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Stand condition assessment of forests and woodlands of Gunbower Forest – 2013

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Cover image: Wetlands near Gunbower after receiving an Environmental Water Allocation. (photo by Arthur Mostead)

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Document History

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December 2014	12/12/2014	EWG Monitoring Sub Group and Icon Site Managers	For Review	1st Draft

Version	Date Issued	Issued to	Purpose	Notes
February 2015	20/2/2015	EWG Monitoring Sub Group	For Endorsement	Revised, post review
May 2015	30/5/2015	Icon Site Managers	For Reporting	Final – Endorsed by EWG Monitoring Sub Group

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- NSW Office of Environment and Heritage (Barmah Forest, Millewa Forest)
- Fire, Flood and Flora (Gunbower Forest)
- GHD (Koondrook-Perricoota Forest)
- Murray-Darling Freshwater Research Centre (Hattah Lakes and Lindsay-Mulcra-Wallpolla Islands)
- South Australian Department of Environment, Water and Natural Resources (Chowilla Floodplain)

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Specifically:

- Goulburn Broken Catchment Management Authority (Barmah Forest)
- NSW Office of Environment and Heritage – Moama (Millewa Forest)
- North Central Catchment Management Authority (Gunbower Forest)
- Forestry Corporation of New South Wales – Deniliquin (Koondrook-Perricoota Forest)
- Mallee Catchment Management Authority (Hattah Lakes and Lindsay-Mulcra-Wallpolla Islands)
- Department of Environment, Water and Natural Resources – Berri and Adelaide (Chowilla Floodplain)

The Living Murray Stand Condition Assessment Tool was developed by Shaun Cunningham, Peter Griffioen, Matt White and Ralph Mac Nally. The Murray-Darling Basin Authority is appreciative of the continued support provided by Shaun Cunningham (Deakin University).

AAM Pty. Ltd. produced the RapidEye imagery mosaic used in this 2013 Stand Condition Assessment, as well as previous years (2009-2012).

The MDBA Geospatial Services Unit, specifically Md. Anisul Islam with support from Amanda Spalding, undertook the modelling and mapping presented in this report.

The MDBA's The Living Murray Environmental Delivery, Planning and Monitoring team, in particular Stuart Little, produced this series of 2013 Stand Condition Assessment reports on behalf of The Living Murray icon sites.

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About this report

This report contains the results of an assessment of condition (health) of river red gum and black box forests and woodlands of Gunbower Forest, a Living Murray icon site, in 2013. Condition is predicted by The Living Murray Stand Condition Assessment Tool (Cunningham, et al., 2014).

The extent of forests and woodlands shown in this report are based on spatial information held by the Murray-Darling Basin Authority (MDBA) Geospatial Services Unit.

Tree condition assessments are also conducted at some icon sites. Readers should note that due to the differences in the methodology, results from the stand condition assessment do not always correlate to results from the tree condition assessments.

Introduction

Assessment of river red gum and black box condition is fundamental to informing progress toward the ecological objectives of The Living Murray program across the majority of The Living Murray Icon Sites.

To provide a consistent assessment of river red gum and black box condition, the MDBA provided funding to develop The Living Murray Stand Condition Assessment Tool.

The Stand Condition Assessment Tool (Cunningham, et al., 2014) uses the relationship between ground surveys of stand condition at monitoring sites and remotely sensed data to predict stand condition across the spatial extent of the icon sites that support river red gum and black box populations, namely:

- Barmah-Millewa Forest
- Gunbower, Koondrook-Perricoota Forests
- Hattah Lakes
- Lindsay-Mulcra-Wallpolla islands
- Chowilla floodplain
- River Murray Channel

Stand condition scores as predicted by the model are then mapped across the various forest types and categorised into the following stand condition classes:

- good
- moderate
- poor
- degraded
- severely degraded

The areas of each vegetation type in each condition class, within each icon site are then reported for each year the assessment has been conducted.

The results from the Stand Condition Assessment can then be used to inform the progress towards, or away from, the ecological targets relevant to icon site river red gum and black box condition (health) objectives.

Methods

Stand Condition Modelling

The Stand Condition Assessment Tool (the Tool) uses the multi-year model developed by Cunningham, et al. (2014) to model stand condition of the Living Murray Icon Sites for any year. The Tool calculates the stand condition map from reflectance values derived from RapidEye satellite imagery and a range of spatial variables used to model stand condition. For further information see Cunningham, et al. (2014).

The RapidEye imagery mosaic for the 2013 stand condition assessment was prepared using RapidEye imagery captured between January and April 2013. The Tool was supplied with the mosaic's five spectral bands and run as per the methods outlined in Cunningham & Griffioen (2013).

The Tool calculated stand condition from the input variables provided and produced the raster file of 2013 stand condition scores to be viewed and analysed in ArcGIS (ESRI, Redlands, California).

Validation of model outputs

In order to determine how well the model has predicted stand condition, a validation survey of stand condition using field-based assessments was undertaken. The validation data provide field observations of stand condition at specific field locations.

The validation feature of the Tool allows the user to check the map predictions against the field observations and if necessary adjust the predictions according to the relationship between the surveyed and predicted values.

A total of 172 field locations were assessed between January and May 2013 as per the methods outlined in *Ground-based survey methods for The Living Murray assessment of condition of river red gum and black box populations* (MDBA, 2012). Field validation sites were selected in 2009 by Cunningham et al. (2009). Sites were chosen to be representative of the range of forest types, forest condition and landscape positions (e.g. riverine, wetland and floodplain) at each Icon Site.

