Wandoo Crown Condition 2010

Report of five years of wandoo crown decline surveys

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Wandoo Recovery GROUP

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Summary

Crown decline of Wandoo (*Eucalyptus wandoo*, Blakely), a major endemic tree species of southwest Western Australia, has been observed since the early 1980's. In 2006 the Wandoo Recovery Group (WRG) implemented a wandoo monitoring project based on surveys undertaken by community groups, TAFE students and private landholders. The aim of this project was to provide a structured and objective assessment of the condition of wandoo crowns on sites across wandoo's distribution. This report examines the results from five years of surveys on twenty-four sites and presents general conclusions for this period.

The initial condition of the twenty-four survey sites varied widely. Some sites showed no impact from wandoo crown decline, while on other sites the primary crowns of many trees had contracted substantially to be partly or wholly replaced by epicormic growth. The condition of these latter sites demonstrates the extensive damage that wandoo crown decline can inflict.

Active decline is evidenced by 'flagging', the browning off and death of clusters of leaves at the branch tips. Over this five years of monitoring only 21% of trees showed any flagging. Of these trees that were flagging, 92% had very low levels of flagging; i.e. less than 20% of the leaves in the tree crown were flagging. The low levels of flagging, both in extent and intensity, indicate that the decline agents have not been particularly active on these sites over this period; consequently, there has been relatively little or no decline in the condition of the tree crowns. The combined assessments of the twenty-four sites over five years indicate that overall there has been a slight improvement in the condition of wandoo tree crowns across the southwest. Tree crowns on most sites improved, if only slightly. A few sites have remained unchanged, and only one site showed a clear deterioration in crown condition.

The survey results and our experiences in using and teaching the survey technique highlight strengths and shortcomings, both in the technique, and in our implementation of the monitoring project. While the assessment technique is largely sound and provides a sensible basis for assessing stand condition and progression of decline, we observed that it does not sensitively track the recovery of tree crowns. We also identified misunderstanding of key concepts of the technique, particularly the over-assessment of flagging, which sometimes produced a biased assessment of the condition of a site. It is important to set up transects with permanent location markers and to ensure repeated surveys are undertaken by the same assessor, or where this is not possible, assessors with similar experience and training. These experiences highlight the importance of training assessors and the baselining all sites by an experienced assessor.

Many volunteers contributed to this monitoring. Beyond learning the survey skills and collecting the data, volunteers exchanged ideas, observations and knowledge about wandoo

crown decline. This interaction fostered community networks that are essential in dealing with a tree species that is dispersed across southwest WA. We gratefully acknowledge the goodwill and enthusiasm shown by all our volunteers.

Introduction

Wandoo (*Eucalyptus wandoo*, Blakely) is a major endemic tree species of southwest Western Australia. It is ecologically significant and widespread across the region with a distribution that extends across the medium and lower rainfall areas of the Wheatbelt and Great Southern regions. Extending from Moora in the north to Mount Barker in the south, wandoo occurs as far east as Kulin, abuts the eastern edge of the jarrah forest and also extends down the Darling Scarp and adjacent plains in the west. Outside of State forest clearing for agriculture has substantially fragmented and diminished wandoo's distribution. Wandoo is now largely restricted to reserves, remnant vegetation and paddock trees on farms, and along road reserves. Despite this contraction in distribution, wandoo remains a valued and iconic tree species in southwest WA.

Episodes of decline in wandoo crowns have been observed and reported from across the range of wandoo since the early 1980's (Brown et.*al.,* 1990; Mercer, 1991, 2003, 2008; Gaynor, 2008). Wandoo decline is a deterioration of tree crowns that begins with a browning off and death of clusters of leaves at the branch tips high in the crown (flagging). The death of this terminal foliage and the supporting branches produces a contraction of the leafy crown downwards towards the central branches of the tree. This contraction typically coincides with the production of new leaves from epicormic shoots which sprout lower down the limbs; though severe or repeated decline can lead to tree death.

Few of these decline events have been systematically monitored while the trees deteriorate from their healthy state, or recover from their decline; consequently, relatively little is recorded about the progression of decline and the recovery over time.

The Wandoo Recovery Group (WRG) developed a simple survey technique (WRG, 2005) to assist landholders and community groups monitor the health of wandoo stands, and provide information on the progression of decline at various sites across the southwest. Monitoring began in 2006. Each year volunteers surveyed the condition of wandoo trees on sites established from Chittering in the north to Cranbrook in the south, and from North Dandalup in the west to east of Narrogin (Figure 1). Data from these sites provide a 'snapshot' of the condition of wandoo trees in the southwest as well as information on the progress of decline and recovery across the range of wandoo.

This is the fifth year the Wandoo Recovery Group (WRG) has supported these community-based surveys through coordination, training, and the collation and reporting of results. The WRG greatly appreciates the contributions of community groups, TAFE students, DEC staff and volunteers in collecting data using this method. Without their assistance this survey work would not be possible. The primary aim of this monitoring project was to provide a structured and objective assessment of the condition of wandoo crowns on sites across wandoo's distribution. This report draws general conclusions on the trends in decline over this monitoring period and provides a statement of the condition of these survey sites as a reference for any future monitoring.

Surveys

The monitoring surveys are based on assessments of individual trees along transects that are typically 100 m long and 20 m wide. Each wandoo tree is assessed to determine its size, the stage of crown decline (Figure 2) and the amount of flagging occurring in the tree crown. Only trees larger than 10 cm in diameter at breast height over bark (DBHOB) are assessed. The survey data is summarized for each site and compared with those from previous years. This year, trained assessors from the WRG and DEC visited every site to provide training and support to volunteers and ensure the survey method was correctly implemented and consistently applied. Surveys commenced in 2006 and are repeated annually where possible; usually in the first half of the year.

