Wandoo Crown Condition 2009

Report of wandoo crown decline surveys, 2009

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Wandoo Recovery GROUP

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Wandoo crown decline is a widespread deterioration of wandoo (*Eucalyptus wandoo*, Blakely) tree crowns that appears to be due to a combination of biotic and abiotic factors acting together. The first symptom of this decline (flagging) is the browning off and death of the leaves at the ends of branch tips high in the crown. The death of this terminal foliage and the branches that support it produces a contraction of the tree crown downwards towards the central branches of the tree. This contraction is typically followed by the production of new leaves from epicormic shoots which sprout along the lower limbs.

Episodic events of crown decline have been observed and reported from sites across the range of wandoo since the early 1980's (Brown et.*al.,*1990; Gaynor, 2008; Mercer, 1991, 2003, 2008), yet few of these events have been systematically monitored while the trees decline from their healthy state or recover from their decline. Consequently relatively little is recorded about progression of the decline, or recovery over time.

In 2005 the Wandoo Recovery Group (WRG) developed an assessment and survey technique to assist landholders and community groups in monitoring the health of wandoo stands and to produce information that could be collated to give an overview of the progression of the decline on stands across the state. Each year volunteers throughout the SW of WA complete surveys of the conditions of Wandoo trees on survey sites dispersed from Chittering in the north to Cranbrook in the south, and from North Dandalup in the west to east of Narrogin (Figure 1). These widely dispersed surveys provide a 'snapshot' of the condition of wandoo trees in the southwest, and monitoring dispersed individual sites provides information on how the progress of decline and recovery varies across the range of wandoo. The WRG greatly appreciates the contribution of survey data collected by community groups, TAFE students, DEC staff and volunteers using the method developed by the Wandoo Recovery Group (WRG, 2005). Without their assistance this survey work would not be possible.

Survey technique and training in 2009

The survey of each site is based on assessments of individual trees along transects that are typically 100 m long and 20 m wide and located within forest, woodlands or remnant wandoo stands. Each tree along the transect is assessed to determine the stage of decline (Figure 2) and the amount of flagging occurring in the tree crown. Flagging is the drying out and browning of leaf clumps in the tree crown. The survey data is summarized for each site and these summaries compared with those from previous years.

Copies of the Assessment Guide, survey sheets and line drawings of crown decline stage are available from the WRG Executive Officer, Liz Manning on 0427 441 482, by email (Elizabeth.Manning@bigpond.com) or can be downloaded from the 'Nature and Biodiversity', 'Managing WA forests', 'Conserving our wandoo', 'Mapping' section on the DEC website www.naturebase.net. The links are: www.naturebase.net/component/option,com_docman/task,doc_download/gid,634/ and www.naturebase.net/component/option,com_docman/task,doc_download/gid,790/Itemid,984/

The WRG ran thirteen training workshops in 2009 which were attended by about 70 people. These workshops provide an opportunity for landowners and volunteers to meet WRG members and DEC staff, learn how to survey wandoo stands for crown decline and raise questions and discuss issues about wandoo. TAFE students and

volunteers also learn practical skills on how to set up and conduct a monitoring project. This active engagement, mutual learning and communication help to build a trustful, working relationship between all parties.

The sites

Twenty-four survey sites have now been established on private property, reserves, national parks and state forest throughout the geographic range of wandoo, (Figure 1). Eighty transects were surveyed this year across twenty-two of the sites. A total of 2657 trees along 7.9 km of transect covering 15.8 ha were assessed. Survey intensity ranged from one transect per site to seven transects per site.

The value of the transects is greatly increased when they are repeated over a number of years in exactly the same location.

Changes in crown condition since monitoring commenced

Reports of previous surveys completed in 2006, 2007 and 2008 are available at www.naturebase.net/component/option,com_docman/task,cat_view/gid,502/dir,DESC/order,name/Itemid,986/limit,5/limitstart,5/

Ten of the twenty-four sites have now been monitored for four years (monitored since 2006). Five sites have been monitored for three years and four sites for two years. Two sites established in 2006 were not surveyed this year, but hopefully will be surveyed again in 2010. Three new sites were added this year, and the initial surveys from these new sites provide a useful baseline record for interpreting future surveys.

