Health and status of eucalypts in the South-East of South Australia

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Introduction

This project aimed to provide baseline data and a distribution map of the health and reproductive condition of key eucalypts over an area of approximately 1500 km^2 near Keith and Tintinara in the South-East of South Australia. There were three reasons for developing these maps. First, there is an increasing concern that there is widespread loss of vigour and performance of at least *Eucalyptus fasciculosa* and *Eucalyptus arenacea* within the region to the point that these plants are no longer flowering regularly. This lack of, or greatly reduced, reproductive performance is shown in the records of beekeepers where *E. fasciculosa*, once a major honey producer in the South East, has produced negligible quantities of honey for the last decade (Paton *et al*. 2004). Second the poor condition (sparse canopies) of E. arenacea within this region and within Ngarkat Conservation Park suggests this species too is also declining at a regional scale; this decline has subsequent implications for threatened fauna like the Red-tailed Black Cockatoo. Third, two other factors that are increasingly impinging on the native vegetation (and eucalypt populations in particular) of the region are Mundulla Yellows and mistletoes. Much of the emphasis on tree decline particularly in the South East in the last few years has concentrated on Mundulla Yellows. This has tended to distract attention form other threats to remnant native vegetation that reduce the vigour and add to losses of scattered trees in the region. The purpose of this project, therefore, was to establish a detailed baseline of the current status of tree health in the region, something that has not been done since the early 1990s (Paton & Eldridge 1994) and to document the relative importance of Mundulla Yellows and mistletoes versus other factors associated with the loss of vigour in rural trees.

Methods

Study areas

Two broad areas were surveyed: a 30km x 30km area including Tintinara and Keith (5990000N > 6030000N, 410000E>450000E) and a 20km x 30km area to the east of this (6000000N > 6030000N, 450000E > 470000E). Two additional 10km x 10km areas adjacent to these areas were also included in the survey. Field work for this project was conducted between October 2003 and January 2004, although the majority of field work was conducted in December 2003.

Site selection

The study areas were divided into 10km x 10km squares and each 10km x 10km square that was sampled was divided into sixteen 2.5km x 2.5km squares. Each of these squares was then divided into twenty-five 500 m x 500 m sites. One of these sites was then chosen by randomly drawing a number from a hat. Chosen sites were then rejected if they were not near access roads and additional random numbers drawn until there was a site with road access (according to CFS maps). Some of these sites on inspection, however, were not accessed as private roads had been marked on the CFS maps. These inaccessible sites were not sampled. For each 500m x 500m site if there were numerous trees to sample then sampling always occurred from coordinates at the edge of the site so as to remove any bias in selecting trees for recording their condition. Wherever possible all of the trees sampled at one site were in one discrete management area i.e. in one paddock as management is often different in different paddocks (fences helped to define the areas being sampled and will aid relocation of trees for future sampling). Within each 10km x 10km area we tried to sample each of the main trees in each of three situations: paddock, roadside and remnant. At any one sampling site we only measured trees in one situation. Since trees along roadsides and in remnants appeared less often one of these two situations was chosen for sampling at the first encounter(s) within each 10 km x 10 km block. At a few sites both roadside and paddock trees were sampled. The purpose of this random stratified sampling procedure was to avoid any bias when selecting sites to sample, and so provide a representative measure of the condition of trees across the region.

Health and vigour of trees

The methods used for scoring the size, condition and reproductive activity of individual trees was similar to and compatible with the current point scoring system used for scattered trees by the Native Vegetation Branch (Cutten & Hodder 1992). Wherever possible we accessed each tree on foot and recorded a full set of data. However some of the individual trees at selected sites could not be accessed on foot (associated with type of crop and difficulty in locating the owner of the land to secure permission to access the trees) and these trees were examined with binoculars and as much the information that could be collected ‘remotely’ collected. As a consequence not every tree had every feature scored. Given that we could not access every tree we recorded the GPS co-ordinates of the trees that marked the boundary of the trees that were scored to define the areas that were sampled.

For each tree that we scored we measured or estimated the size by recording the DBH of each trunk, alive or dead to within 5cm accuracy, and or estimated the heights of the trees to within an accuracy of 1m. The percent canopy that was intact was estimated following the methods of Cutten & Hodder (2002) and including epicormic growth but excluding mistletoe foliage. We also estimated the percentage of the foliage of the canopy (including mistletoes) that was made up of recent epicormic growth (within the last year) and (separately) the percentage made up by mistletoe foliage. There were many trees with large epicormically originating branches with branch diameters from 3-20cm indicating that these trees had major stresses in the past. Although we recorded the percent foliage comprised of old epicormic growth only recent epicormic growth was used as a measure of recent signs of stress.

The extent to which trees were able to reproduce was scored qualitatively with reproductive output (including buds, fruit and flowers) being scored as Negligible, Slight, Moderate or Heavy. Negligible was recorded if no reproductive output could be detected in 10 sec of close examination of the canopy, aided by binoculars when possible. Slight was recorded if evidence of reproduction was detected but only small numbers of buds, flowers or fruit (roughly equivalent to <10 reproductive units/100 leaves) were visible. Moderate was used if reproduction was more easily noticed and the numbers of reproductive units was estimated to fall between 10 and 100 units per 100 leaves. Heavy reproductive activity was used when buds, flowers and fruits were obvious and widespread across the canopy (and was assigned to trees with 100 to 1,000 reproductive units/100 leaves).

