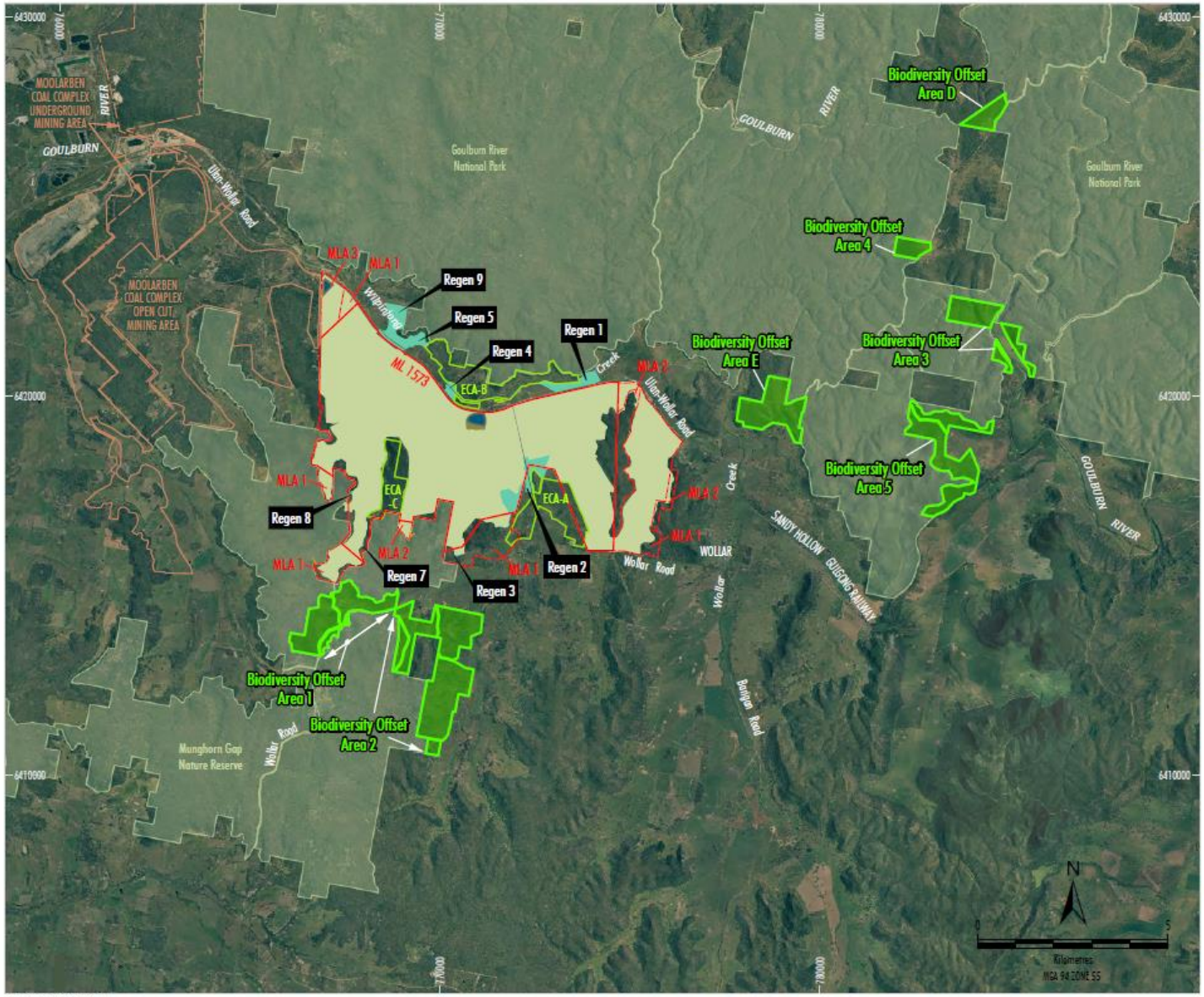
APPENDIX 5 – BIODIVERSITY

Biodiversity Offset Strategy



LEGEND
- Mining Lease Boundary
- Mining Lease Application Boundary
- Final Void
- Rehabilitation Area
- Regeneration Area
- Enhancement and Conservation Area
- Biodiversity Offset Area
- National Park/Nature Reserve

Source: WCPL (2017); NSW Dept of Industry (2015)
Orthophoto: WCPL (Jun 2015, 2011)

Note: Detailed mapping of Regeneration Areas is provided in Appendix 5.

Peabody
WILPINJONG COAL MINE
Project Area and
Biodiversity Offset Strategy

Biodiversity Reports

Wilpinjong Coal Mine

2017 Annual Biodiversity Monitoring Report

Prepared for
Wilpinjong Coal Pty Ltd

14 March 2018

DOCUMENT TRACKING

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Cover photo	(Clockwise from top left) Spotted Marsh Frog; New Holland Mouse; Reference Site 20 Goulburn River National Park (Photo credit: Tom Kelly)

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Abbreviations

Abbreviation	Description
BMP	Biodiversity Management Plan
BOA	Biodiversity Offset Area
DNG	Derived native grassland
ECA	Enhancement and Conservation Area
EIS	Environmental Impact Statement
ELA	Eco Logical Australia Pty Ltd
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
FL	Fallen Logs
IPT	Interim Performance Target
LFA	Landscape Function Analysis
LOI	Landscape Organisation Index
Microbat	Microchiropteran bat
ML	Mining Lease
MOP	Mine Operations Plan
NGC	Native Ground Cover
NMC	Native Midstorey Cover
NOC	Native Overstorey Cover
NP	National Park
NPWS	National Parks and Wildlife Service
NR	Nature Reserve
OR	Overstorey Regeneration
NSR	Native Species Richness
PA	Project Approval
SSA	Soil Surface Assessment
TSC Act	*Threatened Species Conservation Act 1995*
WCM	Wilpinjong Coal Mine
WCPL	Wilpinjong Coal Pty Ltd
WEP	Wilpinjong Extension Project
WSGW	Western Slopes Grassy Woodland
WSDSF	Western Slopes Dry Sclerophyll Forest

Summary of key findings

Biodiversity monitoring undertaken at the Wilpinjong Coal Mine (WCM) during 2017 represented the second year of monitoring for autumn, and the third year of monitoring for spring under the methodology prescribed in the WCM Biodiversity Management Plan (BMP). Monitoring consisted of:

- Vegetation (Biometric) monitoring – Autumn and spring
- Winter bird monitoring
- Landscape function analysis (LFA) – spring
- General fauna monitoring – spring

Vegetation monitoring during 2017 surveyed a total of 65 sites within all Management Domains and Reference sites. Whilst no sites achieved the Interim Performance Targets (IPTs) for all site attributes, both seasons show significant increases compared to the previous monitoring periods, with 17 of 19 sites in autumn and 20 of 22 sites in spring meeting their targets for over half of all site attributes. It should be noted that whilst data recorded in autumn 2017 monitoring shows significant trends, some results and variability are likely correlated to the variation in their relevant IPTs from Year 0 (Baseline) to Year 1 (Years 1-5).

The results collected at Reference Sites during both autumn and spring 2017 monitoring, continue to add to the dataset to be used for comparison with vegetation sites within the various Management Domains. Ongoing monitoring data collected at the Reference Sites will be used to develop more relevant, locally based benchmark values against which future monitoring data would be analysed.

Groundcover, in the form of living flora species, litter and rock material has been monitored within ECAs since 2007, Rehabilitation Areas since 2009 and Regeneration Areas (formerly Regrowth Areas) since 2011. This data can be correlated with the LFA data captured in 2015 - 2017, and both data sets demonstrate consistently high scores since monitoring commenced. Similarly, low levels of erosion observed throughout previous monitoring seasons (2007-2013) can be correlated with the high SSA Stability scores and the lack of any substantial erosion (as recorded in the erosion SSA assessment) recorded since 2015. Overall these combined data sets demonstrate that consistently stable landforms occur across the WCPL Management Domains.

Fauna monitoring undertaken in 2017 recorded 116 fauna species, comprising two amphibian, 12 mammal (including 10 positively identified microbat species), 14 reptile and 88 bird species. Four introduced species were recorded, and 12 fauna species listed as vulnerable under the BC Act and/or the EPBC Act were recorded. Bird species richness ranged from 39 species (R7_101) to 14 species (R1_101) with the Willy Wagtail being the most commonly occurring bird species, recorded at 22 of 25 of the bird monitoring sites. The Eastern Bentwing Bat was the most commonly occurring microbat species, recorded at all 12 bat monitoring sites. Microbat species richness ranged from two species (A_104) to eleven species (E_104).

Overall species diversity has decreased from 2016 monitoring; however, on-going monitoring will determine if the system is stabilising after a peak or if there is a continued downward trend.

1 Introduction

Wilpinjong Coal Pty Ltd (WCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody), operates the Wilpinjong Coal Mine (WCM) situated approximately 40 km north-east of Mudgee, within the Mid-Western Regional Council Local Government Area, in the Western Coalfields of NSW. Project Approval (PA) 05-0021 was granted by the Minister for Planning under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* on 1 February 2006. Development Consent SSD-6764 was granted on 24 April 2017 for the Wilpinjong Extension Project (WEP) and will replace PA 05-0021 once activities under the WEP commence.

The WCM Biodiversity Management Plan (BMP) (WCPL 2017) was prepared to fulfil the requirements of the PA and in accordance with the Environmental Impact Statement (EIS) and Statement of Commitments. The BMP details the management strategies, procedures, controls and monitoring programs required to manage biodiversity within the Management Domains, which include Enhancement and Conservation Areas (ECAs), Biodiversity Offset Areas (BOAs), and Regeneration and Rehabilitation Areas. The Management Domains are listed below in **Table 1-1** with locations shown in **Figure 1**.

Eco Logical Australia (ELA) was engaged by WCPL to undertake biodiversity monitoring of terrestrial flora, fauna and landscape stability during autumn, winter and spring 2017, consistent with the requirements and methods outlined in the BMP (WCPL 2017). This report summarises the results of the biodiversity monitoring undertaken during autumn, winter and spring 2017 and provides an analysis against the Interim Performance Targets and Completion Criteria set out in the BMP (WCPL 2017). A comparative analysis against the baseline data is included where applicable to inform future monitoring and to promote progress towards achieving the Interim Performance Targets and Completion Criteria.

1.1 Objective

The objective of the biodiversity monitoring at WCPL is to ensure that the Management Domains are progressing towards the relevant Completion Criteria. The biodiversity monitoring includes assessment of native vegetation and habitat complexity, landscape stability and fauna diversity (WCPL 2017). Monitoring results from spring 2015 and autumn 2016 represent the baseline (Year 0) data for each monitoring site, with the 2017 results presented in this report representing Year 2 and Year 1 data for spring and autumn respectively.

Table 1-1: WCPL Management Domains

Management Domain	Area (ha)	Location Description
BOA-D	50.36	Located approximately 12 km north-east of Mining Lease (ML) 1573
BOA-E	160.18	Located approximately 3 km east of ML 1573
ECA-A	180.52	Located to the south-east of ML 1573
ECA-B	224.3	Located to the north of ML 1573
ECA-C	97.29	Located in the south-east portion of ML 1573
Regeneration Area 1	78.98	Located adjacent to the eastern boundary of the approved disturbance area
Regeneration Area 2	90.52	Located on the western side of ECA-A
Regeneration Areas 3, 7 and 8	49.26	Located adjacent to the south and south western boundary of the approved disturbance area
Regeneration Area 4	8.68	Located on the north side of the mine, between the approved disturbance boundary and ECA-B
Regeneration Area 5	29.86	Located towards the western end of ECA-B
Regeneration Area 6	38.54	Located in the western portion of the Wilpinjong exploration lease area
Regeneration Area 9	27.56	Located in the northern part of the Wilpinjong exploration lease area
Rehabilitation Areas	Variable	Includes areas within the approved disturbance area for the mine, including active and future mining areas, infrastructure areas and rehabilitation of disturbed areas that is undertaken on a progressive basis in accordance with the approved WCPL Mine Operations Plan (MOP) (WCPL 2014)

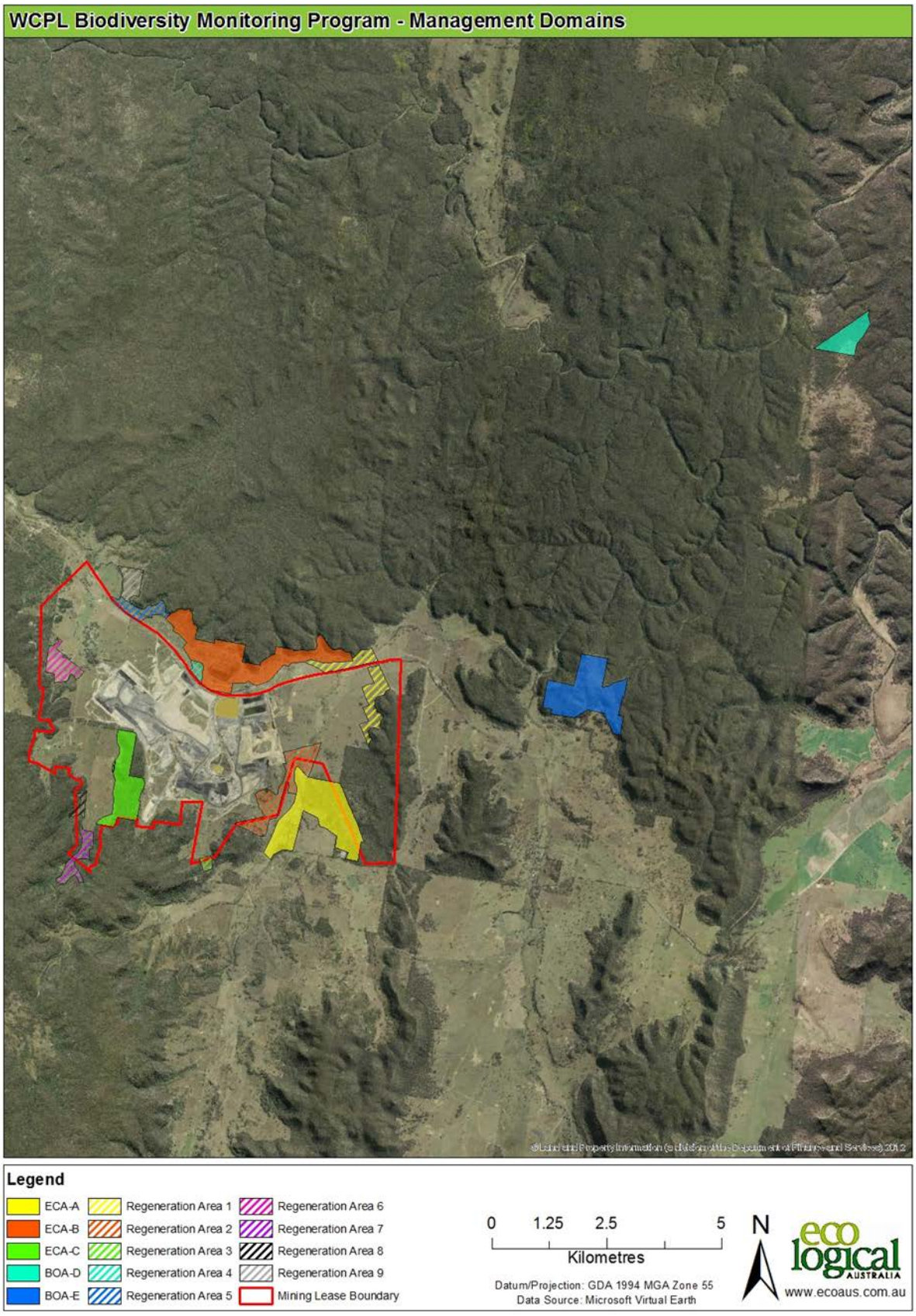

Figure 1-1: WCPL Management Domains

1.2 Previous monitoring

Biodiversity assessment and monitoring of the Management Domains was undertaken as part of the baseline studies and vegetation community mapping components of the EIS, as well as for the Rehabilitation Areas and ECAs under the rehabilitation monitoring requirements of the MOP (WCPL 2014). However, this data does not directly correlate with the performance criteria contained in the BMP (WCPL 2017), and therefore is unable to be used to measure the effectiveness of management practices to improve biodiversity values within the Management Domains.

The monitoring program outlined in the BMP (WCPL 2017) commenced in spring 2015. Monitoring undertaken during 2017 was consistent with the methods and approach described in the 2015 and 2016 annual monitoring reports (ELA 2016 and ELA 2017) and the BMP (WCPL 2017).

1.3 Assessment against Interim Performance Targets

The BMP (WCPL 2017) outlines Interim Performance Targets (IPTs) that will be used to determine progression towards the Completion Criteria and overall mine closure objectives. The IPTs provide ongoing targets against which the progression of rehabilitation and regeneration activities can be assessed against over time. The Completion Criteria will be used to assess the success of establishment of rehabilitation and regeneration areas against the proposed final land use.

1.3.1 Vegetation

The BMP (WCPL 2017) defines IPTs and Benchmark values (Completion Criteria) for low, moderate to good and high condition vegetation within each of the Keith Vegetation Classes (Western Slopes Dry Sclerophyll Forest (WSDSF) and Western Slopes Grassy Woodland (WSGW)).

Within this monitoring report, IPTs for years 1-5 have been used to assess the performance of individual floristic monitoring sites and to evaluate progress towards achieving benchmark condition. A colour coding system has been applied to all the Management Domain site attribute results, whereby:

- GREEN indicates site attributes that have met the relevant IPTs (indicating that no additional management intervention is required)
- AMBER indicates site attributes that have not met the relevant IPTs, but are within 50 - <100% of the IPTs and do not show a substantial decrease compared to the previous year's monitoring results (indicating a requirement to monitor closely, management intervention may be required)
- RED indicates site attributes that are <50% of the relevant IPTs or show a substantial decline compared to the previous year's monitoring results (indicating that management intervention is required).

A "substantial decline" is defined as a relative decline of 50% or greater compared to the previous year's results (e.g. a decline from a value of 20 to a value of 10 or less).

Reference sites were assessed against the relevant Benchmark values, utilising the same colour coding system described above (replacing reference to Interim Performance Targets with Benchmark values).

1.3.2 Landscape Function Analysis

The BMP (WCPL 2017) defines Completion Criteria for a self-sustaining landform as achievement of a score of 50 or more for each Soil Surface Assessment (SSA) Index. A ranking system has been applied in this report, with sites obtaining an SSA Index score of 50 or above (thereby meeting the Completion Criteria) colour coded green, and sites with a SSA score of less than 50 colour coded red.

The BMP (WCPL 2017) further states that incremental improvement (an increase of five or more index points annually) is anticipated, with achievement of Completion Criteria by Year 10. Where sites did not achieve the Completion Criteria score of 50 for a particular SSA index, the changes in this index from spring 2016 to spring 2017 have been assessed against the predicted annual increase. In these cases, sites that achieved the target increase of five points or more within an SSA index are colour coded green, and sites that did not achieve this annual increase are colour coded red.

2 Methodology

The 2017 biodiversity monitoring program was undertaken in accordance with the methods and survey techniques prescribed in the BMP (WCPL 2017). As per the requirements of the BMP (WCPL 2017), the biodiversity monitoring program was comprised of the following components:

- Vegetation monitoring
- Landscape stability monitoring using Landscape Function Analysis (LFA)
- Terrestrial fauna monitoring.

Weather conditions during the autumn, winter and spring 2017 monitoring are presented in **Appendix A**.

Additional information on all vegetation, LFA and fauna monitoring sites can be found in **Appendix B**.

2.1 Vegetation monitoring (Biometric)

Autumn vegetation monitoring was undertaken between the 16th of May and the 2nd of June 2017, by ELA ecologists Tom Kelly, Cassandra Holt, Jessica Southgate and Mitchell Scott. Spring vegetation monitoring was undertaken between the 19th of September and the 2nd of November 2017, by ELA ecologists David Allworth, Sarah Dickson-Hoyle, Tom Kelly, Nicole McVicar and Jessica Southgate.

Vegetation monitoring was undertaken at a total of 65 monitoring sites during 2017. This included floristic monitoring sites across all Management Domains (19 sites monitored during autumn and 22 monitored during spring), and 24 reference sites located within NPWS managed estates. The locations of vegetation monitoring sites are illustrated below in **Figures 2-1** to **2-4**.

Three sites were excluded from the 2017 monitoring, bringing the total sites monitored down from 68 sites monitored during 2016. R1_C and R2_C are located in an area which is currently subject to the Wilpinjong Burn Trial project and were both monitored and burnt during spring 2017. The burn trial monitoring methodology does not include Biometric survey, therefore monitoring results from these two sites are not included in this report. Reference site 13b was also excluded due to the site having been recently burnt (although an LFA assessment was still able to be undertaken at this site).

Vegetation monitoring was undertaken utilising the method of plot assessment outlined in the Biobanking Assessment Methodology (OEH 2014) and prescribed in the BMP (WCPL 2017). Permanent Biometric plots, comprising a 20 m x 20 m (0.04 ha) plot nested within a 20 m x 50 m plot, were established in spring 2015 and autumn 2016 and were monitored in accordance with the methods described in Section 9.1 of the BMP (WCPL 2017). Within each plot, the following data was collected:

- native species richness, cover and abundance within 20 m x 20 m plot
- native and exotic tree cover and native midstorey cover – at regular 5 m intervals along 50 m transect (10 points)
- native ground (grass, shrub, other) and exotic cover – at regular 1 m intervals along 50 m transect (50 points)
- habitat features (number of trees with hollows, length of fallen logs) and proportion of overstorey species regeneration – within 20 m x 50 m plot.

All vascular plants species were recorded and identified to the lowest taxonomic level possible, with samples of unknown species collected for further identification.

2.2 Landscape Function Analysis

LFA monitoring was undertaken between the 19th of September and the 2nd of November 2017, by ELA ecologists David Allworth, Sarah Dickson-Hoyle, Tom Kelly, Nicole McVicar and Jessica Southgate. LFA monitoring was undertaken in accordance with the methods prescribed in Tongway and Hindley (2005) and the BMP (WCPL 2017).

In total, LFA assessments were undertaken at 22 monitoring sites, including 12 within WCPL Management Domains and 10 reference sites located within NPWS managed estate (**Figure 2-3** and **Figure 2-4**). LFA assessment was not conducted at site R6_101 due to the presence of cattle.

At each LFA site, a 50 m transect line was established downslope between transect start and end markers. The majority of LFA transects directly correspond to the 50 m Biometric transect of the respective monitoring site. However, at a number of sites, the LFA transect does not align with the Biometric transect, predominantly due to the Biometric transect being established across slope rather than downslope in these locations. Along each LFA transect, LFA attributes were assessed to monitor the Landscape Organisation Index (LOI) and SSA.

2.2.1 Landscape organisation index

The LOI characterises and maps the spatial patterns of resource loss or accumulation at a site. The LOI provides a proportion of the transect occupied by patches (patches being landscape elements that are relatively permanent and provide stable, resource accumulating structures, such as grassy tussocks, ground cover and logs). A higher LOI implies a more stable transect that is less prone to erosion, with a LOI of 1.00 indicating that an entire transect is occupied by patches. The SSA is more in-depth, providing an index (0-100) of Stability, Soil Infiltration and Nutrient Cycling for the whole of landscape (transect). Table 19 in the BMP (WCPL 2017) summarises the SSA attributes that contribute to each of these indices.

According to the LFA method, patches are long-lived/term features that obstruct or divert water flow and/or collect/filter out material from runoff and where there is evidence of resource accumulation. Inter-patches are zones where resources such as water, soil materials and litter may be mobilised and freely transported either down slope when water is the active agent or down-wind when aeolian processes are active.

The following data was recorded for each patch/inter-patch along each transect:

- the distance (m) from the start of the transect
- the patch width (cm)
- the patch/inter-patch identification.

The following patch types were defined and monitored across all monitoring sites and monitoring periods:

- bare soil
- litter (including annual plants)
- rock (<5 cm diameter)
- log (>10 cm diameter)
- ground cover (perennial)
- shrub/tree
- cryptogam

- any combinations of the above (e.g. Ground Cover – Litter patch).

2.2.2 Soil surface assessment

Each patch/inter-patch type identified in the landscape organisation data log was subject to a SSA. A subset of up to five occurrences of each patch/inter-patch type were monitored, and the following SSA attributes measured:

- rain splash protection
- perennial vegetation cover
- structural classification of vegetation, including the height of each canopy layer
- litter
- cryptogam cover
- crust brokenness
- soil erosion type and severity
- deposited materials
- soil surface roughness
- surface nature (resistance to disturbance)
- description of ephemeral drainage lines
- slake test
- soil texture.

Each of these parameters was assigned a simple score in the field. Data was entered into the LFA calculation spreadsheets and used to calculate stability, infiltration and nutrient cycling indices.

A self-sustaining landform is deemed to have been achieved when SSA scores of 50 or more are recorded (the LFA Completion Criteria, expected to be achieved by Year 10 of the management cycle). Incremental improvement toward that target is expected with each year of monitoring. Failure to achieve an increase of 5 in the annual LFA scores represents a trigger for further investigation. Comparative annual results have been colour-coded to provide a visual indicator, with green reaching or exceeding the incremental increase of 5 or more, and red showing an increase of less than 5 (or in some cases, a reduction from the previous year). Red coded cells indicate a requirement for further investigation. Results maintained at or above the Completion Criteria (50) have been coded green regardless of comparative incremental increase or decrease from 2015.

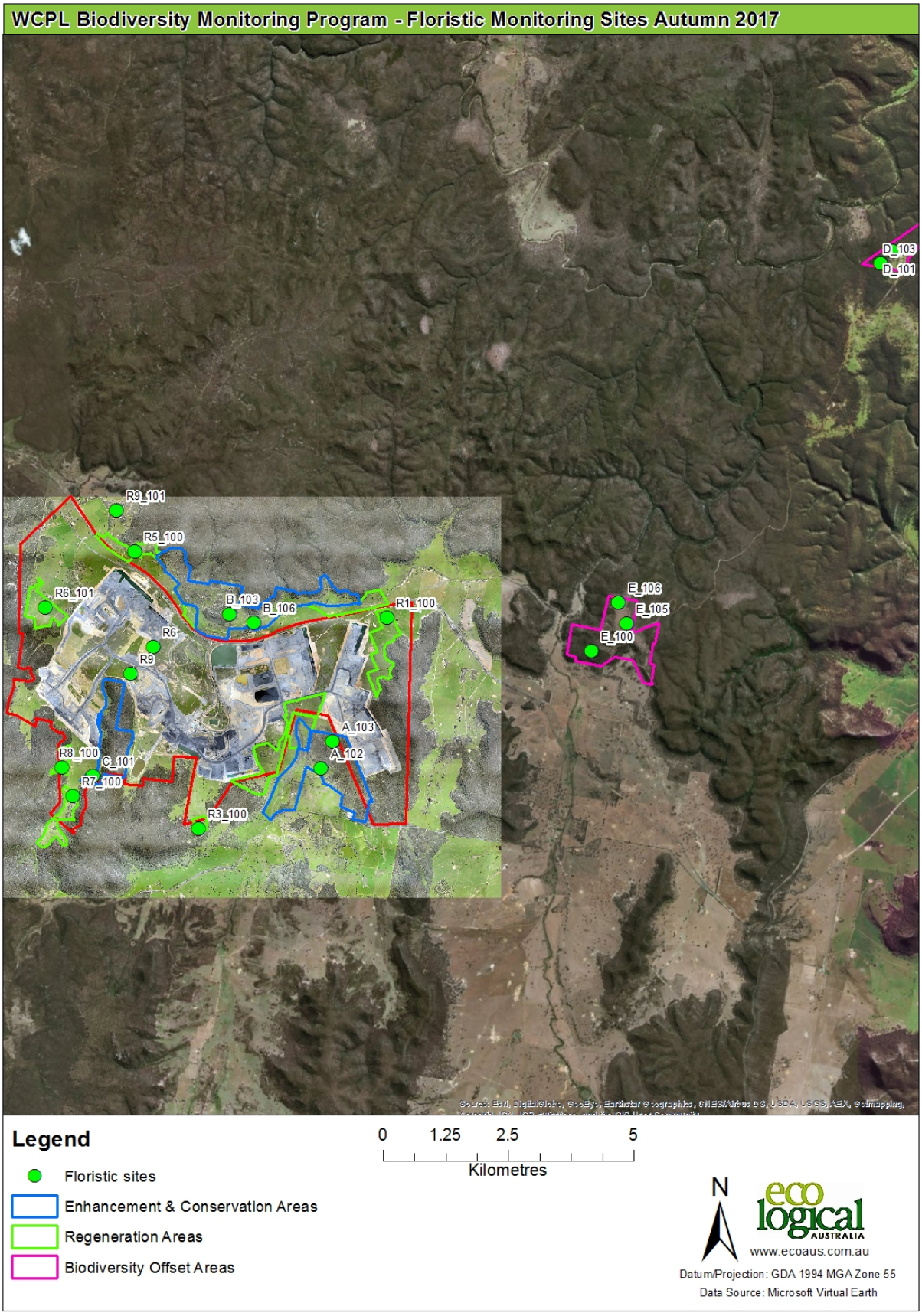

Figure 2-1: Autumn 2017 vegetation monitoring sites

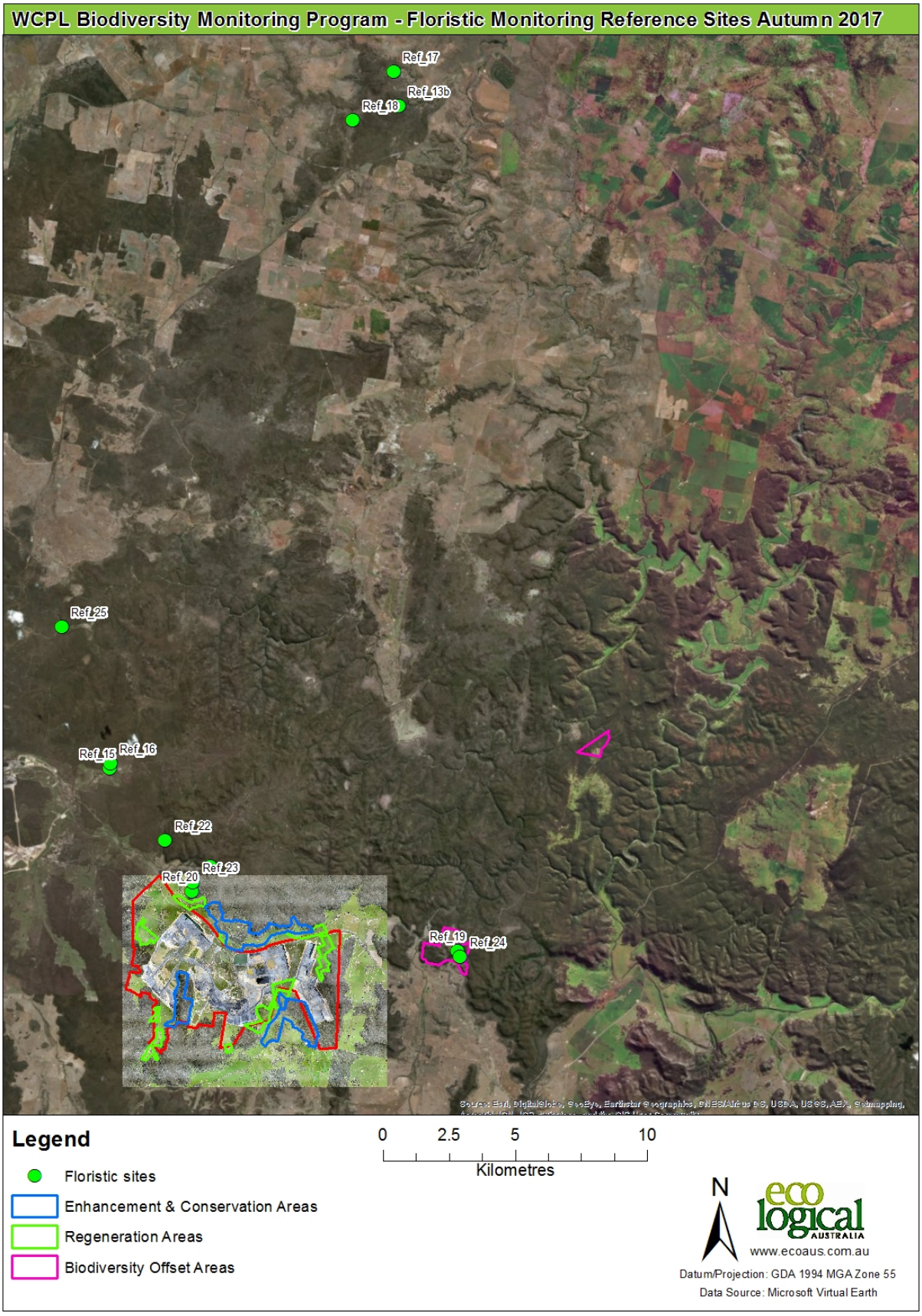

Figure 2-2: Autumn 2017 vegetation reference sites

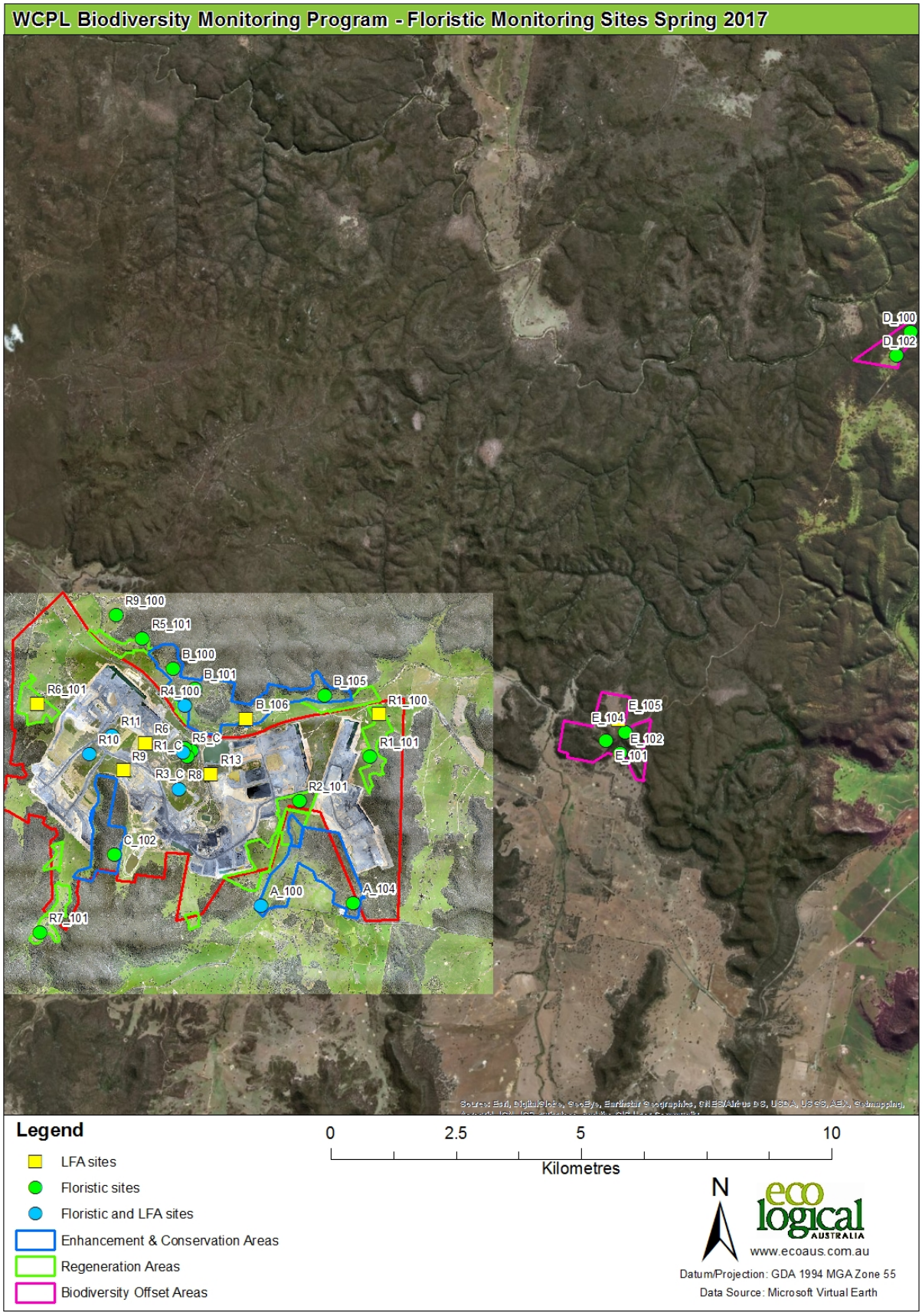

Figure 2-3: Spring 2017 vegetation and LFA monitoring sites

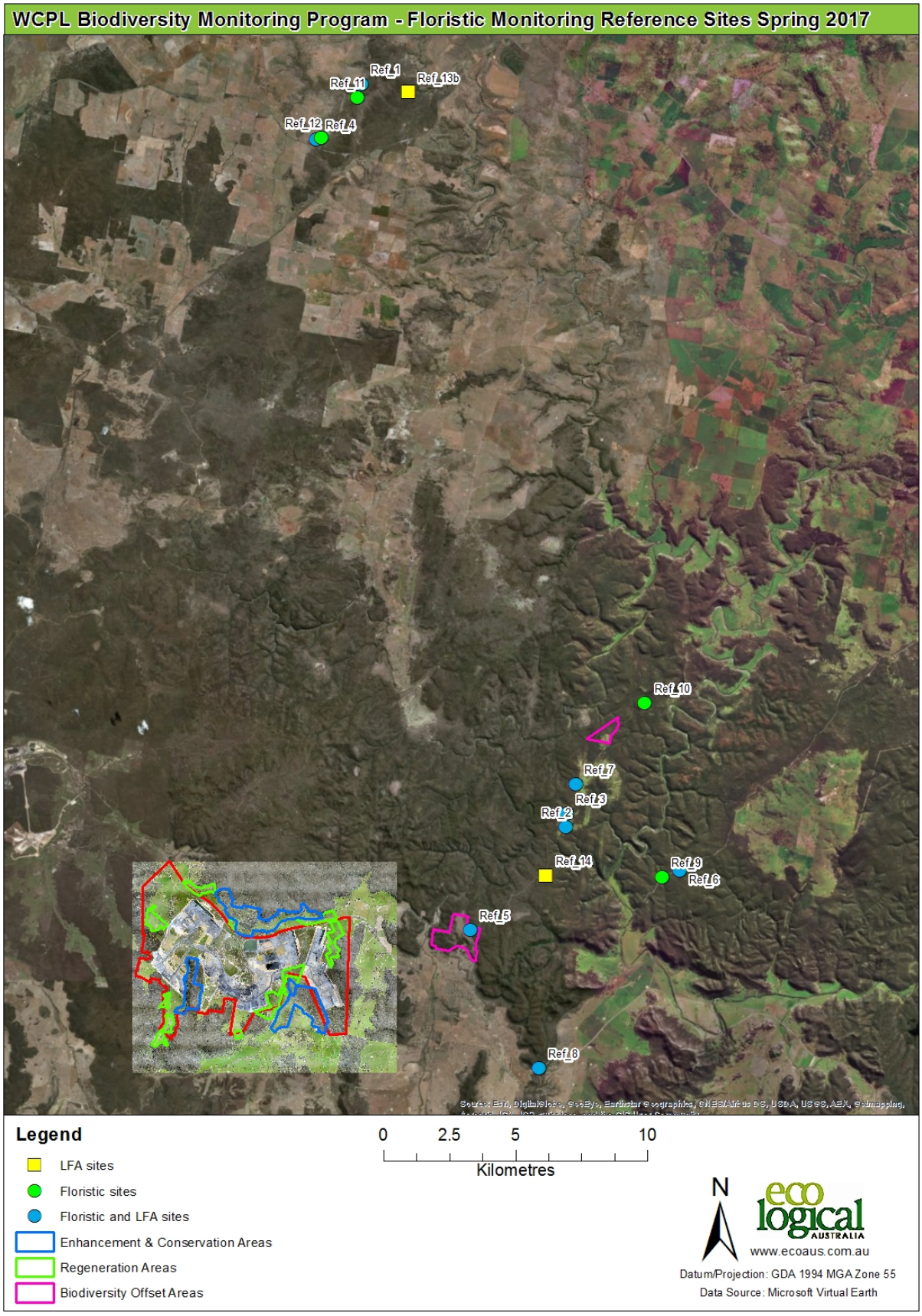

Figure 2-4: Spring 2017 vegetation and LFA reference sites

2.3 Fauna monitoring

2.3.1 Winter bird monitoring

Winter bird monitoring was undertaken at 19 general fauna monitoring sites and six diurnal bird monitoring sites (25 total) from the 21st to the 28th of June 2017 by ELA ecologists Tom Kelly and Cassandra Holt. Winter bird monitoring was targeted to survey for two key species, *Anthochaera phrygia* (Regent Honeyeater) and *Lathamus discolor* (Swift Parrot), which are both listed as either critically endangered or endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the NSW *Biodiversity Conservation Act 2016* (BC Act). These species feed on the blossoms of winter-flowering eucalypts and lerps. Data for other bird species' distribution was also gathered during the winter bird survey.

Winter bird monitoring utilised the bird monitoring methods described below in **Table 2-1**. The 25 monitoring sites are the same sites used during spring monitoring and are shown in **Figure 2-5.**

2.3.2 Spring fauna monitoring

Spring fauna monitoring was undertaken between the 19th of September and the 13th of October 2017, by ELA ecologists Tom Kelly, Alicia Scanlon and Mitchell Scott.

Table 2-1 below outlines the methodology and survey effort for each target species and is based upon the methods prescribed within the BMP (WCPL 2017). Nineteen general fauna monitoring sites, six diurnal bird monitoring sites, and six reference sites targeting microbats were monitored during spring 2017. The locations of fauna monitoring sites are shown in **Figure 2-5**, with reference sites shown in **Figure 2-6**.

Microbat monitoring was undertaken at six general fauna monitoring sites and six reference sites, as required by the BMP (WCPL 2017). Microbat analysis was undertaken by ELA ecologist Dr Rodney Armistead, with the analysis report provided in **Appendix G**.

Opportunistic fauna sightings, including fauna evidence such as scats and tracks, were also recorded, where identified across all fauna monitoring sites.

Table 2-1: Fauna monitoring methods summary (WCPL 2017)

Target species	Fauna site	Methodology	Total Survey Effort
Birds	General fauna	Bird census consisting of 10 minutes recording all birds seen/heard within 50 m radius of central plot point, and further 10 minutes recording all birds seen/heard within balance of a 2 ha plot.	80 minutes per site (20 minutes per survey, per person, per site), over one morning and one afternoon (25 sites).
Ground fauna (amphibians, mammals, reptiles)	General fauna	Pit fall/funnel trap line of 30 m drift fence and five 20 L buckets/10 funnel traps spaced 5 m apart covering both sides of the drift fence.	Twice daily inspections of traps (morning and afternoon) for five days/four nights (25 sites).
Bats	Bat	Automated ultrasonic acoustic recording to identify all bat species occurring.	Recording for 2 nights (6pm – 6am) (11 sites).
All	Opportunistic	Any sightings of fauna recorded whilst moving throughout the Project Area and located using a GPS.	Opportunistic

Target species	Fauna site	Methodology	Total Survey Effort
Mammals	Opportunistic	Opportunistic collection of scats and observations of tree scratchings, animal tracks and paw prints.	Opportunistic

2.3.3 Indicator species analysis

Birds and microbats are common and diverse throughout Australia. Due to the ease of surveying birds and microbats, they are regularly a focus of monitoring surveys and are analysed as an indicator of biodiversity. For this reason, total bird and microbat assemblages, as well as indicator species, were surveyed and analysed during spring 2017 monitoring.

A suite of indicator bird species was identified and used to assess the habitat quality at each site. Of the two bird indicator analyses carried out, the first analysis examines the richness of indicator species (both derived native grassland (DNG) and woodland/forest) in each DNG site. This was compared with the richness of DNG indicator species, and the richness of woodland/forest indicator species that occurred in each corresponding woodland/forest analogue site.

The second analysis utilised the same methodology and serves the same purpose as the first but uses indicator species abundance data instead of indicator species richness data. Conducting the same analyses using two different units of measurement helps paint a more holistic picture of the environment we are monitoring. For this reason, both analyses should be interpreted together. This process was repeated with microbats.

Bird indicator species identified as effective indicators of either woodland/forest or regeneration/revegetation DNG are listed in **Table 2-2**. Microbat indicator species identified as effective indicators of either woodland or DNG are listed in **Table 2-3**.