Summaries and interpretation of survey results from each site for 2009 are shown in Table 1, which also lists the number of transects at each site. Figure 3 has summary graphs of the crown decline stage and flagging at each site. The colour assigned to each site in Table 1 and Figure 3 is based on the relative extent and intensity of flagging on each site, which we interpret as indicating the likely prognosis for the site. Green indicates sites with little or no flagging, which we expect to improve. Red indicates sites with extensive flagging which we expect to further deteriorate. The intermediate colours indicate intermediate conditions. These simple interpretation only considers the extent and intensity of the current decline and do not consider the vigour of the sites, i.e. the varied capacity of individual sites to recover from a decline event. Though not always reliable, our previous interpretations of flagging in 2006, 2007, and 2008 have been generally correct for most sites.

Interpretation of the progression of decline is best on those sites with several transects and the progression of decline is most clearly identified when exactly the same transect is resurveyed each year for several years.

Sites that have improved over the years of monitoring

Eight sites show improvement in crown condition over the two, three, or four years that they have been monitored. These are: Gorrie Road, Foxes Lair Reserve, 12 Mile Reserve, Milli Roo Property, Yilliminning Reserve, Batalling, Crossman Reserve, and Wundabiniring Brook.

Flagging is at very low to low levels at: Gorrie rd., Strathairlie, Foxes Lair Reserve, Maylinga, 12 mile reserve, Milli Roo Property, Yilliminning Reserve, South Bokal, Bowelling, Crossman Reserve, Warrinup Reserve, and West Dale. Consequently, we expect that the tree crowns on these sites will improve next year.

A large number of trees with light flagging, or a few trees with many leaves flagging were observed at Spriggins, Goldmine Hill, Mission rd. Wunderbinnering Brook, and Kupara Reserve. This flagging is not particularly extensive or intense, and the crown decline on these sites is expected to stabilize enabling the trees crowns to recover.

Sites that have worsened over the years of monitoring

Three sites show deterioration in crown condition over the two years that they have been monitored. These sites are: Stockyard, Bennelaking, and Morgan.

Figure 1. The location of wandoo crown decline survey sites. Colours of the markers indicate the relative outlook for the trees at each site (green = good, red = poor) based on the amount of flagging observed.

Based on the flagging observed in 2009 we expect that the trees on Stockyard, Bennelaking, and Morgan will continue to decline next year. Haddleton, which was first surveyed this year, is also expected to decline.

Sites unchanged over the years of monitoring

The condition of the tree crowns at four sites: Strathairlie, West Dale, Goldmine Hill, and Mission Road is interpreted as stable – relatively little change has occurred over the period of monitoring. South Bokal is interpreted as stable but could be slowly declining, while Warrinup Reserve and Kupara Reserve are interpreted as stable but may be slowly improving.

Sites previously monitored, but not surveyed in 2009

Although Karakamia and Paruna were not surveyed in 2009, Liz Manning visited Karakamia to review the health of wandoo on this site. The wandoo trees at Karakamia were healthier than

suggested by the previous annual reports. We attribute this inconsistency to a lack of clarity in interpreting and identifying current 'flagging' – a problem of interpretation that that has been noted in comments from assessors during training workshops.

