Wungong Catchment Trial

Demonstration plots within rehabilitated mine pits

White Gum, Chandler and Jarrahdale roads

September 2012

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Acknowledgement

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ISBN 1 74043 811 6
September 2012

Summary
Several demonstration plots have been set up in the Wungong Catchment Trial area at three sites, which are alongside White Gum, Chandler and Jarrahdale roads. These demonstration plots were specifically established so that interested parties could visit, view and discuss the implementation of various silviculture prescriptions within rehabilitated bauxite mine pits located in the Wungong Catchment Trial. This was successfully achieved and, in five years, over 600 persons have visited the plots accompanied by Water Corporation staff. The feedback from visitors has been positive and there has been strong community support, especially for commercial logging and the planned conversion of pits planted with 'exotic species' to native species. The plots have provided invaluable opportunities for face-to-face interaction on a range of issues within a forest setting, and have also been used for research purposes and for monitoring trends.

Introduction
One of the commitments made in the Wungong Catchment Trial was to examine alternative ways of treating bauxite pits that had been rehabilitated by Alcoa World Alumina. Prior to 1988, because of concerns associated with the fungal disease caused by *Phytophthora cinnamomi* (dieback), most of the eucalypt tree species selected were 'exotics' from the eastern states. However with improvements in hygiene, it was observed that jarrah also grew well on these sites so that, after 1988, only local tree species such as jarrah (*E.marginata*), blackbutt (*E. patens*) and marri (*C. calophylla*) were used.

Three methods are being trialled to treat the rehabilitated mine pits. The first two aim to gradually convert some of the pre-1988 rehabilitation to native eucalypts and understorey species (Water Corporation 2005, DEC 2007a). This is being done by: revegetating areas after clear-felling or by under-sowing native species after a commercial thinning.

For the third method, the Water Corporation selected an area of post-1988 rehabilitation for treatment, by thinning to four densities: control, 600, 350 and 150 stems per hectare (sph) (DEC 2007b), comparing the cut-stump and notching techniques.

Methods

Pre-1988 Clear-fell (Plot A)
An area adjacent to White Gum road was mined in 1972 and then rehabilitated by Alcoa World Alumina by planting with tallowwood (*E microcorys*). As this was one of the earliest areas to be rehabilitated, there was no understorey established (Figure 1, p.7). The tallowwood was showing signs of drought stress in the crowns, and so, in summer 2010 the area was clear-felled by contractors to Forests Products Commission, yielding about 100 tonnes per hectare of 'mixed-chip'. The plot was then burnt by Department of Environment and Conservation (DEC) to reduce the fire hazard (Figure 2, p.8). Coppice that sprouted from the stumps has been treated with herbicide. Once the stump coppice and seedlings of tallowwood have been successfully controlled, some alternative rehabilitation techniques will be trialled.

Pre-1988 Thinning (Plot B)
In 1979, a bauxite pit adjacent to Chandler Road was rehabilitated by replanting with three species of exotic eucalyptus (*E. maculata*, *E. resinifera* and *E. saligna*). By January 2010, the basal area averaged 28 m^2/ha and co-dominant height about 22 m and the site was ready for a commercial thinning. As a demonstration plot for interested parties to visit, 6 ha were tree-marked to a basal area of about 8 m^2/ha by foresters F Batini and R Boykett. The northern half of the pit was tree-marked from 'above', that is removing the larger and very poor trees and retaining some well-formed co-dominants and sub-dominants. The other half was tree-marked from 'below', that is removing sub-dominant and very poor trees and retaining some well-formed dominants and co-dominants. Tree-marking from 'above' generally produces a higher volume of saleable material at first thinning.

The site was then thinned in February 2010 by contractors to Forests Products Commission and yielded 50 tonnes of 'mixed-chip' per ha, or 300 tonnes in total. Utilisation of forest produce was excellent leaving only the tops and smaller branches as residual. In October 2010, the site was prescribed burnt under mild conditions by the Department of Environment and Conservation (DEC). Coppice that developed from cut stumps was then sprayed with herbicide on several occasions by DEC over the next year.

The plot was then measured in July 2012 by M Loh and K Barrett (Water Corporation) and F Batini (consultant). Data were collected on four transects within the plot, each 150 m in length and 10 m wide (0.6 ha), recording basal area (factor 2 prism), stems per hectare, diameter class distribution (in 10 cm classes), crown health, tree height, re-sprouting coppice from stumps, germinating seedlings, and cover (spherical densiometer) (see Table 1, p.12).