Table 2-2: Key bird species

Scientific Name	Common Name	Strongest Habitat Association
Cracticus nigrogularis	Pied Butcherbird	DNG
Anthus novaeseelandiae	Australasian Pipit	DNG
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	DNG
Platycercus eximius	Eastern Rosella	DNG
Manorina melanocephala	Noisy Miner	DNG
Cormobates leucophaea	White-throated Treecreeper	Woodland/Forest
Colluricincla harmonica	Grey Shrike-thrush	Woodland/Forest
Eopsaltria australis	Eastern Yellow Robin	Woodland/Forest
Acanthiza nana	Yellow Thornbill	Woodland/Forest
Acanthiza reguloides	Buff-rumped Thornbill	Woodland/Forest

Table 2-3: Key microbat species identified as effective indicators of either woodland or DNG

Scientific Name	Common Name	Strongest Habitat Association

Scientific Name	Common Name	Strongest Habitat Association
Austronomous australis	White-striped Free-tailed Bat	DNG
Mormopterus planiceps	South-eastern Free-tailed Bat	DNG
Chalinolobus morio	Chocolate Wattled Bat	Woodland/Forest
Rhinolophus megaphyllus	Eastern Horseshoe Bat	Woodland/Forest

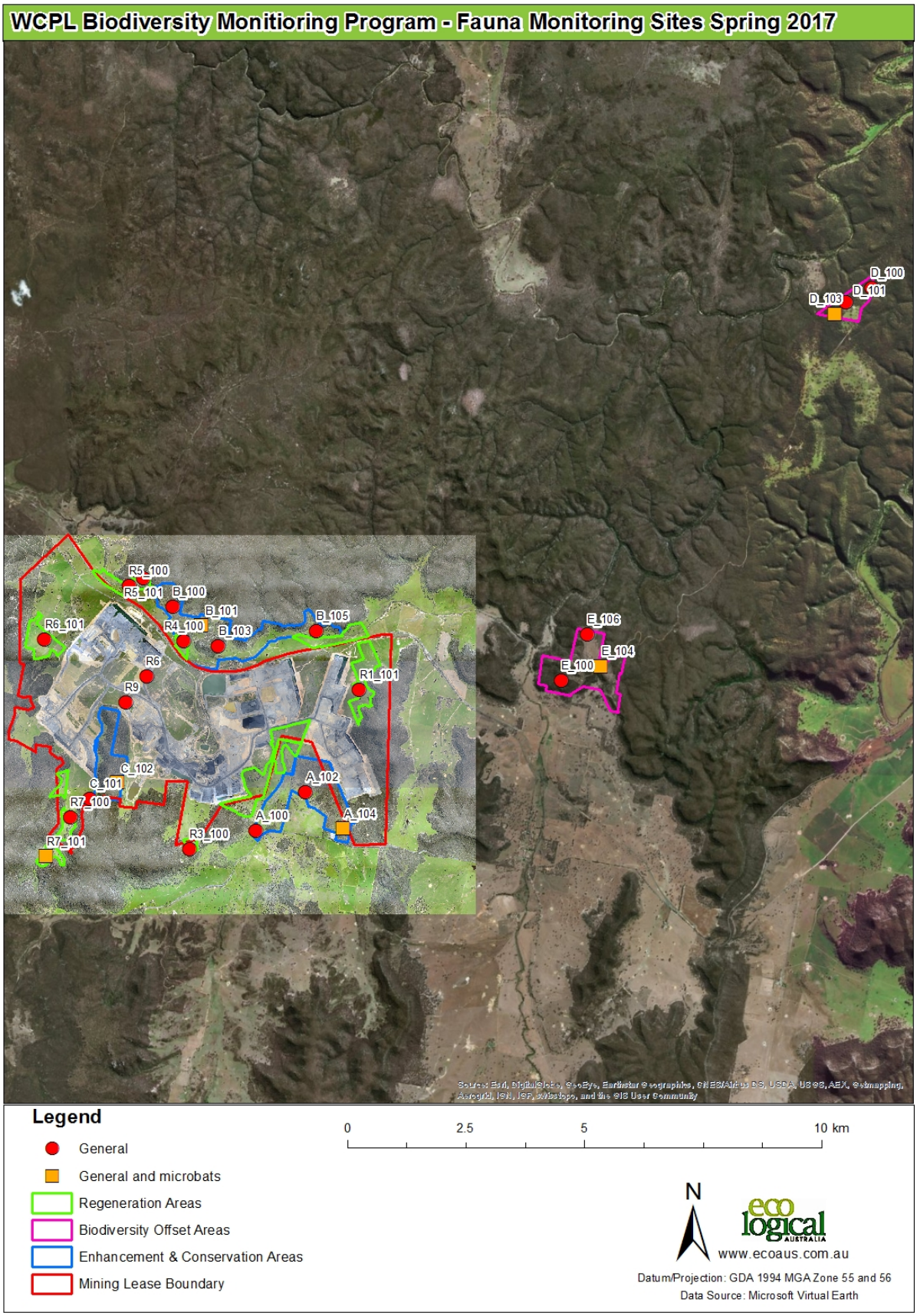

Figure 2-5: Spring 2017 fauna monitoring sites

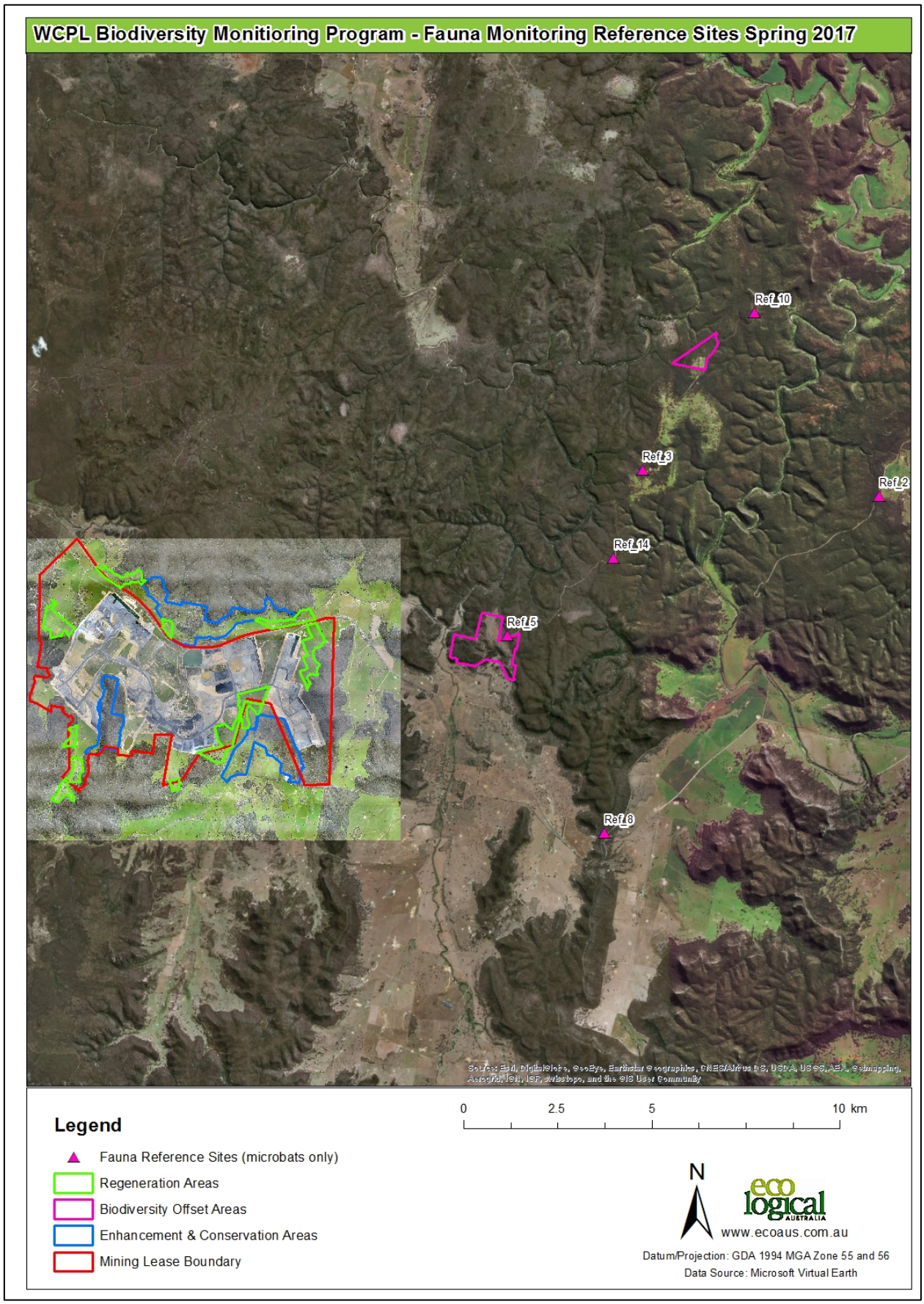

Figure 2-6: Spring 2017 fauna reference sites

3 Results and discussion

This section presents the 2017 monitoring results, including autumn and spring vegetation monitoring, winter bird monitoring, and spring LFA and fauna monitoring. Vegetation monitoring results are presented and discussed collectively for all Management Domains. LFA and fauna monitoring results are presented and discussed individually for each BOA, ECA, Regeneration and Rehabilitation Management Domains.

3.1 Vegetation monitoring

A total of 371 flora species were recorded across the Management Domains and Reference sites during autumn and spring 2017, consisting of 253 native species and 81 exotic species, with a further 37 species unable to be identified as either native or exotic. A full list of all flora species recorded during autumn 2017 and spring 2017 surveys is included in **Appendix C**.

3.1.1 Assessment against Interim Performance Targets

Vegetation monitoring results are assessed against IPTs and Benchmark Targets (for Management Domains and Reference sites respectively [see **Appendix E**]) and compared against the previous year's monitoring results to evaluate trends and progress towards achieving Completion Criteria, as set out in the BMP (WCPL 2017).

Site value scores were calculated for all 2017 monitoring sites to determine the vegetation condition for each site. Each site was then assessed relative to the IPT or Benchmark Targets for the relevant condition within each Keith Vegetation Class as per the BMP (WCPL 2017). Both monitoring periods now fall within the Year 1-5 IPTs, being Year 1 (autumn 2017 sites) and Year 2 (spring 2017 sites). This presents an increase in IPTs values for autumn, as 2016 results were ranked against the lower Year 0 (or baseline) IPTs.

Tables 3-1 to **3-4** below present the individual site attribute and site value scores for each 2017 monitoring site. As discussed above in **Section 1.3.1,** a colour coding system has been applied to all site attribute results.

Table 3-1: Assessment against Interim Performance Targets - autumn 2017

Management Domain	Vegetation Community	Site	Site attributes (% cover)										
			Vegetation condition	SVS	NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
BOA	WSDSF	D_101	HIGH	71	36	17.5	7.9	10	2	26	2	1	1	43
	WSDSF	D_103	MOD-GOOD	41	22	7	47.5	4	44	0	0	0	1	0
	WSDSF	E_100	MOD-GOOD	61	27	15.7	11.5	4	16	4	0	0	1	68
	WSGW	E_105	LOW	14	13	0	0	10	0	8	62	0	0	0
	WSGW	E_106	MOD-GOOD	36	33	0	0	46	0	32	0	0	0.5	3
ECA	WSGW	A_102	LOW	32	14	0	11	52	12	4	12	0	0	0
	WSGW	A_103	HIGH	89	30	19	6.4	12	4	6	0	3	0.8	32
	WSDSF	B_103	MOD-GOOD	53	42	29.5	8	6	14	18	4	0	0.33	12
	WSGW	B_106	LOW	17	16	0	0	18	0	14	39	0	0	0
	WSDSF	C_101	LOW	9	10	0	0	66	0	0	28	0	0	3
Regeneration Areas	WSGW	R1_100	LOW	6	4	0	0	4	0	0	82	0	0	0
	WSDSF	R3_100	LOW	7	15	0	0	62	0	0	32	0	0	0
	WSGW	R5_100	LOW	18	12	0	0	64	0	2	24	0	0	0
	WSGW	R6_101	LOW	9	8	0	0	44	0	0	46	0	0	0

Management Domain	Vegetation Community	Site	Site attributes (% cover)										
			Vegetation condition	SVS	NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
	WSGW	R7_100	LOW	15	14	0	0	34	0	0	60	0	0	0
	WSDSF	R8_100	LOW	8	9	0	0	60	0	2	34	0	0	0
	WSGW	R9_101	LOW	19	13	0	0	62	0	6	18	0	0	0
Rehabilitation Areas	WSDSF	R6	LOW	13	17	0	2	0	0	0	58	0	0	1
	WSDSF	R9	LOW	27	18	0	28	0	0	4	56	0	0	42

SVS = Site Value Score, NSR = Native Plant Species Richness, NOC = Native Overstorey Cover, NMC = Native Midstorey Cover, NGCG = Native Ground Stratum Cover (grasses), NGCS = Native Ground Stratum Cover (shrubs), NGCO = Native Ground Stratum Cover (other), EC = Exotic Plant Cover, NTH = Number of Trees with Hollows, OR = Overstorey Regeneration and FL = Total Length of Fallen Logs

Table 3-2: Assessment against Interim Performance Targets - spring 2017

Management Domain	Vegetation Community	Site	Site attributes (% cover)											
			Vegetation condition	SVS	NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
BOA	WSDSF	D100	MOD-GOOD	41	22	3.1	5	0	8	2	0	1	0	63
	WSGW	D102	LOW	28	17	4.5	0	6	0	10	0	0	0	23
	WSDSF	E101	MOD-GOOD	39	33	0.9	5.2	36	2	4	0	0	0.33	6
	WSGW	E102	LOW	11	9	0	0	18	0	2	4	0	0	0
	WSGW	E104	MOD-GOOD	52	18	5.9	0	6	0	4	0	1	0.33	50
ECA	WSGW	A100	LOW	5	2	0	0	0	0	0	52	0	0	0
	WSGW	A104	MOD-GOOD	57	19	5	5.3	2	2	0	0	0	1	123
	WSGW	B100	MOD-GOOD	55	28	16.5	1.5	10	4	8	0	0	0.67	20
	WSGW	B101	LOW	20	19	0	0	34	0	18	8	0	0	0
	WSDSF	B105	LOW	7	9	0	0	4	0	2	12	0	0	0
	WSGW	C102	HIGH	74	35	11.3	3	8	0	6	0	1	0.33	50
Regeneration Areas	WSGW	R1_101	LOW	16	17	0	0	30	0	2	28	0	0	0
	WSGW	R2_101	LOW	23	18	0	0	14	0	0	24	0	1	0
	WSGW	R4_100	LOW	5	2	0	0	0	0	0	34	0	0	0
	WSDSF	R5_101	LOW	10	14	0	0	62	0	4	28	0	0	0
	WSDSF	R7_101	LOW	31	20	0	22	70	0	0	12	0	1	0
	WSDSF	R9_100	LOW	28	23	0	7.5	54	0	14	2	0	0	0
Rehabilitation	WSDSF	R5_C	LOW	7	11	0	1.2	0	0	0	72	0	0	0.5

Management Domain	Vegetation Community	Site	Site attributes (% cover)										
			Vegetation condition	SVS	NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
Areas	WSGW	R8	LOW	7	6	0	0	0	0	18	48	0	0	0
	WSGW	R10	LOW	14	12	0	0	0	0	10	62	0	0	15
	WSGW	R11	LOW	7	7	0	1	0	0	0	56	0	0	0
	WSDSF	R3_C	LOW	7	6	0	0.4	0	0	52	74	0	0	0

SVS = Site Value Score, NSR = Native Plant Species Richness, NOC = Native Overstorey Cover, NMC = Native Midstorey Cover, NGCG = Native Ground Stratum Cover (grasses), NGCS = Native Ground Stratum Cover (shrubs), NGCO = Native Ground Stratum Cover (other), EC = Exotic Plant Cover, NTH = Number of Trees with Hollows, OR = Overstorey Regeneration and FL = Total Length of Fallen Logs

Table 3-3: Reference sites assessment against Benchmark Targets - autumn 2017

Management Domain	Vegetation Community	Site	Site attributes (% cover)											
			Vegetation condition	SVS	NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
Reference sites	WSDSF	Ref_14	HIGH	72	29	20	10	6	4	14	0	2	1	22
	WSGW	Ref_15	MOD-GOOD	57	22	16	0	24	0	30	2	3	0	65
	WSGW	Ref_16	MOD-GOOD	66	35	14.5	0	14	0	36	4	1	0.5	65
	WSGW	Ref_17	MOD-GOOD	68	17	10.5	0	26	0	46	2	8	0.5	99
	WSGW	Ref_18	MOD-GOOD	51	19	26	2.2	20	0	10	4	0	0.66	90
	WSGW	Ref_19	MOD-GOOD	66	25	14	0.5	52	0	22	6	1	1	30
	WSDSF	Ref_20	MOD-GOOD	61	25	24	4.7	2	0	14	0	3	0.33	44
	WSDSF	Ref_21	MOD-GOOD	64	35	37	0.2	30	0	30	0	2	0.5	65
	WSDSF	Ref_22	MOD-GOOD	49	32	42	0.5	42	0	20	0	0	0.33	114
	WSGW	Ref_23	MOD-GOOD	43	29	20	0	36	0	26	0	0	0.5	0
	WSGW	Ref_24	HIGH	89	36	17	5.2	42	4	12	0	2	0.75	25
	WSGW	Ref_25	MOD-GOOD	47	22	35	0.5	30	0	42	2	1	0.33	22

SVS = Site Value Score, NSR = Native Plant Species Richness, NOC = Native Overstorey Cover, NMC = Native Midstorey Cover, NGCG = Native Ground Stratum Cover (grasses), NGCS = Native Ground Stratum Cover (shrubs), NGCO = Native Ground Stratum Cover (other), EC = Exotic Plant Cover, NTH = Number of Trees with Hollows, OR = Overstorey Regeneration and FL = Total Length of Fallen Logs, ND = No Data

Table 3-4: Reference sites assessment against Benchmark Targets - spring 2017

Management Domain	Vegetation Community	Site	Site attributes (% cover)										
			Vegetation condition	SVS	NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
Reference sites	WSGW	Ref_1	LOW	22	21	0	0	18	0	2	0	0	0	2
	WSDSF	Ref_2	MOD-GOOD	57	25	15.7	12.4	42	6	4	0	1	0.5	15
	WSDSF	Ref_3	MOD-GOOD	53	30	15.3	0.7	6	2	8	0	2	0.5	24
	WSGW	Ref_4	MOD-GOOD	59	24	12.8	0.5	20	0	0	0	5	0	27
	WSDSF	Ref_5	MOD-GOOD	49	34	11.1	3.9	0	6	0	0	0	0	109
	WSDSF	Ref_6	MOD-GOOD	64	22	22	7.5	14	10	0	0	2	0.8	35
	WSDSF	Ref_7	LOW	33	28	4.2	2.5	0	12	0	0	0	0	35
	WSGW	Ref_8	HIGH	80	29	17.5	1.4	22	0	36	0	3	0.5	50
	WSDSF	Ref_9	MOD-GOOD	65	37	28	2.3	17	6	4	0	2	0.67	10
	WSDSF	Ref_10	MOD-GOOD	41	20	4.4	0.5	0	22	0	0	2	0	256
	WSGW	Ref_11	LOW	29	21	13	0	14	0	4	0	0	0	0
	WSGW	Ref_12	MOD-GOOD	35	34	9.6	0	2.6	0	10	2	0	0	24

SVS = Site Value Score, NSR = Native Plant Species Richness, NOC = Native Overstorey Cover, NMC = Native Midstorey Cover, NGCG = Native Ground Stratum Cover (grasses), NGCS = Native Ground Stratum Cover (shrubs), NGCO = Native Ground Stratum Cover (other), EC = Exotic Plant Cover, NTH = Number of Trees with Hollows, OR = Overstorey Regeneration and FL = Total Length of Fallen Log

3.2 Discussion of vegetation monitoring results

A total of 371 flora species were recorded from all monitoring sites during 2017. This has declined since 2016, when 423 species were recorded. The full list of flora species recorded during 2017 is included in **Appendix C**.

3.2.1 Management Domains

Comparison of attributes from sites monitored during autumn 2017 (**Table 3-1** above) showed lower values relative to the autumn 2016 results, with no sites meeting all the IPTs. Most 2017 autumn sites (17 out of 19) did, however, meet the targets for five or more of the 10 site attributes, with only two sites scoring the lowest results (meeting targets for four out of 10 site attributes). Consistent with the 2016 data, BOA sites recorded the highest average value scores in autumn, followed by ECA sites. Regeneration and Rehabilitation sites recorded the lowest average scores for autumn.

Consistent with autumn 2016 results, native overstorey cover and the number of trees with hollows were the highest performing site attributes for autumn 2017, with all Management Domain sites achieving the IPTs. Native midstorey cover has increased (taking into consideration the IPTs increases from 2016 (Year 0 IPT) to 2017 (year 1-5 IPT)) and is no longer the worst performing autumn site attribute. Overstorey regeneration and fallen logs were the lowest performing autumn site attributes, with only three sites meeting the respective IPTs.

Vegetation sites monitored during spring 2017 (**Table 3-2** above) achieved overall higher performing results than 2016, although the results are consistently variable across the sites. Whilst no site has met the targets for all site attributes during spring, 20 out of 22 sites achieved the IPTs for at least half of all site attributes. Native overstorey cover and the number of hollow bearing trees were the best performing site attributes, with all sites meting the IPT, which is followed closely by exotic cover (19 of 22 sites meeting the relevant IPT). Native midstorey trends are comparable to those shown in autumn 2017 and have increased significantly compared to the previous year. Fallen logs and overstorey regeneration were the lowest scoring site attributes, with three and seven sites respectively achieving the IPTs.

Lower attribute scores for autumn 2017 sites may be correlated to the significant increases in IPT scores for several site attributes from Year 0 (Baseline) to Year 1 (Year 1-5 IPTs). This was noted for spring data in 2016. For example, the IPT for overstorey regeneration for low condition sites increases from 0% to 100% from Year 0 to Year 1. This increase is not reflective of the natural development of overstorey regeneration, and as such, it is expected to be several years until overstorey regeneration reaches its respective target. Consistent with 2016 results for spring, BOA sites exhibited the highest average site values, followed by ECA sites, reflective of the remnant condition of these areas.

3.2.2 Reference sites

Reference sites monitored during 2017 are compared to the Benchmark targets for their respective vegetation community (**Table 3-3** and **Table 3-4**). Continuing from 2016, sites monitored during autumn 2017 exhibit a higher achievement of the benchmark targets compared to sites monitored during spring, with average site scores of 61 and 49 respectively. This is a slight decrease from 2016 for both seasons. Both seasons showed largely consistent target results for site attributes, with all sites achieving the benchmark for native species richness, exotic cover and native overstorey cover. Attribute scores were less comparable and more variable for other attributes, however both seasons shared high results for number of hollow bearing trees (22 of 24 sites achieving benchmark), fallen logs (17 of 22 sites achieving benchmark) and native ground-stratum cover other (16 of 22 sites achieving benchmark).

3.2.3 Multi-year comparisons

The results of key individual attributes have been graphed to illustrate the variability between 2015, 2016 and 2017 monitoring results for spring, and 2016 and 2017 monitoring results for autumn. The key attributes analysed include total native species richness, and the native vegetation structure attributes, including overstorey cover, midstorey cover and groundcover.

Species richness

Total species richness has been variable between sites and years. Spring species richness was higher in 2015 than 2016 or 2017 monitoring (**Figure 3-1**), whilst autumn data was higher in 2017 than 2016 monitoring (**Figure 3-2**).

Native species richness ranged from only two species recorded at sites A_100 and R4_100, to the highest being 42 species at site B_103. Several sites located within remnant native vegetation of the BOAs and ECAs also recorded a notably high native species richness. These sites included D_101 (36 species), C102 (35 species) and E106 and E101 recording 33 species each. Reference sites, overall, contained a higher native species richness compared to sites within the Management Domains, with 22 of the 24 sites recording at least 20 species. Native species richness for all sites is compared below in **Figure 3-3**.

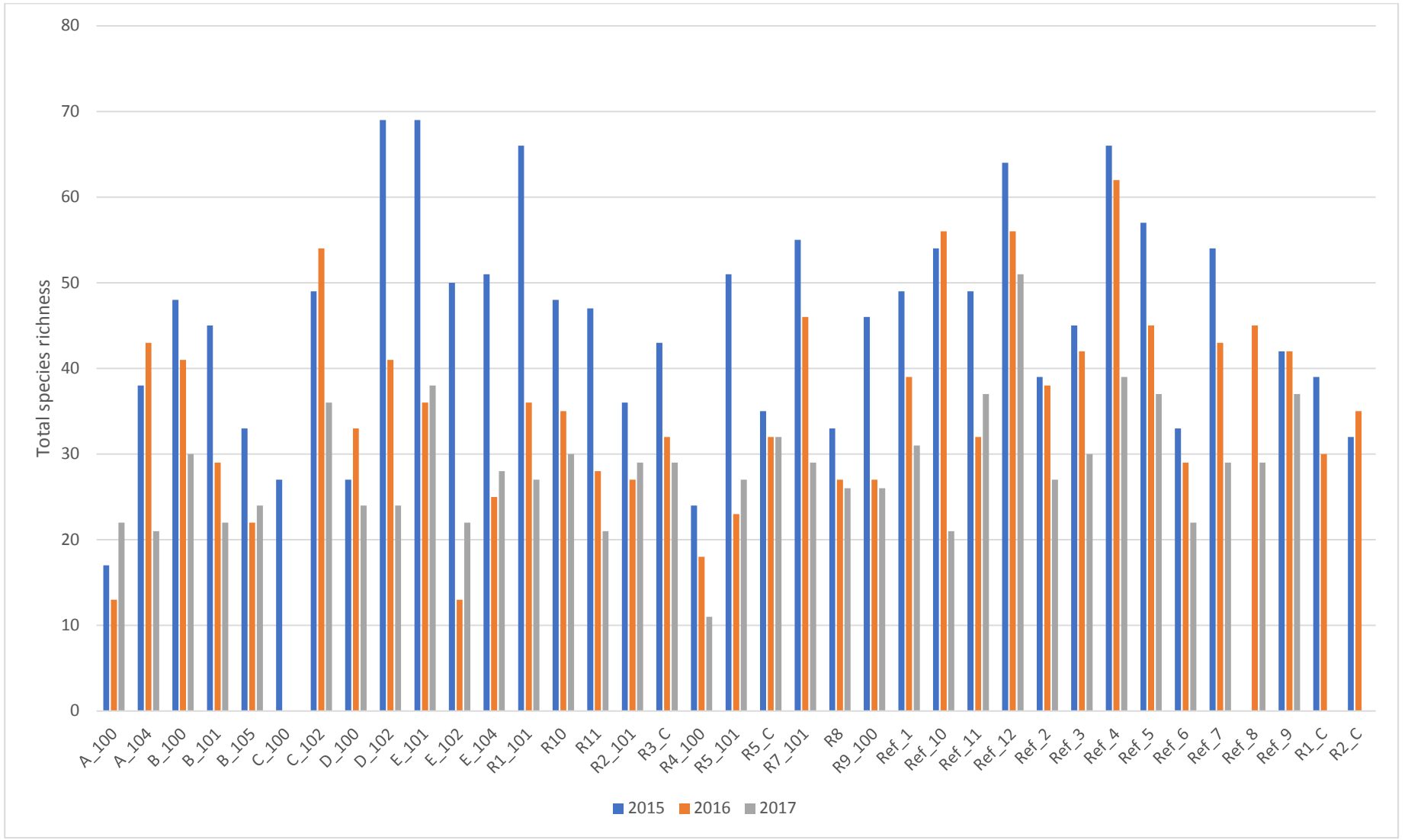

Figure 3-1: Total species richness across all management domains - spring 2015-2017

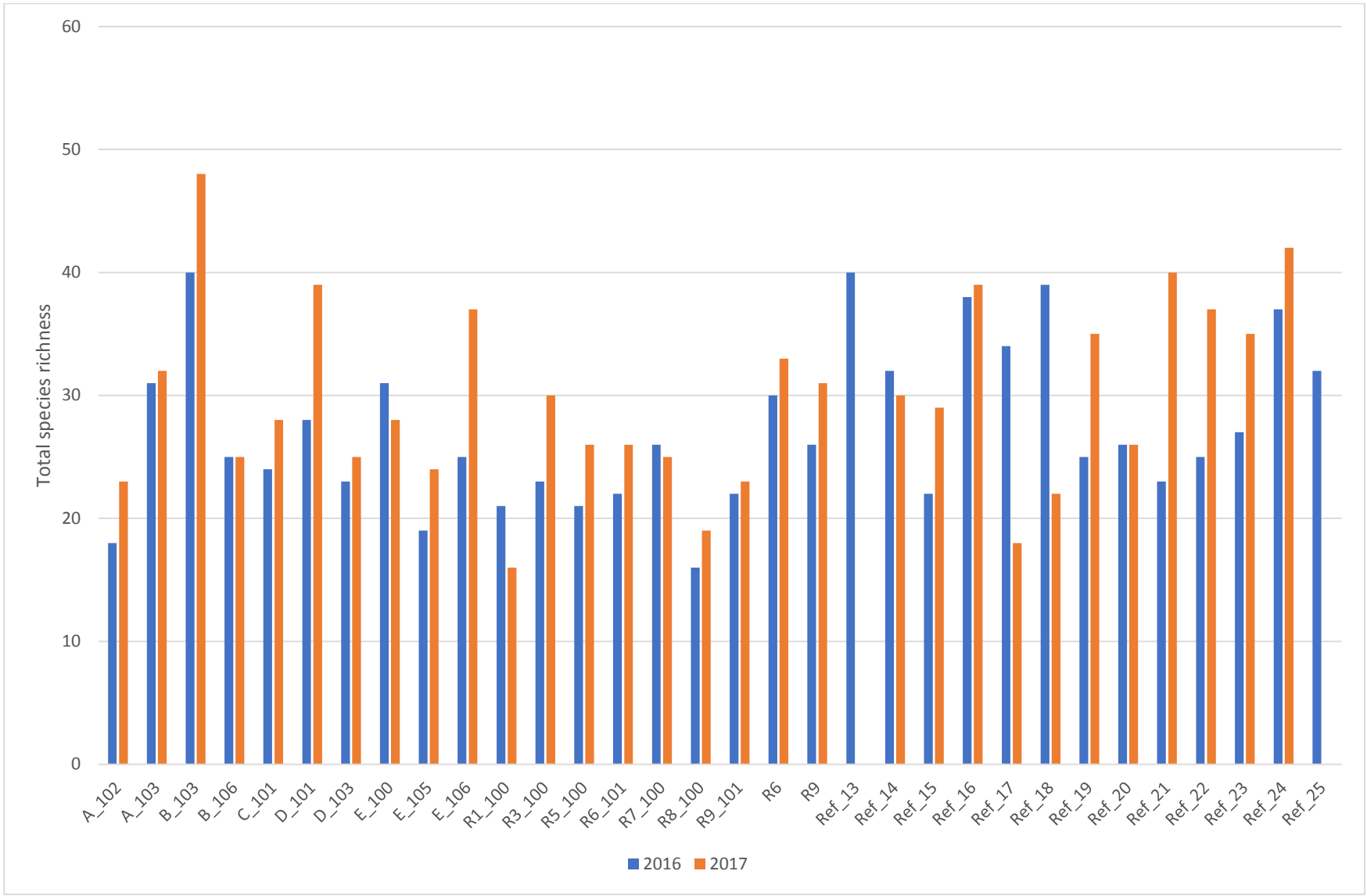

Figure 3-2: Total species richness across all management domains - autumn 2016-2017

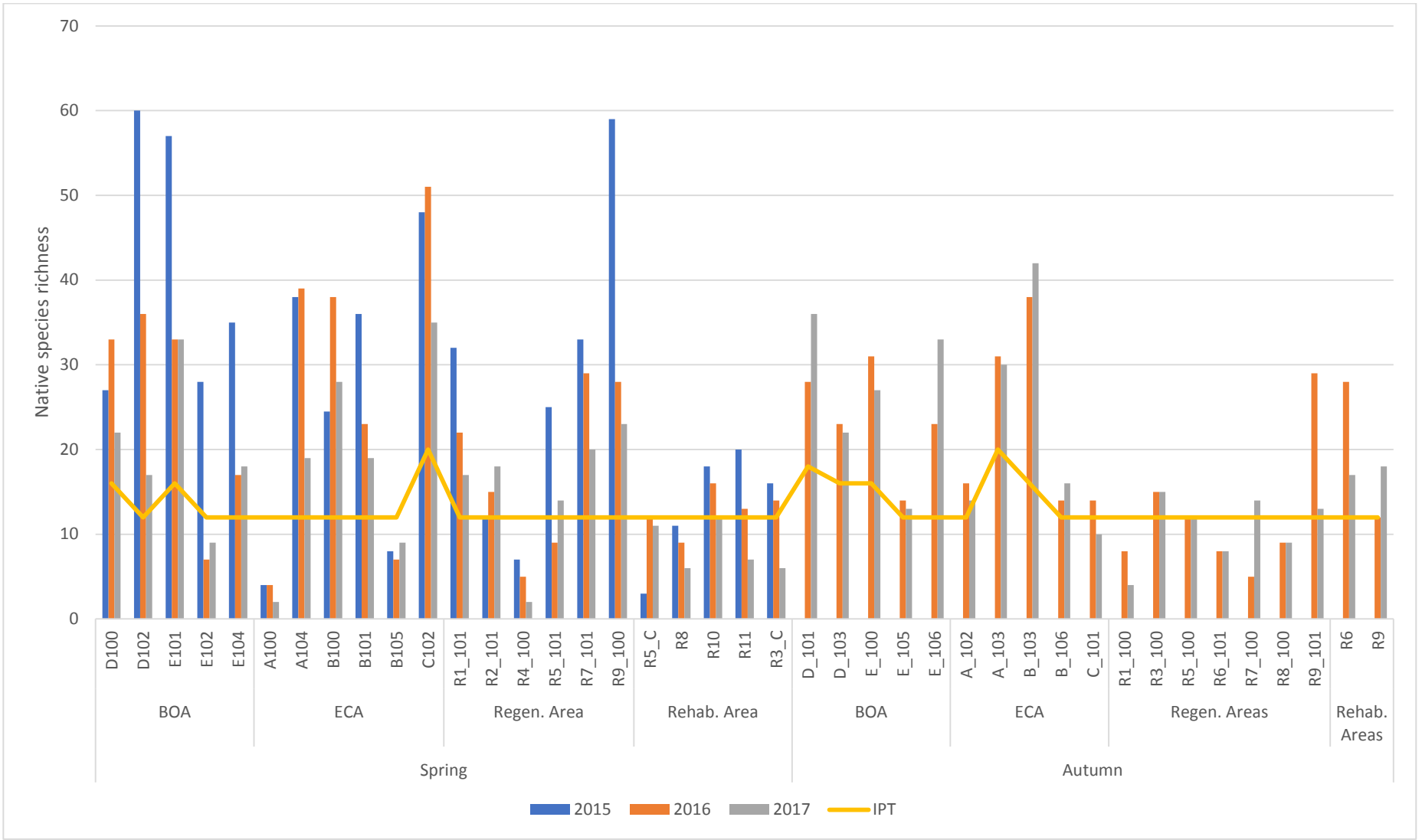

Figure 3-3: Native species richness at all sites – spring and autumn 2015-2017

Vegetation structure

Vegetation structure data recorded at the monitoring sites during autumn and spring 2017 monitoring (dominant species, height range and percentage foliage cover for all vegetation strata) is presented in **Appendix D**.

Comparison of vegetation structure attributes for the overstorey cover, midstorey cover and groundcover strata layers are illustrated below in **Figures 3-4**, **3-5** and **3-6**.

Monitoring sites within both regenerating and intact native vegetation in the BOAs continued to show high levels of structural complexity consistent with 2016 monitoring results, with native species in almost all strata levels and strong upper canopy development. Additionally, most sites showed new strata development as well as increased percentage cover. ECA monitoring results were also consistent with the 2016 monitoring results, with six out of 11 of the ECA monitoring sites continuing to comprise no upper strata (overstorey cover), though midstorey strata levels have increased and percentage groundcover counts increased slightly in the majority of stratum.

Only one Regeneration site (R9_100) contained an upper canopy of eucalypt species and is the only regeneration site to constitute an upper stratum. No Rehabilitation sites recorded any upper strata in their structure, though eucalypts are present in the midstorey of two Rehabilitation sites in addition to various *Acacia* species (R6 and R9).

Consistently low scores for overstorey regeneration from 2016 to 2017 monitoring periods are likely attributable to the high level of natural ground layer competition found in grassy woodland communities, which can limit the ability for overstorey regeneration to develop.

Across the Rehabilitation sites, the groundcover remained dominated by exotic species, with perennial pasture species contributing the majority of cover, which is consistent with 2016 monitoring results. Some Regeneration sites recorded no exotic groundcover, however, those that did, experienced considerable increases in exotic cover compared to 2016 monitoring results. Results indicate that native groundcover has also increased since the 2016 monitoring, suggesting a general increase in groundcover. Consistent with 2016 monitoring results, native perennial grasses were the dominant native ground cover, with *Aristida* spp. comprising much of the cover. The dominance of perennial grasses is consistent with historical grazing and disturbance in the area.

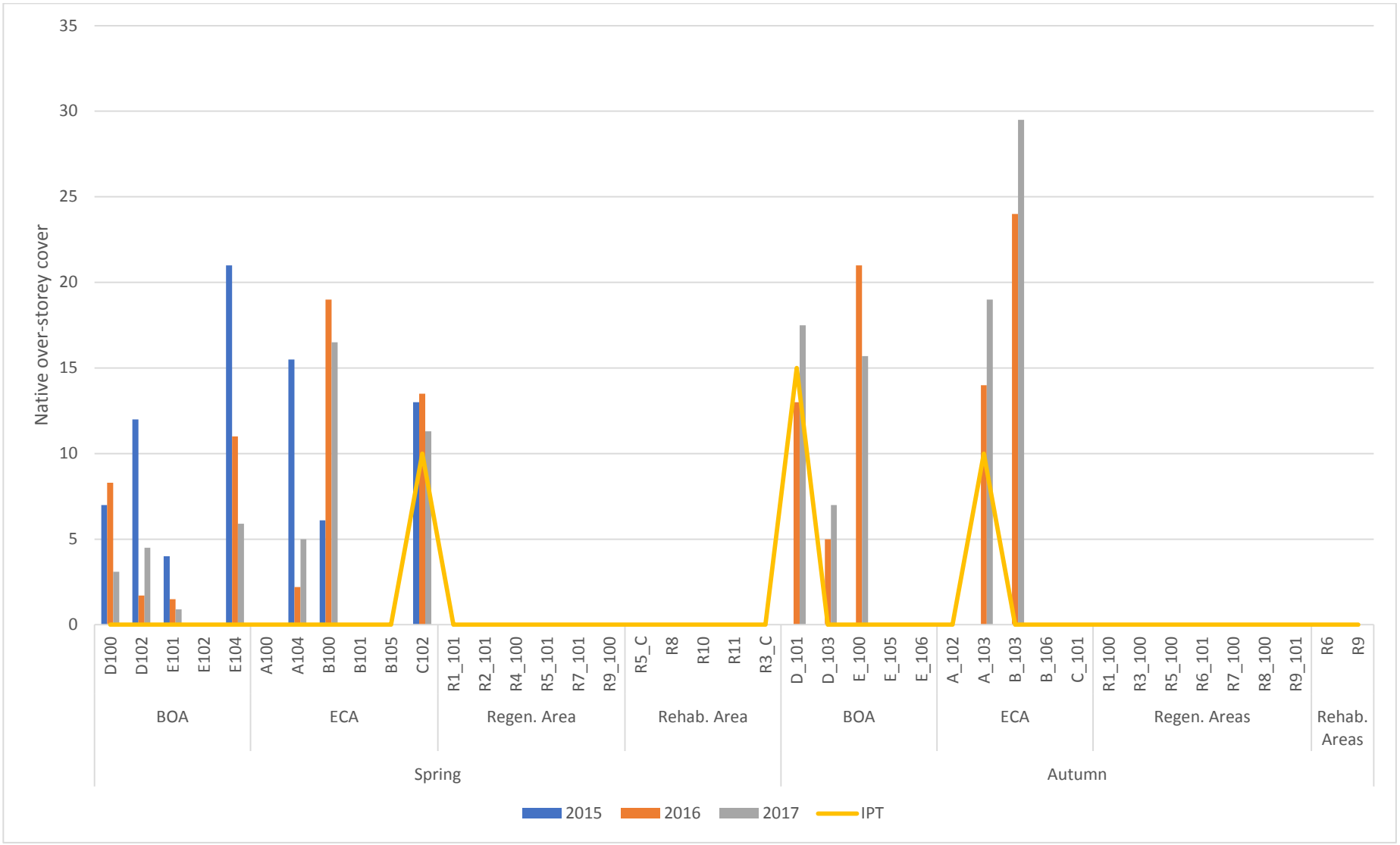

Figure 3-4: Native overstorey cover at all sites 2015-2017 compared against the 1-5 year IPT

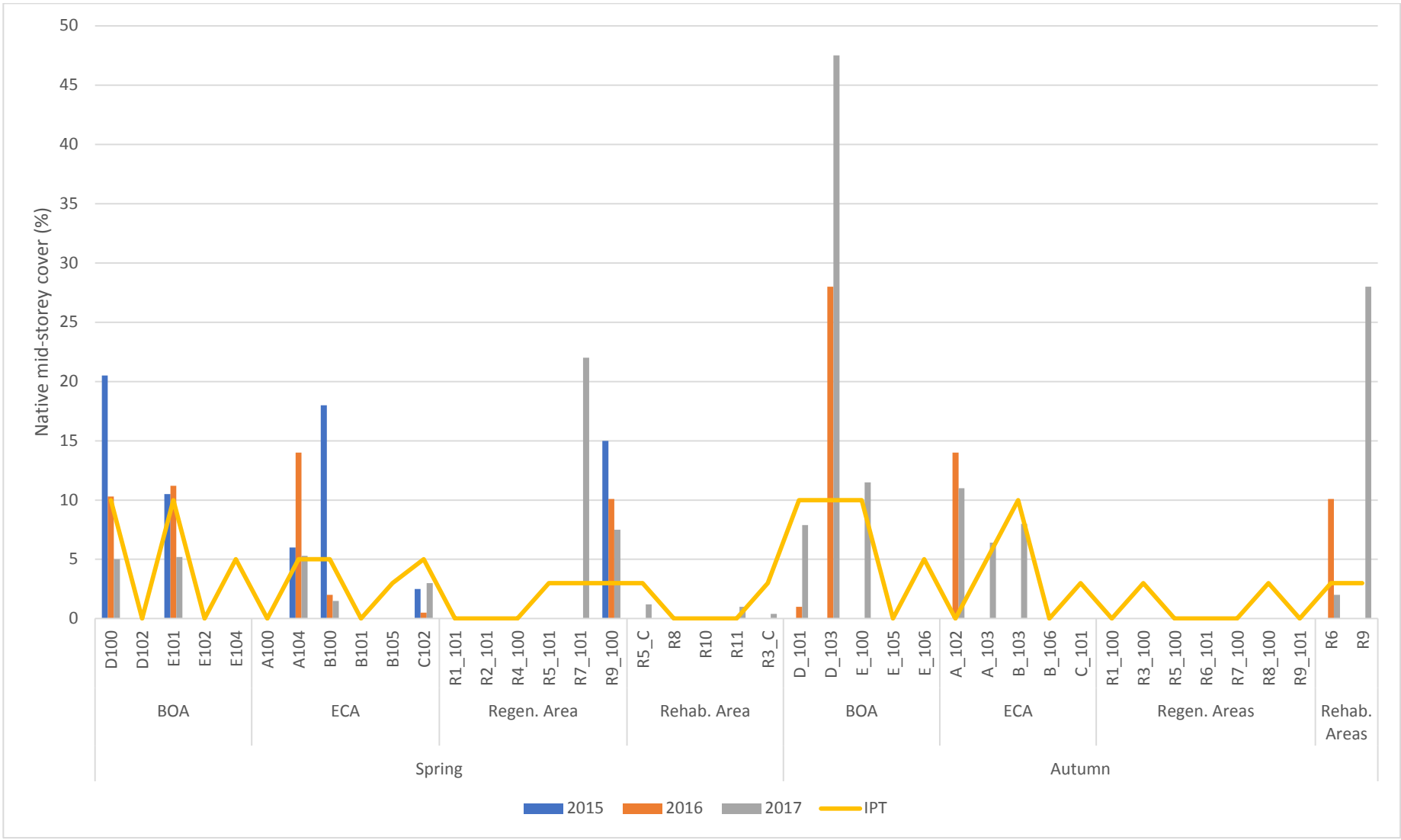

Figure 3-5: Native midstorey cover at all sites 2015-2017 compared against the 1-5 year IPT

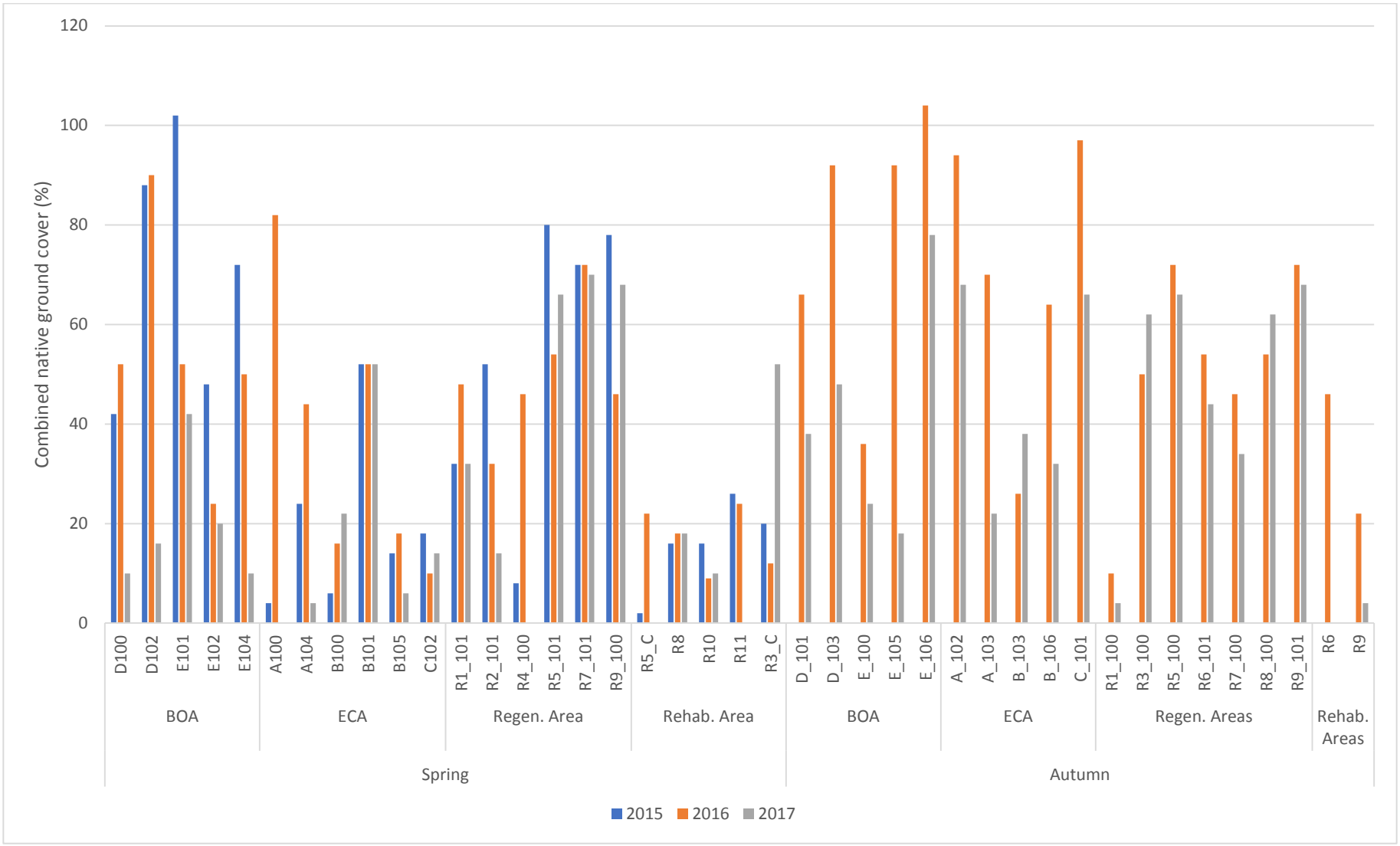

Figure 3-6: Combined native groundcover at all sites 2015-2017

Exotic flora species

Exotic species results were generally moderate across all 2017 Management Domain monitoring sites, with 37 of the 42 total sites monitored over autumn and spring achieving the exotic cover IPT. Consistent with 2016 monitoring results, exotic species richness was highest at the Rehabilitation sites (12 – 22 exotic species recorded within each site). Some sites within the ECA and Regeneration areas also recorded high exotic species diversity, including A_100, C_101, R3_100 and R6_101.