For each tree we also recorded any signs of yellowing of the foliage, particularly interveinal chlorosis. Where interveinal chlorosis was observed the tree was recordied as having the symptoms of Mundulla Yellows. In addition we noted the abundance of lerp on the foliage and recorded lerp infestations as Negligible (none detected after 10 seconds of searching the foliage), Slight (lerps detected on a few leaves (<10%) and relatively few lerps per leaf), Moderate where the lerp infestation was conspicuous on up to half of the canopy, and Heavy where greater than 50% of the leaves were affected and often discoloured by lerps. Damage to the trunks of trees due to borers and or stock rubbing were also noted on a similar four-point scale, based on the percentage of the trunk affected and or density of holes caused by borers. Additional details on the sizes of any exit holes, extent and type of stock damage – rubbing or chewing were also noted for each tree that was examined closely.

Results and Discussion

Tree condition

Data on the condition of trees were collected from seventeen 10km x 10km cells within the Keith to Tintinara area (e.g. Figure 1). The overall condition of the trees across the study area was poor with typically more than half of all the trees scored in each cell having less than 60% of their canopies intact (i.e. at least 40% canopy dieback; Figure 1). In general there was little geographic variation in the condition of eucalypts across the study area (all species combined) with all areas exhibiting relatively high levels of dieback. This broad survey suggests that dieback is widespread within the region and not restricted in distribution and the widespread extent of this dieback is of concern.

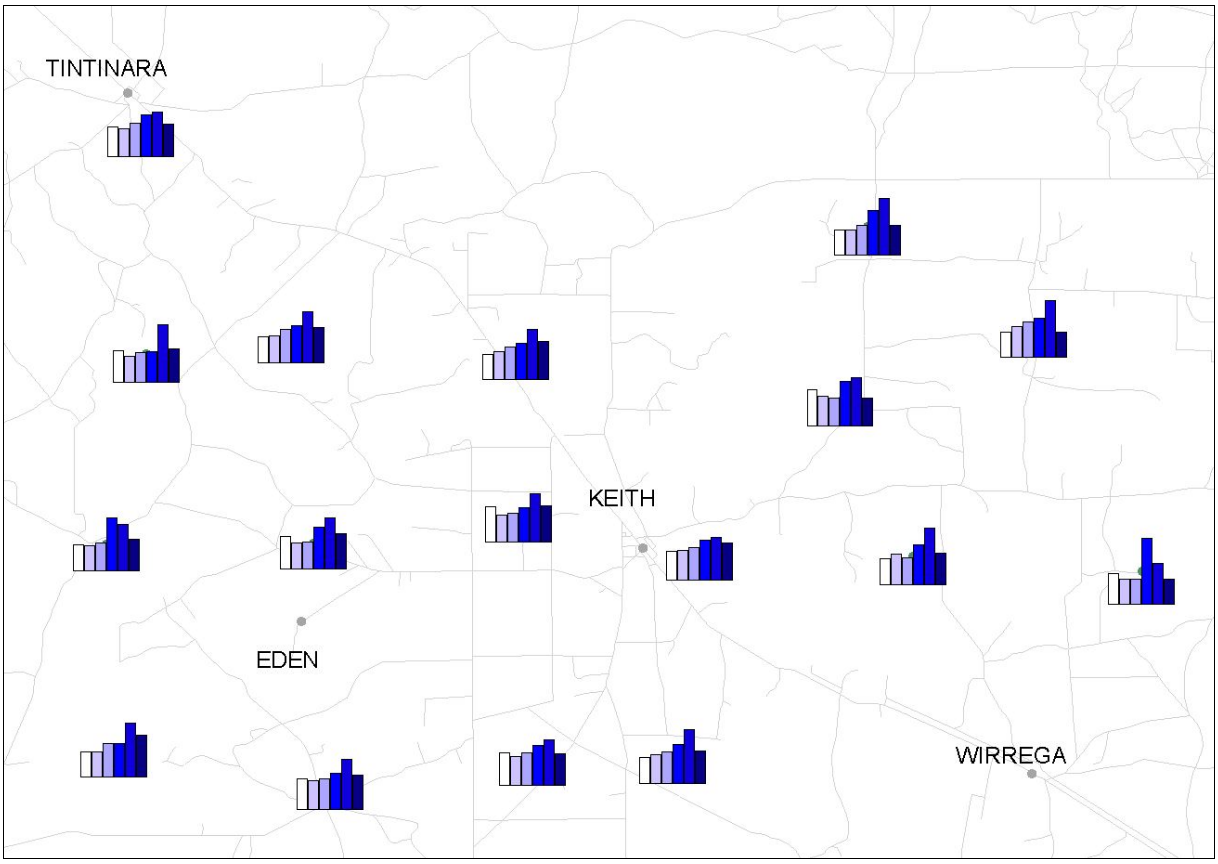


Figure 1. Levels of canopy cover for samples of trees in each of seventeen 10 km x 10 km areas in the Keith – Tintinara area of South Australia in December 2003. In each histogram % canopy cover is arranged from white = 0% (dead) to 100% to dark blue = 81- 100% canopy cover (moderately healthy trees). Intermediate shades represent 1-20, 21-40, 41-60 and 61-80% canopy cover respectively. Each set of data shows the relative proportion of trees (all species combined) in each category with the histograms centred on the averaged GPS locations of the trees sampled in each area (rather than the centre of each 10km x 10 km cell)

Reproductive activity of rural eucalypts

Figure 2 shows the extent to which rural eucalypts were reproducing across the study area and illustrates that high proportion (over 50%) of the trees scored showed negligible to slight levels of reproductive activity, consistent with the general poor health of many of the trees