Reports of previous surveys completed in 2006, 2007, 2008, and 2009 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/

Copies of the Assessment Guide, survey sheets and line drawings of crown decline stage 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 sites

Twenty-four sites were surveyed in 2010. These are located on private property, reserves, national parks and State forest throughout the geographic range of wandoo (Figure 1). Eighty-two transects were completed, assessing 3078 trees along 8.1 km of strip transects covering 16 ha. Survey intensity ranged from one transect per site to seven transects per site.

We endeavour to ensure that transects are repeated each year in exactly the same location, assessing the exactly the same group of trees. Unfortunately, transects are sometimes dropped, added or repositioned and not all sites have been surveyed every year. Of the twenty-four sites established:

- thirteen sites were monitored over five years (with five escaping monitoring in one year);
- four sites were monitored over four years;
- four sites were monitored over three years;
- three sites were monitored over two years.

A total of 11,212 tree assessments have been completed since monitoring began in 2006.

Figure 1. The location of the twenty-four wandoo crown condition monitoring sites.

Stand structure

Figure 3 (on page 12) shows the distribution of tree diameters for each site surveyed in 2010. These graphs show how sites vary greatly in both the number of trees (stems) and the distribution of tree sizes. The number of trees on a site (stand density) ranged from 105 stems per ha at West Dale to 353 stems per ha at the Maylinga property. The average stand density across the survey sites was 193 stems per ha. The distributions of tree sizes were skewed towards the 10–25 cm diameter class on twenty of the twenty-four sites. Five sites were heavily skewed, with many more trees in the small diameter class than in the larger classes. Such skewed distributions of tree diameters are common in forests and woodlands. The 25–50 cm diameter class was most frequent on only three sites. Data from Rose (1993) for two wandoo stands that have never been logged indicates old-growth stands of wandoo have a relatively flat distribution of tree diameters, with approximately equal numbers of trees in each

of the three diameter classes. The skewed distributions on many of the survey sites may be due to historical timber harvesting or other management practices.