Exotic cover recorded across the Management Domains reduced from spring 2016 to spring 2017 monitoring periods, although there was a slight increase from autumn 2016 to autumn 2017 monitoring periods. These changes were not significant and can likely be attributed to normal seasonal variations. Comparison of exotic cover attribute scores are illustrated below in **Figure 3-7**.

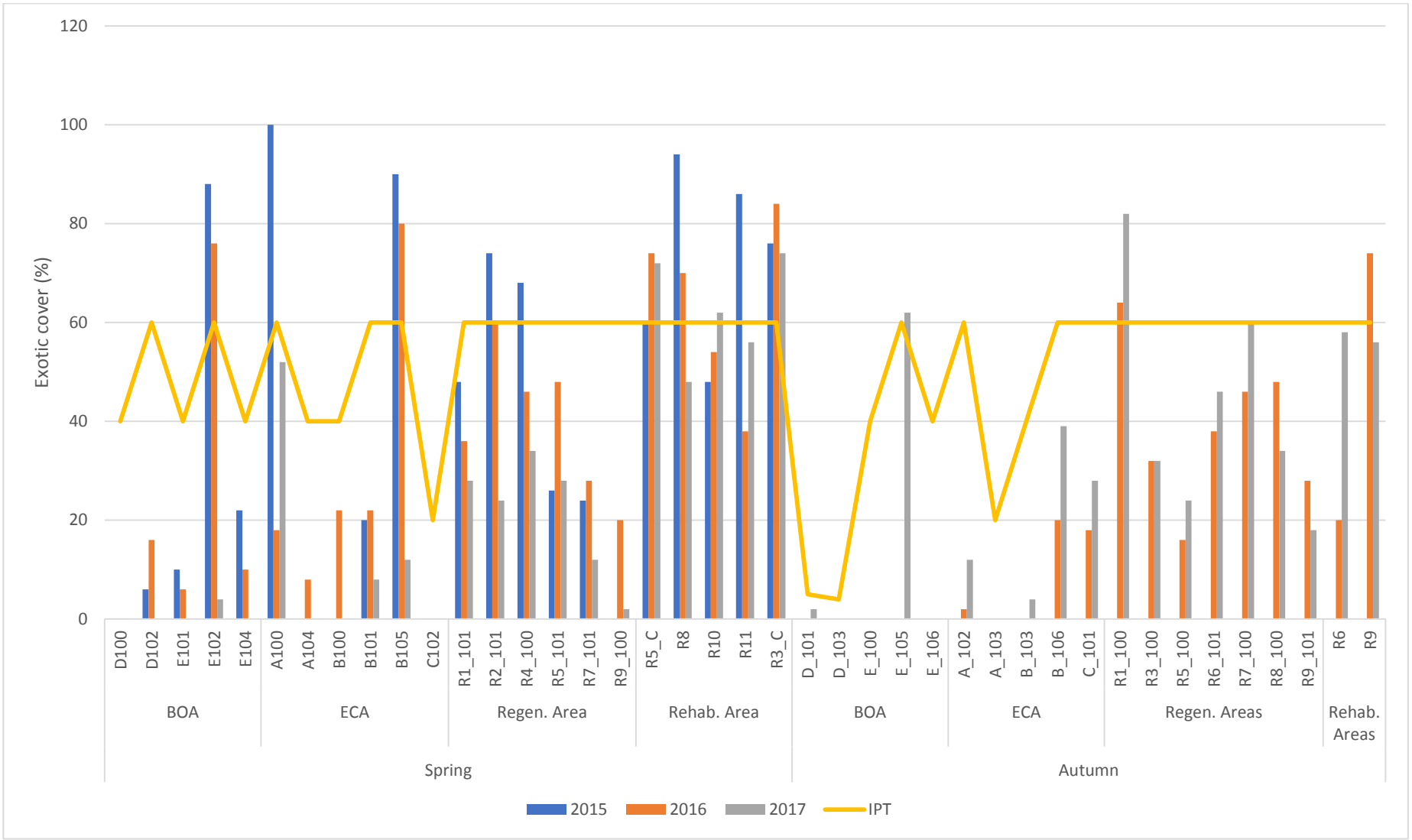

Figure 3-7: Exotic cover at all sites 2015-2017 compared against the 1-5 year IPT

Weeds classified as weeds of national significance (Schedule 3 of the NSW *Biosecurity Regulation 2017*) or as priority weeds under the Central Tablelands Regional Strategic Weed Management Plan 2017 – 2022 were identified at a number of monitoring sites across the Management Domains. These declared weeds and their site locations are presented below in **Table 3-5**.

Table 3-5: Declared weeds recorded in 2017

Scientific name	Common name	Weeds of national significance	State Priority Weed	Regional Priority Weed	Site	Management Domain
Heliotropium amplexicaule	Blue Heliotrope			Y	R2_101	Regeneration Areas
Hypericum perforatum	St John's Wort			Y	D_102, E_102, E_104, E_105, E_106	BOAs
					A_100, B_105, B_106, C_101	ECAs
					R1_101, R3_100, R5_100, R5_101, R6_101, R7_100, R7_101, R8_100, R9_101	Regeneration Areas
					Ref_19	Reference Sites
					R3_C, R5_C, R6, R9, R10, R11	Rehabilitation Areas
Opuntia sp.	Common Pear; Prickly Pear	Y	Y	Y	E_106, E_104, Ref_19	BOAs, Reference Sites
Senecio madagascariensis	Fireweed	Y	Y	Y	Ref_15	Reference Sites

3.3 Landscape Function Analysis

The LOI and SSA scores calculated from spring 2017 LFA monitoring are presented in **Table 3-6** to **3-10** below. The results are presented as a comparison to the 2016 monitoring data to provide an assessment against the LFA completion criteria as described above in **Sections 1.3.2** and **2.2**. It

should be noted that there are a number of contributing factors in the data collection and calculation of scores which may result in minor inconsistencies from year to year.

3.3.1 Biodiversity Offset Areas

Site E_105 is the only LFA monitoring site within the BOA Management Domains. The LOI and SSA results for this site are presented in **Table 3-6**, with the spring 2016 monitoring results included to provide an assessment of tracking toward the Completion Criteria.

The LOI of 1.00 achieved at this site indicates that the entire transect continues to be occupied by patches, with a dense cover of native perennial ground cover and leaf litter. This is consistent between the 2016 and 2017 monitoring results. Stability continues to exceed the Completion Criteria (>50), despite a reduction from the spring 2016 monitoring results. Soil Infiltration and Nutrient Cycling are both below the annual incremental increase target, with Nutrient Cycling representing a reduction from the spring 2016 monitoring results.

Table 3-6: LOI and SSA results for BOA transects

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
E_105	Spring 2017	1.00	53.8	45.2	33.3
	Spring 2016	*1.00*	*62.6*	*41.4*	*34.0*
		Annual incremental increase	-8.8	3.8	-0.7

3.3.2 Enhancement and Conservation Areas (ECAs)

Two LFA monitoring sites are located within the ECA Management Domains, including site A_100 within ECA-A, and site B_106 within ECA-B. Both sites are located in regenerating vegetation.

The LOI and SSA results for these sites are presented in **Table 3-7**. During spring 2017 monitoring, site A_100 recorded a LOI of 1.00, being entirely covered by perennial ground cover. This is consistent with previous results. Site B_106 recorded a LOI of 0.90, with extensive perennial ground cover and litter patches, and three small, discrete patches of bare soil.

During spring 2017 monitoring, the Stability Completion Criteria was exceeded at both ECAs, despite reductions compared to 2016 monitoring results. At Site A_100, the Soil Infiltration and Nutrient Cycling scores recorded during spring 2017 monitoring were below the Completion Criteria target of 50. At site B_106 all three Soil Surface Assessment criteria have declined compared to spring 2016 monitoring, with Soil Infiltration no longer achieving the Completion Criteria. Consistent with 2016 monitoring results, Nutrient Cycling is below the Completion Criteria (>50).

Table 3-7: LOI and SSA results for ECA transects

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient Cycling
A_100	Spring 2017	1.00	53.9	45.5	33.8
	Spring 2016	*1.00*	*56.7*	*42.1*	*31.8*
		Annual incremental increase	-2.8	3.4	2

B_106	Spring 2017	0.90	56.4	39.0	31.0
	Spring 2016	*0.97*	*79.8*	*57.3*	*46.2*
	Annual incremental increase		-23.4	-18.3	-15.2

3.3.3 Regeneration Areas

Two LFA monitoring sites are located within the Regeneration Area Management Domains, including site R1_100 within Regeneration Area 1 and site R4_100 within Regeneration Area 4 (see **Appendix B**). The LOI and SSA results for these sites are presented in **Table 3-8**.

During spring 2017 monitoring, LOI at both sites within the Regeneration Area Management Domains increased, with the transects being entirely occupied with patches. The Soil Stability score exceeded the Completion Criteria at both Rehabilitation Areas. The Soil Infiltration and Nutrient scores at R4_100 exceeded the annual incremental increase target. Soil Infiltration at R1_100 declined since 2016 monitoring, whilst the Nutrient Cycling score exceeded the annual incremental increase target.

Table 3-8: LOI and SSA results for Regeneration Area transects

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient Cycling
R1_100	Spring 2017	1.00	55.6	36.9	31.9
	Spring 2016	*0.88*	*70.4*	*39.3*	*24.1*
	Annual incremental increase		-14.8	-2.4	7.8
R4_100	Spring 2017	100	55.9	50.5	41.7
	Spring 2016	*0.95*	*52.2*	*40.6*	*34.0*
	Annual incremental increase		3.7	9.9	7.7

3.3.4 Rehabilitation Areas

Seven LFA monitoring sites are located within the Rehabilitation Areas, including R5; R6; R8; R9; R10; R11 and R13. The LOI and SSA results for the sites are presented in **Table 3-9**.

Spring 2016 monitoring results indicate that all Rehabilitation Area transects had high LOI scores (above 0.8). Transects R5_C, R8 and R9 experienced a decline in LOI compared to spring 2016 monitoring, while all other sites increased of remained stable. The Soil Stability scores recorded at all the Rehabilitation Area transects exceeded the Completion Criteria, however no sites achieved the annual incremental increase, with five of the seven sites experiencing a reduction in Soil Stability. The Soil Infiltration and Nutrients scores for all the Rehabilitation Area transects were below the Completion Criteria and the incremental increase target. With the exception of R9, all sites experienced a reduction from the 2016 monitoring results for at least one of the SSA indices.

Table 3-9: LOI and SSA results for Rehabilitation Area transects

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
R5_C	Spring 2017	0.81	58.0	30.1	25.0

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
	Spring 2016	*0.96*	*58.2*	*33.5*	*28.3*
	Annual incremental increase		-0.2	-3.4	-3.3
R6	Spring 2017	0.80	56.9	30.8	25.8
	Spring 2016	*0.78*	*62.5*	*35.6*	*28.0*
	Annual incremental increase		-5.6	-4.8	-2.2
R8	Spring 2017	0.95	53.2	31.4	24.2
	Spring 2016	*0.96*	*58.8*	*41.5*	*33.3*
	Annual incremental increase		-5.6	-10.1	9.1
R9	Spring 2017	0.98	58.1	42.7	38.1
	Spring 2016	*1.00*	*57.4*	*41.0*	*34.7*
	Annual incremental increase		0.7	1.7	3.4
R10	Spring 2017	0.69	56.6	28.8	22.1
	Spring 2016	*0.63*	*59.2*	*30.0*	*21.7*
	Annual incremental increase		-2.6	-1.2	0.4
R11	Spring 2017	0.98	60.9	40.6	36.9
	Spring 2016	*0.98*	*65.2*	*40.8*	*34.3*
	Annual incremental increase		-4.3	-0.2	2.6
R13	Spring 2017	0.91	57.9	33.7	28.1
	Spring 2016	*0.87*	*56.3*	*36.6*	*29.3*
	Annual incremental increase		1.6	-2.9	-1.2

3.3.5 Reference sites

During spring 2017 monitoring, ten LFA transects were undertaken at Reference sites to provide comparative data to assist in guiding management of WCPLs Management Domains (see **Appendix B**). The LOI and SSA scores for the Reference Site transects are presented in **Table 3-10**.

During spring 2017 monitoring, high LOI scores (above 0.8) were recorded at all the Reference sites, with the exception of site Ref_4, indicating that most the sites were close to being entirely occupied with patches and have a stable landform. The Soil Surface Stability scores recorded at all Reference sites were above the Completion Criteria. Soil Infiltration and Nutrient Cycling for all reference site were below the Completion Criteria and did not achieve the incremental increase target. All sites, except Ref_13b, experienced a reduction from the 2016 monitoring results in one or more SSA indices.

Table 3-10: Spring 2016 LOI and SSA results - Reference Sites

SITE	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling

SITE	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
Ref_1	Spring 2017	0.80	56.7	39.6	32.1
	Spring 2016	*0.95*	*59.3*	*41.9*	*32.2*
	Annual incremental increase		-2.6	-2.3	-0.1
Ref_2	Spring 2017	1.00	54.3	40.5	35.2
	Spring 2016	*0.98*	*55.3*	*45.8*	*35.6*
	Annual incremental increase		-1.0	-5.3	-0.4
Ref_3	Spring 2017	0.97	56.9	39.6	34.7
	Spring 2016	*0.96*	*54.1*	*45.2*	*34.8*
	Annual incremental increase		2.8	-5.6	-0.1
Ref_4	Spring 2017	0.78	50.0	35.3	25.5
	Spring 2016	*1.00*	*61.2*	*43.4*	*35.3*
	Annual incremental increase		-11.2	-8.1	-9.8
Ref_5	Spring 2017	0.82	54.4	45.7	33.4
	Spring 2016	*0.98*	*56.6*	*55.3*	*38.0*
	Annual incremental increase		-2.2	-9.6	-4.6
Ref_6	Spring 2017	0.96	54.3	42.3	32.8
	Spring 2016	*0.99*	*53.2*	*48.8*	*35.8*
	Annual incremental increase		1.1	-6.5	-3.0
Ref_7	Spring 2017	0.89	54.3	45.1	34.1
	Spring 2016	*0.98*	*55.7*	*44.9*	*37.5*
	Annual incremental increase		-1.4	0.2	-3.24
Ref_8	Spring 2017	1.00	55.7	39.1	33.6
	Spring 2016	*0.89*	*55.7*	*48.9*	*33.1*
	Annual incremental increase		0	-9.8	0.5
Ref_13b*	Spring 2017	0.98	54.4	42.7	35.2
	Spring 2016	*1.00*	*57.9*	*38.2*	*31.7*
	Annual incremental increase		-3.8	4.5	3.5
Ref_14	Spring 2017	1.00	59.3	43.1	38.8
	Spring 2016	*0.88*	*55.3*	*54.1*	*39.7*
	Annual incremental increase		4	-11	-0.9

Note: Ref_13b was established in spring 2016. The original Ref_13 site was impacted by fire from a NPWS controlled burn.

3.3.6 Discussion of LFA monitoring results

All the sites recorded relatively high LOI scores, indicating stable, functioning landform covered by patches. However, LOI should be considered as an indicator only and correlation of these scores

against vegetation and non-vascular ground cover data (for example, fallen logs) is important to gain a more detailed understanding of the overall functioning of the monitoring sites.

Within the Management Domains, the dominant patch types were groundcover, litter (with litter consisting of exotic annual species and/or leaf litter) and a mixture of groundcover and litter. The dense perennial groundcover at many monitoring sites is reflective of their vegetation type and condition, including regenerating DNG of grassy woodland communities.

All sites met the Completion Criteria target for Stability, despite 15 of the 22 sites experiencing a decrease from the 2016 monitoring results. The Stability scores across the Management Domains monitoring sites were comparable to the Reference site scores. The decrease in Stability scores may be attributed to a range of factors, including changed soil moisture levels affecting individual indicators, for example, surface resistances and slake tests, or observer variation of field conditions.

While Infiltration and Nutrient Cycling indices were lower and did not meet the annual incremental increase targets for the majority of sites, this pattern was similarly recorded in Reference sites. Variations from the 2016 monitoring results may be a result of a reduction in grass cover due to drier field conditions in 2017. Nutrient Cycling may be affected by perennial vegetation cover, litter cover and extent of decomposition, cryptogam cover and soil surface roughness. While many LFA sites have moderate to dense cover of perennial vegetation (grasses) and/or high litter cover, there was limited litter decomposition observed and largely flat soil micro topography. Low Soil Infiltration and Nutrient Cycling scores may be due to historical clearing and livestock usage across the BOAs, ECAs and Regeneration Sites. Low scores recorded within the Rehabilitation Sites may be due to the compacted artificial soils on which the Rehabilitation areas are located.

This decline in SSA scores within the Management Domains and Reference Sites is consistent with results from the 2015 to 2016 monitoring periods, suggesting there may be a downward trend. Longer term data would be required to assess whether this reduction represents a short-term change (for example due to a reduction in grass cover from seasonal variance, data collection and calculation, observer variation) or an ongoing trend requiring management action.

3.4 Fauna monitoring

Fauna monitoring was undertaken during winter (birds) and spring 2017. One hundred and sixteen native fauna species were recorded, comprising two amphibian, 12 mammal (including 10 positively identified microchiropteran bat (microbat) species), 14 reptile and 88 bird species. A full list of all fauna species recorded during the winter and spring 2017 monitoring program is included in **Appendix E.**

3.4.1 Winter bird monitoring

A total of 71 species were identified during the winter bird monitoring surveys, representing an increase of one species from winter 2016 monitoring. Bird species richness ranged from four individual species at site R1_101 to 29 species at site D_101. The most abundant species was *Lichenostomus chrysops* (Yellow-faced Honeyeater), with 381 individuals recorded across all 25 monitoring sites. The most commonly occurring species were the Yellow-faced Honeyeater, *Manorina melanocephala* (Noisy Miner and *Cracticus tibicen* (Australian Magpie), which were recorded at 19 of the 25 sites. One introduced species was recorded; *Sturnus vulgaris* (Common Starling).

The two target species (Swift Parrot and Regent Honeyeater) were not observed at any site. Survey conditions were suitable, and the target feed tree species were in flower. The survey methods were adept at recording other species, including threatened species, suggesting the target species would have been detected if they were present.

Five species listed as vulnerable under the BC Act were identified; including *Calyptorhynchus lathami* (Glossy Black-cockatoo), *Chthonicola sagittata* (Speckled Warbler), *Climacteris picumnus victoriae* (Brown Treecreeper), *Daphoenositta chrysoptera* (Varied Sittella) and *Glossopsitta pusilla* (Little Lorikeet) (**Table 3-11**). The occurrence of threatened species has increased since winter 2016 monitoring. The Little Lorikeet was not detected during winter 2016 monitoring.

Table 3-11: Winter bird monitoring - Threatened species

Scientific Name	Common Name	Site Recorded	BC Act Listing	EPBC Act Listing
Climacteris picumnus victoriae	Brown Treecreeper (eastern subsp.)	A_104, C_102, D_101, D_103, R5_100	V	-
Calyptorhynchus lathami	Glossy Black-cockatoo	D_103	V	-
Glossopsitta pusilla	Little Lorikeet	D_103, R3_100, R7_101	V	-
Chthonicola sagittata	Speckled Warbler	D_101, E_104, R3_100, R5_101, R7_101	V	-
Daphoenositta chrysoptera	Varied Sittella	A_104, D_101	V	-

3.4.2 Spring fauna monitoring

The most commonly occurring bird species was *Rhipidura leucophrys* (Willy Wagtail), occurring at 22 of the 25 bird monitoring sites. Bird species richness ranged from 39 species at R7_101 to 14 species at R1_101. *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) was the most commonly occurring microbat species, recorded at all 12 microbat monitoring sites. Microbat species richness ranged from two species (A_104) to eleven species (E_104).

Four introduced species were recorded. Twelve species listed as vulnerable under BC Act and/or the EPBC Act were recorded and are listed below in **Table 3-12**.

Table 3-12: Threatened fauna recorded

Assemblage	Scientific Name	Common Name	Site Recorded	BC Act Listing	EPBC Act Listing
Microbats	*Chalinolobus dwyeri*	Large-eared Pied Bat	C_102, D_103, E_104, R7_100, Ref 3, Ref 5, Ref 8, Ref 14	V	V
	Miniopterus australis	Little Bentwing Bat	Ref 2, Ref 3*, Ref 5	V	-
	Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	A_104*, B_101, C_102, D_103, E_104, R7_100, Ref 2, Ref 3, Ref 5, Ref 8, Ref 10, Ref 14	V	-
	Myotis macropus	Large-footed Myotis	C_102*, E_104*, Ref 2*, Ref 3*, Ref 5*, Ref 8*, Ref 14*	V	-
	Vespadelus troughtoni	Eastern Cave Bat	A_104*, B_101*, C_102*, E_104*	V	-
Mammals	*Pseudomys novaehollandiae*	New Holland Mouse	C_101	-	V
Birds	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subsp.)	D_103, R5_100	V	-
	Artamus cyanopterus	Dusky Woodswallow	A_104, C_102, E_106, R5_100, R7_101	V	-
	Glossopsitta pusilla	Little Lorikeet	B_103, C_102, D_103, R3_100	V	-
	Chthonicola sagittata	Speckled Warbler	B_101, B_103, E_106, R3_100, R7_101	V	-
	Daphoenositta chrysoptera	Varied Sittella	A_104, B_103, D_101	V	-

*Possible identification only. V = Vulnerable

3.4.3 Biodiversity Offset Areas

The results of microbat monitoring undertaken across BOA-D and BOA-E during spring 2017 monitoring is presented below in **Table 3-13**. Two threatened species, *Chalinolobus dwyeri* (Large-eared Pied Bat) and Eastern Bentwing Bat, were recorded in both BOAs. The DNG indicator species *Austronomus australis* (White-Striped Freetail Bat) and the woodland indicator species *Chalinolobus morio* (Chocolate Wattled Bat) were recorded in both BOAs, with *Rhinolophus megaphyllus* (Eastern Horseshoe Bat) (woodland indicator species) also positively recorded at BOA-D and South-eastern Freetail Bat (DNG indicator species) possibly recorded at both BOAs.

Table 3-13: Results of the microbat analysis for BOA-D and BOA-E, spring 2017

Species Name	Common Name	D_103		E_104	
		11 - 12 October		9 - 10 October	
		Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-Striped Freetail Bat	✓		✓	
Chalinolobus dwyeri[1]	Large-eared Pied Bat	✓		✓	
Chalinolobus gouldii	Gould's Wattled Bat	✓		✓	
Chalinolobus morio	Chocolate Wattled Bat	✓		✓	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	✓		✓	
Mormopterus (*Ozimops*) *planiceps*	South-eastern Freetail Bat		✓		✓
Mormopterus (Ozimops) ridei	Ride's Freetail Bat		✓		✓
Unknown *Mormopterus* spp.	Unknown Freetail Bat		✓		✓
*Myotis macropus**	Large-footed Myotis				✓
Nyctophilus spp.	Long-eared Bats	✓			✓
Rhinolophus megaphyllus	Eastern Horseshoe Bat			✓	
Scotorepens balstoni	Inland Broad-nosed Bat			✓	
Scotorepens orion	Eastern broad-nosed Bat			✓	
Vespadelus regulus	Southern Forest Bat		✓		✓
*Vespadelus troughtoni**	Eastern Cave Bat				✓
Vespadelus vulturnus	Little Forest Bat		✓		✓
Species Diversity (Positive identification)		**6**		**8**	
Species Diversity (Possible identification)		**5**		**8**	

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Biodiversity Offset Area D (BOA-D)

All sites occur in remnant eucalypt and *Callitris* dominated dry sclerophyll forest that contains a range of habitat features suitable for supporting various fauna assemblages (**Table 3-14**).

A total of 57 fauna species were recorded within BOA-D during spring 2017, comprising 42 birds, six mammal species (all of which were positively identified microbat species) and seven reptile species. Overall, species richness was the same as the 2016 monitoring, however microbat and reptile diversity have increased while bird and amphibian diversity have decreased.

Site D_100 recorded all four woodland/forest indicator bird species and no DNG indicator bird species. The other two sites also had a higher proportion of woodland/forest indicator birds, despite two DNG

indicator bird species being recorded. This is consistent with the vegetation assessments at these sites. The White-Striped Freetail Bat was detected at higher abundances than woodland/forest indicator microbat species. The Eastern Horseshoe Bat was not detected at D_103 and only possibly at E_104, while the Chocolate Wattled Bat was detected at relatively low numbers. Live trapping resulted in six reptile species, with an additional species being observed opportunistically. D_103 had the highest reptile species richness of the BOA-D sites.

Pig and rabbit scats were observed at D_103, and pig scats were present at D_101.

Table 3-14: Habitat features at BOA-D fauna monitoring sites

Site Number	Habitat Features
D_100	**High** floristic and forage resource diversity. Abundant canopy and shrub layer foliage with minimal ground vegetation coverage. The presence of litter and fallen logs provides good habitat features for ground fauna. No surface water present. The site is adjacent to Goulburn River National Park (NP) and surrounded by significant tracts of remnant woodland.
D_101	**High** floristic and forage resource diversity present with abundant canopy and shrub layer foliage. Abundant litter along with the presence of fallen logs provides good habitat features for ground fauna. Minimal rock coverage and no surface water available. The site is adjacent to Goulburn River NP and surrounded by significant tracts of remnant woodland.
D_103	**High** floristic and forage resource diversity. Dominant shrub layer vegetation with good canopy coverage. Abundant litter and fallen logs provides good habitat features for ground fauna. No surface water present. The site is adjacent to Goulburn River NP and surrounded by significant tracts of remnant woodland.

Biodiversity Offset Area E (BOA-E)

Site E_100 is located within remnant dry sclerophyll forest, with sites E_104 and E_106 located in remnant grassy woodland communities. All three fauna monitoring sites contain substantial habitat features for a variety of fauna assemblages (**Table 3-15**).

A total of 59 fauna species were recorded within BOA-E during spring 2017 monitoring, comprising 41 bird species, 12 mammal species (including eight positively identified microbat species), and six reptile species.

Overall species richness recorded in BOA-E during spring 2017 **monitoring** was slightly lower than that recorded during spring 2016 **monitoring**, with bird and amphibian diversity decreasing, whilst microbat and reptile diversity increased. Indicator microbat species were detected at E_104, with DNG indicator microbats present in slightly higher abundance.

All three sites had a higher proportion of woodland/forest indicator bird species present than DNG indicator species. Site E_104 had the highest diversity of indicator birds, four of the five species detected were woodland/forest indicator bird species. Twenty-five individuals of seven reptile species were live trapped at the BOA-E sites.

Pig and rabbit scats were observed at E_104. E_100 also had pig scats present.

Table 3-15: Habitat features at BOA-E fauna monitoring sites

Site Number	Habitat Features
E_100	**High** floristic and forage resource diversity present with abundant canopy and shrub layer foliage. Litter, fallen logs and abundant rock coverage provides good habitat features for ground fauna. No surface water present. The site is located immediately south of Goulburn River NP and is surrounded by significant patches of remnant native vegetation.
E_104	**Moderate** floristic and forage resource diversity dominated by ground cover vegetation. Limited litter, rock and fallen log coverage on ground. No surface water present. The site is located immediately south of Goulburn River NP and is surrounded by significant patches of remnant native vegetation.
E_106	**Moderate** floristic and forage resource diversity is dominated by groundcover vegetation. Limited presence of litter, fallen logs and rocks. No surface water present. Abundant rock cover with only limited presence of litter and fallen logs. Large dam located on periphery of site. The site is located immediately south of Goulburn River NP and is surrounded by significant patches of remnant native vegetation.

3.4.4 Enhancement and Conservation Areas

The results of microbat monitoring undertaken across ECA-A, ECA-B and ECA-C during spring 2017 monitoring is presented in **Table 3-16**. More detailed results from fauna monitoring are discussed per ECA below.

The Chocolate Wattled Bat, a woodland/forest microbat indicator species, was positively identified at all ECA sites.

Table 3-16: Results of the microbat analysis for A_104, B_101 and C_102

Species Name	Common Name	A_104		B_101		C_102	
		19 - 20 September		26 - 27 September		26 - 27 September	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-Striped Freetail Bat					✓	
Chalinolobus dwyeri[1]*	Large-eared Pied Bat					✓	
Chalinolobus gouldii	Gould's Wattled Bat			✓		✓	
Chalinolobus morio	Chocolate Wattled Bat	✓		✓		✓	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat		✓	✓		✓	
Mormopterus	South-eastern						✓

Species Name	Common Name	A_104		B_101		C_102	
		19 - 20 September		26 - 27 September		26 - 27 September	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
(*Ozimops*) *planiceps*	Freetail Bat						
Mormopterus (Ozimops) ridei	Ride's Freetail Bat						✓
Unknown *Mormopterus* spp.	Unknown Freetail Bat						
*Myotis macropus**	Large-footed Myotis						✓
Nyctophilus spp.	Long-eared Bats					✓	
Rhinolophus megaphyllus	Eastern Horseshoe Bat					✓	
Scotorepens balstoni	Inland Broad-nosed Bat				✓	✓	
Scotorepens orion	Eastern broad-nosed Bat						
Vespadelus regulus	Southern Forest Bat				✓		✓
*Vespadelus troughtoni**	Eastern Cave Bat		✓		✓		✓
Vespadelus vulturnus	Little Forest Bat				✓	✓	
Species Diversity (Positive identification)		**1**		**3**		**9**	
Species Diversity (Possible identification)		**2**		**4**		**5**	

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Enhancement and Conservation Area A (ECA-A)

Sites A_100 and A_102 are located within DNG areas, whilst A_104 is located in remnant *Callitris* forest with abundant lichen coverage in the ground layer. Landscape features within ECA-A provide habitat for a range of fauna assemblages (**Table 3-17**).

A total of 51 species were recorded within ECA-A during spring 2017 monitoring, comprising 48 bird species, one positively identified microbat (mammal) species, and two reptile species. Overall species richness was slightly lower than spring 2016 monitoring, with mammal and amphibian diversity decreasing while bird and reptile diversity increased.

Results for the site A_104 were consistent with it being in remnant habitat. This site contained the highest species richness of the three ECA-A sites, and four of the five woodland/indicator bird species were recorded at this location.

The other two sites recorded a higher proportion of DNG indicator bird species. Both sites had three DNG indicator birds present, with A_102 also recording one woodland/forest indicator species. These results are as expected for DNG sites.

No feral animal activity was detected across the ECA-A area during spring 2017.

Table 3-17: Habitat features at ECA-A fauna monitoring sites

Site Number	Habitat Features
A_100	**Low** floristic and forage resource diversity as the site is situated in a cleared paddock with no canopy or shrub layer foliage. Some surface water present in drainage line.
A_102	**Low** floristic and forage resource diversity as the site is situated in a cleared paddock with no canopy or minimal shrub layer foliage. Rocks and fallen logs absent. No surface water present.
A_104	**High** floristic and forage resource diversity dominated by abundant canopy coverage. Shrub layer present with abundant litter coverage over ground. The presence of fallen logs and abundant lichen coverage adds further habitat value to the site.

Enhancement and Conservation Area B (ECA-B)

Landscape features present within ECA-B provide habitat for a range of fauna assemblages (**Table 3-18**). ECA-B is located immediately south of the Goulburn River NP, providing enhanced habitat values for the area through landscape connectivity. Sites B_101 and B_105 are located within DNG, whilst B_100 and B_103 are located in remnant eucalypt/*Callitris* forest. B_105 is in close proximity to remnant Yellow Box Woodland, while also being bordered by two creeks. These landscape features are likely to influence which species utilise and are recorded at this site.

A total of 56 species were recorded in ECA-B during spring 2017 monitoring, comprising 47 bird species, three mammal species (all of which were positively identified microbat species), four reptile species and two amphibian species. This is slightly lower than 2016 monitoring results, due to a decrease in mammal diversity.

Indicator bird results support B_103 being a valuable remnant site, with four of the five woodland/forest indicator bird species present. The remaining ECA-B sites all had a higher proportion of DNG indicator birds, with B_101 and B_105 not recording any woodland/forest indicator bird species.

The Chocolate Wattled Bat, a woodland/forest indicator microbat species, was the only indicator microbat recorded at B_101. The threatened Eastern Bentwing Bat was positively identified and threatened species *Vespadelus troughtoni* (Eastern Cave Bat) was possibly identified at B_101. Three threatened bird species, Little Lorikeet, Speckled Warbler and Varied Sittella were also recorded across the ECA-B area. This suggests the site can support a variety of species, which may be attributed to the presence of water at the site.

Pig diggings were present at B_100, and rabbits were observed at B_101.

Table 3-18: Habitat features at ECA-B fauna monitoring sites

Site Number	Habitat Features
B_100	**High** floristic and forage resource diversity with abundant canopy, shrub and ground layer cover. Litter cover and the presence of fallen logs provides further habitat values for

Site Number	Habitat Features
	ground fauna. No surface water present.
B_101	**Moderate** floristic and forage resource diversity with only limited canopy coverage but abundant shrub and ground layer coverage. Dam located on southern border of the site.
B_103	**High** floristic and forage resource diversity with dominant canopy coverage. The site is located on a rocky ridge which combined with the presence of fallen logs and litter coverage, provides good habitat features for ground fauna. No surface water present.
B_105	**Low** floristic and forage resource diversity as site has been extensively cleared. A creek line borders the southern and western edges of the site which contain bulrushes and some canopy coverage.

Enhancement and Conservation Area C (ECA-C)

Across the monitoring sites within this domain, landscape features provide habitat for a range of fauna assemblages (**Table 3-19**). ECA-C is located adjacent to Munghorn Gap Nature Reserve (NR), which provides enhanced habitat values for the area through landscape connectivity. Site C_101 is located within DNG, whilst site C_102 is located in remnant eucalypt/*Callitris* forest.

A total of 51 species were recorded in ECA-C during spring 2017 monitoring, comprising 39 bird species, 10 mammal species (including nine positively identified microbat species) and two reptile species. Overall species richness is higher than spring 2016 monitoring.

The threatened *Pseudomys novaehollandiae* (New Holland Mouse) was caught in a pitfall trap at site C_101. Four species of threatened microbats were also detected at C_102, two were positively identified (Large-eared Pied Bat and Eastern Bentwing Bat) and two were possibly identified (*Myotis macropus* (Large-footed Myotis) and Eastern Cave Bat). The threatened birds Dusky Woodswallow and Little Lorikeet were also detected at C_102.

One DNG indicator bird species was recorded at C_101. Site C_102 recorded two DNG and two woodland/forest indicator bird species. All four indicator microbat species were positively identified at C_102. This is an improvement from spring 2016 monitoring, when no woodland/forest indicator microbat species were detected.

The site C_101 was very dry and heavily grazed, with rabbits observed on the site.

Table 3-19: Habitat features at ECA-C fauna monitoring sites

Site Number	Habitat Features
C_101	**Low** floristic and forage resource diversity as site has been cleared. Limited litter, fallen log and rock cover. No surface water present.
C_102	**High** floristic and forage resource diversity with abundant canopy, shrub and ground layer coverage. The site is located on a rocky ridge which combined with the presence of fallen logs and litter coverage, provides good habitat features for ground fauna. No surface water present.

3.4.5 Regeneration Areas

The results of microbat monitoring undertaken within Regeneration Areas (one site, R7) during spring 2017 monitoring is presented in **Table 3-20**. More detailed results from fauna monitoring are discussed per Regeneration Area below.

Table 3-20: Results of the microbat analysis for R7_100

Species Name	Common Name	R7_100	
		26 – 27 September	
		Positively identified	Possibly present
Austronomus australis	White-striped Freetail Bat	✓	
Chalinolobus dwyeri[1]	Large-eared Pied Bat	✓	
Chalinolobus gouldii	Gould's Wattled Bat	✓	
Chalinolobus morio	Chocolate Wattled Bat	✓	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	✓	
Mormopterus (*Ozimops*) *planiceps*	South-eastern Freetail Bat		✓
Mormopterus (Ozimops) ridei	Ride's Freetail Bat		✓
Unknown *Mormopterus* spp.	Unknown Freetail Bat		✓
Rhinolophus megaphyllus	Eastern Horseshoe Bat	✓	
Vespadelus regulus	Southern Forest Bat		✓
Vespadelus vulturnus	Little Forest Bat		✓
Species Diversity (Positive identification)		**6**	
Species Diversity (Possible identification)		**5**	

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Regeneration Area 1

Landscape features at site R1_101 provide habitat for a range of fauna assemblages (**Table 3-21**). The site is located within a regenerating paddock with a groundcover dominated by exotic forb species. The site is in close proximity to a densely vegetated hillside with extensive rocky outcropping. The proximity to this higher quality habitat likely affected the fauna observed/heard during monitoring of this site.

A total of 14 species were recorded at R1_100 during spring 2017 monitoring, comprising 14 birds. This is lower than spring 2016 monitoring, when a total of 24 species were recorded. Consistent with 2016 monitoring results, no threatened fauna was recorded in Regeneration Area 1. Two DNG indicator bird were present, which is consistent with the vegetation type at R1_101. The site is very dry and heavily grazed, which can be attributed in part to the cattle observed on the site.

Table 3-21: Habitat features at Regeneration Area 1 fauna monitoring site

Site Number	Habitat Features

Site Number	Habitat Features
R1_101	**Low** floristic and forage resource diversity as the site has been extensively cleared (no canopy or shrub layer present). Scattered rock cover provides habitat value across the site with small pools of water present in several rock cavities.

Regeneration Area 3

Site R3_100 is located within a regenerating paddock dominated by exotic perennial pasture species, with limited habitat features (**Table 3-22**). The site is in close proximity to an area of White Box Shrubby Woodland, with an ephemeral creek approximately 50 m from the site.

A total of 29 bird species were recorded at R3_100. No other species were recorded during spring 2017 monitoring. The threatened species Speckled Warbler and Little Lorikeet were recorded within the site. Four DNG indicator bird species were present at the site, compared to one woodland/forest indicator bird species. General fauna surveys did not detect any ground-dwelling species across the site.

Table 3-22: Habitat features at Regeneration Area 3 fauna monitoring site

Site Number	Habitat Features
R3_100	**Low** floristic and forage resource diversity due to minimal canopy and shrub coverage. Limited presence of litter and rock cover. No surface water present on site.

Regeneration Area 4

Site R4_100 is located within a regenerating paddock, with cover dominated by the exotic grasses *Phalaris aquatica* and *Vulpia* sp., and a high abundance of exotic forbs (**Table 3-23**). Regeneration Area 4 is located south of the Goulburn River NP.

A total of 18 bird species were recorded at R4_100, no other species were detected during spring 2017 monitoring. This is lower than spring 2016 monitoring, when 22 species were recorded. General fauna monitoring was not undertaken at this site. Two DNG indicator bird species were recorded at the site, which is consistent with the identified habitat features. No threatened fauna species were recorded within Regeneration Area 4 during the monitoring period. Rabbits were observed within the site during monitoring.

Table 3-23: Habitat features at Regeneration Area 4 fauna monitoring site

Site Number	Habitat Features
R4_100	**Low** floristic and forage resource diversity as the site has been extensively cleared. Creek lines border the site to the north and east.

Regeneration Area 5

Regeneration Area 5 is located immediately south of Goulburn River NP, which provides enhanced habitat values for the area through landscape connectivity. Both sites in this Management Domain are

located within DNG (**Table 3-24**). R5_101 is in close proximity to an area of Rough-barked Apple Woodland and Yellow Box Woodland, while R5_100 is bordered by an ephemeral vegetated creek line.

A total of 34 bird species were recorded during spring 2017 monitoring. No other species were detected, as general fauna monitoring was not conducted in Regeneration Area 5. Species richness is marginally lower than spring 2016 monitoring, when 36 species were recorded, despite an increase in bird diversity. The Dusky Woodswallow and Brown Treecreeper - eastern subspecies, listed as vulnerable under the BC Act, were recorded at R5_100. Both sites within Regeneration Area 5 had two species of DNG indicator bird species present. No woodland/forest indicator species were recorded, which is to be expected of DNG sites.

Pigs and rabbits were observed at both sites within Regeneration Area 5.

Table 3-24: Habitat features at Regeneration Area 5 fauna monitoring sites

Site Number	Habitat Features
R5_100	**Moderate** floristic and forage resource diversity. Scattered canopy coverage, mostly on border of site. Creek along the southern and eastern edge of site with a large dam at the north of the site. Minimal litter and rock cover.
R5_101	**Moderate** floristic and forage resource diversity. Good canopy coverage, mostly on borders of site. Creek along the southern edge of site with a dam in the centre. Presence of litter, rocks and fallen logs provide good habitat features for ground fauna.

