
BUSH BIRD MONITORING WITHIN BARMAH-MILLEWA FOREST

2015-2016



Office of
Environment & Heritage
NSW National Parks & Wildlife Service



2015-16 Bush Bird Monitoring Report

Report Title: Bush Bird Monitoring within Barmah-Millewa Forest 2015-2016

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Front cover photo: Bush bird monitoring plot, Gulpa Island (left: spring 2008: right: spring 2015) - Rick Webster

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Summary

The bush bird surveys in 2015-16 identified a total of 70 species. Species were recorded from both the survey plots and the adjoining habitat. There were 1114 individual birds recorded from across the twenty sites in Barmah-Millewa Forest. The spring surveys identified 54 species, summer 47 species, autumn 41 species and winter 33 species. Seven of the species (brown treecreeper *Climacteris picumnus*, rufous whistler *Pachycephala rufiventris*, dusky woodswallow *Artamus cyanopterus*, jacky winter *Microeca fascinans*, red-capped robin *Petroica goodenovii*, restless flycatcher *Myiagra inequata* and white-browed babbler *Pomatostomus superciliosus*,) recorded during the 2015-16 surveys are considered to be declining species within the temperate agricultural zone of southern Australia. Eight vulnerable/significant species (NSW *Threatened Species Conservation Act* [TSC Act] 1995, Victoria DSE 2013) were recorded during the current surveys: superb parrot *Polytelis swainsonii*, black-chinned honeyeater *Melithreptus gularis*, varied sittella *Daphoenositta chrysoptera*, flame robin *Petroica phoenicea*, hooded robin *Melanodryas cucullata*, scarlet robin *Petroica boodang* and diamond firetail *Stagonopleura guttata*. The superb parrot, black-chinned honeyeater and hooded robin is also listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act* 1999.

1. Introduction

A baseline monitoring survey of bush birds (1999-2002) was undertaken in Barmah-Millewa Forest (Webster 2004a, b). Follow-up seasonal surveys were conducted during 2008, 2010, 2011/12 and 2012/13 (Webster 2008a, b, c, d, 2010a, b, c, d, OEH 2012a, b, c, 2013). The current year of surveys were undertaken as part of the ongoing condition monitoring program within Barmah-Millewa Forest – a Living Murray icon site.

The surveys aim to monitor bush bird assemblages to provide information on species richness and relative abundance. This information can potentially be used to identify changes in bird assemblages in the forest over time. Indices have been created by Wayne Robinson of CSU University which will enable species richness and abundance to be calculated over time (Robinson, 2013).

This report presents an overview of the 2015-2016 monitoring results and a brief discussion on observational trends in bush bird diversity and abundance within the Barmah-Millewa Forest icon site.

2. Methods

Census Methodology

Twenty woodland bird monitoring sites were established within the Barmah-Millewa Forest (Figure 1) in 1999, in conjunction with the Forestry Corporation of NSW (formerly Forests NSW) and the Victorian Department of Environment, Lands, Water and Planning (DELWP) (formerly Department of Sustainability and Environment). Sites were selected to represent the following habitat types:

- River red gum (*Eucalyptus camaldulensis*) Site Quality 1
- River red gum Site Quality 2
- River red gum Site Quality 3
- Box woodlands (western grey box *E. microcarpa*, yellow box *E. melliodora*)
- Sandhills (includes river red gum [1], box/pine (*Callitris* sp.) [2], box [1])

These sites were also selected based on accessibility during major floods and in New South Wales on previous fauna surveys.

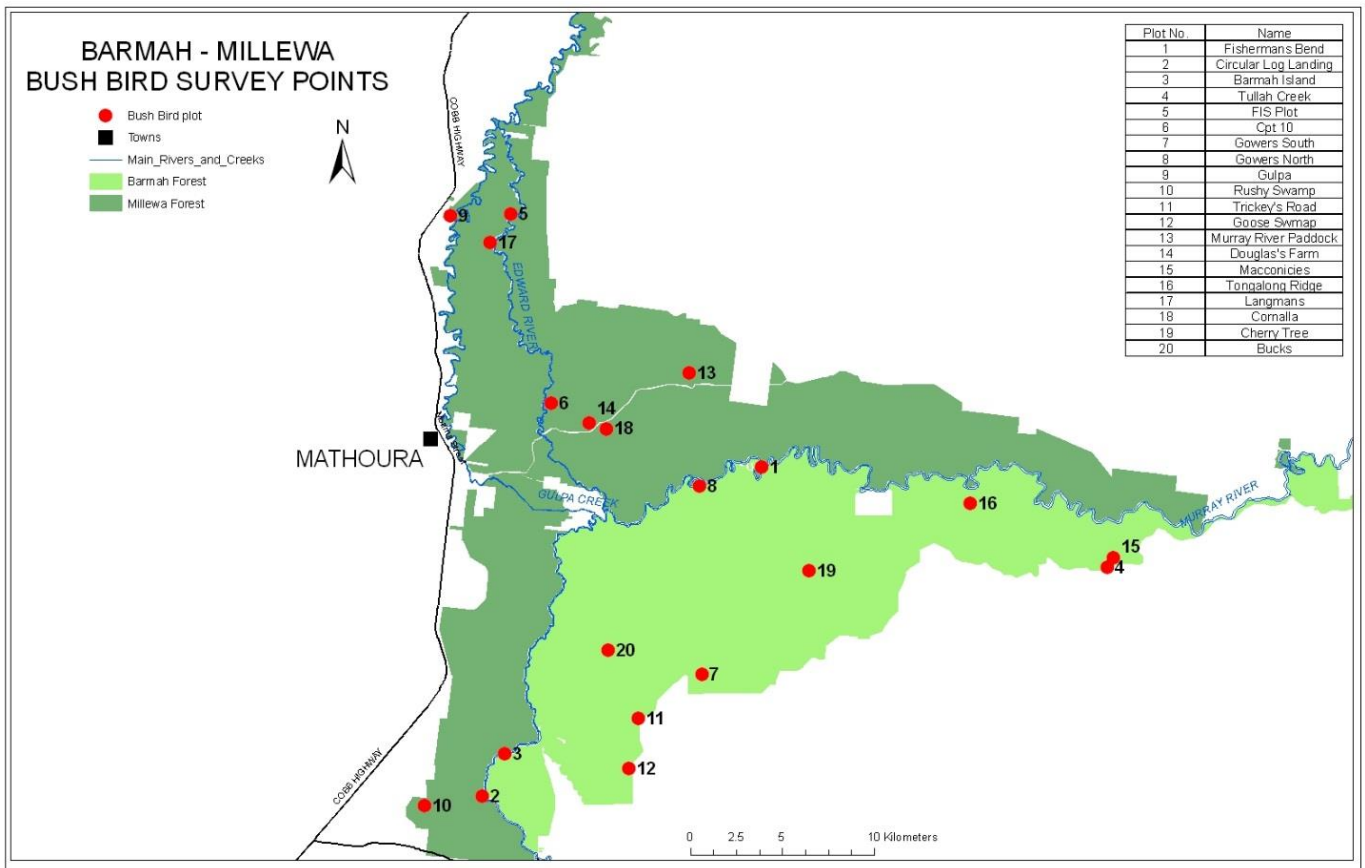


Figure 1: Location of bush bird monitoring sites within the Barmah-Millewa Forest icon site.

Across the five habitat types, two 2ha plots were established in both the Murray Valley National Park (NSW) and in Barmah National Park (Vic). Surveys at each plot were carried out for twenty minutes and are repeated once each season. During the twenty minute survey all birds observed or heard on the plot were recorded. Birds seen or heard outside of the plot were recorded as being present within that habitat type, if the observer was confident that this was the case. Birds flying over or through the plot were recorded as on the plot only if they were species that utilise the air space to forage for food (e.g. brown goshawk *Accipiter fasciatus*, tree martin *Hirundo nigricans*).

In the event of excessively windy weather (i.e. crowns of the trees moved violently) or rain, surveys were not undertaken. Each plot was visited either prior to 9am (early) or between 9am and 12pm (late). This ensures all counts are completed by 12:20pm. Early and late sessions are alternated across the four seasons at each site, to minimise potential bias in the results.

