Is thinning in dieback affected areas detrimental to tree health?

Cobiac Research Catchment Trial

By Frank Batini, Consultant

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Acknowledgement

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Summary
Thinning was carried out in the Cobiac research catchment in summer /autumn 2008 and crown health classes were assessed in 2012, following a severe drought in 2010. Thinning targeted the smaller sizes classes and reduced the number of stems by about two-thirds. Comparisons were made between an un-thinned stand (104 tree crowns) and thinned stands that were classified as either dieback-free (104 crowns) or as dieback-affected (162 crowns), on a site infested with the soil-borne pathogen *Phytophthora cinnamomi*. The dominant trees were jarrah (76 percent) and marri (15 percent). Thinning substantially increased the crown health on the retained trees, irrespective of the dieback status of the site. In contrast, within the un-thinned control there were several recently dead trees and many others had poor crowns.

Introduction
Thinning forests to reduce competition and to enhance the health and growth rate of the retained trees has been practiced by foresters for centuries. In Western Australia, the earliest thinning trials were conducted in the 1920's and 30's, soon after the formation of the Forests Department in 1918, but the capacity of jarrah to coppice vigorously nullified the benefits (Forests Department 1929, 1968). More extensive thinning trials were then established in Mundlimup (1928 and 1956) and Inglehope Blocks (1964). The results from Mundlimup were summarised by Abbott and Loneragan (1986) and the latter was re-measured and published by Stoneman in 1996. More widespread thinning of high-quality stands occurred near Dwellingup in the 1960s and 1980s, when hormone inhibitors applied to the stump were successful in controlling coppice.

Most trials and operational thinning were located in forest areas that were considered as free from *Phytophthora* dieback-disease. The benefits of thinning areas affected by *Phytophthora* dieback-disease are less clear based on the presumption that thinning will speed up the ill-health and death of retained trees. The reasons put forward (Water Corporation 2005b) were:

- Thinning increases soil temperatures and soil moisture and this will favour fungal activity such as sporulation and mycelial growth of *P. cinnamomi*. It is therefore anticipated that thinning will result in more extensive root infection. (However, higher soil moisture and temperature will also favour root growth. Also, trees that are healthy can mobilise more resources to combat infection).
- Research has shown that when *P. cinnamomi* was inoculated into wounded stems and roots of trees, lesion extension was greater where trees had been thinned, as compared to the un-thinned controls (Bunny, Crombie and Williams 1995). (However no trees were recorded as unhealthy or dead during the three year period of the trial. Also, there was minimal difference measured in the higher rainfall areas (>1100mm) where bark moisture contents were higher. In addition, variations in summer rainfall had a far greater effect on lesion growth than thinning.)

The current silvicultural prescriptions from the Department of Environment and Conservation (DEC) specify that a basal area of at least 15 m2/ha should be retained in areas that have been mapped as dieback-affected (Conservation Commission 2004). This is a precautionary measure, to ensure a reasonable canopy cover is retained should some trees die post thinning.

It is important that research and monitoring be also done at a landscape-scale. This is the first report of a large-scale thinning trial that compared the crown health between an un-thinned control, and thinned areas that were designated as either dieback-affected or dieback-free.

The Cobiac Research Catchment Trial

The trial area of about 360 ha is located within Cobiac forest Block at the south-eastern end of the Wungong Catchment. The rainfall is about 1100mm pa with jarrah (*Eucalyptus marginata*) as the dominant tree species, but including some marri (*Corymbia calophylla*), banksia (*Bankisa grandis*) and sheoak (*Allocasuarina fraseriana*).

The vegetation complex where the surveys were done is described as "Dwellingup 2" and the site-vegetation types are variations of the widespread site-types S and P (Havel 1975a).Two-thirds of the catchment has been mapped as affected by *Phytophthora* dieback-disease by trained interpreters. Site-type P is often poorly drained and known to be susceptible to *Phytophthora* disease.

In early 2008, a 220 ha area was tree-marked for felling by Forest Products Commission (FPC) staff to either a thinning or a shelterwood prescription, in accordance with tree-marking guidelines approved in the Forest Management Plan 2004-2013. Trees were retained as either "habitat trees" or as "growing stock". Following the commercial operation, all other trees that were not marked for retention were then notched in autumn by contractors supervised by staff from the Department of Environment and Conservation (DEC). Non-commercial notching was required as the smaller-sized logs could not be sold.