Regeneration Area 6

Site R6_101 is located within heavily degraded DNG, with a moderately high cover of exotic pasture species and limited habitat features (**Table 3-24**).

A total of 19 bird species were recorded at R6_101. This is an increase in species bird species richness compared to spring 2016 monitoring, whilst amphibian diversity has decreased. General fauna monitoring was not undertaken at this site. Consistent with spring 2016 monitoring results, only DNG indicator birds were recorded at R6_101. Cattle was also observed at the site.

Table 3-25: Habitat features at Regeneration Area 6 fauna monitoring site

Site Number	Habitat Features
R6_101	**Low** floristic and forage resource diversity due to absence of canopy and shrub cover. Minimal litter and rock cover present. Small dam situated in the eastern section of the site.

Regeneration Area 7

Landscape features within this Management Domain provide habitat for a range of fauna assemblages (**Table 3-26**). Regeneration Area 7 is located directly adjacent to the Munghorn Gap NR, which provides enhanced habitat values for the area through landscape connectivity.

A total of 53 species were recorded, comprising 47 bird species and six positively identified microbat (mammal) species. This is an increase in bird species richness compared to spring 2016 monitoring.

Microbat diversity has increased, whilst general mammal diversity has decreased. General fauna trapping at this site did not detect any ground-dwelling species.

The threatened Large-eared Pied Bat and Eastern Bentwing Bat and three of the four indicator microbat species were positively identified at R7_100. In the context of the surrounding landscape (i.e. proximity to Munghorn Gap NR), this assemblage of species is perhaps not surprising as the site may be in a flyway.

The Dusky Woodswallow and Speckled Warbler, were recorded at R7_101. Both sites had a higher proportion of DNG indicator bird species present, with R7_100 not recording any woodland/forest indicator species. Cattle were also observed at R7_101.

Table 3-26: Habitat features at Regeneration Area 7 fauna monitoring sites

Site Number	Habitat Features
R7_100	**Moderate** floristic and forage resource diversity. Scattered canopy and shrub coverage across site. Litter, rock and fallen logs present within site. No surface water present.
R7_101	**Moderate** floristic and forage resource diversity. Scattered canopy and shrub coverage across site. Litter cover and fallen logs present within site. No surface water present.

3.3.12 Rehabilitation Areas

Sites R6 and R9 are surrounded by active mine operations which presents limitations to landscape connectivity and fauna dispersal (**Table 3-27**). Both sites have a dense groundcover dominated by exotic pasture species. These sites are to be rehabilitated to a woodland community, with scattered eucalypt seedlings and saplings are present.

A total of 24 species were recorded within this Management Domain, comprising 23 bird and one reptile species. Overall this is an increase in species richness compared to spring 2016 monitoring, despite reptile and amphibian diversity decreasing. Both sites recorded two DNG indicator bird species. There was some success with funnel traps at these sites, yielding eleven *Carlia tetradactyla* (Southern Rainbow Skink). This is an increase in abundance of this species compared to 2016 monitoring.

Rabbits were also observed at the site R9.

Table 3-27: Habitat features at Rehabilitation Area fauna monitoring sites

Site Number	Habitat Features
R6	**Moderate** floristic and forage resource diversity due to abundant shrub and ground vegetation cover and presence of litter and rock coverage. No surface water present.
R9	**Moderate** floristic and forage resource diversity due to abundant shrub and ground vegetation cover and presence of litter, rock and fallen log coverage. No surface water present.

3.4.6 Reference sites

Results for the microbat analysis at the six reference sites is shown in **Table 3-28** and **Table 3-29**.

Species richness was similar across the sites, ranging from seven species (Ref_2, Ref_3 and Ref_10) to ten (Ref_5). This is consistent with microbat diversity recorded in spring 2016 monitoring, when species richness ranged from six to ten species. This is the first year of monitoring at Ref_05, all data collected forms baseline data and cannot be compared with previous years' data.

Four threatened species were detected across the reference sites (with the Large-footed Myotis possibly identified, and three species positively identified). The Eastern Bentwing Bat was positively identified at all six sites, making it the most commonly occurring listed species.

Reference sites 05, 08 and 14 had all four microbat indicator species present (Chocolate Wattled Bat was only possibly identified at Ref_10, all other records were positively identified). Sites Ref_03 and Ref_14 had both DNG indicator microbat species present, however the woodland/forest indicator species Chocolate Wattled Bat was more abundant.

Table 3-28: Results of the microbat analysis for the WCPL Reference Sites

Species Name	Common Name	Ref_2		Ref_3		Ref_5	
		19 – 20 September		11 - 12 October		9 - 10 October	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-striped Freetail Bat			✓		✓	
Chalinolobus dwyeri[1]	Large-eared Pied Bat			✓		✓	
Chalinolobus gouldii	Gould's Wattled Bat	✓			✓	✓	
Chalinolobus morio	Chocolate Wattled Bat	✓		✓		✓	
*Miniopterus australis**	Little Bentwing Bat	✓			✓	✓	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	✓		✓		✓	
Mormopterus (*Ozimops*) *planiceps*	South-eastern Freetail Bat		✓		✓		✓
Mormopterus (Ozimops) ridei	Ride's Freetail Bat		✓		✓		✓
Unknown *Mormopterus* spp.	Unknown Freetail Bat		✓		✓		✓
*Myotis macropus**	Large-footed Myotis		✓		✓		✓
Nyctophilus spp.	*Long-eared Bats*		✓		✓	✓	
Rhinolophus megaphyllus	Eastern Horseshoe Bat	✓				✓	
Scotorepens balstoni	Inland Broad-nosed Bat			✓		✓	
Vespadelus regulus	Southern Forest Bat		✓		✓		✓
Vespadelus vulturnus	Little Forest Bat		✓		✓		✓
Species Diversity (Positive identification)		**5**		**5**		**9**	
Species Diversity (Possible identification)		**7**		**9**		**6**	

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Table 3-29: Results of the microbat analysis for the WCPL Reference Sites

Species Name	Common Name	Ref_8		Ref_10		Ref_14	
		19 – 20 October		11 – 12 October		9 and 10 October	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	**White-striped Freetail Bat**	✓		✓		✓	
Chalinolobus dwyeri**[1]	**Large-eared Pied Bat**	✓				✓	
Chalinolobus gouldii	**Gould's Wattled Bat**	✓		✓		✓	
Chalinolobus morio	**Chocolate Wattled Bat**	✓			✓	✓	
Miniopterus australis*	**Little Bentwing Bat**			✓		✓	
Miniopterus schreibersii oceanensis*	**Eastern Bentwing Bat**	✓			✓		
Mormopterus* (*Ozimops*) *planiceps	**South-eastern Freetail Bat**		✓		✓		
Mormopterus (Ozimops) ridei	**Ride's Freetail Bat**		✓		✓		
Unknown *Mormopterus* spp.	**Unknown Freetail Bat**		✓				✓
Myotis macropus*	**Large-footed Myotis**		✓				✓
***Nyctophilus* spp.**	***Long-eared Bats***		✓	✓			
Rhinolophus megaphyllus	**Eastern Horseshoe Bat**	✓		✓		✓	
Scotorepens balstoni	**Inland Broad-nosed Bat**	✓			✓		✓
Vespadelus regulus	**Southern Forest Bat**		✓		✓		✓
Vespadelus vulturnus	**Little Forest Bat**		✓		✓		✓
Species Diversity (Positive identification)		**7**		**5**		**6**	
Species Diversity (Possible identification)		**7**		**7**		**5**	

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

3.4.7 Fauna discussion

Fauna species diversity correlated positively with habitat condition and complexity (vegetation structural diversity, presence of hollows, and fallen logs). This was demonstrated through high species richness recorded within BOA and ECA monitoring sites. Regeneration and Rehabilitation areas did not have as much complexity and were often isolated from larger tracts of native vegetation.

Consistent with 2016 monitoring results, proximity to intact remnant vegetation and vegetation patch size is likely to have influenced monitoring results. Several survey sites within ECA and Regeneration areas that contained relatively low habitat features, but were close to Munghorn Gap NR or Goulbourn River NP, recorded high bird and microbat richness and/or abundance. In contrast, isolated monitoring sites within Rehabilitation areas (R6 and R9) that are surrounded by active mine operations had low bird observations, potentially due to lower habitat values in these areas and disturbance caused by mining operations.

Amphibian diversity has declined across the fauna sites, with the exception of the ECA-B area where it remained stable. The above average rainfall experienced during spring 2016 created favourable conditions for amphibians, likely increasing abundance and activity, in turn affecting detectability. It is likely amphibian levels are returning to more stable levels after experiencing a peak during 2016 monitoring. On-going monitoring will highlight if there is a continued trend.

Similarly, overall species richness has declined since 2016 monitoring, which is likely to be due to the lower rainfall and drier conditions experienced during the 2017 monitoring. On-going monitoring will determine if the system is stabilising after a peak or if there is a continued trend.

Limitations

In contrast to the 2016 monitoring period, which was very wet and cool, the 2017 monitoring program took place in a hot and dry period. The months leading up to and during spring 2017 monitoring experienced below average rainfall.

Drier conditions would likely have decreased foraging resource availability for birds, and therefore abundances could be potentially lower, with some species moving away to areas with more suitable conditions.

Many streams and pools which were running during 2016 monitoring were dry during 2017 monitoring. This decline in available surface water could be expected to significantly impact amphibian activity and breeding cycles. Decreases in amphibian diversity and abundance would be expected, especially compared to the favourable wet conditions experienced during 2016 monitoring.

4 Recommendations and Conclusion

Biodiversity monitoring undertaken at the Wilpinjong Coal Mine during 2017 represented the second year of monitoring (or Year 1) for autumn, and the third year of monitoring (or Year 2) for spring. Seasonal variation is still prevalent, and timing cannot be discounted as impacting the results and therefore drawing any conclusions at this early stage is difficult.

4.1.1 Vegetation

Monitoring during 2017 surveyed a total of 65 sites within all Management Domains and Reference sites. Whilst no sites have achieved all 10 of the IPTs, both seasons show significant increases compared to the previous monitoring periods, with 17 of 19 sites during autumn and 20 of 22 sites during spring meeting their IPTs for at least half of all site attributes. It should be noted that whilst data recorded during autumn 2017 shows significant trends, some results and variability are likely correlated to the variation in their relevant IPTs from Year 0 (Baseline) to Year 1 (Years 1-5).

The results collected at Reference Sites during both autumn and spring 2017 monitoring, continue to add to the dataset to be used for comparison with vegetation sites within the various Management Domains. The BMP suggests that baseline data collected from Year 0 monitoring at the Reference Sites will be used to develop more relevant, locally based benchmark values against which future monitoring data would be analysed.

ELA recommends that this should occur following several years of successive monitoring to account for seasonal variability and assessment of the performance of the reference sites is adequate for this purpose. Whilst this is not in complete compliance with the BMP, ELA recommends this approach to ensure that locally based benchmark values are realistic, comparable and attainable. A comparison of all reference site data is to be included in future monitoring reports, with assessment against the BMP benchmark values which were developed based on theoretical site attribute scores for the specified vegetation types.

4.1.2 Landscape stability

Groundcover in the form of living flora species, litter and rock material has been monitored within ECAs since 2007, Rehabilitation Areas since 2009 and Regeneration Areas (formerly Regrowth Areas) since 2011. This data can be correlated with the LOI data captured during the 2015 – 2017 monitoring, and both data sets demonstrate consistently high scores since monitoring commenced. Similarly, low levels of erosion observed throughout previous monitoring seasons (2007-2013) can be correlated with the high SSA Stability scores and the lack of any substantial erosion (as recorded in the erosion SSA assessment) recorded since 2015. Overall these combined data sets demonstrate that consistently stable landforms occur across the WCPL Management Domains.

4.1.3 Fauna

Fauna monitoring undertaken during 2017 recorded 116 fauna species, comprising two amphibian, 12 mammal (including 10 positively identified microbat species), 14 reptile and 88 bird species. Four introduced species were recorded, and 12 fauna species listed as vulnerable under the BC Act and/or the EPBC Act were recorded. Bird species richness ranged from 39 species (R7_101) to 14 species (R1_101), with the Willy Wagtail being the most commonly occurring bird species, recorded at 22 of 25 bird monitoring sites. The Eastern Bentwing Bat was the most commonly occurring microbat species, recorded at all 12 microbat monitoring sites. Microbat species richness ranged from two species (A_104) to eleven species (E_104).

Overall, species diversity has decreased from 2016 monitoring, however, on-going monitoring will determine if the system is stabilising after a peak or if there is a continued downward trend.

The conclusions that can be drawn are limited due to there being only three years of spring data and two of autumn; therefore, it is recommended that fauna monitoring is continued at the same sites into the future. However, the varying weather conditions of the last three years monitoring highlights limitations of the program, some of which can be addressed. It is clear that timing of both the bird and trapping surveys is a determinant of success. Though this can be difficult to control, an additional method of herpetological survey may assist in increasing trap success during colder months; that is, placing sheets of metal on the ground at monitoring sites several months before spring, which may provide shelter for reptiles and amphibians so that during spring there is a greater chance of them being present.

4.2 General recommendations

To inform the recommendations for the Management Domains, **Table 4-1** provides a review of the monitoring results and IPTs, and provides recommendations to inform future monitoring and to meet the IPTs and progress towards the Completion Criteria.

An Annual Works Program (ELA 2018) has been developed separate to this Annual Monitoring Report to provide specific management actions to be considered in response to the findings of this report.

Table 4-1: Review of monitoring results and recommendations

Interim Performance Target	Comment from results	Recommendations
Vegetation		
IPTs are listed in the BMP for Western Slopes Dry Sclerophyll Forest and Western Slopes Grassy Woodlands based on vegetation condition. Biometric site attribute scores for the Management Domain monitoring sites (ECAs, BOAs, Regeneration and Rehabilitation Areas) were compared to the IPTs whilst Reference Sites were compared to Benchmark Targets.	Management Domain sites surveyed during spring 2017 monitoring demonstrated a high level of achievement for their respective IPTs, whilst autumn 2017 monitoring recorded more variable results reflective of increased IPTs for Year 1 comparison. Inability of Reference Sites to meet benchmark targets (e.g. overstorey regeneration) likely due to naturally ground cover competition.	Ongoing weed management is recommended across all Management Domains with a particular focus on the occurrences of Priority Weeds. Targeted planting of native overstorey and midstorey species is recommended to accelerate the establishment of the mid and upper strata. These recommendations are in line with short term biodiversity management strategies outlined in the BMP. Ongoing monitoring of the Reference Sites to inform the development of more relevant, site-specific benchmarks.
The management of Priority weeds is listed as a priority in the BMP in accordance with the legal responsibility of WCPL under the (now repealed) *Noxious Weeds Act 1993*.	Declared weed species were recorded in all Management Domains.	Targeted weed management is recommended. Priority weed locations have been noted and their presence should be reviewed during future monitoring periods.
LFA		
Completion criteria for SSA indices (Slope Stability, Soil Infiltration and Nutrient Cycling) are listed in the BMP as a minimum score of 50. The BMP also anticipates a minimal annual increase by 5 for these scores.	High LOI indicating stable, functioning landforms, was recorded at all the sites presenting an improvement from 2016 monitoring at most sites. Slope Stability was above completion criteria for all sites. Soil Infiltration and Nutrient Cycling scores were more variable and below completion criteria for the majority of sites. Soil Infiltration and Nutrient Cycling scores reduced instead of recording the anticipated annual improvement of 5. However, this was reduction was also recorded at the reference sites.	Management measures to be implemented as recommended in the BMP would be expected to improve LFA monitoring results over time. Annual improvement of less than 5 for any of the SSA indices triggers the need for further investigation. WCPL should review past management measures in these areas and consult the BMP recommended management actions going forward. Continued monitoring of sites to provide longer term data and determine the effectiveness of management actions.

Interim Performance Target	Comment from results	Recommendations
Fauna		
Landforms and vegetation structure within WCPL Management Domains are inhabited or frequented by local fauna.	A broad variety of species were recorded in monitoring sites across the various Management Domains. These results demonstrated that the condition of landforms, vegetation structure and other habitat features at the monitoring sites, including the surrounding environment, were a key factor in determining species numbers and diversity.	Continue monitoring fauna sites, targeting fauna groups such as birds and microbats. Birds and microbats are common and diverse throughout Australia. Due to the ease of surveying birds and microbats, they are regularly a focus of monitoring surveys and are analysed as an indicator of biodiversity. Comparison of bird and microbat assemblages can be undertaken and tracking of trends over time can indicate sites providing improved habitat. Placement of permanent tiles to survey for reptiles and amphibians could improve survey results and provide greater species numbers and diversity at little cost and effort.
Introduced feral and pest species control is essential to environmental management works with targeted programs implemented.	Introduced predators and herbivores were observed throughout all Management Domains. Targeted monitoring of these species would be necessary to determine abundance and activity levels.	Ongoing management of introduced species is recommended. Management methods are to be implemented as per the BMP (including poison baiting of predators and ripping rabbit warrens) and recommendations from this report. Control of herbivore populations should be prioritised within regeneration and rehabilitation areas to increase resilience. Ongoing control of introduced predators will reduce pressure on native species.

5 References

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Appendix A – Weather conditions

Table A-1: 2017 Monthly mean and historical average weather conditions

Month	2017			Historical Averages		
	Min Temp (°C)	Max Temp (°C)	Total Rainfall (mm)	Min Temp (°C)	Max Temp (°C)	Rainfall Mean (mm)
January	19.8	33.7	27.8	16.8	31.1	70.5
February	18.8	34.0	34.2	16.3	29.9	61.1
March	16.9	27.5	146	13.8	27.4	55.2
April	8.7	22.1	23.0	9.8	23.4	43.9
May	5.6	19.5	32.4	6.3	19.1	45.1
June	3.0	16.8	10.4	3.7	15.5	50.9
July	-6.3	16.6	5.8	2.6	14.8	49.1
August	1.6	17.3	25.2	3.4	16.5	45.8
September	4.1	22.6	3.0	6.0	19.8	47.1
October	11.7	26.0	28.4	9.3	23.7	55.5
November	13.0	25.9	92.6	12.3	26.8	60.0
December	16.9	30.8	102.6	15.0	29.8	67.3

Source: WCPL (2017 data); Bureau of Meteorology, 2017 (Historical averages)

Table A-2: Weather conditions during 2017 Biodiversity Monitoring Program

Date	Min Temp (°C)	Max Temp (°C)	Rainfall (mm)	Average Wind Speed (km/hr)
Autumn monitoring				
16/05/2017	3.5	19.8	0	0.8
17/05/2017	2	20	0	0.8
18/05/2017	4.6	20.7	0	1.7
31/05/2017	0.3	14	0	1.3
1/06/2017	-2.5	16.7	0.1	0
2/06/2017	-2	17.6	0.1	0
Winter bird monitoring				
21/06/2017	1	18.5	0	0.7
22/06/2017	0.7	17.7	0	0.3
23/06/2017	1.4	17.9	0	1.3
24/06/2017	2.5	18.1	0	1.4
25/06/2017	4.5	17.7	1.2	1.3

Date	Min Temp (°C)	Max Temp (°C)	Rainfall (mm)	Average Wind Speed (km/hr)
26/06/2017	1.3	16.9	0	1
27/06/2017	-1.5	13	0	0.8
28/06/2017	7.8	11.3	4.4	0.5
Spring monitoring				
19/09/2017	5.7	20.1	0	2.9
20/09/2017	-0.2	22.5	0	0.3
21/09/2017	1.6	26.8	0	1.1
22/09/2017	2.7	29.8	0	0.8
23/09/2017	6	33.7	0	1.6
24/09/2017	13.2	29.2	0	2.7
25/09/2017	7.8	23.7	0	2.7
26/09/2017	4.6	24.9	0	0.7
27/09/2017	10.3	29.1	0	2
28/09/2017	9.5	25.4	0	2.9
30/10/2017	11.8	31.6	0	3.5
31/10/2017	9.2	21.8	0	3.4
1/11/2017	7.1	22.9	0	1.5
2/11/2017	6.6	26.3	0	0.8

Source: WCPL

Table A3: Monthly Rainfall from 2013 - 2017 (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2013	73.6	54.2	61.4	12.2	17.4	77.9	20.8	6.6	33.0	8.8	78.6	27.6	472.1
2014	15.6	60.0	112.6	62.8	13.8	29.8	28.6	28.8	14.6	15.4	24.4	126.7	533.1
2015	127.6	11.6	9.4	108.4	42.8	42.8	38.0	53.8	7.8	61.0	59.0	118.4	680.6
2016	152.1	7.2	23.5	14.8	66.8	104.2	101.1	40.9	198.7	86.6	51.9	90.6	938.4
2017	27.8	34.2	146	23	32.4	10.4	5.8	25.2	3	28.4	92.6	102.6	531.4
Historical Mean	**70.5**	**61.1**	**55.2**	**43.9**	**45.1**	**50.9**	**49.1**	**45.8**	**47.1**	**55.5**	**60.0**	**67.3**	**651.9**

Source: WCPL and Bureau of Meteorology, 2017 (Historical averages).

Appendix B – 2017 biodiversity monitoring sites

Table B-1: Autumn 2017 Vegetation Monitoring Sites

Domain	Site	Management Domain	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
BOA	D_101	BOA-D	Native vegetation	WSDSF	Narrow-leaved Ironbark Woodland	784318	6427419
	D_103	BOA-D	Native vegetation	WSDSF	Mugga Ironbark Woodland	784084	6427171
	E_100	BOA-E	Native vegetation	WSDSF	Narrow-leaved Ironbark - Brown Bloodwood - Dwyer's Red Gum Woodland	778311	6419426
	E_105	BOA-E	Regeneration	WSGW	White Box Grassy Woodland (regenerating)	779016	6419982
	E_106	BOA-E	Native vegetation	WSGW	White Box Grassy Woodland (DNG)	778855	6420402
ECA	A_102	ECA-A	Regeneration	WSGW	Box-Gum Grassy Woodland on Valley Floors (DNG)	772917	6417079
	A_103	ECA-A	Native vegetation	WSGW	Blakely's Red Gum Woodland	773142	6417621
	B_103	ECA-B	Native vegetation	WSDSF	Grey Gum - Narrow-leaved Stringybark Forest	771079	6420160
	B_106	ECA-B	Regeneration	WSGW	Yellow Box Woodland (DNG)	771570	6420003
	C_101	ECA-C	Regeneration	WSDSF	White Box Shrubby Woodland (DNG)	768365	6416938
Regeneration	R1_100	Regeneration Area 1	Regeneration	WSGW	Blakely's Red Gum Woodland (DNG)	774228	6420096
	R3_100	Regeneration Area 3	Regeneration	WSDSF	White Box Shrubby Woodland (DNG)	770462	6415880
	R5_100	Regeneration Area 5	Regeneration	WSGW	Rough-barked Apple Woodland (DNG)	769194	6421424
	R6_101	Regeneration Area 6	Regeneration	WSGW	Rough-barked Apple Woodland (DNG)	767412	6420304
	R7_100	Regeneration Area 7	Regeneration	WSGW	Yellow Box Woodland (DNG)	767957	6416541
	R8_100	Regeneration Area 8	Regeneration	WSDSF	Rough-barked Apple Woodland (DNG)	767740	6417104
	R9_101	Regeneration Area 9	Regeneration	WSGW	Rough-barked Apple Woodland (DNG)	768829	6422231

Domain	Site	Management Domain	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
Rehabilitation	R6	Rehabilitation	Rehabilitation	WSDSF	NA	769566	6419516
	R9	Rehabilitation	Rehabilitation	WSDSF	NA	769120	6418969
	Ref_14	Goulburn River NP	Native vegetation	WSDSF	N/A	782174	6421967
	Ref_15	Goulburn River NP	Native vegetation	WSGW	N/A	766024	6426575
	Ref_16	Goulburn River NP	Native vegetation	WSGW	N/A	766047	6426748
	Ref_17	Turill SCA	Native vegetation	WSGW	N/A	776767	6452950
	Ref_18	Goulburn River NP	Native vegetation	WSGW	N/A	775232	6451125
	Ref_19	BOA-E	Native vegetation	WSGW	N/A	779189	6419668
	Ref_20	Goulburn River NP	Native vegetation	WSDSF	N/A	769129	6421893
	Ref_21	Goulburn River NP	Native vegetation	WSDSF	N/A	769832	6422848
	Ref_22	Goulburn River NP	Native vegetation	WSDSF	N/A	768130	6423829
	Ref_23	Goulburn River NP	Native vegetation	WSGW	N/A	769183	6422270
	Ref_24	BOA-E	Native vegetation	WSGW	N/A	779295	6419440
	Ref_25	Goulburn River NP	Native vegetation	WSGW	N/A	764212	6431932

Table B-2: Spring 2017 vegetation monitoring sites

Domain	Site	Management Domain/Location	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
BOA	D_100	BOA-D	Native Vegetation	WSDSF	Narrow-leaved Ironbark - Box Woodland	784857	6427722
	D_102	BOA-D	Regeneration	WSGW	Grassy White Box Woodland	784563	6427262
	E_101	BOA-E	Regeneration	WSDSF	Shrubby regeneration	778761	6419564
	E_102	BOA-E	Regeneration	WSGW	Yellow Box Woodland	779053	6419319
	E_104	BOA-E	Native Vegetation	WSGW	Grassy White Box Woodland	779148	6419734
ECA	A_100	ECA-A	Regeneration	WSGW	DNG - other native (non-EEC)	771861	6416276
	A_104	ECA-A	Native Vegetation	WSGW	Narrow-leaved Ironbark Forest	773695	6416293
	B_100	ECA-B	Native Vegetation	WSGW	Sandstone Ranges Shrubby Woodland	770111	6420997
	B_101	ECA-B	Regeneration	WSGW	DNG - other native (non-EEC)	770542	6420592
	B_105	ECA-B	Regeneration	WSDSF	DNG - other native (non-EEC)	773141	6420468
	C_102	ECA-C	Native Vegetation	WSGW	Shrubby White Box Woodland	768940	6417281
Regeneration Area	R1_101	Regeneration Area 1	Regeneration	WSGW	DNG - other native (non-EEC)	774053	6419239
	R2_101	Regeneration Area 2	Regeneration	WSGW	DNG - other native (non-EEC)	772639	6418355
	R4_100	Regeneration Area 4	Regeneration	WSGW	DNG - other native (non-EEC)	770347	6420268
	R5_101	Regeneration Area 5	Regeneration	WSDSF	DNG - other native (non-EEC)	769500	6421595

Domain	Site	Management Domain/Location	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
	R7_101	Regeneration Area 7	Regeneration	WSDSF	DNG - other native (non-EEC)	767446	6415726
	R9_100	Regeneration Area 9	Regeneration	WSDSF	DNG - other native (non-EEC)	768975	6422067
Rehabilitation Area	R8	Rehabilitation Area	Rehabilitation – Grassland	WSGW	N/A	770231	6418596
	R10	Rehabilitation Area	Rehabilitation – Grassland	WSGW	N/A	768433	6419301
	R11	Rehabilitation Area	Rehabilitation – Grassland	WSGW	N/A	768896	6419664
	R3_C	Rehabilitation Area	Rehabilitation – Cattle excluded	WSDSF	N/A	770396	6419246
	R5_C	Rehabilitation Area	Rehabilitation – Cattle	WSDSF	N/A	770315	6419331
Reference	Ref_1	Turill SCA	Native vegetation	WSGW	Blakely's Red Gum Grassy Woodland	775261	6451958
	Ref_2	Goulburn River NP	Native vegetation	WSDSF	Narrow-leaved Ironbark - Box Woodland	224152	6424015
	Ref_3	Goulburn River NP	Native vegetation	WSDSF	Grey Gum – Narrow-leaved Stringybark Forest	217853	6424354
	Ref_4	Turill SCA	Native vegetation	WSGW	Grassy White Box Woodland	773477	6449770
	Ref_5	WCPL Offset Area	Native vegetation	WSDSF	Ironbark Bloodwood Red Gum Woodland	779353	6419938
	Ref_6	Goulburn River NP	Native vegetation	WSDSF	Ironbark Bloodwood Red Gum Woodland	222265	6422430
	Ref_7	Goulburn River NP	Native vegetation	WSDSF	Narrow-leaved Ironbark - Box Woodland	218145	6425455

Domain	Site	Management Domain/Location	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
	Ref_8	Goulburn River NP	Native vegetation	WSGW	White Box Shrubby Woodland	781932	6414688
	Ref_9	Goulburn River NP	Native vegetation	WSDSF	Grey Gum – Narrow-leaved Stringybark Forest	221614	6422152
	Ref_10	Goulburn River NP	Native vegetation	WSDSF	Narrow-leaved Ironbark - Box Woodland	220576	6428690
	Ref_11	Turill SCA	Native vegetation	WSGW	Blakely's Red Gum – White Box DNG	775036	6451459
	Ref_12	Turill SCA	Native vegetation	WSGW	Rough-barked Apple DNG	773663	6449945

Table B-3: LFA monitoring sites

Site	Management Domain	Easting	Northing	Zone	Type
A_100	ECA-A	771861	6416276	55H	BioMetric and LFA
B_106	ECA-B	771571	6420001	55H	LFA
E_105	BOA-E	779002	6419978	55H	LFA
R1_100	Regeneration Area 1	774228	6420095	55H	LFA
R10	Rehabilitation Area	768433	6419301	55H	BioMetric and LFA
R11	Rehabilitation Area	768896	6419664	55H	BioMetric and LFA
R13	Rehabilitation Area	770872	6418901	55H	LFA
R4_100	Regeneration Area 4	770347	6420268	55H	BioMetric and LFA
R5_C	Rehabilitation Area	770315	6419331	55H	BioMetric and LFA
R6	Rehabilitation Area	769562	6419517	55H	LFA
R8	Rehabilitation Area	770231	6418596	55H	BioMetric and LFA
R9	Rehabilitation Area	769118	6418973	55H	LFA
Ref_1	Turill SCA	775261	6451958	55H	BioMetric and LFA
Ref_10	Goulburn River NP	220576	6428690	56H	LFA
Ref_13b	Turill SCA	777202	6449998	55H	LFA
Ref_14	Goulburn River NP	782171	6421993	55H	LFA
Ref_2	Goulburn River NP	224152	6424015	56H	BioMetric and LFA
Ref_3	Goulburn River NP	217853	6424354	56H	BioMetric and LFA
Ref_4	Turill SCA	773477	6449770	55H	BioMetric and LFA
Ref_5	WCPL Offset Area	779353	6419938	55H	BioMetric and LFA
Ref_6	Goulburn River NP	222265	6422430	56H	BioMetric and LFA

Site	Management Domain	Easting	Northing	Zone	Type
Ref_7	Goulburn River NP	218145	6425455	56H	LFA
Ref_8	Goulburn River NP	781932	6414688	55H	BioMetric and LFA

Table B-4: Fauna monitoring sites

Area	Site ID	Coordinates		Management Zone	Vegetation Class	Survey		
		Easting	Northing			Fauna	Bats	Birds only
ECA-A	A_100	771861	6416276	Regeneration (poor resilience)	Western Slopes Grassy Woodland	Y		
	A_102	772926	6417078	Regeneration (moderate resilience)	Western Slopes Grassy Woodland	Y		
	A_104	773695	6416293	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y	Y	
BOA-D	D_100	784857	6427722	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	D_101	784306	6427422	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	D_103	784083	6427173	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest	Y	Y	
BOA-E	E_100	778299	6419408	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	E_104	779148	6419734	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y	Y	
	E_106	778854	6420399	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y		
ECA-B	B_100	770111	6420997	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y		
	B_101	770542	6420592	Regeneration (moderate resilience)	Western Slopes Grassy Woodland	Y	Y	
	B_103	771072	6420157	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	B_105	773141	6420468	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest			Y
ECA-C	C_101	768377	6416929	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	C_102	768940	6417281	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y		

Area	Site ID	Coordinates		Management Zone	Vegetation Class	Survey		
		Easting	Northing			Fauna	Bats	Birds only
Regeneration Area 1	R1_101	774053	6419239	Regeneration (moderate resilience)	Western Slopes Grassy Woodland			Y
Regeneration Area 3	R3_100	770500	6415898	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest	Y		
Regeneration Area 4	R4_100	770347	6420268	Regeneration (no resilience)	Western Slopes Grassy Woodland			Y
Regeneration Area 5	R5_100	769191	6421422	Regeneration (moderate resilience)	Western Slopes Grassy Woodland			Y
	R5_101	769500	6421595	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest			Y
Regeneration Area 6	R6_101	767406	6420303	Regeneration (no resilience)	Western Slopes Grassy Woodland			Y
Regeneration Area 7	R7_100	767907	6416557	Regeneration (moderate resilience)	Western Slopes Grassy Woodland	Y	Y	
	R7_101	767446	6415726	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest	Y		
Rehabilitation	R6	769562	6419517	Rehabilitation - Woodland	Western Slopes Dry Sclerophyll Forest	Y		
	R9	769118	6418973	Rehabilitation - Woodland	Western Slopes Dry Sclerophyll Forest	Y		
Reference Sites	Ref_2	224153	6424016	Goulburn River NP	Western Slopes Dry Sclerophyll Forest		Y	
	Ref_3	217853	6424354	Goulburn River NP	Western Slopes Grassy Woodland		Y	
	Ref_5	779353	6419939	WCPL Offset Area	Western Slopes Grassy Woodland		Y	
	Ref_8	781933	6414689	Goulburn River NP	Western Slopes Grassy Woodland		Y	
	Ref_10	220576	6428690	Goulburn River NP	Western Slopes Grassy Woodland		Y	
	Ref_14	782174	6421967	Goulburn River NP	Western Slopes Grassy Woodland		Y	

Appendix C – Flora species list (autumn 2017 and spring 2017)

Family	Scientific Name	Native / Exotic
Fabaceae	*Acacia decora*	Native
Fabaceae	*Acacia difformis*	Native
Fabaceae	*Acacia doratoxylon*	Native
Fabaceae	*Acacia implexa*	Native
Fabaceae	*Acacia ixiophylla*	Native
Fabaceae	*Acacia leucolobia*	Native
Fabaceae	*Acacia linearifolia*	Native
Fabaceae	*Acacia montana*	Native
Fabaceae	*Acacia penninervis*	Native
Fabaceae	*Acacia sp.*	Native
Fabaceae	*Acacia spectabilis*	Native
Fabaceae	*Acacia terminalis*	Native
Fabaceae	*Acacia triptera*	Native
Fabaceae	*Acacia ulicifolia*	Native
Fabaceae	*Acacia uncinata*	Native
Fabaceae	*Acacia verniciflua*	Native
Fabaceae	*Acacia leucoclada*	Native
Rosaceae	*Acaena echinata*	Native
Rosaceae	*Acaena sp.*	Native
Epacridaceae	*Acrotriche rigida*	Native
Poaceae	*Aira cupaniana*	Exotic
Poaceae	*Aira sp.*	Exotic
Lamiaceae	*Ajuga australis*	Native

Family	Scientific Name	Native / Exotic
Casuarinaceae	*Allocasuarina gymnanthera*	Native
Casuarinaceae	*Allocasuarina luehmannii*	Native
Amaranthaceae	*Alternanthera pungens*	Exotic
Amaranthaceae	*Alternanthera sp.*	Exotic
Loranthaceae	*Amyema sp.*	Native
Myrtaceae	*Angophora floribunda*	Native
Asteraceae	*Arctotheca calendula*	Exotic
Poaceae	*Aristida ramosa*	Native
Poaceae	*Aristida sp.*	Native
Poaceae	*Aristida vagans*	Native
Poaceae	*Arundinella nepalensis*	Native
Rubiaceae	*Asperula conferta*	Native
Asteraceae	*Asteraceae sp.*	Native/Exotic
Ericaceae	*Astroloma humifusum*	Native
Poaceae	*Austrodanthonia densiflora*	Native
Poaceae	*Austrodanthonia sp.*	Native
Poaceae	*Austrostipa scabra*	Native
Poaceae	*Austrostipa sp.*	Native
Poaceae	*Austrostipa verticillata*	Native
Asteraceae	*Bidens subalternans*	Native/Exotic
Rutaceae	*Boronia rubiginosa*	Native
Fabaceae	*Bossiaea buxifolia*	Native
Fabaceae	*Bossiaea prostrata*	Native
Fabaceae	*Bossiaea sp.*	Native
Poaceae	*Bothriochloa macra*	Native
Poaceae	*Bothriochloa sp.*	Native

Family	Scientific Name	Native / Exotic
Malvaceae	*Brachychiton populneus*	Native
Ericaceae	*Brachyloma daphnoides*	Native
Ericaceae	*Brachyloma sp.*	Native
Brassicaceae	*Brassica sp.*	Exotic
Brassicaceae	*Brassicaceae sp.*	Exotic
Poaceae	*Bromus hordeaceus*	Exotic
Poaceae	*Bromus molliformis*	Exotic
Poaceae	*Bromus sp.*	Exotic
Acanthaceae	*Brunoniella australis*	Native
Asphodelaceae	*Bulbine bulbosa*	Native
Pittosporaceae	*Bursaria spinosa*	Native
Cupressaceae	*Callitris endlicheri*	Native
Asteraceae	*Calotis cuneifolia*	Native
Asteraceae	*Calotis lappulacea*	Native
Myrtaceae	*Calytrix tetragona*	Native
Brassicaceae	*Capsella bursa-pastoris*	Exotic
Cyperaceae	*Carex appressa*	Native
Cyperaceae	*Carex inversa*	Native
Asteraceae	*Carthamus ap.*	Exotic
Asteraceae	*Carthamus lanatus*	Exotic
Asteraceae	*Cassinia arcuata*	Native
Asteraceae	*Cassinia cunninghamii*	Native
Asteraceae	*Cassinia quinquefaria*	Native
Lauraceae	*Cassytha pubescens*	Native
Poaceae	*Cenchrus clandestinus*	Exotic
Caryophyllaceae	*Cerastium glomeratum*	Exotic

Family	Scientific Name	Native / Exotic
Pteridaceae	*Cheilanthes sieberi*	Native
Poaceae	*Chloris gayana*	Exotic
Poaceae	*Chloris sp.*	Exotic
Poaceae	*Chloris truncata*	Native
Poaceae	*Chloris ventricosa*	Native
Asteraceae	*Chrysocephalum apiculatum*	Native
Asteraceae	*Chrysocephalum sp.*	Native
Asteraceae	*Cirsium sp.*	Exotic
Asteraceae	*Cirsium vulgare*	Exotic
Poaceae	*Cleistochloa rigida*	Native
Ranunculaceae	*Clematis aristata*	Native
Ranunculaceae	*Clematis glycinoides*	Native
Convolvulaceae	*Convolvulus erubescens*	Native
Asteraceae	*Conyza bonariensis*	Exotic
Asteraceae	*Conyza sp.*	Exotic
Rutaceae	*Correa reflexa var. reflexa*	Native
Myrtaceae	*Corybas sp.*	Native
Myrtaceae	*Corymbia trachyphloia*	Native
Asteraceae	*Cotula australis*	Native
Crassulaceae	*Crassula sieberiana*	Native
Asteraceae	*Cymbonotus lawsonianus*	Native
Poaceae	*Cymbopogon refractus*	Native
Poaceae	*Cynodon dactylon*	Native
Boraginaceae	*Cynoglossum australe*	Native
Cyperaceae	*Cyperaceae sp.*	Native
Cyperaceae	*Cyperus gracilis*	Native

Family	Scientific Name	Native / Exotic
Cyperaceae	*Cyperus sp.*	Native
Apiaceae	*Daucus glochidiatus*	Native
Fabaceae	*Daviesia genistifolia*	Native
Fabaceae	*Desmodium brachypodum*	Native
Fabaceae	*Desmodium sp.*	Native
Fabaceae	*Desmodium varians*	Native
Phormiaceae	*Dianella longifolia*	Native
Phormiaceae	*Dianella revoluta*	Native
Phormiaceae	*Dianella sp.*	Native
Poaceae	*Dichelachne micrantha*	Native
Convolvulaceae	*Dichondra repens*	Native
Convolvulaceae	*Dichondra sp. sensu*	Native
Poaceae	*Digitaria brownii*	Native
Poaceae	*Digitaria eriantha*	Exotic
Poaceae	*Digitaria sp.*	Native
Sapindaceae	*Dodonaea triangularis*	Native
Sapindaceae	*Dodonaea viscosa*	Native
Sapindaceae	*Dodonaea viscosa subsp. cuneata*	Native
Poaceae	*Echinopogon caespitosus*	Native
Poaceae	*Echinopogon sp.*	Native
Boraginaceae	*Echium plantagineum*	Exotic
Boraginaceae	*Echium vulgare*	Exotic
Chenopodiaceae	*Einadia hastata*	Native
Chenopodiaceae	*Einadia nutans*	Native
Chenopodiaceae	*Einadia sp.*	Native
Chenopodiaceae	*Einadia trigonos*	Native

Family	Scientific Name	Native / Exotic
Poaceae	*Eleusine tristachya*	Native
Poaceae	*Enneapogon sp.*	Native
Poaceae	*Entolasia stricta*	Native
Poaceae	*Eragrostis brownii*	Native
Poaceae	*Eragrostis cilianensis*	Native
Poaceae	*Eragrostis curvula*	Exotic
Poaceae	*Eragrostis leptostachya*	Native
Poaceae	*Eragrostis sp.*	Native/Exotic
Myoporaceae	*Eremophila debilis*	Native
Geraniaceae	*Erodium botrys*	Exotic
Geraniaceae	*Erodium cicutarium*	Exotic
Geraniaceae	*Erodium crinitum*	Native
Geraniaceae	*Erodium sp.*	Native
Myrtaceae	*Eucalyptus albens*	Native
Myrtaceae	*Eucalyptus blakelyi*	Native
Myrtaceae	*Eucalyptus bridgesiana*	Native
Myrtaceae	*Eucalyptus crebra*	Native
Myrtaceae	*Eucalyptus dealbata*	Native
Myrtaceae	*Eucalyptus dwyeri*	Native
Myrtaceae	*Eucalyptus fibrosa*	Native
Myrtaceae	*Eucalyptus melliodora*	Native
Myrtaceae	*Eucalyptus moluccana*	Native
Myrtaceae	*Eucalyptus punctata*	Native
Myrtaceae	*Eucalyptus rossii*	Native
Myrtaceae	*Eucalyptus sideroxylon*	Native
Myrtaceae	*Eucalyptus sparsifolia*	Native

Family	Scientific Name	Native / Exotic
Asteraceae	*Euchiton sp.*	Native
Asteraceae	*Euchiton sphaericus*	Native
Euphorbiaceae	*Euphorbia sp.*	Native
Euphorbiaceae	*Euphorbia drummondii*	Native
Santalaceae	*Exocarpos strictus*	Native
Santalaceae	*Exocarpos cupressiformis*	Native
Fabaceae	*Fabaceae sp.*	Exotic
Cyperaceae	*Fimbristylis dichotoma*	Native
Cyperaceae	*Gahnia aspera*	Native
Rubioideae	*Galium sp.*	Native
Asteraceae	*Gamochaeta calviceps*	Exotic
Asteraceae	*Gamochaeta sp.*	Exotic
Rubioideae	*Gardenia sp.*	Exotic
Geraniaceae	*Geranium solanderi*	Native
Geraniaceae	*Geranium solanderi var. solanderi*	Native
Geraniaceae	*Geranium sp.*	Native
Fabaceae	*Glycine clandestina*	Native
Fabaceae	*Glycine sp.*	Native
Fabaceae	*Glycine tabacina*	Native
Fabaceae	*Gompholobium huegelii*	Native
Fabaceae	*Gompholobium sp.*	Native
Haloragaceae	*Gonocarpus elatus*	Native
Haloragaceae	*Gonocarpus sp*	Native
Goodeniaceae	*Goodenia hederacea*	Native
Goodeniaceae	*Goodenia heterophylla*	Native
Goodeniaceae	*Goodenia ovata*	Native