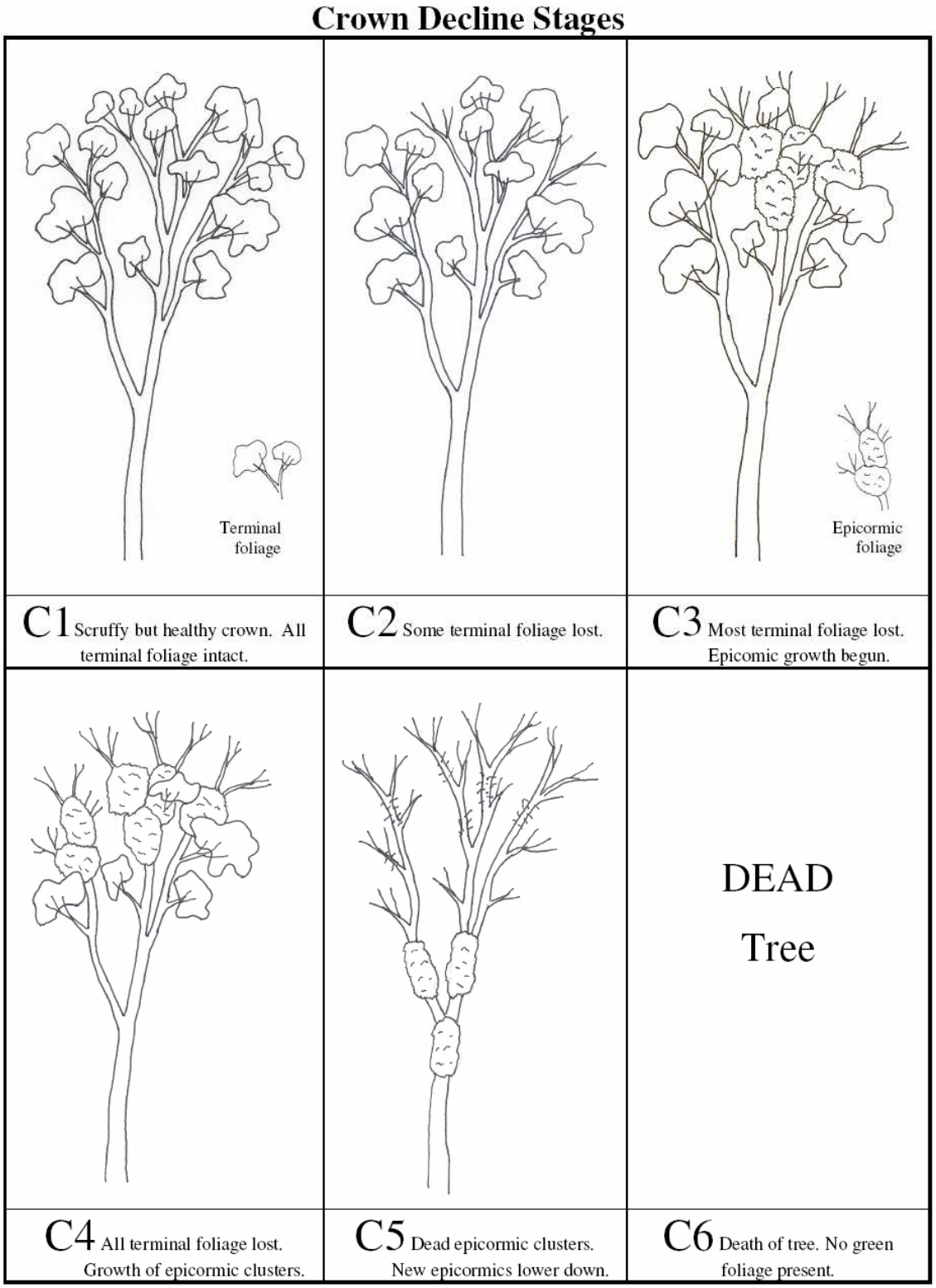

Figure. 2. Line drawings used to assess the progression of crown decline. The condition of the crown of each tree along the survey transects was scored according to its stage of decline.

Sites not previously monitored

There were three new sites surveyed this year: Bowelling, Spriggins Coup and Haddleton. Bowelling had only light flagging this year, though the site is in advanced decline with most trees showing some impact of crown decline. As flagging was light on this site the trees should improve. Similarly Spriggins Coup had very few trees flagging and the crown decline is expected to stabilize enabling the trees crowns to recover. In contrast Haddleton has almost half the trees flagging and some of these trees have extensive flagging. The decline is likely to progress on this site.

Lessons learnt from these surveys

The four years of monitoring completed so far has provided useful data that allows trends on many of the sites to be confidently interpreted. We are keen to continue monitoring all sites. Some surveys have also suggested unexpected and inconsistent changes in crown condition. These findings provide insights into how we can improve training and the survey procedure.

We attribute these unexpected changes in crown to:

1. Incorrect assessment of flagging;
2. Variation in assessment of crown decline stage between years and between sites.
3. Changes in the number of trees assessed on a site or transect;

Incorrect assessment of flagging has occurred on some sites. Flagging is the presence of clusters of dead leaves still held on the tree. Flagging is different from the natural process of continuous leaf aging and death, which is usual for native plants. Dead twigs which remain as evidence of a previous decline episode or previous flagging may have been miss-interpreted as 'flagging'. These dead twigs should be considered in the assessment of crown decline stage (Fig. 2). Flagging should refer to the presence of clusters of dead leaves still held on the tree.

Variation in assessment of crown decline stage between years and between sites has several potential causes and is an inherent problem of subjective visual assessments such as our assessments of crown decline stage (Fig. 2). This variation occurs with: changes in the people doing the assessment, slight variation in assessment between individual assessors, 'drift' in assessors over time, insufficient or no training of new assessors, and a tendency for inexperienced assessors (who have not seen crowns in poor condition) to harshly assess relatively healthy crowns. Changes in assessors are unavoidable at some sites, but are best avoided if possible; however this and all other sources of variation are most effectively minimized through training, clarification and support.