The designated stream reserve was left un-thinned, as was a "control" strip 200 m in width from stream zone to ridge top for experimental purposes, as well as three small areas totalling 20 ha that had been mined for bauxite by Alcoa World Alumina and then rehabilitated (Figure 1). The areas not treated totalled 140 ha or 40 percent of the area of the catchment.

As thinning operations were undertaken in areas designated as dieback-free as well as dieback-affected, Cobiac was considered a suitable site to compare post-thinning forest structure and crown health. Transects were selected randomly from maps, within dieback-free, dieback-affected and the control strip and were 10m wide. Survey staff included a chainman who recorded GPS position and basal area and an assessor. Diameter classes and distances were estimated and borderline cases checked with a Biltmore stick or by pacing. With this rapid assessment 370 tree crowns were assessed in five hours.

Crown health was classified as very healthy, healthy, average, poor, very poor, recently dead and notched (Figure 2). Crown health was assessed on 104 trees in the thinned, dieback- free site; 162 in a thinned site infested with *Phytophthora* disease and 104 trees in the un-thinned stand. Tree health was assessed by 10 cm diameter classes from 10-20 cm to >60 cm as well as by species. The same assessor was used throughout. Estimates of basal area were collected with factor 2 prism every 50 m along each transect.

Results

The dieback-free and dieback-affected transects were similar in density with basal areas over-bark of 9.5 (n=31) and 7 (n= 36) respectively, well below the estimate of 34 m2/ha prior to thinning.

Crown cover estimates at a resolution of 0.5 m were obtained from remotely sensed imagery collected by Spec Terra Services. Data showed that the estimated crown cover pre and post thinning on both sites was 50 percent (in November 2005) and 25 percent (in November 2008), with the control strip remaining at 50 percent cover.

Estimates of Leaf Area Index (LAI) were obtained from data supplied by consultant G Mauger (Geographic Information Analysis) to the Water Corporation. These data show that January 2010 LAI values in the control area averaged 2 whereas in both the dieback-free and dieback-affected transects the average LAI was 0.8 (Figure 3).

Post thinning, the number of stems/ha were reduced by two-thirds, from about 410 to 140 sph, with all size classes still represented. The distribution of size classes retained after thinning was similar in dieback-free and dieback-affected samples (Figure 4). As notching targeted the smaller size classes (90 percent of notched stems were less than 30 cm dbhob), the average size of the retained trees increased after silvicultural treatment. Commercial logging removed very few trees, with an average of only four stumps/ ha recorded.

Thinning substantially increased the crown health of the remaining trees. Crown health was expressed as the ratio of the number of above average (very good/good) to below average (very poor/poor) crowns. In both the dieback-affected and dieback-free transects, this ratio was 3:1, indicating that most crowns were healthy, irrespective of the dieback status. In contrast, within the un-thinned control strip this ratio was 0.8:1, with many poor crowns as well as several recently dead trees (Figure 4).

The crown health in younger trees (<30 cm diameter) calculated as 3.3:1, but older trees (>50 cm diameter) were still healthy, with a ratio of 2:1. This is as expected, as tree crowns usually deteriorate with increasing age.

Jarrah was the dominant tree (76 %) with marri (15 %), banksia (8 %) and allocasuarina (1%) the other species recorded on thinned sites. The low number of individuals other than jarrah meant that any comparison between species would not be considered as valid.

Discussion

The rainfall recorded at the Cobiac pluviometer (with a 14-year average of 920mm) from 2008 to 2011 was 913, 1030, 470 and 1057 mm respectively. This included a range from a year of extreme drought to two years of above-average rainfall. After thinning, both the deep and shallow water tables rose several metres and stream-flows increased considerably (Water Corporation 2012), indicating a substantial improvement in soil moisture within the thinned areas.

The 2010 winter rainfall was the lowest ever recorded in Perth and the forest areas. This was then followed by a long, dry, hot summer. By March 2011, major collapse of vegetation was obvious, particularly on shallower soils in the higher-rainfall, western jarrah forest, and deaths continued until June/July. Some re-sprouting of trees from epicormic shoots on stems and branches was observed during winter 2011.

The thinned areas that were sampled had basal areas ranging from 7 to 9.5 m^2/ha and LAI's averaging 0.8 (two years after the thinning) which is well below the current silviculture prescription of 15 m2/ha. These values recorded in the Cobiac transects are similar to the values proposed in the draft silvicultural guideline (LAI 0.6 or approximately basal area 8-10 m^2/ha) for Treatment Area No 4 in the Wungong catchment (DEC 2012).