Post 1988 Thinning (Plot C)
This area is alongside Jarrahdale Road and was seeded in 1991 with a mixture of native understorey and tree species. In 2007, the site was dominated by healthy jarrah-blackbutt-marri regrowth to a height of 11-14 metres, basal area over bark of 20-23 m^2/ha and diameters of 15-20 cm in co-dominants. The area was prescribed burnt by DEC in spring 2006, in advance of thinning in 2007. There are eight square plots, each 0.5 ha in size.

Tree-marking was done by DEC staff and the following silviculture treatments were compared:

1. Thinning to 150, 350 or 600 stems per hectare, with an un-thinned control (about 1800 sph)
2. Basal area range from 8 to 25 m^2/ha
3. Thinning by falling (cut-stump with herbicide treatment) or by notching with herbicide
4. Retention of thinning debris on site or removal of larger debris off-site

Details of the treatments for each plot are shown in Table 2, p. 12.

In December 2008, Dr Macfarlane (CSIRO Perth) and Dr Grigg (Alcoa of Australia) then used vertical photography to estimate crown cover, foliage cover, crown porosity and Leaf Area Index (LAI). The photos were taken at 5 m spacing on plots of 0.16 ha located centrally within each treatment. The diameter of all stems greater than 10 cm diameter breast height was also recorded (see Table 3, p.12).

Baseline vegetation monitoring in the post-1988 demonstration site was carried out by Mattiske Consulting Pty Ltd in spring 2009, about 2.5 years after establishment (Mattiske 2010). Data were obtained on samples of both the overstorey trees (species, diameter, height, health) as well as understorey (species, number healthy/dead, cover healthy/dead). This allows calculation of species richness, diversity and cover.

Results

Pre-1988 Clear fell (Plot A)
Coppice control has commenced and is successful, there is minimal regeneration from seed to date but no results are yet available.

Pre-1988 Thinning (Plot B)
The sample size of 0.6 ha is about ten per cent of the area of the plot. A total of 73 trees were assessed on these transects, 39 stems when tree-marked from 'above' and 34 stems from 'below'. Half of the retained trees were the exotic eucalyptus species, *E maculata*.

The data shown in Table 1 (p. 12) confirm that the plot tree-marked from 'below' has bigger and taller trees with larger crowns; a higher basal area, crown cover and Leaf Area Index and fewer stems than the plot marked from 'above'. Tree marking from 'above' favours not only water production, but also the economics of first thinning, by removing more saleable volume. The trees on both plots were of good form and had healthy crowns. This is in contrast to adjacent areas that were not thinned, where many trees had died or lost a lot of crown in summer 2011, following a very dry winter in 2010 (see Figure 3, p.9).

We recorded a total of about 250 seedlings and stumps with some coppice on each hectare and these will need monitoring and eventually control with herbicide. There is also some low native understorey on the site (see Figure 4, p.10).

Post-1988 Thinning (Plots C)
The difficulties of tree-marking in dense stands, even with experienced personnel, meant that the target number of trees was not achieved exactly in each plot. It was therefore decided to analyse results by calculating regressions between the various variables. Regressions coefficients were as follows: stocking rate and basal area (r^2= 0.97) a very strong relationship, as one variable increases, so does the other; stocking rate and mean diameter (r^2 =-ve 0.89) again a strong, but a negative relationship, as the stocking increases, the mean diameter decreases; stocking rate and crown cover/LAI (r^2 = 0.68/0.76) moderately strong relationships, as stocking rate increases, crown cover and the Leaf Area Index also increase.

There is a moderate correlation between species richness and stocking density (r^2 =0.61) when the control plot at 1775 stems/ha is included. However, at stocking densities between 213 and 725 stems/ha there is no measurable difference in richness (r^2 =0.17). Four years after thinning, a vigorous, dense, tall understorey dominated by Mirbelia, Bossia and Acacia grew from stored seed (see Figure 5, p. 11).

Discussion

Pre-1988 Clear-fell (Plot A)
Within the clear-felled site it is proposed that a comparison of several possible rehabilitation options will be trialled. One hectare could be sown using the currently approved seed mix of eucalypts and understorey species; another hectare will be sown with understorey species and planted with 50 trees only; a third hectare will be sown only with low understorey species and the remainder will be left untreated as a control.