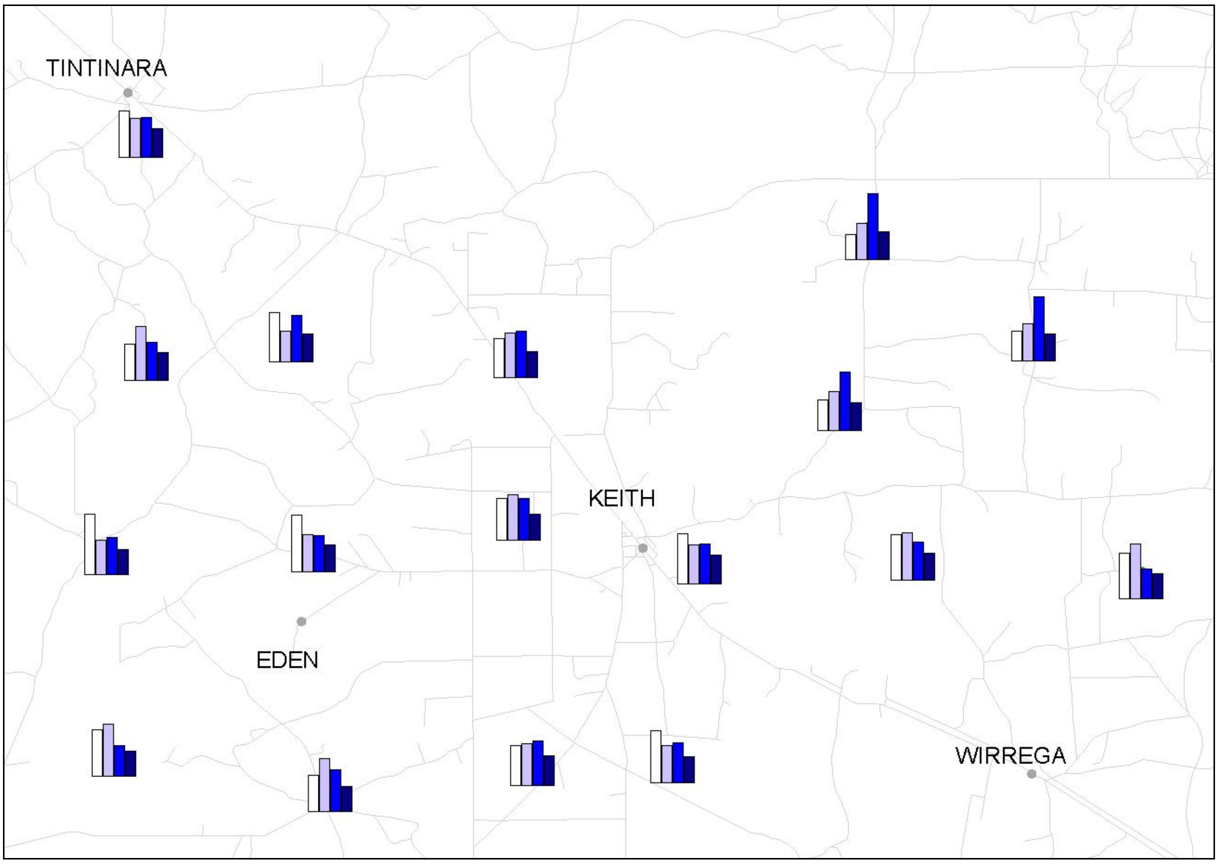


Figure 2. Relative proportion of trees (all species combined) showing varying levels of reproductive activity across the study area where white indicates negligible activity and progressive darker bars slight, moderate and heavy reproductive activity respectively.

Patterns of tree health and reproductive activity for individual species in different settings

Figures 3 – 7 summarize the condition, reproductive activity and size distributions for trees sampled in remnants, along roadsides or in paddocks for each of five species of eucalypts (*E. arenacea, E. fasciculosa, E. incrassata, E. leucoxylon* and *E. porosa*) where the data exist. These figures re-inforce those given for the region as a whole (Figures 1, 2) and indicate that even in areas of remnant vegetation many trees are doing poorly for each of these species. In general a higher proportion of trees in paddocks than roadsides and remnants are doing poorly (lower canopy cover, lower reproductive activity) but even along roadsides and in intact vegetation substantial numbers of trees are in poor condition. This contrasts with surveys conducted in parts of this region in 1992-93 where almost all trees in remnant vegetation at least were in good health (canopy cover of >80%; Paton & Eldridge 1994; Paton *et al*. 1999). Given the general poor condition of trees, the trend for average tree condition to deteriorate even in remnant vegetation and broadly over the last decade, the prognosis for sustaining these trees in this rural landscape is poor unless some concerted efforts and strategies for recovery of these tree populations are developed and implemented at a regional scale.

Although in recent years, much emphasis has been placed on Mundulla Yellows (MY) in the deterioration of trees in the South East, MY is almost confined to roadside trees (Paton & Eldridge 1994, Paton & Cutten 2000; Paton *et al.* 1999) and is not implicated in the loss of condition for most of the trees that we surveyed. Table 1 shows the proportion of trees with various ailments (lerp, MY, borers, leaf damage, mistletoes). Most of these ailments were present on most species although lerp infestations were only prominent for pink gums (*E. fasciculosa*). The wide variety of symptoms expressed by the trees suggests that these ailments were more likely to be symptoms rather than underlying ultimate causes of rural tree decline.

Species	**Mundulla Yellow**	**Lerp**	**Borers**	**Leaf Damage**	**Mistletoe**	**n**
E. arenacea	8.1	0	19.1	1.2	6.9	246
E. camaldulensis	0	4.4	26.1	0	8.7	23
E. fasciculosa	3.1	40.5	23.9	4.2	9.5	738
E. incrassata	3.9	0	3.9	5.8	0	52
E. leucoxylon	8.7	2.1	39.8	6.6	3.4	472
E. porosa	2.6	1.8	20.2	0	8.8	114

Table 1. Percentage of trees with various ailments in the Keith-Tintinara area in December 2003, for species of eucalyts with at least 20 trees measured. Only trees with slight, moderate, or heavy damage were scored as has having that ailment. Note that at the time of assessing these trees (December 2004) most Pink Gums had recently replaced old foliage with new foliage and the percentage of pink gums affected by lerps may be underestimated because the ability to assess lerp infestations is reduced when trees have just produced new foliage.

