COMMONWEALTH APPROVALS EPBC 2013/6963 CONDITIONS COMPLIANCE TRACKING AND MANAGEMENT ANNUAL REPORT

Nambucca Heads to Urunga Pacific Highway Upgrade

DECEMBER 2013 – FEBRUARY 2015

Document control

File name	N2U EPBC conditions compliance_1409
Report name	Commonwealth approval EPBC 2013/6963 conditions compliance tracking and management
Revision number	6

Revision history

Revision	Date	Description	Approval
1	March 2014	1st Review	
2	June 2014	2nd Review	
3	September 2014	3rd Review	
4	October 2014	4th Review	
5	December 2014	5th Review	
6	February 2015	6th Review	

Contents

Glossary / Abbreviations

☐ *Acronyms used in this document*

Acronym	Definition
BEM	Benchmark Environmental Management
CEMP	Construction Environmental Management Plan
Clear Milkvine	Marsdenia longiloba
Cryptic Forest Twiner	Tylophora Woollsii
Ecos	Ecos Environmental Pty Ltd
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
NGOMP	Norton and Griffin Offset Management Plan
SAP	Sensitive Area Plan
SES	Sandpiper Ecological Surveys
TFOMP	Threatened Flora Offset Management Plan
TFMP	Threatened Flora Management Plan
TFOS	Threatened Flora Offset Strategy

1 Introduction

□ Purpose of this document

The purpose of this document is to facilitate demonstration by Roads and Maritime Services (Roads & Maritime) of satisfactory compliance with the Commonwealth approval conditions for the Nambucca Heads to Urunga Pacific Highway Upgrade project with particular reference to Condition 25. The report covers the first period from December 2013 to February 2015.

For each condition, one or more actions are identified which, once implemented, will achieve satisfactory compliance with the condition. Where appropriate, the timing for completion of individual actions is identified.

For each action, the minimum relevant documentation to support demonstration of compliance is identified. This documentation would inform any future compliance audit.

Where an approval condition makes reference to information being provided to the Commonwealth Minister for the Environment, the associated action(s) assumes that this information will be provided, in the first instance, to the Commonwealth Department of the Environment.

□ Key dates

The timing for compliance with certain approval conditions is linked to specific dates as follows:

- Commonwealth approval: 26 Nov 2013
- Start of construction: 4 Dec 2013
- Scheduled completion of construction: 3 Dec 2016
- Expiry of Commonwealth approval 1 Jan 2031

□ Responsibility for compliance

Responsibility for compliance with all approval conditions sits with Roads & Maritime.

□ NSW planning approval

Condition 29 (of the Commonwealth approval) provides for the use of plans, strategies or reports required under the NSW approval to satisfy the requirements of the Commonwealth approval, subject to provision of a separate document demonstrating how the document addresses the relevant Commonwealth approval requirements.

Specialists in the fields of flora and fauna have been engaged by Roads & Maritime and the construction contractor to undertake various ecology-related management activities with regard to complying with the NSW planning approval and the CEMP. The following specialist had been engaged to undertake ecology related activities prior to the EPBC approval:

- Benchmark Environmental Management (BEM) has prepared an ecological monitoring program that addresses relevant matters in the NSW planning approval. The ecological monitoring program has been incorporated into the CEMP for the contractor to implement during construction.

- Ecos Environmental (Ecos) has been engaged by Roads and Maritime to prepare and Threatened Flora Translocation Program that addresses relevant matters in the NSW planning approval and has additionally been engaged by the contractor to provide advice on the implementation of the translocation program and provide specialist advice on flora to implement other CEMP requirements.
- Sandpiper Ecological Surveys (SES) has been engaged by the contractor to provide specialist advice on fauna to implement CEMP requirements

This document contains actions relevant to compliance with the NSW planning approval that are also considered to satisfy compliance with Commonwealth approval requirements.

□ Definitions for action status conditions

TBA	To Be Arranged - Further works required prior to starting action.
In progress	Action initiated but not yet complete.
Ongoing	Action in place but ongoing works required to ensure compliance.
Complete	Action completed.

□ Non Compliances with EPBC Conditions

There was one noncompliance with the EPBC approval for the period. Approval Condition number 8 requires the implementation of measures to relocate and / or ensure the appropriate care of individuals of EPBC species that are identified during searches. The Nambucca Heads to Urunga project developed a Koala Capture and Relocation Strategy to detail a methodology for capturing and relocating koalas identified during pre-clearing searches.

On the morning of 16-6-2014 a koala was captured and relocated following identification during the pre-clearing survey, the relocation receival site was located within state forest land outside of the project boundary approximately 500m from where the animal was captured. The animal was recorded as being healthy and the relocation process went smoothly with limited stress to the animal. However, the relocation receival site was contrary to the Koala Capture and Relocation Strategy which states that captured individuals are to be relocated within the project boundary and within 200m of the point of capture.

The relocation was undertaken following the advice of the Project Ecologist who considered previous sightings of the koala to estimate the home range and used knowledge of the local area to identify an ideal patch of koala feed trees within the estimated home range as being the most suitable receival site. Irrespective of ecologist advice, the relocation method was not strictly in accordance with the approved strategy and a noncompliance was identified.

The NSW EPA Senior Threatened Species Officer was notified of the relocation and noncompliance with the strategy on the morning of the event and whilst he respects the decision of the Project Ecologist, has identified the need to update the strategy to allow the relocation of koalas outside of the project boundary when within the animals home range. The strategy has been updated to reflect the comments of the NSW EPA Threatened Species Officer.

Condition 1

The person taking the action must not clear more than:

a) 171 ha of Koala habitat;

b) 184 ha of Grey-headed Flying-fox habitat;

c) 166 ha of Spotted-tail Quoll habitat;

d) 73 ha of habitat for the Swift Parrot and Regent Honeyeater; and

e) 36 ha of habitat for the Cryptic Forest Twiner and Clear Milkvine.

Action		Timing	Status	Compliance evidence
1.1	Progressive review of area cleared	Regularly during construction	In progress	Record of clearing numbers
1.2	Review outstanding clearing requirements at 75% clearing to confirm clearing limitation targets will be met	Construction (75% clearing)	Complete	Memo provided 18-6-2014
1.3	Confirm clearing limitation targets have been met	Post-construction	TBA	As built survey of actual clearing area. Not able to action until after completion of clearing. Memo/short report

February 2015 Design Clearing Quantities (EN1 FDD + Additions)

Habitat Type	Design Quantity (ha)	Limit (ha) as per Condition 1 Approval	Current Difference showing remaining habitat (ha) under Condition 1 Approval
Koala	157.89	171	13.11
Grey-headed Flying-fox	170.89	184	13.11
Spotted –tail Quoll habitat	71.63	166	94.37
Swift Parrot and Regent Honeyeater	71.63	73	1.37
Cryptic Forest Twiner and Clear Milkvine	34.08	36	1.92

Mainline clearing was completed during 2014. There is potential for minor ongoing clearing associated with ancillary works to be undertaken till the completion of the project.

Condition 2

Within 30 days of the completion of *construction* works, the person taking action must:

a) notify *the Minister* in writing of the completion of *construction*; and

b) provide a report (supported by appropriate mapping) that clearly shows the location of all vegetation and *EPBC species* habitat cleared as a result of *the action*, and that demonstrates compliance with Condition 1.

Action		Timing	Status	Compliance evidence
2.1	Prepare works as executed Environmental and Clearing Plans to show extent of clearing.	2 Jan 2017	TBA	Report & supporting mapping
2.2	Calculate final clearing quantity and include in summary table.	2 Jan 2017	TBA	Report & supporting mapping
2.3	Provide written notification (letter) of completion of construction and report to Dept of the Environment	2 Jan 2017	TBA	Notification letter Completed document transmittal form or equivalent

Condition 3

The *person taking the action* must undertake progressive rehabilitation of *EPBC species' habitat* in areas where *temporary infrastructure* is to occur or, where *short term* impacts are anticipated. Where appropriate, the landscaping / rehabilitation of these areas must be done in a manner that targets the needs and requirements of *EPBC species*.

Action		Timing	Status	Compliance evidence
3.1	Finalise urban design and landscape plan to capture rehabilitation and revegetation temporary works and areas of short term impact.	Pre-construction or prior to any works in EPBC species habitat areas during construction	Approved Feb 2015	Urban Design and Landscape Plan
3.2	Implement rehabilitation / landscaping of affected areas as per landscape design.	Following cessation of use of affected areas	Ongoing	Annual reporting. To date 61% of batters within the alignment have been treated with a hydro mulch cover crop.

Note: Urban Design Landscape Plan was approved by NSW Department of Planning (DoP) in February 2015.

Condition 4

At completion of construction (and every three years thereafter for the life of this approval or until *the Minister* has agreed in writing that further revisions are no longer required) a progress report assessing the effectiveness of restoring habitat on site (in accordance with Condition 3) must be provided to *the Minister*.

Action		Timing	Status	Compliance evidence
4.1	Submit progress report 1 to Dept of the Environment	3 Dec 2016	TBA	Completed document transmittal form or equivalent
4.2	Submit progress report 2 to Dept of the Environment	3 Dec 2019	TBA	Completed document transmittal form or equivalent
4.3	Submit progress report 3 to Dept of the Environment	3 Dec 2022	TBA	Completed document transmittal form or equivalent
4.4	Submit progress report 4 to Dept of the Environment	3 Dec 2025	TBA	Completed document transmittal form or equivalent
4.5	Submit progress report 5 to Dept of the Environment	3 Dec 2028	TBA	Completed document transmittal form or equivalent

Condition 5

Prior to *commencement of the action* the person taking the action must engage a *suitably qualified expert* to:

a) map any areas of habitat for EPBC species that lie adjacent to the construction zone;

b) map the locations of known individuals of Clear Milkvine and Cryptic Forest Twiner that lie adjacent to the construction zone;

c) map any areas of lowland rainforest of subtropical Australia that lie adjacent to the construction zone; and

d) clearly mark exclusion zones along (or around) these areas on site.

Action		Timing	Status	Compliance evidence
5.1	Engage suitably qualified expert	Prior to start of construction	Complete	Ecos Environmental mapped vegetation and habitat types with information included in SAPs.
5.2	SAPs to show required items	Prior to construction in affected areas	Complete	SAPs drafted prior to start of construction. SAPs – amended as required with any updated information
5.3	Exclusion zones to be marked on site as appropriate	Prior to construction in affected areas	Complete	Exclusion zone delineation installed prior to construction in affected areas and maintained as required. Ongoing compliance documented through surveillance checklist.
5.4	SAPs Updated	Construction	Ongoing (last revised October 2014)	SAPs updated following new information or removal of sensitive area. Tracked through updated revision of the SAPs.

Condition 6

To mitigate and reduce indirect impacts on the *exclusion zones* identified as a requirement of Condition 5, the *person taking the action* must:

a) ensure that temporary and high visibility fencing will be erected to restrict access to *exclusion zones*. Temporary fencing must be of a design appropriate to deter the passage of vehicles or placement of construction materials, equipment and waste, in *exclusion zones* where accidental incursion could reasonably occur;

b) implement measures to prevent the spread or establishment of new or additional weed species, soil or plant pathogens into these *exclusion zones* as a result of *construction*;

c) implement stormwater management measures to prevent the unintentional diversion or discharge of stormwater during both construction and operation over *exclusion zones*; and

d) implement targeted measures for managing construction impacts to *Cryptic Forest Twiner and Clear Milkvine* associated with dust, sedimentation and erosion.

Action		Timing	Status	Compliance evidence
6.1	Implement protection measures:			
	(a) Fencing of exclusion zones	During construction	Complete	Exclusions zones installed prior to clearing. Exclusion delineation to be maintained until construction completion. Environmental surveillance checklist documenting compliance.
	(b) Prevent spread of weeds, soil or pathogens	During construction	Ongoing	CEMP measures include implementation of Roads and Maritime best practice measures detailed in the biodiversity guidelines. Including plant wash down prior to entry onto site and separation and segregation of weed infested topsoil. Environmental surveillance checklist documenting compliance. The November 2014 EPBC Checklist is attached in Attachment 6 for reference.

	(c) Stormwater measures to prevent discharge of stormwater during construction and operation over exclusion zones	Detailed design and during construction	Ongoing	Detailed design includes the retention and treatment of road runoff adjacent to sensitive areas. CEMP measures include implementation of best practice erosion and sediment controls during construction. Environmental surveillance checklist documenting compliance
	(d) Implement target measures to manage construction impacts to threatened flora.	During construction	Ongoing	Directly and indirectly impacted threatened flora removed from site through implementation of Threatened Flora Management Plan. CEMP includes best practice measures to manage dust and erosion and sedimentation impacts. Environmental surveillance checklist documenting compliance. Progressive revegetation to be undertaken to provide dense ground cover that excludes weeds. Revegetation checklists maintained monthly.
6.2	Monitor In-situ Roadside Threatened Flora	Every 6 months for the first two years and then yearly for 5 years.	Ongoing (Refer to Attachment 1 for Year one Summary Report)	Summary of roadside threatened plant monitoring prepared and included in the annual translocation monitoring report (Attachment 1)

In Situ road side threatened flora monitoring was completed at six monthly intervals (July and December 2014) as required by ECOS Environmental. A summary of ECOS findings are provided below

- Spider Orchid plants remaining in-situ within 20 metres of the edge of clearing/construction were monitored. A total of 56 in-situ plants were tagged and monitored. Two individuals of Spider Orchid declined in condition between July and December 2014. It was noted that these minor changes were probably related to the natural dynamics of the population; there was no obvious evidence to indicate that the decline in the two individuals was due to clearing and highway construction.
- Eight in-situ Slender Marsdenia within 10 metres of the edge of clearing/construction were monitored. In December 2014, all individuals had leaves and appeared to be healthy and in similar condition to when recorded in July 2014.