Family	Scientific Name	Native / Exotic
Goodeniaceae	*Goodenia rotundifolia*	Native
Goodeniaceae	*Goodenia sp.*	Native
Proteaceae	*Grevillea sericea*	Native
Proteaceae	*Hakea dactyloides*	Native
Haloragaceae	*Haloragis heterophylla*	Native
Fabaceae	*Hardenbergia violacea*	Native
Boraginaceae	*Heliotropium amplexicaule*	Exotic
Dilleniaceae	*Hibbertia circumdans*	Native
Dilleniaceae	*Hibbertia monogyna*	Native
Dilleniaceae	*Hibbertia obtusifolia*	Native
Dilleniaceae	*Hibbertia riparia*	Native
Dilleniaceae	*Hibbertia sp.*	Native
Fabaceae	*Hovea lanceolata*	Native
Apiaceae	*Hydrocotyle laxiflora*	Native
Clusiaceae	*Hypericum gramineum*	Native
Clusiaceae	*Hypericum perforatum*	Exotic
Asteraceae	*Hypochaeris glabra*	Exotic
Asteraceae	*Hypochaeris radicata*	Exotic
Asteraceae	*Hypochaeris sp*	Exotic
Juncaceae	*Juncus sp.*	Native
Juncaceae	*Juncus usitatus*	Native
Myrtaceae	*Kunzea ambigua*	Native
Poaceae	*Lachnagrostis filiformis*	Native
Asteraceae	*Lactuca serriola*	Exotic
Asteraceae	*Lactuca sp.*	Exotic
Anthericaceae	*Laxmannia gracilis*	Native

Family	Scientific Name	Native / Exotic
Brassicaceae	*Lepidium africanum*	Exotic
Brassicaceae	*Lepidium sp.*	Native
Cyperaceae	*Lepidosperma gunnii*	Native
Cyperaceae	*Lepidosperma laterale*	Native
Myrtaceae	*Leptospermum parvifolium*	Native
Myrtaceae	*Leptospermum polygafolium*	Native
Myrtaceae	*Leptospermum sphaerocarpum*	Native
Myrtaceae	*Leptospermum trinervium*	Native
Ericaceae	*Leucopogon muticus*	Native
Linaceae	*Liliaceae sp.*	Exotic
Ericaceae	*Lissanthe sp.*	Native
Ericaceae	*Lissanthe strigosa*	Native
Poaceae	*Lolium perenne*	Exotic
Poaceae	*Lolium rigidum*	Exotic
Poaceae	*Lolium sp.*	Exotic
Lomandraceae	*Lomandra confertifolia*	Native
Lomandraceae	*Lomandra filiformis*	Native
Lomandraceae	*Lomandra filiformis subsp. coriacea*	Native
Lomandraceae	*Lomandra filiformis subsp. filiformis*	Native
Lomandraceae	*Lomandra glauca*	Native
Lomandraceae	*Lomandra longifolia*	Native
Lomandraceae	*Lomandra multiflora*	Native
Lomandraceae	*Lomandra multiflora subsp. multiflora*	Native
Primulaceae	*Lysimachia arvensis*	Native
Zamiaceae	*Macrozamia communis*	Native
Zamiaceae	*Macrozamia secunda*	Native

Family	Scientific Name	Native / Exotic
Malvaceae	*Malva parviflora*	Exotic
Lamiaceae	*Marrubium vulgare*	Exotic
Myrtaceae	*Melaleuca erubescens*	Native
Myrtaceae	*Melaleuca uncinata*	Native
Epacridaceae	*Melichrus erubescens*	Native
Epacridaceae	*Melichrus procumbens*	Native
Epacridaceae	*Melichrus urceolatus*	Native
Violaceae	*Melicytus dentatus*	Native
Lamiaceae	*Mentha satureioides*	Native
Poaceae	*Microlaena stipoides*	Native
Malvaceae	*Modiola caroliniana*	Exotic
Ericaceae	*Monotoca scoparia*	Native
Asteraceae	*Olearia elliptica*	Native
Rubiaceae	*Opercularia diphylla*	Native
Rubiaceae	*Opercularia hispida*	Native
Cactaceae	*Opuntia stricta*	Exotic
Orchidaceae	*Orchidaceae sp.*	Exotic
Fabaceae	*Ornithopus compressus*	Exotic
Oxalidaceae	*Oxalis perennans*	Native
Oxalidaceae	*Oxalis sp.*	Native
Poaceae	*Panicum effusum*	Native
Poaceae	*Panicum sp.*	Native
Caryophyllaceae	*Paronychia brasiliana*	Exotic
Poaceae	*Paspalum dilatatum*	Exotic
Iridaceae	*Patersonia sericea*	Native
Proteaceae	*Persoonia curvifolia*	Native

Family	Scientific Name	Native / Exotic
Proteaceae	*Persoonia linearis*	Native
Caryophyllaceae	*Petrorhagia nanteuilii*	Exotic
Poaceae	*Phalaris aquatica*	Exotic
Poaceae	*Phalaris sp.*	Exotic
Rutaceae	*Phebalium squamulosum*	Native
Euphorbiaceae	*Phyllanthus hirtellus*	Native
Euphorbiaceae	*Phyllanthus occidentalis*	Native
Phyllanthaceae	*Phyllanthus sp.*	Native/Exotic
Thymelaeaceae	*Pimelea linifolia*	Native
Thymelaeaceae	*Pimelea sp.*	Native
Plantaginaceae	*Plantago debilis*	Native
Plantaginaceae	*Plantago lanceolata*	Exotic
Plantaginaceae	*Plantago sp.*	Native
Poaceae	*Poa annua*	Exotic
Poaceae	*Poaceae sp.*	Native/Exotic
Asteraceae	*Podolepis neglecta*	Native
Asteraceae	*Podolepis sp.*	Native
Fabaceae	*Podolobium ilicifolium*	Native
Caryophyllaceae	*Polycarpon sp.*	Exotic
Polygonaceae	*Polygonum aviculare*	Exotic
Rubiaceae	*Pomax umbellata*	Native
Phyllanthaceae	*Poranthera corymbosa*	Native
Phyllanthaceae	*Poranthera microphylla*	Native
Portulaceae	*Portulaca oleracea*	Native
Dennstaedtiaceae	*Pteridium esculentum*	Native
Orchidaceae	*Pterostylis sp.*	Native

Family	Scientific Name	Native / Exotic
Fabaceae	*Pultenaea cinerascens*	Native
Fabaceae	*Pultenaea microphylla*	Native
Rosaceae	*Rosaceae sp.*	Exotic
Polygonaceae	*Rumex brownii*	Native
Polygonaceae	*Rumex sp.*	Native
Poaceae	*Rytidosperma pallidum*	Native
Poaceae	*Rytidosperma racemosum*	Native
Poaceae	*Rytidosperma sp.*	Native
Chenopodiaceae	*Salsola australis*	Native
Lamiaceae	*Salvia verbenaca*	Exotic
Myrtaceae	*Sannantha cunninghamii*	Native
Asteraceae	*Senecio hispidulus*	Native
Asteraceae	*Senecio madagascariensis*	Native
Asteraceae	*Senecio pinnatifolius var. pinnatifolius*	Exotic
Asteraceae	*Senecio quadridentatus*	Native
Asteraceae	*Senecio sp.*	Native
Poaceae	*Setaria parviflora*	Exotic
Poaceae	*Setaria pumila*	Native/Exotic
Poaceae	*Setaria sp.*	Native/Exotic
Malvaceae	*Sida corrugata*	Native
Malvaceae	*Sida sp.*	Native
Asteraceae	*Sigesbeckia sp.*	Native
Solanaceae	*Solanum campanulatum*	Native
Solanaceae	*Solanum nigrum*	Exotic
Solanaceae	*Solanum prinophyllum*	Native
Solanaceae	*Solanum sp.*	Native

Family	Scientific Name	Native / Exotic
Asteraceae	*Solenogyne bellioides*	Native
Asteraceae	*Solenogyne sp.*	Native
Asteraceae	*Sonchus oleraceus*	Exotic
Asteraceae	*Sonchus sp.*	Exotic
Poaceae	*Sporobolus creber*	Native
Poaceae	*Sporobolus elongatus*	Native
Stackhousiaceae	*Stackhousia monogyna*	Native
Stackhousiaceae	*Stackhousia sp.*	Native
Stackhousiaceae	*Stackhousia viminea*	Native
Caryophyllaceae	*Stellaria media*	Exotic
Caryophyllaceae	*Stellaria pugens*	Native
Epacridaceae	*Styphelia triflora*	Native
Fabaceae	*Swainsona galegifolia*	Native
Asteraceae	*Tagetes minuta*	Exotic
Asteraceae	*Taraxacum officinale*	Exotic
Poaceae	*Themeda triandra*	Native
Anthericaceae	*Thysanotus sp.*	Native
Anthericaceae	*Tolpis barbata*	Native
Fabaceae	*Trifolium arvense*	Exotic
Fabaceae	*Trifolium campestre*	Exotic
Fabaceae	*Trifolium glomeratum*	Exotic
Fabaceae	*Trifolium hirtum*	Exotic
Fabaceae	*Trifolium repens*	Exotic
Fabaceae	*Trifolium sp.*	Exotic
Fabaceae	*Trifolium subterraneum*	Exotic
Asteraceae	*Triptilodiscus pygmaeus*	Native

Family	Scientific Name	Native / Exotic
Urticaceae	*Urtica incisa*	Native
Scrophulariaceae	*Verbascum thapsus*	Exotic
Scrophulariaceae	*Verbascum virgatum*	Exotic
Verbenaceae	*Verbena bonariensis*	Exotic
Verbenaceae	*Verbena sp.*	Exotic
Scrophulariaceae	*Veronica plebeia*	Native
Asteraceae	*Vittadinia cuneata*	Native
Asteraceae	*Vittadinia sp.*	Native
Asteraceae	*Vittadinia sulcata*	Native
Asteraceae	*Vittadinia muelleri*	Native
Poaceae	*Vulpia sp.*	Exotic
Campanulaceae	*Wahlenbergia sp.*	Native
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Native
Zygophyllaceae	*Zygophyllaceae sp.*	Native

Appendix D – Vegetation structure data

Table D-1: Autumn 2017 Vegetation Structure Data

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
BOA-D	D_101	U1	7	14	15	*Eucalyptus crebra, Eucalyptus moluccana*
		M1	0.5	2	5	*Acacia triptera, Acacia montana, Acrotriche rigida*
		L1	0.01	0.3	5	*Austrostipa densiflora, Gahnia aspera*
		L2	15	0.01	0.5	*Gahnia aspera, Cheilanthes sieberi, Goodenia hederacea*
	D_103	U1	5	8	7	*Eucalyptus crebra, Eucalyptus fibrosa, Eucalyptus sideroxylon*
		M1	2.5	5	25	*Allocasuarina gymnanthera, Melaleuca uncinata*
		M2	0.5	2.5	50	*Acacia triptera, Melichrus erubescens, Kunzea ambigua*
		L1	0.01	0.5	2	*Microlaena stipoides, Digitaria sp.*
		L2	0.01	0.5	1	*Goodenia hederacea, Cheilanthes sieberi, Acrotriche rigida*
BOA	E_100	U1	8	12	10	*Eucalyptus crebra, Eucalyptus dealbata, Callitris endlicheri*
		M1	2	8	7	*Allocasuarina gymnanthera, Persoonia linearis, Cassinia arcuata*
		M2	0.5	1.8	10	*Acrotriche rigida, Acacia triptera, Leucopogon muticus*
		L1	0.01	0.5	2	*Lomandra glauca, Lomandra confertifolia, Goodenia hederacea*
		L1	0.01	0.3	1	*Aristida ramosa, Digitaria sp., Microlaena stipoides*
BOA-E	E_105	L1	0.01	0.4	20	*Aristida ramosa, Aristida vagans, Bothriochloa macra*
		L2	0.01	0.2	65	**Hypochaeris glabra, *Hypochaeris radicata, *Taraxacum officinale*
	E_106	U1	6	10	8	*Eucalyptus albens, Eucalyptus dealbata*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		M1	5	5	0.1	*Acacia implexa*
		L1	0.01	0.5	50	*Aristida ramosa, Aristida vagans, Bothriochloa macra*
		L2	0.01	0.2	35	*Vittadinia muelleri, Lomandra confertifolia, Calotis lappulacea*
ECA-A	A_102	M1	0.5	1.8	30	*Cassinia arcuata*
		L1	0.01	0.4	60	*Aristida ramosa, Aristida vagans, Bothriochloa macra*
		L2	0.01	0.5	15	**Hypochaeris radicata, Cheilanthes sieberi*
	A_103	U1	10	16	20	*Eucalyptus blakelyi, Eucalyptus melliodora*
		M1	2	8	2	*Acacia implexa, Eucalyptus blakelyi, Eucalyptus melliodora*
		M2	0.5	2	15	*Cassinia arcuata*
		L1	0.01	0.4	15	*Aristida vagans, Aristida ramosa, Microlaena stipoides*
		L2	0.01	0.3	5	*Cassinia arcuata, Cheilanthes sieberi, Dichondra repens*
ECA-B	B_103	U1	8	15	25	*Angophora floribunda, Eucalyptus sparsifolia, Eucalyptus punctata*
		M1	2	8	2	*Persoonia linearis, Acacia linearifolia*
		M2	0.5	1.7	10	*Acrotriche rigida, Cassinia cunninghamii, Goodenia ovata*
		L1	0.01	0.5	8	*Stellaria pungens, Goodenia ovata, Microlaena stipoides*
		L2	0.01	0.1	2	**Cerastium vulgare, Stellaria media, *Hypochaeris radicata*
	B_106	M2	0.8	1.2	0.1	*Rosa rubiginosa
		L1	0.01	1	45	*Aristida ramosa, Carex appressa, Bothriochloa macra*
		L2	0.01	1.2	40	**Hypochaeris radicata, *Plantago lanceolate, Trifolium sp.*
ECA	C_101	L1	0.01	0.2	60	*Bothriochloa macra, Microlaena stipoides, Digitaria sp.*
		L2	0.01	0.2	30	*Trifolium repens, *Cerastium vulgare, *Taraxacum officinale*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
Regeneration Area	R1_100	L1	0.01	0.4	15	*Bromus sp.*, Sporobolus creber, Paspalum dilatatum**
		L2	0.01	0.5	75	*Trifolium repens*, Carthamus lanatus*, *Verbena bonariensis**
	R3_100	L1	0.01	0.2	70	*Bothriochloa macra, Microlaena stipoides, Rytidosperma sp.*
		L2	0.01	0.3	25	**Hypochaeris radicata, *Conyza sp., *Taraxacum officinale*
	R5_100	L1	0.01	0.5	60	*Aristida ramose, Bothriochloa macra, Sporobolus creber*
		L2	0.01	1.5	30	**Hypochaeris radicata, *Plantago lanceolata, Vulpia sp.*
	R6_101	L1	0.01	0.5	45	*Chloris ventricosa, Sporobolus creber, Panicum effusum*
		L2	0.01	0.8	45	**Trifolium repens, *Verbena bonariensis*
	R6_101	ND	ND	ND	ND	ND
	R7_100	L1	0.01	0.2	35	*Aristida ramosa, Bothriochloa macra, Microlaena stipoides*
		L2	0.01	0.1	60	**Trifolium repens, *Carthamus lanatus, *Hypochaeris radicata*
	R8_100	L1	0.01	0.2	60	*Bothriochloa macra, Digitaria sp., Microlaena stipoides*
		L2	0.01	0.4	35	**Carthamus lanatus, *Hypochaeris radicata, *Trifolium repens*
	R9_101	M1	0.3	0.7	0.2	*Cassinia arcuata, Acacia decora*
		L1	0.01	0.4	65	*Digitaria brownii, Sporobolus creber, Cheilanthes sieberi*
		L2	0.01	0.8	20	**Hypochaeris radicata, *Conyza sp., *Hypericum perforatum*
Rehabilitation Area	R6	M	0.5	4	5	*Acacia linearifolia, Acacia leucolobia, Eucalyptus albens*
		L1	0.01	1.5	10	*Cheilanthes sieberi, *Verbena bonariensis, *Plantago lanceolata*
		L2	0.01	1.5	70	**Eragrostis curvula, *Chloris gayana, *Phalaris aquatica*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
	R9	M1	3	7	10	*Acacia implexa, Eucalyptus albens, Eucalyptus crebra*
		M2	0.5	3	20	*Acacia verniciflua, Eucalyptus crebra, Eucalyptus bridgesiana*
		L1	0.01	1.5	50	*Cynodon dactylon, *Digitaria eriantha, Bothriochloa macra*
		L2	0.01	0.3	15	**Plantago laceolata, *Hypochaeris radicata, *Conyza bonariensis*

Table D - 2: Spring 2017 Vegetation Structure Data

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
BOA- D	*D_100*	U1	N/A	N/A	N/A	*Eucalyptus crebra*
		M1	N/A	N/A	N/A	*Callitris endlicheri*
		M2	N/A	N/A	N/A	*Leptospermum parvifolium*
		L1	N/A	N/A	N/A	*Pomax umbellata,* *Lomandra filiformis*
	D_102	U1	N/A	N/A	N/A	*Eucalyptus albens*
		M1	N/A	N/A	N/A	*Brachychiton populneus*
		L1	N/A	N/A	N/A	*Unable to ID*
		L2	N/A	N/A	N/A	*Pimelea sp.*
BOA-E	E_101	M1	3	4	3	*Callitris endlicheri, Acacia linearifolia*
		M2	0.2	2	1	*Eucalyptus blakelyi*
		L1	0.5	1	5	*Cassinia arcuate,* *Gahnia aspera*
		L2	0.1	0.4	2	*Eragrostis sp.,* *Aristida* sp.
	E_102	N/A	N/A	N/A	N/A	N/A
	E104	U1	5	10	10	*Eucalyptus albens*
		M1	2	2	0.5	*Olearia sp.*
		L1	0.1	0.4	4	*Aristida sp, *Marrubium vulgare*
		L2	0.1	0.2	3	*Austrostipa scabra*
ECA-A	A_100	L1	N/A	N/A	N/A	**Plantago lancelota, *Paspalum dilatatum*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		L2	N/A	N/A	N/A	**Carthamus sp.*
	A_104	U1	10	12	5	*Eucalyptus crebra*
		M1	1	8	15	*Callitris endlicheri, Eucalyptus crebra*
		M2	0.5	1.3	1	*Cassinia arcuata*
		L1	0.2	1	1	*Cassinia arcuata, Lissanthe strigosa*
		L2	0.01	0.2	1	*Austrostipa scabra, Cheilanthes sieberi*
ECA-B	B_100	U1	8	10	20	*Eucalyptus melliodora, Eucalyptus blakelyi*
		M1	3	5	<1	*Eucalyptus melliodora, Eucalyptus blakelyi*
		M2	0.5	2	2	*Cassinia acuate, Exocarpos sp.*
		L2	N/A	N/A	1 (*<1)	*Aristida vagans., Lomandra sp., Microlaena stipoides*
	B_101	L1	0.2	0.5	10	*Lomandra multiflora, Aristida sp*
		L2	0.1	0.2	5(*1)	*Lomandra filiformis*
	B105	L1	N/A	N/A	10	**Carthamus lanatus, *Hypochaeris radicata*
		L2	N/A	N/A	5	*Bothriochloa macra, Juncus sp.*
ECA-C	C_102	U1	10	14	8	*Eucalyptus albens, Eucalyptus punctata*
		U2	8	10	5	*Angophora floribunda, Callitris endlicheri*
		M1	1.5	4	1	*Persoonia sp., Cassinia sp., Cassinia cunninghamiana, Acacia sp.*
		M2	0.5	1	3	*Podolobium ilicifolium* *Acrotriche rigida*
		L1	0.1	0.3	1	*Goodenia ovata*
		L2	0.1	0.25	1	*Lomandra spp.*
Regeneration Area	R1_101	L2	0.01	0.5	15(*3)	**Hypochaeris radicata, Aristida spp., Bothriochloa macra*
	R2_101	L1	N/A	N/A	20	**Plantago sp., *Carthamus sp.,*
		L2	N/A	N/A	10	*Aristida spp., Austrostipa sp.*
	R4_100	L2	0.01	0.1	20	**Carthamus lanatus, *Phalaris*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
						*sp., *Vulpia sp.*
	R5_101	L1	0.1	0.5	85	*Aristida spp.*
		L2	0.1	0.15	<1(*4)	**Hypochaeris radicata, *Vulpia sp.*
	R7_101	M2	1.5	3	1	*Bursaria spinosa*
		L2	0.01	0.3	20(*<1)	*Eragrostis leptostachya, Microlaena sp., Aristida spp.*
	R9_100	U1	9	9	1	*Eucalyptus melliodora*
		M1	0.5	1.5	20	*Cassinia arcuata*
		L1	0.1	0.5	10	*Aristida app., Gahnia aspera, Lomandra sp, Lomandra multiflora*
	R5_C	M1	N/A	N/A	10	*Cassinia arcuata*
		L1	0.8	1.8	*50	**Eragrostis sp., *Plantago sp., *Digitaria eriantha, *Phalaris aquatica*
		L2	0.01	0.05	5(*5)	*Cynodon dactylon, Plantago sp., *Trifolium sp.*
	R8	L1	N/A	N/A	0.1(*15)	*Digitaria sp., *Eragrostis curvula*
		L2	N/A	N/A	2(*8)	*Plantago sp., Erodium sp., *Carthamus sp., *Cenchrus clandestinus*
	R10	L1	0.3	1	20	**Eragrostis curvula, *Digitaria eriantha*
		L2	0.1	0.25	12(*3)	*Erodium spp., Cynodon dactylon, *Trifolium spp.,*
	R11	M2	1	1.5	<1	*Cassinia acuate, Acacia decora*
		L1	0.5	1.5	25	**Phalaris aquatic, *Eragrostis curvula, *Digitaria eriantha*
		L2	N/A	N/A	2(*25)	*Erodium sp, *Cenchrus clandestinus*
	R3_C	M1	0.8	1.8	5	*Cassinia arcuata*
		L1	0.3	1.8	*25	**Digitaria eriantha, *Eragrostis curvula, *Phalaris aquatica*
		L2	0.1	0.25	TBI	*Poaceae sp. (TBI), Cynodon dactylon*
Reference Site	Ref_1	L1	N/A	N/A	N/A	*Dichondra repens, Hypochaeris sp.*
		L2	N/A	N/A	N/A	**Hypochaeris radicata*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
	Ref_2	U1	8	12	15	*Eucalyptus crebra, Eucalyptus moluccana (TBC)*
		M1	0.5	2	15	*Cassinia quinquefaria, Acacia difformis*
		L2	0.1	0.5	7	*Austrostipa scabra, Gahnia aspera, Aristida vagans*
	Ref_3	U1	8	10	15	*Eucalyptus fibrosa, Eucalyptus sparsifolia, Eucalyptus punctate, Corymbia trachyphloia*
		M1	1	3	2	*Allocasuarina gymnanthera, Eucalyptus fibrosa, Cassinia quinquefaria*
		M2	0.3	1.5	3	*Dodonaea viscosa, Macrozamia sp., Acrotriche rigida*
		L2	0.05	0.2	<1	*Lomandra filiformis*
	Ref_4	U1	N/A	N/A	N/A	*Eucalyptus albens*
	Ref_5	U1	3.5	10	N/A	*Eucalyptus crebra,*
		U2	2	10	N/A	*Acacia linearifolia*
		M1	1	4	N/A	*Persoonia sericea*
		M2	1	2.5	N/A	*Leucopogon muticus*
		L1	0.6	1.2	N/A	*Acrotriche rigida*
		L2	<0.2	<0.2	N/A	*Lomandra sp.*
	Ref_6	U1	N/A	N/A	20	*Eucalyptus dwyeri, Eucalyptus fibrosa, Corymbia trachyphloia*
		U2	N/A	N/A	N/A	*Eucalyptus spp.*
		M1	N/A	N/A	1	*Eucalyptus spp., Leptospermum trinervium, Persoonia linearis*
		M2	N/A	N/A	15	*Dodonaea triangularis, Phebalium squamulosum,*
		L1	N/A	N/A	2	*Cleistochloa rigida*
	Ref_7	U1	N/A	N/A	N/A	*Eucalyptus crebra, Eucalyptus albens*
		U2	N/A	N/A	N/A	*Acacia linearifolia*
		M1	N/A	N/A	N/A	*Allocasuarina gymnanthera*
		M2	N/A	N/A	N/A	*Persoonia linearis*
		L1	N/A	N/A	N/A	*Dodonaea triangularis*
		L2	N/A	N/A	N/A	*Pomax umbellate, Dichondra*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
						repens
	Ref_8	U1	6	10	15	*Eucalyptus albens, Callitris endlicheri*
		M2	1	4	10	*Cassinia quinquefaria, Bursaria spinosa*
		L2	0.2	1.2	30	*Gahnia aspera, Austrostipa sp. (TBC)*
	Ref_9	U1	10	15	30	*Eucalyptus punctata, Eucalyptus sparsifolia, Eucalyptus fibrosa*
		U2	8	10	3	*Callitris endlicheri, Eucalyptus rossii*
		M1	4	8	3	*Acacia terminalis, Acacia uncinata, Callitris endlicheri, Leptospermum trinervium*
		M2	1	4	5	*Leptospermum sphaerocarpum, Dodonaea spp., Persoonia spp.*
		L2	0.1	0.8	10	*Entolasia matinaga (TBC), Lomandra confertifolia*
	Ref_10	U1	N/A	N/A	N/A	*Eucalyptus albens, Eucalyptus crebra*
		M1	N/A	N/A	N/A	*Allocasuarina Luehmanniana,*
		M2	N/A	N/A	N/A	*Persoonia linearis*
		L1	N/A	N/A	N/A	*Acrotriche rigida*
	Ref_11	U1	N/A	N/A	N/A	*Angophora floribunda,*
		L1	N/A	N/A	N/A	*Microlaena stipoides, Dichondra repens*
		L2	N/A	N/A	N/A	*Lomandra confertifolia*
	Ref_12	U1	N/A	N/A	N/A	*Eucalyptus albens*

Appendix E — Interim Performance Targets / Benchmark Values

Table C-1: Vegetation class benchmark condition state (WCPL 2017)

Vegetation Class	Site Attribute									
	NSR (count)	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH (count)	OR	FL (m)
Western Slopes Dry Sclerophyll Forests	≥32	15 - 40	10 – 55	3 - 10	5 - 15	5 - 25	<5%	≥3	1	≥70
Western Slopes Grassy Woodlands	≥23	10 - 45	5 – 60	5 - 45	2 - 10	5 -35	<5%	≥2	1	≥50

Table C-2: Interim Performance Targets for Western Slopes Dry Sclerophyll Forests

Management Period	Interim Performance Target (site value score)	Site Attributes (% cover)									
		NSR (count)	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH (count)	OR	FL (m)
Low Condition Vegetation											
Year 0 (Baseline)	6	<8	0	0	1	0	0	60	0	0	0
Years 1-5	34	12	0	3-10	1-2	1-5	1-3	60	0	1	10
Benchmark	>78	≥32	15-40	10-55	3-10	5-15	5-25	<5	≥3	1	≥70
Moderate to Good Condition Vegetation											
Year 0 (Baseline)	34	12	0	10	<3	<5	<4	60	0	1	10
Years 1-5	45	16	0	10-55	3-10	5-15	5-25	40	0	1	10
Benchmark	>78	≥32	15-40	10-55	3-10	5-15	5-25	<5	≥3	1	≥70
High Condition Vegetation											

Management Period	Interim Performance Target (site value score)	Site Attributes (% cover)									
		NSR (count)	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH (count)	OR	FL (m)
Year 0 (Baseline)	70	18-32	15-40	10-55	3 -10	5-15	5-25	≤5	0	1	≥70
Years 1-20	70	18-32	15-40	10-55	3 -10	5-15	5-25	≤5	0	1	≥70
Benchmark	>78	≥32	15-40	10-55	3 -10	5-15	5-25	≤5	≥3	1	≥70

Table C-3: Interim Performance Targets for Western Slopes Grassy Woodlands

Management period	Interim Performance Target (Site value score)	Site Attributes (% cover)									
		NSR (count)	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH (count)	OR	FL (m)
Low Condition Vegetation											
Year 0 (Baseline)	7	<9	0	0	5	0	0	60	0	0	0
Years 1-5	34	12	0	<4	60+	<2	<2	60	0	1	10
Benchmark	>78	≥23	10-45	5-60	5-45	2-10	5-35	<5	≥2	1	≥50
Moderate to Good Condition Vegetation											
Year 0 (Baseline)	34	12	0	≤3	60+	<2	<2	60	0	1	10
Years 1-5	45	12	0	5-60	45-60	<2	<2	40	0	1	10
Benchmark	>78	≥23	10-45	5-60	5-45	2-10	5-35	<5	≥2	1	≥50
High Condition Vegetation											
Year 0 (Baseline)	70	20-22	10-45	5-60	5-45	2-10	5-35	≤20	0	1	≥50
Years 1-20	70	20-23	10-45	5-60	5-45	2-10	5-35	≤20	0	1	≥50
Benchmark	>78	≥23	10-45	5-60	5-45	2-10	5-35	<5	≥2	1	≥50

Appendix F – Fauna species list

Species name	Common name	TSC Act	EPBC Act
Bird			
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		
Acanthiza lineata	Striated Thornbill		
Acanthiza nana	Yellow Thornbill		
Acanthiza pusilla	Brown Thornbill		
Acanthiza reguloides	Buff-rumped Thornbill		
Acanthorhynchus tenuirostris	Eastern Spinebill		
Acrocephalus australis	Australian Reed-warbler		
Alisterus scapularis	Australian King-Parrot		
Anas gracilis	Grey Teal		
Anthochaera carunculata	Red Wattlebird		
Anthus novaeseelandiae	Australasian Pipit		
Aquila audax	Wedge-tailed Eagle		
Ardea pacifica	White-necked Heron		
Artamus cyanopterus	Dusky Woodswallow	V	
Cacatua galerita	Sulphur-crested Cockatoo		
Cacomantis flabelliformis	Fan-tailed Cuckoo		
Cacomantis pallidus	Pallid Cuckoo		
Calyptorhynchus funereus	Yellow-tailed Black-cockatoo		
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	
Chalcites basalis	Horsfield's Bronze-cuckoo		
Chenonetta jubata	Australian Wood Duck		
Chrysococcyx lucidus	Shining Bronze-cuckoo		
Cisticola exilis	Golden-headed Cisticola		
Climacteris picumnus victoriae	Brown Treecreeper eastern subsp.	V	
Colluricincla harmonica	Grey Shrike-thrush		
Coracina novaehollandiae	Black-faced Cuckoo-shrike		
Corcorax melanorhamphos	White-winged Chough		
Cormobates leucophaea	White-throated Treecreeper		
Corvus coronoides	Australian Raven		
Coturnix sp.	Quail sp.		
Coturnix ypsilophora	Brown Quail		
Cracticus nigrogularis	Pied Butcherbird		

Species name	Common name	TSC Act	EPBC Act
Cracticus tibicen	Australian Magpie		
Cracticus torquatus	Grey Butcherbird		
Dacelo novaeguineae	Laughing Kookaburra		
Daphoenositta chrysoptera	Varied Sittella	V	
Dicaeum hirundinaceum	Mistletoebird		
Dromaius novaehollandiae	Emu		
Egretta novaehollandiae	White-faced Heron		
Elanus axillaris	Black-shouldered kite		
Eolophus roseicapillus	Galah		
Eopsaltria australis	Eastern Yellow Robin		
Falco berigora	Brown Falcon		
Falco cenchroides	Nankeen Kestrel		
Geopelia placida	Peaceful Dove		
Gerygone albogularis	White-throated Gerygone		
Glossopsitta concinna	Musk Lorikeet		
Glossopsitta pusilla	Little Lorikeet	V	
Grallina cyanoleuca	Magpie-lark		
Haliastur sphenurus	Whistling Kite		
Hirundo neoxena	Welcome Swallow		
Lalage tricolor	White-winged Triller		
Lichenostomus chrysops	Yellow-faced Honeyeater		
Lichenostomus leucotis	White-eared Honeyeater		
Lichenostomus melanops	Yellow-tufted Honeyeater		
Lichenostomus penicillatus	White-plumed Honeyeater		
Malurus cyaneus	Superb Fairy-wren		
Manorina melanocephala	Noisy Miner		
Melithreptus brevirostris	Brown-headed Honeyeater		
Melithreptus lunatus	White-naped Honeyeater		
Menura novaehollandiae	Superb Lyrebird		
Microeca fascinans	Jacky Winter		
Myzomela sanguinolenta	Scarlet Honeyeater		
Neochmia temporalis	Red-browed Finch		
Ocyphaps lophotes	Crested Pigeon		
Origma solitaria	Rockwarbler		
Oriolus sagittatus	Olive-backed Oriole		
Pachycephala pectoralis	Golden Whistler		

Species name	Common name	TSC Act	EPBC Act
Pachycephala rufiventris	Rufous Whistler		
Pardalotus punctatus	Spotted Pardalote		
Pardalotus striata	Striated Pardalote		
Petrochelidon aerial	Fairy Martin		
Petrochelidon nigricans	Tree Martin		
Petroica goodenovii	Red-capped Robin		
Phaps chalcoptera	Common Bronzewing		
Philemon citreogularis	Little Friarbird		
Philemon corniculatus	Noisy Friarbird		
Platycercus elegans	Crimson Rosella		
Platycercus eximius	Eastern Rosella		
Plectorhyncha lanceolata	Striped Honeyeater		
Poliocephalus poliocephalus	Hoary-headed Grebe		
Pomatostomus superciliosus	White-browed Babbler		
Psephotus haematonotus	Red-rumped Parrot		
Psophodes olivaceus	Eastern Whipbird		
Ptilonorhynchus violaceus	Satin Bowerbird		
Pyrrholaemus sagittatus	Speckled Warbler	V	
Rhipidura albiscapa	Grey Fantail		
Rhipidura leucophrys	Willie Wagtail		
Sericornis frontalis	White-browed Scrubwren		
Smicrornis brevirostris	Weebill		
Strepera graculina	Pied Currawong		
Sturnus vulgaris	Common Starling		
Taeniopygia guttata	Zebra Finch		
Todiramphus sanctus	Sacred King Fisher		
Vanellus miles	Masked Lapwing		
Zosterops lateralis	Silvereye		
Amphibian			
Limnodynastes dumerilii	Eastern Pobblebonk		
Limnodynastes tasmaniensis	Spotted Marsh Frog		
Mammal			
Antechinus flavipes	Yellow-footed antechinus		
Oryctolagus cuniculus	Rabbit		
Pseudomys novaehollandiae	New Holland Mouse	V	
Sus scrofa	Pig		

Species name	Common name	TSC Act	EPBC Act
Reptile			
Amphibolurus muricatus	Jacky Dragon		
Anomalopus leuckartii	Two-clawed Worm-skink		
Carlia tetradactyla	Southern Rainbow-skink		
Diplodactylus vittatus	Eastern Stone Gecko		
Diporiphora nobbi	Common Nobbi Dragon		
Eulamprus tenuis	Bar-sided Skink		
Furina diadema	Red-naped Snake		
Lialis burtonis	Burton's Legless Lizard		
Lygisaurus foliorum	Tree-based Litter Skink		
Morethia boulengeri	Boulenger's Morethia		
Parasuta dwyeri	Dwyer's Snake		
Pogona barbata	Eastern Bearded Dragon		
Pseudechis porphyriacus	Red-bellied Black Snake		
Varanus varius	Lace Monitor		
Microbat			
Austronomus australis	White-Striped Freetail Bat		
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Chalinolobus gouldii	Gould's Wattled Bat		
Chalinolobus morio	Chocolate Wattled Bat		
Miniopterus orianae oceanensis	Eastern Bentwing Bat	V	
Nyctophilus spp.	Long-eared Bats		
Rhinolophus megaphyllus	Eastern Horseshoe Bat		
Scotorepens balstoni	Inland Broad-nosed Bat		
Scotorepens orion	Eastern Broad-nosed Bat		
Vespadelus vultumus	Little Forest Bat		
V	=		vulnerable

Appendix G – Microbat analysis report

Anabat Results – Wilpinjong mine microbat call analysis - August to November 2017

Methods

Four songmeter (SM) recorders were set at 12 distinct locations within the Wilpinjong study area between 19 September and 12 October 2017. The site reference numbers, SM reference numbers, date each SM was set to record for and the number of survey nights are described below:

- Site A_104: Songmeter (SM) 2-1 was set to record microbat calls among a remnant Ironbark – Cypress Pine open shrubby woodland with abundant hollow-bearing trees (HBTs) between the 19 and 20 September 2017 (two survey nights)
- Site B_101: SM 2-1 was set to record microbat calls among cleared grassland, shrubland with isolated paddock trees, some of which contain hollows. The SM was positioned approximately 100 m away from the nearest patch of remnant woodland between the 26 and 27 September 2017 (two survey nights)
- Site C_102: SM 3-1 was set to record calls microbat calls among remnant White Box dominated shrubby woodland on slopes between the 26 and 27 September 2017 (two survey nights). A sandstone escarpment is located approximately 50 m up slope from the location that the SM was set at.
- Site D_103: SM3-1 was set to record microbat calls among remnant ironbark shrubby/heathy woodland between the 11 and 12 October 2017 (two survey nights). Some of the trees present nearby contained hollows.
- Site E_104: SM 3-1 was set to record calls microbat calls between the 9 and 10 October 2017 (two survey nights) among remnant partly cleared White Box grassy woodland, some HBTs
- Site R7_100: SM 3-2 was set to record calls microbat calls among partly cleared Rough-barked Apple / Yellow Box grassy woodland between the 26 and 27 September 2017 (two survey nights)
- Site Ref_2: SM 3-2 was set to record calls microbat calls among remnant White Box / Grey Box grassy woodland with HBTs between the 19 and 20 September 2017 (two survey nights)
- Site Ref_3: SM 3-1 was set to record calls microbat calls among remnant Bloodwood / Ironbark woodland with abundant HBTs and directly adjacent to sandstone caves and escarpment between the 11 and 12 October 2017 (two survey nights)
- Site Ref_5: SM 3-1 was set to record calls microbat calls among remnant Bloodwood / Ironbark woodland with some HBTs between the 9 and 10 October 2017 (two survey nights)
- Site Ref_8: SM 3-1 was set to record calls microbat calls among remnant White Box / Cypress Pine shrubby woodland on foot-slopes with abundant HBTs. Adjacent to railway easement and the base of sandstone escarpment (approx. 100 m away) between the 19 and 20 September 2017 (two survey nights)

- Site Ref_10: SM 3-5 was set to record calls microbat calls among remnant White Box / Ironbark shrubby woodland with abundant HBTs between the 11 and 12 October 2017 (two survey nights)
- Site Ref_14: SM 3-5 was set to record calls microbat calls among remnant Bloodwood / Scribbly Gum shrubby woodland with abundant between the 9 and 10 October 2017 (two survey nights)

The survey effort included twenty-four (24) survey nights over the September and October 2017 survey period.

Data Analysis

Bat calls were analysed by Dr Rodney Armistead between the 24 and 28 November 2017 using the program AnalookW (Version 4.2 March 2017, written by Chris Corben). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW (which is available at http://www.environment.nsw.gov.au/surveys/Batcalls.htm).

Bat calls were analysed using species-specific call profile parameters including call shape, characteristic frequency, initial slope and time between pulses (Reinhold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et. al. 2006) were followed:

- Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al. 2002). Cruise phase or feeding calls were labelled as being of low quality.
- For those calls that were useful to identify the species making the call, three categories of confidence were used (Mills et al. 1996):
    - definite – the quality and structure of the call profile is such that the identity of the bat species making the calls is not in doubt
    - probable – the quality and structure of the call profile is such that there is some / low probability of confusion with species that produce similar calls profiles
    - possible – the quality and structure of the call profile is such that there is medium to high probability of confusion with species with similar calls profiles
- *Nyctophilus* spp. (Long-eared bats) are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004)
- Sequences not attributed to microbat echolocation calls (e.g. insect buzzes, wind, train and vehicle movement) were dismissed, as they don't represent microbat activity
- Recorded calls containing less than three pulses or were of low quality, were not analysed as they cannot be used to confidentiality determine the identity of the species making the call (Law et al. 1999). These calls were labelled as 'low' quality. These calls are retained in data as they can be used to indicate microbat activity at each subject site.

Results

Data summary and species diversity

There were 6,362 sequences recorded during this survey. Of these, 4,326 (68.00%) were deemed useful because the call profile was of sufficient quality or length to enable positive identification of bat species that made the call to genus or species. The remaining 2,036 (32.00%) sequences were either short, of low quality or were foraging buzzes, thus preventing positive identification of the bat species that made these calls.

Ten (10) species were positively identified in this survey (**Table 1, Table 2 and Table 3**). Six (6) additional species are considered to be likely as being present within the subject (**Table 1, Table 2 and Table 3**). However, these six species could be positively identified due to lack of high quality calls or because of similarities among call profiles between other microbat species.

In addition, and as stated previously *Nyctophilus* spp. (Long-eared bats) cannot not be identified to species levels based on their calls profiles. Possible *Nyctophilus* spp. calls were recorded at the survey (**Table 1, Table 2 and Table 3**). Because of the uncertain regarding these species and whilst their presence must be noted, they were not included in the species counts presented above.

Further, there is some uncertainty regarding flat calls (slope of less than 100 OPS) and with a frequency less than 25 kHz. Presently these calls have been assigned to an unknown *Mormopterus* spp. This is because these calls are outside the known range of other microbat species that produce flat shaped calls. These calls are included as being only 'possibly', due uncertainty surrounding assigning them to a species.

Based on these results, the threatened *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat), *Chalinolobus dwyeri* (Large-eared Pied Bat) as well as the non-threatened *C. gouldi* (Gould's Wattled Bat) and *C. morio* (Chocolate Wattled Bat) are widespread across the study area. These species were generally recorded at all of the survey sites (**Table 1**, **Table 2** and **Table 3**).

In addition, these four species were also the most active. Collectively, the calls that were recorded from these four-species accounted for 2,138 (49.42%) of the 4,426 useful calls recorded during this survey.

A further 1,423 calls were assigned to the Eastern Bentwing Bat, *V. regulus* (Southern Forest Bat and *V. vulturnus* (Little Forest Bat) group. These three species are grouped together because their call profiles are similar and as shown by Pennay et al. (2011), they are expected to occur in the region. Despite the difficulty in separating the call profiles of these species, the combined total of both positive and possibly Eastern Bentwing Bat calls accounted for 2,676 (61.85%) of the 4,426 calls recorded during this survey.

Threatened species records

Definite calls were recorded for three species listed as vulnerable under the NSW *Biodiversity Conservation Act 1995* (BC Act) were recorded (**Table 1 - Table 14 and Figure 1 - Figure 13**). Those species that were recorded included:

- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Miniopterus australis* (Little Bentwing Bat)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)

Possible at calls were recorded for two other threatened species also listed as vulnerable under the BC Act, including.

- *Myotis macropus* (Large-footed Myotis)

- *Vespadelus troughtoni* (Eastern Cave Bat)

Chalinolobus dwyeri (Large-eared Pied Bat) is also listed as vulnerable under the Commonwealths *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). During the 2017 surveys, the Large-eared Pied Bat was recorded at eight of the 12 survey sites C_102, D_103, E_104, R7_100, Ref 3, Ref 5, Ref 8 and Ref 14 (**Tables 1** to **3**). In 2016, this species was only recorded in 12 survey sites including Ref 14, B_101, C_102, E – 104.2 and R7_101 (**Tables 1** to **3**). High levels of Large-eared Pied Bat activity were recorded at C_102 and E 104. A cumulative total of 219 Large-eared Pied Bat calls were recorded at these two sites. At E_104 83 of the 122 (68.03%) *C. dwyeri* calls recorded were in the early hours of the morning or evening. Thus, suggesting that roosting habitat for this species may be located somewhere nearby where the Songmeter was positioned at E_104. The number of definite calls recorded from this sub-terraranan roosting species, could suggest that maternal roost habitat for this species may occur in the study area.

Survey Limitations

Calls were only positively identified when the defining characteristics (shape of calls and frequency) were present. Some microbat species have similar call profiles and when these calls are present, it is impossible determine, with a high level of confidence, which individual species is responsible for the call. When this occurred, species with similar call profiles were lumped together into groups of two or three potential species depending on call characteristics. These calls are then assigned to the lowest certainty level of 'possible'. Some examples of when this occurred during this study, are provided below.

The calls of Gould's Wattled Bat*, Scotorepens balstoni* (Inland Broad-nosed Bat) and the *Mormopterus* group of species can be difficult to separate. This includes *Mormopterus* (*Ozimops*) *planiceps* (South-eastern Free-tailed Bat) with flat calls that have frequencies that range between 26.5 and 30.5 kHz and *Austronomus australis* (White-striped Freetail Bat) with flat or slightly curved calls with calls that usually do not exceed 15 kHz (Pennay et al. 2004).

Calls were identified as South-eastern Free-tailed Bat if the call shape was flat (slope of less than 100 OPS) and the frequency was between 25 – 31 kHz. Gould's Wattled Bat was distinguished by a frequency of 27.5 – 32.5 kHz and alternation in call frequency between pulses. Calls were labelled as being from Inland Broad-nosed Bat if the slope of the pulses were greater than 200 OPS, non-alternating and the frequency fell between 29 and 34 kHz.

