

Gunbower Forest

TLM Stand Condition Assessments 2017

Prepared for the North Central Catchment Management Authority

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Fire, Flood and Flora
Cape Woolamai Victoria

This report may be cited as: Bennetts K and Jolly K (2017) Gunbower Forest TLM Stand Condition Assessments 2017. Unpublished report for the North Central Catchment Management Authority, *Fire, Flood and Flora*, Cape Woolamai, Victoria.

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Document Information:

Draft Report: March 2017

Report Reviewed by: Gen Smith (North Central Catchment Management Authority)

Final Report: June 2017

Please note: the primary output of this project is the stand condition dataset (Microsoft Excel format)

Acknowledgements:

The authors extend their gratitude to the following people for their support throughout the duration of the project: Genevieve Smith and Kathryn Stanislawski (North Central Catchment Management Authority). Additionally, they thank Marita McGuirk and Sharni Hamilton for assisting with field work.

Cover photograph: Hemispherical photograph from Gunbower Forest Stand Condition Site S112-GRF, March 2017

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This project was funded by The Living Murray initiative of the Murray-Darling Basin Authority. The Living Murray is a joint initiative funded by the New South Wales, Victorian, South Australian, Australian Capital Territory and Commonwealth governments, coordinated by the Murray–Darling Basin Authority.

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CONTENTS

LIST OF FIGURES	2
LIST OF TABLES	2
1.0 INTRODUCTION	3
1.1 Project Context	3
1.2 Study Area	3
2.0 METHODOLOGY	3
2.1 Field Survey	3
2.1.1 Stand Condition Assessment.....	4
2.2 Data Analysis	5
2.2.1 Calculations to inform stand condition model	5
2.3 Limitations	5
3.0 RESULTS.....	6
3.1 Stand Condition Assessment	6
3.1.1 Plant Area Index.....	6
3.1.2 Crown Extent	6
3.1.3 Live Basal Area.....	7
3.1.4 Site Contextual Information	7
4.0 KEY FINDINGS	9
5.0 REFERENCES	10
APPENDIX 1 Summary of TLM stand condition sites surveyed Gunbower Forest autumn 2017	11
APPENDIX 2 Summary of stand condition attributes by site for TLM Stand Condition Sites sampled in Gunbower Forest, 2010 - 2017	12

LIST OF FIGURES

Figure 1 Stand Condition Variables for TLM Stand Sites sampled in Gunbower Forest, 2017	8
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LIST OF TABLES

Table 1 Attributes and variables assessed to inform the TLM Stand Condition Model	4
Table 2 Category scale for reporting crown extent (source: Cunningham, 2016).....	4
Table 3 Mean Crown Extent by vegetation type for TLM Stand Condition Sites sampled in Gunbower Forest, 2010 – 2017. The values displayed are the average for all sites within each vegetation type. Crown Extent at each site is derived from the 30 permanently marked trees.	6
Table 4 Mean percentage Live Basal Area by vegetation type for TLM Stand Condition Sites sampled in Gunbower Forest, 2010 – 2017. The values displayed are the average for all sites within each vegetation type.	7
Table 5 Summary of key finding from TLM Stand Condition assessment in Gunbower Forest sampled 2010 - 2017 ...	9

1.0 INTRODUCTION

1.1 Project Context

Fire, Flood and Flora was engaged by the North Central Catchment Management Authority (North Central CMA) to collect data on the condition of River Red Gum and Black Box stands in Gunbower Forest, Victoria, in 2017 as part of Murray Darling Basin Authority's (MDBA) *The Living Murray* (TLM) program.

Stand condition assessments are undertaken at the five terrestrial Murray River Icon Sites, including Gunbower-Koondrook-Perricoota (GKP), as part of the MDBA's Condition Monitoring Program. The assessments comprise of two principal components: field surveys; and the amalgamation of the field data with remotely sensed data to model the condition of the eucalypts across the entire Icon Site (Cunningham *et al.*, 2011; Souter *et al.*, 2012). The MDBA undertake the latter component (the modelling) using the data from the field surveys (see for example MDBA, 2015).

The 2017 Gunbower Forest field data is the primary output for the current project; the purpose of the following report is only to provide a brief synopsis of this data. The 2017 survey represents the seventh in the series, with baseline stand data collected by Monash University in 2009, and subsequent years of monitoring undertaken by FNSW (2010), Fire Flood and Flora (Bennetts and Jolly, 2012; Bennetts and Jolly, 2013; Bennetts and Jolly, 2014; Bennetts and Jolly, 2016), and the Murray Darling Freshwater Research Centre (2015).