Condition 7

The *person taking the action* must engage a *suitably qualified expert* to undertake pre-clearing fauna searches within all areas proposed for disturbance, including: hollow bearing trees, logs, existing culverts and bridges, no earlier than 48 hours prior to the removal of vegetation occurring in that area to ensure that the area is free of the *Koala* and *Spotted-tail Quoll*.

Action		Timing	Status	Compliance evidence
7.1	Engage suitably qualified expert	Prior to start of construction	Complete	Sandpiper Ecological Surveys engaged by contractor in accordance with SWTC Appendix 5. (Refer to Attachment 4 Clearing Report)
7.2	Pre-clearing fauna searches identified as activity in fauna management plan (or equivalent)	Prior to start of construction	Complete	BEM Ecological Monitoring Program
7.3	Undertake pre-clearing fauna searches as required	Prior to start of construction in specified areas	Ongoing	Environmental surveillance checklist.

Notes:

- The Clearing report prepared by SES is currently in draft format to allow for the provision of further clearing that may be completed (See Attachment 4). SES concluded that mortality rates for fauna during clearing to date were comparable to several other studies including recent Pacific Highway Upgrade Projects. Survey methods applied during this project included, pre-clear inspections (active search), spotlight surveys (including wetland frog surveys), targeted ground trapping and stag watching and inspection of HBT Targeted ground trapping and stag watching and inspection of HBT. These methods resulted in the capture and relocation of 480 individuals from 54 species. Survey effort was substantial with a total of 719 habitat trees inspected, 350 pre-clear surveys and 310 spotlight surveys completed.
- Sections 2.1 and 3.2 of the ecological monitoring program prepared by BEM addresses undertaking pre-clearing fauna searches and fauna relocation.
- Section 5 of the ecological monitoring program prepared by BEM addresses reporting.

Condition 8

The *person taking the action* must implement measures to relocate and/or ensure the appropriate care of individuals of *EPBC species* that are identified during searches referred to in condition 7.

Action		Timing	Status	Compliance evidence
8.1	Provide for appropriate fauna relocation measures in CEMP documentation	Prior to construction	Complete	Fauna rescue procedure contained with the FFMP. A specific koala relocation strategy has been prepared and forms an attachment to the Clear and Grubbing Environmental Work Method Statement.
8.2	Relocate affected fauna as per procedures in ecological monitoring program	As part of pre-clearing activities	Ongoing	Environmental surveillance checklist.

Note:

- CEMP contains fauna rescue procedure and a specific koala relocation strategy was developed by SES in consultation with NSW EPA Senior Threatened Species Officer.
- On the morning of 16-6-2014 a koala was captured and relocated following identification during the pre-clearing survey, the relocation receival site was located within state forest land outside of the project boundary approximately 500m from where the animal was captured. The animal was recoded as being healthy and the relocation process went smoothly with limited stress to the animal. However, the relocation receival site was contrary to the Koala Capture and Relocation Strategy which states that captured individuals are to be relocated within the project boundary and within 200m of the point of capture. This was captured in a non-conformance report and the strategy updated in consultation with the NSW EPA Senior Threatened Species Officer. The updated strategy has been incorporated into the Flora and Fauna Management Plan.
- A long-nosed potoroo (Potorous tridactylus) ~50m to the west of the underpass at Ch:73800 was sighted in October 2013 as part of fauna monitoring for the project. Brian Tolhurst (Biodiversity Officer) from the EPA was notified in accordance with the FFMP.
- Koala road kills occurred on 22-8-2014 and 10-9-2014 (refer to condition 12). Additional mitigation measures undertaken across the project following risk assessment and consultation with EPA and OEH. Mitigation measures applied at identified high risk areas at Waterfall Way and Ballard's Rd include breaks in concrete barriers with drop down structures and temporary fauna fence to match concrete barriers and tie barrier into natural landforms and existing structures to provide effective exclusion. Further, Variable Message

Board Signage has been deployed to warn motorists to be on the lookout for Koalas.

Condition 9

Prior to *commencement of the action* the *person taking the action* must engage a *suitably qualified expert* to collect baseline data on *local populations* of the *Koala* and *Spotted-tail Quoll*. The data must address the likely densities and distribution of these species within all habitat *adjacent to* the *construction* footprint that are likely to contain these species and that are likely to be adversely impacted by *the action* (as determined by a *suitably qualified expert*).

Action		Timing	Status	Compliance evidence
9.1	Engage suitably qualified expert	Prior to start of construction	Complete	Roads & Maritime engagement of BEM.
9.2	Review existing baseline data and assess adequacy with regard to specified matters for management of impacts on identified fauna species	Prior to completion of clearing.	Complete	Short report or equivalent documenting review outcomes and any identified information gaps
9.3	Where substantive information gaps are identified, develop strategy to obtain required information	Prior to construction activity in adjacent to areas containing potential habitat for either of the two species	Complete (see Attachment 8)	Short report or equivalent documenting methodology used for monitoring, results of monitoring and compiling the new results with existing information.

Note:

- BEM provided the report in August 2014 that consolidates actions 9.2 and 9.3. The report concluded that the local koala population in the vicinity of the Project corridor is is of low density. Consequently, the available information is insufficient to determine an accurate estimate of the koala population. However, assuming there is a low density of koalas in the locality, the Project corridor appears to traverse only a small number of home ranges of individual koalas. The project design incorporates a combination of fauna exclusion fencing and fauna underpass structures within 500 metres of each sample site where koala activity was recorded. The Project is expected to have minimal impact on the viability of the local koala population by preventing direct mortalities during vegetation clearing and operation and by maintaining opportunities for safe koala movement across the Project corridor once operational.

- In reference to Spotted Tail Quolls, no quolls were identified during the study. This is not definitive evidence that the species does not occur in the study area. Whether there is a resident population is uncertain but the distribution of records and presence of recent (2010) records are sufficient to conclude that quolls utilise the study area. Quolls are predicted to occur at low densities

and with heightened awareness records may be obtained during construction or in the operational phase. Given the predicted occurrence of quolls the implementation of specific measures, such as underpasses and fauna fencing is warranted to enable quolls to effectively cross the upgraded highway.

Condition 10

The *person taking the action* must construct and maintain *fauna crossings* and fencing in areas that are likely to benefit the Koala and *Spotted-tail Quoll*.

Action		Timing	Status	Compliance evidence
10.1	Provide for fauna crossings and fencing in detailed design	During design	In progress	Final design showing required fauna crossings and fencing. Attachment 7 provides summary update on fauna crossing requirements.
10.2	Construct fauna crossings and fencing	Construction	In progress	Attachment 7 provides summary update on fauna crossing requirements.
10.3	Undertake regular maintenance of fauna crossings and fencing	Post-construction	TBA	Annual reporting and/or maintenance inspection reports

Note:

- Installation of fauna fence will follow completion of baseline monitoring for fauna crossing structures in accordance with the Ecological Monitoring Program. Expect construction of fauna fencing to be initiated in the middle of 2015

- All combined /dedicated fauna crossing have been completed and installation works have now commenced on vertical and horizontal refuge poles that offer connection from the mitigation structures to the adjacent native vegetation.

Condition 11

The *person taking the action* must engage a *suitably qualified expert* to advise on the design and location of *fauna crossings*, fencing and road medians, for the purpose of maintaining habitat connectivity and facilitating the safe passage of the *Koala* and *Spotted-tail Quoll* across the Pacific Highway.

A *suitably qualified expert* must also be engaged to design a comprehensive monitoring program that tests the *long term success* of these measures.

Action		Timing	Status	Compliance evidence
11.1	Design development in consultation with NSW EPA Biodiversity Specialist	During design	Complete	Environmental Design Fauna Crossing Refinements report approved by NSW DP&I.
11.2	Engage suitably qualified expert to design monitoring program	Prior to start of construction	Complete	Roads and Maritime engagement of BEM
11.3	Prepare monitoring program	Prior to start of construction	Complete	BEM Ecological Monitoring Program

Note:

- Monitoring addressed via Section 3.5 of BEM ecological monitoring program.
- The Before-After Control Versus Impact (BACI) design of the monitoring program requires the monitoring of the fauna crossings prior to the installation of the fauna fence (i.e. before the underpass structures become operational).
- The first stage of the construction phase underpass monitoring was conducted in Oct/Nov 2014. The second stage is currently being undertaken (February/March) and a summary of results will be provided in the next reporting period.

Condition 12

To inform the *long term success* of *fauna crossings*, fencing and road medians the *person taking the action* must engage a *suitably qualified expert* to prepare a strategy for monitoring and recording any road kill sightings of the *Koala* and *Spotted-tail Quoll* along the *Pacific Highway*. Prior to *commencement of the action*, the road kill monitoring and recording strategy must be implemented.

Action		Timing	Status	Compliance evidence
12.1	Ecological Monitoring Program to include road kill monitoring and recording strategy	Prior to start of construction	Complete	Section 3.5.3 of the Ecological Monitoring Program specifies road mortality monitoring and recording strategy
12.2	Implement strategy	Prior to start of construction and ongoing during construction	In progress	Environmental surveillance checklist. Summary provided below.
12.3	Report on outcomes of monitoring strategy	Construction Post-construction	Ongoing	Annual reporting

Threatened Fauna Road Kill – Summary:

Date	Species	Location
22-8-2014	Koala	Existing highway South of Waterfall Way – approx. chainage 82400
10-9-2014	Koala	Existing highway north Ballard's Rd – approx. chainage 72700

Note:

- Refer to condition 8 for details on mitigation measures undertaken following road kills.
- A risk assessment was undertaken for the southern connector road that concluded the risk of koala movement across the existing highway was lower for the southern end of the project than the Ballard's Road area. It was then determined that temporary fauna fence would not be installed along the southern section due to the lower risk combined with constructability issues and the extent of temporary fencing required to secure the length of existing highway. The need for temporary fauna fence at this southern zone will be reassessed prior to next year's movement season (i.e. August 2015) where Roads and Maritime will assess the status of the project works in this area and whether the works would be impeding koala movement east to west across the existing highway and as such increasing the chance of conflict with highway traffic. Note - the risk level was determined using information from baseline koala surveys in the area (condition 9) and discussions with John Turbill following the koala road kill near Ballard's Road.

- Attachment 5 details the Annual Flora and Fauna monitoring reports completed for the project.

Condition 13

One year following the *completion of construction works*, the *person taking the action* must provide a report to *the Minister* detailing the success and/or failings of *fauna crossings*, fencing and road medians in achieving their intended purpose. The report must address (but need not be limited to):

a) baseline data collected as a requirement of conditions 9 and 12;

b) the number, *design* and location of *fauna crossings*, fencing and road medians, accompanied by maps and photographs;

c) details of a monitoring program to determine the *long-term success* of *fauna crossings*, fencing and road medians (including timing, duration, methodology, and performance objectives);

d) the success of *fauna crossings* to date; and

e) a comparison of data / results from other projects involving upgrades to the *Pacific Highway* regarding the long-term success of fauna crossings and/or fencing;

The report must be updated on a three-yearly basis until the *long term success* of *fauna crossings* has been proven or *the Minister* has agreed in writing that further revisions are no longer required. All updated reports must be provided to *the Minister* within three years of the last report having being submitted.

Action		Timing	Status	Compliance evidence
13.1	Provide fauna crossings, fencing and road medians outcomes report to Dept of the Environment	By 3 Dec 2017	TBA	Transmittal form (and any confirmation of receipt)
13.2	Provide updated fauna crossings, fencing and road medians outcomes report to Dept of the Environment	By 3 Dec 2020	TBA	Transmittal form (and any confirmation of receipt)
13.3	Provide updated fauna crossings, fencing and road medians outcomes report to Dept of the Environment	By 3 Dec 2023	TBA	Transmittal form (and any confirmation of receipt)
13.4	Provide updated fauna crossings, fencing and road medians outcomes report to Dept of the Environment	By 3 Dec 2026	TBA	Transmittal form (and any confirmation of receipt)
13.5	Provide updated fauna crossings, fencing and road medians outcomes report to Dept of the Environment	By 3 Dec 2029	TBA	Transmittal form (and any confirmation of receipt)

Condition 14

Should monitoring associated with conditions 11 to 13 demonstrate that the use of *fauna crossings* and/or fencing is not achieving its intended purpose or is having a detrimental effect upon *EPBC species* (as determined by *the Minister*), *the Minister* may request that the *person taking the action* implement alternative forms of mitigation and/or corrective actions to address the relevant impacts to *EPBC species*. Such measures must be implemented as requested.