No nocturnal bird surveys are undertaken as part of this project. There were also no targeted surveys undertaken for significant, rare or threatened species.

2.2 Data Interpretation

The review of condition monitoring programs for icon sites in the Living Murray (TLM) initiative resulted in a set of concise key outcome descriptions being developed for refined components. The aim of these outcome descriptions is to allow the determination of icon site condition through evaluating particular parameters. Barmah-Millewa has a set of bush bird data that has been collected over a period of ten years, which enabled indices to be developed. The objective that was adopted by the project was that the overall health or condition of the floodplain and non-floodplain woodland habitats within Barmah-Millewa Forest would be reflected by health woodland bird populations (Robinson, 2014b).

Three parameters were used in developing the Icon Site Condition Assessment (ISCA). These were species richness of Victorian Woodland Bird Community (VWBC), extent of VWBC species and total species richness.

The Victorian temperate woodland bird community species list was extracted from the Flora and Fauna Guarantee and includes woodland dependant and woodland associated bird species. The VWBC index may be a truer indicator of bush bird community health, as it only takes into account species that are reliant on temperate woodlands, and not species utilising other habitats. For this report, both the VWBC index and the total species index are referenced to as there can be large discrepancies between them. By comparing the two values, more information can be gleaned on the bird communities utilising the forest.

Using these indices, icon site condition assessment scores were developed for all site types in the Barmah-Millewa condition monitoring program (Table 1). These scores will be compared to scores

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achieved, to give an indicator on change in species diversity over time and forest condition from year to year.

habitat	number of sites in database	90th percentile total species richness	90th percentile VWBC species richness
BOX	44	12	9
RRGQ1	55	10	10
RRGQ2	32	9	8
RRGQ3	39	12	11
SANDH	44	12	11

Table 1: The reference scores developed for each of the survey habitat types (Robinson, 2014b)

3. Results

Spring

The spring 2015 surveys for bush birds were conducted between the 8th and 13th of November. A total of 251 individuals and 54 bird species were recorded, including 6 species that were recorded in the adjoining habitat (see section 2 for definition of the habitat) (Appendix B). There were 4 species recorded that have been classified as vulnerable (Table 1).

Count	Species	Status	Sites
2	Superb Parrot <i>Polytelis swainsonii</i>	Vulnerable	Box 4
2	Diamond Firetail <i>Stagonopleura guttata</i>	Vulnerable	Box 4, Sandhill 3
3	Varied Sittella <i>Daphoenositta chrysoptera</i>	Vulnerable	Box 1, Box 3, Gowers Nth
1	Black-chinned Honeyeater <i>Melithreptus gularis</i>	Vulnerable	Box 4

Table 2: Threatened and vulnerable species recorded during spring surveys, as per the NSW Threatened Species Conservation Act [TSC Act] 1995 and Victoria DSE 2013

The ISCA scores for spring show that most of the habitats achieved VWBC scores below the reference scores (Figure 2). The only habitat that wasn't below the VWBC reference score was the RRGQ1 habitat which was equal. The total score across all habitats was closer to the total reference scores, with RRGQ1 and RRGQ2 exceeding the reference scores.

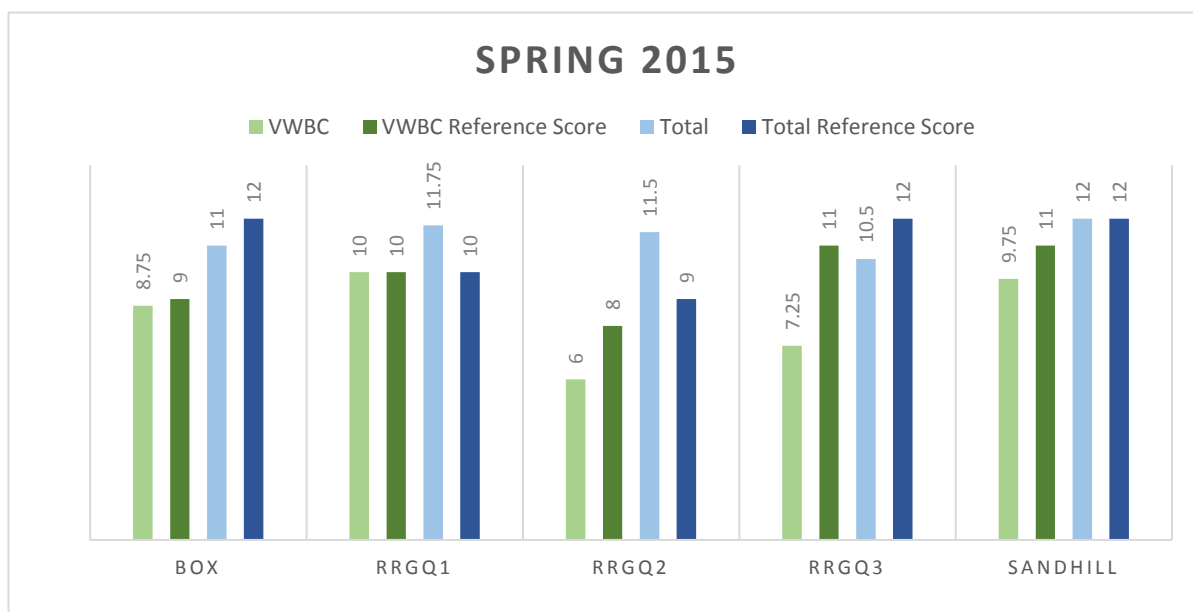


Figure 2: ISCA Scores for spring across the five habitat types in Barmah-Millewa. The VWBC score only uses birds listed on the Victorian Woodland Bird Communities list, whilst the total takes into account all species present.

Summer

The summer 2016 surveys for bush birds were conducted between the 19th and 25th of January. A total of 259 individuals and 47 bird species were recorded (Appendix B), of which 11 were recorded in the adjoining habitat. There were 3 species recorded that have been classified as vulnerable (Table 3).

Count	Species	Status	Sites
H	Hooded Robin <i>Melanodryas cucullata</i>	Vulnerable	Box 4
H	Black-chinned Honeyeater <i>Melithreptus gularis</i>	Vulnerable	Box 3
1	Little Eagle <i>Hieraetus morphnoides</i>	Vulnerable	FIS Plot

Table 3: Vulnerable species recorded during the summer surveys, as per the NSW Threatened Species Conservation Act [TSC Act] 1995 and/or Victoria DSE 2013.

The summer ISCA scores across all the habitats scored below the reference score for the VWBC (Figure 3: ISCA Scores for summer. Figure 3), however some of the total ISCA scores (Box, RRGQ1 and RRGQ2) exceeded the total reference score.

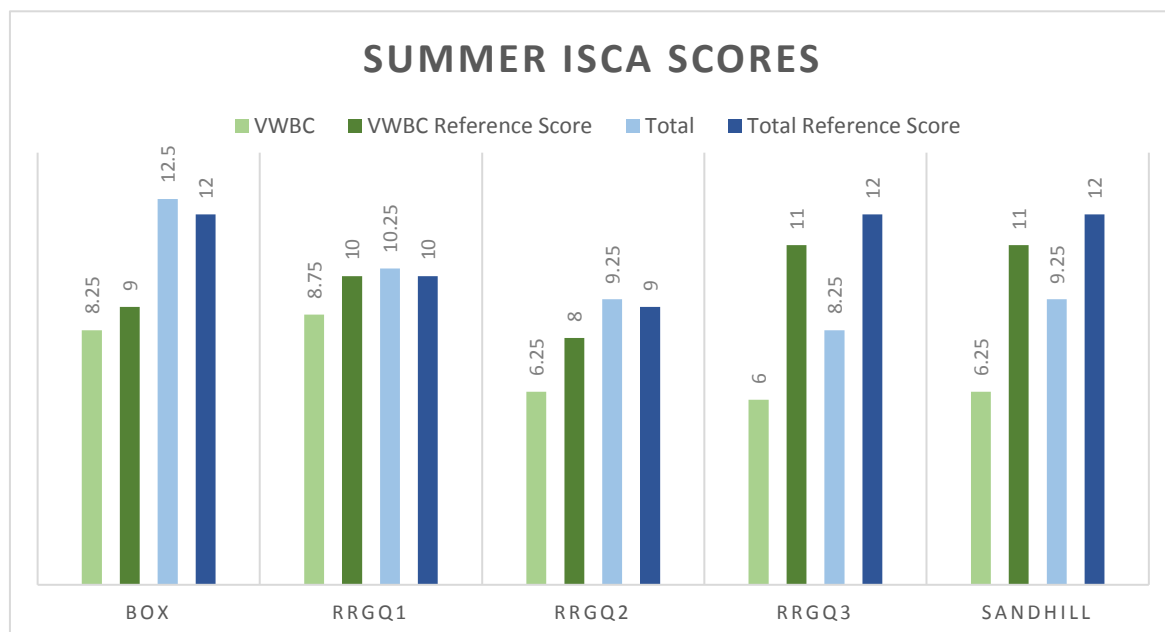


Figure 3: ISCA Scores for summer. The VWBC score only uses birds listed on the Victorian Woodland Bird Communities list, whilst the total takes into account all species present.