1.2 Study Area

Gunbower Forest is a large (19,450 ha), narrow forest located on the River Murray floodplain between Koondrook and Torrumbarry. The forest is jointly managed by the Victorian Department of Land, Environment, Water and Planning, Parks Victoria and the North Central CMA.

Stand condition assessment sites are stratified to capture the diversity of forest and landscape types in the forest (Souter *et al.*, 2012). Landscape positions ranged from riverside to floodway channels, floodplain and gilgai. Forest types assessed include River Red Gum Forest, River Red Gum Woodland, and Black Box Woodland (see Appendix 1).

2.0 METHODOLOGY

2.1 Field Survey

A field survey of Gunbower Forest was undertaken by Kate Bennetts, Marita McGuirk and Sharni Hamilton, between 20th February and 9th March 2017. Stand data were collected at 25 established 50 x 50 m monitoring sites (Appendix 1), in accordance with the *Field protocol for assessing stand condition of river red gum, black box and coolabah populations across the Murray–Darling Basin* (Cunningham, 2016). Spatially referenced tree coordinates, collected in 2012, were used to relocate sample trees. Data were submitted using the Stand Condition Datasheet (4 Oct 2016) supplied by the MDBA.

Data from previous years (Bennetts and Jolly, 2012-2014 and 2016; Murray Darling Freshwater Research Centre 2015) were used to clarify anomalous records and to assess change in stand condition attributes over time. Notably, assessments prior to 2017 were made in accordance with *Ground-based survey methods for*

The Living Murray assessment of condition of river red gum and black box populations - For Implementation January 2012 (Souter *et al.*, 2012); and while a high proportion of the resulting data fields are congruent between the two methods, others have been omitted or added to the more recent version. As was necessary to maintain the integrity of the dataset, the authors' have elected to retain the 'prefix' field¹; thus, maintaining the unique identifier each tree was given at project inception.

2.1.1 Stand Condition Assessment

Three variables were assessed at each stand condition site ($n = 25$): diameter at breast height (DBH); live/dead status; and crown extent (Table 1). The DBH measurements and live/dead assessments were undertaken for all trees present within the 50 x 50 m plot with DBH >10 cm; whereas the assessment of crown extent was limited to the 30 permanently marked trees. A category scale was used to report the latter variable (Table 2). Where trees had a high number of stems with small diameters, assessors captured a minimum of 80% of the basal area of the tree.

Table 1 Attributes and variables assessed to inform the TLM Stand Condition Model

Attribute	Variables	Sample Size
Live Basal Area (%)	<ul style="list-style-type: none"> DBH Live/Dead Assessment 	All trees >10 cm DBH within the 0.25 ha site
Crown Extent	<ul style="list-style-type: none"> Crown Extent 	30 permanently marked live trees >10 cm DBH within the 0.25 ha site
Plant Area Index	<ul style="list-style-type: none"> Hemispherical Photograph 	1 photograph per site

Table 2 Category scale for reporting crown extent (source: Cunningham, 2016)

Score	Description	Percentage of assessable crown
0	None	0 %
1	Minimal	1 - 20 %
2	Sparse	21 - 40 %
3	Poor	41 - 60 %
4	Declined	61 - 80 %
5	Full	81 - 100 %

A digital hemispherical photograph was taken from the fixed position at the centre of each site using a Canon EOS 40D with a Sigma 4.5mm F2.8 EX DC Circular Fisheye lens. In order to avoid direct sunlight on the canopy, photographs were typically taken during the 90 minutes after sunrise, or the 90 minutes before sunset.

¹ When the sites at Gunbower Forest were established by Monash University in 2009, the 'prefix' field was used to denote the assessment types that a given tree was subject to (T = Tree, S = Stand or C = both Stand and Tree Assessments). The prefix was included on the Tree Tags and on all data sheets, and remains necessary to identify the tree during surveys, and to provide a unique identifier for each tree. At sites where both stand and tree assessments were conducted, and where the same suite of trees were not used for both assessments, there are multiple trees with the same number, i.e. T1 and S1, and removing the prefix would result in duplicate (not unique) identifiers. For the stand crown condition assessment, 'T' trees are not included in the set of '30 marked trees' used, however, they form part of the suite of trees within the plot, and for which Live/Dead assessments and DBH measurements are made. In future data submissions, it would be possible to combine the prefix and tree number in one field to create a unique ID (i.e. S1), or to omit the prefix field and renumber all trees with a 'T' prefix to create a sequential set of trees after 1-30. However, as trees are tagged *in situ*, this may create confusion when locating trees during future surveys, and thus feedback from the MDBA is sought on this matter before further revisions are made.