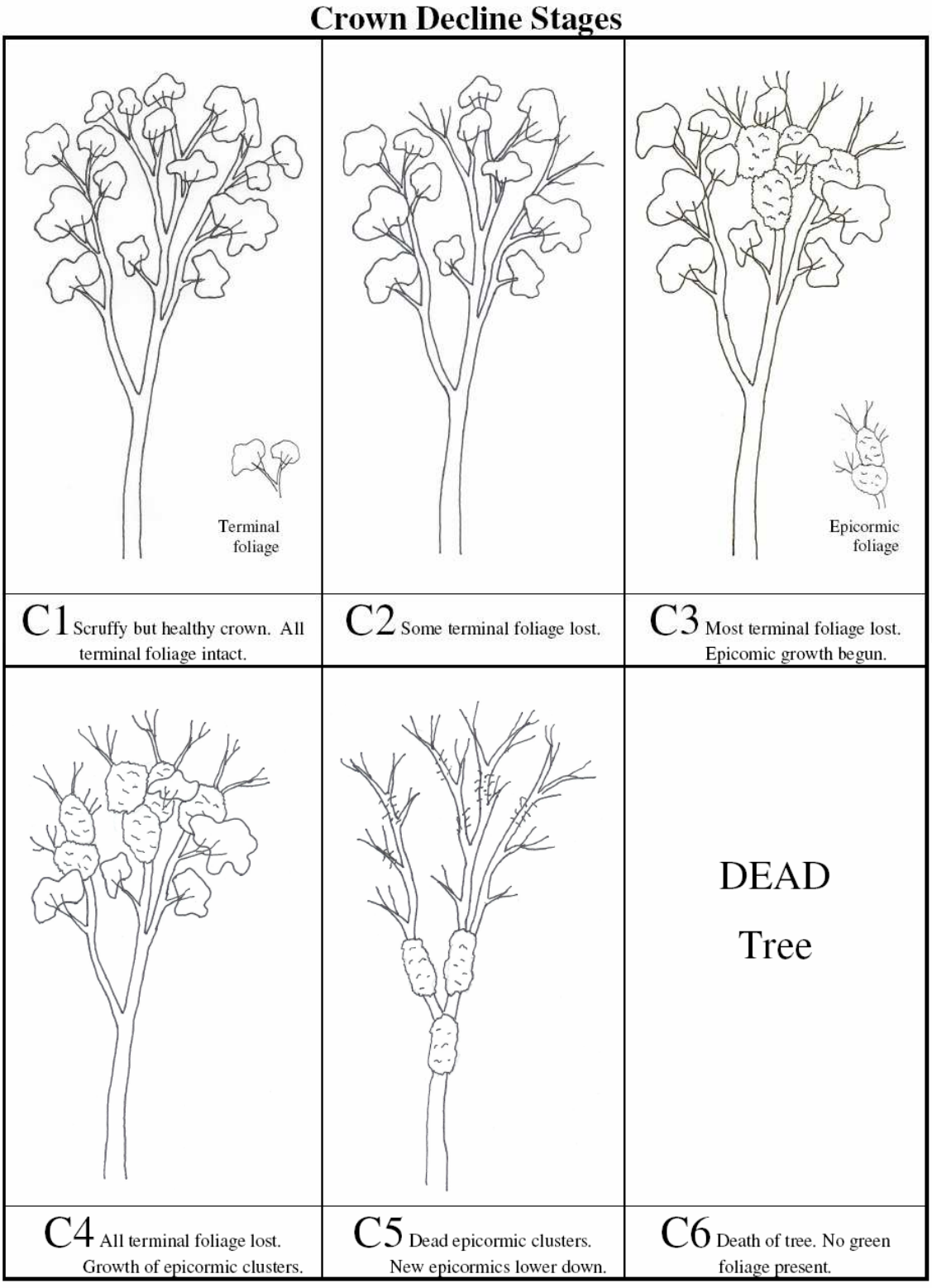

Figure. 2. Line drawings used to assess the stage of crown decline. The condition of the crown of each tree along the survey transects was scored according to its crown decline stage.

Changes in crown condition since monitoring commenced

Figure 5 shows the survey results for 2010. We examined the overall trends in the crown decline stage assessment across the years of monitoring at each site (Tables 1 and 2). The potential for wandoo crown decline to cause serious extensive damage to tree crowns was demonstrated by the condition of some of sites when they were first surveyed. The initial surveys of sites such as Kupara and Twelve Mile Reserve reveal the extent of crown damage that can be produced by wandoo crown decline. Over the five years of our monitoring the changes in crown condition have been relatively minor compared to the potential deterioration that wandoo crown decline can produce. Condition of the tree crowns improved on Gorrie rd, Yilliminning Reserve, Foxes Lair Reserve and Wundabiniring Brook. Slight improvement also appears to have occurred at West Dale, South Bokal, Crossman Reserve, Milli Roo, Warrenup Reserve, Morgan, and Batalling. Slight improvements in crown condition may have also occurred at Maylinga, Stockyard, Haddelton, Bennelaking, and at Bowelling, which has only been monitored over the last two years. Little change was observed at Goldmine Hill, Strathairlie Pastoral Lease, Mission Road, and Kupara Reserve. The trend at Spriggins coup, which has only been surveyed the last two years, was unclear. Crown condition deteriorated at Twelve Mile Reserve. This site shows a clear trend of decline although it has only been surveyed over the last three years.

Previous assessments of crown condition at Karakamia and Paruna Sanctuaries appear incorrect as they recorded high levels of flagging and crown decline which identified them as declining sites. Assessment in 2010 by trained assessors revealed that trees on these two sites were predominantly healthy with more than 80% of trees rated in crown decline stages 1 and 2. Due to this anomaly, overall trends for Paruna and Karakamia are unclear.

In summary, this monitoring shows that changes in crown condition across these twenty-four sites have mostly been small (Table 1). The tree crowns on most sites have improved, if only slightly. A few sites have remained unchanged and a clear deterioration in the condition of the tree crowns was only evident at one site.

Table 1. Trends in the crown condition of 24 wandoo sites assessed between 2006 and 2010.

Improved	**Slighty improved**	**Little or no change**	**Deteriorated**	**Trend Unclear**
Gorrie Road	Haddleton	Goldmine HIll	Twelve Mile Reserve	Paruna
Yilliminning Reserve	West Dale	Strathairlie Pastoral Lease		Karakamia
Foxes Lair Reserve	South Bokal	Mission Rd		Spriggins Coup
Wundabiniring Brook	Stockyard	Kupara Reserve		
	Warrenup Reserve			
	Crossman			
	Bennelaking			
	Bowelling			
	Milli Roo			
	Maylinga			
	Morgan			
	Batalling			

Flagging

Flagging is the browning off and death of the leaves at the ends of branch tips high in the crown. The annual flagging of leaves is the most visible symptom of active decline and can lead to contraction of the leafy crown Over the five years of these surveys both the amount of flagging in individual trees and the number of trees on the sites that have flagging has been low. The vast majority of trees assessed over the five years (79%) had no flagging. Twenty percent of trees had flagging in less than 20% of the crown. Only 1% of trees had flagging affecting 20 to 50% of the crown, and less than 0.5% of trees had flagging in 50 to 100% of the crown.

In 2010 the incidence of flagging remained low. Eighty-three percent of trees showed no flagging, 16% of trees exhibited less than 20% flagging of the crown. One percent of trees had flagging in 20 to 50% of the crown. Less than 0.5% of trees showed flagging in 50 to 100% of the crown. The low numbers of trees flagging and the small proportion of flagging leaves in their crowns was consistent with the overall trend in crown condition that we have observed. Though prolonged low level flagging can produce crown decline; generally, tree crowns will not decline when flagging affects only a small proportion of leaves in the crown, as these leaves can be readily replaced in the following year.