Action		Timing	Status	Compliance evidence
14.1	Implement additional mitigation/corrective actions	As and when directed by the Minister	TBA	Annual reporting or as directed by the Minister

Condition 15

The *person taking the action* must implement a salvage and translocation program for all individuals of *Clear Milkvine* and *Cryptic Forest Twiner* that are proposed to be cleared as a result of *the action*. Translocation procedures must be developed and implemented by a *suitably qualified expert* in accordance with *Guidelines for the Translocation of Threatened Plants in Australia* prepared by the Australian Network for Plant Conservation.

Action		Timing	Status	Compliance evidence
15.1	Engage suitably qualified expert	Prior to construction	Complete	Engagement of Ecos to prepare Threatened Flora Management Plan.
15.2	Develop translocation procedures	Prior to construction	Complete	Ecos TFMP developed in consultation with NSW EPA Biodiversity Specialist and approved by NSW DP&I.
15.3	Implement translocation procedures	During construction	Complete	Annual reporting. First report completed January 2015. (See Attachment 3)

Notes:

- These two species are referenced in Section 2.7 (*Establishment of translocation areas*) of the BEM ecological monitoring program by their scientific names, ie *Marsdenia longiloba* (Clear Milkvine), and *Tylophora woollsii* (Cryptic Forest Twiner).
- A Threatened Flora Translocation Program was developed by Ecos in consultation with the NSW Biodiversity Specialist and approved by the NSW DP&I. The program includes a salvage and translocation program for all individuals of *Clear Milkvine* and *Cryptic Forest Twiner* that are proposed to be cleared and the program is considered to meet the requirements of Condition 15. The translocation monitoring report is detailed in Attachment 3.
- The annual monitoring report for 2014 concluded that results for Year 1 were generally good with all sectors except one having a species survival rate of 80% or higher. Eight monitoring sectors recorded a survival rate of 92% or higher

Condition 16

One year following the *completion of construction works*, *the person taking the action* must provide a report to *the Minister* detailing the long term success of the translocation program. The report must include, but need not be limited to:

a) background information on translocated species (in relation to ecological requirements and life history);

b) the scope of the translocation program (with respect to timing, duration, methodology, and objectives, as well as comprehensive details on the recipient translocation site(s) and how they meet the ecological requirements of each species);

c) details of a comprehensive monitoring program to determine the *long-term success of translocation*; and

d) the success of translocation to date.

Action		Timing	Status	Compliance evidence
16.1	Prepare translocation outcomes report addressing specified matters and other relevant matters	Prior to 3 Dec 2017	TBA	Completed report
16.2	Provide translocation outcomes report to Dept of the Environment	By 3 Dec 2017	TBA	Transmittal form (and any confirmation of receipt)

Condition 17

The report must be updated on a three-yearly basis to provide further insights on the *long-term success* of translocation. All reports must be provided to *the Minister* and made available on the *person taking the action's* website for the life of this approval or until *the Minister* has agreed in writing that further revisions are no longer required.

Action		Timing	Status	Compliance evidence
17.1	Update translocation outcomes report (update #1) and provide to Dept of the Environment	3 Dec 2020	TBA	Completed report Transmittal form (and any confirmation of receipt)
17.2	Update translocation outcomes report (update #2) and provide to Dept of the Environment	3 Dec 2023	TBA	Completed report Transmittal form (and any confirmation of receipt)
17.3	Update translocation outcomes report (update #3) and provide to Dept of the Environment	3 Dec 2026	TBA	Completed report Transmittal form (and any confirmation of receipt)
17.4	Update translocation outcomes report (update #4) and provide to Dept of the Environment	3 Dec 2029	TBA	Completed report Transmittal form (and any confirmation of receipt)

Note:

- Uploading of the reports to the project website is addressed via compliance with Condition 29.

Condition 18

With reference to the *department's offset policy*, the *person taking the action* must provide for *the Minister's* approval a threatened flora offset strategy for the *Clear Milkvine* and *Cryptic Forest Twiner*, within 12 months of the date of this approval. *The Minister* will only approve the Threatened Flora Offset Strategy (TFOS), if it demonstrates how a threatened flora offset meeting no less than 90 % of the direct offset requirements (as determined *by the department* in accordance with the offset user guide) will be legally secured in perpetuity within two years of the date of this approval.

Note: At the time the offset required by condition 18 is submitted for approval, the person taking *the action* may ask the Minister to consider that the salvage and translocation program required by condition 15, meets 10% of the offset requirements for the *Clear Milkvine* and *Cryptic Forest Twiner.*

Action		Timing	Status	Compliance evidence
18.1	Prepare TFOS in accordance with Dept of the Environment offset policy and addressing specified matters	By 26 Nov 2014	Completed	Completed TFOS
18.2	Submit TFOS to Dept of the Environment for approval	By 26 Nov 2014	Submitted to DoE on the 21/11/14	Transmittal form (and any confirmation of receipt)

Action 18.1:

- Prepare brief for tender (Complete)
- Tender assessment – (Complete)
- Draft for RMS review expected (Complete)
- RMS review Complete
- Final of the TFOS Complete
- Submit to DoE for approval 21/11/14

Condition 19

The *person taking the action* must provide a plan for the management and delivery of the offset requirements of the threatened flora offset to *the Minister* for approval no later than 30 June 2015. The Threatened Flora Offset Management Plan (TFOMP) must include, but need not be limited to:

a) map(s) and *shapefiles* that clearly define the location and boundaries of the offset;

b) details on the *quality* of the offset;

c) information about *Clear Milkvine* and *Cryptic Forest Twiner* (in relation to ecology, biology and conservation status) to inform appropriate management actions;

d) performance objectives and management actions that will enable maintenance and enhancement *of Clear Milkvine* and *Cryptic Forest Twiner* the offset and habitat covered by the plan;

e) demonstration that any management actions to be undertaken will not adversely impact *EPBC species* (for example, this may apply to herbicide usage);

f) a description of funding arrangements or agreements including work programs and responsible entities;

g) an assessment of the baseline population and distribution for *Clear Milkvine* and *Cryptic Forest Twiner* within the offset, including:

   i. the number of plants protected and their location;

   ii. plant and habitat condition; and

   iii. age classes.

h) measures for regular monitoring of the status of individuals of *Clear Milkvine* and *Cryptic Forest Twiner* and their habitat as measured against the baseline population and distribution, including:

   i. fluctuations in population size and distribution;

   ii. life cycle patterns

   iii. habitat requirements; and

   iv. response to disturbances and/or management actions.

i) Provision to revise the approved threatened flora offset management plan in response to the findings of research associated with condition 20(h).

The approved TFOMP must be implemented within seven days of its approval.

Action		Timing	Status	Compliance evidence
19.1	Prepare TFOMP addressing specified matters and other relevant matters	By 30 Jun 2015	In progress	Completed TFOMP

19.2	Provide TFOMP to Dept of the Environment for approval	By 30 Jun 2015	TBA	Transmittal form (and any confirmation of receipt)
19.3	Implement TFOMP	Within 7 days of Minister's approval	TBA	Annual reporting
19.4	Report on outcomes of TFOMP	During construction Post-construction	TBA	Annual reporting

Action 19.1:

- Prepare brief for tender (Complete)
- Tender assessment (Complete)
- Consultant awaiting approval from landowners to enter shortlisted properties to undertake floristic surveys. Expected to be completed in March 15.
- Draft TFOMP for RMS Review - (expected 1-5-15);
- Final - (Expected 14-6-15).
- Submit TFOMP to DoE for Approval - 30/6/15

Condition 20

Within three months from the date of this approval, the person taking the action must provide to the Minister, a strategy that details how, and when, the Norton Offset Site and Griffin Offset Site (as described in the referral documentation), will be legally secured in perpetuity by the person taking the action.

If the EPBC species habitat cleared as a result of the action is less than the impacts described in the referral documentation then any surplus biodiversity offset areas included in the offset management plans referred to in condition 19 and condition 21 could be secured as biodiversity offsets for other actions undertaken by the person taking the action and included in the offset strategies for those actions.

Action		Timing	Status	Compliance evidence
20.1	Prepare strategy to legally secure offset sites in perpetuity	By 26 Feb 2014	Complete	Both Norton and Griffin sites have been purchased by Roads and Maritime.
20.2	Provide strategy to Dept of the Environment	By 26 Feb 2014	Complete	Letter provided to Dept on 11-2-2014

Condition 21

Within 12 months from the date of this approval, the *person taking the action* must provide to *the Minister* for approval, a plan for the management of the Norton Offset Site and Griffin Offset Site. The Norton and Griffin Offset Management Plan (NGOMP) must be targeted to the ecological requirements of the *Koala*, *Grey-headed Flying-fox*, *Spotted-tail Quoll*, *Regent honey eater* and *Swift Parrot* and build upon the ideas and concepts described in the *referral*. The plan must include, but need not be limited to:

a) map(s) and *shapefiles* that clearly define the location and boundaries of the offset sites;

b) details on the quality of the offset with reference to all *EPBC species* this plan is intended to protect;

c) information about the *Koala, Grey-headed Flying-fox*, *Spotted-tail Quoll*, *Regent honey eater* and *Swift Parrot* (in relation to ecology, biology and conservation status) to inform appropriate management actions;

d) the results of targeted field surveys within both offset sites (undertaken at any ecologically appropriate time of the year) to assess habitat suitability and presence / absence of individuals in relation to the *Koala, Grey-headed Flying-fox*, *Spotted-tail Quoll*, *Regent honey eater* and *Swift Parrot*;

e) clear performance objectives and management actions that will enable maintenance and enhancement of habitat within the offset area, as well as contribute to the better protection of individuals and/or populations of *EPBC species* onsite;

f) an assessment of the baseline population for *EPBC species* which are detected within the offset area during field surveys;

g) demonstration that any management actions to be undertaken will not adversely impact *EPBC species* (for example, this may apply to pest control);

h) a description of funding arrangements or agreements including work programs and responsible entities;

i) details of a comprehensive long term monitoring program for determining the effectiveness of management actions;

j) commitments to undertake contingency measures and corrective actions in the event that performance objectives are not met; and

k) anticipated timeframes for achieving performance objectives.

The approved Norton and Griffin offset management plan must be implemented within seven days of its approval.

Action		Timing	Status	Compliance evidence
21.1	Prepare NGOMP addressing specified matters and other relevant matters	By 26 Nov 2014	Complete	Completed NGOMP

Action		Timing	Status	Compliance evidence
21.2	Provide NGOMP to Dept of the Environment	By 26 Nov 2014	Completed - submitted to DoE on the 11/12/14	Transmittal form (and any confirmation of receipt)
21.3	Implement NGOMP	Within 7 days of Minister's approval	Ongoing	Annual reporting

Note:

- It is assumed that satisfactory documentary evidence of implementation of the NGOMP would be provided through annual reporting.

Action 21.1:

- Prepare brief for tender (Complete)
- Tender assessment (Complete);
- Draft for RMS review (Complete);
- RMS review (Completed)
- Final - (Compete)
- Submitted to DoE for approval on the 11/12/14

Condition 22

Within one month after the commencement of *the action*, the *person taking the action* must advise *the Department* in writing of the actual date of commencement.

Action		Timing	Status	Compliance evidence
22.1	Provide written advice to Dept of the Environment of actual date of commencement	4 Jan 2014	Complete	Signed copy of letter on Roads & Maritime letterhead. Provided to Dept on 4-1-2014.

Condition 23

The *person taking the action* must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement any management plans or reports required by this approval, and make them available upon request to *the Department*. Such records may be subject to audit by *the Department* or an independent auditor in accordance with section 458 of the *EPBC Act*, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media.

Action		Timing	Status	Compliance evidence
23.1	Quarterly review of the EPBC conditions compliance tracking program.	Quarterly	Ongoing	First review March 2014 Second review June 2014 Third Review September Forth Review October 2014. Fifth Review December 2014
23.2	Provide records to Dept of the Environment as requested	As requested	TBA	Transmittal form (and any confirmation of receipt)

Condition 24

Within three months of every one year anniversary of the commencement of *the action*, the *person taking the action* must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans as specified in the conditions. Documentary evidence providing proof of the date of publication and noncompliance with any of the conditions of this approval must be provided to *the Department* at the same time as the compliance report is published.

At any time within the life of this approval the Minister may agree, in writing, that further compliance is not required.

Action		Timing	Status	Compliance evidence
24.1	Prepare compliance report and upload to project website	By 4 Mar 2015	This document	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.2	Prepare compliance report and upload to project website	By 4 Mar 2016	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.3	Prepare compliance report and upload to project website	By 4 Mar 2017	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.4	Prepare compliance report and upload to project website	By 4 Mar 2018	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.5	Prepare compliance report and upload to project website	By 4 Mar 2019	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.6	Prepare compliance report and upload to project website	By 4 Mar 2020	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.7	Prepare compliance report and upload to project website	By 4 Mar 2021	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.8	Prepare compliance report and upload to project website	By 4 Mar 2022	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.