The field validation data was inputted to the Stand Condition Assessment Tool and correlated to the initial modelled values. The accuracy of the model's predictions of condition were assessed by determining if the linear fit (i.e. the correlation value) was >0.77 (which equates to an R^2>0.6).

Confirmation that the linear fit is > 0.77, does not necessarily mean the model is predicting the observed values accurately. Therefore, additional tests are applied to determine if:

- the offset (i.e. the regression intercept) is between -1 and +1, and
- the scalar (i.e. the regression slope) is between 0.8 and 1.2

If the offset or scalar values are outside of the ranges outlined above, the predicted stand condition values do not correlate well with field observations and would benefit from a post-process adjustment (using an inverse-linear regression) being applied (Cunningham, et al., 2014).

Map analysis

Stand condition assessment maps were produced for the Living Murray Icon Sites using ArcGIS. The Tool predicts a stand condition score that is based on the variables: percentage live basal area, plant area index and crown extent. Values of the stand condition score range between 0 (dead) to 10 (excellent condition).

For reporting purposes, the maps were then classified into five condition classes: good, moderate, poor, degraded and severely degraded (see Table 1) using ArcGIS.

Table 1: Classification of Stand Condition Score to Condition Categories.

Stand Condition Score Range	Condition Category
>8 to 10	Good
>6 to 8	Moderate
>4 to 6	Poor
>2 to 4	Degraded
0 to 2	Severely Degraded

To enable reporting of Stand Condition for the various forest and woodland types that exist within the Living Murray icon sites, distribution maps were created for the following six forest types:

- River red gum forest – stands dominated by *Eucalyptus camaldulensis* with 30-45% projective foliage cover.
- River red gum woodland – stands dominated by *E. camaldulensis* with 20-25% projective foliage cover.
- River red gum / black box woodland – mixed stand of *E. camaldulensis* and *E. largiflorens*.
- Black box woodland – stands dominated by *E. largiflorens*.
- River red gum / box woodland – stands dominated by *E. camaldulensis*, *E. largiflorens* and *E. microcarpa* included in Millewa and Koondrook-Perricoota only.
- Box woodland – stands dominated by *E. largiflorens* and *E. microcarpa* included in Millewa and Koondrook-Perricoota only.

Distribution maps were developed from the sources described in Table 2. The forest type distribution for Barmah Forest is presented in Map 1.

Proportions, and area (in hectares) of each forest type in each condition class were then determined from the attribute table of the stand condition shapefile and reported in the results section of this report.[1]

[1] Total areas for each Icon Site and Forest Type provided in the results section may vary between assessments due to errors caused by data transformation and combining vector data (forest types) and raster data (stand condition).

Table 2: Information sources used to map forest type distribution (from Cunningham et al. (2009)).

Region	Map	Source
Barmah Forest	Ecological Vegetation Community (EVC)	Dept. Sustainability & Environment (Victoria)
	State Forest Resource Inventory (SFRI)	Dept. Sustainability & Environment (Victoria)
Millewa Forest	State Forest NSW map	Forests NSW
Gunbower Island	Ecological Vegetation Community (EVC)	Dept. Sustainability & Environment (Victoria)
	State Forest Resource Inventory (SFRI)	Dept. Sustainability & Environment (Victoria)
Koondrook & Perricoota	State Forest NSW map	Forests NSW
Hattah Lakes	Ecological Vegetation Community (EVC)	Dept. Sustainability & Environment (Victoria)
	State Forest Resource Inventory (SFRI)	Dept. Sustainability & Environment (Victoria)
Lindsay, Mulcra & Wallpolla Islands	Ecological Vegetation Community (EVC)	Dept. Sustainability & Environment (Victoria)
	State Forest Resource Inventory (SFRI)	Dept. Sustainability & Environment (Victoria)
Chowilla Floodplain	Vegetation of Chowilla floodplain	CSIRO Land and Water
River Murray Channel (NSW & SA)	Riparian Vegetation of the River Murray	MDBC – Margules and others
River Murray Channel (Vic)	Ecological Vegetation Community (EVC)	Dept. Sustainability & Environment (Victoria)

Results

Model Validation and Correction

The initial Stand Condition model predictions of stand condition scores were highly correlated (R^2=0.802) with the observations from the field validation surveys across the icon sites. However, the offset (regression intercept) and the scalar (regression slope) of the validation relationship indicated that the initial scores under-represented the number of good condition and severely degraded condition sites. This result is similar to Stand Condition Assessments in previous years (Cunningham, et al., 2014; Cunninhgam, et al., 2011; Cunningham, et al., 2009).

Therefore, as per the method outlined in Cunningham and Griffioen (2013) an adjustment was applied to the initial stand condition scores to improve the accuracy at the extreme ends of the condition spectrum. The correlation between the adjusted stand condition scores and field observations from the validation surveys is presented in Figure 1 and Figure 2.

It is noted that in conducting this assessment at the whole of TLM scale (i.e. 14,037km^2) across years and different forest types, a perfect match between field observations and stand condition scores at the pixel scale (0.000625km^2) does not always occur.

The correlation between model predictions and observations from the field shows that whilst different forest types have differing levels of accuracy at the pixel scale, the 2013 stand condition assessment does provide land managers with whole of icon site information on stand condition that is highly correlated with field observations. These results are suitable for informing the progress towards, or away from, the ecological targets relevant to icon site river red gum and black box condition.