Data on crown health were collected four years after thinning which should have been sufficient time to observe any detrimental effects of *P.cinnamomi* on tree health, particularly in view of the improved soil-moisture regime within thinned areas and the drought year in 2010. However it is recommended that similar surveys are carried out in about three years' time to monitor change.

These observations are similar to those made by Davison and Tay (1989), where they also observed that the trends in leaf production were similar on both dieback-affected and dieback-free sites.

Within the Cobiac trial area, loss of crown and tree deaths were observed in all un-thinned areas : the bauxite rehabilitated pits, the stream reserve and the control strip, but not in areas that had been thinned, irrespective of their dieback status, as mapped by trained

dieback-interpreters. These field observations (Figure 5) were supported by data acquired from Landsat imagery (Figure 6).

These results are quite contrary to the statements that claim any thinning in dieback-affected forest will result in the death of most of the retained trees. The rate of mortality on these particular dieback sites is low, with the loss of < 1 percent of trees over the period. The presumption that this type of intensive treatment would always provide conditions highly suited to *Phytophthora* infestation expressed as mortality has not been seen. However thinning may not give similar positive responses on sites that are waterlogged or very poorly drained. The rate of mortality in the control area (7 percent) suggests that in current conditions drought is a far greater threat to forest health.

The lesson to be learnt from the results of this trial is that it is unwise to extend research results obtained on a few trees or on differences in lesion length in wounded stems and roots, into broad-scale management prescriptions. It is far better to test silvicultural theories in landscape-scale, adaptive management trials that cover tens if not hundreds of hectares. It is these larger trials that will better reflect reality.

Acknowledgement

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References

Abbott I and O Loneragan (1986). Ecology of jarrah (*Eucalyptus marginata*) in the Northern jarrah forest of Western Australia. Bulletin No1 Department of Conservation and Land Management WA

Bunny F J , D S Crombie and M R Williams (1995). Growth of lesions of *Phytophthora cinnamomi* in stems and roots of jarrah (*Eucalyptus marginata*) in relation to rainfall and stand density in Mediterranean forest of Western Australia Can J For Res 25 (6) 961-969.

Conservation Commission (2004). Forest management plan 2004-2013. Conservation Commission of Western Australia January 2004.

Davison E M and F C Tay (1989) Phenology of *Eucalyptus marginata* on sites infested with *Phytophthora cinnamomi*. Aust J. Bot 37: 193-206

Department of Environment and Conservation (2012). Silvicultural treatment of native forest to enhance streamflow and groundwater reserves in the Wungong catchment (Treatment Area No4). Draft Silviculture Guideline.

Forests Department of Western Australia (1929, 1968). Annual Reports

Havel J (1975a) Site-vegetation mapping in the northern jarrah forest (Darling Range). 1 definition of site-vegetation types. Bulletin 86, Forests Department of Western Australia.

Stoneman G L, D S Crombie, K Whitford, F J Hingston, R Giles, C C Portlock, H J Galbraith and G M Dimmock (1996). Growth and water relations of *Eucalyptus marginata* (jarrah) stands in response to thinning and fertilisation. Tree Physiology 16, 267-274.

Water Corporation (2005b). Wungong catchment environment and water management project. Water Corporation response to submissions from 2005 public review.

Water Corporation (2012). Wungong Catchment trial. Streamflow and groundwater enhancement in native forest within Treatment Area No 4.