Autumn

The autumn 2016 surveys were conducted between the 20th of April and the 30th of May. A total of 346 individual birds were recorded, and 49 different species with an additional 6 species identified in the habitat. One species classified as vulnerable was recorded (Table 4).

Count	Species	Status (TSC Act, 1995)	Sites
4	Flame Robin <i>Petroica phoenicea</i>	Vulnerable	Gowers Nth, Sandhill 1

Table 4: Vulnerable species recorded during the autumn surveys, as per the NSW Threatened Species Conservation Act [TSC Act] 1995 and/or Victoria DSE 2013.

The autumn ISCA VWBC scores are all below the reference scores (Figure 4), except for the RRGQ2 habitat which exceeded the reference score. It was also the only habitat where the total species exceeded the reference score. Box and RRGQ1 habitats achieved considerably lower scores across the VWBC and total reference scores, than in summer and spring.

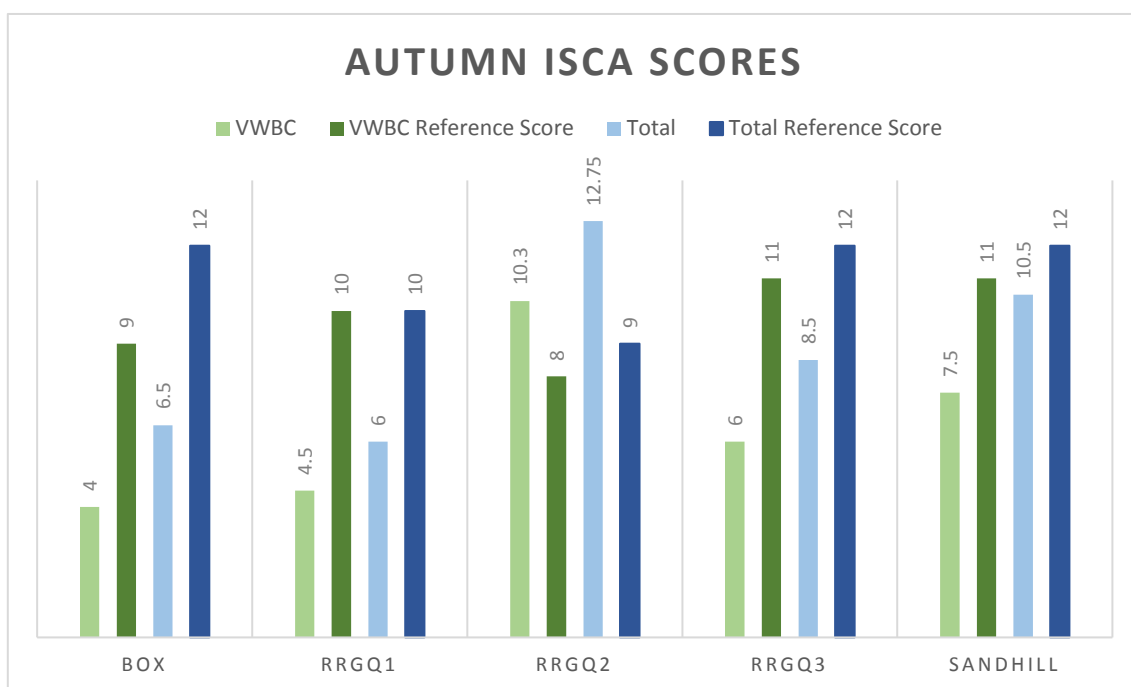


Figure 4: ISCA Scores for autumn. The VWBC score only uses birds listed on the Victorian Woodland Bird Communities list, whilst the total takes into account all species present.

Winter

The winter surveys were conducted between the 13th of June and the 21st of June. A total of 266 birds were counted, and 33 different species. Two species classified as vulnerable were recorded (Table 5).

Count	Species	Status (TSC Act, 1995)	Sites
1	Flame Robin <i>Petroica phoenicea</i>	Vulnerable	Sandhill 3
2	Scarlet Robin <i>Petroica boodang</i>	Vulnerable	Gowers Sth

Table 5: Vulnerable species recorded during the winter surveys, as per the NSW Threatened Species Conservation Act [TSC Act] 1995 and/or Victoria DSE 2013.

The winter ISCA scores were all much lower than both the reference scores, across all the surveyed habitats (Figure 5). The sandhill habitat returned the lowest scores from all the habitats, with the large differences between the both the VWBC and the total species reference values. The RRGQ2 habitat appears to be the closest in returning scores close to the reference scores.

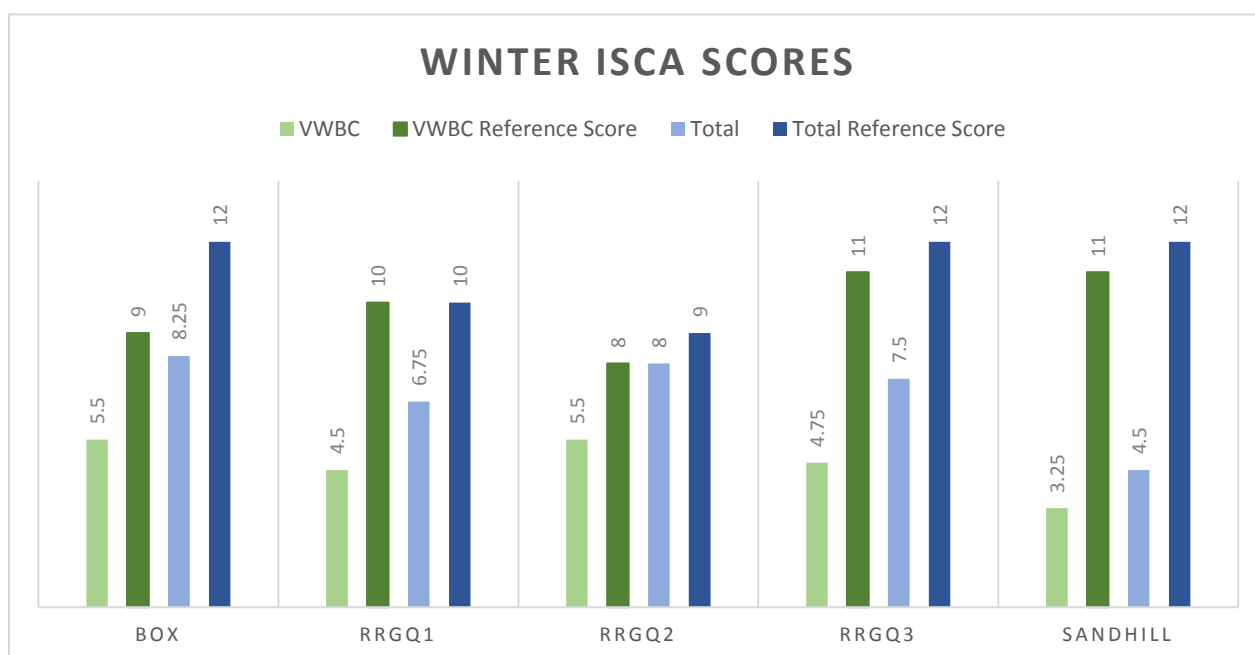


Figure 5: ISCA Scores for winter. The VWBC score only uses birds listed on the Victorian Woodland Bird Communities list, whilst the total takes into account all species present.

