>
<td>5,500</td>
<td>11.5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>George Brown Darwin Botanic Gardens</td>
<td>250,000</td>
<td>42 ha</td>
<td>TBA</td>
<td>14</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Kings Park &amp; Botanic Garden</td>
<td>5.9m</td>
<td>400.6ha</td>
<td>20,572</td>
<td>28(+12 students)</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>National Arboretum Canberra</td>
<td>550,000</td>
<td>250ha</td>
<td>38,000</td>
<td>3 (+ contract staff)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Royal Botanic Gardens Melbourne</td>
<td>1.8 million</td>
<td>38ha</td>
<td>54,817</td>
<td>17</td>
<td>3</td>
<td>1 shared</td>
</tr>
<tr>
<td>Royal Botanic Gardens Cranbourne</td>
<td>220,000</td>
<td>363ha</td>
<td>8,350 live accessions</td>
<td>11</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Royal Tasmanian Botanical Gardens</td>
<td>410,000</td>
<td>14.5 ha</td>
<td>8,000</td>
<td>11.6</td>
<td>3.6</td>
<td>1</td>
</tr>
<tr>
<td>Wollongong Botanic Garden</td>
<td>370,000</td>
<td>30</td>
<td>5,000</td>
<td>12</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>
## Appendix 9: Suggested Work Program Over the Next 5 Years

<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>Review Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Trans-planting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Quercus suber</em></td>
<td>1</td>
<td>Dead tree removal needed</td>
<td>15.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><em>Eucalyptus local ssp</em></td>
<td>1</td>
<td>Management review needed</td>
<td>12</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>13</td>
<td><em>Acacia caerulescens</em></td>
<td>1</td>
<td>Species Replacement Needed</td>
<td>6</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>19</td>
<td><em>Eucalyptus argophloia</em></td>
<td>1</td>
<td>Replantings needed</td>
<td>9</td>
<td>140</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>20</td>
<td>STEP Forest</td>
<td>1</td>
<td>Review of role needed</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td><em>Lagerstroemia fauriei</em></td>
<td>2</td>
<td>Not fully planted</td>
<td>8</td>
<td>300</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>22</td>
<td>Central Valley Spine</td>
<td>1</td>
<td>Planting Design needed</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td><em>Ginkgo biloba</em></td>
<td>1</td>
<td>Replantings needed</td>
<td>9</td>
<td>575?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td><em>Wollemia nobilis</em></td>
<td>1</td>
<td>Federation Forest suggested</td>
<td>7.2, 11</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TASKS NEEDED
<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>See Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>Cupressus dupreziana</td>
<td>1</td>
<td>Not fully planted</td>
<td>8, 15.10</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Quercus palustris</td>
<td>1</td>
<td>Not fully planted</td>
<td>8</td>
<td>129</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Callitris oblonga</td>
<td>1</td>
<td>Replantings needed, Disease checks needed</td>
<td>9, 15.10</td>
<td>500, less 70</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Arbutus canariensis</td>
<td>1</td>
<td>Replantings needed</td>
<td>9</td>
<td>107</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Pinus radiata subsp. radiata</td>
<td>1</td>
<td>Remove dead trees</td>
<td>15.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Podocarpus totara</td>
<td>1</td>
<td>Not fully planted?</td>
<td>8</td>
<td>146, less 150</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>Chamaecyparis lawsoniana</td>
<td>1</td>
<td>Replantings needed, Disease checks needed</td>
<td>9, 15.10</td>
<td>224</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>Styx japonicus</td>
<td>1</td>
<td>Replantings needed</td>
<td>9</td>
<td>215, less 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>68</td>
<td>Eucalyptus lacrimans</td>
<td>1</td>
<td>Replantings needed</td>
<td>9</td>
<td>276, less 20</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Populus euphratica</td>
<td>1</td>
<td>Not fully planted</td>
<td>8</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest</td>
<td>Forest Planted</td>
<td>Priority</td>
<td>Status</td>
<td>See Chapter</td>
<td>Approx Tree No needed</td>
<td>Planting plan</td>
<td>Site Preparation or improvement</td>
<td>Irrigation</td>
<td>Propagation or Plant Sourcing</td>
<td>Tree removal</td>
<td>Planting</td>
<td>Transplanting</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------</td>
<td>----------</td>
<td>-------------------------------</td>
<td>-------------</td>
<td>-----------------------</td>
<td>---------------</td>
<td>----------------------------------</td>
<td>------------</td>
<td>-----------------------------</td>
<td>--------------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>74 Populus yunnanensis</td>
<td>1 Not fully planted</td>
<td>8</td>
<td>8 ? less 36</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>80 Fagus sylvatica</td>
<td>1 Replantings needed</td>
<td>9</td>
<td>203 less 80</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>93 Franklinia alatamata</td>
<td>1 Not fully planted</td>
<td>8</td>
<td>79 less 50</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>98/99 Corymbia maculata</td>
<td>1 Replantings needed</td>
<td>13</td>
<td>?</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>98/99 Eucalyptus tricarpa</td>
<td>1 Replantings needed</td>
<td>13</td>
<td>?</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>101 Failed ANU forest</td>
<td>1 Species replacement needed</td>