The adjusted stand condition scores, classified into stand condition classes as per Table 1, have been used to produce the statistics and mapping presented in this report.

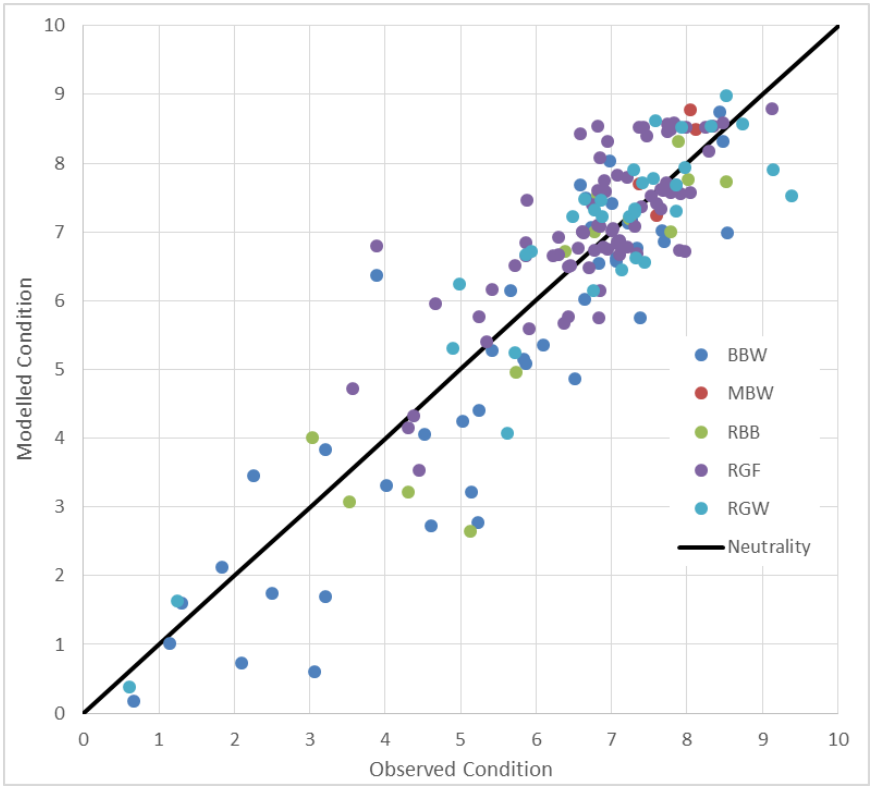


Figure 1: Relationship between predicted and observed Stand Condition and for 172 validation sites across all TLM icon sites. Forest types are black box woodland (BBW), mixed box woodlands (MBW), mixed river red gum and black box woodlands (RBB), river red gum forests (RGF) and river red gum woodlands (RGW).

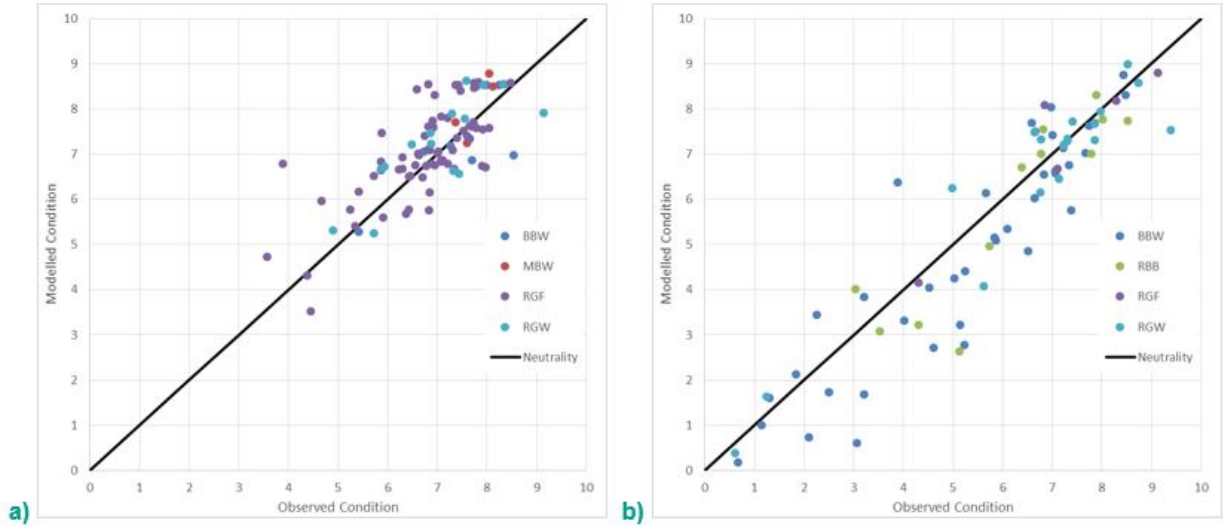


Figure 2: Relationship between predicted and observed condition for validation sites in the Riverina (n=100) (a) and Mallee (n=75) (b) bioregions. . Forest types are black box woodland (BBW), mixed box woodlands (MBW), mixed river red gum and black box woodlands (RBB), river red gum forests (RGF) and river red gum woodlands (RGW).

Stand Condition Assessment

Table 3 provides the results of the 2013 stand condition assessment for Gunbower Forest. Spatial extent of each condition class is presented in Map 2.