Results from across the year

Seven species which have been listed as declining were identified in the 2015-16 surveys (Table 6). Six were identified across all seasons and two were identified as present in 75% of the seasons.

Species	Status	Presence
Brown treecreeper <i>Climacteris picumnus</i>	Declining	All seasons
Jacky winter <i>Microeca fascinans</i>	Declining	All seasons
White-browed babbler <i>Pomatostomus superciliosus</i>	Declining	Spring, Autumn, Winter
Rufous whistler <i>Pachycephala rufiventris</i>	Declining	All seasons
Dusky woodswallow <i>A. cyanopterus</i>	Declining	Spring, Autumn, Winter
Restless flycatcher <i>Myiagra inequata</i>	Declining	All seasons
Red-capped robin <i>Petroica goenovii</i>	Declining	All seasons

Table 6: Bush birds that were recorded in the 2015-16 surveys which are listed as declining in the wheat sheep belt (Reid, 1999). All these species have recorded previously (i.e. during earlier surveys Webster 2004a, 2008a, b, c, d, OEH 2012a, b, c).

The total number of individuals identified in the 2015-16 Barmah-Millewa surveys is summarised in Figure 6. The spring total individuals was below the mean for all previous years, whilst autumn and winter exceeded the mean for all previous years. NSW and Victoria recorded similar numbers of individuals in spring and summer, however NSW recorded 38% more individuals in autumn and 28% more in winter.

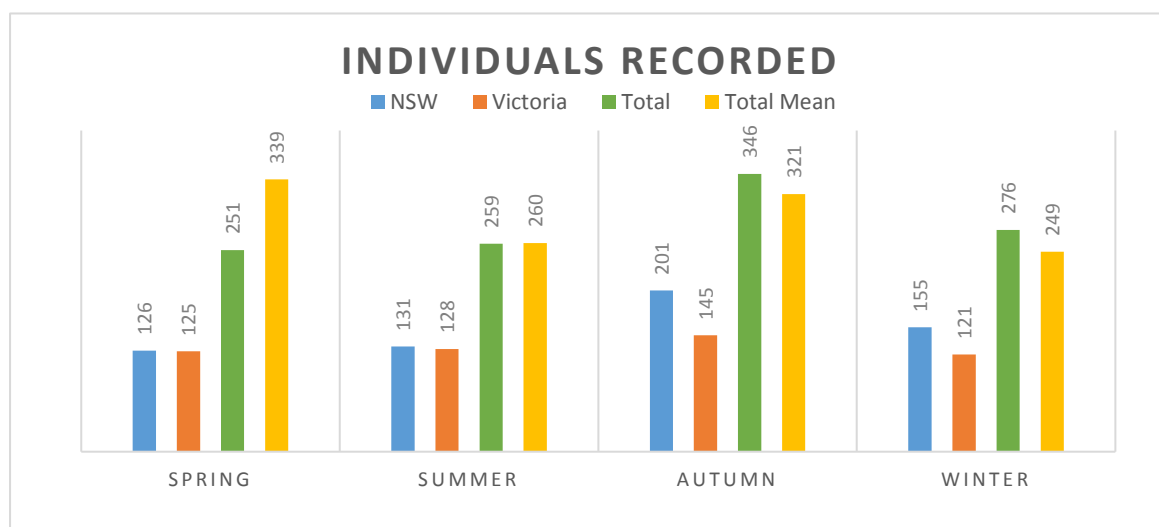


Figure 6: Total number of individuals recorded in Barmah and Millewa in the 2015-16 surveys and the mean individuals calculated from previous year's survey data.

The ISCA Score was calculated for 2015-16 (Table 7). The only habitat to exceed the VWBC reference score was RRGQ2. RRGQ2 also returned species totals that exceeded the reference score for spring, summer and autumn. RRGQ1 returned a score that was equal to the VWBC reference score in spring. Winter consistently scored below the reference values, whilst spring and summer had the highest incidence of values scored. ISCA scores can be viewed for the survey data for all years in Appendix A.

	Box		RRGQ1		RRGQ2		RRGQ3		Sandhill	
	Total	VWBC	Total	VWBC	Total	VWBC	Total	VWBC	Total	VWBC
Spring	11	8.75	11.75	10	11.5	6	10.5	7.25	12	9.75
Summer	12.5	8.25	10.25	8.75	9.25	6.25	8.25	6	9.25	6.25
Autumn	6.5	4	6	4.5	12.75	10.3	8.5	6	10.5	7.5
Winter	8.25	5.5	6.75	4.5	8	5.5	7.5	4.75	4.5	3.25

Table 7: The icon site condition assessment scores recorded for 2015-16. Green indicates that the score is higher than the reference value, the yellow indicates that the value is equal to the reference value and the red indicates that the value calculated is lower than the reference value. The reference values that were used to calculate increases and decreases can be found in section 2.2. The first column is the total richness, and the second column is the VWBC richness. The total score is higher, as it includes all the bird species found in the surveys, whilst the VWBC total only takes into account species listed on the Victorian Woodland Bird Community list. This score is more likely to reflect changes in the environment.

Monitoring which occurs across the seasons allows changes in bird assemblages to be documented. In 2015-16, 23% of the birds recorded were only recorded in one season, with 36% occurring in all seasons. The birds that were identified in a single season included the superb parrot (vulnerable), varied sittella (vulnerable), Australian owl nightjar and diamond firetail (vulnerable). Some species may have only been recorded in limited seasons as their preferred habitat may not have been included in the monitoring sites (e.g. superb parrots are only present in particular sections of the forest). Species such as varied sittellas are probably utilising the forest all year round, but are highly mobile and therefore may not be present on the survey sites at the time the surveys are conducted.

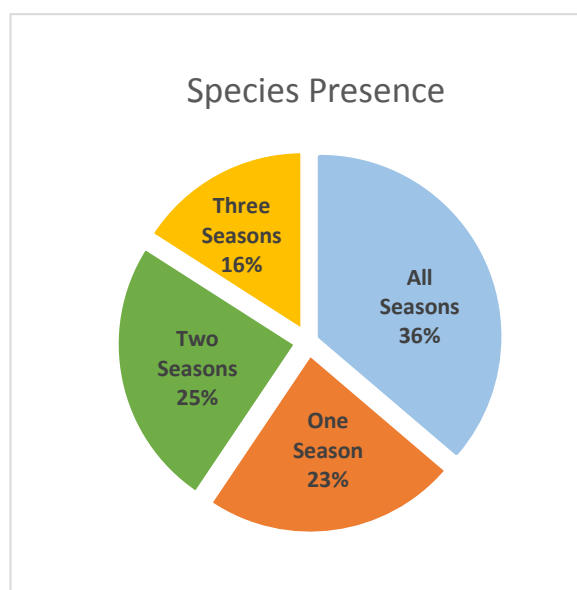


Figure 7: Species presence across the seasons in Barmah-Millewa.

Among the birds relying on Barmah-Millewa Forest all year are five of the species listed as declining in the wheat sheep belt. Two additional declining species were identified as present during 75% of the year.

4. Discussion

Since data collection began, ninety species have been identified either on the survey plots or in the surrounding habitat. A complete list of bush bird species recorded during bush bird surveys within Barmah-Millewa Forest since spring 1999 is included in Appendix 1. The species diversity determined from The Living Murray (TLM) bush bird surveys is less than identified by Tzaros (2001). Tzaros (2001) surveyed bush bird communities in riparian habitats from the Ovens River in the east, to Walpolla Island in the west and identified 143 species utilising river red gum forests/woodlands. The difference in species diversity between the two surveys could be accounted for by the larger geographical area covered in Tzaros's surveys compared to the targeted Barmah-Millewa Forest surveys. Tzaros's surveys also included Wandown Nature Reserve (a mallee dominated reserve) which would cause further disparities in species abundance and richness between the two studies.