2.2 Data Analysis

2.2.1 Calculations to inform stand condition model

For each stand condition site the *mean crown extent* was calculated using the crown extent assessments for the 30 marked trees. The *percentage of live basal area* (BA) for each site was also calculated using the DBH measurements of each stem and the Live/Dead assessments. This latter attribute was derived by summing the BA of all stems for Live trees, and taking this as a proportion of the summed BA for all stems (both Live and Dead trees), where the BA of each stem was calculated using the following formula:

$$BA \text{ (cm}^2\text{)} = \pi \times [\text{DBH(cm)}/2]^2.$$

The digital hemispherical photographs of the stand canopy were thresholded (cluster processing: 15 clusters) using the image analysis software Multispec Application Version 3.4 (Purdue University, 2016). Plant Area Index (PAI) was then calculated for the thresholded images using the LAI tool functionality within Winphot 5.00 (ter Steege, 1996).

2.3 Limitations

Sample size, pattern, season and frequency all influence the utility of a dataset, with a range of these influences apparent during the collection of TLM stand condition data between 2010 and 2017. Site flooding was a confounding factor in 2012, and hindered access and hence assessment of five sites, resulting in an unbalanced sample size across the six years of the monitoring program.

As reported by Bennetts and Jolly (2013), another potential limitation the precise location of the hemispherical photo-point may have altered between 2009, 2010 and 2012 and will yield slightly different estimates of PAI. A star picket was secured to mark each photo-point in 2012 and ensured this error was not repeated in 2013, 2014 or 2016 and 2017.

At some sites the ability to relocate the original corner markers of the plot (even when using the provided GPS coordinates) proved difficult. In turn, ascertaining exact plot boundaries and therefore which trees proximate to these had been assessed in previous surveys, has also been challenging. The level of difficulty increased at denser stands (i.e. sites S103, S120 and S123), and for trees outside those tagged 1-30. Accordingly, in some instances more or less trees than referenced in the 2009 and/or 2010 stand data were observed and reported in 2012, 2013 and/or 2016 and 2017. To minimise tree numbering errors in future data collection events, the 30 stand and 30 tree condition trees were spatially referenced with a handheld GPS at each of the surveyed condition sites in 2012, and this increased the ability to relocate individual trees during the 2013, 2016 and 2017 field surveys.

3.0 RESULTS

3.1 Stand Condition Assessment

Plant Area Index (PAI), percentage live BA and crown extent are considered reliable and objective indicators of stand condition (Cunningham *et al.*, 2011). A summary of these attributes for the 25 stand condition sites assessed at Gunbower Forest in 2017, and a cursory synopsis of temporal changes in these variables between 2010 and 2017, is presented in the following pages. Site specific data is provided in Appendix 1 and Appendix 2.

3.1.1 Plant Area Index

The area of leaves and stems relative to a unit of land (i.e. PAI) is thought to reflect a plants' biophysical and ecological processes (Asner *et al.*, 2003). PAI, estimated at each TLM site based on hemispherical photographs of the canopy, ranged from 0.36 to 1.81 in 2017 (Appendix 2). The spatial distribution of these values across the forest is depicted in Figure 1 (page 8). For display purposes, values are presented as ranges; the value divisions are arbitrary.

A comparison between the 2010 and 2017 sample years suggests an increase in PAI at all sites (Appendix 2). There were minor declines in PAI value at two sites from 2016 to 2017 (S103-GRF and S119-GRW); however, at the latter, this deficit was negligible (-0.02).

3.1.2 Crown Extent

The extent of each tree's crown was estimated relative to the optimal crown the tree's branches could reasonably support (or its 'assessable crown'). The mean crown extent, based on the assessment of 30 permanently marked trees, ranged from 33% to 82% for the sites sampled in 2017 (Appendix 2). Individual sites routinely fell within the *poor* and *moderate* condition classes (11 of 25, and 13 of 25 sites respectively), with a single site classified as *degraded*, and a single site deemed in *good* condition (Figure 1, page 8).