The *Mormopterus* (*Ozimops*) (Freetail Bats) groups of species have recently undergone taxonomic revision (Reardon, et al. 2014) and previously published reference calls for this groups of species (Pennay et al, 2004) are believed to contain significant errors (Greg Ford pers. comm.). As there are no known threatened Freetail Bats occurring in the geographic region of this survey, we have grouped *Mormopterus* (*Ozimops*) *planiceps* (South-eastern Freetail Bat) and *M.* (*Ozimops*) *ridei* (Ride's Freetail Bat) together.

In this region the calls of the Chocolate Wattled Bat and *V. troughtoni* (Eastern Cave Bat) can be difficult to separate in the range 49 – 53 kHz. Calls were identified as *C. morio* when a down-sweeping tail was present within the call profiles. Alternatively, calls with up-sweeping tails that an end frequency below 51 kHz were generally identified as an Eastern Cave Bat. When no distinguishing characteristics were present within the calls, they were assigned as Chocolate Wattled Bat / Eastern Cave Bat. According to Pennay et al. (2011) and OEH (2017 relevant to the Eastern Cave Bat), these three species are all likely to occur in the study area.

All *Vespadelus spp.* have curved calls with up-sweeping tails with frequencies that range between 40 and 53kHz. In this study, curved with upsweeping calls with frequencies that range:

- between 40 and 43 kHz were identified as being from *V. darlingtoni*,
- between 43 – 44 kHz were assigned to a *V. darlingtoni* / *V. regulus* combination
- between 44 – 47 kHz were assigned to a *V. regulus* / *V. vulturnus* combination
- 47 – 49 kHz were assigned to *V. vulturnus*
- 49 – 53 were assigned to a *V. troughtoni* and *V. vulturnus* combination

Those species that grouped together are done so because these three species are all likely to occur in the study area and they have similar call profiles.

Calls of Eastern Bentwing Bat overlap in frequency with those of Southern Forest Bat and Little Forest Bat in this geographic region. Eastern Bentwing Bat calls were distinguished from the forest bats by down-sweeping tails, drop of more than 2 kHz in the pre-characteristic section, and pulse shape and a variable amount of time separating each call. Whilst, call that have frequencies ranging between 42 and 46 kHz cannot be separated and calls falling within this frequency were assigned as Eastern Bentwing Bat / Southern Forest Bat / Little Forest Bat.

The calls of Large-footed Myotis are very similar to all *Nyctophilus* species and it is often difficult to separate these species. Calls were identified as *Nyctophilus* spp. when the time between calls (TBC) was higher than 95 min and the initial slope (OPS) was lower than 300 min. Calls were identified as Large-footed Myotis when the TBC was lower than 75 ms and the OPS was greater than 400.

The call profiles that were difficult to separate are not shown in this document as all of the species discussed were positively identified.

Table 1: Microbat species (Sites A_104, B_101, C_102, D_103 and E_104)

Species Name	Common Name	A_104 (SM2-1)		B_101 (SM2-1)		C_102 (SM3-1)		D_103 (SM3-1)		E_104 (SM3-1)	
		19 - 20 September		26 - 27 September		26 - 27 September		11 - 12 October		9 - 10 October	
		Definite	Possible	Definite	Possible	Definite	Possible	Definite	Possible	Definite	Possible
Austronomus australis	White-Striped Freetail Bat					X		X		X	
Chalinolobus dwyeri[1]	Large-eared Pied Bat					X		X		X	
Chalinolobus gouldii	Gould's Wattled Bat			X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X		X		X		X		X	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat		X	X		X		X		X	
Mormopterus (*Ozimops*) *planiceps*	South-eastern Freetail Bat						X		X		X
Mormopterus (Ozimops) ridei	Ride's Freetail Bat						X		X		X
Unknown *Mormopterus* spp.	Unknown Freetail Bat								X		X
*Myotis macropus**	Large-footed Myotis						X				X
Nyctophilus spp.	Long-eared Bats					X		X			X
Rhinolophus megaphyllus	Eastern Horseshoe Bat					X				X	
Scotorepens balstoni	Inland Broad-nosed Bat				X	X				X	
Scotorepens orion	Eastern broad-nosed Bat									X	
Vespadelus regulus	Southern Forest Bat				X		X		X		X
*Vespadelus troughtoni**	Eastern Cave Bat		X		X		X				X
Vespadelus vulturnus	Little Forest Bat				X	X			X		X
Species Diversity (Positive identification)		**1**		**3**		**9**		**6**		**8**	
Species Diversity (Possible identification)			**2**		**4**		**5**		**5**		**8**

* Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act

Table 2: Microbat species (Sites R7_100, Ref 2, Ref 3, Ref 5 and Ref 8)

Species Name	Common Name	R7_100 (SM3-2)		Ref 2 (SM3-2)		Ref 3 (SM3-1)		Ref 5 (SM3-1)		Ref 8 (SM3-1)	
		26 – 27 September		19 – 20 September		11 - 12 October		9 - 10 October		19 – 20 October	
		Definite	Possible	Definite	Possible	Definite	Possible	Definite	Possible	Definite	Possible
Austronomus australis	White-striped Freetail Bat	X				X		X		X	
Chalinolobus dwyeri[1]	Large-eared Pied Bat	X				X		X		X	
Chalinolobus gouldii	Gould's Wattled Bat	X		X			X	X		X	
Chalinolobus morio	Chocolate Wattled Bat	X		X		X		X		X	
Miniopterus australis	Little Bentwing Bat			X			X	X			
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	X		X		X		X		X	
Mormopterus (*Ozimops*) *planiceps*	South-eastern Freetail Bat		X		X		X		X		X
Mormopterus (Ozimops) ridei	Ride's Freetail Bat		X		X		X		X		X
Unknown *Mormopterus* spp.	Unknown Freetail Bat		X		X		X		X		X
*Myotis macropus**	Large-footed Myotis				X		X		X		X
Nyctophilus spp.	*Long-eared Bats*				X		X	X			X
Rhinolophus megaphyllus	Eastern Horseshoe Bat	X		X				X		X	
Scotorepens balstoni	Inland Broad-nosed Bat					X		X		X	
Vespadelus regulus	Southern Forest Bat		X		X		X		X		X
Vespadelus vulturnus	Little Forest Bat		X		X		X		X		X
Species Diversity (Positive identification)		**6**		**5**		**5**		**9**		**7**	
Species Diversity (Possible identification)			**5**		**7**		**9**		**6**		**7**

* Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act

Table 3: Microbat species (Sites 6, 7, 8 and 9)

Species Name	Common Name	Ref R 10 (SM3-5)		Ref 14 (SM3-5)	
		11 – 12 October		9 - 10 October	
		Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-Striped Freetail Bat	X		X	
Chalinolobus dwyeri[1]*	Large-eared Pied Bat			X	
Chalinolobus gouldii	Gould's Wattled Bat	X		X	
Chalinolobus morio	Chocolate Wattled Bat		X	X	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	X		X	
Mormopterus (*Ozimops*) *planiceps*	South-eastern Freetail Bat		X		
Mormopterus (Ozimops) ridei	Ride's Freetail Bat		X		
Unknown *Mormopterus* spp.	Unknown Freetail Bat		X		
*Myotis macropus**	Large-footed Myotis				X
Nyctophilus spp.	Long-eared Bats				X
Rhinolophus megaphyllus	Eastern Horseshoe Bat	X			
Scotorepens balstoni	Inland Broad-nosed Bat	X		X	
Scotorepens orion	Eastern broad-nosed Bat		X		X
Vespadelus regulus	Southern Forest Bat		X		X
Vespadelus vulturnus	Little Forest Bat		X		X
Species Diversity (Positive identification)		**5**		**6**	
Species Diversity (Possible identification)			**7**		**5**

* Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act

Site by site table data

The following tables provide a summary of the attributes outlined below:

- site by site variations in species richness and diversity
- definite, potential and possible calls for each species
- species by species activity levels based on the number of calls recorded across all species and by individual species
- site specific percentage / ratio of useful calls and un-interpretable calls

Table 4: Microbat species Site A_104 (SM2-1) 19 - 20 September 2017

Species Name	Common name	Definite	Potential	Possible	Total
Chalinolobus morio	Chocolate Wattled Bat	2	0	0	2
*Chalinolobus morio / Vespadelus troughtoni**	Chocolate Wattled Bat / Eastern Cave Bat	0	0	4	4
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	0	1	0	1
Low					38
Definite, with confidence to species calls		**2**			
Useable calls		**7**			
Total Calls		**45**			
Percentage of useful calls		**15.56**			

* Threatened species listed under BC Act

Table 5: Microbat Site B_101 (SM2-1) 26 - 27 September 2017

Species Name	Common name	Definite	Potential	Possible	Total
Chalinolobus gouldii	Gould's Wattled Bat	3	1	0	4
Chalinolobus morio	Chocolate Wattled Bat	28	10	1	39
*Chalinolobus morio / Vespadelus troughtoni**	Chocolate Wattled Bat / Eastern Cave Bat	0	0	17	17
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	26	11	1	38
*Miniopterus schreibersii oceanensis** / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Southern Forest Bat / Little Forest Bat	0	0	90	90
Scotorepens balstoni	Inland Broad-nosed Bat	0	1	0	1
Vespadelus regulus / Vespadelus vulturnus	Southern Forest Bat / Little Forest Bat	0	0	20	20
*Vespadelus troughtoni**	Eastern Cave Bat	0	0	2	2
Low					99
Useable calls		**214**			
Total Calls		**310**			
Percentage of useful calls		**69.03**			

* Threatened species listed under BC Act

Table 6: Microbat species Site C_102 (SM3-1)) 26 - 27 September 2017

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	5	1	0	6
Chalinolobus dwyeri[1]	Large-eared Pied Bat	85	12	0	97
Chalinolobus gouldii	Gould's Wattled Bat	40	19	5	64
Chalinolobus morio	Chocolate Wattled Bat	9	2	3	14
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	4	4
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	61	23	2	86
*Miniopterus schreibersii oceanensis** / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	109	109
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Ride's Freetail Bat			15	15
*Myotis macropus** / *Nyctophilus* spp	Large-footed Myotis / Long-eared Bat	0	0	1	1
Nyctophilus spp	Long-eared Bat	1	0	0	1
Rhinolophus megaphyllus	Eastern Horseshoe Bat	1	0	0	1
Scotorepens balstoni	Inland Broad-nosed Bat	8	4	2	14
Vespadelus regulus / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 47 kHz)	Southern Forest Bat / Little Forest Bat	0	0	23	23
Vespadelus troughtoni/ *Vespadelus vulturnus* (defined by curved calls with Fc above 49Hz)	Eastern Cave Bat / Little Forest Bat			3	3
Vespadelus vulturnus	Little Forest Bat	5		0	5
Low					169
	Useable calls	**438**			
	Total Calls	**607**			
	Percentage usable calls	**72.15**			

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Table 7: Site D_103 (SM3-1) 11 - 12 October 2017

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	26	0	0	26
Chalinolobus dwyeri[1]	Large-eared Pied Bat	1	0	0	1
Chalinolobus gouldii	Gould's Wattled Bat	5	2	5	12
Chalinolobus morio	Chocolate Wattled Bat	6	2	0	8
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	9	9
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	14	17	0	31
*Miniopterus schreibersii oceanensis** / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	336	337
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat			21	21
Unknown *Mormopterus* spp.	Unknown Freetail Bat	15	5	2	22
Nyctophilus spp	Long-eared Bat	1	0	0	1
Scotorepens greyi	Little Broad-nosed Bat	0	0	1	1
Vespadelus regulus / *Vespadelus vulturnus*	Southern Forest Bat / Little Forest Bat	0	0	6	6
Low					181
Useable calls		**490**			
Total Calls		**656**			
Percentage usable calls		**74.69**			

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Table 8: Site E_104 (SM3-1) 9 -10 October 2017

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	4	0	2	6
Chalinolobus dwyeri[1]	Large-eared Pied Bat	118	3	1	122
Chalinolobus gouldii	Gould's Wattled Bat	21	11	0	32
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	5	5
Chalinolobus morio	Chocolate Wattled Bat	8	6	0	14
Chalinolobus morio / *Vespadelus troughtoni**	Chocolate Wattled Bat / Eastern Forest Bat / Eastern Cave Bat	0	0	10	10
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	92	22	0	114
Miniopterus schreibersii oceanensis / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	147	147
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat			21	21
Unknown *Mormopterus* spp.	Unknown Freetail Bat	23	29	0	52
*Myotis macropus** / *Nyctophilus* spp	Large-footed Myotis / Long-eared Bat	0	0	2	2
Rhinolophus megaphyllus	Eastern Horseshoe Bat	5	0	0	5
Scotorepens balstoni	Inland Broad-nosed Bat	3	1	0	4
Scotorepens balstoni / *Scotorepens orion*	Inland Broad-nosed Bat / Eastern broad-nosed Bat	0	0	3	3
Scotorepens orion	Eastern broad-nosed Bat	1	0	0	1
Vespadelus regulus / *Vespadelus vulturnus*	Southern Forest Bat / Little Forest Bat	0	0	9	9
Vespadelus troughtoni	Eastern Cave Bat			1	1
Low					122
Definite with confidence to species calls		**292**			
Useable calls		**551**			
Total Calls		**670**			
Percentage usable calls		**82.24**			

* Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act

Table 9: Site R7_100 (SM3-2)) 26 -27 September 2017

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	12	1	0	13
Chalinolobus dwyeri[*1]	Large-eared Pied Bat	28	0	2	30
Chalinolobus gouldii	Gould's Wattled Bat	19	6	0	25
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	7	7
Chalinolobus morio	Chocolate Wattled Bat	15	3	0	18
Chalinolobus morio / *Vespadelus troughtoni* / *Vespadelus vulturnus*	Chocolate Wattled Bat / Eastern Cave Bat / Little Forest Bat	0	0	8	8
Chalinolobus morio / *Vespadelus troughtoni*	Chocolate Wattled Bat / Eastern Cave Bat	0	0	2	2
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	100	10	0	110
Miniopterus schreibersii oceanensis / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	55	55
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat	0	0	18	18
Unknown *Mormopterus* spp.	Unknown Freetail Bat	12	8	0	20
Rhinolophus megaphyllus	Eastern Horseshoe Bat	2	0	0	2
Low					100
Useable calls		**308**			
Total Calls		**408**			
Percentage usable calls		**74.26**			

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Table 10: Ref_2 (SM3-2) 19 -20 September 2017

Species Name	Common name	Definite	Potential	Possible	Total
Chalinolobus gouldii	Gould's Wattled Bat	4	5	1	10
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	9	9
Chalinolobus morio	Chocolate Wattled Bat	50	27	0	77
Chalinolobus morio / *Vespadelus troughtoni**	Chocolate Wattled Bat / Eastern Cave Bat	0	0	25	25
Chalinolobus morio / *Vespadelus vulturnus*	Chocolate Wattled Bat / Little Forest Bat	0	0	21	21
*Miniopterus australis**	Little Bentwing Bat	1	0	0	1
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	120	53	0	173
*Miniopterus schreibersii oceanensis** / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	106	106
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat	0	0	4	4
Unknown *Mormopterus* spp.	Unknown Freetail Bat	2	0	0	2
*Myotis macropus** / *Nyctophilus* spp	Large-footed Myotis / Long-eared Bat	0	0	1	1
Rhinolophus megaphyllus	Eastern Horseshoe Bat	2	0	0	2
Low					200
Useable calls		**436**			
Total Calls		**631**			
Percentage usable calls		**70.00**			

* Threatened species listed under BC Act

Table 11: Ref_3 (SM3-1)) 11-12 October 2017

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	19	0	0	19
Chalinolobus dwyeri[1]	Large-eared Pied Bat	11	9	0	20
Chalinolobus gouldii	Gould's Wattled Bat	0	2	1	3
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	1	1
Chalinolobus morio	Chocolate Wattled Bat	10	16	0	26
Chalinolobus morio / *Vespadelus troughtoni**	Chocolate Wattled Bat / Eastern Cave Bat	0	0	5	5
Chalinolobus morio / *Vespadelus vulturnus*	Chocolate Wattled Bat / Little Forest Bat	0	0	1	1
*Miniopterus australis**	Little Bentwing Bat	0	0	1	1
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	81	25	0	106
*Miniopterus schreibersii oceanensis** / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	44	44
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat	0	0	3	3
Unknown *Mormopterus* spp.	Unknown Freetail Bat	5	10	0	15
*Myotis macropus** / *Nyctophilus* spp	Large-footed Myotis / Long-eared Bat	0	0	3	3
Scotorepens balstoni	Inland Broad-nosed Bat	0	1	0	1
Low					271
Useable calls					**248**
Total Calls					**519**
Percentage usable calls					**47.78**

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Table 12: Ref_5 (SM3-1)) 9 -10 October 2017

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	2	0	0	2
Chalinolobus dwyeri[1]	Large-eared Pied Bat	2	0	0	2
Chalinolobus gouldii	Gould's Wattled Bat	2	4	0	6
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	10	10
Chalinolobus morio	Chocolate Wattled Bat	54	27	0	81
Chalinolobus morio / *Vespadelus troughtoni**	Chocolate Wattled Bat / Eastern Cave Bat	0	0	4	4
Chalinolobus morio / *Vespadelus vulturnus*	Chocolate Wattled Bat / Little Forest Bat	0	0	2	2
*Miniopterus australis**	Little Bentwing Bat	2	0	2	2
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	235	44	0	279
*Miniopterus schreibersii oceanensis** / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	395	395
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat	0	0	10	10
Unknown *Mormopterus* spp.	Unknown Freetail Bat	11	6	0	17
*Myotis macropus** / *Nyctophilus* spp	Large-footed Myotis / Long-eared Bat	0	0	5	5
Nyctophilus spp	Long-eared Bat	1	0	0	1
Rhinolophus megaphyllus	Eastern Horseshoe Bat	7	0	0	7
Scotorepens balstoni	Inland Broad-nosed Bat	2	1	0	3
Scotorepens balstoni / *Scotorepens orion*	Inland Broad-nosed Bat / Eastern broad-nosed Bat	0	0	1	1
Vespadelus regulus / *Vespadelus vulturnus*	Southern Forest Bat / Little Forest Bat	0	0	4	4
Low					374
Useable calls		**833**			
Total Calls		**1205**			
Percentage usable calls		**69.13**			

* Threatened species listed under BC Act - [1] Threatened species listed under the EPBC Act

Table 13: Site Ref 8 (SM3-1)) 19 -20 September 2017

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	1	0	0	1
Chalinolobus dwyeri[1]	Large-eared Pied Bat	16	8	0	24
Chalinolobus gouldii	Gould's Wattled Bat	5	7	0	12
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	3	3
Chalinolobus morio	Chocolate Wattled Bat	9	12	0	21
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	208	48	0	256
Miniopterus schreibersii oceanensis / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Southern Forest Bat / Little Forest Bat	0	0	78	78
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat	0	0	5	5
Unknown *Mormopterus* spp.	Unknown Freetail Bat	0	0	2	2
*Myotis macropus** / *Nyctophilus* spp	Large-footed Myotis / Long-eared Bat	0	0	2	2
Rhinolophus megaphyllus	Eastern Horseshoe Bat	9	0	0	9
Scotorepens balstoni	Inland Broad-nosed Bat	0	1	0	1
Low					294
Useable calls		**414**			
Total Calls		**708**			
Percentage usable calls		**58.48**			

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Table 14: Site R_10 (SM3-5)) 11 12 October 2016

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	13	0	0	13
Chalinolobus gouldii	Gould's Wattled Bat	21	7	4	
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	3	3
Chalinolobus morio	Chocolate Wattled Bat	0	1	0	1
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	27	20	0	47
*Miniopterus schreibersii oceanensis** / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Southern Forest Bat / Little Forest Bat	0	0	28	28
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat			18	18
Unknown *Mormopterus* spp.	Unknown Freetail Bat	3	4	0	7
Rhinolophus megaphyllus	Eastern Horseshoe Bat	1	0	0	1
Scotorepens balstoni	Inland Broad-nosed Bat	6	3	0	9
Scotorepens balstoni / *Scotorepens orion*	Inland Broad-nosed Bat / Eastern broad-nosed Bat	0	0	1	1
Low					108
Useable calls		**160**			
Total Calls		**268**			
Percentage usable calls		**59.71**			

* Threatened species listed under BC Act

Table 15: Site R_14 (SM3-5)) 9 - 10 October 2016

Species Name	Common name	Definite	Potential	Possible	Total
Austronomus australis	White-Striped Freetail Bat	2	0	0	2
Chalinolobus dwyeri[1]	Large-eared Pied Bat	2	0	0	2
Chalinolobus gouldii	Gould's Wattled Bat	7	9	0	16
Chalinolobus morio	Chocolate Wattled Bat	64	11	0	75
Chalinolobus gouldii / *Mormopterus* (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	Gould's Wattled Bat / South-eastern Freetail Bat / Eastern Freetail Bat	0	0	18	18
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	9	3	0	12
Miniopterus schreibersii oceanensis / *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus*	Eastern Bentwing Bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	35	35
Mormopterus (*Ozimops*) *planiceps* / *Mormopterus* (*Ozimops*) *ridei*	South-eastern Freetail Bat / Eastern Freetail Bat	0	0	26	26
Unknown *Mormopterus* spp.	Unknown Freetail Bat	24	12	0	36
*Myotis macropus** / *Nyctophilus* spp	Large-footed Myotis / Long-eared Bat	0	0	1	1
Scotorepens balstoni	Inland Broad-nosed Bat	3	1	0	4
Scotorepens balstoni / *Scotorepens orion*	Inland Broad-nosed Bat / Eastern broad-nosed Bat	0	0	1	1
Low					107
Useable calls		**228**			
Total Calls		**335**			
Percentage usable calls		**68.06**			

* Threatened species listed under BC Act

[1] Threatened species listed under the EPBC Act

Call profiles

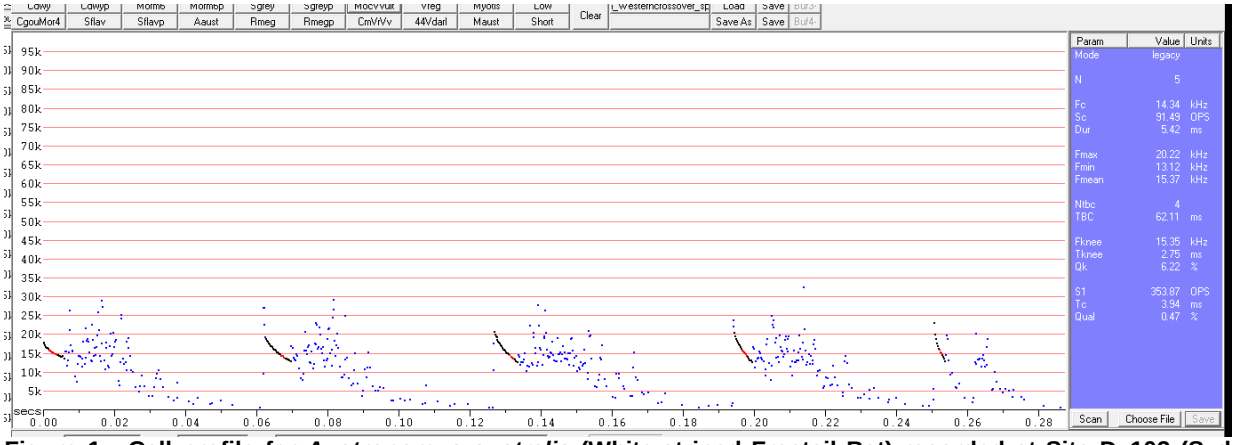

Figure 1: Call profile for *Austronomus australis* (White-striped Freetail Bat) recorded at Site D_103 (Syd SM3-1) among remanent ironbark, shrubby and healthy woodland at 2148 (9.48 pm), 11 October 2017

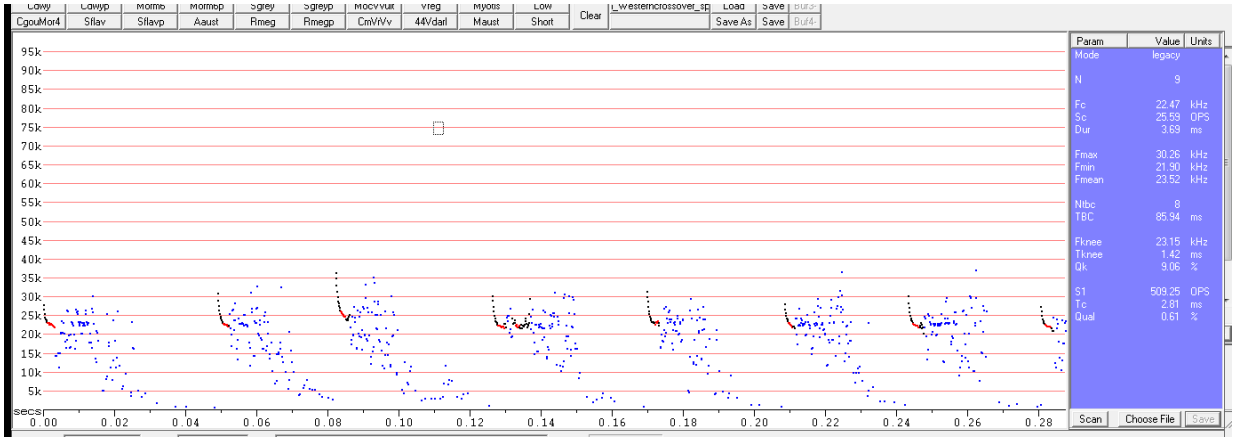

Figure 2: Call profile for *Chalinolobus dwyeri* (Large-eared Pied Bat) recorded at Site R_100 (Syd SM3-2) among remanent ironbark, shrubby and healthy woodland at 0257 (2.57 am), 27 September 2017

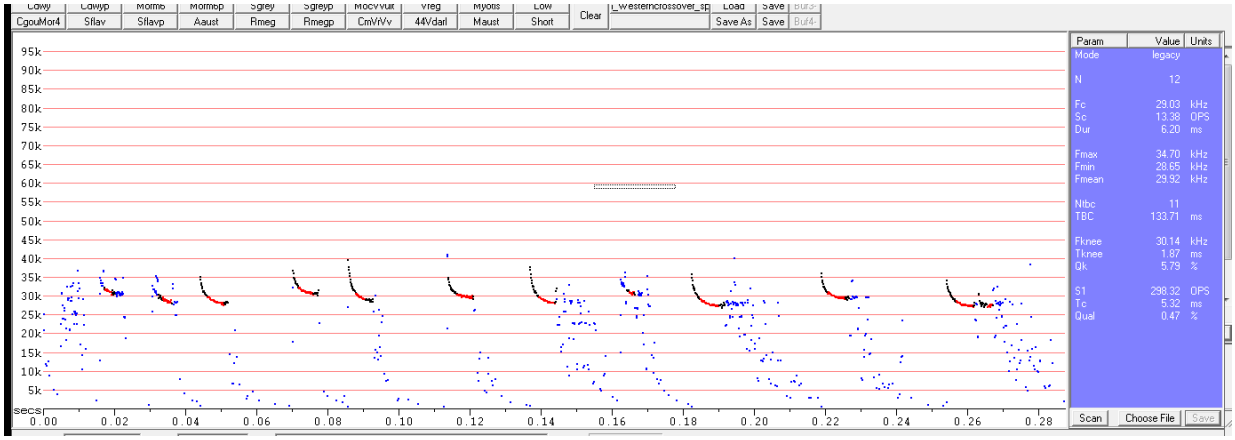

Figure 3: Call profile for *Chalinolobus gouldii* (Gould's Wattled Bat) recorded at Site R_100 (SM3-2) among remanent ironbark, shrubby and healthy woodland at 1917 (7.17 Pm), 27 September 2017

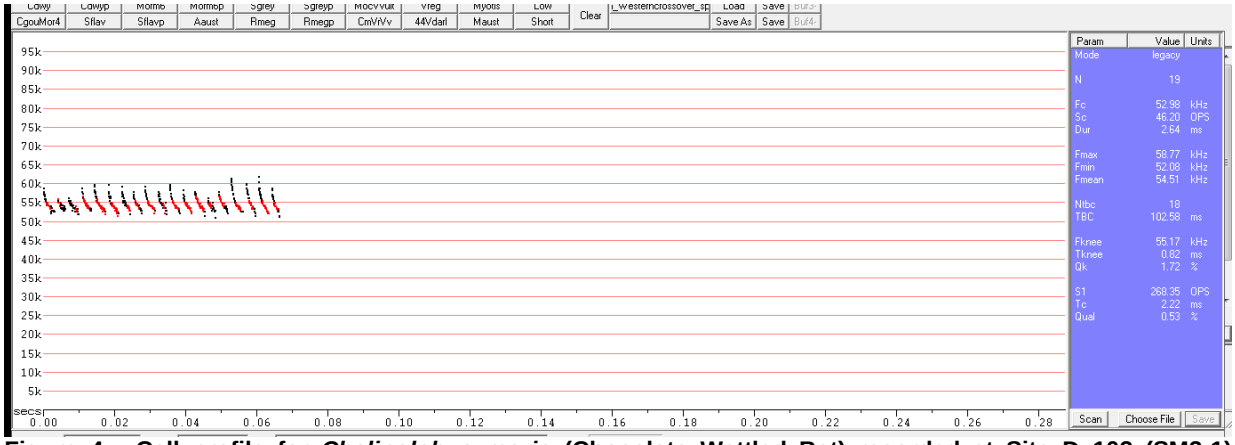

Figure 4: Call profile for *Chalinolobus morio* (Chocolate Wattled Bat) recorded at Site D_103 (SM3-1) among remanent ironbark, shrubby and healthy woodland at 1922 (7.22 pm), 26 September 2017

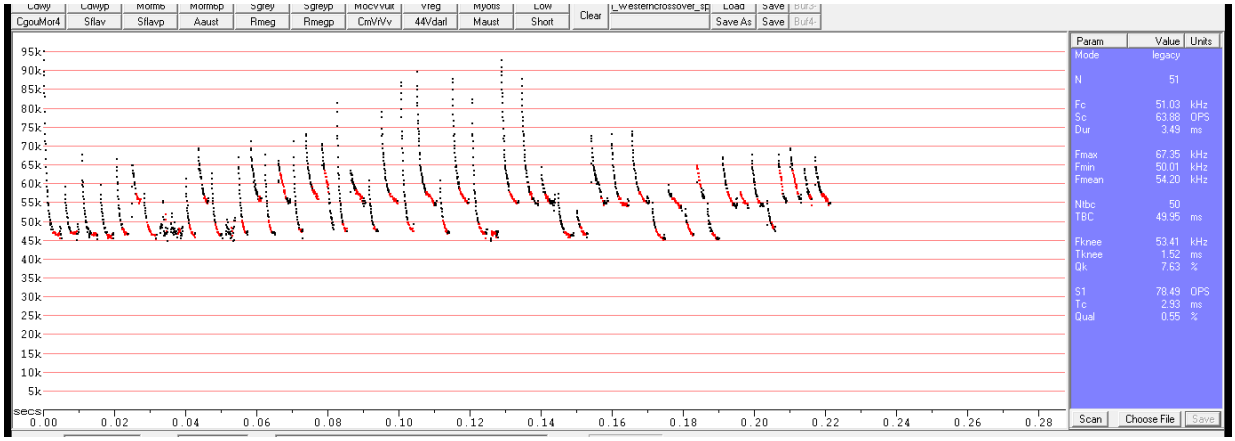

Figure 5: Possible call profile for *Miniopterus australis* (Little Bentwing Bat) (with *Miniopterus schreibersii oceanensis* / *Vespadelus* spp. call also present) recorded at Ref 2 (SM3-2) set among remnant White Box / Grey Box grassy woodland with HBTs at 1853 (06.53 pm), 19 September 2017

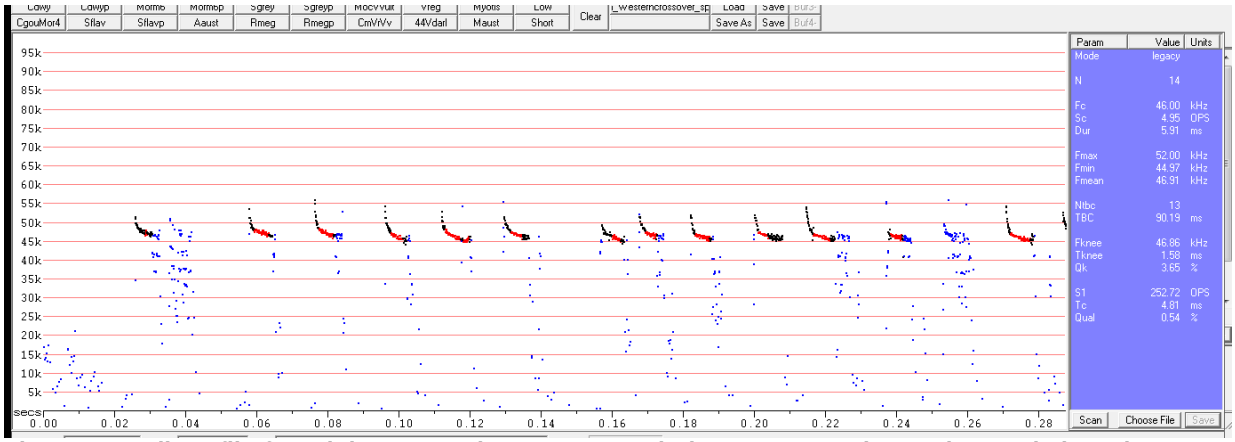

Figure 6: Call profile for *Miniopterus orianae oceanensis* (Eastern Bentwing Bat) recorded at Site R_107 (SM3-2) set among partly cleared *A. floribunda* and *E. melliodora* at 2051 (08.51 pm), 27 September 2017

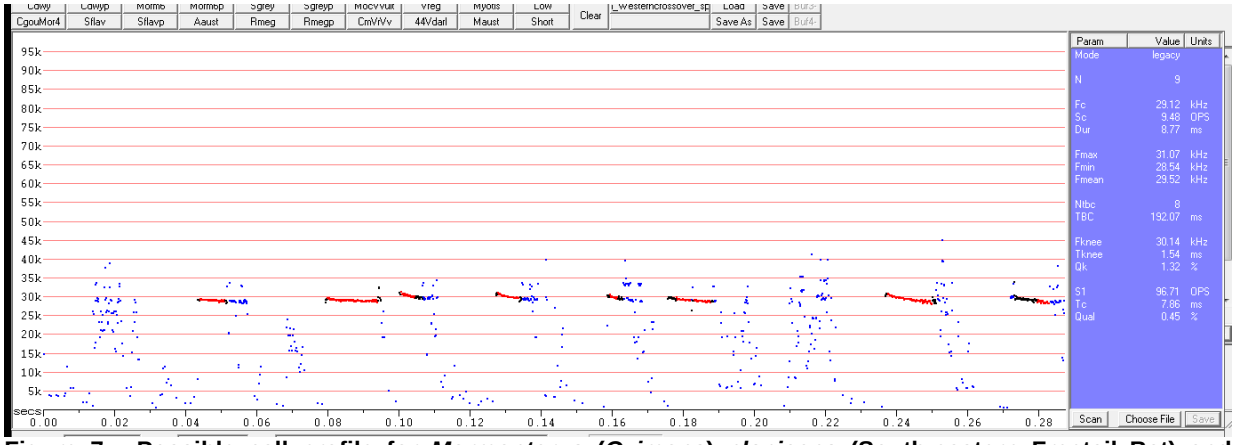

Figure 7: Possible call profile for *Mormopterus* (*Ozimops*) *planiceps* (South-eastern Freetail Bat) and *Mormopterus (Ozimops) ridei* (Ride's Freetail bat) recorded at Site R_107 (SM3-2) set among partly cleared *A. floribunda* and *E. melliodora* at 2137 (09.37 pm), 27 September 2017

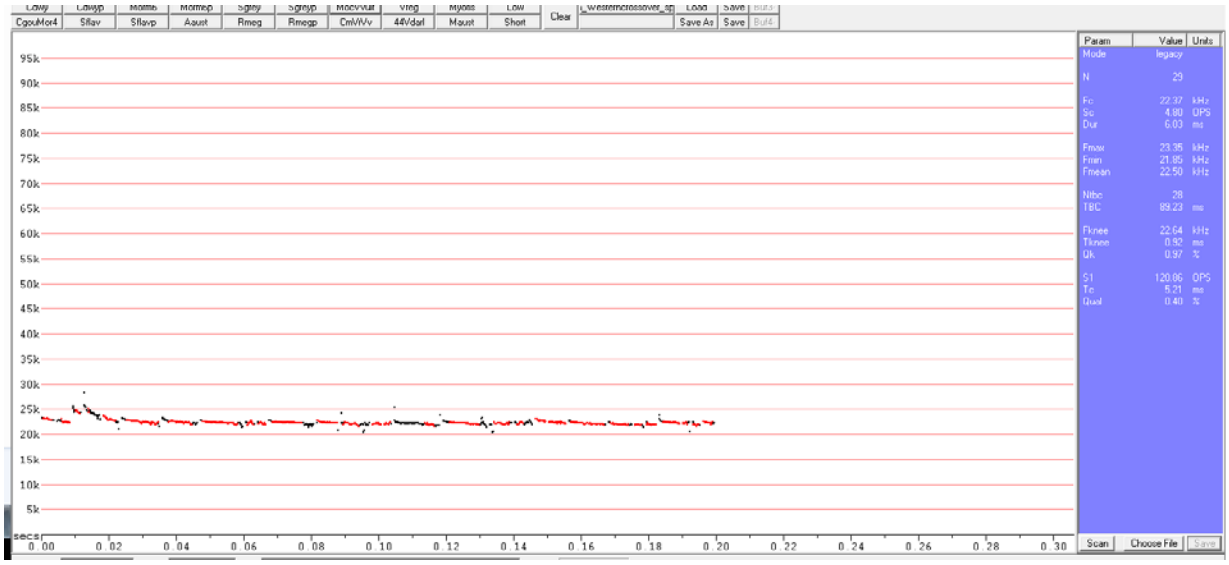

Figure 8: Call profile for Unknown *Mormopterus* spp (Unknown Freetail Bat) recorded at Site D_103 (Syd SM3-1) among remanent ironbark, shrubby and healthy woodland at 2125 (9.25 pm), 11 October 2017

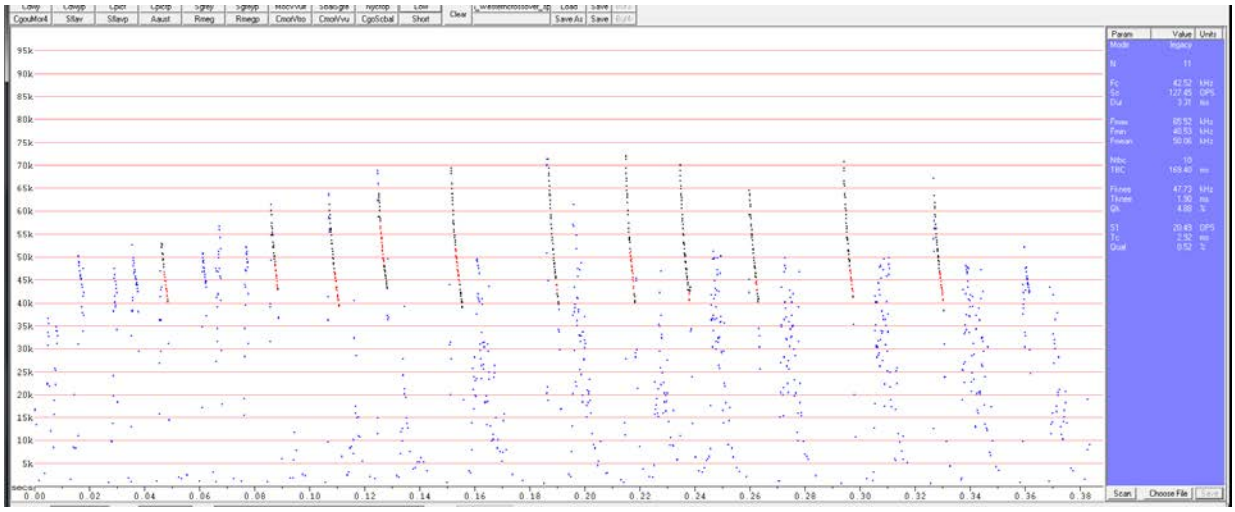

Figure 9: Possible call profile for *Myotis Macropus* (Large-footed Myotis) and *Nyctophilus* spp. recorded at Ref 2 (SM3-2) at 2127 (9.27 am), 19 September 2017

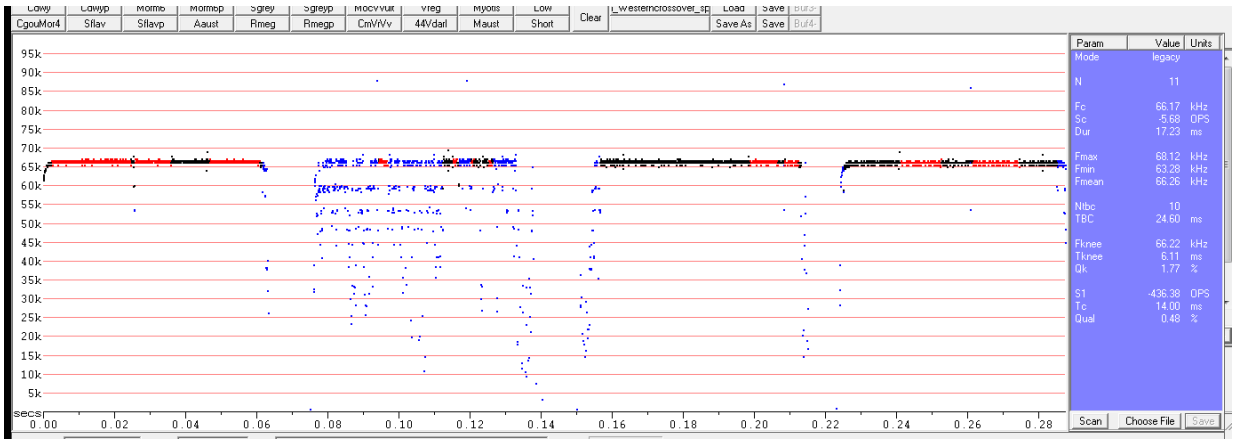

Figure 10: Call profile for *Rhinolophus megaphyllus* (Eastern Horseshoe Bat) recorded at Site R_107 (SM3-2) set among partly cleared *A. floribunda* and *E. melliodora* at 0455 (04.55 pm), 27 September 2017

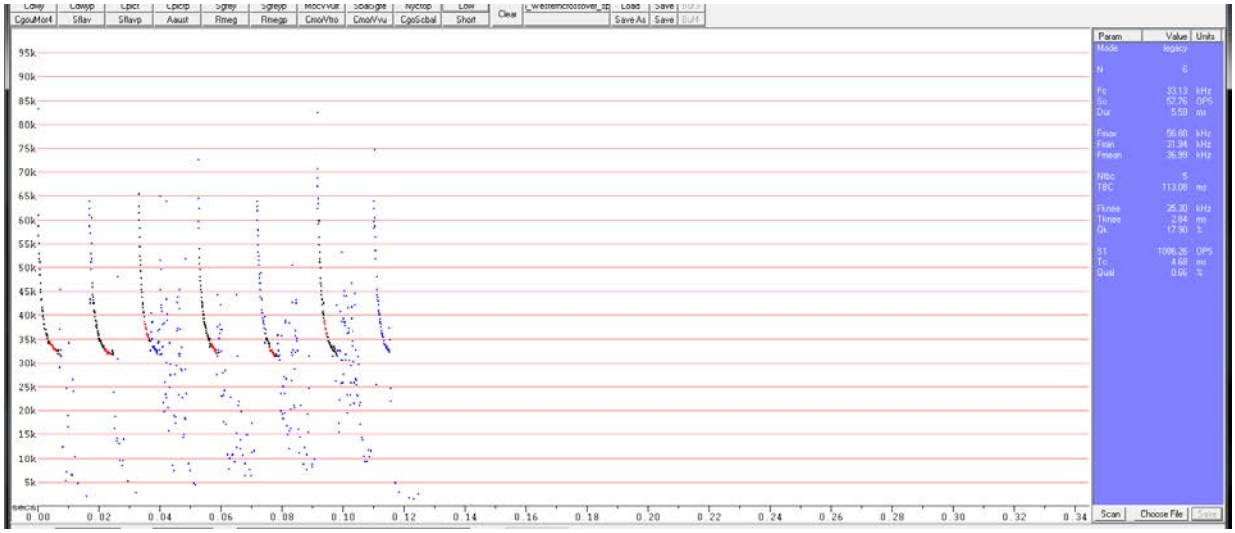

Figure 11: Possible call profile for *Scotorepens balstoni* (Inland Broad-nosed Bat) recorded at B-101 (SM2-1) at1832 (6.32pm), 26 September 2017 (Time between calls = 113.08ms)

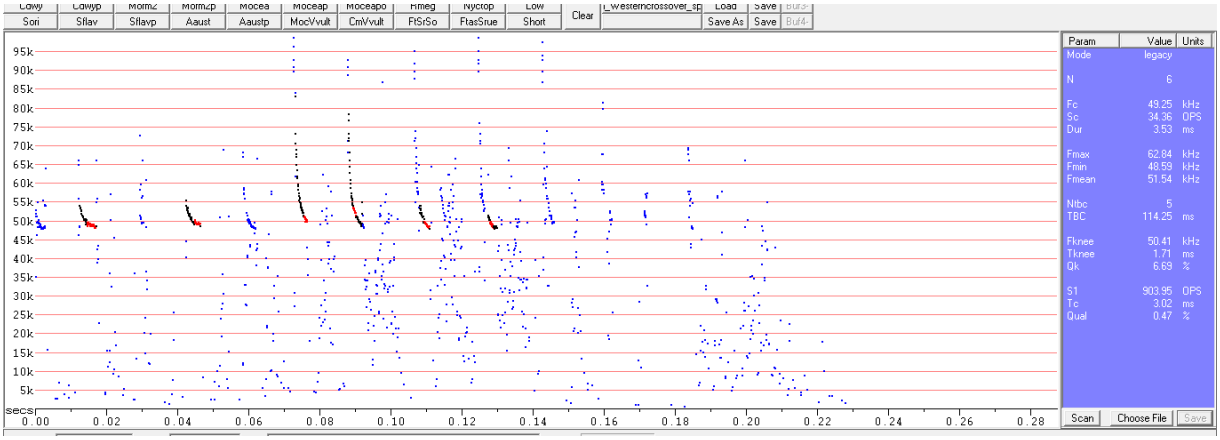

Figure 12: Possible call profile for *Chalinolobus morio* (Chocolate Wattled Bat) and *Vespadelus troughtoni* (Eastern Cave Bat) recorded at Site B 101 (SM2-1) at 1855 (6.55 pm), 26 September 2017.