Figure 3. ***E. fasciculosa***

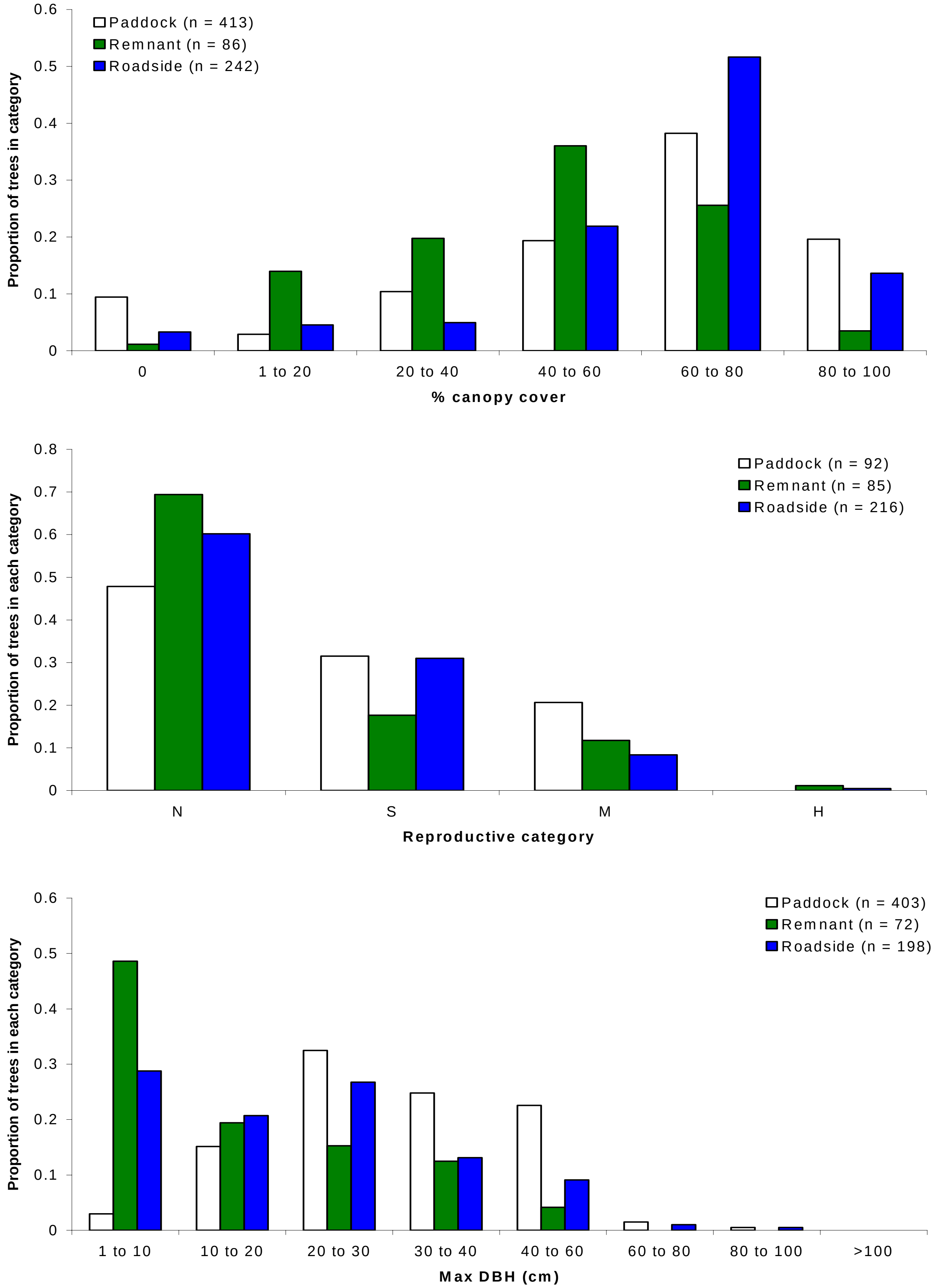
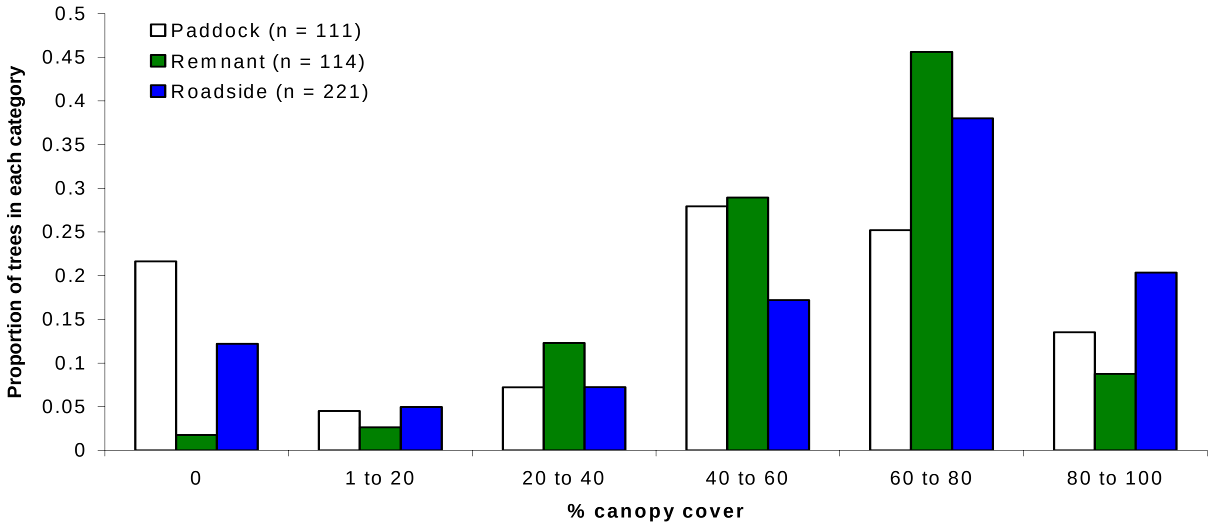
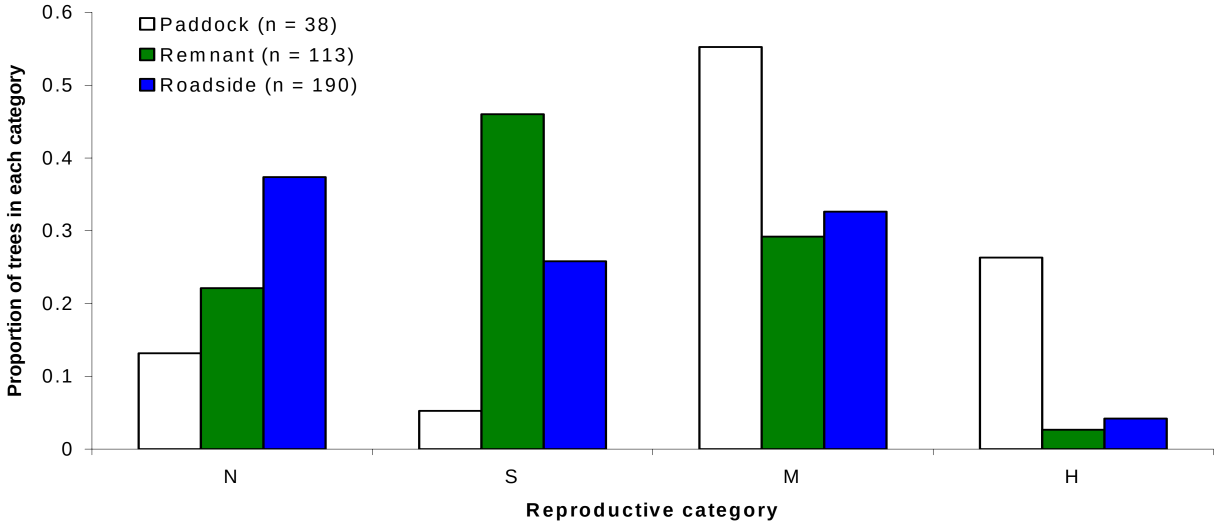