The average value for mean crown extent across all sites fell within the *moderate* condition class in each of the 2012 – 2017 sample years (Table 3). Notably, thirteen of the 25 individual sites were within the same condition class across all survey years, and few sites changed classes between 2016 and 2017. Overall, crown extent was lesser in the River Red Gum Forest vegetation type.

Table 3 Mean Crown Extent by vegetation type for TLM Stand Condition Sites sampled in Gunbower Forest, 2010 – 2017. The values displayed are the average for all sites within each vegetation type. Crown Extent at each site is derived from the 30 permanently marked trees.

Vegetation Type	Mean Crown Extent (%)						
	2010	2012	2013	2014	2016	2017	Diff
River Red Gum Forest	53.83	51.69	57.01	58.02	57.66	59.53	5.71
River Red Gum Woodland	68.44	71.42	71.17	70.54	67.46	68.93	0.49
Black Box Woodland	61.22	72.23	72.53	71.37	66.23	66.48	5.26
All Sites	57.64	60.77	62.38	62.70	60.94	62.43	4.78

Diff = change in average score between 2010 and 2017. Average values are coloured according to the following condition classes:

Good (80 - 100%)	Moderate (60 - 80%)	Poor (40 - 60%)	Degraded (20 - 40%)	Severely Degraded (0 - 20%)
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3.1.3 Live Basal Area

The cross-section area of trees (i.e. BA) in a stand is commonly measured as an indicator of productivity (e.g. stand biomass) and/or site occupancy. Similar to findings in 2016, the proportion of Live BA (relative to total BA) ranged from 44% to 100% for the sites sampled in 2017 (Appendix 2). Again, akin to 2016, individual sites fell within the *poor*, *moderate* and *good* condition classes; with the majority of sites (16 of 25) in the latter class in 2017 (Figure 1, page 8).

The average value for % Live BA across all sites fell within the *good* condition class in the 2012 to 2017 sample years (Table 4). Typically, sites remained within the same condition class across all survey years (18 of the 25 sites followed this pattern), although there was considerable inter-site variation, particularly within River Red Gum Forest. Congruent with Mean Crown Extent, the proportion of Live Basal Area was lesser in the River Red Gum Forest vegetation type.

Table 4 Mean percentage Live Basal Area by vegetation type for TLM Stand Condition Sites sampled in Gunbower Forest, 2010 – 2017. The values displayed are the average for all sites within each vegetation type.

Vegetation Type	% Live Basal Area Per Site						Diff
	2010	2012	2013	2014	2016	2017	
River Red Gum Forest	75.11	76.69	78.88	78.45	78.07	78.73	3.62
River Red Gum Woodland	89.69	85.31	88.75	88.36	85.21	85.39	-4.29
Black Box Woodland	86.93	88.81	90.67	91.69	94.03	91.95	5.02
All Sites	79.80	81.44	82.82	82.68	82.41	82.44	4.78

Diff = change in average score between 2010 and 2017. Average values are coloured according to the following condition classes:

Good (80 - 100%)	Moderate (60 - 80%)	Poor (40 - 60%)	Degraded (20 - 40%)	Severely Degraded (0 - 20%)
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3.1.4 Site Contextual Information

When attempting to determine the influence of environmental conditions on ecological responses such as stand condition, it is important to consider site-based factors and disturbances.

When surveyed in 2017 there was evidence of flooding at 16 of the 25 sample sites. A number of these sites were also recently flooded with eFlow (e.g. 2014 and 2015) and/or naturally (e.g. 2010). The region also received relatively high winter – spring rainfall in 2016.