Figures

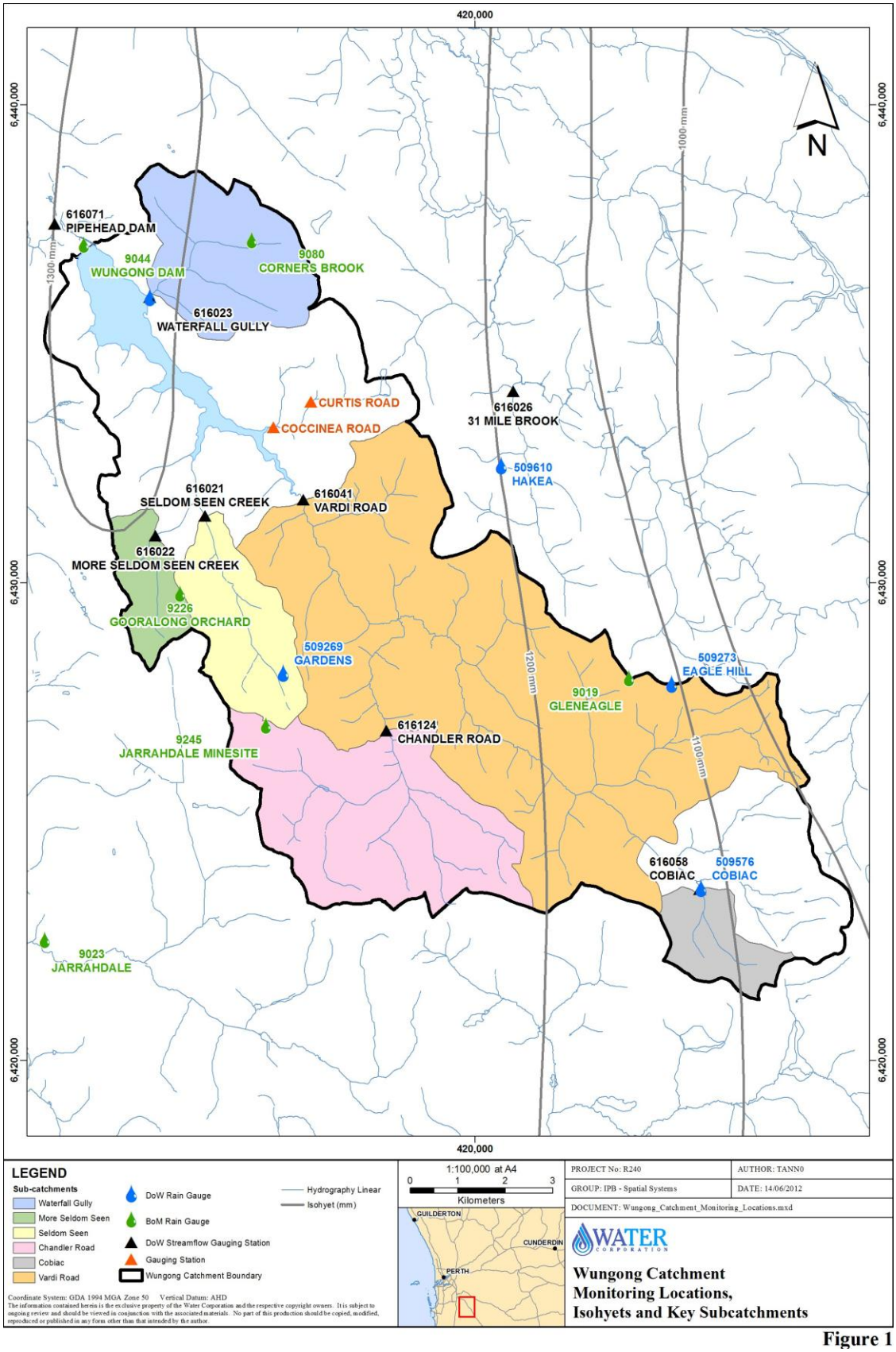

Figure 1
Location of Cobiac catchment

Figure 2
Photographs of crown classes 1, 2, 4 and 5 in jarrah (*E. marginata*)

Top left: Crown class 1 – Full crown, dense, leaves on primary branches

Top right: Crown class 2 – Full crown, less dense, leaves on primary branches

Bottom left: Crown class 4 – Open crown, dead branches, leaves on epicormic branches

Bottom right: Crown class 5 – very open crown, dead branches, leaves on epicormic branches