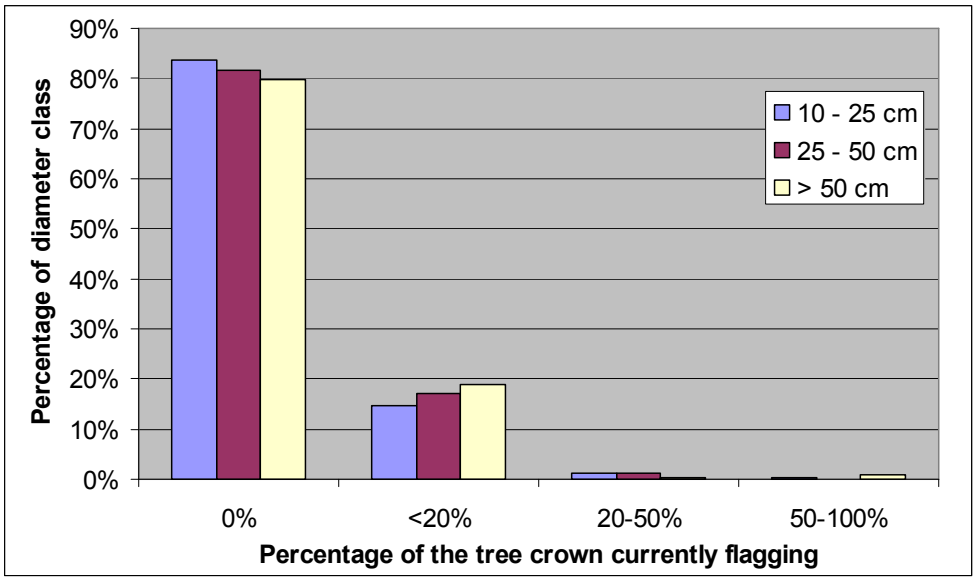

Figure 4. The percentage of trees flagging. Values are for three diameter classes: trees of 10-25cm, 25-50cm, and greater than 50 cm in diameter (DBHOB). Classes of flagging are for four different intensities: no flagging, 0%; minor flagging, < 20% of leaves; moderate flagging, 20-50% of leaves; and extensive flagging, 50-100% of leaves.

Flagging does not appear to be related to tree size. Although there were many more small trees than large trees (see Figure 3), the proportion of trees flagging in each diameter class was similar i.e. small trees had similar amounts of flagging as large trees (Figure 4).

Over the years of reporting this monitoring we have worked with a simple assumption that the amount of flagging observed in the tree crowns indicates the trajectory of the site. Sites with little or no flagging are those we have expected to improve, and sites with extensive flagging

are those we have expected to deteriorate. Survey results from some sites indicate this presumption is too simple (e.g. Twelve Mile Reserve). It does not consider the vigour of the sites - the varied capacity of individual sites to recover from a decline event. However, we note the low levels of flagging observed over the period of this monitoring. With a greater range in flagging intensity we expect the response of sites would more closely follow the amount of flagging, i.e. intensive flagging that affected many trees on a site would likely predominate over the vigour of the site, and the site would decline. The response of sites with low to moderate levels of flagging would depend on the interplay between the loss of leaves (flagging) and site vigour – the capacity of the trees to replace leaves and branches through the epicormic response.

The assessment technique

This summation of five years of monitoring warrants examination of the strengths, weaknesses and sensitivity of the assessment technique. Although these assessments are not entirely subjective, they rely on interpretations by the assessor. Some variability between assessors and by individual assessors is to be expected and does not invalidate the surveys if the variability is random. Anomalous surveys of a site usually stand out because the assessments of crown decline stage are inconsistent with previous assessments and the related assessments of flagging. Surveys which are clearly anomalous can be discounted. Consistent bias by individual assessors at a particular site may only be revealed when an another experienced assessor surveys the site. Although most surveys appear to be sound, over the years of monitoring there have been anomalous surveys of particular sites in individual years. There is also evidence of consistent bias or misinterpretation of the survey technique over several years at individual sites. To remedy this problem, this year trained assessors visited all sites to oversee the assessments and ensure volunteers understood the technique. These outcomes and our own experiences in using and teaching the survey technique have highlighted some strengths and shortcomings in how we implemented this monitoring project.

Firstly we believe the assessment technique is largely sound and provides a sensible basis for assessing stand condition. However, this assessment procedure has a notable weakness. The pictorial crown decline stage assessment scale was developed to track the progressive deterioration and contraction of tree crowns. It is sensitive to deterioration of crowns, adequately captures the evidence of past and current decline, but does not sensitively track the recovery of tree crowns. Recovery initially occurs as an increase in the density of leaves in the crown, before any outward expansion and enlargement of the crown occurs. Our assessments do not track this increase in leaf density. In addition, dead branches above the tree crown - one of the indicators shown in the pictorial scale - remain in the crown for more than a decade after a decline episode. This aspect of the pictorial scale is potentially misleading and for some assessors the presence of these dead branches in the crown holds back their assessment of crown recovery. Consequently, in periods of crown recovery, our assessment technique underestimates the amount of recovery.

We also note that the distinction between crown decline stages 1 and 2 is minor, and individual assessors often vary in distinguishing these two classes. Consequently variability in these classes between years and between sites is often inconsequential and may not indicate a change in a site, or a difference between sites. Another common source of variability we observed was misinterpretation of low levels of flagging. Many tree crowns carry a few dead leaves which may be due to a range of common factors such as branches breaking in the wind, or bird damage. These few dead leaves were at times incorrectly interpreted as flagging. Flagging only occurs as clearly visible clumps of leaves and typically on branches larger than 1

cm in diameter. This misinterpretation of flagging occasionally lead to excessive assessment of flagging at a site.

Another lesson we draw from this experience is the importance of training assessors and of baselining all sites by an experienced assessor. Without training, simple misunderstanding of key concepts in the assessment method can lead to bias assessments of the condition of a site. Where there is a baseline survey by an experienced assessor, these misunderstandings are generally revealed by anomalous surveys which are inconsistent with the previous surveys of decline stage and flagging.

Detecting and identifying these problems in assessment and correctly identifying changes in site condition are easiest where the same assessor has assessed exactly the same trees along the same transect each year. At the beginning of this project we did not emphasize the importance of fixing the transect locations on the ground using wooden pegs or other long-term markers. Similarly, we did not clearly establish the importance of repeated surveys being undertaken or overseen by the same assessor.