Figure 4. ***E. leucoxylon***





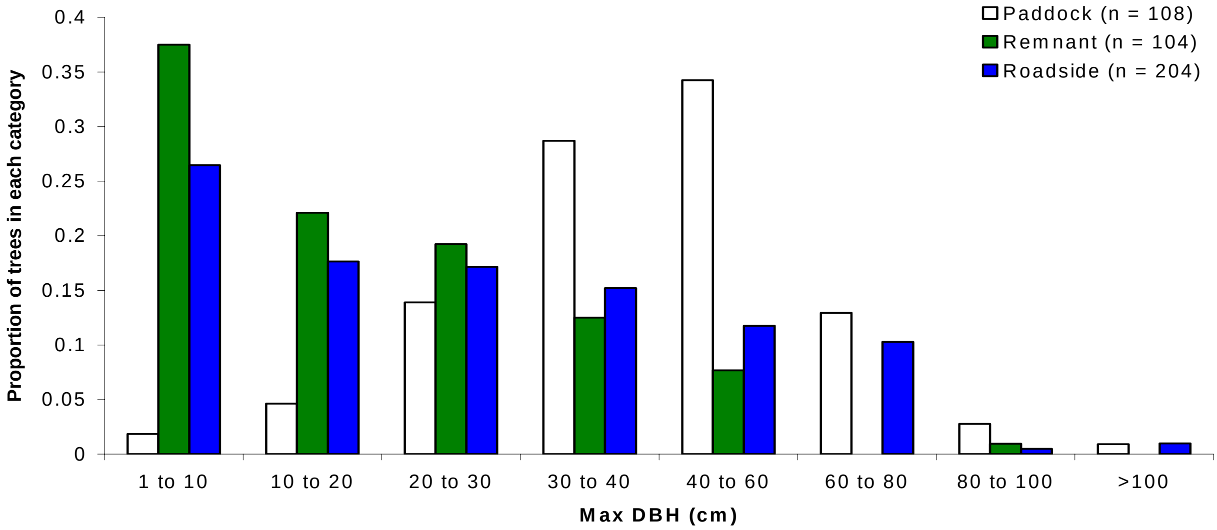
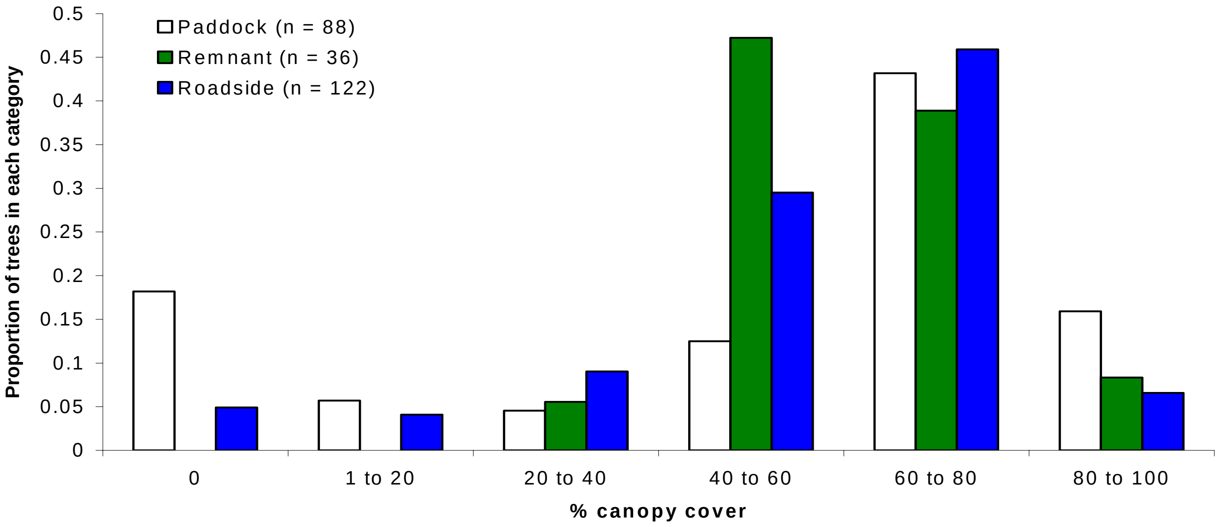
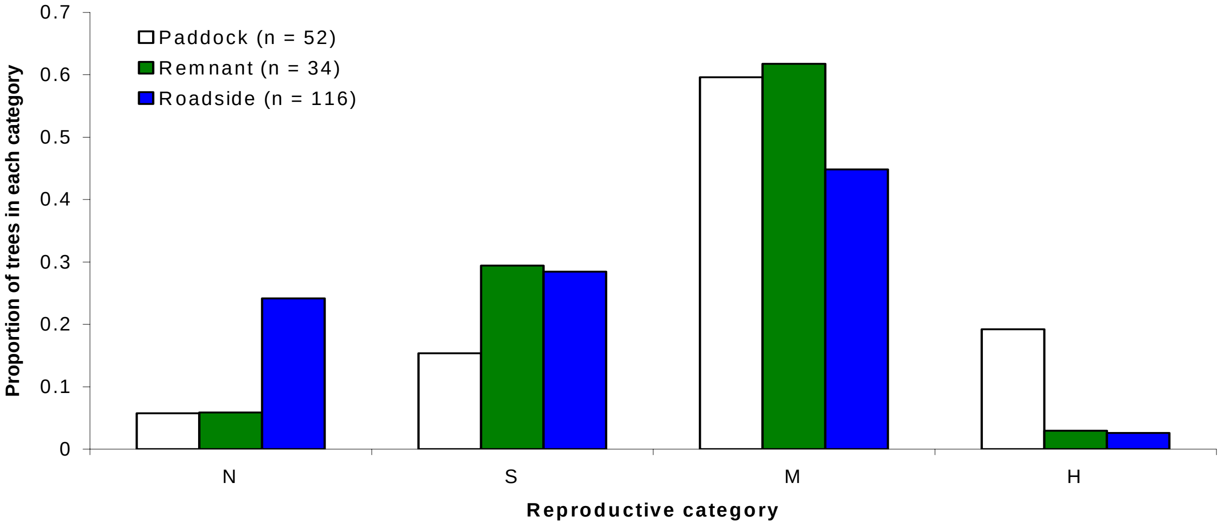