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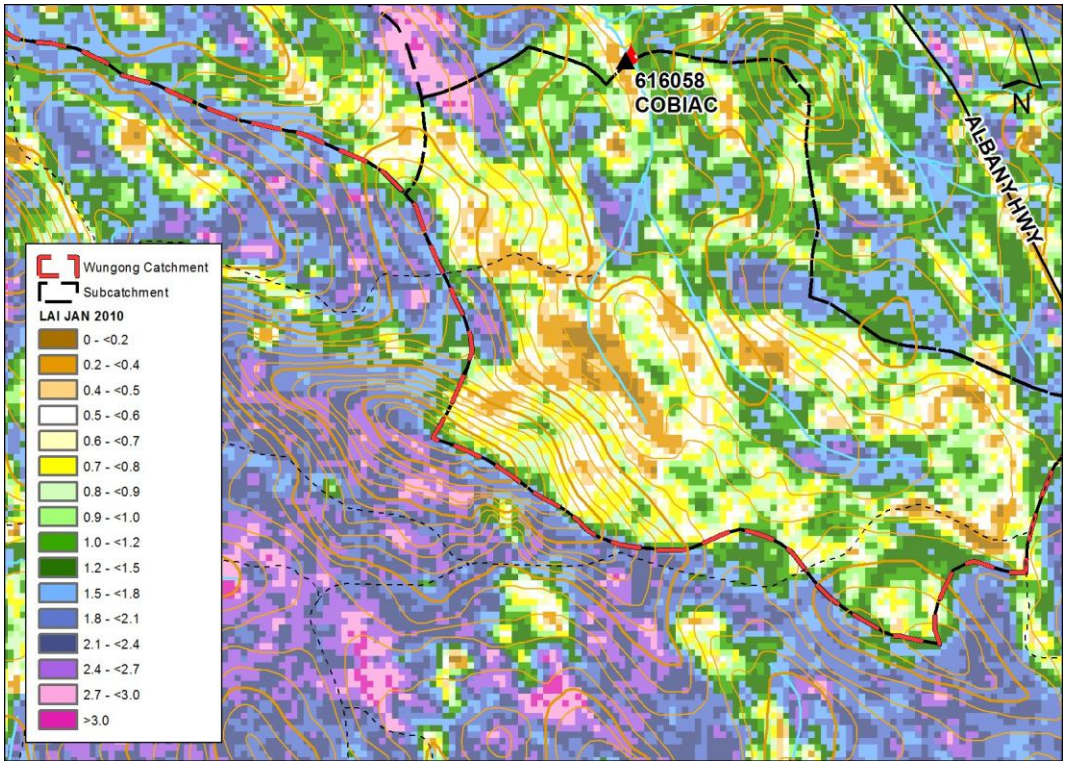


Figure 3

Estimates of leaf Area Index (LAI) in January 2010.

Thinned areas have low LAI, mostly <1.0, whereas un-thinned areas have LAI that exceed 2.0