Despite these weaknesses in the survey procedure and practice, most surveys provided a useful assessment of the condition of trees on the sites and the combined assessments of the twenty-four sites over five years provides a clear picture of a general improvement in the condition of the wandoo tree crowns across the survey sites. The negative impact of most of these weaknesses would have been greatly reduced if this had been a period of even moderate crown decline.

The monitoring project

The adoption and acceptance of the survey technique by community volunteers with a range of backgrounds and experiences, in addition to its use by environmental practitioners, points to the efficiency and effectiveness of the method. We gratefully acknowledge the goodwill and enthusiasm shown by all our volunteers and their patient attention to the task of collecting and recording the survey results. Beyond the direct task of collecting this data the monitoring days spent in wandoo stands across the southwest provided many benefits. Valuable skills in survey setup, observation and recording, have been passed on to TAFE students and volunteers. These days have also been opportunities to exchange personal knowledge of the local environment which has assisted us in interpreting observations. The networks fostered through this process are particularly valuable when dealing with a tree species and with communities dispersed across the expanse of southwest WA. Our network of volunteers are valuable environment ambassadors within their communities. This project has helped build a working relationship of trust, respect and friendship which has greatly contributed to the success of this monitoring over the past five years.

Conclusions

- The primary aim of this project was to provide a structured assessment of the condition of wandoo crowns on sites across wandoo's distribution. This structured assessment was seen as providing a more objective picture of the sites than may be provided by casual visual inspection. We aimed to quantify the condition of the sites and the progress of wandoo decline to the extent possible with this assessment method.
- This extensive monitoring program achieved a total of 329 transect surveys covering twenty-four sites over five years. These monitoring sites are spread across the range of

wandoo. Many people have contributed to this monitoring program and hopefully gained from this experience.

- The initial condition of the twenty-four sites that we surveyed varied widely. Some sites, such as Twelve Mile Reserve and Foxes Lair, had a large number of trees in relatively poor condition, while other sites such as Goldmine Hill and South Bokal showed few signs of crown decline.
- Over the five years of monitoring there has been very little flagging of leaves on our sites. Both the number of trees flagging and the proportion of leaves that were flagging in the tree crowns have been low on all sites. Over this period 79% of the trees had no flagging. Of the 21% of trees that were flagging, 92% had very low levels of flagging; i.e. flagging in less than 20% of the tree crown. The low levels of flagging, both in extent and intensity, indicate that the decline agents have not been particularly active on these sites over this period of monitoring.
- There does not appear to be any relationship between the initial condition of the site and the subsequent progression of recovery or decline at the site. This period of monitoring, with little or no decline, was less than ideal for considering this relationship. It may be that consistent trends between initial condition and subsequent recovery or decline would be clearer over periods of more intense flagging and crown decline.
- Our surveys do not show a consistent relationship between the amount of flagging and the progressive decline or recovery of the sites. Again, such a relationship would be more clearly demonstrated over a period and across a set of sites where flagging ranged more widely from no flagging through to very high levels of flagging. Very few trees on any site we monitored had more than 20% of leaves flagging; consequently, most sites improved, if only slightly, over the period of this monitoring and we were unable to identify any consistent relationship between the amount of flagging and the progressive decline or recovery of the sites.
- The low numbers of trees flagging and the small proportion of flagging leaves in the crowns of these trees is consistent with the overall trend in crown condition that we observed.
- Over the period of this monitoring the condition of most tree crowns on most sites improved.

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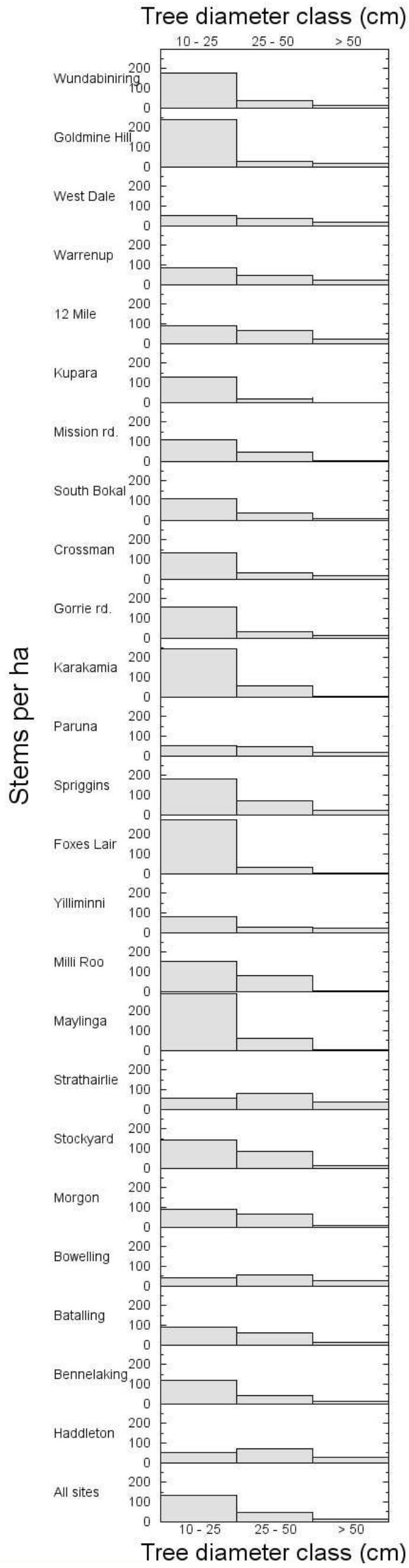

Figure 3. The number of stems per hectare at each site in the three diameter classes.