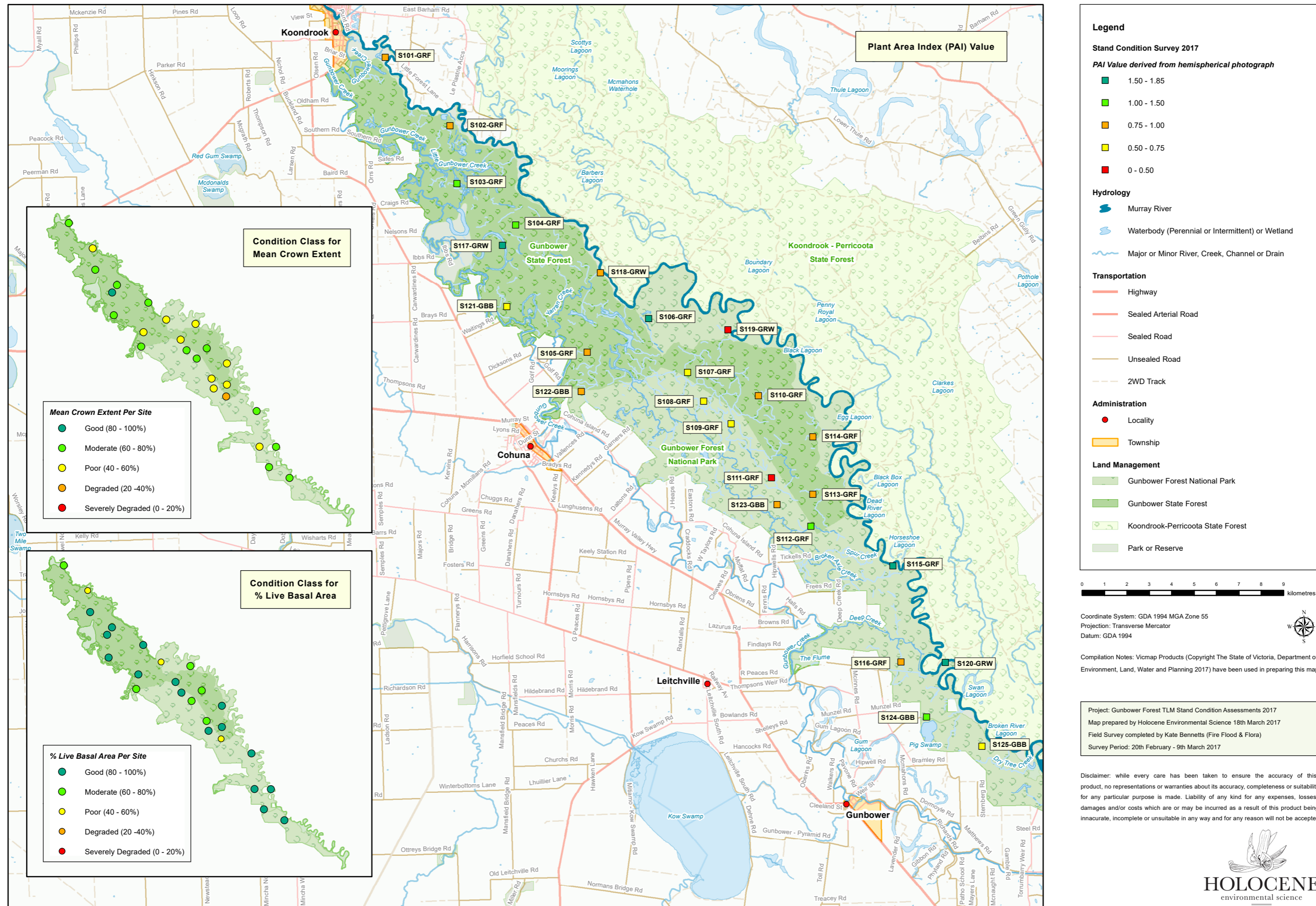


Figure 1 Stand Condition Variables for TLM Stand Sites sampled in Gunbower Forest, 2017

4.0 KEY FINDINGS

The Living Murray stand condition results for Gunbower Forest suggest a modest improvement in the components assessed between 2010 and 2017; however akin to findings in 2016, the condition and trajectories of individual sites varied (Table 5). It is likely the trend of overall improvement reflects the effect of rainfall and flooding between 2010 and 2012 and in 2016, and the receipt of eFlow from the Hipwell Regulator at some sites in 2014 and 2015.

Table 5 Summary of key finding from TLM Stand Condition assessment in Gunbower Forest sampled 2010 - 2017

Component Assessed	Assessment	Temporal Change
Plant Area Index (indicator of plant biomass)	Stand condition (25 sites)	<ul style="list-style-type: none"> ▪ An overall increase at all sites surveyed from 2010 to 2017; however, some variability in the trajectory of individual sites between sample years. ▪ Minor declines at two sites from 2016 to 2017.
Crown Extent	Stand condition (750 trees)	<ul style="list-style-type: none"> ▪ An increase in 19 of the 25 sites surveyed from 2010 to 2017; however, variation in individual site trajectories was high for this period, and at most sites there were shifts in both directions between these sample years. ▪ The average condition for all sites has changed from <i>poor</i> to <i>moderate</i> from 2010 to 2017; however, declines were observed in the value of this attribute between 2014 and 2017. ▪ The majority of individual sites fell in the <i>poor</i> and <i>moderate</i> condition classes in 2017.
Ratio of live to dead Basal Area (indicator of tree volume)	Stand condition (25 sites)	<ul style="list-style-type: none"> ▪ The proportion of live stems to dead stems both increased and decreased across the sites surveyed from 2010 to 2017. ▪ The average condition for all sites has changed from <i>moderate</i> to <i>good</i> from 2010 to 2017. ▪ The majority of individual sites fell in the <i>good</i> condition class in 2017.