In 2013, 20.3% (3,516 ha) of the forests and woodlands of Gunbower Forest are considered to be in Good condition. An additional 69.2% (11,977 ha) of the forests are considered to be in Moderate condition. The remaining areas of floodplain forests are considered to be in Poor, Degraded or Severely Degraded condition. The area of floodplain forest in these condition classes is 10.6% (1,826 ha).

Table 3: Percentage of the total forest and woodland and estimated area within Gunbower Forest in each condition class in 2013 as predicted by the Stand Condition Assessment Tool.

	Good	Moderate	Poor	Degraded	Severely Degraded
% of forest area in each condition class	20.3%	69.2%	9.9%	0.2%	0.5%
Estimated area	3,516 ha	11,977 ha	1,712 ha	36 ha	78 ha

Historical comparisons of icon site proportions in each stand condition class are provided in Table 4.

Table 4: Historical comparison of the percentage of the total forest and woodland and estimated area within Gunbower Forest in each condition class as predicted by the Stand Condition Assessment Tool.

Year	Good	Moderate	Poor	Degraded	Severely Degraded
% of Forest Area - 2009	21.0%	68.8%	9.5%	0.2%	0.4%
% of Forest Area - 2010	17.6%	66.0%	15.4%	0.4%	0.5%
% of Forest Area - 2011	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Not Assessed
% of Forest Area - 2012	22.4%	67.7%	9.2%	0.2%	0.5%
% of Forest Area - 2013	20.3%	69.2%	9.9%	0.2%	0.5%
Estimated Area - 2009	3,631 ha	11,921 ha	1,653 ha	38 ha	75 ha
Estimated Area - 2010	3,050 ha	11,438 ha	2,670 ha	78 ha	82 ha
Estimated Area - 2011	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Not Assessed
Estimated Area - 2012	3,876 ha	11,732 ha	1,592 ha	36 ha	81 ha
Estimated Area - 2013	3,516 ha	11,977 ha	1,712 ha	36 ha	78 ha

The Stand Condition Assessment results for each forest type within Gunbower Forest are presented in Table 5.

Spatial extents of each condition class, within each forest type are presented in Maps 3 to 5. Stand Condition Assessment results for previous years are provided in Appendix 1.

River red gum forest has the largest extent of good condition stands with 22.2% (2,648 ha) of the area of these forests predicted to be in Good condition. The remaining areas are predominantly in Moderate condition (66.3% - 7,890 ha), with 11.6% (1,368 ha) of the river red gum forest area considered to be in poor, degraded or severely degraded condition.

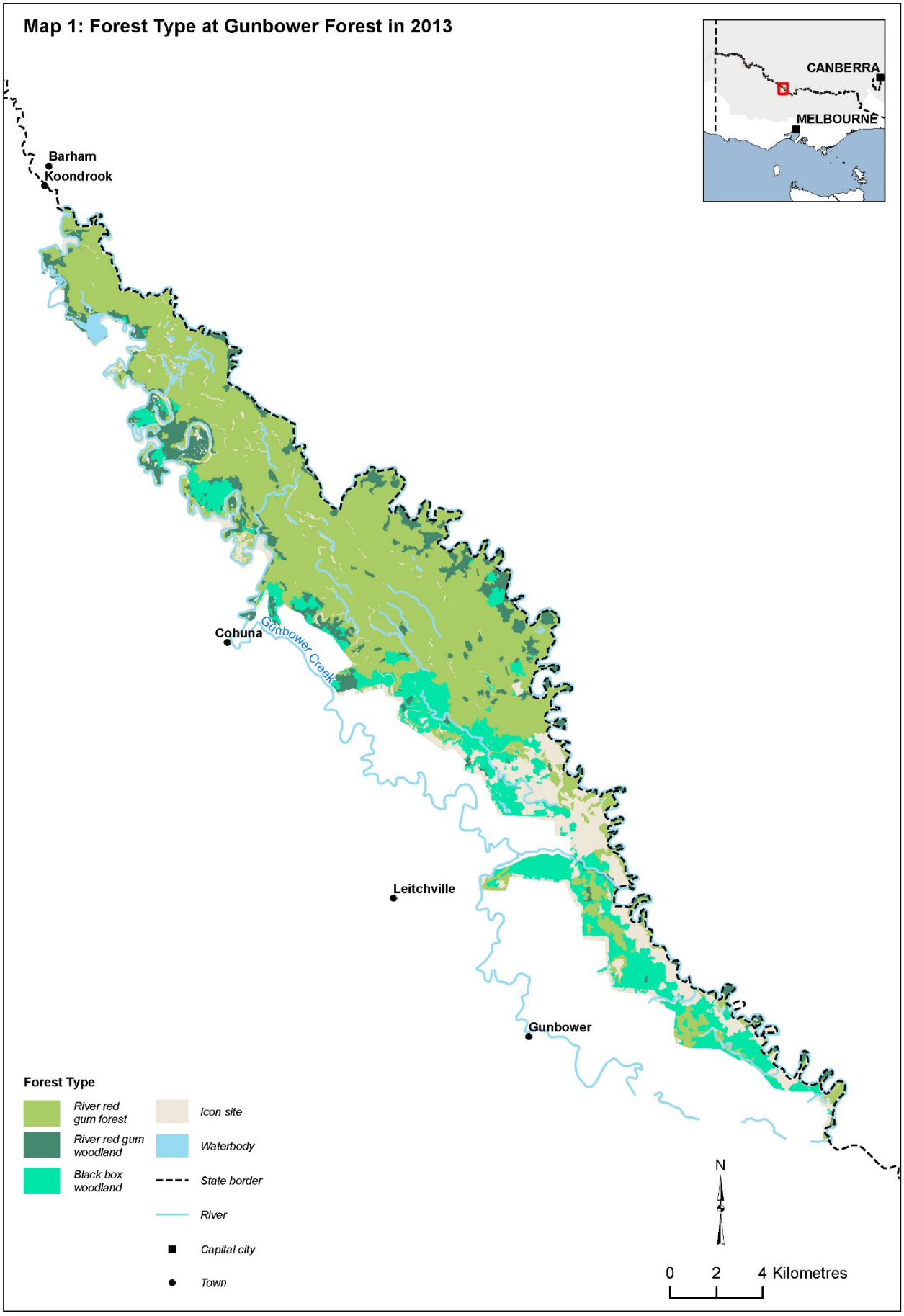
River red gum woodlands show a similar pattern to river red gum forests with 23.8% (495 ha) of the area of river red gum woodlands considered in good condition and a further 60.6% (1,260 ha) predicted to be in Moderate condition. 15.7% (325 ha) of the forests are predicted to be in poor, degraded or severely degraded condition.