24.9	Prepare compliance report and upload to project website	By 4 Mar 2023	Ongoing	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.10	Prepare compliance report and upload to project website	By 4 Mar 2024	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.11	Prepare compliance report and upload to project website	By 4 Mar 2025	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.12	Prepare compliance report and upload to project website	By 4 Mar 2026	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.13	Prepare compliance report and upload to project website	By 4 Mar 2027	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.14	Prepare compliance report and upload to project website	By 4 Mar 2028	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.15	Prepare compliance report and upload to project website	By 4 Mar 2029	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.16	Prepare compliance report and upload to project website	By 4 Mar 2030	TBA	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.

Condition 25

Upon the direction of *the Minister*, the *person taking the action* must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to *the Minister*. The independent auditor must be approved by *the Minister* prior to the commencement of the audit. Audit criteria must be agreed to by *the Minister* and the audit report must address the criteria to the satisfaction of *the Minister.*

Action		Timing	Status	Compliance evidence
25.1	Identify potentially suitable auditor(s)	On direction of the Minister	TBA	Tenderer(s) proposal(s) documenting expertise
25.2	Provide auditor's details to Dept of the Environment for approval	On direction of the Minister	TBA	Transmittal form (and any confirmation of receipt)
25.3	Auditor to develop audit criteria	Following receipt of Minister's approval	TBA	Completed audit criteria
25.4	Provide audit criteria to Dept of the Environment for approval	Following receipt of Minister's approval	TBA	Transmittal form (and any confirmation of receipt)
25.5	Conduct audit and document findings	Following receipt of Minister's approval	TBA	Completed audit report
25.6	Provide audit report to Dept of the Environment	At completion of audit	TBA	Transmittal form (and any confirmation of receipt)

Note – Alex Taylor from Department of Environment requested information relating to compliance with conditions 5, 6, 7, 8, 9, 12 and 20 via e-mail on 25-2-2014. An e-mail response was sent from Roads and Maritime Senior Project Manager, Paul Leonard on 14-3-2014 and this response was confirmed to adequately address DoE questions in e-mail from Alex Taylor on the 28-4-2014.

Condition 26

If the *person taking the action* wishes to carry out any activity otherwise than in accordance with the TFOS, TFOMP, or NGOMP as specified in these conditions, the *person taking the action* must submit to *the Department* for *the Minister's* written approval a revised version of that TFOS, TFOMP, or NGOMP. The varied activity shall not commence until the Minister has approved the varied TFOS, TFOMP, or NGOMP in writing. *The Minister* will not approve a varied TFOS, TFOMP, or NGOMP unless the revised TFOS, TFOMP, or NGOMP will result in an equivalent or improved environmental outcome over time. If *the Minister* approves the TFOS, TFOMP, or NGOMP then that TFOS, TFOMP, or NGOMP must be implemented in place of the TFOS, TFOMP, or NGOMP originally approved.

Action		Timing	Status	Compliance evidence
26.1	Assess potential departure(s) from TFOS, TFOMP and/or NGOMP as relevant	As required	TBA	Consistency assessment
26.2	Revise TFOS, TFOMP and/or NGOMP as relevant	As required	TBA	Revised TFOS, TFOMP and/or NGOMP as relevant
26.3	Provide revised TFOS, TFOMP and/or NGOMP as relevant to Minister for approval	As required	TBA	Transmittal form (and any confirmation of receipt)
26.4	Implement revised TFOS, TFOMP and/or NGOMP as relevant in accordance with the Minister's written approval	Prior to any action that would not be consistent with the original approval or subsequent modified approval(s)	TBA	Annual reporting

Condition 27

If *the Minister* believes that it is necessary or convenient for the better protection of listed threatened species and communities to do so, *the Minister* may request that the *person taking the action* make specified revisions to TFOS, TFOMP, or NGOMP specified in these conditions and submit the varied TFOS, TFOMP, or NGOMP for *the Minister's* written approval. The *person taking the action* must comply with any such request. The revised approved TFOS, TFOMP, or NGOMP must be implemented. Unless *the Minister* has approved the TFOS, TFOMP, or NGOMP, then the *person taking the action* must continue to implement the TFOS, TFOMP, or NGOMP originally approved, as specified in these conditions.

Action		Timing	Status	Compliance evidence
27.1	Revise TFOS, TFOMP and/or NGOMP as relevant as per directed by the Minister	As directed by the Minister	TBA	Completed revised TFOS, TFOMP and/or NGOMP as relevant
27.2	Provide revised TFOS, TFOMP and/or NGOMP as relevant to Dept of the Environment for approval	As directed by the Minister	TBA	Transmittal form (and any confirmation of receipt)
27.3	Implement revised TFOS, TFOMP and/or NGOMP as relevant in accordance with Minister's written approval	As directed by the Minister	TBA	Annual reporting

Condition 28

If, at any time after five years from the date of this approval, the *person taking the action* has *not substantially commenced the action*, then the *person taking the action* must not *substantially commence the action* without the written agreement of *the Minister*.

Action		Timing	Status	Compliance evidence
28.1	Obtain written agreement of the Minister to substantially commence the project	As required after 25 Nov 2018	Complete	Minister's written agreement

Condition 29

Unless otherwise agreed to in writing by *the Minister*, the *person taking the action* must publish all management plans and reports referred to in these conditions of approval on their website. Each management plan or report must be published on the website within 1 month of being approved, or where approval is not required, on the same day as the report is provided to *the Minister.*

Note

Any plan, strategy or report that has been prepared as a requirement of a state legislation approval (in relation to *the action*) may be used to satisfy the requirements of any of the above conditions, providing the relevant criteria have been met (as specified in these conditions). Where the option is employed, the plan, strategy or report must be accompanied by a standalone document detailing where each of the relevant criteria have been addressed within that plan, strategy or report. This note is particularly relevant to conditions 13, 16, 17, 19, 21 and 25.

Action		Timing	Status	Compliance evidence
29.1	Upload approved NGOMP to project website (21)	Within 1 month of the Minister's approval	TBA	NGOMP uploaded to project website
29.2	Upload approved TFOMP to project website (19)	Within 1 month of the Minister's approval	TBA	TFOMP uploaded to project website
29.3	Upload fauna crossings, fencing and road medians outcomes report to project website (13)	3 Dec 2017	TBA	Report uploaded to project website
29.4	Upload translocation outcomes report to project website (16)	3 Dec 2017	TBA	Report uploaded to project website
29.5	Upload updated fauna crossings, fencing and road medians outcomes report to project website (13)	3 Dec 2020	TBA	Report uploaded to project website
29.6	Upload updated translocation outcomes report to project website (17)	3 Dec 2020	TBA	Report uploaded to project website
29.7	Upload updated fauna crossings, fencing and road medians outcomes report to project website (13)	3 Dec 2023	TBA	Report uploaded to project website
29.8	Upload updated translocation outcomes report to project website (17)	3 Dec 2023	TBA	Report uploaded to project website

Action		Timing	Status	Compliance evidence
29.9	Upload updated fauna crossings, fencing and road medians outcomes report to project website (13)	3 Dec 2026	TBA	Report uploaded to project website
29.10	Upload updated translocation outcomes report to project website (17)	3 Dec 2026	TBA	Report uploaded to project website
29.11	Upload updated fauna crossings, fencing and road medians outcomes report to project website (13)	3 Dec 2029	TBA	Report uploaded to project website
29.12	Upload updated translocation outcomes report to project website (17)	3 Dec 2029	TBA	Report uploaded to project website
29.13	Upload compliance audit report to project website (25)	Same day as provided to the Minister	As required	Report uploaded to project website

Note:

- Number in parentheses under 'Action' refers to approval condition

Report Completion Register January 2015

Report	Date Completed	Date Uploaded	Next Due
TFOS	21/11/14	--	Nov 2014
TFOMP	--	--	Jun 2015
NGOMP	--	--	Dec 2015
Fauna crossings, fencing and road medians outcomes	--	--	Dec 2017
Translocation outcomes report	--	--	Dec 2017
Compliance audit report	--	--	As required

Attachment 1

In Situ Flora Monitoring Report

To protect flora locations this appendix will not be made publically available.

Attachment 2

Sensitive Area Plans (SAPs)

This appendix will not be made publically available to protect heritage sensitive locations.

Attachment 3
Threatened Flora Translocation Monitoring Report

To protect threatened species locations this appendix will not be made publically available.

Attachment 4
Mainline Clearing Report

Pacific Highway Upgrade: Nambucca Heads to Urunga

Clearing Report

Sandpiper Ecological

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Final Report – Version 4

9 March 2015

Document Distribution

Date	Version	Status	Sent to	Represent	Delivered Format	Dispatched By
3/12/14	1	Draft – internal review	B. Taylor	SES	MSWord doc	D. Rohweder
5/12/14	2	Draft	J. Butler	LLE	MSWord doc	D. Rohweder
13/12/14	3	Final Draft	J. Butler	LLE	PDF	D. Rohweder
9/3/15	4	Final Report	J. Butler	LLE	PDF	D. Rohweder

Project Team: Dr D. Rohweder (project management, field survey, reporting)
Dr B. Taylor (field survey, review)
Mr T. St-Vincent Welch (field survey)
Mr N. Priest (field survey, reporting)
Mr D. Owner (field survey)
Dr S. Townley (field survey)

Report prepared for: Lend Lease Engineering (LLE)

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Cover Photo: Powerful Owl (Ninox strenua) roosting north of Ballard's Road, Newry State Forest (T. Welch, Sandpiper Ecological)

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1. Introduction

Sandpiper Ecological Surveys was contracted by Lend Lease Engineering to provide ecological services during construction of the Nambucca Heads to Urunga (NH2U) section of the Pacific Highway Upgrade. The following report discusses the procedures and results of ecological tasks undertaken during the clearing phase of the project. The need for a summary report on the outcomes of fauna survey and rescue during the clearing phase is specified in the Fauna and Flora Management Sub Plan (Appendix B2 of the CEMP) and Ecological Monitoring Program (EMP) (BEM 2013).

The aim of this report is to summarise the methods applied to mitigate impacts on fauna during the clearing phase of the NH2U upgrade and to present results of those surveys. A general discussion of results with reference to other highway upgrades and the efficacy of procedures applied is included.

1.1 Background

The EMP (BEM 2013) provides a summary of the pre-clearing and clearing procedures required and includes details on the type of data to collect. Further specification on survey requirements is provided in the various threatened species management strategies, namely giant barred frog (Mixophyes iteratus), green-thighed frog (Litoria brevipalmata) and microbats (see Lewis 2013a, b & c). The need for clearing phase surveys of culverts for microbats was negated by an initial exclusion of such structures in September 2013 (see Sandpiper 2013). Supplementary giant barred frog surveys (see Lewis 2013d) negated the need to undertake targeted surveys for that species during clearing. Green-thighed frog was the only species covered by a specific strategy that required consideration during the clearing phase. Baseline surveys for koala (Phascolarctos cinereus) and spotted-tailed quoll (Dasyurus maculatus) are summarised by Owner and Rohweder (2014).

2. Methods

2.1 Terrestrial Fauna

2.1.1 Habitat Resource Surveys

Prior to commencement of clearing in a specific area the alignment was traversed to mark fauna habitat resources, including hollow-bearing trees (HBT), nest trees, excavations in arboreal termitaria, dreys and large hollow logs. The HBT survey included remarking of trees identified by Lewis (2013e) and additional trees. HBT were marked with red and white danger tape and four large “H” were painted on the tree (Plate 1). Data collected on each tree included: tree number, species, location (GDA 94), diameter at breast height (DBH), proportion of crown remaining, and hollow size (small 10-50mm, medium 51-150mm, large 151-300mm and very large >300mm) and type (e.g. branch, trunk, spout, fissure, decorticating bark). Habitat resource surveys began one week prior to the commencement of clearing and were undertaken progressively during the clearing phase.

Plate 1: HBT's marking protocol – red and white danger tape and painted orange "H".

2.1.2 Nocturnal Pre-clear Surveys

Nocturnal surveys included spotlighting, stag watch and frog surveys. Spotlight surveys targeted the clearing front (i.e. area to be cleared the next day) the night before clearing was to occur. The area spotlighted was based on daily advice from Lend Lease site engineers. Spotlighting was undertaken from Sunday through to Thursday each week. The spotlight surveys targeted all fauna, with specific emphasis on arboreal mammals (particularly koala) and involved a slow meandering foot-traverse of the clearing front by two staff using hand-held spotlights and binoculars. Observed fauna were identified to species level.

Spotlighting in areas of koala habitat was meant to occur each night prior to clearing, whilst spotlighting in other areas (i.e. non koala habitat) could occur up to seven days prior to clearing (BEM 2013). Spotlighting was undertaken nightly in all habitats except areas dominated by paperbark (Melaleuca spp) and swamp oak (Casuarina glauca). Nightly surveys were undertaken in most vegetation communities due to the broad extent of potential koala habitat and presence of core habitat throughout the alignment. Most of the alignment was spotlighted on multiple occasions due to the three-stage clearing process (i.e. stage 1 - drains & basins, stage 2 – mainline, stage 3 – habitat trees). Once isolated, habitat trees were not spotlighted.