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APPENDIX 1 Summary of TLM stand condition sites surveyed Gunbower Forest autumn 2017

Site ID	Forest Type	Forest Condition / Disturbance	No. Trees Surveyed	Survey Notes	Closest Road / Track	Location within Forest	Easting	Northing
S101-GRF	River Red Gum Forest	2016 high rainfall	125	An additional 5 trees that met DBH criteria recorded in 2017 than in 2016. Marked tree S2 fallen and thus not assessed	Link Trk	River Murray Reserve	242126.2	6051056.4
S102-GRF	River Red Gum Forest	2016 high rainfall and flooding	45	An additional 2 trees that met DBH criteria recorded in 2017 than in 2016.	River Trk	Gunbower State Forest	245020.0	6048009.0
S103-GRF	River Red Gum Forest	2016 high rainfall and flooding	104	An additional 2 trees that met DBH criteria recorded in 2017 than in 2016. Marked Tree C2 not relocated; presumably fallen	Unnamed Trk off Koondrook Trk	Gunbower State Forest	245334.0	6045423.4
S104-GRF	River Red Gum Forest	2016 high rainfall and flooding	138	An additional 3 trees that met DBH criteria recorded in 2017 than in 2016.	Unnamed Trk off Iron Punt Trk	Gunbower State Forest	247953.6	6043568.2
S105-GRF	River Red Gum Forest	2016 high rainfall and flooding	60	Consistent with previous surveys; Tree Nos. S21 and S22 were not relocated	Corduoy Trk; near intersection with Half Way Stump Trk	Gunbower State Forest	251144.6	6037885.8
S106-GRF	River Red Gum Forest	2016 high rainfall and flooding	128	An additional 6 trees that met DBH criteria recorded in 2017 than in 2016.	Wee Wee Rup Trk or Peter Creek Trk	Gunbower National Park	253892.8	6039389.6
S107-GRF	River Red Gum Forest	2016 high rainfall	43	Marked tree C23 not relocated; presumably fallen	Centre Trk	Gunbower State Forest	255634.4	6036986.8
S108-GRF	River Red Gum Forest	2016 high rainfall and flooding	92	-	Barton Trk; near intersection with Robertson Trk	Gunbower National Park	256356.0	6035694.2
S109-GRF	River Red Gum Forest	2016 high rainfall and flooding	46	An additional tree that met DBH criteria recorded in 2017 than in 2016.	Smith Swamp Trk and Unnamed Trk	Gunbower National Park	257582.4	6034691.6
S110-GRF	River Red Gum Forest	2016 high rainfall and flooding	61	-	Smith Swamp Trk	Gunbower State Forest	258797.2	6035944.2
S111-GRF	River Red Gum Forest	2016 high rainfall and flooding	34	Marked Tree S22 not relocated; presumably fallen	Unnamed Trk off Centre Trk	Gunbower National Park	259379.0	6032278.4
S112-GRF	River Red Gum Forest	2016 high rainfall and flooding	103	-	Centre Trk; near intersection with Station Trk	Gunbower National Park	261140.0	6030106.2
S113-GRF	River Red Gum Forest	2016 high rainfall and flooding	81	-	Batemans Trk	Gunbower State Forest	261222.2	6031540.0
S114-GRF	River Red Gum Forest	2016 high rainfall and flooding	75	Marked Tree S30 not relocated; presumably fallen	River Trk and Unnamed Trk; between 84 and 86 Tracks	Gunbower State Forest	261226.2	6034114.8
S115-GRF	River Red Gum Forest	2016 high rainfall	62	-	River Trk; near intersection with Kate Malone Trk	River Murray Reserve	264809.4	6028343.6
S116-GRF	River Red Gum Forest	2016 high rainfall and flooding	65	-	Headworks Trk	Gunbower National Park	265166.2	6024060.4
S117-GRW	River Red Gum Woodland	2016 high rainfall and flooding	109	An additional tree that met DBH criteria recorded in 2017 than in 2016.	Unnamed Trk off Plantation Trk; Reedy Lagoon	Gunbower State Forest	247372.6	6042663.0
S118-GRF	River Red Gum Woodland	2016 high rainfall	35	Marked Tree S24 not relocated; was recorded as fallen in 2016	River Trk and Five Sleeper Trk	River Murray Reserve	251745.8	6041443.6
S119-GRW	River Red Gum Woodland	2016 high rainfall	100	-	Cemetery Trk and Unnamed Trk	River Murray Reserve	257432.0	6038890.8
S120-GRW	River Red Gum Woodland	2016 high rainfall and flooding	71	An additional 2 trees that met DBH criteria recorded in 2017 than in 2016.	Unnamed Trk; access from River Trk near intersection with Middle Trk	River Murray Reserve	267152.0	6024029.4
S121-GBB	Black Box Woodland	2016 high rainfall	31	-	Horseshoe Trk	Gunbower State Forest	247555.6	6039923.0
S122-GBB	Black Box Woodland	2016 high rainfall	73	An additional 3 trees that met DBH criteria recorded in 2017 than in 2016.	Log Hauler Trk or Mawson Trk	Gunbower National Park	250882.8	6036133.8
S123-GBB	Black Box Woodland	2016 high rainfall	99	-	Batemans Trk and Spur Island Trk	Gunbower National Park	259632.4	6031081.8
S124-GBB	Black Box Woodland	2016 high rainfall	61	-	Brereton Rd; near intersection with Middle Trk	Gunbower National Park	266305.0	6021587.2
S125-GBB	Black Box Woodland	2016 high rainfall and flooding	34	-	Bramley Trk	Gunbower National Park	268782.2	6020278.6