Table 2. Summary of wandoo crown decline survey results from 24 sites over five years. The surveys were based on the method described in WRG (2005). Colours indicate the relative amounts of flagging in the tree crowns in 2010 (green = good, the trees should improve; yellow = fair, the trees should not decline) based on the intensity and extent of flagging in the tree crowns on the site in 2010.

Site Name	Flagging summary 2006	Flagging summary 2007	Flagging summary 2008	Flagging summary 2009	Flagging summary 2010	Crown Decline Stage 2010	Changes at the site over the period of monitoring	Number of transects 2010	Trees per ha 2010	Five year trend in crown condition
Paruna Sanctuary	Extensive flagging on most trees	Extensive flagging on most trees	Extensive flagging on most trees	Not surveyed	Trivial flagging	Early decline	Surveyed since 2006 but missed in 2009. Flagging was substantially overestimated in previous years and the assessment of crown decline stage has been excessive. The tree crowns are in reasonable condition. Minor flagging on a few trees. Early decline.	3	110	Trend unclear
Spriggins Coup	Not surveyed	Not surveyed	Not surveyed	Minor or moderate flagging on a few trees	Trivial flagging	Early decline	First surveyed in 2009. The two years of surveys show no change in the condition of the tree crowns.	2	273	Only monitored for two years
Gorrie Road	Trivial flagging	Trivial flagging	Trivial flagging	No flagging	Trivial flagging	Early decline	The location of transects changed in 2007, a new transect was added in 2008 and transect length and the number of trees has varied. Flagging has been low to absent over all years with a slight increase in 2010. Crowns appear to have improved each year since 2007 consistent with this trivial flagging observed over all years. Early decline with trivial flagging.	7	202	Improved
Maylinga	Trivial flagging	Trivial, with isolated extensive flagging	Trivial, with isolated moderate flagging	Trivial flagging	Trivial flagging with isolated moderate flagging	Early decline	The number of transects and number of trees surveyed has varied since 2006. Crown scorch in 2007 obscures the progression of any decline. Flagging has been consistently low on this site and remains low this year. The conditions of the crowns possibly improved slightly over the five years of monitoring. The 2007 and 2009 assessments of the crown decline stage were excessive.	2	353	Probably improved
Wundabiniring Brook	Not surveyed	Trivial flagging	Trivial flagging	Minor or moderate flagging on some trees	Minor or moderate flagging on some trees	Early to intermediate decline	Surveyed since 2007. Some variation in the number of transects and trees. Early to intermediate decline. Some moderate flagging on a few trees, but mostly flagging is minor. The tree crowns on this site have improved slightly over the four years of monitoring.	7	314	Improved
Twelve Mile Reserve	Not surveyed	Not surveyed	Minor flagging on some trees	Trivial flagging	Trivial flagging	Advanced decline	First surveyed in 2008, the number of transects has remained constant. Flagging has changed little and remained low over all years. This site is in advanced decline; the tree crowns are in relatively poor condition. Despite the low levels of flagging, over the three years of monitoring the condition of the tree crowns has declined slightly.	2	178	Worsened
Karakamia Sanctuary	Extensive flagging on some trees	Minor to extensive on most trees	Minor to extensive on most trees	Not surveyed	Trivial flagging	Early decline	Surveyed since 2006 but missed in 2009. Flagging has been substantially overestimated in previous years and the assessment of crown decline stage has been excessive. The tree crowns are in reasonable condition. Minor flagging on some trees. Early decline.	1	305	Trend unclear
Stockyard	Not surveyed	Not surveyed	Minor or moderate on half the trees.	Minor or moderate flagging on more than half the trees.	Trivial flagging with isolated moderate flagging	Early decline	Surveyed since 2008. Flagging is greatly reduced on this site from the previous years when the flagging assessment was probably excessive. Early decline. The condition of the tree crowns on this site has changed little but may have improved since the first assessment in 2008.	3	143	Possibly improved slightly
Goldmine Hill	Not surveyed	No flagging	No flagging	Minor flagging on one third of the trees	Trivial flagging	Early decline	Surveyed since 2007. Some variation in the number of transects and transect length. Flagging is low and reduced from 2010, when the assessment of flagging was excessive. The assessment of crown decline stage was also excessive in 2010. This site shows little or no evidence of crown decline and over the years of monitoring the site has changed little.	6	310	Little or no change
Strathairlie Pastoral Lease	Minor flagging on some trees	Minor flagging on some trees	Minor flagging on some trees	Trivial flagging	Trivial flagging	Early decline	The same transects and trees have been consistently monitored each year since 2006. As in previous years flagging remains low in 2010. Although the surveys do not show any great change in condition of the crowns since 2006, the consistently low levels of flagging observed since 2006 indicate the condition of the tree crowns may be slowly improving.	2	166	Little or no change
West Dale	Minor flagging on some trees	Minor to extensive flagging on some trees	Minor flagging on some trees	Minor flagging on some trees	Minor flagging on some trees	Early to intermediate decline	The same transects have been consistently monitored since 2006. Flagging has been minor since 2006 and remains at low levels. The site has advanced crown decline but the condition of the tree crowns has gradually improved over the five years of monitoring.	4	105	Slightly improved
Crossman Reserve	Minor flagging on some trees	Not surveyed	Minor flagging on some trees	Minor flagging on some trees	Minor flagging on some trees	Early to intermediate decline	Surveyed since 2006 but missed in 2007. The number of transects and locations changed in 2008. Flagging has remained consistently low over the five years of monitoring. The condition of crowns on this site has improved slightly over the five years of monitoring.	5	181	Some slight improvement
Bowelling	Not surveyed	Not surveyed	Not surveyed	Minor flagging on some trees	Minor flagging on some trees, isolated extensive flagging	Early to intermediate decline	First surveyed in 2009. The number of transects increased in 2010. A single tree on this site has extensive flagging but flagging remains low or is absent on all other trees. The condition of the tree crowns on this site has possibly improved slightly since last year, consistent with the low flagging levels.	3	125	Slightly improved. Only monitored for two years