Frogs were recorded during all spotlight surveys, although greater effort was focussed on frogs in priority habitats such as, wetlands, dams, creeks and potential green-thighed frog habitat. Stag watching was undertaken on a targeted basis as needs required. For example, when a hazardous tree was identified (refer section 2.1.6 for more details).

Data collected during spotlight surveys included: personnel, area sampled (chainage or location description), start and end time, date, weather conditions (rain, cloud cover, wind speed, air temperature, relative humidity), habitat type, species, number of individuals and behaviour (foraging, calling, roosting, transit). The

location of threatened species was recorded using a hand held GPS (datum GDA 94). Species observed and heard calling were recorded. When possible fauna were captured and released immediately in a predetermined location outside the limit of clearing.

2.1.3 Diurnal Pre-clearing Surveys

Diurnal pre-clearing surveys were conducted immediately prior to clearing a section of the alignment and the section inspected was the same as that spotlighted the previous evening. Surveys typically commenced prior to the start of clearing each morning but some sections of habitat were inspected at other times, as required by the clearing schedule. In many cases habitat was inspected several times as the area inspected always exceeding that cleared within a day.

Pre-clearing inspections involved a meandering foot-based traverse of the clearing footprint by one or (typically) two observers. During the traverse all accessible fauna habitats were inspected. This included use of a wrecking bar to roll and split logs and searching the shrub and canopy layers for koalas, bird nests, possum dreys and unmarked HBT. Captured fauna were housed temporarily in cotton bags and released into adjoining habitat.

2.1.4 Targeted Frog Surveys

Targeted surveys were required for green-thighed frog. Potential green-thighed frog habitat was identified in low-lying areas (i.e. flats & drainage lines) in three locations; chainage 74665-74965, chainage 78765-78965 and chainage 79765-80765 (Lewis 2013b). In accordance with the management strategy suitable microhabitats were inspected immediately prior to commencing clearing operations. A wrecking bar was used to split and role woody debris and a rake used to turn leaf litter (Plate 2). Targeted frog surveys were undertaken concurrently with standard pre-clear surveys and were concentrated on the base and sides of drainage lines within the abovementioned areas. A minimum of 15-person minutes/ha was spent conducting searches in areas of potential habitat.

Plate 2: Raking leaf litter in search of green-thighed frogs at chainage 74800.

2.1.5 Trapping

Small and large Elliott traps were used in areas with high potential for small ground mammals, such as north of Access Road G (chainage 78500). Cage traps (20x20x40cm treadle design) were used when there was a high risk of arboreal fauna moving from an under-scrubbed area containing HBT onto the existing highway. Cage trapping occurred in narrow strips of vegetation that were to be totally removed by clearing and was

undertaken during the 48 hour HBT retention period. Traps, baited with peanut butter honey and oats or fruit, were set at the base of HBT in the late afternoon and checked at first light. Captured fauna were processed and released into surrounding habitat at least 100m from the Limit of Clearing (LoC) boundary. A koala trap was used as required. The koala trap was based on Phillips (2011) and included a corflute fence positioned around the occupied tree with a large cage trap fitted into a hole in the fence (Plate 3).

Plate 3: Koala trap installed around a small-fruited grey gum occupied by a male koala. A second section of fence has been installed around the trap.

2.1.6 Habitat Tree Inspections

HBTs were left in-situ for a minimum of 48 hours (2 nights) after surrounding vegetation had been cleared. In some instances the retention period was longer due to weather, equipment breakdown or clearing logistics. A small number of hazardous trees and trees retained in a small isolated patch of vegetation north of Valla Road were removed after 24 hours or one night. Trees were removed after 24hrs on the basis of human safety and animal welfare. After the first stage of clearing (i.e. under-scrubbing) dead trees can become unstable due to increased wind exposure and vibration from nearby machinery and pose a risk to the safety of workers (Plate 4). The risk posed by dead trees is exacerbated by the inclusion of a third clearing stage whereby a strip of vegetation is removed to construct drains and basins. Staff working on drains and basins were typically within the fall zone of most trees left on the edge of clearing or within the cleared area. Lend Lease developed a hazardous tree protocol (Appendix A) that included assessment by clearing contractor, ecologist, Lend Lease staff and, on occasions, an arborist and RMS staff.

Trees containing dreys and nests were removed immediately or after one night. Retention of these trees for longer periods either has no benefit as animals cannot leave (i.e. nests) or increases the risk of injury (i.e. dreys). Common ringtail possums (*Pseudocheirus peregrinus*) will often leave dreys during the first stage of clearing moving into vegetation to be cleared where they are at risk of injury. In addition dreys are often situated in the shrub-layer and can be difficult for operators to see and clear around. Removing dreys at the start of clearing reduces the risk of injuring fauna.

Plate 4: Example of a potentially hazardous HBT, in this case a stag, left within the work zone. Staff excavating drains and laying geofabric are within the fall zone of this tree.

The majority of HBTs were felled carefully using a harvester, although a small number of trees, mainly in creek lines, close to the existing highway, or on the boundary were felled by a tree climber or, on rare occasions, by chainsaw. Immediately prior to felling each HBT was inspected visually and the preferred fall direction discussed with the machine operator.

During the inspection the location of major hollows was noted to enable quicker detection once the tree was felled. HBT were felled in a careful manner with specific attention given to the direction of falling in relation to visible hollows, topography and ground debris. Where possible, trees were felled on the side without hollows, upslope, away from windrows and uneven ground.

The clearing method varied between contractors depending on operator skill and equipment capability. In most cases small and medium sized trees were cut near the base and placed on the ground, or the tree was pushed with the root bole intact and lowered to the ground. Large trees were felled with the root bole intact by either direct pushing or use of two machines to slow the fall (Plate 5).

Plate 5: Example of two harvesters falling a large coastal blackbutt.

Once felled, two ecologists carefully inspected the tree. All trunk and branch hollows and broken hollow limbs were inspected using a hand-held LED torch and/or a bore scope. Trees were rolled over to expose buried hollows and branches were cut off to enable closer inspection or set aside for further trimming with a hand-held chainsaw. Inspection time varied depending on tree size and hollow number and ranged from 5-20 minutes. Information collected on each HBT included:

- Date and personnel;
- Tree number and species;
- Number, type (branch, trunk, spout) and size (small 2-5cm; medium 5-15cm, large 15-30cm; very large >30cm) of hollows;
- Species and number of individuals present;
- Evidence of previous use; and
- If fauna were detected the fate of captured individuals.

Evidence of previous use by fauna was based on the presence of:

- Leaf nest;
- Feathers, scats, fur, eggs or egg shell;
- Wear or chew marks at the hollow entrance.

The shape and size of the nest and the size of the entrance hole and type of tree were used to determine which species might have used the hollow.

Fauna were either left in hollows or captured and placed in cotton bags or a cat cage. Frogs were housed individually in plastic clip-seal bags with a small amount of water and leaf litter. Hollows containing fauna were plugged with a cotton bag and placed between the LoC and project boundary (Plate 6). Fauna were only left in-situ if they were uninjured, if the tree could be left undisturbed and if there was minimal activity nearby. Hollows were unplugged at dusk and reinspected the following morning. In cases where there was no adjoining forest to place hollows in or animal/s were suspected of being injured a hand-held chainsaw was used to trim retained sections of tree to enable extraction of fauna.

Captured fauna and occupied hollows were placed into the adjoining forest, or the closest area of suitable forest (i.e. appropriate area and habitat type for the subject species) within 100m from the LoC boundary. All gliders and some bats were transferred to nest boxes, which were installed temporarily in adjoining habitat (Plate 7). Nest boxes were inspected the following day and removed if there was no sign of continued use. Reptiles were placed on trees with decorticating bark and hollows or in piles of logs where there was good refuge habitat. Insectivorous bats were released at dusk near their point of capture. Frogs were released on drainage lines or at dams within close proximity to their capture site.

Plate 6: Section of tree with a hollow occupied by two sugar gliders being moved outside the LoC. The hollow (centre of log) is plugged with a cotton bag.

Plate 7: Adult and juvenile sugar glider placed in a nest box with fresh eucalypt leaf (left) and the box is then strapped temporarily to a tree at the relocation site (right).

2.2 Road-kill Surveys

Road-kill surveys along the Pacific Highway were undertaken throughout the clearing phase (i.e. December to July). A weekly two-way vehicle traverse between the Waterfall Way interchange and the Nambucca Heads exit (Link Road) was conducted. The survey was conducted at speeds of 50-80kpH. The single traverse was supplemented by multiple shorter traverses during weekly movement throughout the site. Care was taken to avoid duplicating records and all records subsequent to the full traverse were vetted. Data collected included: survey date, species or species group (e.g. wallaby, possum, and bird), location (distance to nearest cross-road), presence of clearing within past 48hrs and presence of safety barriers or exclusion fence. Safety requirements prohibited pedestrian access onto the existing highway and therefore it was not possible to closely inspect road-killed fauna to improve accuracy of identification.

3. Results

3.1 Threatened Fauna

Ten threatened species were recorded during the clearing phase (Table 1, Table B1, Appendix B). All 10 species are listed on the NSW *Threatened Species Conservation Act 1995* and two are also listed on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Table 1). Koalas were recorded on eight occasions during the construction phase, including three records during clearing and two individual road-kill records. During the clearing phase, all koala records were in the Dalhousie Creek to Ballard's Road area, with two subsequent records in that area post clearing, one of which was a road-kill and the second a male calling near Dalhousie Creek on 15 October 2014.

Grey-headed flying-fox were recorded throughout the alignment with consistent records during the clearing phase. Flying-fox abundance peaked in February/March when pink bloodwood (Corymbia intermedia) was in flower. One grey-headed flying-fox was recorded roosting in swamp forest habitat near the Short Cut and South Arm Road interchange on 7 May 2014. Wompoo fruit-dove, black-necked stork and black bittern were recorded at one site each. The black bittern record was of an individual found entangled in geofabric at Boggy Creek and taken to WIRES for care. It was released after being fed.

Glossy black cockatoo and little lorikeet were recorded throughout the alignment. The number of lorikeets peaked in February/March when bloodwood was flowering. Glossy black cockatoo were commonly recorded in the northern median, Burkes Lane area and around Valla Road.

Powerful owl and sooty owl were recorded on several occasions in the northern median (Table B1, Appendix B). Powerful owl was also recorded north of Ballard's Road and near Burkes Lane, whilst sooty owl was also recorded at Ballard's Road and Boggy Creek. A roosting powerful owl was recorded in the gully north of Ballard's Road (chainage 72500) on 18 February 2014 (cover photo).

Table 1: Threatened species recorded during and immediately after the clearing phase. V = vulnerable, E = endangered.

Species Name	Common Name	Status		No. Sites ; Comment
		NSW	C'Wealth	
Phascolarctos cinereus	Koala	V	V	8; 2 near Dalhousie Creek; 2 road killed individuals.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Throughout site; refer spotlight data
Ptilinopus magnificus	Wompoo Fruit-Dove	V		1; Fill 26
Ephippiorhynchus asiaticus	Black-necked Stork	E		1: Boggy Creek Road
Ixobrychus flavicollis	Black Bittern	V		1: Boggy Creek
Lophoictinia isura	Square-tailed Kite	V		2; Moyles Lane & Fill 26
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		5; throughout alignment
Glossopsitta pusilla	Little Lorikeet	V		5; throughout alignment in summer/autumn
Ninox strenua	Powerful Owl	V		4; Blackbutt Lane, Rails Road, Nth median
Tyto tenebricosa	Sooty Owl	V		3; Boggy Ck, Ballard's Rd, nth median

3.2 Spotlighting

A total of 310 spotlight surveys were conducted between 16 December 2013 and 17 July 2014 (Table B2, Appendix B). During spotlight surveys 634 records of 54 species were made, including 13 species of frog, eight reptiles, 19 mammals and 14 birds (Table 2). Two introduced species, house mouse and cat, were recorded. Threatened species recorded during spotlight surveys included; koala, grey-headed flying-fox, sooty owl and powerful owl. During spotlighting 116 vertebrates from 14 species were relocated from the clearing front. Of these 104 were frogs removed from dams, sedge swamps and drainage lines.

3.2.1 Koala Capture and Relocation

One koala was spotlighted in the alignment, north of Ballard's Road, on 15 June 2014. That individual, a healthy adult male, was trapped that night and relocated west of the alignment in Newry State Forest. The individual was suspected of being the same animal recorded near Rails Road on 6 December 2013 (Table B1, Appendix B).