Figure 5. *E. aranacea*





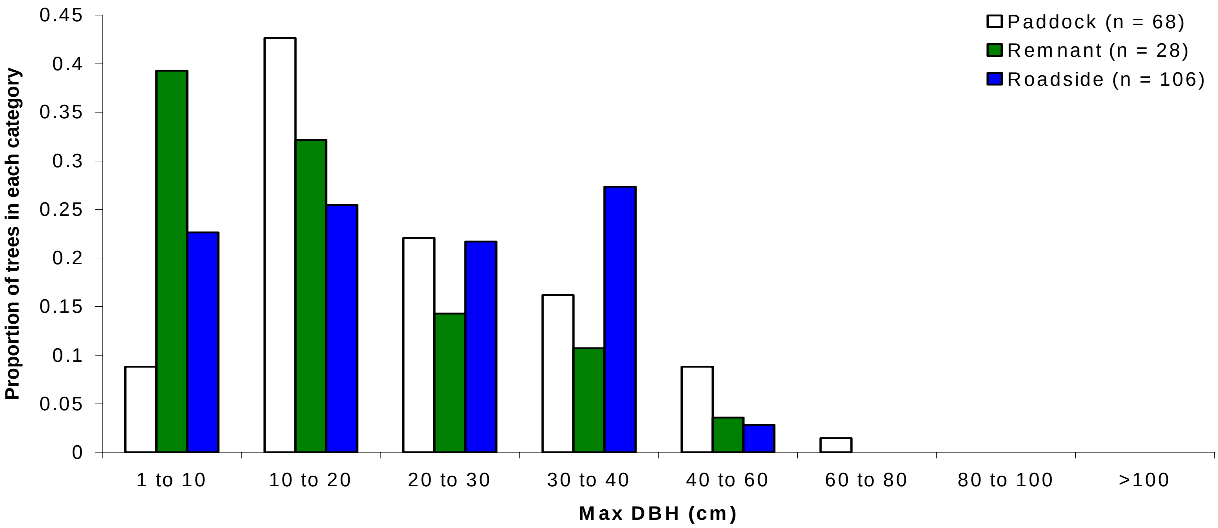


Figure 6. ***E. porosa***

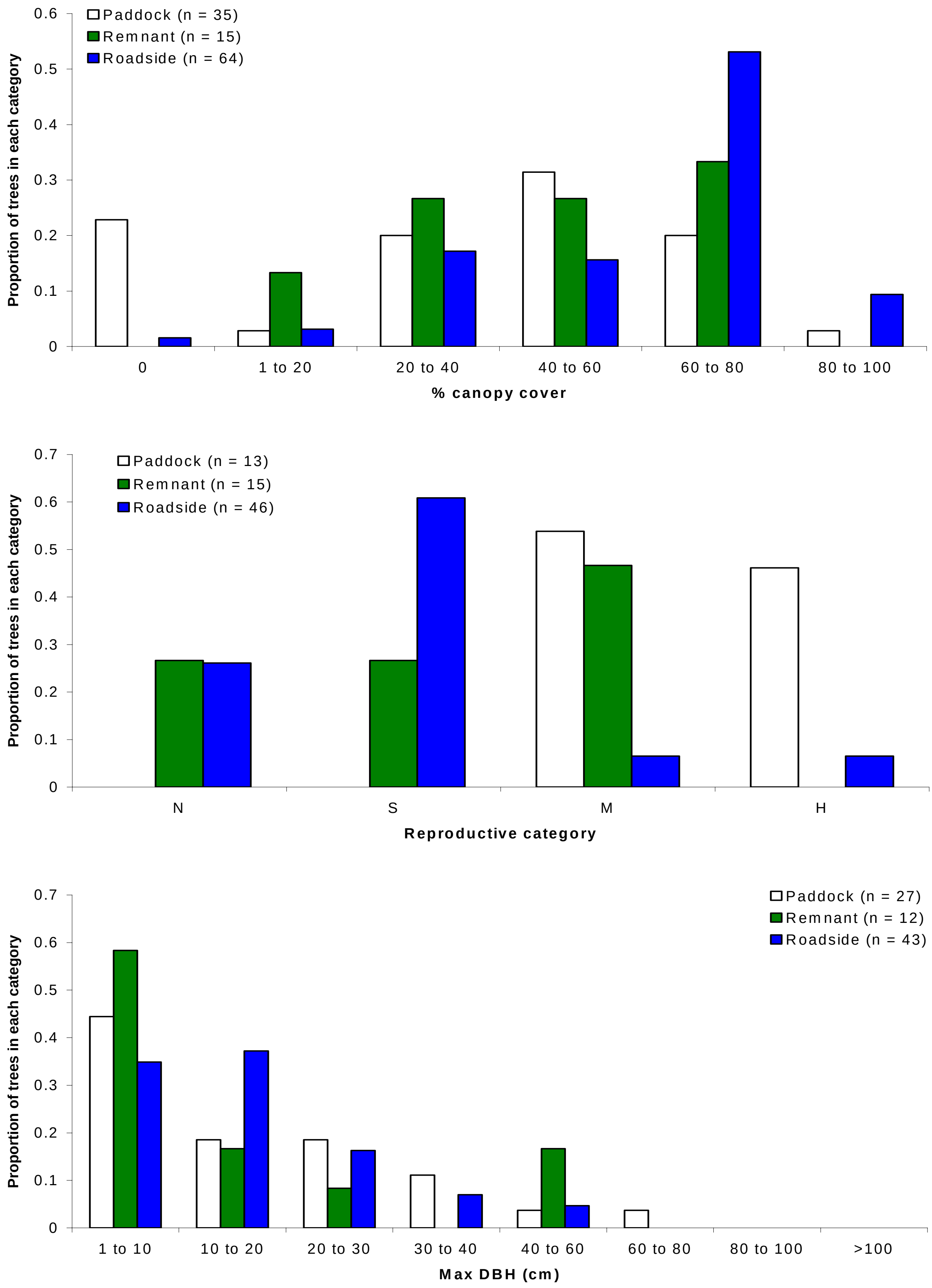