Chesterfield *et al.* (1984) surveyed Barmah National Park (formerly state forest) by monitoring six 4ha study plots for one hour over two years (1977 & 1978). In addition to this, the study also included opportunistic observations and historical records in their total species diversity list (108 species). Although the current study has been conducted over the whole icon site and over a longer time frame than Chesterfield *et al.*'s (1984) study, the differences in methodology (the current study only recorded species during a 20 minute count on a 2ha survey plot compared to one hour over 4ha) and inclusion of historical records by Chesterfield *et al.* (1984) most likely accounts for the differences in the total species diversity recorded by the two studies.

The management plan produced by Forestry Commission (FC) of NSW (1985) for the Murray Area (which included all state forests along the Murray, Wakool and Edward Rivers between Tooleybuc in the west and Corowa in the east, including the Millewa group of forests) recorded 153 species utilising the forest blocks. The difference in species diversity between the management plan and the current study can probably be attributed to the much larger area covered by the management plan than the current survey.

Since surveys began in 1999, one nationally threatened species (*EPBC Act 1999*), the superb parrot *Polytelis swainsonii* has been identified. The superb parrot is also listed as vulnerable in NSW. Over this time ten threatened or significant species (*NSW TSC Act 1995*, DSE 2013) have been recorded (Appendix 1) within the icon site. No introduced species have been recorded on the survey plots or in the surrounding habitat.

Robinson and Trail (1996) and Reid (1999) conducted a review of the status of woodland birds within the wheat-sheep belt nationally and within New South Wales. The review identified forty one species (including two extinct species and sixteen threatened species) as declining. From these lists, eighteen species have been recorded within Barmah-Millewa (Appendix 1) since surveys commenced in 1999.

In order to be classified as declining, a species must have *'undergone widespread reductions in abundance and occurrence in southern Australia, reflected in diminishing population sites and shrinking distributional ranges'* (Watson, 2011). Despite declining population numbers, many woodland species possess widespread distributions and as such, are not yet listed as threatened (Traill, 2015). It is likely that other woodland species in southern Australia are also in decline (Robinson & Traill, 1996; Reid, 1999). The decline of woodland bird species not only raises concerns for the biodiversity of Australia's bird life, but also the health of overall forest ecosystems with woodland bird numbers inextricably linked to forest health and productivity (Watson, 2011). The long term collection of bird data is an important tool to assess overall forest health and ensure a holistic approach to management.

Icon Site Condition Assessment Scores

The ISCA score derived from the summer surveys is the most indicative of forest condition out of the surveys from the four seasons. Robinson (2014b) found that there was not a significant difference in species richness between winter, autumn or spring ($p > 0.05$) across all years analysed in the Barmah-Millewa condition monitoring surveys. However, in summer there was a significant difference between years ($p < 0.0001$), and this depended on which habitat was being considered ($p < 0.05$). The current sampling strategy is able to detect a change of 13% or less when looking at the summer ISCA scores.

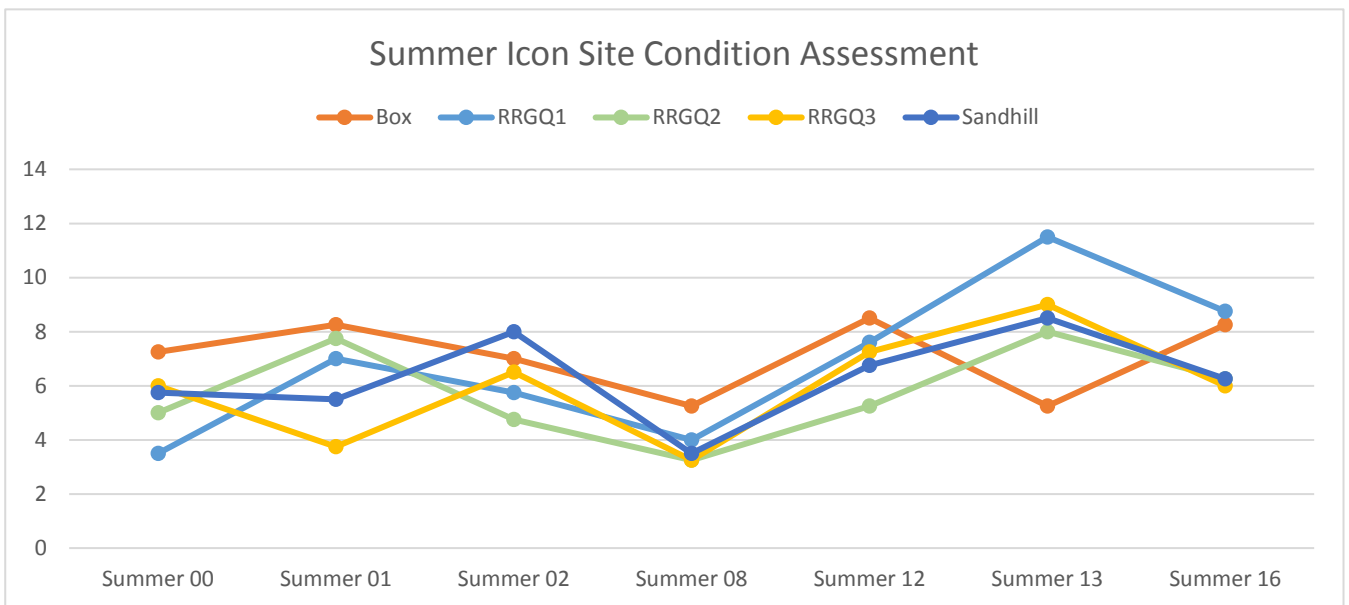


Figure 8: The ISCA scores for each habitat graphed against the years which have been surveyed.

The scores from the summer surveys show the driest years (2008) scoring the lowest overall ISCA scores and the wetter years achieving higher ISCA scores (2012 and 2013), indicating forest health decreased during the 2000's and forest condition began to increase when the drought ended in 2010/11. All habitat types followed a similar trend line across the years under the summer conditions (Figure 8), with decreases heading into 2008, and an upward movement in the following years. The box habitat appears

to have experienced the least response to rapid change in environmental conditions, with limited variation across the years and a less significant decrease in 2008 when compared with the other habitat types. This could be due to the lower frequency of flooding required to maintain healthy box habitats as it occurs generally on higher elevations which are not inundated regularly. Box habitat may be slower to respond to changes in environmental conditions, and may be more effective at showing changes caused by long term climate change. Summer 2013 returned an unusually low value for the box habitat considering the wet conditions received in that year, however there was a considerable increase in RRGQ1 scores in that year indicating that forest condition was responding. The relatively short term set of data means that it is not clear whether short term drops/increases which are not consistent between all habitat types are anomalies or there are other variables influencing the results.

The ISCA scores indicate that the condition of the habitat within Barmah-Millewa Forest decreased in condition throughout the millennium drought and have improved over the last five years (due to flooding and environmental water use), with the river red gum habitats responding particularly well. There has been a decrease in scores since 2013, and this could be attributed to lower flows in the Murray River below Yarrawonga Weir compared to 2011 and 2012.