Pre-1988 Thinning (Plot B)
The proposal for the future is to under-plant some of this area to jarrah (*E. marginata*) seedlings at a rate of about 150 per hectare, and then re-thin the site in about 10–15 years' time. By this time, the jarrah will have developed a lignotuber and some will be released as 'dynamic shots' and these trees will gradually replace the exotic eucalypts. An observation from other areas is that jarrah seedlings that grow under a canopy develop much better form than those that are 'open-grown'.

Post-1988 Thinning (Plots C)
These eight plots have been successfully used for demonstration, for observation, monitoring and research. It is proposed to prescribe burn the site soon, under mild conditions, to observe the effects on and response by the understorey. It is expected that monitoring of stand dynamics and biodiversity trends will continue at about 5-yearly intervals. Monitoring data (Mattiske 2010) show that the understorey in the unmined forest was more diverse and had a more even species distribution than did the rehabilitated bauxite pit. The lower species diversity in the pit is due to a predominance of re-seeder species in the rehabilitation. This dense understorey, as well as intercepting and transpiring

water, will also cause ongoing management problems and increased costs, particularly associated with access and fire control.

Community involvement

The demonstration plots were specifically established within bauxite mine pits so that interested parties could visit, view alternative strategies and discuss the results of the Wungong Catchment Trial. They have proved to be extremely useful, both for internal communication within Water Corporation as well as with external stakeholders. In the past four years, over 600 persons have visited these sites accompanied by Water Corporation staff and/or consultants. Groups have ranged in size from small groups to university parties of 30–40 students.

Some visitors have come from overseas, for example Scotland, USA, Vietnam, India and Italy; others were Australians from New South Wales, Victoria, Tasmania and the ACT. There were many local visitors representing a wide range of interests (see Appendix 1, p. 13).

The Water Corporation has used several strategies to engage with the public on the Wungong Catchment Trial. These include seeking formal public comment on the proposal and on all silvicultural guidelines, a regular newsletter *Wungong Whispers*, a Technical Reference Panel, the engagement of scientific research studies (on flora, fauna, aquatic biodiversity, streamflow, groundwater tables, remote sensing and public perceptions] and making all reports available on the Water Corporation website as well as conducting four forums on research outcomes (in 2006, 2007, 2009 and 2010).

While all these avenues have value, the demonstration plots offer the only opportunity to engage on a face-to face basis, out in the forest environment. The feedback received has been positive, since most visitors have supported commercial logging and the gradual conversion of pits planted with 'exotic species' to native flora, as well as the thinning of over-dense rehabilitated mine pits. The feedback from visitors is that they now have a much better understanding of the complexity of the issues, and the reasons why Water Corporation is undertaking these studies.

Figures

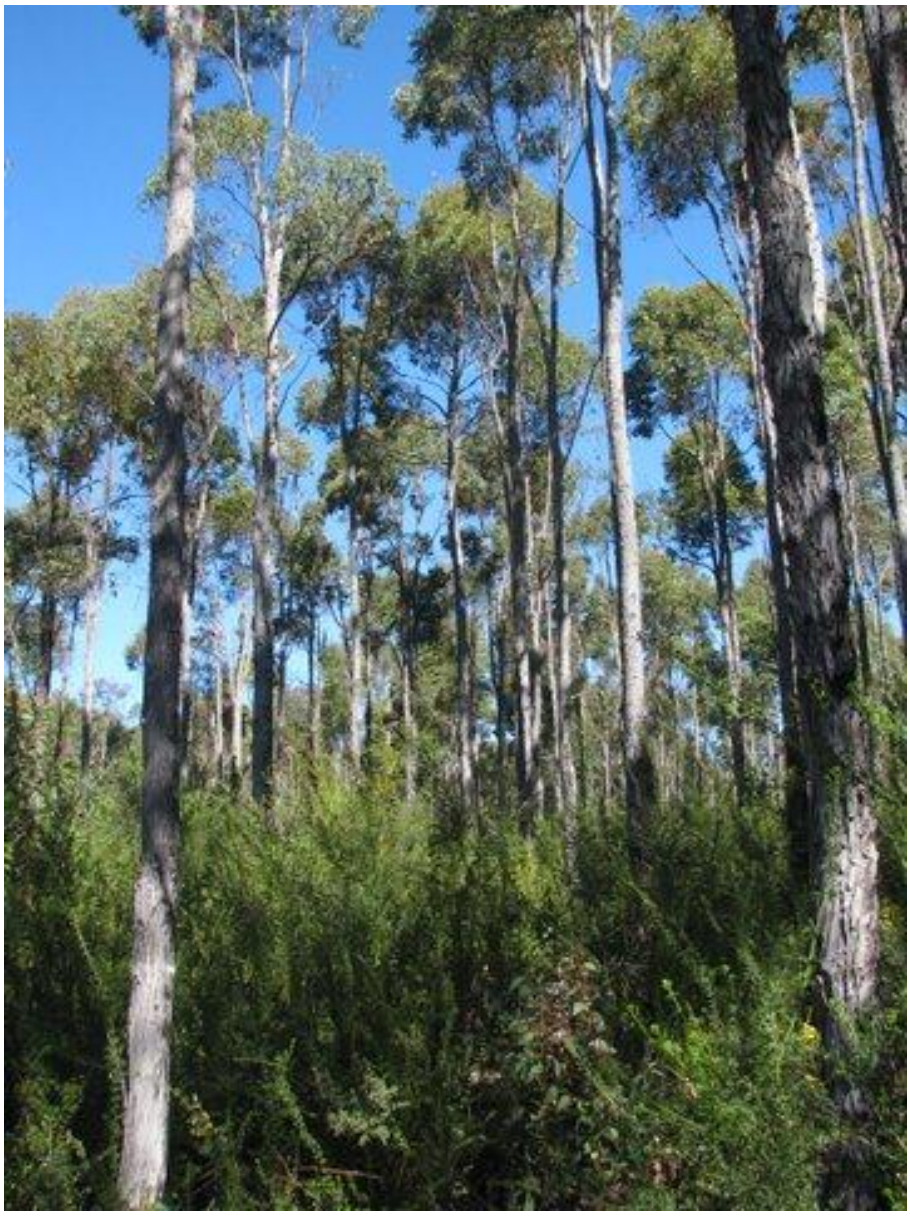
Figure 1 — Tallowwood (*E. microcorys*) planted on rehabilitated bauxite pit, no understorey