Pure black box woodlands are generally in moderate condition with only 11.2% (373 ha) of the area predicted to be in good condition. 84.8% (2,827 ha) of the area is classed as Moderate. The remaining Black box woodlands (3.9% - 133 ha) are predicted to be in poor, degraded or severely degraded condition.

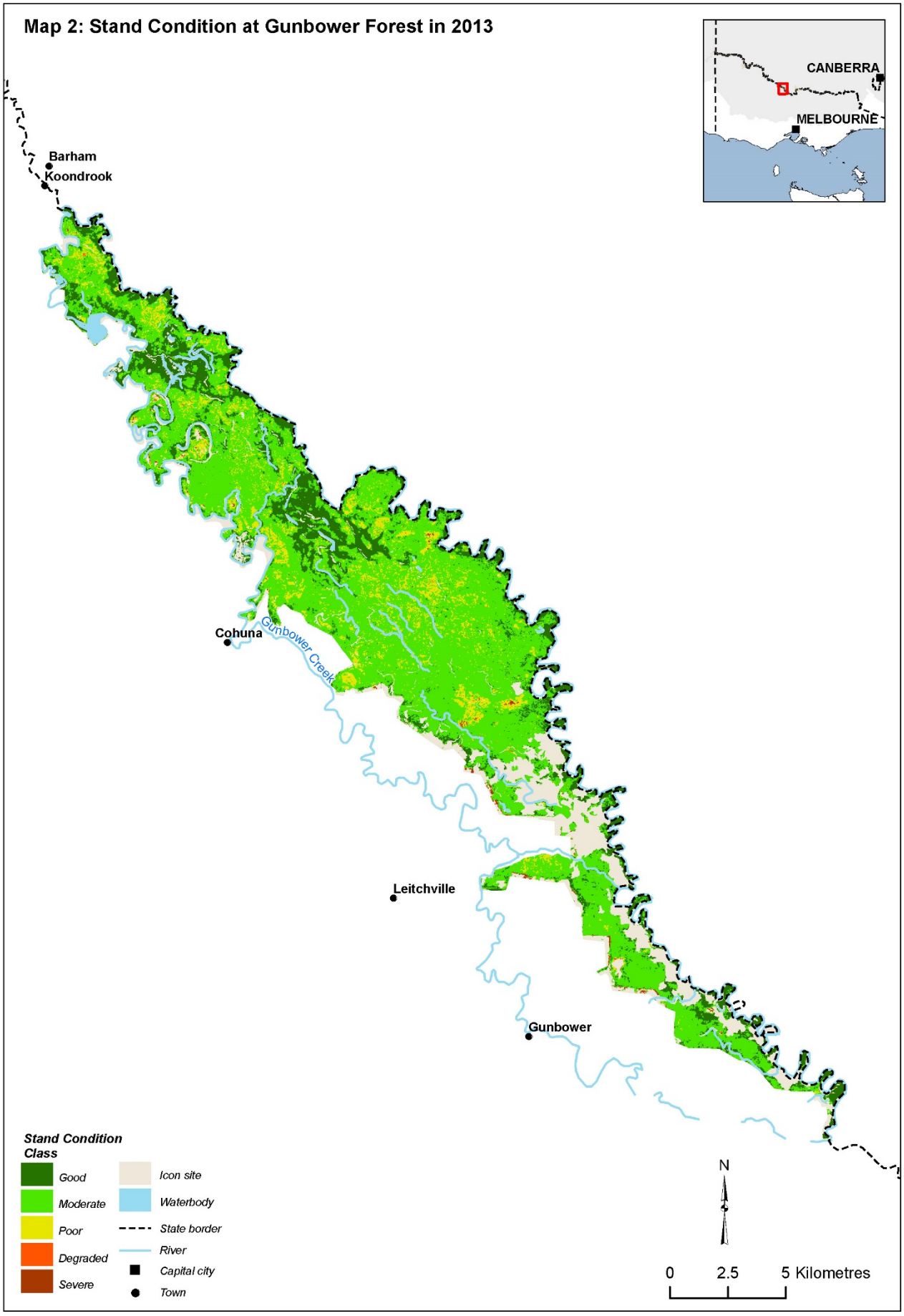
Table 5: Proportion and estimated area of each forest type in each condition class in 2013 as predicted by the Stand Condition Assessment Tool