3.3 Pre-clearing Surveys and Trapping

A total of 350 pre-clearing surveys were undertaken between 5 December 2013 and 15 July 2014 (Table B3, Appendix B). Pre-clearing surveys prior to the commencement of spotlighting were for minor clearing work. Thirty-three species were recorded during the surveys, included 3 frogs, 11 reptiles, 11 mammals and eight birds (Table 2). Most bird records were of nests with eggs. Sixteen species and 35 individuals were captured and relocated. Three species, swamp wallaby (pinky), black bittern and satin bowerbird were captured and taken to WIRES for care. Both the black bittern and satin bowerbird were released near their point of capture after a brief period in care but the swamp wallaby died in care. Three species, red-bellied black snake, dwarf crowned snake and swamp rat were found dead at the clearing front. Six black rats were euthanased in accordance with Sandpiper's DPI AC&E licence.

Table 2: Species of vertebrate captured during pre-clearing and spotlight surveys for the Nambucca Heads to Urunga Pacific Highway Upgrade. [v] = Listed as Vulnerable by the NSW *Threatened Species Conservation Act 1995*. d = died. e = euthanased.

Species Name	Common Name	Pre-clearing & Trapping (No. relocated)	Spotlighting (No. relocated)
Amphibians			
Adelotus brevis	Tusked Frog		√ (1)
Pseudophryne coriacea	Red Backed Toadlet		√(2)
Litoria dentata	Bleating Tree Frog		√
Litoria tyleri	Southern Laughing Tree Frog		√
Litoria fallax	Eastern Dwarf Tree Frog	√(2)	√(62)
Litoria jervisiensis			√
Litoria revelata			√
Litoria gracilenta			√
Litoria peronii	Peron's Tree Frog		√(1)
Litoria latopalmata			√
Lymnodynastes peronii	Striped Marsh Frog	√(2)	√(28)
Mixophyes fasciolatus	Great Barred Frog		√(9)
Crinia signifera	Common Eastern Froglet	√	√(1)
Reptiles			
Egernia mcpheei	Mcphee's Skink	√(2)	
Varanus varius	Lace Monitor	√	
Cyclodomorphus gerrardii	Pink Tongue Lizard		√(3)
Egernia major	Land Mullet	√(2)	
Saproscincus rosei	Rose's Skink	√(1)	
Calyptotis ruficauda	Southern Calyptotis	√(2)	
Physignathus leusueri	Eastern Water Dragon	√(2)	√
Lialis burtoni	Burton's Snake Lizard	√(1)	
Ramphotyphlops nigrescens	Blackish Blind Snake	√(1)	
Hemiaspis signata	Black-bellied Swamp Snake	√(1)	√(1)
Pseudechis porphyriacus	Red-bellied Black Snake	√(d)	
Vermicella annulata	Bandy Bandy		√(2)
Rhinoplocephalus nigrecens	Eastern Small-eyed Snake		√(1)
Cacophis squamulosus	Golden Crowned Snake		√(1)
Boiga irregularis	Brown Tree Snake		√(3)
Morelia spilota	Carpet Python		√(1)
Cacophis krefftii	Southern Dwarf Crowned Snake	√(d)	
Mammals			
Antechinus stuartii	Brown Antechinus	√(8)	√
Perameles nasuta	Long-nosed Bandicoot		√
Isoodon macrourus	Northern Brown Bandicoot		√
Melomys spp.		√(3)	√

Petaurus breviceps	Sugar Glider		√
Acrobates pygmaeus	Feathertail Glider		√
Trichosurus vulpecula	Common Brushtail Possum	√	√
Pseudocheirus peregrinus	Common Ringtail Possum	√(4)	√
Trichosurus caninus	Short-eared Possum		√
Phascolarctos cinereus	Koala[V]		√(1)
Macropus rufogriseus	Red-necked Wallaby		√
Macropus giganteus	Eastern Grey Kangaroo		√
Wallabia bicolor	Swamp Wallaby	√(1)	√
Rattus lutreolus	Swamp Rat	√(d)	
Rattus fuscipes	Bush Rat	√(1)	
Rattus spp.		√(1)	
Pteropus poliocephalus	Grey-headed Flying-fox[V]	√	√
Pteropus scapulatus	Little Red Flying-fox		√
Pteropus alecto	Black Flying-fox		√
Tadarida australis	White-striped Freetail Bat		√
Nyctophilus spp.	Long-eared Bat	√	
Birds			
Dendrocygna eytoni	Plumed Whistling Duck		√
Ptilinopus magnificus	Wompoo Fruit-Dove[V]	√	
Porphyrio porphyrio	Purple Swamp Hen		√
Dacelo novaeguineae	Laughing Kookaburra		√
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo		√
Calyptorhynchus lathami	Glossy Black-Cockatoo[V]	√	
Podargus strigoides	Tawny Frogmouth		√
Eurostopodus mystacalis	White-throated Nightjar		√
Aegotheles cristatus	Australian Owlet Nightjar		√
Ninox strenua	Powerful Owl[V]		√
Ninox novaeseelandiae	Southern Boobook		√
Tyto tenebricosa	Sooty Owl[V]		√
Tyto javanica	Eastern Barn Owl		√
Pitta versicolor	Noisy Pitta		√
Ixobrychus flavicollis	Black Bittern[V]	√(1)	
Trichoglossus haematodus	Rainbow Lorikeet		
Neochmia temporalis	Red Browed Finch (eggs)	√	√
Columba leucomela	White-headed Pigeon (eggs)	√	
Ptilinorhynchus violaceus	Satin Bowerbird	√(1)	
Orthonyx temminckii	Logrunner (nest)	√	
Manorina melanocephala	Noisy Miner		√
Introduced Species			
Felis cattus	Cat		√
Mus musculus	House Mouse		√
Rattus rattus	Black Rat	√(6e)	

3.2 Habitat Tree Removal

3.2.1 Habitat Resource Survey

719 Hollow-bearing Trees (HBT) were marked during the habitat resource surveys (Table B4, Appendix B). This included 299 trees marked during the initial survey (Lewis 2013d) and an additional 420 trees marked during the habitat resource survey and pre-clear surveys.

3.2.2 Hollow Characteristics and Species Recorded

During clearing of the NH2U alignment, 710 habitat trees were inspected, of which 447 (63%) contained 1099 hollows (Table 3). Small branch hollows were most abundant (457) followed by medium branch (309), small trunk (106), medium trunk (90), large branch (49), large trunk (44), large spout (22), very large trunk (21), medium spout (18), very large spout (17), very large branch (5) and small spout (1) (Table 3). Inspected trees also contained 39 nests, 50 termitaria (with hollows) and 40 dreys. Thirty-six trees had native beehives and seven had European beehives. A further 12 trees contained fissures and eight had decorticating bark. A total of 158 trees were occupied by vertebrate fauna and a further 171 trees displayed evidence of use. Of the 447 trees with hollows 329 (73%) were occupied or showed evidence of use by vertebrate fauna.

A total of 329 individuals and 32 species were captured during HBT removal (Table 3, Plates 8-10). Species richness was comprised of nine mammal, eight reptile, seven bird and five frog species. The most commonly captured species were sugar glider (73 individuals), feathertail glider (38 ind), brown antechinus (14 ind), tree frogs (50 ind, 4 spp), tree snakes (25 ind 3 spp), tree skinks (47 ind, 3 spp) and large possums (17 ind, 3 spp). Non hollow dependent species recorded during HBT inspections were *Calyptotis ruficauda* (1 ind), *Ramphotyphlops nigrescens* (14 ind) and *Lampropholis* spp. (1 ind). *R. nigrescens* (blackish blind snake) is often recorded in the root-ball of trees, particularly stags.

The largest number of individuals (hollow dependent & non hollow dependent) was removed from coastal blackbutt (108), followed by stag (79), flooded gum (27), pink bloodwood (23) and white mahogany (19). The highest proportion of active trees was recorded in flooded gum (62%) and red mahogany (61%) followed by small fruited grey gum (55%), pink bloodwood and tallowwood (53%). Stags, which comprised the highest number of checked trees (182), had an activity proportion of 50% (Table 2). *Callistemon* spp. had an activity rating of 81% due to the high occurrence of dreys.

3.2.2 Mortality

Thirty individuals comprising 17 species died from 27 separate incidents during mainline clearing (Table B5, Appendix B). Eleven individuals, comprised of 7 species, died during habitat tree removal and eight individuals (5 species) were found dead during general clearing. All deaths attributed to general clearing were of reptiles. Five sugar gliders died in two separate incidents during HBT removal. Two reptiles were found dead in the earthworks zone and eight individuals died due to collision with light vehicles, including two swamp wallabies. Three sugar gliders and one short eared possum died during removal of large hazardous trees that were each retained for a single night after under-scrubbing.

The number of individuals killed during HBT removal was 3.3% of fauna relocated from HBT. The total number of individuals killed during the clearing phase (19 individuals) represents <4% of fauna captured and relocated during all activities.

Table 3: Results of Hollow Bearing Tree inspections conducted during the clearing phase of the Nambucca Heads to Urunga Pacific Highway Upgrade. * A hollow was considered viable if it was >1cm in diameter and 10cm deep; S = small; M = medium; L = large; VL = very large; sp = spout; T = trunk; Term = Termitaria; Fis = Fissure. CN = Cup Nest, F = Fissures, E= Epiphyte, SN = Stick Nest, NB = Native Beehive, D = drey, De = Decorticating Bark, T = Termitaria, GN = Globe Nest, EB = European Beehive, Basal = Basal Hollow

Tree Type	No. Inspected	No. trees with Hollows* (%)	Hollow Type								Spout	Other	No. Active HBT	No. HBT with evidence	No. Individuals & Species
			Branch				Trunk								
			S	M	L	VL	S	M	L	VL					
Blackbutt	176	128 (72)	175	153	19	1	17	17	7	10	1S, 1M, 2L, 1VL	SNx5, NBx4, Tx4, EBx2	45	33	Sugar Glider (44), Common Brushtail Possum (7), Feathertail Glider (5), Rainbow Lorikeet (5), Litoria peronii (9), Common Tree Snake (Green) (9), Litoria dentata (4), Litoria caerulea (2), Litoria tyleri (1), Lace Monitor (3), Brown Antechinus (1), Egernia mcpheei (1), Gould's Wattled Bat (2), Eulamprus tenuis (3), Carpet Python (2), Mormopterus spp. (1), Microbat spp. (6) Yellow-tail Black Cockatoo (3), Total: 108 individuals
Stag	182	122 (67)	92	58	13	0	46	33	13	1	6M, 14L, 10VL	Dex6, Tx5, NBx16, Fx6, Dx5, GNx4	46	45	Eulamprus tenuis (19), Brown Tree Snake (1), Common Tree Snake (Green) (1), Sugar Glider (10), Lampropholis spp. (1), Ramphotyphlops nigrescens (9), Brown Antechinus (9), Litoria peronii (12), Feathertail Glider (5), Short-eared Possum (2), Common Brushtail Possum (1) Lace Monitor (4), Egernia mcpheei (2), Common Ringtail Possum (1), Litoria dentata (1), Australian Owlet Nightjar (1), Microbat spp. (1), Southern Leaf-tailed Gecko (2), Total: 79 individuals
Turpentine	55	40 (71)	28	11	9	0	12	10	7	6	4L, 1VL	CNx4, NBx2 Dx3, Fx1, SNx1	9	5	Australian Owlet Nightjar (1), Litoria fallax (1), Eulamprus tenuis (8), Scincidae spp. (1), Litoria peronii (2) Total: 13 individuals
Swamp Mahogany	44	29 (64)	32	10	0	0	1	3	1	0	1M, 2L	Dx1, Tx11, Bx2, NBx2, SNx1, Fx1	7	11	Sacred Kingfisher (4) (chicks), Ramphotyphlops nigrescens (3), Brown Antechinus (1), Carpet Python (1), Common Tree Snake (Green) (1), Calyptotis ruficauda (1), Eulamprus tenuis (1), Feathertail Glider (1), Litoria dentata (1), Rattus spp. (1) Total: 15 individuals