<td>6.1</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>103 Widdringtonia wallachii</td>
<td>1 Species transplant needed</td>
<td>7.1</td>
<td>270 planted</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>9 Liriodendron chinense</td>
<td>2 Replantings needed</td>
<td>9</td>
<td>91</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>15 Dracaena draco</td>
<td>2 Review planting</td>
<td>8</td>
<td>?</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>30 Eucalyptus benthamii</td>
<td>2 Replantings needed</td>
<td>9</td>
<td>?</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>32 Wollemia nobilis</td>
<td>2 Relocation suggested</td>
<td>7.2</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>32 Wollemia nobilis</td>
<td>2 New Forest suggested</td>
<td>Append 2</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>TASKS NEEDED</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TASKS NEEDED**
<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>See Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Eucommia ulmoides</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Pinus radiata ssp binata</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>Picea abies</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>74</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Ceiba speciosa</td>
<td>2</td>
<td>Possible replacement needed</td>
<td>6.2</td>
<td>94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>59</td>
<td>Butia capitata</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>54</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Sophora microphylla</td>
<td>2</td>
<td>Pest control needed Possible species replacement needed</td>
<td>9</td>
<td>97 less 30</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>70</td>
<td>Cercis canadensis</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>98</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Styphnolobium japonicum</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>62</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>Quercus robur</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>62</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>88</td>
<td>Juglans regia</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>69</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>89</td>
<td>Pseudopanax ferox</td>
<td>2</td>
<td>Replantings needed</td>
<td>9</td>
<td>50</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TASKS NEEDED**
<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>See Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td><em>Ficus carica</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><em>Aesculus hippocastrum</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><em>Melia azedarach</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><em>Albizia julibrissin</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><em>Magnolia delavayi</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>1 less 7??</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><em>Magnolia grandiflora</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td><em>Cornus kousa</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td><em>Washingtonia filifera</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td><em>Cedrus deodara</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td><em>Araucaria araucana</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td><em>Grevillea robusta</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td><em>Acer saccharum</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td><em>Prunus x yedoensis</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TASKS NEEDED**
<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>See Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Quercus macrocarpa</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>13</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Quercus engelmannii</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>47</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Araucaria augustifolia</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>38</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Jubaea chilensis</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>44</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Schotia brachypetala</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>17</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Podocarpus latifolius</td>
<td>3</td>
<td>Forest unplanted</td>
<td>5.1</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Cupressus sempervirens</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>1</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Betula nigra</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>7</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Larix decidua</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>22</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Trial Plot</td>
<td>3</td>
<td>Unplanted</td>
<td>5.2</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Tilia cordata</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>35</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Cedrus libani</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>24</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Nyssa sylvatica</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>32</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Luma apiculata</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>34</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>Brahea edulis</td>
<td>2</td>
<td>Forest unplanted</td>