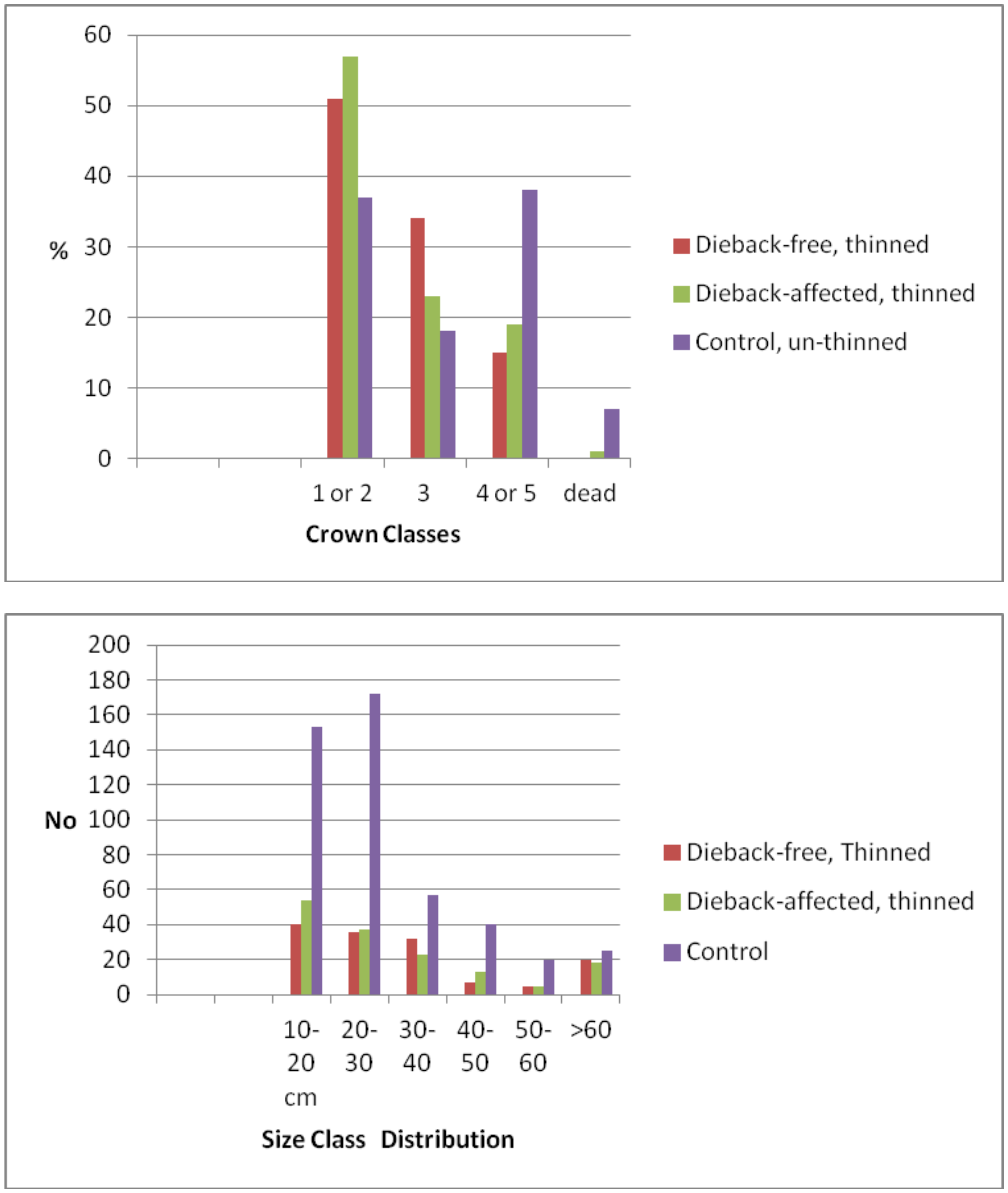
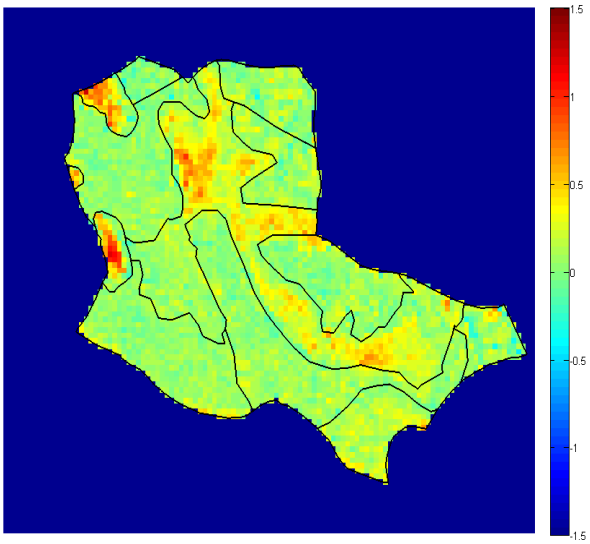


Figure 4

Crown class and size class distributions for thinned and un-thinned areas in the Cobiac research catchment trial. Thinning occurred in 2008 and crown health class was assessed four years later.

Figure 5
Photograph of dead and dying trees on lower slopes of CSIRO un-thinned control strip (left) and within a rehabilitated bauxite pit (right), Cobiac research catchment, March 2012.



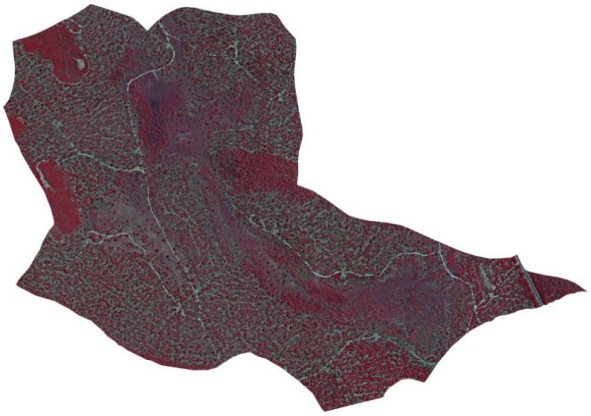


Figure 6

Above: Estimates of changes in Leaf Area Index(LAI), January 2010 to March 2011 (red and yellow = decline; green and blue = improvement) provided by Dr C Macfarlane, CSIRO

Below: canopy density post thinning, false colour image, provided by Spec Terra remote sensing services.

Note: the denser areas were not thinned and show a greater decline in LAI.