Pink Bloodwood	45	33 (73)	37	25	3	1	7	6	3	0	2M, 1VL	Tx7, Dex1, EBx1, NBx3, Dx1	12	12	Feathertail Glider (8), Brown Tree Snake (3), Common Tree Snake (Green) (2), Eulamprus tenuis (4), Litoria spp. (1), Brown Antechinus (1), Common Brushtail Possum (1), Common Ringtail Possum (3) Australian Wood Duck Eggs (10) Total: 23 individuals + 10 eggs
Forest Oak	32	9 (28)	8	0	0	0	4	2	2	0	1M	EBx2, Dx8, GNx2, Fx1, CNx1, SNx1	6	9	Common Ringtail Possum (1), Litoria fallax (1), Eulamprus tenuis (2), Australian Owlet Nightjar (1), Lace Monitor (1) Total: 6 individuals
Tallowwood	30	19 (68)	22	9	6	0	5	4	2	0	3M, 1VL	Tx12, NBx6, Fx2, EBx1	7	9	Feathertail Glider (5), Sugar Glider (1), Eulamprus tenuis (1), Ramphotyphlops nigrescens (1), Pink Tongue Lizard (1), Scincidae spp. (1) Total: 10 individuals
White Mahogany	27	17 (63)	17	10	0	0	5	3	2	0	0	Tx4	5	7	Feathertail Glider (11), Sugar Glider (6), Ramphotyphlops nigrescens (1), Litoria spp. (1) Total: 19 individuals
Flooded Gum	21	12 (71)	15	12	3	2	1	2	2	2	3M, 2VL	NBx2, Dx2, Tx1	9	4	Litoria peronii (9), Sugar Glider (8), Feathertail Glider (1), Common Tree Snake (Green) (4), Eulamprus tenuis (3), Lace Monitor (3), Gould's Wattled Bat (1), Yellowtail Black Cockatoo (2 + 2 Eggs) Total: 27 individuals + 2 eggs
Callistemon	16	0 (0)	0	0	0	0	0	0	0	0	0	Dx12, GNx5, CNx1	1	12	Common Tree Snake (Green) (1) Total: 1 individual
Red Mahogany	13	9 (69)	7	8	2	0	0	2	1	0	1M, 1VL	Tx3	2	6	Feathertail Glider (1), Sugar Glider (4) Total: 5 individuals
Small Fruited Grey Gum	11	6 (55)	4	4	0	0	2	2	0	0	0	Bx1	2	4	Eulamprus tenuis (1), Litoria spp. (1) Total: 2 individuals
Ironbark	11	3 (27)	4	4	3	1	0	0	2	0	0	CNx2, Bx1, NBx1, Tx2, EBx1	1	1	Brown Tree Snake (3) Total: 3 individuals
Brushbox	8	6 (75)	7	1	0	0	1	1	0	0	0	Dx1	1	1	Feathertail Glider (5) Total: 5 individuals
Broadleaf Paperbark	7	6 (86)	2	0	0	0	1	4	1	1	0	CNx1, Fx1	3	2	Brown Antechinus (3), Litoria peronii (2), Litoria dentata (1) Total: 6 individuals
Melaleuca spp.	7	0 (0)	0	0	0	0	0	0	0	0	0	GNx6, SNx1	0	0	Red Browed Finch Eggs (13)

														Total: 13 Eggs
Smooth-barked Apple	3	2 (66)	1	2	0	0	0	1	1	1	0		0	1	Litoria peronii (1) Total: 1 individuals
Swamp Box	3	1 (33)	0	0	0	0	1	0	0	0	0	GNx1, Dx1	0	1	Total: 0 individuals
Acacia spp.	2	1 (50)	1	0	0	0	1	0	0	0	0	Dex1	1	0	Eulamprus tenuis (1) Total: 1 individual
Swamp Oak	2	0 (0)	0	0	0	0	0	0	0	0	0	Dx2	0	2	Total: 0 individuals
Rainforest spp.	4	2 (50)	1	0	0	0	0	0	0	0	0	GNx1	0	1	Total: 0 individuals
Callitris spp.	1	0 (0)	0	0	0	0	0	0	0	0	0	Dx1	0	1	Total: 0 individuals
Forest Red Gum	1	0 (0)	0	0	0	0	0	0	0	0	0	SNx1	0	0	Total: 0 individuals
Red Ash	1	0 (0)	0	0	0	0	0	0	0	0	0	Dx1	0	1	Total: 0 individuals
Spotted Gum	1	1 (100)	0	0	0	0	0	1	0	0	0	0	0	1	Total: 0 individuals
Callicoma spp.	1	0 (0)	0	0	0	0	0	0	0	0	0	Dx1	0	1	Total: 0 individuals
Camphor Laurel	1	0 (0)	0	0	0	0	0	0	0	0	0	Dx1	1	0	Common Ringtail Possum (3), Common Tree Snake (Green) (1) Total: 4 individuals
Eucalyptus spp.	1	0 (0)	0	0	0	0	0	0	0	0	0	Tx1	0	1	Lace Monitor Eggs (5) Total: 5 Eggs
Unidentified Tree spp.	4	1 (0)	4	0	0	0	0	0	0	0	0	SNx1	0	0	White-headed Pigeon (2 + 1 Egg), Feathertail Glider (1) Total: 1 individual + 1 Egg
Totals	710	447	457	309	49	5	106	90	44	21	58		158	171	329 individuals

A

B

C

D

E

F

Plate 8: Reptiles captured and relocated during the clearing phase of the NH2U Pacific Highway Upgrade. A) juvenile carpet python, b) southern leaf-tailed gecko, c) Burton's snake lizard, d) lace monitor, e) land mullet and f) blackish blind snake.

A

B

Plate 9: Frogs captured and relocated during the clearing phase of the NH2U Pacific Highway Upgrade. A) great barred frog, B) tusked frog (underbelly).

A

B

C

D

E

F

Plate 10: Mammals captured and relocated during the clearing phase of the NH2U Pacific Highway Upgrade. A) feathertail glider, B) feathertail gliders released into nest box, C) brown antechinus, D) Gould's wattled bat, E) common brushtail possum, F) koala.

3.3 Road Kill Survey

A total of 102 records of road-killed fauna were obtained between 17 December 2013 and 29 September 2014 (Table B6, Appendix B). Twenty species and several species groups (i.e. snake, bird) were identified during the survey. The ability to identify species depended on the degree to which the carcass had been degraded and location within the road alignment. Animals on the pavement were easier to identify than those on the verge.

For comparison, the sample area was divided into two sections, adjoining clearing (Link Road to 250m north Ballard's Road & 600m north Short Cut Road to Waterfall Way overpass – total of 12.71km) and no clearing (250m north Ballard's Road to 500m North Short Cut Road – total of 8.95km). Fifty-nine records occurred adjacent to the clearing section and 43 adjacent to non-cleared areas. In the clearing section six records occurred within 48 hours of clearing with a further 34 records after clearing but outside the 48 hour period. In total, 68% of records adjacent to the cleared section occurred after clearing. Between 4 July and 29 September 29 road-kills were recorded, 20 of which (or 69%) occurred in the cleared section. In comparison, of the 73 records between 17 December and 30 June 53% occurred in the cleared section.

Four records occurred in areas with concrete barriers and all were after clearing. Eight records occurred within or near the area with temporary koala fence, several of which occurred near the end of fencing. The two koala road-kills are not included in the data presented as neither was recorded during a road-kill survey.

The alignment was divided into nine sections based on the frequency of road-kills. Sections include:

- Deep Creek area - Chainage 63850-65600; 1750m (12 records; 67% after clearing).
- Valla Beach Road area - Chainage 66100-67700; 1600m (18 records; 100% after clearing).
- Burkes Lane area - Chainage 68200-69600; 1400m (10 records; 40% after clearing).
- Jacksons area - Chainage 69700-71300; 1600m (4 records; nil after clearing).
- Ballard's Road area – Chainage 71500-72750; 1250m (8 records; 50% after clearing).
- Dalhousie Creek to Tower Road; 1500m (5 records).
- Martells Road area; 1100m (9 records).
- Urunga township; 3800m (25 records).

- Short Cut Road; 900m (5 records).

The highest number of road kills was recorded in the Urunga township section. The highest number of records adjacent to clearing occurred in the Valla Beach Road area, all of which occurred after clearing. Twelve road-kills were also recorded in the area immediately south, that is, the Deep Creek area.

4. Discussion

4.1 Success of Clearing Phase Fauna Mitigation

4.1.1 Clearing Method

The method of clearing adopted was successful in reducing impacts on local fauna. The low mortality rate (i.e. <4%) and large number of individuals relocated from HBT (329), pre-clear surveys (35 individuals) and spotlight surveys (116 individuals) supports this notion. The use of harvesters to fall HBT reduces the risk of impact to fauna, although mortality rates were similar to other projects where harvesters have not been used (refer section 4.1.2). Whilst the inclusion of harvesters in clearing operations has obvious benefits for careful removal of small and medium sized trees the ability to lower trees is influenced by machine and operator capability. Standard 30 - 40 tonne harvesters cannot lower large trees.

One notable benefit of harvesters is a reduction in use of hand-held chainsaws to remove vegetation from drainage lines. Falling trees with hand-held saws increases the risk of mortality, as the impact tends to be greater than if a tree is pushed with the root ball attached or lowered with a harvester. Harvesters are also able to cut and carry sections of tree with occupied hollows, which reduces stress (& risk of mortality) associated with getting animals out of hollows.

Two-stage clearing and two-night (or 48hr) HBT retention was applied during this project. In actuality clearing, in some areas, was undertaken in three stages where basins and drains were initially cleared, followed by remaining vegetation. HBT “isolated” during the initial (basin & drain) clearing were often in proximity to intact vegetation and well within the glide distance of small petaurid gliders. The three-stage process may have contributed to higher levels of fauna occurrence in HBT.

The two-night retention time for potential HBT provides a reasonable balance between animal welfare and clearing progress. Shorter time periods are probably insufficient as highlighted by two prominent instances where large HBT were taken down after one night. On both occasions they were hazardous trees located at Blackbutts Lane and Blue Hills Road. Four arboreal mammals were killed during removal of these trees. The degree of isolation of HBT following the initial clearing phase contributes to the likelihood of occupancy after two nights. Animals are more likely to continue using trees situated on the edge of clearing than those that are fully isolated, particularly those featuring seasonal food resources such as blossom. Small animals, such as Feathertail Glider and many lizards and frogs, can remain in large isolated trees for several days as they are still able to forage within the tree canopy.

The results show that the first stage of clearing (i.e. all non-HBT) is insufficient to force all animals away from the clearing zone. This is not surprising given the influence of competition for resources and the importance of viable hollows for hollow dependent fauna. Competition for space in adjoining vegetation featuring occupied home ranges will influence the ability of fauna to relocate. Generally, total canopy separation is regarded as essential to encourage movement and reduce clearing impacts on hollow dependent fauna. The high number of abandoned HBT (171) suggests that animals relocate following the initial clearing, however, these figures cannot be interpreted as the number of animals relocating as several species utilise multiple dens within a home range (Lindenmayer 2002). An appropriately designed scientific study is required to resolve the issue of

one verses two nights retention time. Such a study should be conducted in similar habitats using the same clearing methods and with sufficient replication.

4.1.2 Impacts on Fauna

Approximately 165ha[1] of native vegetation was removed during the clearing phase including 447 HBT containing 1099 hollows. At NH2U the proportion of HBT with evidence of use by fauna (74%) was substantially higher than that reported for the Coopernook to Herons Creek (44%), Hunter Expressway (KK2B) (48%), Glenugie (65%) and Karuah to Bulahdelah (31%) highway upgrades (see Benchmark Environmental Management 2007; Sandpiper Ecological Surveys 2009, 2010). The proportion of occupied HBT recorded at NH2U (35%) was equivalent to Sapphire to Woolgoolga (35%) and Glenugie (38%) but substantially greater than the Hunter Expressway KK2B (22%) and Karuah to Bulahdelah (20%) Differences in rates of occupancy and evidence of use between sites is due, in part, to different habitat type and quality, survey effort and clearing method. The Sapphire to Woolgoolga upgrade is most comparable to NH2U in terms of effort and habitat quality. Although Glenugie also had high occupancy rates results are biased by a higher abundance of reptiles, including species such as greater bar-sided skink (Eulamprus tenuis) and robust velvet gecko (Oedura robusta), which have small home ranges and may be capable of remaining on a tree for several days.

In general, the NH2U section of the Pacific Highway Upgrade had a high density and diversity of fauna, particularly, ground reptiles and gliders. Sugar gliders were abundant and the number captured was similar to the S2W project (BEM 2013). The results show that a substantial number of individuals do not relocate following initial clearing and findings are consistent with other similar studies in northeastern NSW (e.g. BEM 2007, 2011; SES 2009, 2010). Implementation of a third clearing phase for drains and basins increases the likelihood that fauna, particularly gliders, will continue to use hollows in the clearing zone. The narrow clearing widths for drains and basins (i.e. 20-25m) means that petaurid gliders can continue to move in and out of the clearing area with minimal disruption. The importance of hollows in the daily cycle of gliders and their scarcity in the landscape means that they are likely to display strong fidelity even after disturbance. Species such as common brushtail possums may be more tolerant of disturbance.

Squirrel, yellow-bellied and greater gliders are rarely detected during HBT inspections. It is unclear why this is the case but may be due to a greater sensitivity to disturbance. Although squirrel gliders have been removed from hollows at K2B and S2W at HEX they were rarely detected in HBT but were the most common petaurid glider in nest boxes (SES 2012 & 2013). The 32 species recorded during HBT inspections is comparable to S2W (30 species) and Coopernook to Herons Creek (37 species).

The mortality rate during clearing at NH2U (3.3%) was comparable to several other studies, including HEX (4%), Karuah to Bulahdelah (4%), Glenugie (4%), Sapphire to Woolgoolga (3%) and Coopernook to Herons Creek (3%) (BEM 2007, 2011; SES 2009, 2010, 2012). The similarity in mortality rates between NH2U and other similar clearing programs is interesting because, of the studies cited, NH2U is the only one in which harvesters were consistently used to fell HBT's. The result for Coopernook to Herons Creek is biased by the exclusion of mortality whilst animals were in care. The finding indicates that harvesters do not substantially reduce mortality.