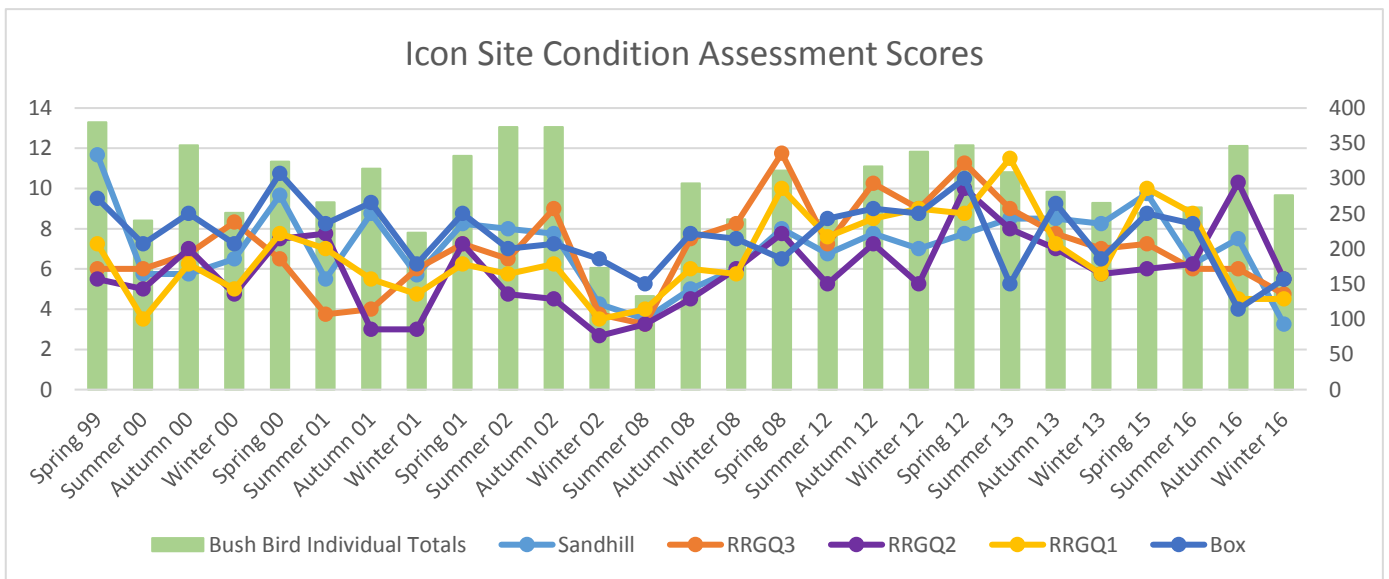


Figure 9: Icon Site Condition Assessment scores for all years surveyed and across all seasons, compared with total bush bird individuals recorded. Changes in total bird individuals appears to follow similar trends to the ISCA scores, however, some anomalies are seen after the wet period in 2000/2001.

Figure 9 plots the scores calculated for each habitat across the seven years surveyed, and across all the seasons. There was a spike in spring 2000 which occurred alongside high flow conditions, resulting in long periods of overbank flows (Figure 10). The year after this, in spring, summer and autumn of 2001/02 there was an increase in the total individuals recorded. This could be the result of improved forest health due to widespread flooding, providing good breeding conditions for bush birds in the following year.

A small flood event in 2002 before the region experienced a significant dry period for a number of years. This dry period is reflected with a drop in ISCA scores heading into winter 2002 and going into summer early 2008 before a peak in spring late 2008. As 2008 was the first year of surveys after a five year absence, it's unclear what led to the spring increase in scores. RRGQ3 scored particularly well in the spring of 2008, with an all-time high score. This could be attributed to a small increase in the average yearly rainfall in 2008 after receiving its lowest rainfall ever recorded in 2006, however it is still far lower than rainfall recorded in the late 1990's. The annual mean rainfall for Mathoura is 442mm a year (recorded from the Mathoura State Forest Gauge, the closest gauge to the National Park), and rainfall in 2008 was 347mm, with the preceding years (2006 and 2007) also recording very low rainfall(BOM, 2016). Hence, the higher scores in late 2008 could possibly be the result of the forest acting as a drought refuge in an otherwise, very dry region.

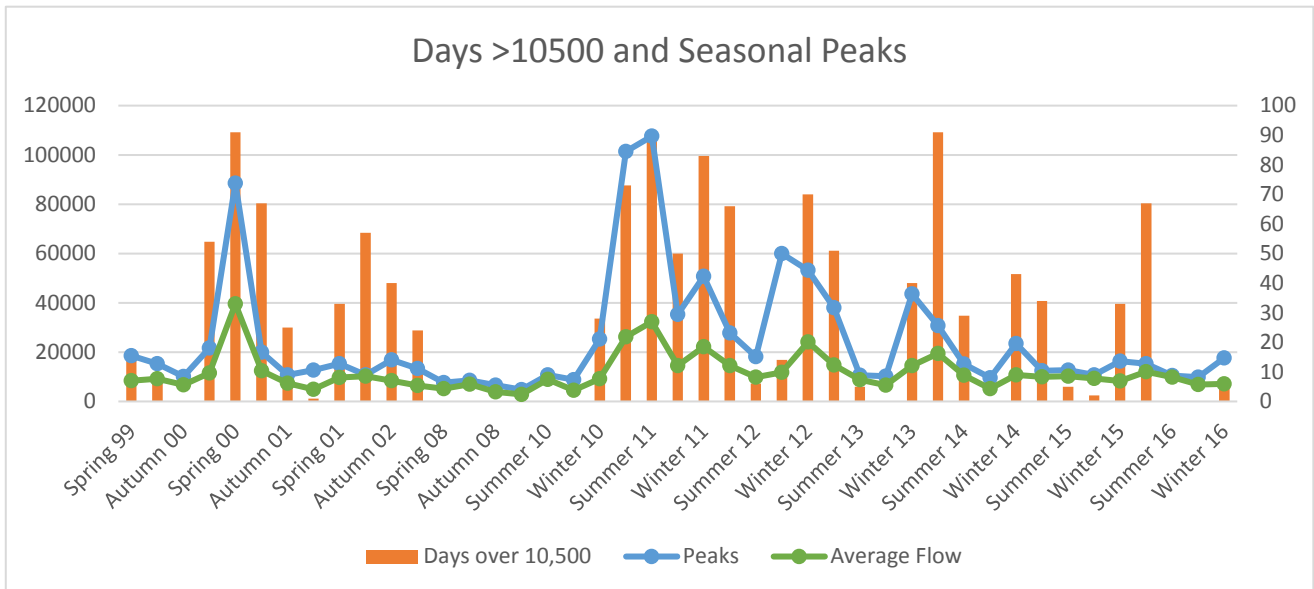


Figure 10: The average flow for each season which has been surveyed and the peaks for each season. The number of days in flows greater than 10500 ML/day is also plotted. 10500ML/d amounts to overbank flows through the Barmah-Millewa choke and regulators into the forest must be opened to ensure that the banks are not over topped. This has been assumed that some flooding as occurred in the forest as a result (equally days that the floodplain has been inundated).

In 2015-16, the year began with fairly average scores recorded which may have been the result of Barmah-Millewa Forest receiving environmental water over the spring/summer period. However, the period of overbank flows that were received was limited (Figure 10). ISCA scores decreased in the autumn/winter period which were relatively dry. Notable trends in 2015-16 is the increase in RRGQ2 habitat score which returned a particularly high score in autumn, compared to previous year's scores.

The ISCA score ranked 2015-16 as the fourth best year, out of the seven years in which bush bird data has been collected. 2013, 2012 and 2000 ranked higher than 2015-16 (respectively). The lower scores recorded could be due to the smaller flood/e-watering events in 2014-15 and 2015-16, which did not

achieve the extent of inundation as compared to 2011 and 2012 and the below average rainfall received (BOM, 2016) . The reduced inundation experienced may have had a negative impact on the condition of the forest types and availability of food resources within Barmah-Millewa thus resulting in reduced ISCA scores. Flood history and bush bird assemblages have been linked, with significant relationships found between the frequency of flooding in river red gum habitats and species diversity (Blackwood, 2010).

This relationship is reflected in data collected through the TLM tree and stand condition monitoring. The data from 2012 showed a 5.4% increase in vegetation classified as ‘good’ in Barmah-Millewa, a year which produced the second best ISCA scores. This change correlated with a decrease in the ‘poor’ category (Figure 11). The 2015 data shows a decrease of 4% in the ‘good’ category, with this loss reflected with increases across the ‘moderate’ and ‘poor’ classes. This further demonstrates a link between tree and stand condition and the ISCA scores, and the tracking of ecosystem health through bush birds.