The number of trees surveyed represents the number of trees with >10 cm DBH within each 0.25 ha site.

The coordinates are for the centre of the plot and are provided in Geocentric Datum of Australia (GDA) 1994 MGA94

APPENDIX 2 Summary of stand condition attributes by site for TLM Stand Condition Sites sampled in Gunbower Forest, 2010 - 2017

Site ID	Forest Type	Mean Crown Extent (%)						% Live Basal Area Per Site						Plant Area Index Value					
		2010	2012	2013	2014	2016	2017	2010	2012	2013	2014	2016	2017	2010	2012	2013	2014	2016	2017
S101-GRF	River Red Gum Forest	56.43	46.83	53.67	64.50	63.00	64.40	50.90	50.98	59.65	66.34	59.52	67.28	0.24	0.33	0.38	0.54	0.75	0.84
S102-GRF	River Red Gum Forest	46.70	39.33	41.50	30.67	53.17	47.92	42.43	48.16	43.97	36.73	44.24	45.88	0.20	0.31	0.47	0.43	0.57	0.77
S103-GRF	River Red Gum Forest	69.60	-	77.50	78.00	63.62	73.45	98.88	-	99.13	99.11	99.04	92.58	0.42	-	1.34	1.23	1.66	1.40
S104-GRF	River Red Gum Forest	60.77	-	77.83	74.67	71.83	78.00	51.02	-	85.52	83.42	87.54	88.24	0.10	-	0.47	0.43	0.89	1.10
S105-GRF	River Red Gum Forest	43.67	40.18	44.29	44.46	39.82	44.29	84.61	85.65	86.52	86.61	89.00	87.79	0.16	0.47	0.41	0.43	0.37	0.78
S106-GRF	River Red Gum Forest	38.77	-	51.00	49.00	57.67	56.17	69.17	-	48.24	47.73	52.78	52.79	0.24	-	1.08	0.90	1.18	1.56
S107-GRF	River Red Gum Forest	59.23	-	43.13	45.17	52.93	53.28	99.24	-	99.32	100.00	100.00	100.00	0.24	-	0.38	0.42	0.41	0.71
S108-GRF	River Red Gum Forest	62.97	-	68.17	72.00	74.50	73.58	88.09	-	88.45	90.18	88.83	90.36	0.13	-	0.48	0.44	0.60	0.70
S109-GRF	River Red Gum Forest	68.57	62.50	64.83	73.67	74.73	70.67	75.33	99.50	99.02	99.04	77.52	73.10	0.19	0.51	0.41	0.45	0.56	0.68
S110-GRF	River Red Gum Forest	64.77	57.50	69.17	69.17	69.83	63.92	59.79	72.09	72.29	65.92	66.38	73.96	0.20	0.46	0.45	0.47	0.61	0.84
S111-GRF	River Red Gum Forest	47.27	45.83	51.17	57.07	59.48	58.45	69.70	73.01	66.75	66.36	67.15	67.62	0.09	0.24	0.30	0.29	0.31	0.36
S112-GRF	River Red Gum Forest	21.37	24.17	26.50	27.0	34.33	33.00	51.82	49.84	42.56	41.20	42.07	43.79	0.22	0.62	0.68	0.57	1.04	1.31
S113-GRF	River Red Gum Forest	54.20	67.17	66.33	62.30	44.00	58.00	98.04	98.50	98.33	98.42	98.45	98.50	0.27	0.51	0.67	0.71	0.59	0.93
S114-GRF	River Red Gum Forest	50.10	57.41	53.10	51.38	50.17	50.69	86.87	82.62	86.57	88.23	89.94	90.96	0.31	0.80	0.53	0.61	0.64	0.94