	Good	Moderate	Poor	Degraded	Severely Degraded
% of River red gum forest area	22.2%	66.3%	11.2%	0.2%	0.2%
% of River red gum woodland area	23.8%	60.6%	14.4%	0.2%	1.1%
% of Black box woodland area	11.2%	84.8%	2.5%	0.3%	1.1%
Estimated Area of River red gum forest	2,648 ha	7,890 ha	1,328 ha	21 ha	19 ha
Estimated Area of River red gum woodland	495 ha	1,260 ha	299 ha	4 ha	22 ha
Estimated Area of Black box woodland	373 ha	2,827 ha	85 ha	11 ha	37 ha

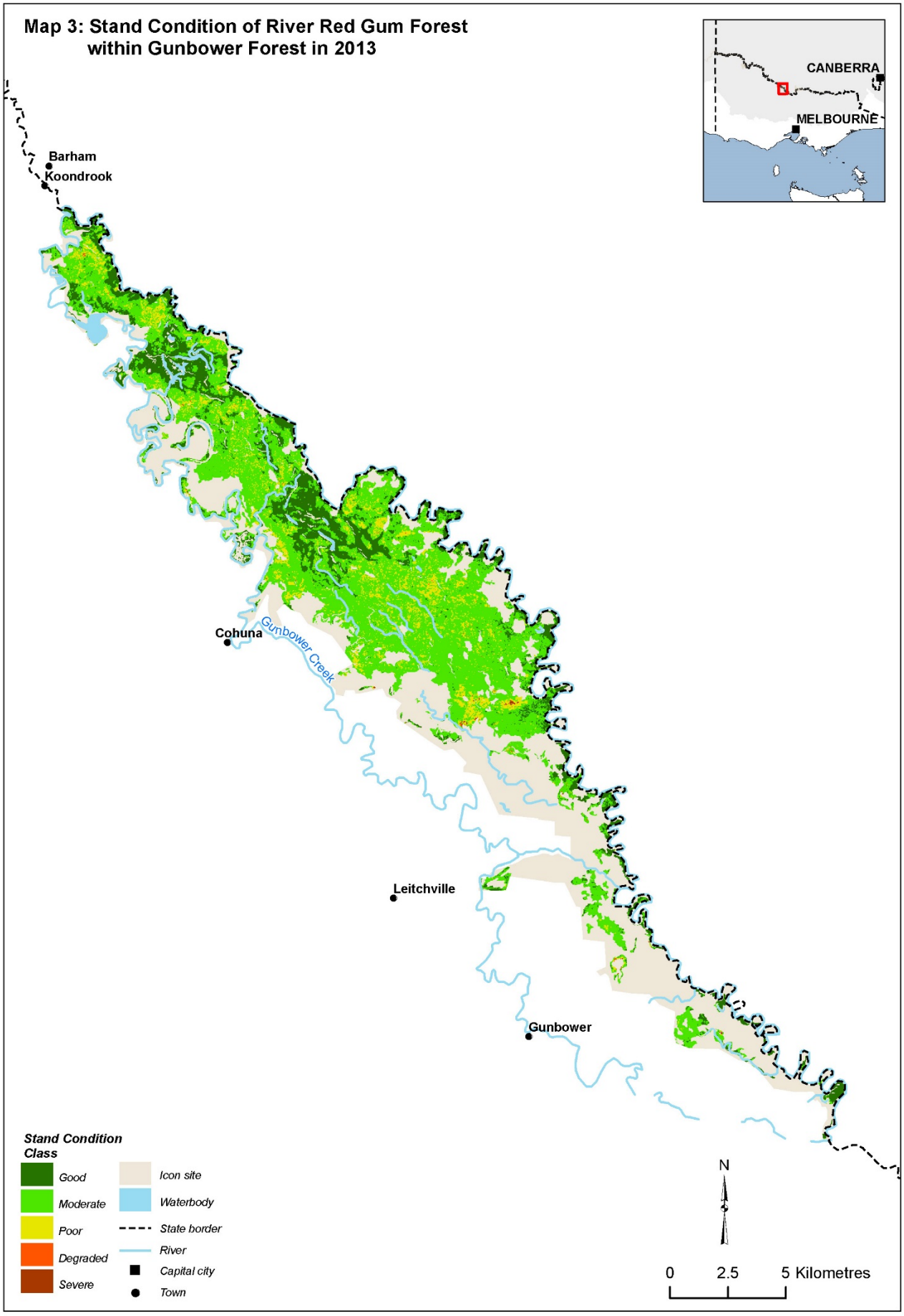
Map 1: Forest Type at Gunbower Forest in 2013