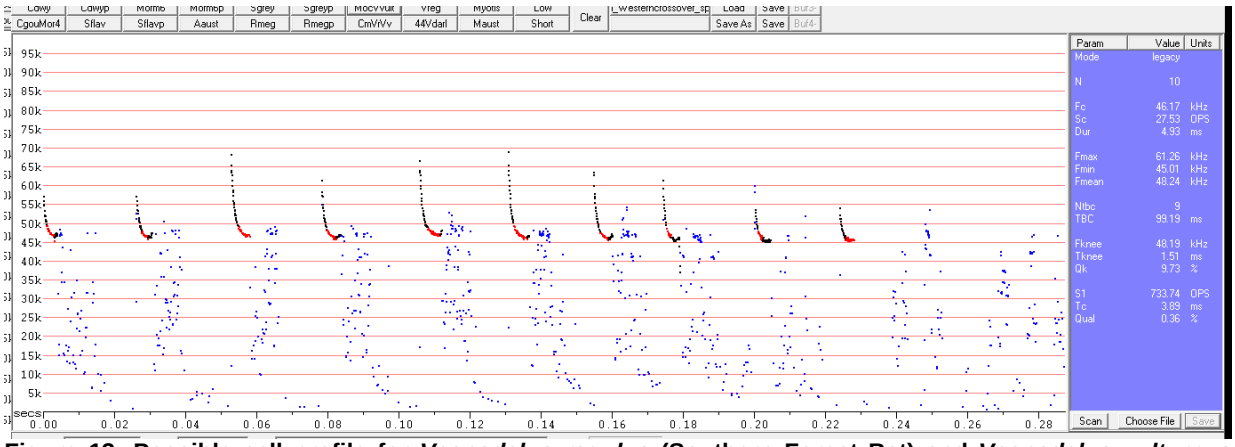

Figure 13: Possible call profile for *Vespadelus regulus* (Southern Forest Bat) and *Vespadelus vulturnus* (Little Forest Bat) recorded at Site D_103 (Syd SM3-1) among remanent ironbark, shrubby and healthy woodland at 0242 (2.42 am), 12 October 2017

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BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2017	Assessment of Actions
Cultural Heritage Management	Identification of cultural heritage sites within the Biodiversity Offset Areas to avoid potential harm	Undertake Due Diligence cultural heritage surveys in accordance with Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW within areas of proposed disturbance of the 2 Biodiversity Offset Areas to identify cultural heritage sites	Not Triggered in 2017. No disturbance activities during the 2017 reporting period. There is a scheduled survey of the WEP Offset Areas in 2018.
	Cultural heritage items within the approved disturbance area, ECAs, Regeneration and Rehabilitation Areas are managed in accordance with the WCPL ACHMP (within DA boundaries) and Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW for areas elsewhere	Continue implementation of WCPLs ACHMP, Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW and WCPLs GDP Process	
Fencing, Gates and Signage	Clearly delineate all Biodiversity Offset Areas, ECAs and Regeneration Areas	Undertake annual security inspection. Schedule and undertake necessary repairs	Inspections ongoing throughout the 2017 reporting period. All stock excluded. Repair of fences and gates ongoing as required.
	Prevent unauthorised human access to all Management Domains	Undertake annual security inspection. Schedule and undertake necessary repairs	
	Exclude livestock from areas of native regeneration (unless being used as within management program i.e. crash grazing)	Undertake annual security inspection. Schedule and undertake necessary repairs	
	Access to the Management Domains is retained for maintenance and safety purposes	Undertake annual security inspection. Schedule and undertake necessary repairs	
Access Tracks	Reduce and rehabilitate unnecessary access tracks in all Biodiversity Offset Areas , ECAs and Regeneration Areas	Undertake quarterly rehabilitation inspection. Schedule and undertake necessary repairs	Inspections ongoing throughout the 2017 reporting period. Repair and maintenance of access tracks ongoing as required.
	Provide safe, unimpeded access for monitoring and maintenance, bushfire management, and asset protection in all Biodiversity Offset Areas, ECAs and Regeneration Areas	Undertake annual access track inspection. Schedule and undertake necessary repairs	Bushfire management plan review completed in 2017 which included a detailed review by bushfire ecologist in November 2017. Finalising of the revised BFMP is scheduled in early 2018.
Waste Management	All Biodiversity Offset Areas, ECAs and Regeneration Areas are free of waste, disused buildings and redundant farm equipment	Undertake quarterly waste inspections. Schedule and commission removal of all additional waste Include disused building sites on quarterly rehabilitation inspection. Schedule and undertake necessary repairs.	Inspections ongoing throughout the 2017 reporting period. Removal of wastes will continue in 2018 and focussing on the additional WEP Offset Areas.
Erosion, Sedimentation and Soil Management	Erosion, sediment or soil (i.e. Salinity) risks are identified and mapped in all Biodiversity Offset Areas, ECAs and Regeneration Areas	Undertake quarterly erosion, sediment and soil inspections. Update GIS database with necessary changes	Inspections ongoing throughout the 2017 reporting period, which included use of LFA in accordance with the BMP.

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2017	Assessment of Actions
	A risk based monitoring and management plan is developed for erosion, sediment and soil risks in all Biodiversity Offset Areas, ECAs and Regeneration Areas	Continue to implement WCPLs Erosion and Sediment Control Plan Undertake quarterly erosion, sediment or soil inspections. Schedule and undertake necessary repairs	
Grazing and Stock Management	Exclude livestock from areas of native regeneration in all Biodiversity Offset Areas, ECAs and Regeneration Areas (unless being used as within management program)	Undertake annual security inspection. Schedule and undertake necessary repairs	Inspections ongoing throughout the 2017 reporting period. All stock excluded. Lessee inspections of fences prior to stocking to ECAs and Regen Areas.
	Consider livestock as a rehabilitation management tool	Review rehabilitation performance towards completion criteria If deemed appropriate, seek technical advice regarding the use of livestock as a rehabilitation management tool	Livestock used as part of rehab trial in 2016. Focus on the development of BVT performance and completion for 2017. Livestock unlikely to be use due to the revised requirement for native vegetation as opposed to previous agricultural land use.
Seed Collection and Propagation	All seed collectors are appropriately qualified and trained	Confirm training records for engaged seed collectors	Hunter Ecological is confirming seed species mix appropriate required BVTs. Scope of works to be developed for seed collection subject to BVT seed mix confirmation.
	Local species are included in revegetation and rehabilitation seed mixes		
	Locally sourced seed is available for revegetation and rehabilitation works within all Management Domains	Implement seed collection and propagation procedure opportunistically	As Above
Habitat Augmentation	Habitat augmentation opportunities are identified and assessed Habitat within poor and moderate resilience areas within Biodiversity Offset Areas, ECAs, and Regeneration and Rehabilitation Areas is enhanced	Implement recommendations from the habitat augmentation assessment	The BMP monitoring includes assessment of native vegetation and habitat complexity. The assessments are annually and reviewed accordingly.
Revegetation and Regeneration	Increase overall native plant species richness to meet Interim Performance Targets in Biodiversity Offset Areas, ECAs and	Undertake quarterly revegetation and regeneration inspections. Schedule and undertake necessary	The BMP monitoring includes assessment of native vegetation and habitat complexity. The

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2017	Assessment of Actions
	Regeneration and Rehabilitation Areas	maintenance including reapplication of seed or supplementary tree and shrub planting.	assessments are annually and reviewed accordingly. No planting in ECAs and/or BOAs was undertaken due to the dry conditions and will be reassessed in 2018.
Weed Management	Noxious and environmental weeds are identified and mapped in all Biodiversity Offset Areas, ECAs and Regeneration Areas	Undertake quarterly weed inspections. Update GIS database with necessary changes	Weed spraying undertaken in portions of BOAs, ECAs and Regen Area (refer to 2017 Spray Map – Appendix 5). In 2017 target weed spraying was completed based o internal and MWRC inspections from previous seasons. Lessees across the broader company landholdings also undertake ongoing weed management.
	A risk based weed management program is developed for all Biodiversity Offset Areas, ECAs and Regeneration Areas	Implement weed management program Undertake quarterly weed inspections. Schedule and undertake necessary weed treatment	
	Reduced presence of noxious and environmental weeds	Implement weed management program Specific Actions include: Targeted spraying of prickly pear and garden escapes around the disused dwelling in Biodiversity Offset Area-D Targeted spraying of blackberry and *Juncus acutus* (Spiny Rush) along Cumbo Creek within ECA-A and Regeneration Area 2 Targeted spraying of blackberry and *Juncus acutus* (Spiny Rush) along Wilpinjong Creek within ECA-B and Regeneration Areas 1 and 5	
Vertebrate Pest Management	Vertebrate pest species and their presence is known within the Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas		Monitoring for pests species include in annual biodiversity monitoring program. In 2017, targeted pest species management included feral pig trapping in ECA 'A' and 'D', fox and wild dog control was undertaken in Spring and Autumn in conjunction with the local wild dog group. Aerial dog bating and trapping campaign between Pit 3/7 and Slate Gully in December 2017. This program was undertaken in consultation with Local Land Services (LLS) as a result of know wild dog activity in the local area. Lessees across the broader company
	Control vertebrate pest species likely to pose a threat to the Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas	Implement vertebrate pest management program	

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2017	Assessment of Actions
			landholdings also undertake ongoing vertebrate pest management.
Bushfire Management	Maintain the environmental and habitat features of the Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas	Implement WCPL Bushfire Management Maintain APZs	Bushfire management plan review completed in 2017 which included a detailed review by bushfire ecologist in November 2017. Finalising of the revised BFMP is scheduled in early 2018.
Biodiversity Monitoring	Monitor biodiversity within the Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas to assess progress against completion criteria	Implement Biodiversity Monitoring Program and analyse results against the completion criteria and undertake corrective actions where required.	The BMP monitoring includes assessment of native vegetation and habitat complexity. The assessments are annually and reviewed accordingly.
Inspections and Document Control	Ensure implemented management actions are successful in progressing towards completion criteria	Undertake and document inspections	This Annual Review. BVT performance and completion criteria relevant to the rehabilitation areas are still being developed in accordance with Schedule 3, Condition 37 of the Development Consent SSD-6764. Upon resolution of the performance and completion criteria, in accordance with Condition 65 of the Development Consent SSD-6764, the BMP will be comprehensively updated as required to reflect the new criteria.
	All actions, monitoring data and performance outcomes are documented and reported	Document all actions, monitoring data and performance outcomes	
Management of Biodiversity Offsets 1-5	Manage Biodiversity Offset Areas 1-5 and facilitate their transfer to the National Parks Estate.	Demolition and removal of any houses and/or buildings that are not required by the NPWS. Undertake a survey of the Biodiversity Offset Area boundaries that do not follow existing cadastral boundaries (and any necessary lot subdivision with the assistance of the Mid-Western Regional Council).	This process has commenced and WCPL are schedule to complete within the timeframes as nominated by the SSD-6764.
Early establishment of Regent Honeyeater habitat in available areas	Establish Regent Honeyeater habitat within existing mine rehabilitation areas where rehabilitation to date has focussed on the establishment of productive pasture for grazing.	Undertake monitoring of Rehabilitation Areas and determine initial success of non-native species control and re-seeding works. Continue to implement the control of non-native species and re-seeding of select existing rehabilitation areas to a combination of suitable native plant species (e.g. key canopy species of recognised BVTs).	In 2017, a burn and herbicide trial in August 2017 was undertake in a section of the rehabilitation area to determine if existing woodland areas could be converted to nominated BVTs. BVT performance and completion criteria relevant to the rehabilitation areas are still being developed in accordance with Schedule 3, Condition 37 of the Development Consent SSD-6764. Upon resolution of the performance and
Rehabilitation of the Mine site to recognised	Establish recognised BVTs and Regent Honeyeater habitat in the Rehabilitation Areas.	Commence implementation of rehabilitation strategy to develop BVT and Regent Honeyeater habitat.	

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2017	Assessment of Actions
habitat and ecosystem values			completion criteria, in accordance with Condition 65 of the Development Consent SSD-6764, the BMP will be comprehensively updated as required to reflect the new criteria
Propagation of *Ozothamnus tesselatus*	Successfully propagate *Ozothamnus tesselatus* in suitable Mine site rehabilitation areas.	Undertake trial plantings of *Ozothamnus tesselatus* within potentially suitable rehabilitation areas.	Collection of seeds for *Ozothamnus tessalatus* will be undertaken in 2018. The focus of 2017 was to develop the BVT performance and completion criteria.
Revegetation works along Cumbo and Wilpinjong Creeks	Establish revegetation on sections of Cumbo and Wilpinjong Creeks in WCPL and Peabody ownership.	Continue to implement the works program with remedial measures as required.	Weed management activities occurred in the upper reaches of Cumbo Creek. Stock was excluded from portions of the creek in 2017. Activities along sections of Wilpinjong Creek included weed spraying and excluding stock.

Wilpinjong BOA Microbat Monitoring

Report

Prepared for
Wilpinjong Coal Pty Ltd

23 February 2018




DOCUMENT TRACKING

Item	Detail
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Prepared by	Rebecca Croake, Angelina Siegrist
Reviewed by	Kalya Abbey
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Contents

List of tables

1 Introduction

Eco Logical Australia (ELA) was engaged by Wilpinjong Coal Pty Ltd (WCPL) to undertake monitoring for microbats across five of their Biodiversity Offset Areas (BOAs 1 - 5), using the methods outlined in the Wilpinjong Coal Biodiversity Management Plan (BMP) (WCPL 2017).

2 Method

Selection of monitoring sites for the placement of the microbat detection devices was undertaken via a desktop review, based on the vegetation communities and habitat availability mapped within each of the five BOAs (data supplied by WCPL). Site selection was further refined in-field with all sites located near (20 – 100 m) to sandstone cliff-lines, in mature woodland with hollows present. Microbat monitoring site locations are shown in **Appendix A**.

One microbat detection device was set to record in each BOA for a period of two consecutive nights from the 13th to the 14th of December 2017. The recorded data was downloaded and provided to Peter Knock (Fauna Sonics) for analysis to provide a baseline assessment of microbat activity in each of the five BOAs. The analysis report is provided in **Appendix B**.

Analysis and identification of calls was undertaken with reference to Pennay and others (2004) and Australian Bats (Churchill 2008). Each call sequence was assigned a confidence level to which an identification can be made, being:

- Definite: Call sequence identified to species level and could not be confused with another species
- Probable: Call sequence identified to species level and there is a low chance of confusion with another species
- Possible: Call sequence identified to species level, but short duration or poor quality of the sequence increases the chance of confusion with another species

Some call sequences could not be identified to a species level and could belong to one of two or more species, which commonly occurred when call sequences were short or poor quality. The total number of sequences per unit per night was tallied to give an indication of the level of microbat activity at each site.

Weather data for the recording period was obtained from the weather station at the Wilpinjong Coal Mine (WCPL 2017). Minimum night time temperatures ranged from 15.7 °C to 18.3 °C, with no rainfall recorded over the period. Weather data is shown in Table 2-1.

Table 2-1: Weather data

Date	Minimum temp (°C)	Maximum temp (°C)	Rain (mm)
13/12/2017	15.7	34.9	0
14/12/2017	16.1	36.8	0
15/12/2017	18.3	34.9	0

Source: WCPL (2017 data)

3 Results

A total of 972 call sequences were recorded, of which 318 call sequences were able to be analysed. The remaining sequences were unable to be analysed to species level due to the poor quality of data (noise) or short length of calls.

A total of nine microbat species were positively identified, with a further 10 species probably or possibly identified. Those species detected which are listed under the NSW *Biodiversity Conservation Act 1995* (BC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are presented in Table 3-1, along with the confidence level of identification.

Table 3-1: Threatened microbat species recorded

Scientific Name	Common Name	BC Act	EPBC Act	Definite	Probable	Possible
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	✓	✓	✓
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-		✓	
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	V	-		✓	✓
Saccolaimus flaviventris	Yellow Bellied Sheath-tail Bat	V	-	✓	✓	
Vespadelus troughtoni	Eastern Cave Bat	V	-		✓	

Calls from the Eastern Horseshoe Bat formed a large proportion of the calls identified to the definite confidence level, due to its strong and distinct characteristics. Large numbers of unidentified calls were in the 45-50 Khz range, with most likely to be from the Eastern Bentwing Bat and Chocolate Wattled Bat.

Call sequence analysis for each of the BOAs 1 – 5 are detailed below.

3.1 Biodiversity Offset Area 1

BOA 1 had the highest recorded number of microbat call sequences across the monitoring period with 311 call sequences, 14 of which could be positively identified to species level. Results of call analysis are presented below (**Table 3-2**). The Eastern Bentwing Bat and Little Forest Bat were the most commonly recorded species; however the Long-eared Bat had the highest amount of calls identified to the definite level of confidence.

Table 3-2: BOA 1 call analysis results

Scientific Name	Common Name	Total	Definite	Probable	Possible
Austronomus australis	White-striped freetail Bat	**3**	3	0	0
*Chalinolobus dwyeri**	Large-eared Pied Bat	**1**	0	1	0
Chalinolobus gouldii	Gould's Wattled Bat	**7**	2	5	0

Scientific Name	Common Name	Total	Definite	Probable	Possible
Chalinolobus morio	Chocolate Wattled bat	**9**	3	5	1
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	**26**	0	10	16
Ozimops spp. (old Mormopterus_sp2,3,4)	Free-tailed bats	**4**	0	4	0
Myotis macropus / Nyctophilus spp.	Southern Myotis	**3**	0	3	0
Nyctophilus spp.	Long-eared Bat	**9**	9	0	0
Rhinolophus megaphyllus	Eastern Horseshoe Bat	**1**	1	0	0
*Saccolaimus flaviventris**	Yellow-bellied Sheath-tail Bat	**1**	0	1	0
Scotorepens balstoni	Inland Broad-nosed Bat	**2**	0	2	0
Vespadelus vulturnus	Little Forest Bat	**26**	3	20	30

*Listed under the BC and/or EPBC Act

3.2 Biodiversity Offset Area 2

Recordings from BOA 2 were unable to be analysed due to a hardware system fail during recording. This was discussed with the WCPL and it was decided not to repeat the recording due to time constraints. Future monitoring will be undertaken as part of an overall monitoring program to be developed for the BOAs, which over time will provide a comprehensive microbat monitoring data set.

3.3 Biodiversity Offset Area 3

The Eastern Bentwing Bat was likely the most commonly recorded species in BOA 3 with 21 probable and 3 possible recordings, whilst the Eastern Horseshoe Bat had the highest number of definite identifications (**Table 3-3**). Four threatened species (Large-eared Pied Bat, Eastern False Pipistrelle, Eastern Bentwing Bat and Eastern Cave Bat) were identified as probably occurring within BOA 3.

Table 3-3: BOA 3 call analysis results

Scientific Name	Common Name	Total	Definite	Probable	Possible
Austronomus australis	White-striped freetail Bat	**2**	2	0	0
*Chalinolobus dwyeri**	Large-eared Pied Bat	**7**	1	4	2
Chalinolobus gouldii	Gould's Wattled Bat	**1**	0	1	0
Chalinolobus morio	Chocolate Wattled Bat	**3**	0	3	0
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle	**1**	0	1	0
Falsistrellus tasmaniensis / Scotorepens orion	Eastern False Pipistrelle/ Eastern Broad-nosed Bat	**2**	2	0	0
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	**26**	0	3	23
Ozimops spp. (old Mormopterus_sp2,3,4)	Free-tailed bats	**24**	0	21	3
Rhinolophus megaphyllus	Eastern Horseshoe Bat	**9**	9	0	0

Scientific Name	Common Name	Total	Definite	Probable	Possible
Vespadelus regulus	Southern Forest Bat	**2**	0	2	0
Vespadelus vulturnus	Little Forest Bat	**4**	0	2	2
*Vespadelus troughtoni**	Eastern Cave Bat	**1**	0	1	0

*Listed under the BC and/or EPBC Act

3.4 Biodiversity Offset Area 4

BOA 4 had the least amount of recorded call sequences with 146, with only five definitely identified to species level (**Table 3-4**). Consistent with results from other BOAs, the Eastern Bentwing Bat was the most commonly recorded species. Three species listed as vulnerable under the BC Act were identified in BOA 4 to the probable confidence level.

Table 3-4: BOA 4 call analysis results

Scientific Name	Common Name	Total	Definite	Probable	Possible
Chalinolobus gouldii	Gould's Wattled Bat	**1**	1	0	0
Chalinolobus morio	Chocolate Wattled bat	**4**	1	3	0
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle	**1**	0	1	0
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	**16**	0	9	7
Chalinolobus morio / Miniopterus schreibersii oceanensis	Chocolate Wattled bat/ *Miniopterus schreibersii oceanensis*	**1**	1	0	0
Ozimops spp. (old Mormopterus_sp2,3,4)	Ozimops group	**1**	0	1	0
Scotorepens balstoni	Inland Broad-nosed Bat	**1**	0	1	0
Vespadelus regulus	Southern Forest Bat	**9**	0	9	0
*Vespadelus troughtoni**	Eastern Cave Bat	**3**	0	3	0
Vespadelus vulturnus	Little Forest Bat	**6**	1	4	1
Vespadelus vulturnus / regulus	Little Forest Bat/ Southern Forest Bat	**2**	0	2	0
*Vespadelus vulturnus / troughtoni**	Grouped *Vespadelus spp.*	**1**	1	0	0

*Listed under the BC

3.5 Biodiversity Offset Area 5

A total of 14 species were detected within BOA 5 (**Table 3-5**). The Eastern Bentwing Bat was the most commonly recorded species, although none of the records are calls identified to the definite level of confidence. Three species listed as vulnerable under the BC Act and/or EPBC Act were were probably identified within BOA 5.

Table 3-5: BOA 5 call analysis results

Scientific Name	Common Name	Total	Definite	Probable	Possible
Austronomus australis	White-striped freetail Bat	**2**	2	0	0
*Chalinolobus dwyeri**	Large-eared Pied Bat	**7**	0	6	1
Chalinolobus gouldii	Gould's Wattled Bat	**6**	0	6	0
Chalinolobus morio	Chocolate Wattled bat	**7**	3	2	2
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	**19**	0	6	13
Ozimops spp. (old Mormopterus_sp2,3,4)	Free-tailed bats	**4**	0	4	0
Nyctophilus spp.	Long-eared Bat	**1**	1	0	0
Rhinolophus megaphyllus	Eastern Horseshoe Bat	**1**	1	0	0
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	**5**	2	3	0
Vespadelus regulus	Southern Forest Bat	**17**	3	14	0
*Vespadelus troughtoni**	Eastern Cave Bat	**1**	0	1	0
Vespadelus vulturnus	Little Forest Bat	**11**	3	7	1
Vespadelus vulturnus / regulus	Little Forest Bat/ Southern Forest Bat	**2**	0	2	0
*Vespadelus vulturnus / troughtoni**	Grouped *Vespadelus spp.*	**1**	0	1	0

*Listed under the BC and/or EPBC Act

4 Discussion

Nineteen microbat species were recorded across the four BOAs, nine of which were identified to a definite level of confidence. Two threatened species listed under the BC Act and/or EPBC Act (Large-eared Pied Bat and Yellow-bellied Sheath-tail Bat) were positively identified, with a further three threatened species probably identified. The Eastern Bentwing Bat was likely the most commonly recorded species at all four sites, although call sequences from this species could not be identified to a definite level of confidence.

Failure of the recording device at BOA 2 has resulted in no recordings for this BOA.

This level of survey provides a rudimentary baseline assessment for microbat activity in four of the five BOAs. Future monitoring involving multiple recording site locations within each BOA, incorporated as part of a longer-term monitoring program, could be expected to provide a more conclusive assessment of the level of microbat activity.

5 References

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Pennay, M., Law, B. and Reinhold, L. (2004). *Bat calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville.

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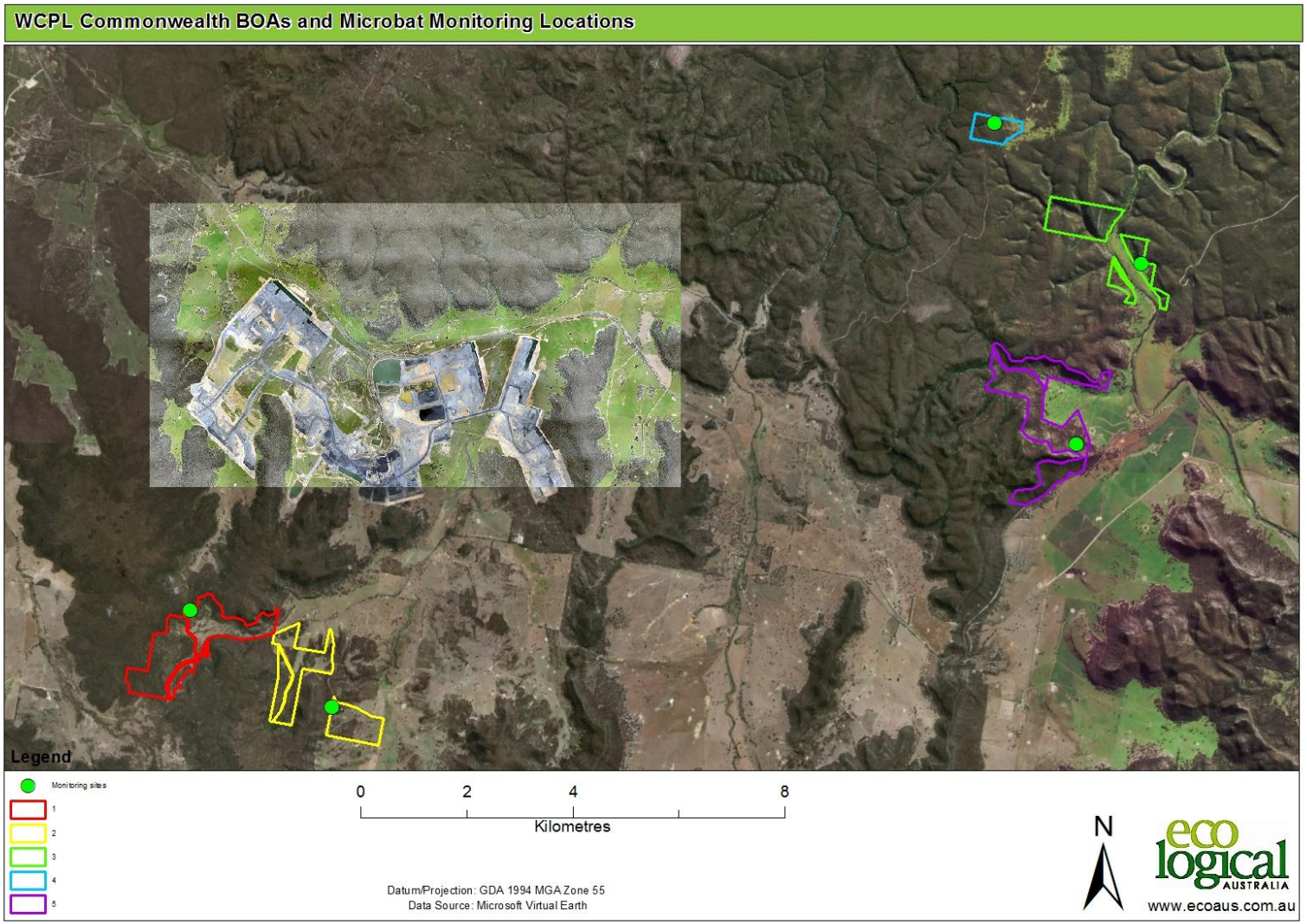
Appendix A - Microbat monitoring locations



Appendix B - Microbat call identification report

Microbat Call Identification Report

Client : Eco Logical Australia
Project Name: 9059 Wilpinjong Offset Monitoring
Report Date : 21 February 2018

Contents

1. Introduction

This report has been commissioned by Eco Logical Australia Pty Ltd to analyse bat echolocation call data collected from Wilpinjong Offsett Area, NSW. Data was provided electronically to Peter Knock, *Fauna Sonics* for 4 sites over consecutive nights on 13-14 December 2017. This report documents the methods involved in analysing bat call data and the results obtained only.

2. Methods

The identification of bat echolocation calls recorded during surveys was undertaken using AnalookW (Version 4.12N) software. The identification of calls was undertaken with reference to Pennay and others (2004) and Australian Bats (Churchill 2008). Also through the comparison of recorded reference calls from personal surveys and trapping and analysis of data from the Gunnedah and Narrabri basins. Reference calls were also obtained from the NSW database. Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

• Definite - Pass identified to species level and could not be confused with another species

• Probable - Pass identified to species level and there is a low chance of confusion with another species

• Possible - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species

• Species group - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality

• Unknown - Either background 'noise' files or passes by bats which are too short and/or of low quality to confidently identify.

Call sequences that were three pulses or less in length were not analysed and were assigned to 'short' and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar characteristics of plotted sonograms.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

Identification Notes:

- *Ozimop's* previously *Mormopterus* genus group have undergone taxonomic revision (Reardon, et al, 2014). The previously published reference calls for this groups of species (Pennay et al, 2004) are believed to contain significant errors (Greg Ford ELA review 2018). Consideration has been given to the overlap in call frequency and call profile characteristics and that being specific for these three common species (listed below) occurring in this region may not be possible. They will be labelled to the most likely species during identification but grouped in any table provided.

  - Ozimops ridei
  - O. petersi
  - O. planiceps
- Bats in the *Nyctophilus* genus are also considered difficult to differentiate to species level and are labelled as genus group only.
- Calls were attributed to Eastern Bent-winged Bat (44 – 48.5 kHz) by a down-sweeping tail, drop of more than 2 kHz in the pre-characteristic section, and the pulse shape and time between calls was variable.
- Calls of Little Forest Bat (42.5 – 48 kHz) potentially overlap with, Eastern Cave Bat (49 - 53.5 kHz) and Southern Forest bat (43.5 – 46 kHz) in this region and data set. Calls were attributed where there was a clear frequency separation and good quality call characteristics.
- Chocolate Wattled Bat can be difficult to separate in the range 48 – 53 kHz where they overlap with Vespedelus species. Calls were identified by a down-sweeping tail. Calls with an end frequency below 50 kHz were generally identified as Little Forest Bat. Eastern Cave Bat displayed an end frequency above 50 kHz. All other calls were assigned mixed species labels in frequency overlap zone.
- Gould's Wattled Bat was labelled at a frequency of 27.5 – 32.5 kHz with alternation in call frequency between pulses.
- Inland Broad-nosed Bat calls have a slope of greater than 200 OPS, are non-alternating and fall between 29 and 34 kHz. When no distinguishing characteristics were present calls were assigned to multi-species groups.
- Where call characteristics can't be fully discerned, species that overlap in frequency have been paired and only listed as possible occurrence.

3. Results

A total of 972 call sequences were recorded, of which 318 call sequences were able to be analysed (i.e. were not 'noise' files or bat calls of short length).

Site description data was limited to the following, "All sites were located in close proximity (20-100 m) to sandstone cliff-lines in mature woodland with hollows present." No detailed site descriptions were provided prior to completion of report.

A summary table of species, species and genus groups with corresponding confidence levels are displayed below. Nine species were definitely confirmed from data with a further four species listed as probable. Species and genus groupings are listed as possible only as a default level.

Species in bold are listed under NSW *Biodiversity Conservation Act 1995* (BC Act) or the Commonwealths *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Species detected from all sites with confidence level are listed below.

Scientific Name	**Common Name**	DEFINITE	PROBABLE	POSSIBLE
Austronomus australis	White-striped freetail Bat	x		
Chalinolobus dwyeri	**Large-eared Pied Bat**	x	x	x

Chalinolobus gouldii	Gould's Wattled Bat	x	x	
Chalinolobus morio	Chocolate Wattled bat	x	x	x
Chalinolobus morio / Miniopterus schreibersii oceanensis				x
Falsistrellus tasmaniensis	**Eastern False Pipistrelle**		x	
Falsistrellus tasmaniensis / Scotepens orion				x
Miniopterus schreibersii oceanensis	**Eastern Bentwing Bat**		x	x
Myotis macropus / Nyctophilus sp				x
Nyctophilus sp	Long-eared Bat	x		
Ozimops sp (old Mormopterus_sp2,3,4)	Ozimops group		x	x
Rhinolophus megaphyllus	Eastern Horseshoe Bat	x		
Saccolaimus flaviventris	**Yellow-bellied Sheathtail Bat**	x	x	
Scotorepens balstoni	Inland Broad-nosed Bat		x	
Vespadelus regulus	Southern Forest Bat	x	x	
Vespadelus troughtoni	**Eastern Cave Bat**		x	
Vespadelus vulturnus	Little Forest Bat	x	x	x
Vespadelus vulturnus / regulus	grouped Vespdelus			x
Vespadelus vulturnus / regulus	grouped Vespdelus			x
Vespadelus vulturnus / troughtoni	grouped Vespdelus			x
Vespadelus vulturnus / troughtoni	grouped Vespdelus			x

Table 1: Anabat results

Folder1	Night	Scientific Name	*Common Name*	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
SM3-3 (Offset Area 3)	13/12/2017	*Austronomus australis*	*White-striped freetail Bat*	1	1	0	0
	13/12/2017	*Chalinolobus dwyeri*	*Large-eared Pied Bat*	3	1	0	2
	13/12/2017	*Chalinolobus morio*	*Chocolate Wattled bat*	2	0	2	0
	13/12/2017	*Falsistrellus tasmaniensis / Scotepens orion*		2	2	0	0
	13/12/2017	*Miniopterus schreibersii oceanensis*	*Eastern Bentwing Bat*	18	0	2	16
	13/12/2017	*Ozimops sp (old Mormopterus_sp2,3,4)*	*Ozimops group*	10	0	10	0
	13/12/2017	*Rhinolophus megaphyllus*	*Eastern Horseshoe Bat*	5	5	0	0
	13/12/2017	*Vespadelus vulturnus*	*Little Forest Bat*	3	0	1	2
	13/12/2017	*Vespadelus troughtoni*	*Eastern Cave Bat*	1	0	1	0
	13/12/2017	short		71			
	13/12/2017	low		61			
		Total Id.éd		45			

		Total calls		177			
SM3-3 (Offset Area 3)	14/12/2017	*Austronomus australis*	*White-striped freetail Bat*	1	1	0	0
	14/12/2017	*Chalinolobus dwyeri*	*Large-eared Pied Bat*	4	0	4	0
	14/12/2017	*Chalinolobus gouldii*	*Gould's Wattled Bat*	1	0	1	0
	14/12/2017	*Chalinolobus morio*	*Chocolate Wattled bat*	1	0	1	0
	14/12/2017	*Falsistrellus tasmaniensis*	*Eastern False Pipistrelle*	1	0	1	0
	14/12/2017	*Miniopterus schreibersii oceanensis*	*Eastern Bentwing Bat*	8	0	1	7
	14/12/2017	*Ozimops sp (old Mormopterus_sp2,3,4)*	*Ozimops group*	14	0	11	3
	14/12/2017	*Rhinolophus megaphyllus*	*Eastern Horseshoe Bat*	4	4	0	0
	14/12/2017	*Vespadelus regulus*	*Southern Forest Bat*	2	0	2	0
	14/12/2017	*Vespadelus vulturnus*	*Little Forest Bat*	1	0	1	0
	14/12/2017	low		17			
	14/12/2017	Short		47			
		Total Id.éd		37			
		Total calls		101			
SYD AB01 (Offset Area 4)	13/12/2017	*Chalinolobus morio*	*Chocolate Wattled bat*	4	1	3	0
	13/12/2017	*Falsistrellus tasmaniensis*	*Eastern False Pipistrelle*	1	0	1	0
	13/12/2017	*Miniopterus schreibersii oceanensis*	*Eastern Bentwing Bat*	9	0	4	5
	13/12/2017	*Ozimops sp (old Mormopterus_sp2,3,4)*	*Ozimops group*	1	0	1	0
	13/12/2017	*Vespadelus regulus*	*Southern Forest Bat*	3	0	3	0
	13/12/2017	*Vespadelus troughtoni*	*Eastern Cave Bat*	2	0	2	0
	13/12/2017	*Vespadelus vulturnus*	*Little Forest Bat*	4	1	2	1
	13/12/2017	*Vespadelus vulturnus / troughtoni*	*grouped Vespdelus*	1	1	0	0
	13/12/2017	Low		38			
	13/12/2017	Short		20			
		Total Id.éd		25			
		Total calls		83			
SYD AB01 (Offset Area 4)	14/12/2017	*Chalinolobus gouldii*	*Gould's Wattled Bat*	1	1	0	0
	14/12/2017	*Miniopterus schreibersii oceanensis*	*Eastern Bentwing Bat*	7	0	5	2
	14/12/2017	*Chalinolobus morio / Miniopterus schreibersii oceanensis*		1	1	0	0

	14/12/2017	*Scotorepens balstoni*	*Inland Broad-nosed Bat*	1	0	1	0
	14/12/2017	*Vespadelus regulus*	*Southern Forest Bat*	6	0	6	0
	14/12/2017	*Vespadelus troughtoni*	*Eastern Cave Bat*	1	0	1	0
	14/12/2017	*Vespadelus vulturnus / regulus*	*grouped Vespdelus*	2	0	2	0
	14/12/2017	*Vespadelus vulturnus*	*Little Forest Bat*	2	0	2	0
	14/12/2017	Low		37			
	14/12/2017	Short		35			
		Total Id.éd		21			
		Total calls		93			
SYD SM3-1 (Offset Area 5)	13/12/2017	*Austronomus australis*	*White-striped freetail Bat*	1	1	0	0
	13/12/2017	*Chalinolobus dwyeri*	*Large-eared Pied Bat*	5	0	4	1
	13/12/2017	*Chalinolobus gouldii*	*Gould's Wattled Bat*	2	0	2	0
	13/12/2017	*Chalinolobus morio*	*Chocolate Wattled bat*	4	3	1	0
	13/12/2017	*Miniopterus schreibersii oceanensis*	*Eastern Bentwing Bat*	11	0	5	6
	13/12/2017	*Ozimops sp (old Mormopterus_sp2,3,4)*	*Ozimops group*	2	0	2	0
	13/12/2017	*Saccolaimus flaviventris*	*Yellow-bellied Sheathtail Bat*	3	0	3	0
	13/12/2017	*Vespadelus regulus*	*Southern Forest Bat*	10	2	8	0
	13/12/2017	*Vespadelus troughtoni*	*Eastern Cave Bat*	1	0	1	0
	13/12/2017	*Vespadelus vulturnus*	*Little Forest Bat*	11	3	7	1
	13/12/2017	*Vespadelus vulturnus / regulus*	*grouped Vespdelus*	2	0	2	0
	13/12/2017	low		45			
	13/12/2017	short		25			
		Total Id.éd		52			
		Total calls		122			
SYD SM3-1 (Offset Area 5)	14/12/2017	*Austronomus australis*	*White-striped freetail Bat*	1	1	0	0
	14/12/2017	*Chalinolobus dwyeri*	*Large-eared Pied Bat*	2	0	2	0
	14/12/2017	*Chalinolobus gouldii*	*Gould's Wattled Bat*	4	0	4	0
	14/12/2017	*Chalinolobus morio*	*Chocolate Wattled bat*	3	0	1	2
	14/12/2017	*Miniopterus schreibersii oceanensis*	*Eastern Bentwing Bat*	8	0	1	7
	14/12/2017	*Ozimops sp (old Mormopterus_sp2,3,4)*	*Ozimops group*	2	0	2	0
	14/12/2017	*Nyctophilus sp*	*Long-eared Bat*	1	1	0	0
	14/12/2017	*Rhinolophus megaphyllus*	*Eastern Horseshoe Bat*	1	1	0	0
	14/12/2017	*Saccolaimus flaviventris*	*Yellow-bellied Sheathtail Bat*	2	2	0	0
	14/12/2017	*Vespadelus regulus*	*Southern Forest Bat*	7	1	6	0

	14/12/2017	*Vespadelus vulturnus / troughtoni*	*grouped Vespdelus*	1	0	1	0
	14/12/2017	low		21			
	14/12/2017	short		32			
		Total Id.éd		32			
		Total calls		85			
SYD SM3-2 (Offset Area 1)	13/12/2017	*Austronomus australis*	*White-striped freetail Bat*	2	2	0	0
	13/12/2017	*Chalinolobus gouldii*	*Gould's Wattled Bat*	2	1	1	0
	13/12/2017	*Chalinolobus morio*	*Chocolate Wattled bat*	3	1	1	1
	13/12/2017	*Miniopterus schreibersii oceanensis*	*Eastern Bentwing Bat*	19	0	6	13
	13/12/2017	*Ozimops sp (old Mormopterus_sp2,3,4)*	*Ozimops group*	3	0	3	0
	13/12/2017	*Myotis macropus / Nyctophilus sp*		3	0	3	0
	13/12/2017	*Nyctophilus sp*	*Long-eared Bat*	6	6	0	0
	13/12/2017	*Rhinolophus megaphyllus*	*Eastern Horseshoe Bat*	1	1	0	0
	13/12/2017	*Vespadelus vulturnus*	*Little Forest Bat*	15	1	13	1
	13/12/2017	Low		53			
	13/12/2017	Short		50			
		Total Id.éd		54			
		Total calls		157			
SYD SM3-2 (Offset Area 1)	14/12/2017	*Austronomus australis*	*White-striped freetail Bat*	1	1	0	0
	14/12/2017	*Chalinolobus dwyeri*	*Large-eared Pied Bat*	1	0	1	0
	14/12/2017	*Chalinolobus gouldii*	*Gould's Wattled Bat*	5	1	4	0
	14/12/2017	*Chalinolobus morio*	*Chocolate Wattled bat*	6	2	4	0
	14/12/2017	*Miniopterus schreibersii oceanensis*	*Eastern Bentwing Bat*	7	0	4	3
	14/12/2017	*Ozimops sp (old Mormopterus_sp2,3,4)*	*Ozimops group*	1	0	1	0
	14/12/2017	*Nyctophilus sp*	*Long-eared Bat*	3	3	0	0
	14/12/2017	*Saccolaimus flaviventris*	*Yellow-bellied Sheathtail Bat*	1	0	1	0
	14/12/2017	*Scotorepens balstoni*	*Inland Broad-nosed Bat*	2	0	2	0
	14/12/2017	*Vespadelus vulturnus*	*Little Forest Bat*	25	2	20	3
	14/12/2017	Low		44			
	14/12/2017	short		58			
		Total Id.éd		52			
		Total calls		154			

4. Sample Calls

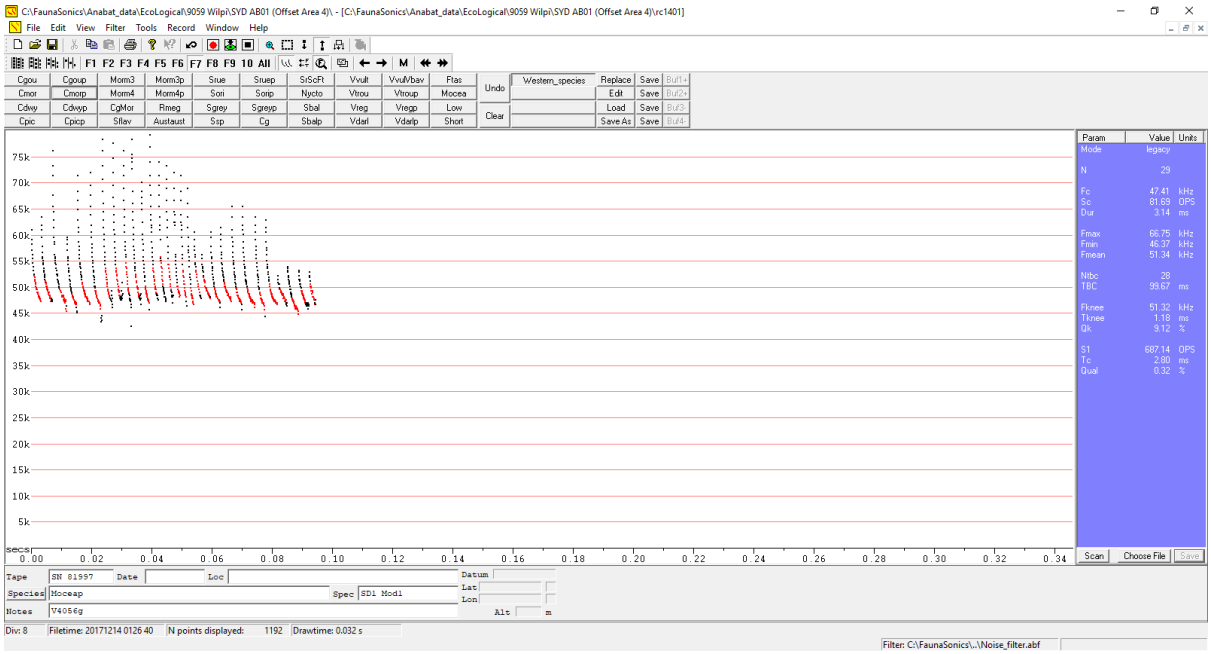


Figure 1: Call profile of Miniopterus schreibersii oceanensis (probable).