Changes in the number of trees assessed on a site or transect occurs when the location, length or width of the transects change - adding or removing some trees from the group assessed in the previous year. This highlights the need to clearly mark the transect start and end points, the transect centre line and the external boundary. We suggest the transect beginning and end should be marked with a stake and flagging tape and some guide stakes be placed at intervals along the 10 meter perimeter of the transect line or at least along the transect centre line. Using chalk to mark each tree once it is assessed can help to eliminate accidental reassessment of trees, which is another source of this error.

During the 2010 survey period, WRG and DEC staff will attempt to visit every site to conduct refresher training with volunteers, help establish markers of transects where applicable and review the condition of crowns on each site. We see this as the most effective means of ensuring consistent application of the survey technique and providing reliable interpretation and reporting across all sites.

It may also be deemed useful to set up a photo reference spot on each transect and begin photographing specific reference trees. This will provide visual clues as to the progression of decline and or recovery of these individual trees.

Conclusions

The survey project continues to grow with three new sites surveyed for the first time this year. Nineteen sites were resurveyed this year and additional transects were added to two of these sites. Only two sites were not resurveyed in 2009 and these sites are expected to be resurveyed next year, allowing monitoring to continue. The expansion of the surveys and the continued annual resurvey of existing sites all give encouraging support to the project.

Wandoo crown decline can quickly devastate a stand of trees; however over the four years of monitoring, only three sites have shown clear substantial deterioration (Stockyard, Bennelaking and Morgan). Most sites show stable or improving trends in overall health. Our monitoring does not indicate that these four years have been a period of substantial decline in wandoo crown health.

This observation of relative stability in crown condition contrasts with the period before this monitoring started. The condition of crowns at five sites when they were first monitored clearly show that they had experienced marked or prolonged decline prior to their first monitoring (Foxes Lair, 12 Mile Reserve, West Dale, Wundabiniring Brook, and Kupara). The specific nature of this decline, whether it occurred quickly over one or two years, or slowly over several years, is unknown. The great benefit of monitoring is in providing a reliable record of tree health so that the specific changes such as the rate of decline and recovery can be known, and possibly related to conditions in the wider environment.

To correctly interpret accurate trends in the progress of decline, stability or recovery, it is important to survey the exact same trees each year. Care must be taken to ensure that individual trees occurring in dense stands are not accidentally missed out or assessed more than once. Understanding how to identify 'flagging' and recognising the difference between 'flagging' and the natural occurrence of leaf shed is critical for accurate reporting, as is consistent use of the crown decline stage assessment.

This survey project has fostered trust and friendship and developed a working relationship of mutual learning and shared knowledge. The lessons learnt over these four years will help improve assessment and survey of these sites. We greatly appreciate the time given by volunteers involved in monitoring and we are committed to providing training and refresher courses on the survey technique to support consistent standards of assessment.

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Table 1. Summary and interpretation of wandoo crown decline survey results from 24 sites. Surveys based on the method described in WRG (2005). Colours indicate the relative outlook for the trees at each site (green = good, red = poor).