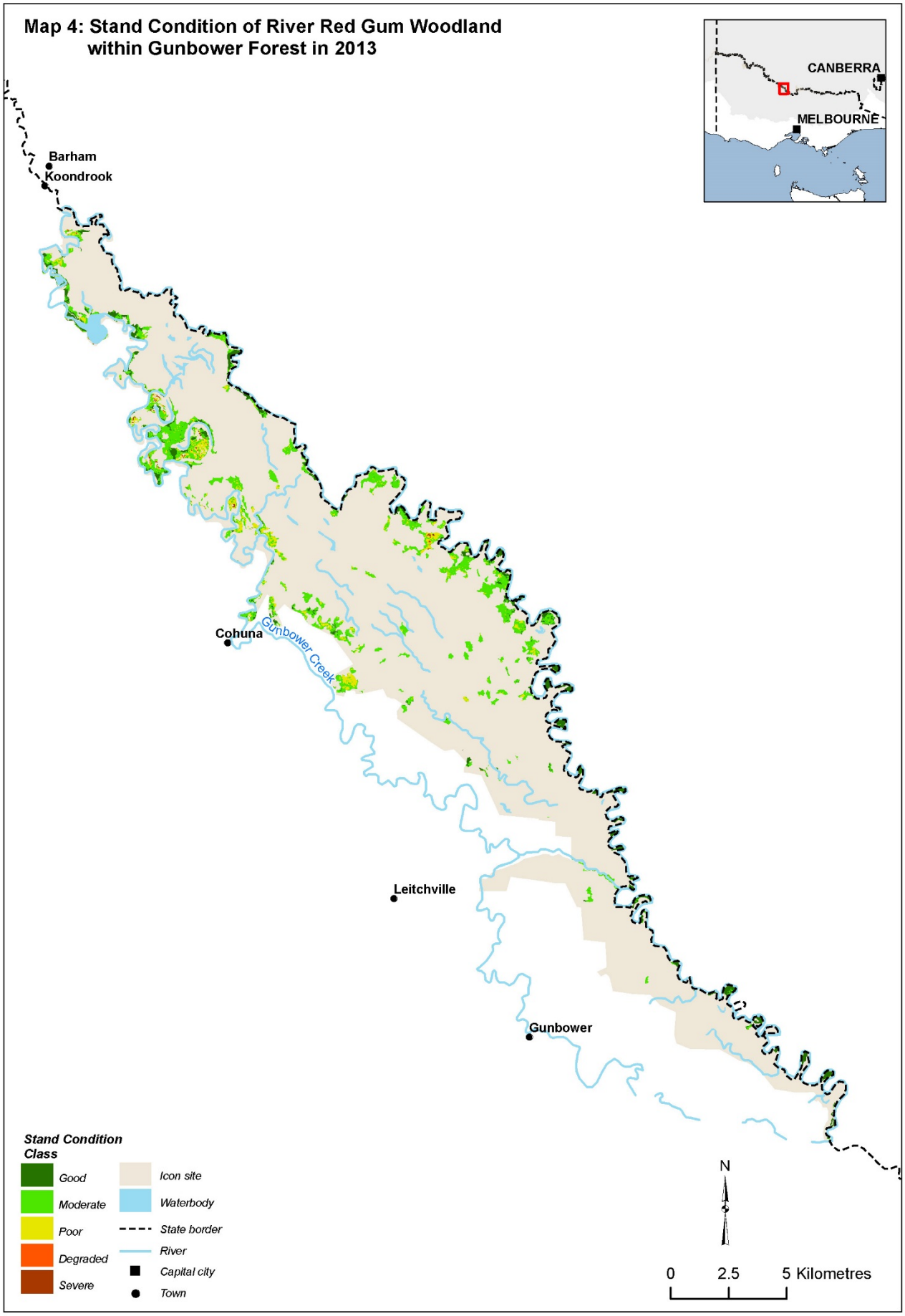


Map 2: Stand Condition at Gunbower Forest in 2013

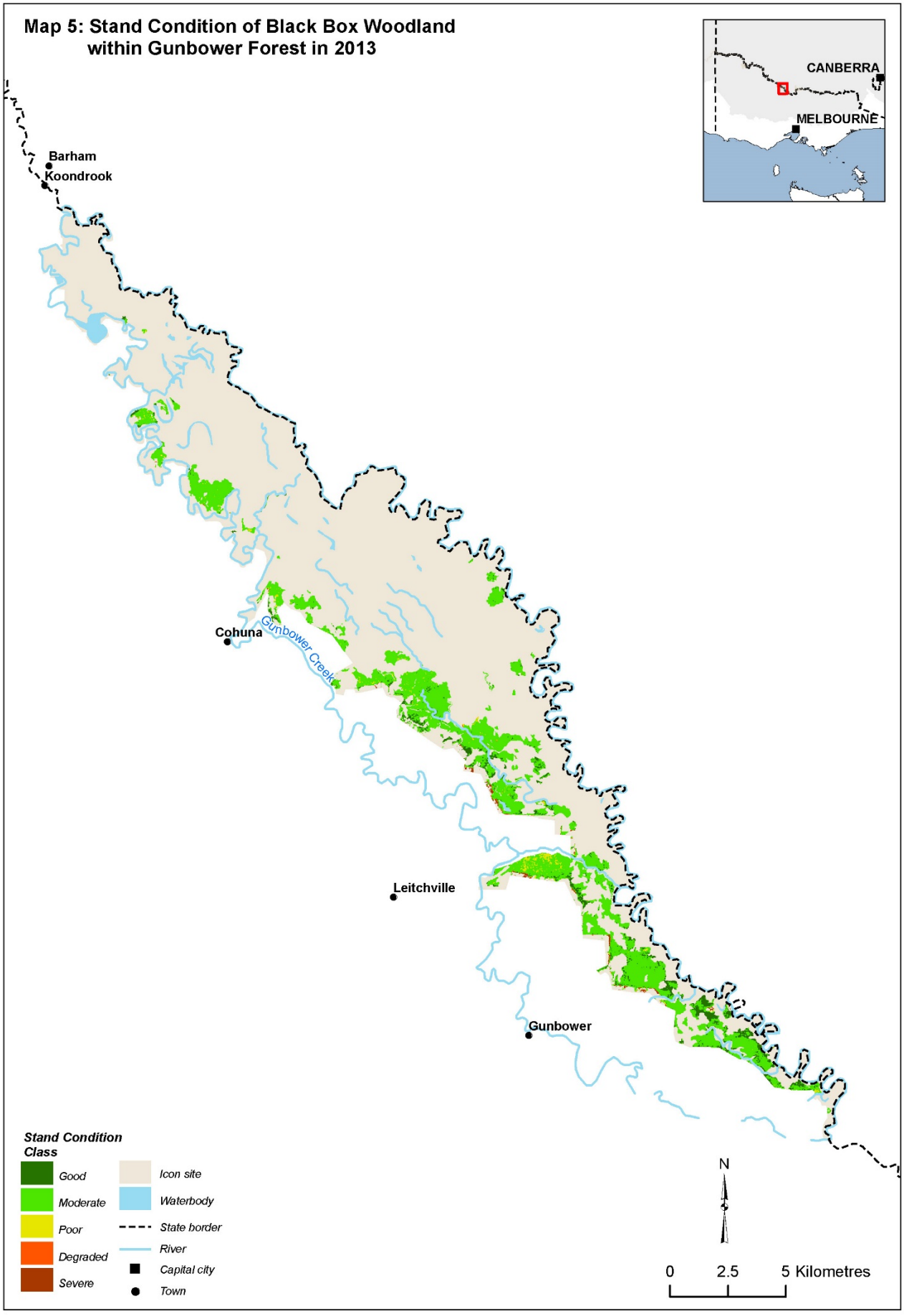


Map 3: Stand Condition of River Red Gum Forest within Gunbower Forest in 2013




Map 4: Stand Condition of River Red Gum Woodland within Gunbower Forest in 2013
CANBERRA
MELBOURNE
Barham
Koondrook
Cohuna
Gunbower Creek
Leitchville
Gunbower
Stand Condition Class
Good
Moderate
Poor
Degraded
Severe
Icon site
Waterbody
State border
River
Capital city
Town
N
0
2.5
5 Kilometres

Map 5: Stand Condition of Black Box Woodland within Gunbower Forest in 2013



Further Information

The following spatial data are available by forwarding a request to gis@mdba.gov.au:

- Forest type mapping used in The Living Murray Stand Condition Assessment
- Stand Condition Assessment maps for all years (2009, 2010, 2012, 2013)

All products can be supplied as whole of The Living Murray (i.e. icon sites including the River Murray Channel) or clipped to areas of interest (where specifications are provided within the data request).

For further details on the validation of model results, RapidEye imagery utilised in the assessment or any other questions on the Stand Condition Assessment please email TLMMonitoring@mdba.gov.au.

References

Cunningham, S. & Griffioen, P., 2013. *Murray Stand Condition Tool User's Guide,* Canberra: Murray-Darling Basin Authority.

Cunningham, S., Griffioen, P., White, M. & Mac Nally, R., 2014. *A Tool for Mapping Stand Condition across the Floodplain Forests of The Living Murray Icon Sites,* Canberra: Murray-Darling Basin Authority.