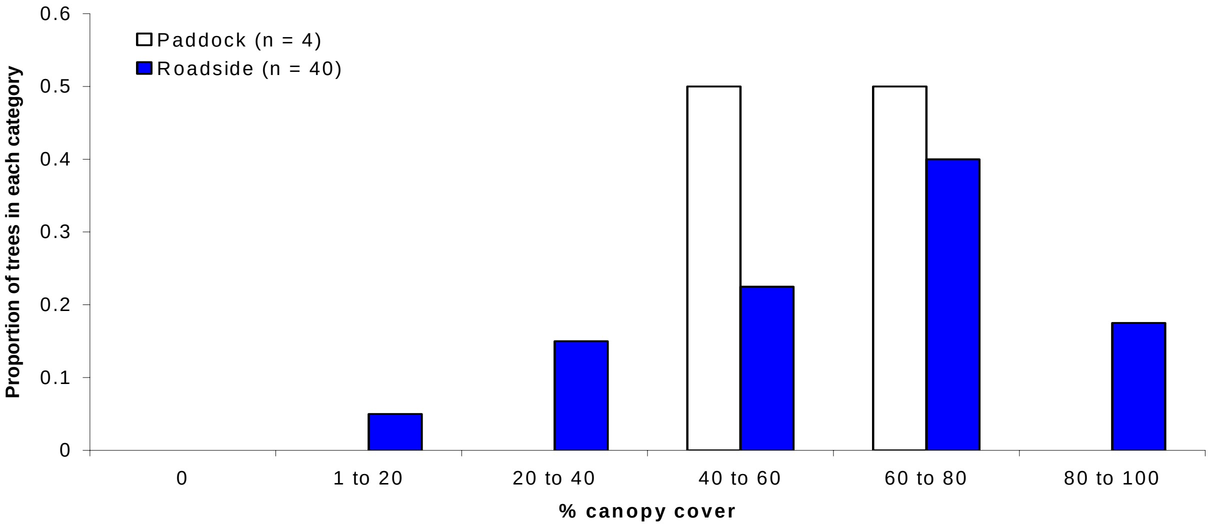
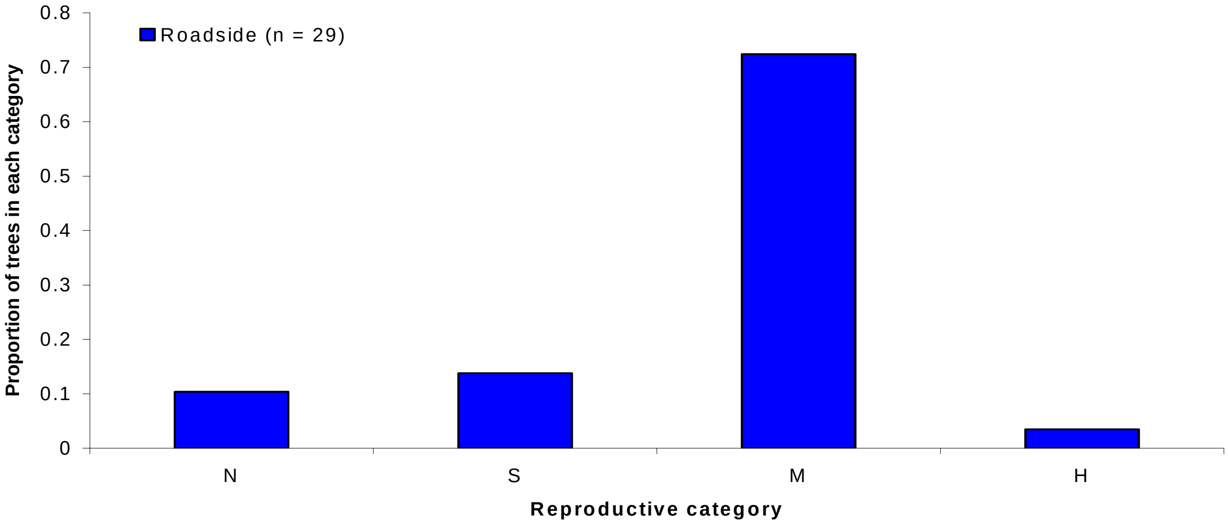
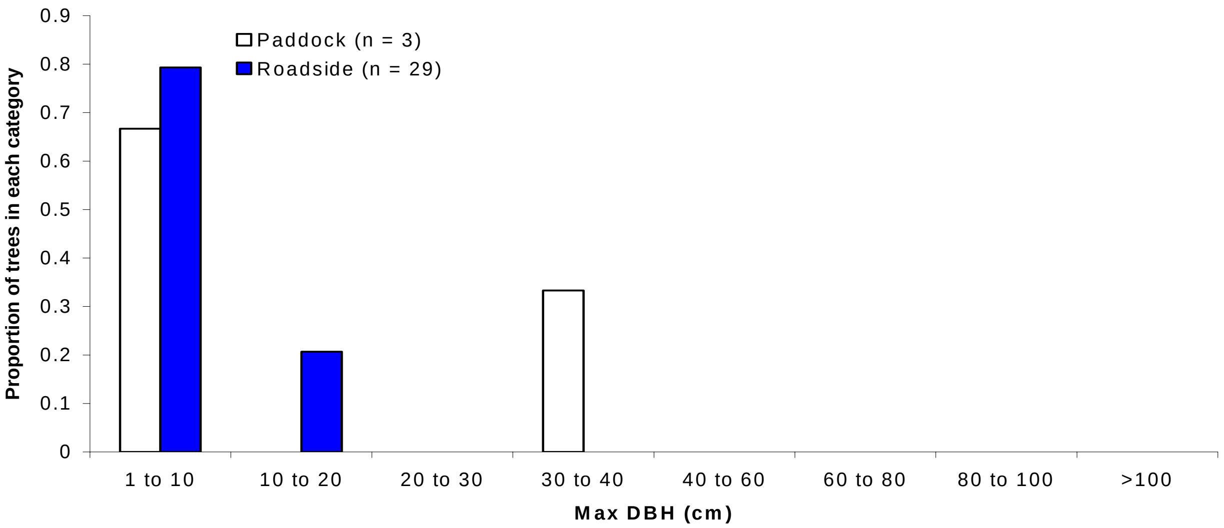