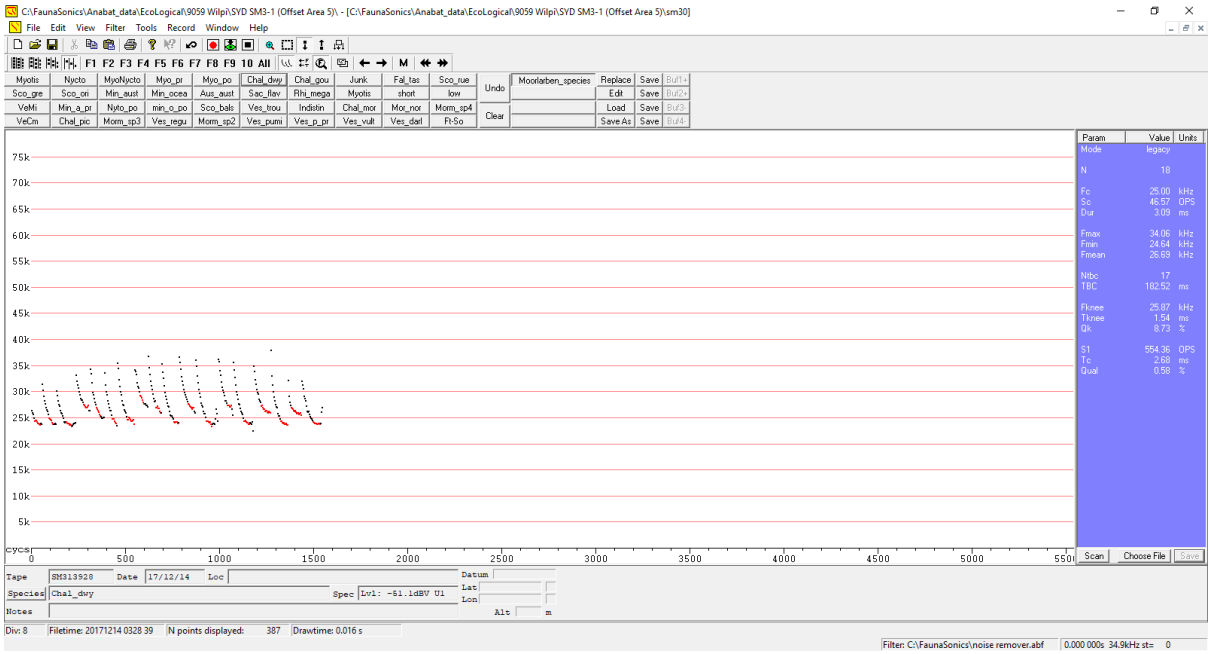


Figure 2: Call profile of Chalinolobus dwyeri.

Figure 3: Call profile of Rhinolophus megaphyllus.

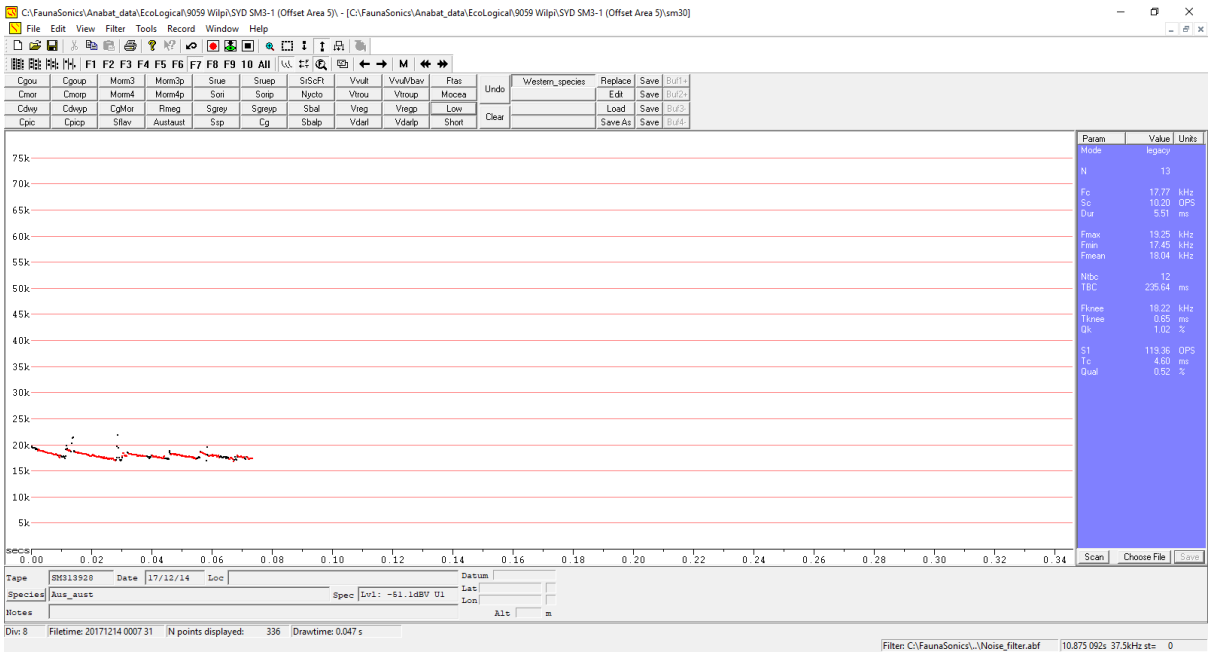


Figure 4: Call profile of Austronomus australis.

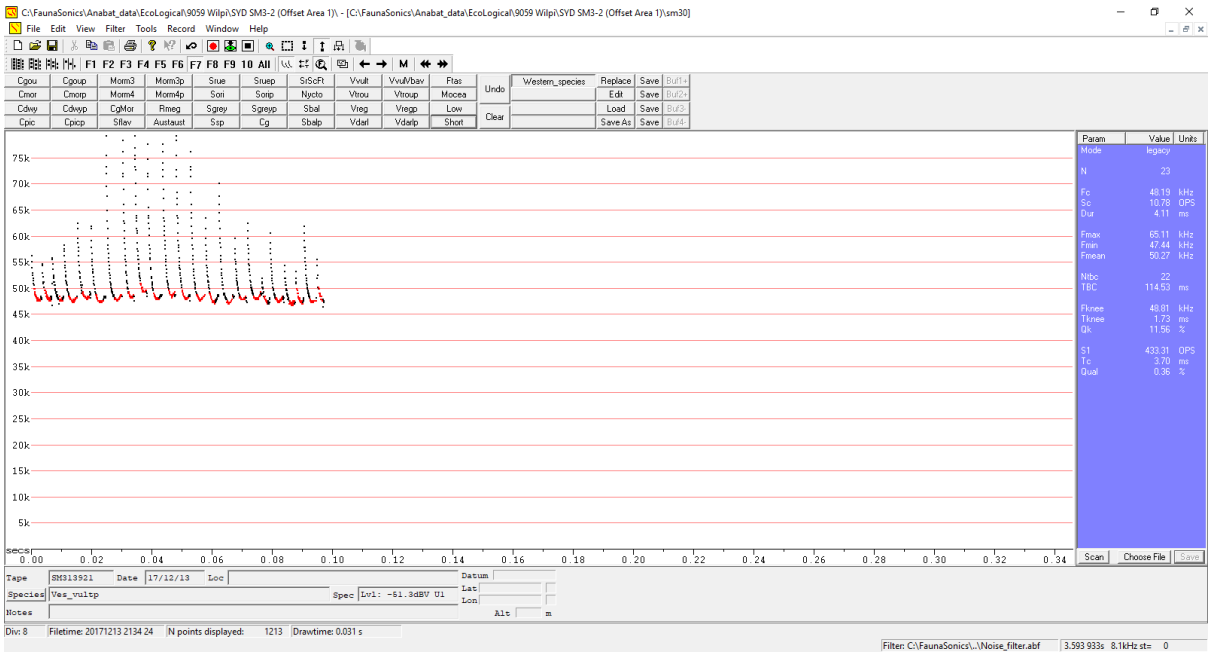


Figure 5: Call profile of Vespadelus vulturnus (probable).

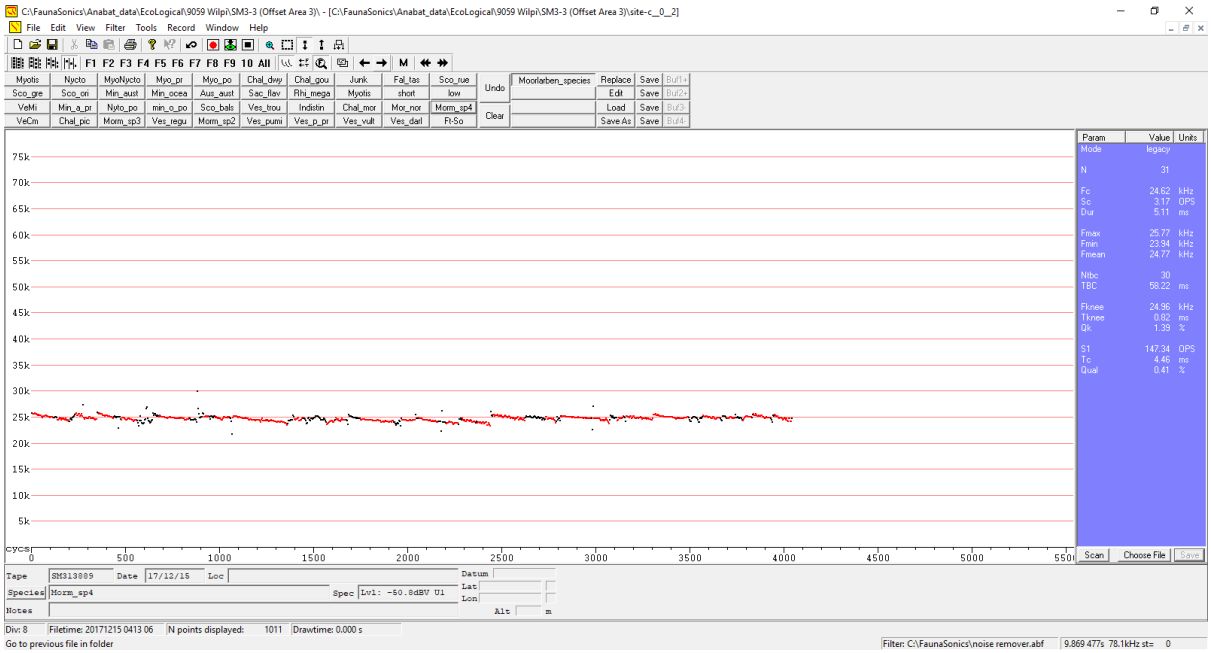


Figure 6: Call profile of Ozimops group (old Mormopterus sp 2, 3, & 4).

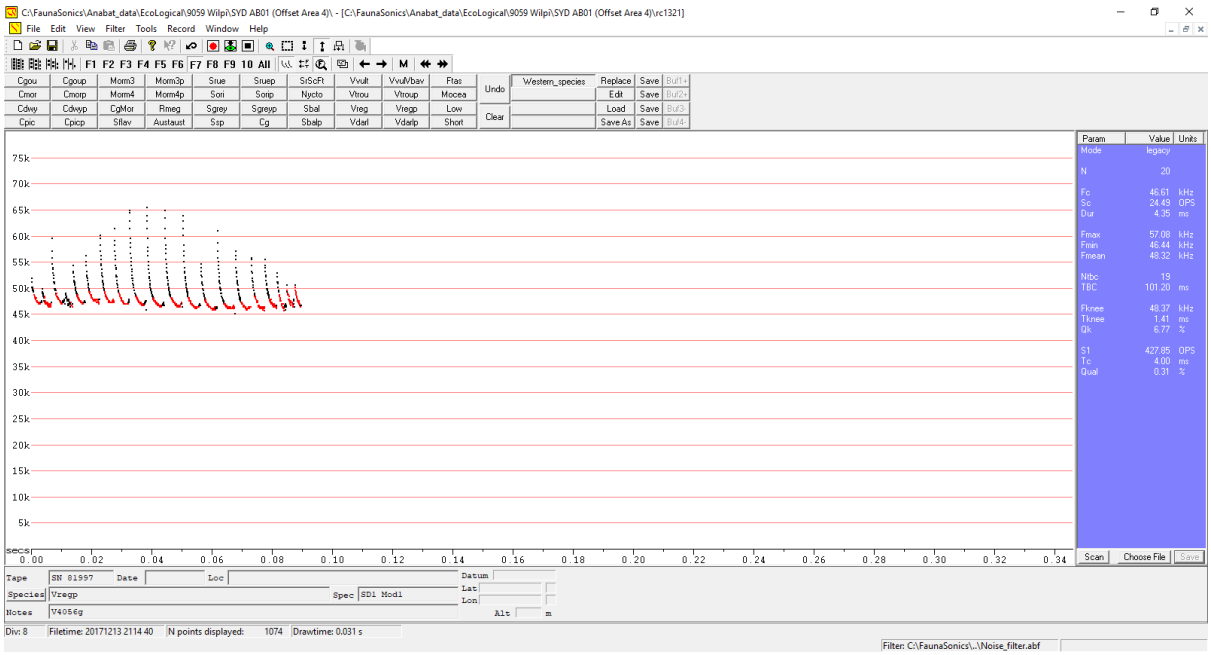


Figure 7: Call profile of Vespadelus regulus (probable).

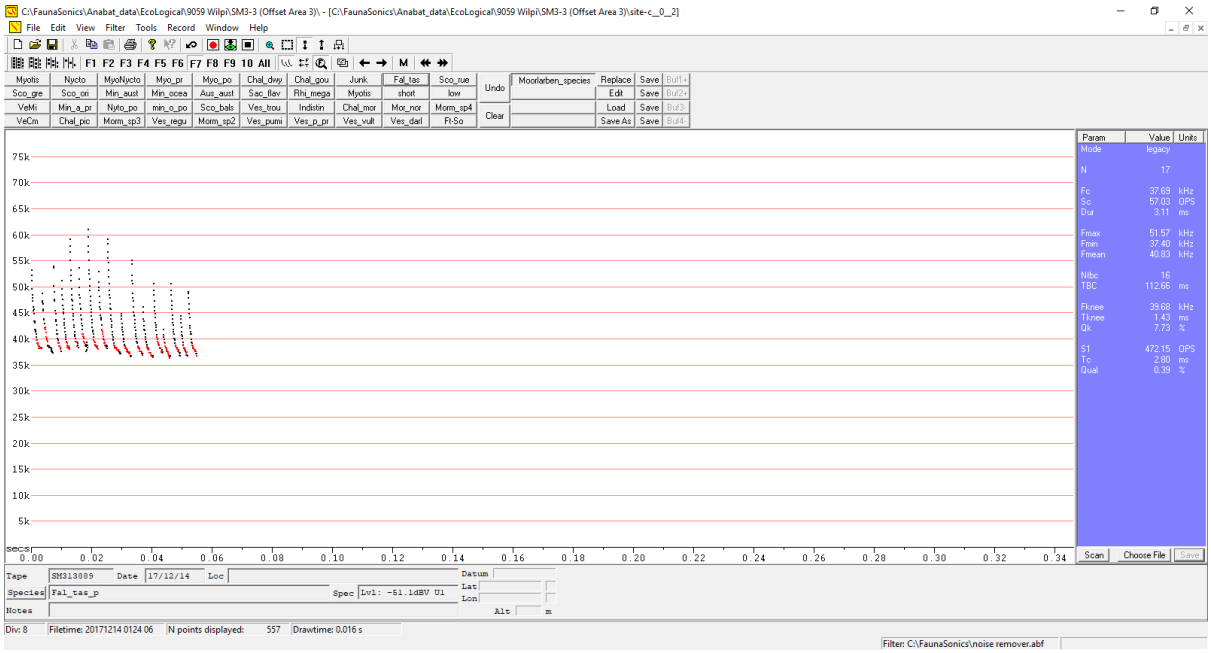


Figure 8: Call profile of Falsistrellus tasmaniensis (probable).

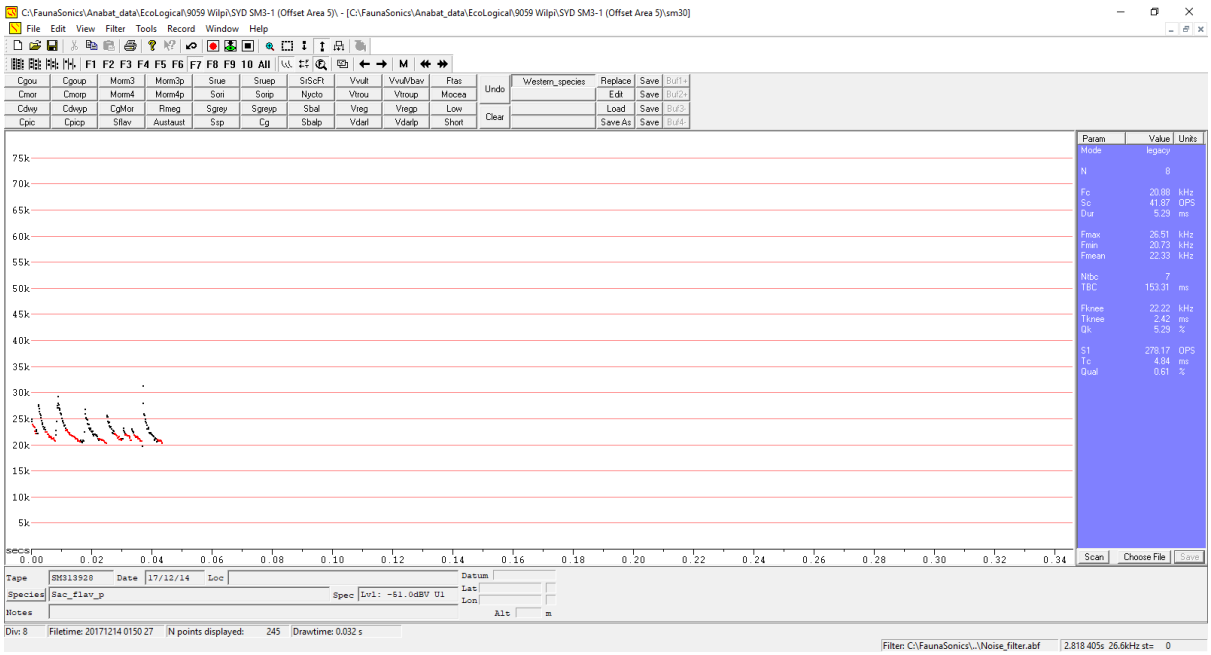


Figure 9: Call profile of Saccolaimus flaviventris (probable).

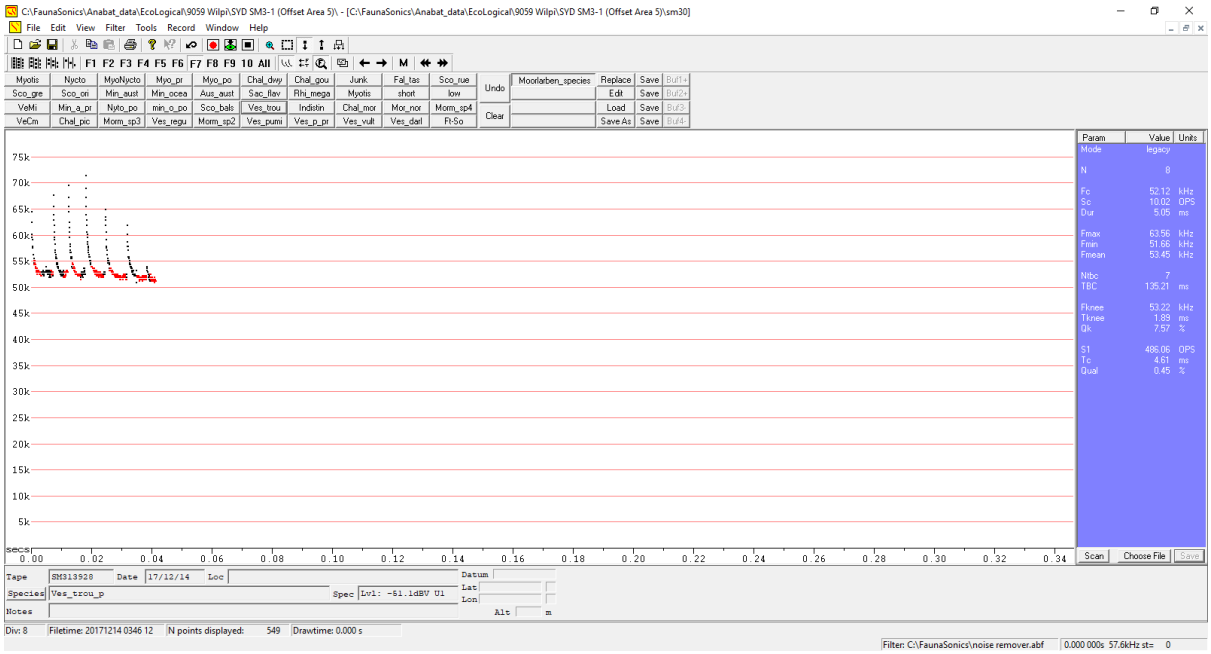


Figure 10: Call profile of Vespadelus troughtoni (probable).

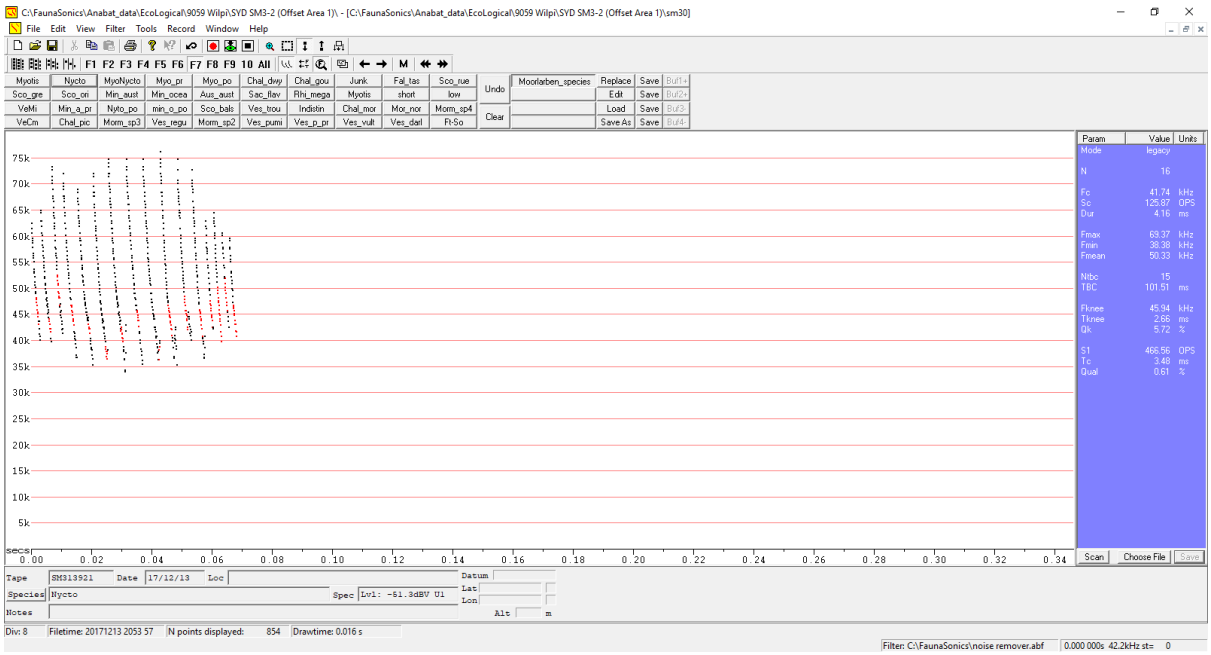


Figure 11: Call profile of Nyctophilus sp

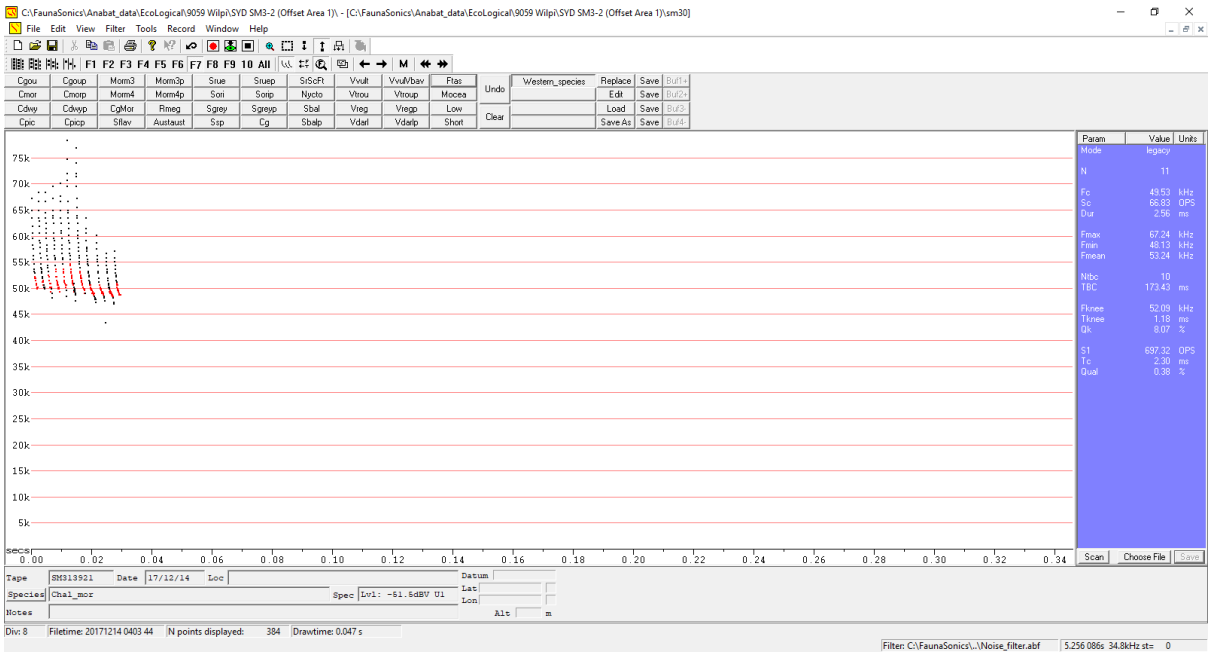


Figure 12: Call profile of Chalinolobus morio

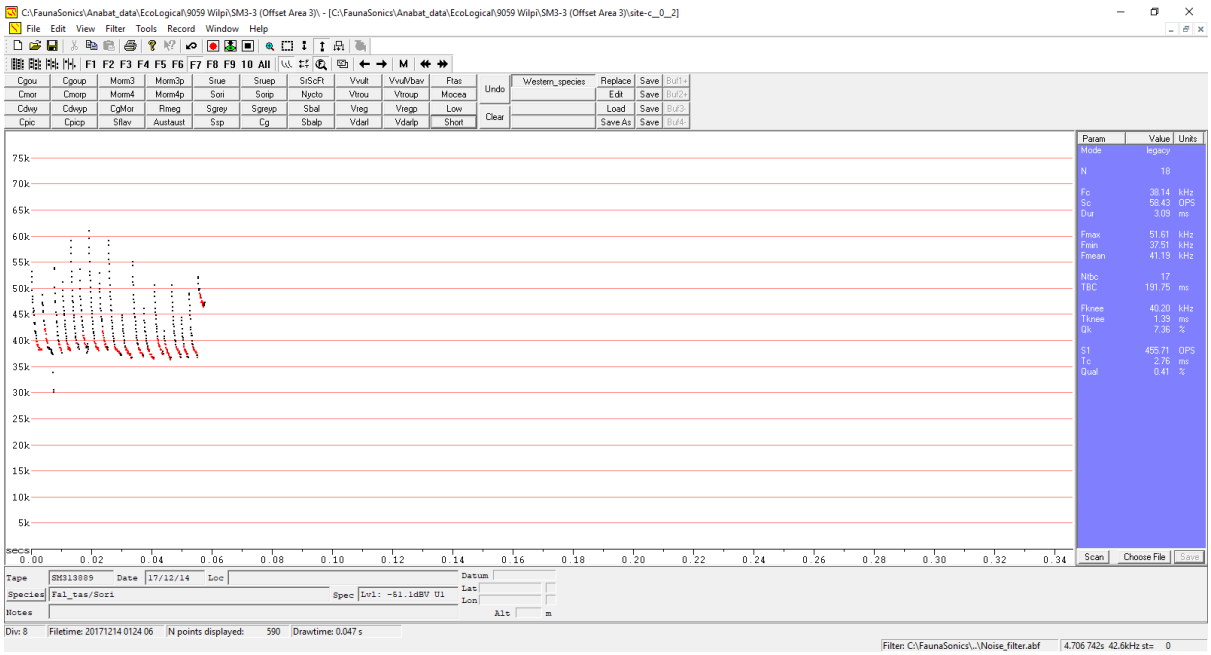


Figure 13: Call profile of Falsistrellus tasmaniensis / Scotepens orion.

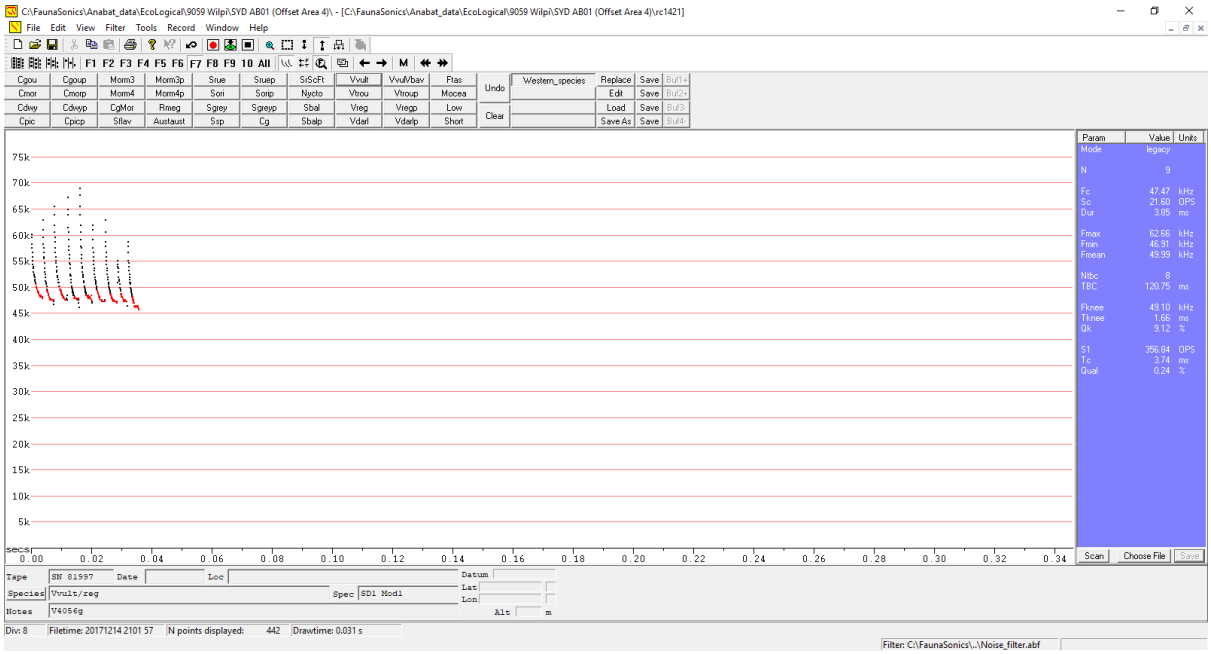


Figure 14: Call profile of Vespadelus vulturnus / regulus.

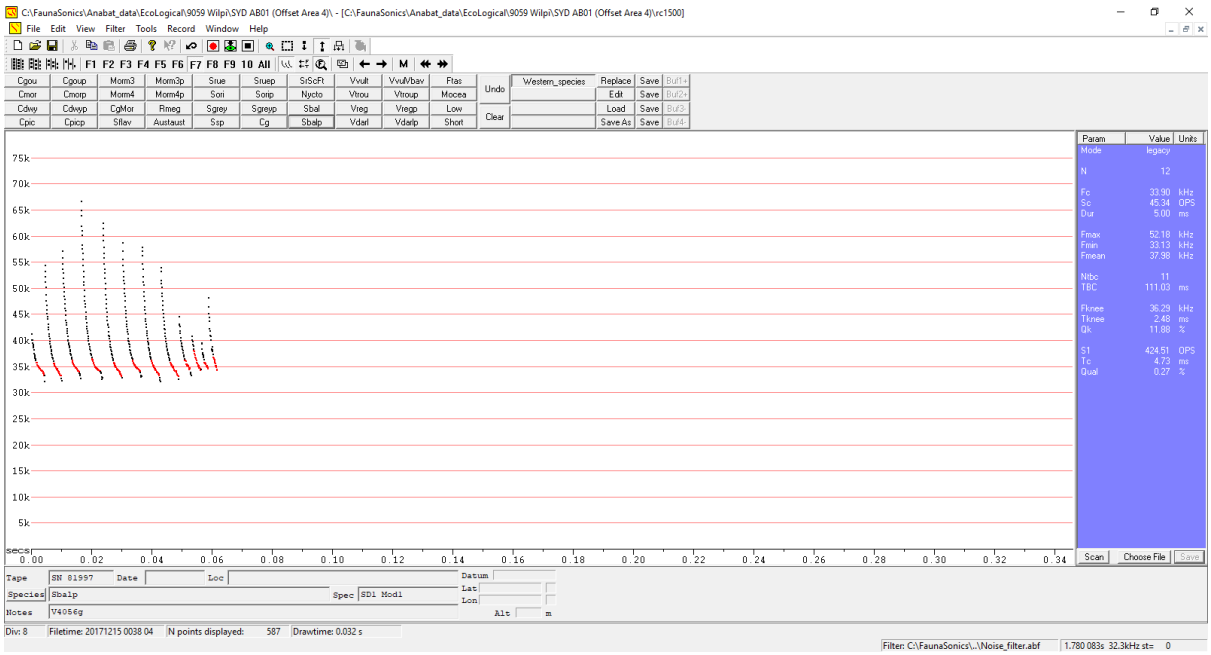


Figure 15: Call profile of Scotorepens balstoni (probable).

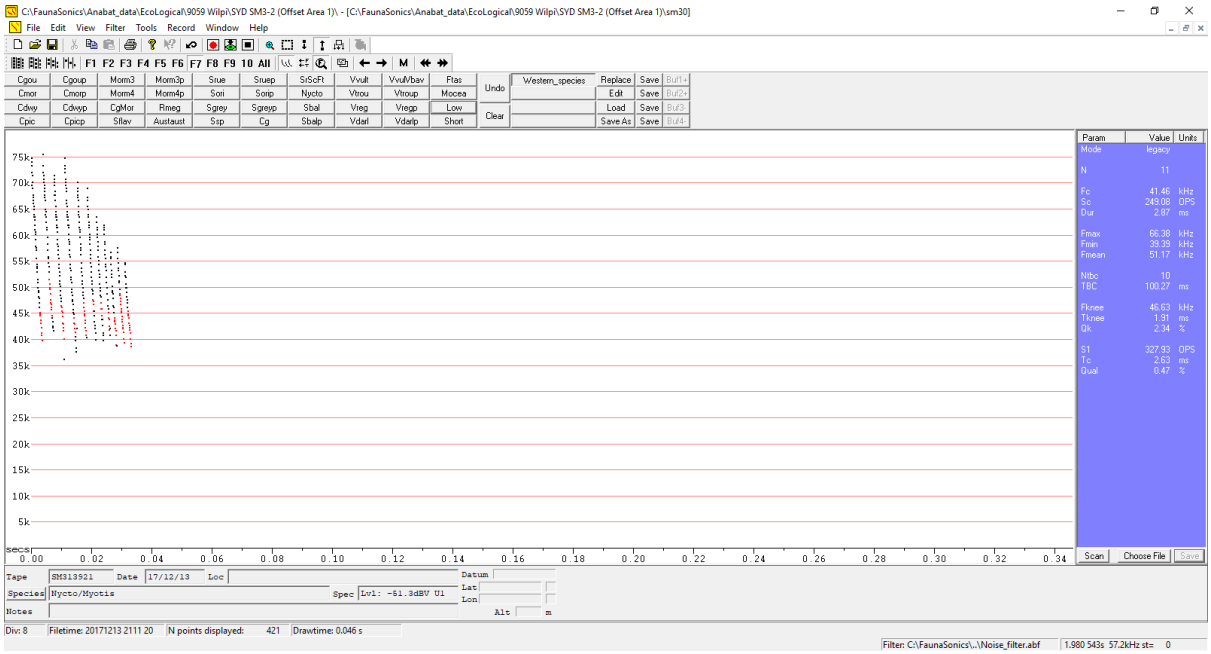


Figure 16: Call profile of mixed Myotis macropus / Nyctophilus sp call parameters.

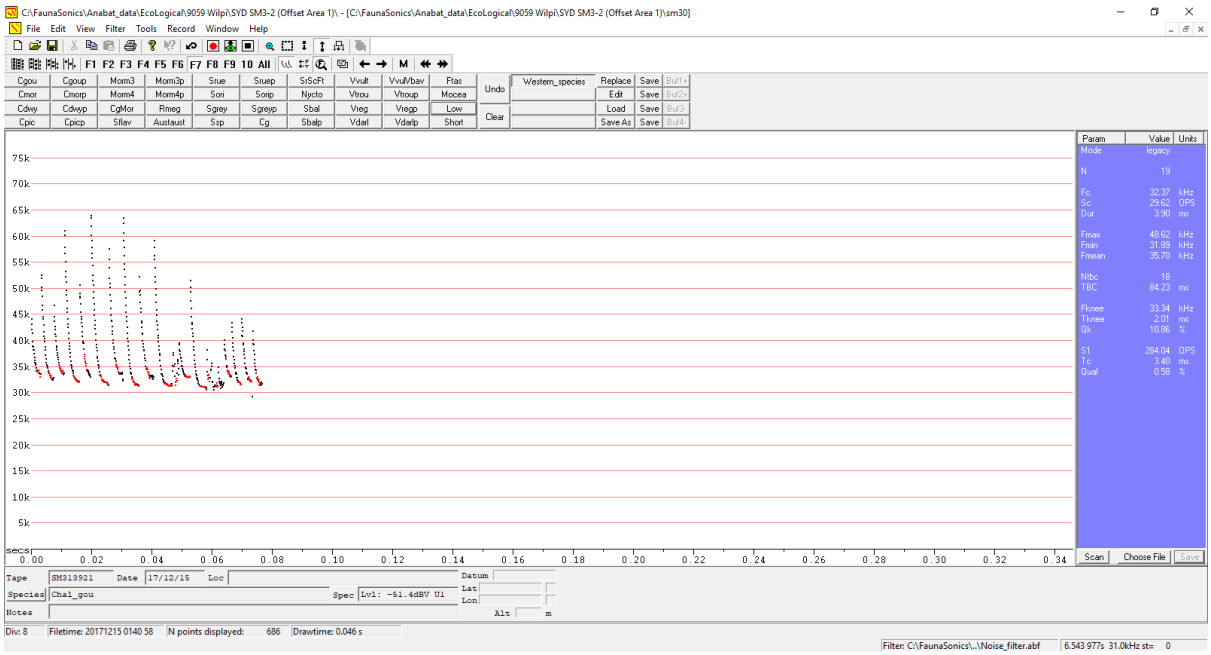


Figure 17: Call profile of Chalinolobus gouldii.

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12th January, 2018

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Results of a summer microbat survey of a disused oil shale mine adit, Slate Gully, Wilpinjong, New South Wales.

Dear Ian,

Following are the results of our survey of a disused oil shale mine adit at Slate Gully, Wilpinjong, New South Wales. Counts of bats exiting the adit were conducted from dusk on the evening of 12th December 2017 using hand held counters. Only twelve individuals were counted exiting the adit from dusk. From their flight pattern, most of the individuals exiting were Eastern Horseshoe Bats (*Rhinolophus megaphyllus*) although a couple of individuals of the Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) also appeared to be present. This is in stark contrast to the autumn and winter surveys of the adit when between 700 and 900 individuals of the Eastern Bent-wing Bat were present (Fly by Night 2017a&b). Harp trapping of the adit was undertaken on the evening of 13th December from dusk until 9.30pm. The only capture obtained was that of a male Eastern Horseshoe Bat.

Weather conditions during the survey are detailed in *Table 1*. Rainfall during the survey was recorded at Ulan Water (Station No. 62036, Lat: 32.28° S Long: 149.74° E, Elevation: 420 m).

Maximum and minimum temperatures during the survey were recorded at Merriwa (Station No. 61287, Lat: 32.19° S Long: 150.17° E, Elevation: 375 m).

Table 1
Weather conditions during the survey

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
11/12/2017	13.0	32.7	0
12/12/2017	15.2	34.1	0
13/12/2017	14.7	36.0	0

Weather was warm to hot with mild nights. No rain was experienced during the survey. Minimum temperatures varied from 13.0°C to 15.2°C while maximum temperatures varied from 32.7°C to 36.0°C.

In contrast to the surveys undertaken in autumn and winter 2017, only a small number of microbats were present within the disused oil shale mine at Slate Gully. The majority of the bats present were Eastern Horseshoe Bats (*Rhinolophus megaphyllus*). Females would be expected to be present at a maternity roost at the time of survey and would have given birth. The capture of a male and the low numbers present during the December 2017 survey indicate that breeding by this species is not undertaken within the workings. At the time of survey it is likely that mainly males are present although some non-breeding females may also use the working to roost during the summer months.

Eastern Bent-wing females that were present within the workings during the autumn and winter surveys have moved to breeding sites. These would be located at known maternity roosts within limestone karst systems or may be present in other disused mine workings (Hoye & Hall 2008). The recording of post lactating females as well as recently free-flying young in late February 2014 (BMS 2015) may indicate when females and their young return to the mine at Slate Gully. Monitoring of the adit by Ecological Australia (2016) did not record significant numbers of Eastern Bentwing Bats during October 2016. This suggests that most of the Eastern Bent-wings have left the workings by October but return prior to late February. Monitoring of the roost following works to stabilise the adit opening would be worthy of consideration to ensure it has no detrimental effects on microbat roosting within the workings. A survey in early April would allow comparison with results obtained during the April 2017 survey.

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Best wishes

Glenn Hoye and Andrew Lothian

2017 Weed Spraying