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Cunninhgam, S., Griffioen, P., White, M. & Mac Nally, R., 2011. *Mapping the Condition of River Red Gum (Eucalyptus camaldulensis Dehnh.) and Black Box (Eucalyptus largiflorens F.Muell.) Stands in The Living Murray Icon Sites. Stand Condition Report 2010.,* Canberra: Murray-Darling Basin Authority.

MDBA, 2012. *Ground-based survey methods for The Living Murray assessment of condition of river red gum and black box populations,* Canberra: Murray-Darling Basin Authority.

Appendix 1

Stand Condition Assessment results for Gunbower Forest – 2009 to 2013

Table A1: River red gum forest

Year	Area in condition class (ha)					Proportion in condition class (%)				
	Good	Mod.	Poor	Deg.	Sev.	Good	Mod.	Poor	Deg.	Sev.
2009	2725	7835	1306	21	18	22.9%	65.8%	11.0%	0.2%	0.1%
2010	2389	7508	1938	50	20	20.1%	63.1%	16.3%	0.4%	0.2%
2011	Not Assessed									
2012	2944	7743	1178	21	20	24.7%	65.0%	9.9%	0.2%	0.2%
2013	2648	7890	1328	21	19	22.2%	66.3%	11.2%	0.2%	0.2%

Table A2: River red gum woodland

Year	Area in condition class (ha)					Proportion in condition class (%)				
	Good	Mod.	Poor	Deg.	Sev.	Good	Mod.	Poor	Deg.	Sev.
2009	513	1295	246	4	22	24.7%	62.3%	11.8%	0.2%	1.1%
2010	437	1212	391	17	23	21.0%	58.3%	18.8%	0.8%	1.1%
2011	Not Assessed									
2012	520	1240	292	5	23	25.0%	59.6%	14.0%	0.3%	1.1%
2013	495	1260	299	4	22	23.8%	60.6%	14.4%	0.2%	1.1%

Table A3: Black box woodland

Year	Area in condition class (ha)					Proportion in condition class (%)				
	Good	Mod.	Poor	Deg.	Sev.	Good	Mod.	Poor	Deg.	Sev.
2009	392	2790	102	13	36	11.8%	83.7%	3.1%	0.4%	1.1%
2010	223	2718	341	11	40	6.7%	81.6%	10.2%	0.3%	1.2%
2011	Not Assessed									
2012	412	2750	122	9	39	12.4%	82.5%	3.7%	0.3%	1.2%
2013	373	2827	85	11	37	11.2%	84.8%	2.5%	0.3%	1.1%