Table 2. continued from previous page.

Site Name	Flagging summary 2006	Flagging summary 2007	Flagging summary 2008	Flagging summary 2009	Flagging summary 2010	Crown Decline Stage 2010	Changes at the site over the period of monitoring	Number of transects 2010	Trees per ha 2010	Five year trend in crown condition
South Bokal	Minor flagging on some trees	Trivial flagging	Minor flagging on some trees	Minor flagging on some trees	Minor flagging on some trees	Early decline	The number of transects increased in 2010. Flagging has remained consistently low over the five years of monitoring. Last years assessment of the crown decline stage appears excessive. Considering the full five years of monitoring the condition of the tree crowns on this site has improved slightly.	3	92	Slightly improved
Mission Road	Minor flagging on some trees	No flagging	Minor flagging on some trees	Minor flagging on one third of the trees	Minor flagging on some trees	Early decline	The number of transects and trees has varied since 2006. Flagging has declined slightly on this site since last year. The crown decline assessment in 2008 was anomalous. The condition of the tree crowns on this site has changed little in the five years of monitoring but may have declined slightly.	2	158	Little or no change
Milli Roo Property	Trivial flagging	Not surveyed	Trivial flagging	Minor flagging on some trees	Minor flagging on some trees	Early decline	Surveyed since 2006 but not in 2007. Flagging has been trivial but increased slightly with minor flagging on one fifth of the trees over the last two years. The condition of the tree crowns on this site has improved slightly over the five years of monitoring.	4	243	Slightly improved
Yilliminning Reserve	Extensive flagging on some trees	Minor flagging on some trees	Minor flagging on half the trees	Minor flagging on some trees	Minor flagging on some trees, isolated moderate flagging	Early to intermediate decline	The number of transects has remained constant since 2006. Flagging rose in 2008 but has generally declined over the five years of monitoring. The condition of trees crowns on this site has improved slightly over the five years of monitoring.	4	133	Improved
Batalling	Not surveyed	Trivial flagging	Minor or moderate on most trees	Minor or moderate on most trees	Minor flagging on some trees, isolated moderate and extensive flagging	Early to intermediate decline	Surveyed since 2007. Some variation in the number of trees in 2008. Flagging increased on this site in 2008 but has progressively declined since then. The condition of tree crowns on this site has improved slightly over the four years of monitoring.	4	160	Slightly improved
Warrenup Reserve	Not surveyed	Not surveyed	Minor or moderate on half the trees.	Minor flagging on some trees	Minor flagging on some trees, isolated moderate flagging	Early to intermediate decline	Surveyed since 2008. Flagging declined in 2009. The condition of the tree crowns has improved slightly over the three years of monitoring.	4	155	Some slight improvement
Morgan	Not surveyed	Not surveyed	Minor flagging on most trees	Minor flagging on most trees, some moderate flagging	Minor flagging on some trees, some moderate flagging	Early decline	Surveyed since 2008. The assessment in 2009 may be anomalous. Flagging has declined since 2009. The condition of the site has improved slightly over the three years of assessment.	3	162	Slightly improved
Haddelton	Not surveyed	Not surveyed	Not surveyed	Minor, moderate or extensive flagging on half of the trees.	Minor flagging on one third of the trees	Early decline	Site first assessed in 2009. Flagging has declined substantially since 2009. The condition of the tree crowns may have improved slightly since 2009.	3	143	Possibly improved slightly
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.	Minor or moderate flagging on one third of the trees.	Intermediate to advanced decline	Surveyed since 2006; missed in 2007, half transect only in 2008. Flagging has declined on this site since 2008. The surveys of the crown condition on this site have been variable over the years of monitoring. There has probably been little change in the crown condition over the period of assessment.	2	145	Unclear, little change
Foxes Lair Reserve	Minor flagging on most trees	Minor flagging on some trees	Minor flagging on one third of the trees	Trivial flagging	Minor moderate and extensive flagging on half of the trees	Intermediate to advanced decline	The number of transects and number of trees surveyed has varied since 2006. Flagging appears to have decreased from 2006 to 2009 and then increased in 2010. Overall the crown condition appears to have improved from 2006 to 2009, but may have declined slightly in 2010.	3	305	Improved
Bennelaking	Not surveyed	Extensive flagging on some trees	All trees have minor flagging	Minor flagging on most trees, some moderate flagging	Minor flagging on half the trees	Early decline	Surveyed since 2007. Flagging appears to have declined since 2008 and the condition of the tree crowns has probably improved since 2008.	3	172	Some slight improvement