S115-GRF	River Red Gum Forest	70.83	78.17	73.00	76.83	78.00	73.17	91.88	91.44	93.40	93.69	94.04	94.18	0.45	1.19	1.12	1.32	1.51	1.81
S116-GRF	River Red Gum Forest	46.00	49.50	51.00	52.50	35.50	53.58	83.97	91.76	92.41	92.18	92.65	92.58	0.21	0.71	0.67	0.73	0.76	0.94
AVERAGE FOR RIVER RED GUM FOREST		53.83	51.69	57.01	58.02	57.66	59.53	75.11	76.69	78.88	78.45	78.07	78.73	0.23	0.38	0.62	0.62	0.78	0.98
S117-GRW	River Red Gum Woodland	76.63	86.50	87.00	81.33	74.00	81.75	98.30	84.28	98.48	98.06	83.18	84.48	0.51	1.24	1.40	1.49	1.07	1.55
S118-GRW	River Red Gum Woodland	75.63	70.67	73.33	72.33	73.28	71.90	99.51	92.01	92.02	91.85	93.17	93.19	0.24	0.38	0.55	0.64	0.65	0.82
S119-GRW	River Red Gum Woodland	54.37	53.00	52.67	55.50	50.87	48.75	65.88	68.24	67.28	67.23	67.60	67.69	0.16	0.27	0.33	0.34	0.51	0.49
S120-GRW	River Red Gum Woodland	67.13	75.50	71.67	73.00	71.67	73.33	95.05	96.71	97.22	96.32	96.89	96.23	0.41	0.88	1.04	1.11	1.26	1.51
AVERAGE FOR RIVER RED GUM WOODLAND		68.44	71.42	71.17	70.54	67.46	68.93	89.69	85.31	88.75	88.36	85.21	85.39	0.33	0.69	0.83	0.90	0.87	1.09
S121-GBB	Black Box Woodland	70.70	79.33	81.33	78.00	69.17	70.42	100.00	100.00	100.00	100.00	100.00	100.00	0.23	0.26	0.35	0.52	0.45	0.51
S122-GBB	Black Box Woodland	67.43	64.67	72.67	71.50	58.17	64.00	67.51	78.55	78.52	79.08	90.40	78.81	0.27	0.62	0.54	0.65	0.69	0.82
S123-GBB	Black Box Woodland	24.30	60.67	51.50	51.67	56.83	51.50	67.13	65.50	74.85	79.36	79.76	80.93	0.14	0.28	0.35	0.36	0.53	0.79
S124-GBB	Black Box Woodland	70.10	76.50	75.17	75.67	68.83	71.83	100.00	100.00	100.00	100.00	100.00	100.00	0.31	0.73	0.97	0.64	0.78	1.19
S125-GBB	Black Box Woodland	73.57	80.00	82.00	80.00	78.17	74.67	100.00	100.00	100.00	100.00	100.00	100.00	0.26	0.56	0.52	0.53	0.69	0.74
AVERAGE FOR BLACK BOX WOODLAND		61.22	72.23	72.53	71.37	66.23	66.48	86.93	88.81	90.67	91.69	94.03	91.95	0.24	0.49	0.55	0.54	0.63	0.81
AVERAGE ALL SITES		57.64	60.77	62.38	62.70	60.94	62.43	79.80	81.44	82.82	82.68	82.41	82.44	0.25	0.45	0.64	0.65	0.76	0.96

Mean Crown Extent is calculated for permanently marked stand trees 1 to 30 only

% Live Basal Area is calculated for all trees >10 cm DBH within each 0.25 ha stand site

Plant Area Index is estimated from the image analysis of a single hemispherical photograph taken at the centre point of each stand condition site