Site Name	Flagging summary 2006	Flagging summary 2007	Flagging summary 2008	Flagging summary 2009	Crown Decline Stage 2009	Changes at site since 2006 and current outlook 2009	Number of transects 2006	Number of transects 2007	Number of transects 2008	Number of transects 2009	Trees per ha 2009
Gorrie Road	Trivial flagging	Trivial flagging	Trivial flagging	No flagging	Early decline	The location of transects changed in 2007 and a new transect was added in 2008. Crowns have improved each year since 2007 consistent with the trivial flagging observed in 2007, 2008 and 2009. Early decline with no flagging. The tree crowns should continue to improve as no flagging was observed in 2009.	4	6	7	7	174
Strathairlie Pastoral Lease	Minor flagging on some trees	Minor flagging on some trees	Minor flagging on some trees	Trivial flagging	Early decline	Consistently the same transects and trees monitored since 2006. The surveys do not show any great change in condition of the crowns on this site since 2006; however with low levels of flagging observed since 2006 and very little flagging observed in 2009, the condition of the tree crowns is probably slowly improving and the decline will not progress. Stable	2	2	2	2	163
Foxes Lair Reserve	Minor flagging on most trees	Minor flagging on some trees	Minor flagging on one third of the trees	Minor flagging on some trees	Early to intermediate decline	The condition of the tree crowns on this site has slowly but consistently improved since 2006. Flagging decreased from 2006 to 2007 and remained at similarly low levels in 2008 and then further decreased in to very low levels in 2009. Probably the tree crowns will continue to recover.	1	4	3	3	248
Maylinga	Trivial flagging	Trivial, with isolated extensive flagging	Trivial, with isolated moderate flagging	Trivial flagging	Intermediate to advanced decline	Crown scorch in 2007 obscures the progression of any decline. The number of transects has increased each year. The absence of any flagging this year and very little flagging in previous years indicate that the tree crowns on this site should be improving.	1	1	2	3	347
12 Mile Reserve	Not surveyed	Not surveyed	Minor flagging on some trees	Trivial flagging	Advanced decline	First surveyed in 2008. The condition of the tree crowns appears to have improved slightly since 2008. Flagging was light in 2008 and trivial in 2009. The site is in advanced decline but the crown decline should not progress and the condition of trees on the site should further improve.	Not surveyed	Not surveyed	2	2	165
Milli Roo Property	Trivial flagging	Not surveyed	Trivial flagging	Minor flagging on some trees	Early decline	Not surveyed in 2007. The condition of the tree crowns has been improving since 2006 and this is consistent with the absence of flagging in 2006 and 2008; however some minor flagging was observed on one fifth of the trees in 2009. If flagging remains light the crown decline will not progress and the tree crowns will continue to improve.	5	Not surveyed	4	4	218
Yilliminning Reserve	Extensive flagging on some trees	Minor flagging on some trees	Minor flagging on half the trees	Minor flagging on some trees	Early decline.	The number of transects increased in 2008. Flagging decreased in 2007, rose in 2008 and then declined again in 2009. The condition of the tree crowns has steadily improved since 2006. Probably the tree crowns will continue to recover.	2	2	4	4	134
South Bokal	Minor flagging on some trees	Trivial flagging	Minor flagging on some trees	Minor flagging on some trees	Early decline	Flagging on this site has been light or trivial since 2006; however, the surveys indicate that the tree crowns have deteriorated slightly since 2006. The low levels of flagging observed the crown decline	1	1	1	1	102
Bowelling	Not surveyed	Not surveyed	Not surveyed	Minor flagging on some trees	Early to intermediate decline	Site not previously surveyed. The site is in advanced decline but only minor flagging was observed in 2009 on one fifth of all trees. The low levels of flagging may enable to tree crowns to recover in the coming years.	Not surveyed	Not surveyed	Not surveyed	7	74
Crossman Reserve	Minor flagging on some trees	Not surveyed	Minor flagging on some trees	Minor flagging on some trees	Early to intermediate decline	Not surveyed in 2007. The tree crowns appear to have improved slightly since 2006. Very little flagging on one fifth of all trees in 2009. Though decline is advanced, flagging has been light since 2006 and the tree crowns should be improving. Possibly crown decline will not progress.	7	Not surveyed	5	5	125
Warrinup Reserve	Not surveyed	Not surveyed	Minor or moderate on half the trees.	Minor flagging on some trees	Early to intermediate decline	Surveyed since 2008. The number of trees showing flagging and the amount of flagging on those trees has decreased since 2008. The condition of trees crowns on the site may have improved slightly since 2008. The tree crowns should continue to improve as flagging is light.	Not surveyed	Not surveyed	4	4	145
West Dale	Minor flagging on some trees	Minor to extensive flagging on some trees	Minor flagging on some trees	Minor flagging on some trees	Advanced decline	Flagging has been light since 2006; however the condition of the tree crowns appears only slightly changed since 2006. The site has advanced crown decline. The condition of the tree crowns on the site may be static or only slowly improving. If flagging remains light then the crown decline should not progress.	4	4	4	4	105
Spriggins Coup	Not surveyed	Not surveyed	Not surveyed	Minor or moderate flagging on a few trees	Early decline	Site not previously surveyed. Light flagging on a few trees in 2009. The condition of the tree crowns indicates the decline agents have previously been active on this site and are currently producing some minor flagging. The relatively light flagging indicates that the tree crowns on this site should improve.	Not surveyed	Not surveyed	Not surveyed	2	283
Goldmine Hill	Not surveyed	No flagging	No flagging	Minor flagging on one third of the trees	Early decline	Surveyed since 2007. Flagging increased in 2009 and crowns appear to have declined. This is actually a very small shift and may possibly be attributed to the change in students assessing the site. One third of the trees have some minor flagging.	Not surveyed	1	6	6	227
Mission Road	Minor flagging on some trees	No flagging	Minor flagging on some trees	Minor flagging on one third of the trees	Early decline	Although flagging has increased slightly in the last two years, flagging is still light with less than a third of the trees showing any flagging. The tree crowns appear to have improved since 2008 when a new transect was added, but the changes since 2006 may have been minor. Early decline. Possibly crown decline will not progress.	1	1	2	2	130
Wundabiniring Brook	Not surveyed	Trivial flagging	Trivial flagging	Minor or moderate flagging on some trees	Early to intermediate decline	Surveyed since 2007. The crowns appear to have made some slight improvement since 2007, consistent with the low levels of flagging observed in 2007 and 2008. Although some moderate flagging was observed this year on a few trees, the site appears to be recovering. Probably crown decline will not progress.	Not surveyed	6	7	6	203