Figure 7. ***E. incrassata***







Similarly, most of these ailments were expressed by comparable numbers of trees in each of the settings, except that Mundulla Yellows was not detected in remnant vegetation, consistent with other surveys (Table 2). There was also a tendency for more trees in remnant vegetation to carry mistletoes (Table 2). Relative to surveys conducted in 1993, the proportion of trees with trunk borers has increased from 11 to 24% in paddock trees, and from 0 to 18% and 0 to 21% percent for trees in remnants and along roadways, respectively (Table 2), consistent with an increase in the numbers of trees that were stressed over the last 10 years.

Situation	Mundulla Yellows	Lerp	Borers	Leaf Damage	Mistletoe	n
Paddock	2.3	17.2	23.8	0.8	6.8	652
Remnant	0	17.7	30.3	7.2	17.7	277
Roadside	10.6	20.5	27.3	6.7	3.1	748

Table 2. Percentage of trees located in different environments with different ailments. Only trees with slight, moderate, or heavy damage were scored as has having that ailment.

Conclusion

The primary purpose of this study was to establish some rigorous baseline data from which changes in the condition, reproductive activity, demography and population structure (size distributions) of key eucalypts in agricultural regions can be documented. Our baseline assessments indicate further deterioration in the condition of rural trees that exist in the Keith-Tintinara area since a similar survey in 1993, and that MY symptoms and mistletoe infestations are not ubiquitous across the region with the trees suffering from a range of ailments that typically inflict stressed trees (e.g. trunk borers). The poor condition of these trees, and the likely prognosis that tree condition and reproductive activity will continue to deteriorate in this region and broadly across rural landscapes has significant implications for the maintenance of biodiversity and for a range of ecological processes (e.g. addressing rising water tables) and hence agricultural productivity. There is an urgent need to understand the underlying causes of this deterioration in the condition of trees at the regional scale and to implement remedial works rather than focusing on just one or two high profile symptoms.

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