Figure 2 — Tallowwood site (same area as Figure 1) after clear-felling and before replanting

Figure 3 — General photo of site showing healthy and dead trees

Figure 4 — Thinned pre-1988 plot with sparse understorey

Figure 5 — Post-1988 plot thinned to 600 sph after three years, with dense understorey



Tables

Table 1 Pre-1988 Thinning Plot
Data obtained from sampling of areas tree-marked from 'below' and 'above'

	'Below'	'Above'	Total
Basal area	10	7	8.5
Stems/ha	113	130	122
Top height	30	28	29
Co-dominant height	27	25	26
% Crown cover	21	17	19
LAI 2010	0.45	0.35	0.4
% Healthy crowns	80	80	80
Ratio<30cmto >30cm	1:1	4:1	2 :1
Seedlings/ha	150	190	170
Coppice/ha	100	70	85

Table 2 Plot treatments Post-1988 Thinning

Plot number	Nominal stocking	Notch or cut stump	Thinning debris
1	350	Notch	Retain
2	600	Cut stump	Retain
3	1800	Control	None
4	350	Cut stump	Retain
5	600	Notch	Retain
6	600	Cut stump	Remove
7	150	Notch	Retain
8	150	Cut stump	Retain

Table 3 Post-1988 Thinning Plots
The data collected from the inventory and vertical photography are shown below:

Plot	Stocking Total	BAOB m^2/ha	Diameter Mean cm	Crown cover Per cent	LAI
Post-1988	1775	25.2	12.6	0.45	2
Post-1988/5	725	17.2	16.4	0.41	1.7
Post-1988/2	550	13.5	17	0.22	1.2
Post-1988/6	481	12.6	17.9	0.4	1.6
Post-1988/1	425	10	16.5	0.17	0.7
Post-1988/4	375	12.3	20	0.3	1.3
Post-1988/7	213	7.9	21	0.19	0.7

Appendix 1 – Visitors to Wungong demonstration sites

Visitors from within Western Australia include:

Ministers and Parliamentarians
Local government representatives
Catchment advisory groups

University staff and student groups from:

- Curtin University
- Edith Cowan University
- Murdoch University
- The University of Western Australia

Members and/or staff of:

- Alcoa of Australia
- Beekeepers' Association
- Conservation Commission
- Conservation and Environment
- Centre of Excellence for Climate Change Forest and Woodland Health
- Conservation Council
- CSIRO
- Department of Water
- Forest Products
- Environmental Protection Authority
- Institute of Foresters
- Jarrahdale Historical Society
- Office of the EPA
- Water Corporation

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