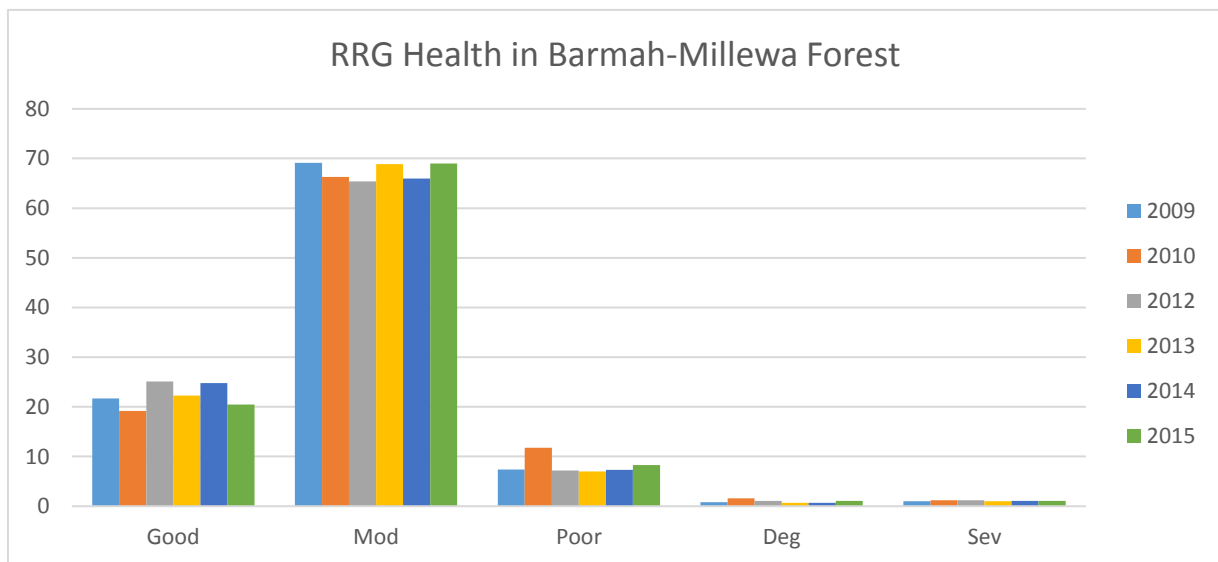


Figure 11: River red gum health which has been mapped by the MDBA using satellite imagery and ground surveys for validation (MDBA, 2015).

Conclusion

2015-16 ranked fourth out of the seven years surveyed. This demonstrates that low flows and shallow inundation in limited parts of the forest may not be achieving maximum vegetation outcomes, which has influenced the presence of bush birds.

The high variability in the returned ISCA scores from year to year indicates that the health of the forest is highly dynamic and responds quickly to changes in environmental conditions. The ISCA scores show that the relationship between bush birds and wetlands in Millewa is complex with multiple variables impacting on bush bird richness and extent. The complex relationship between rainfall, overbank flows and temperature which influence whole of ecosystem health could dictate how bush birds behave.

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By comparing TLM tree and stand condition monitoring data with the ISCA scores, it can be seen that general trends are present and the health of bush bird communities can be indicative of the status of the condition of the forest.

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6. Appendices: Appendix A

Icon Site Condition Assessment Scores

Spring	1999	Box	14.25	9.5	RRGQ1	9.75	7.25	RRGQ2	8.25	5.5	RRGQ3	9.25	6	Sandhill	15.25	11.67
Summer	2000	Box	10.75	7.25	RRGQ1	5	3.5	RRGQ2	8	5	RRGQ3	8.75	6	Sandhill	9.25	5.75
Autumn	2000	Box	12.25	8.75	RRGQ1	8.5	6.25	RRGQ2	10.25	7	RRGQ3	10	6.75	Sandhill	8.5	5.75
Winter	2000	Box	10.75	7.25	RRGQ1	6.75	5	RRGQ2	7	4.75	RRGQ3	12.33	8.33	Sandhill	10.5	6.5
Spring	2000	Box	15.25	10.75	RRGQ1	11.25	7.75	RRGQ2	11.25	7.5	RRGQ3	8.75	6.5	Sandhill	15.33	9.67
Summer	2001	Box	12.5	8.25	RRGQ1	9	7	RRGQ2	9.5	7.75	RRGQ3	5.5	3.75	Sandhill	7.75	5.5
Autumn	2001	Box	15	9.3	RRGQ1	7	5.5	RRGQ2	4	3	RRGQ3	5	4	Sandhill	11	8.75
Winter	2001	Box	10.75	6.25	RRGQ1	5	4.75	RRGQ2	4	3	RRGQ3	9.25	6	Sandhill	7.25	5.7
Spring	2001	Box	12	8.75	RRGQ1	8.5	6.25	RRGQ2	9.25	7.25	RRGQ3	11.5	7.25	Sandhill	10.25	8.25
Summer	2002	Box	11.25	7	RRGQ1	7.5	5.75	RRGQ2	6.75	4.75	RRGQ3	9.5	6.5	Sandhill	12	8
Autumn	2002	Box	11.25	7.25	RRGQ1	7	6.25	RRGQ2	5.75	4.5	RRGQ3	12	9	Sandhill	13.5	7.75
Winter	2002	Box	9.5	6.5	RRGQ1	5	3.5	RRGQ2	5	2.67	RRGQ3	5.25	3.75	Sandhill	5.75	4.25
Spring	2008	Box	11	6.5	RRGQ1	12	10	RRGQ2	11.25	7.75	RRGQ3	11.75	11.75	Sandhill	10	8
Summer	2008	Box	7.75	5.25	RRGQ1	5.5	4	RRGQ2	5.5	3.25	RRGQ3	5.75	3.25	Sandhill	6	3.5
Autumn	2008	Box	11.25	7.75	RRGQ1	7.5	6	RRGQ2	8	4.5	RRGQ3	9	7.5	Sandhill	8.75	5
Winter	2008	Box	12	7.5	RRGQ1	7.25	5.75	RRGQ2	8.5	6	RRGQ3	10.25	8.25	Sandhill	8.75	6
Summer	2012	Box	13	8.5	RRGQ1	9.25	7.6	RRGQ2	7.25	5.25	RRGQ3	10.25	7.25	Sandhill	11.25	6.75
Autumn	2012	Box	13.5	9	RRGQ1	10.75	8.5	RRGQ2	10	7.25	RRGQ3	13.75	10.25	Sandhill	10.5	7.75
Winter	2012	Box	13.5	8.75	RRGQ1	11.5	9	RRGQ2	7.5	5.25	RRGQ3	12.5	9	Sandhill	9.75	7
Spring	2012	Box	13.75	10.5	RRGQ1	12.25	8.75	RRGQ2	13	10	RRGQ3	13.75	11.25	Sandhill	10	7.75
Summer	2013	Box	10.5	5.25	RRGQ1	14.5	11.5	RRGQ2	10.75	8	RRGQ3	12.25	9	Sandhill	11.75	8.5
Autumn	2013	Box	13	9.25	RRGQ1	10.5	7.25	RRGQ2	8.75	7	RRGQ3	9.5	7.75	Sandhill	11.5	8.5
Winter	2013	Box	9.5	6.5	RRGQ1	8	5.75	RRGQ2	7.75	5.75	RRGQ3	8.25	7	Sandhill	11	8.25
Spring	2015	Box	11	8.75	RRGQ1	11.75	10	RRGQ2	11.5	6	RRGQ3	10.5	7.25	Sandhill	12	9.75
Summer	2016	Box	12.5	8.25	RRGQ1	10.25	8.75	RRGQ2	9.25	6.25	RRGQ3	8.25	6	Sandhill	9.25	6.25
Autumn	2016	Box	6.5	4	RRGQ1	6	4.5	RRGQ2	12.75	10.3	RRGQ3	8.5	6	Sandhill	10.5	7.5
Winter	2016	Box	8.25	5.5	RRGQ1	6.75	4.5	RRGQ2	8	5.5	RRGQ3	7.5	4.75	Sandhill	4.5	3.25