Table 1, continued from previous page. .

Site Name	Flagging summary 2006	Flagging summary 2007	Flagging summary 2008	Flagging summary 2009	Crown Decline Stage 2009	Changes at site since 2006 and current outlook 2009	Number of transects 2006	Number of transects 2007	Number of transects 2008	Number of transects 2009	Trees per ha 2009
Kupara Reserve	Extensive flagging on some trees	Not surveyed	Minor or moderate on half the trees.	Minor or moderate flagging on one third of the trees.	Intermediate to advanced decline	The number of trees showing flagging and the amount of flagging on those trees has decreased each year and is substantially less than in 2006. The condition of trees crowns on this site is stable and reduction in flagging should lead to an improvement in the condition of the tree crowns.	1	Not surveyed	1	2	155
Stockyard	Not surveyed	Not surveyed	Minor or moderate on half the trees.	Minor or moderate flagging on more than half of the trees.	Early decline	Surveyed since 2008. The tree crowns on the site have probably deteriorated since 2008 consistent with the amount of light flagging observed in 2008 and there has been a slight increase in the number of trees that are flagging. Early to intermediate decline, most trees have lost some terminal foliage. The decline agents are still active and the trees may continue to decline.	Not surveyed	Not surveyed	3	3	215
Batalling	Not surveyed	Trivial flagging	Minor or moderate on most trees	Minor or moderate on a few trees	Early decline	Surveyed since 2007. The number of tree crowns that have flagging has declined since 2008 and fewer trees now have light flagging. The condition of the crowns has progressively improved since 2007. If flagging continues to decrease the crowns will improve	Not surveyed	4	4	4	151
Bennelaking VCL	Not surveyed	Extensive flagging on some trees	All trees have minor flagging	Minor flagging on most trees, a little moderate flagging	Early to intermediate decline	Surveyed since 2007. All or most trees had some flagging in 2008 and 2009. The tree crowns on this site have deteriorated slightly since 2007. Intermediate decline. Majority of trees with the majority of their terminal foliage intact. The decline agents are currently or recently active. Progression of the decline is likely.	Not surveyed	3	3	3	188
Morgan	Not surveyed	Not surveyed	Minor flagging on most trees	Minor flagging on most trees, some moderate flagging	Early decline	Surveyed since 2008. Almost all of the trees had some flagging in 2008 and this is again the case in 2009. The tree crowns on this site have deteriorated slightly since 2008. Intermediate decline. Majority of trees with the majority of their terminal foliage intact. Decline agents currently or recently active. Progression of the decline is likely due to the large amount of flagging observed.	Not surveyed	Not surveyed	3	3	145
Haddleton Nature Reserve	Not surveyed	Not surveyed	Not surveyed	Minor, moderate or extensive flagging on half of the trees.	Early to intermediate decline	Site not previously surveyed. Site is in advanced decline and flagging was observed on one half of all trees, some with extensive flagging. Decline is likely to progress	Not surveyed	Not surveyed	Not surveyed	3	138
Karakamia Sanctuary	Extensive flagging on some trees	Minor to extensive on most trees	Minor to extensive on most trees	Not surveyed	Not surveyed	Not surveyed in 2009, though site inspection indicated the trees were healthier than suggested by previous surveys	1	1	1	Not surveyed	Not surveyed
Paruna Sanctuary	Extensive flagging on most trees	Extensive flagging on most trees	Extensive flagging on most trees	Not surveyed	Not surveyed	Not surveyed in 2009	1	1	1	Not surveyed	Not surveyed