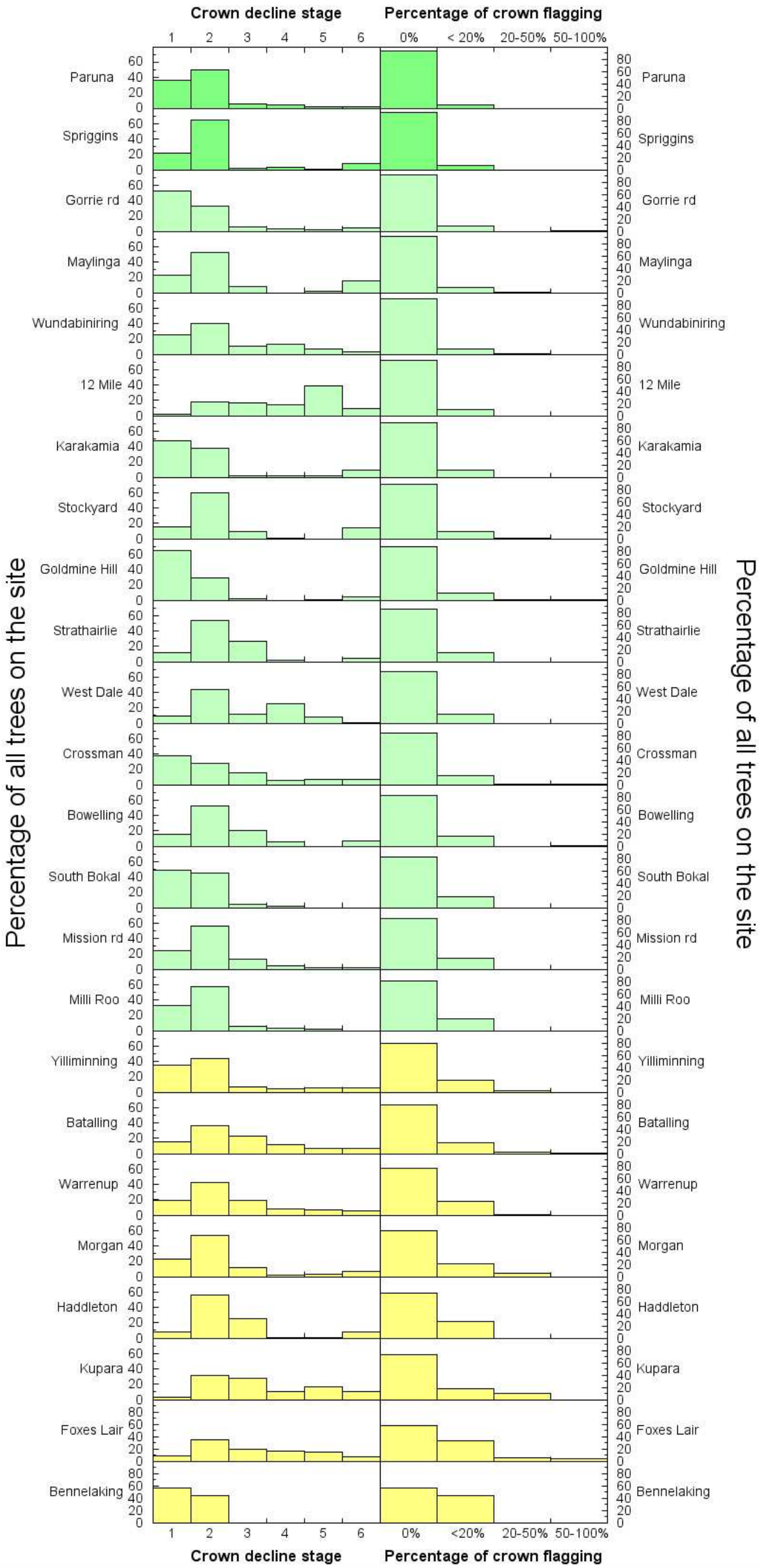

Figure 5. (Left hand side) The percentage of trees at each site assigned to the six crown decline stages. (Right hand side) The proportion of flagging leaves in the tree crown at the time of assessment. Classes are 0%; < 20%; 20%–50%; and 50%–100%. Colours indicate the relative outlook for the trees at each site based on the extent and intensity of flagging in 2010 (green = good, yellow = fair,).

Meet our volunteers

Above left: Students from Challenger Institute of Technology survey Goldmine Hill, at North Dandalup.
Above right: Swan TAFE students survey Wundabiniring Brook.

Above left: Staff from the DEC Collie office break for lunch between surveys at Bennelaking, Bowelling, Batalling, Morgan, Stockyard and Haddleton.

Above right: Great Southern TAFE students survey Warrenup Reserve near Kendenup.

Right: Surveying Crossman Reserve West, 2006.

Above left: Kim Whitford demonstrates the survey technique at Milli Roo near Chittering.
Above right: Chittering Landcare Centre staff help out with the surveys.

Above left: Elinor Craze shows Allan Wills her property "Maylinga".
Above right: Recording data at 12 Mile Reserve, near Kendenup.

Left: Surveying Spriggins Coup. Jodi Wildy (second left) and Julyan Sumner (centre) survey wandoo on their properties near Boyup Brook.

Above left: Allan Wills, Bernie Masters and Liz Manning at the Masters' South Bokal property.
Above right: Carolina Masters loves getting out in her wandoo bushland.
Right: Bernie and Carolina's South Bokal property.

Left: Challenger Institute of Technology student, Janice Ray assesses the condition of a wandoo tree at Goldmine Hill.