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Appendix B

Species List for Barmah-Millewa

Survey Date		Spring 99	Summer 00	Autumn 00	Winter 00	Spring 00	Summer 01	Autumn 01	Winter 01	Spring 01	Summer 02	Autumn 02	Winter 02	Summer 08	Autumn 08	Winter 08	Spring 08	Summer 12	Autumn 12	Winter 12	Spring 12	Summer 13	Autumn 13	Winter 13	Spring 15	Summer 16	Autumn 16	Winter 16	
Common Name	Scientific name																												
Australian Magpie	<i>Cracticus tibicen</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Australian Owlet-Nightjar	<i>Aegotheles cristatus</i>			X																							X		
Australian Raven	<i>Corvus coronoides</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
Black Kite	<i>Milvus migrans</i>																			X									
Black-chinned Honeyeater*	<i>Melithreptus gularis</i>		X			X					X				X	X	X			X	X	X	X	X	X	X	X		
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	X	X	X		X	X	X		X	X	X		X	X		X	X	X	X	X	X	X	X		X	X	X	
Brown Falcon	<i>Falco berigora</i>	X															X						X						
Brown Goshawk	<i>Accipiter fasciatus</i>														X														
Brown Treecreeper*	<i>Climacteris picumnus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	X	X	X		X	X	X	X	X	X	X			X	X	X	X	X	X		X			X	X		X	X
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chestnut-rumped Thornbill*	<i>Acanthiza uropygialis</i>																			X					X				
Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>				X				X			X	X					X		X							X		
Common Bronzewing	<i>Phaps chalcoptera</i>		X		X	X		X	X	X		X					X	X	X		X	X	X				X	X	

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Crested Shrike-tit*	<i>Falcunculus frontatus</i>	X		X	X	X	X	X		X		X		X	X		X		X	X	X	X	X	X	X	X	
Crimson Rosella (Yellow form)	<i>Platycercus elegans flaveolus</i>	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Diamond Firetail*	<i>Stagonopleura guttata</i>	X		X	X	X		X		X	X		X		X	X	X	X	X		X	X					
Dollarbird	<i>Eurystomus orientalis</i>	X	X			X												X								X	
Dusky Woodswallow*	<i>Artamus cyanopterus</i>	X	X	X	X	X	X	X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	
Eastern Rosella	<i>Platycercus eximius</i>			X			X			X				X	X	X	X	X	X	X	X	X	X	X	X	X	
Emu*	<i>Dromaius novaehollandiae</i>																									X	
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	X			X					X				X	X			X	X								
Flame Robin	<i>Petroica phoenicea</i>				X							X		X											X	X	
Fuscous Honeyeater	<i>Lichenostomus fuscus</i>																									X	
Galah	<i>Eolophus roseicapilla</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Gilbert's Whistler	<i>Pachycephala inornata</i>	X			X	X			X		X			X										X			
Golden Whistler	<i>Pachycephala pectoralis</i>				X				X		X			X	X	X		X	X	X		X	X			X	
Grey Butcherbird	<i>Cracticus torquatus</i>												X													X	
Grey Fantail	<i>Rhipidura albiscapa</i>	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	H	X	X	X	X	X	X	X	
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Hooded Robin*	<i>Melanodryas cucullata</i>	X	X			X		X	X		X		X											X	X		
Horsefield's Bronze-Cuckoo	<i>Chalcites basalus</i>				X	X			X					X					X							X	

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Jacky Winter*	<i>Microeca fascians</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Leaden Flycatcher	<i>Myiagra rubecula</i>											X				X				X							
Little Eagle	<i>Hieraaetus morphnoides</i>																										X
Little Friarbird	<i>Philemon citreogularis</i>	X	X	X		X	X			X	X			X					X	X				X	X		
Long-billed Corella	<i>Cacatua tenuirostris</i>			X			X			X	X			X	X								X				
Magpie-lark	<i>Grallina cyanoleuca</i>	X			X	X	X	X			X				X	X	X				X	X	X	X			
Masked Woodswallow	<i>Artamus personatus</i>														X						X						
Mistletoebird	<i>Dicaeum hirundinaceum</i>	X	X	X		X	X			X	X			X	X	X				X			X			X	
Noisy Friarbird	<i>Philemon corniculatus</i>	X	X			X	X	X		X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Noisy Miner	<i>Manorina melanocephala</i>			X	X				X						X	X	X	X	X	X	X	X	X	X	X	X	X
Olive-backed Oriole	<i>Oriolus sagittatus</i>	X								X																	
Painted Button-quail*	<i>Turnix varia</i>																									X	
Pallid Cuckoo	<i>Cacomantis pallidus</i>				X					X										X						X	
Peaceful Dove	<i>Geopelia cuneata</i>	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Peregrine Falcon	<i>Falco peregrinus</i>																										X
Pied Butcherbird	<i>Cracticus nigrogularis</i>					X		X			X				X			X	X	X	X	X	X	X	X	X	
Pied Currawong	<i>Strepera graculina</i>				X				X					X							X	X					X

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Quail sp.									X											X			X		
Rainbow Bee-eater	<i>Merops ornatus</i>	X	X			X	X			X	X									X	X			X	X
Red-browed Finch	<i>Neochima temporalis</i>		X	X		X	X			X	X														
Red-capped Robin*	<i>Petroica goodenovii</i>	X		X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-rumped Parrot	<i>Psephotus haematonotus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red Wattlebird	<i>Anthochaera carunculata</i>																								X
Restless Flycatcher*	<i>Myiagra inquieta</i>			X	X	X		X	X	X		X		X	X	X	X	X		X	X	X	X	X	X
Rufous Songlark	<i>Cincloramphus mathewsi</i>	X				X						X			X				X	X					
Rufous Whistler*	<i>Pachycephala rufiventris</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sacred Kingfisher	<i>Todiramphus sanctus</i>	X	X			X	X		X			X		X	X			X	X			X	X		
Scarlet Robin	<i>Petroica boodang</i>								X						X		X		X		X		X		X
Silvereeye	<i>Zosterops lateralis</i>	X	X	X		X		X	X	X	X				X	X		X	X	X	X	X	X		X
Southern Whiteface*	<i>Aphelocephala leucopsis</i>	X	X	X	X			X	X	X	X			X	X			X		X	X				
Spotted Pardalote	<i>Pardalotus punctatus</i>	X				X		X		X	X	H		X	X			X	X	X	X	X	X	X	X
Square-tailed Kite*	<i>Lophoictinia isura</i>																								X
Striated Pardalote	<i>Pardalotus striatus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Striated Thornbill	<i>Acanthiza lineata</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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Superb Fairy-wren	<i>Malurus cyaneus</i>	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Superb Parrot*	<i>Polytelis swainsonii</i>			X	X	X			X						X		X		X	X		X							
Swamp Harrier	<i>Circus approximans</i>					X																							
Tree Martin	<i>Hirundo nigricans</i>	X	X	X	X		X	X	X	X	X				X	X	X	X	X	X	X					X	X		
Varied Sittella*	<i>Daphoenositta chrysoptera</i>	X	X	X	X	X	X		X		X			X		X	X		X	X	X		X	X					
Wedge-tailed Eagle	<i>Aquila audax</i>				X			X		X		X	X			X	X			X								X	
Weebill	<i>Smicronis brevirostris</i>	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Welcome Swallow	<i>Hirundo neoxena</i>	X		X	X	X		X	X	X		X			X		X	X	X	X	X		X		X		X	X	
Western Gerygone (Warbler)	<i>Gerygone fusca</i>	X	X			X		X		X	X			X			X	X	X	X	X	X	X		X	X	X		
Whistling Kite	<i>Haliastur sphenurus</i>							X							X	X				X		X	X		X	X		X	
White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>															X													
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>	X						X					X				X	X			X								
White-browed Babbler*	<i>Pomatostomus superciliosus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X		X	X	X	X	X	X	X	X	X	
White-browed Scrubwren	<i>Sericornis frontalis</i>			X			X					X				X			X		X		X				X		
White-browed Woodswallow*	<i>Artamus superciliosus</i>	X							X						X					X	X								
White-naped Honeyeater	<i>Melithreptus lunatus</i>																				X								
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
White-throated Treecreeper	<i>Cormobates leucophaeus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

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White-winged Chough	<i>Corcorax melanorhamphos</i>	X X
White-winged Triller	<i>Lalage sueurii</i>	X X
Willie Wagtail	<i>Rhipidura leucophrys</i>	X X
Woodswallow sp.		X
Yellow Thornbill	<i>Acanthiza nana</i>	X X
Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	X
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>	X X

Appendix C

Site Photos

Appendix D

All data collected (in TLM approved format) in 2015-16