<td>5.1</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TASKS NEEDED**
<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>See Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td><em>Cotinus hybrid</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td><em>Platanus orientalis</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td><em>Metasequoia glyptostroboides</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td><em>Eucalyptus michaeliana</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td><em>Pinus pinea</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td><em>Austrocedrus chilensis</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9, 15.10</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td><em>Pinus brutia</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62</td>
<td><em>Davidia involucrata</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63</td>
<td><em>Trial Plot</em></td>
<td>3</td>
<td>Forest Unplanted</td>
<td>5.2</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>66</td>
<td><em>Platycladus orientalis</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>69</td>
<td><em>Pseudolarix amabilis</em></td>
<td>3</td>
<td>Forest Unplanted</td>
<td>5.1</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71</td>
<td><em>Araucaria bidwillii</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TASKS NEEDED**

109
<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>See Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>Liquidambar orientalis</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Acer burgerianum</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Acer b ssp formosanum</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Toona sinensis</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Sophora toromiro</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>35 less 33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>Carpinus orientalis</td>
<td>3</td>
<td>Forest Unplanted</td>
<td>5.1</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>79</td>
<td>Brachychiton populneus</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>79</td>
<td>Brachychiton rupestris</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>Eucalyptus parvula</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>83</td>
<td>Nothofagus obliqua</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>Eucalyptus morrisbyi</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>Diospyros lotus</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>87</td>
<td>Pyrus calleryana</td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TASKS NEEDED**
<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>See Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td><em>Pinus radiata binata</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>92</td>
<td><em>Eucalyptus scoparia</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>91</td>
<td><em>Sciadopitys verticillata</em></td>
<td>3</td>
<td>Forest Unplanted</td>
<td>5.1</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>93</td>
<td><em>Carya illinoiensis</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>94</td>
<td><em>Quillaja saponaria</em></td>
<td>3</td>
<td>Forest Unplanted</td>
<td>5.1</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95</td>
<td><em>Cupressus duclouxiana</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9, 15.10</td>
<td>37</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td><em>Allocasuarina verticillata</em></td>
<td>3</td>
<td>Replantings needed</td>
<td>9</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>102</td>
<td><em>Maclura pomifera</em></td>
<td>3</td>
<td>Part removal from Arboretum needed</td>
<td>7.1</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>104</td>
<td><em>Koelreuteria paniculata</em></td>
<td>3</td>
<td>Removal from Arboretum needed</td>
<td>7.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><em>Ficus carica</em></td>
<td>4</td>
<td>Forest Expansion</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><em>Aesculus hippocastum</em></td>
<td>4</td>
<td>Forest Expansion</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Tasks Needed**
<table>
<thead>
<tr>
<th>Forest</th>
<th>Forest Planted</th>
<th>Priority</th>
<th>Status</th>
<th>See Chapter</th>
<th>Approx Tree No needed</th>
<th>Planting plan</th>
<th>Site Preparation or Improvement</th>
<th>Irrigation</th>
<th>Propagation or Plant Sourcing</th>
<th>Tree removal</th>
<th>Planting</th>
<th>Transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Melia azederach</td>
<td>4</td>
<td>Forest Expansion</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Albizia julibrissin</td>
<td>4</td>
<td>Forest Expansion</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Liriodendron chinense</td>
<td>4</td>
<td>Forest Expansion</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Parrotia parrotia</td>
<td>4</td>
<td>Forest Expansion</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>?</td>
<td>4</td>
<td>Forest Expansion</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>107</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>108</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>109</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>111</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>113</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>114</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>115</td>
<td>?</td>
<td>5</td>
<td>New Forest</td>
<td>10.1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All forests</td>
<td></td>
<td>5</td>
<td>Forest Gardens</td>
<td>18</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>