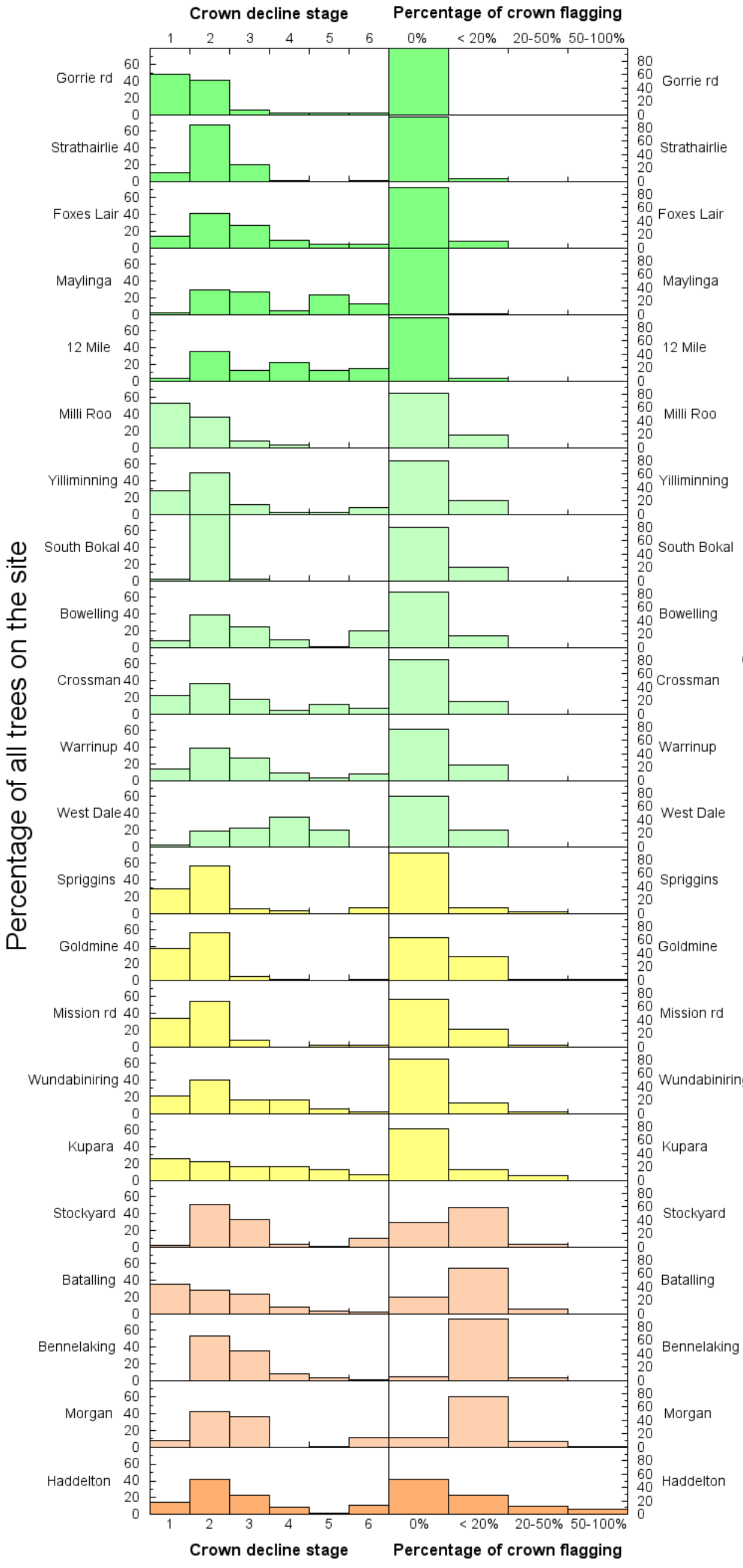

Figure 3. (Left hand side) The percentage of trees at each site assigned to the six crown decline stages. (Right hand side) The proportion of flagging leaves in the tree crown at the time of assessment. Classes are 0%; < 20%; 20%–50%; and 50%–100%. Colours indicate the relative outlook for the trees at each site based on the current extent and intensity of flagging (green = good, red = poor)