4.1.3 Adequacy of Survey Methods

Survey methods applied during this project included, pre-clear inspections (active search), spotlight surveys (including wetland frog surveys), targeted ground trapping and stag watching and inspection of HBT. These

[1] At the time of finalizing this report the clearing total had not been calculated. The results of any additional clearing surveys will be summarised in an addendum.

methods resulted in the capture and relocation of 480 individuals from 54 species. Survey effort was substantial with a total of 719 habitat trees inspected, 350 pre-clear surveys and 310 spotlight surveys completed. Six ecological staff were involved in the project and 3-4 personnel were onsite most days between mid-December and mid-June. Ten threatened species were recorded during clearing, although only two species, one koala and one black bittern, were at direct risk of injury. Whilst the alignment contained potential nest sites for large forest owls and glossy black cockatoos breeding by these species was not recorded.

The result of fauna rescue during clearing is positive and has satisfied the intent of the various conditions of approval that relate to minimising the impact of clearing on fauna and the EMP. All but two of the species relocated are common and abundant in northern New South Wales and the conservation benefit associated with their rescue and relocation is questionable. Capture and relocation of fauna from cleared areas as a conservation measure is flawed as it ignores the effect of competition, home range use, social interactions and distribution of key habitat resources on fauna distribution (Krebs 1994). The premise that removing (occupied) habitat and relocating resident fauna to adjacent habitat where they will continue to survive ignores the ecological factors that influence species distribution. Many translocation programs have been successful but these involve detailed planning and typically, the movement of fauna into unoccupied habitat. Fauna with small home ranges may benefit least from relocation as there is a greater likelihood that a substantial part of their home range would be removed by clearing.

Relocating threatened species may be beneficial, although, positive outcomes are not guaranteed for the reasons listed above. Whilst there have been numerous successful translocations of threatened species from one area to another (Serena 1994) there is less information on the results of small-scale movement. Pietsch (1994) recorded low survival rates of common brushtail possums translocated from urban areas to bushland. Research on the behaviour of relocated fauna is required before it is regarded as a positive conservation measure.

The clearing phase of the NH2U project extended from summer to mid-winter. This period includes the later stages of breeding for several species of bird and the primary breeding season for frogs. Dry weather during summer and autumn constrained breeding by frogs and suitable breeding conditions for green-thighed frog (i.e. 50-75mm of rain in 72hr period) did not eventuate. The dry spring and summer may have prolonged breeding by some species, for example, juvenile lorikeets were recorded in March/April, white-headed pigeons were incubating eggs in Feb/March, outside their typical breeding seasons, and juvenile feathertail gliders were captured in March (Higgins & Davies 1996; Higgins 1999; Lindenmayer 2002).

The dry spring/summer/autumn and commencement of clearing in December was beneficial as overlap with peak breeding seasons was reduced and breeding activity, by some species, was suppressed. This resulted in fewer juveniles, which are often negatively affected by clearing.

4.1.2 Habitat tree retention and clearing times

Retention times for HBT's and other habitat trees warrant further assessment. Habitat tree is a broad term that includes all trees with fauna habitat, whilst HBT includes trees with hollows only. Trees containing dreys and bird nests, that is, habitat trees, can be removed immediately, or one night after initial clearing. Our experience indicates that possum dreys should be removed immediately to reduce the likelihood of possums exiting the drey during the initial clearing phase. Retaining bird nests for longer than one night does not improve conservation outcomes unless chicks can fledge in the period between initial clearing and tree removal.

The timing (season) of clearing has a substantial influence on outcomes, particularly mortality. Clearing during the breeding season for native birds (i.e. October – January) can cause considerable mortality of chicks and eggs (pers obs). In contrast, clearing during autumn and winter reduces the likelihood of impacts on breeding

individuals and also provides time for animals to adjust breeding territories before the onset of the new breeding season. Removal of habitat within the territory of a breeding pair of animals during the breeding season is likely to affect breeding success even if individuals are not directly impacted. Numerous active bird nests were removed during this project, although few nestlings were affected.

Reference to "48hr retention time" of HBT in conditions of approval (CoA) and management plans warrants revision. Most CoA refer to a 48hr retention period for habitat trees, however, in practice a two-night retention time is applied. The difference in time specified in CoA and applied in practice raises the possibility of non-compliance.

5. References

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Appendix A – Hazardous Tree Protocol

Appendix B – Field Data

Table B1: Threatened species recorded during and shortly after the clearing phase of the Nambucca Heads to Urunga pacific Highway Upgrade.

Date	Observer	Species	Number	Chainage/Location	Easting	Northing	Sex	Behaviour
29.11.13	DR&TW	Square-tailed Kite	1	Moyles Road	500313	6622137		Flying
6.12.13	DR	Koala	1	Rails Road	500028	6621366	M	Resting in white mahogany
3.12.13	BT	Glossy Black Cockatoo	2	75800				Foraging
13.12.13	DR	Wompoo Fruit-Dove	1	74750				Calling
10.1.14	DR & JE	Sooty Owl	1	Ballard's Road				Roosting
20.1.14	DR&NP	Little Lorikeet	>5	Cut 31				In transit
2.2.14	DR	Glossy Black Cockatoo	3	65350				In transit
11.2.14	NP & ST	Powerful Owl	2	Nth Median (79600)				Calling
12.2.14	DR	Powerful Owl	1	Blackbutts Lane area				Calling
12.2.14	NP&TW	Koala	1	73828	499633	6621985		Resting in Angophora costata
18.2.14	NP & TW	Powerful Owl	1	Rails Road area				Roosting
28.2.14	DR	Little Lorikeet	>10	Mines Road				In transit
10.3.14	DR	Little Lorikeet	>5	Burkes Lane				In transit
11.3.14	DR	Glossy Black Cockatoo	2	Burkes Lane				Transit
13.3.14	DR	Glossy Black Cockatoo	2	79600				Foraging
13.3.14	DR	Little Lorikeet	7	Cut 26				Transit
17.3.14	DR	Glossy Black Cockatoo	2	79500				Foraging
17.3.14	DR	Little Lorikeet	>10	Ballard's compound				Foraging
31.3.14	DR	Sooty Owl	1	80400				Calling
1.4.14	DR	Sooty Owl	1	80500				Calling
3.4.14	NP/ST	Powerful Owl	1	80500				Calling
4.5.14	NP/DO	Sooty Owl	1	Boggy Ck Rd (Gate 10)				Perched

12.5.14	DR/NP	Black-necked Stork	1	Dam nth Boggy Crk Rd				Flying in to dam
6.6.14	NP	Black Bittern	1	Boggy Creek				Caught in bidum
15.6.14	NP/ST	Koala	1	Ballard's Road	500331	6620942	M	Resting in grey gum
22.8.14	AZ	Koala	1	Pac H'way; Waterfall Way exit			M	Road-killed
	JB	Koala	1	Dalhousie Creek			M	Road-killed
1.10.14	DR	Koala	2	80076 North Tyson's Flat	498526	6627350	F + J	Crossed alignment east to west rested in median. Joey on back.
2.10.14	DR	Square-tailed Kite	1	Fill 26				Flying
15.10.14	TW	Koala	1	50m NE of Dalhousie Crk			M	Calling

Table B2: Results of spotlight surveys undertaken during the clearing phase of the Nambucca Heads to Urunga Pacific Highway Upgrade. Weather – cc = cloud cover, rh = relative humidity, t = temperature (^{0}C), rain (ab-absent, ls-light shower), wind (n-nil, rl-rustles leaves, msb-moves small branches, mlb-moves large branches); Habitat – MOF = moist open forest, DOF = dry open forest, SF = swamp forest; Behaviour – T = transit, F = foraging, C = calling, R = roosting; Relocated – individuals moved into adjoining forest, outside LoC.

Observer	Start time	End time	Chainage sampled	Weather (refer key)	Habitat (refer key)	Species	No. Ind	Behaviour (refer key)	Relocated
DR&TW	2210	2250	Cut 27 sth to gully, sw side of cut 26 - Tower rd	ab, cc100%, rl, rh78.7%, t20.9	MOF	Brown tree snake	1	T	R
						Pseudophryne coriacea	<5	C	
						Owlet Nightjar	1	F	
						Pink Tongue skink	1	T	R
DR&TW	2155	2135	66700 - 66925	ls, cc100%, msb, rh76.4%, t21.6	DOF	Cat	1		
						Litoria fallax	>10	C	
						Common Ringtail Possum	1	F	
DR&TW	2230	2310	76920 - 76750: Base of cut nth - heritage track cut 31	ab, cc100%, n, rh80%, t21.8	DOF	Nil			
DR&TW	2130	2210	Cut 27 - 26 west side	ls, cc100%, n, rh80%, t21.8	MOF	Nil			
DR&TW			Blackbutts lane - macadamia plantation	ab, cc100%, n, rh73.1%, t23.2	DOF	Tawny Frogmouth	2	R	
						Common Ringtail Possum	1	F	
DR/NP	2208	2243	78800 - 79000	ab, cc30%, rl, rh77.7%, t22.1	DOF	Litoria peronii	1	F	
						Little Red Flying Fox	2	F	
						Tawny Frogmouth	1	R	
DR/NP	2030	2100	Ballard's/Pac H'way INT - South	ls, cc90%, msb, rh80%, t19.7	DOF	nil			
DR/NP	2015	2100	Ballard's South to Whittakers	ab, cc40%, rl rh73%, t23.1	DOF	Sugar Glider	1	F	
DR/NP	2108	2142	Cut 27 south to Tower Rd	ab, cc50%, rl, rh73%, t22.9	DOF	Little Red Flying Fox	2	F	
DR/NP	2120	2145	Fill 26	ls, cc 100%, msb, rh83.7%, t19.5	MOF	Little Red Flying Fox	2	F	
DR/NP	2220	2308	Up to 79150, E and W sides	ab, cc100%, rl, rh83%, t19.1	MOF	Little Red Flying Fox	numerous	F	
BT/TW	2045	2105	Access G - 78660	ab, cc100%, rl, rh72%, t24	DOF	Little Red Flying Fox	1	F	
						Grey Headed Flying Fox	1	F	
						Adelotus brevis	2	C	
BT/TW	2124	2205	78800 - 74619	ab, cc100%, rl, rh73%, t24	DOF	Common Ringtail Possum	2	T	
						Owl sp. (Barn Owl)	1	T	
BT/TW	2235	2312	Deep Crk Stockpile - 65365	ab, cc0% nil, rh79.6%, t20	DOF	Swamp Wallaby	1	T	
BT/TW	2016	2036	78333 - 78105	ab, cc100%, nil, rh 71%, t24.5	MOF	Noisy Miner	2	R	
						Little Red Flying Fox	2	F	
BT/TW	2215	2229	South Martells	ab, cc100%, nil, rh71%, t24.5	MOF	Little Red Flying Fox	5	F	
						Bandy Bandy	1	F	R
TW/ST	2145	2300	Fill 26	ls, cc100%, msb, rh91%, t 20	MOF	nil			

TW/ST	2315	2400	Ballard's Rd Carpark/Basin	ls, rl	DOF	Little Red Flying Fox	numerous	F	
						Grey Headed Flying Fox	numerous	F	
ST/NP	2230	2340	SB to Tysons Flat, 200m NB	ab, rl, cc20%, rh75.7%, t22.4	MOF	Little Red Flying Fox	numerous	F	
						Grey Headed Flying Fox	numerous	F	
						Powerful Owl	2	C	
ST/NP	2033	2129	Cut 26 north to clearing extent	ab, msb, cc10%, rh70.4%, t23.7	MOF	Southern Boobook	1	R	
						Feathertail Glider	1	F	
						Little Red Flying Fox	numerous	F	
						Grey Headed Flying Fox	numerous	F	
ST/NP	2151	2219	Swamp Mahogany south of Cut 32	ab, rl, cc10%, rh70.1%, tt23.3	SWF	Little Red Flying Fox	numerous	F	
						Litoria peronii	1	F, C	
						Litoria fallax	1	F, C	
						Frog sp.	1	F, C	
						Grey Headed Flying Fox	numerous	F	
						Eastern Grey Kangaroo	3	T, F	
DO/NP	2142	2225	Cut 27	ab, rl, cc0%, rh73%, t21.4	MOF	Little Red Flying Fox	1	F	
DR/NP	2245	2310		ab, rl, cc0%, rh84%, t19.8	DOF	Little Red Flying Fox	numerous	F	
						Grey Headed Flying Fox	numerous	F	
DO/NP	2021	2116	Access G to Tysons sth bnd	ab, rl, cc10%, rh72.6%, t25.5	DOF	Feathertail Glider	1	F	
						Grey Headed Flying Fox	numerous	F	
						Little Red Flying Fox	numerous	F	
						Owlet Nightjar	2	C	
DO/NP	2135	2150	Island sth of Martells	ab, rl, cc70%, rh79.2%, t23.8	DOF	Little Red Flying Fox	1	F	
DO/NP	2255	2320	Access G sth on E bdy	ab, rl, cc0%, rh72.5%, t22.5	DOF	Sugar Glider	1	F	
						Grey Headed Flying Fox	3	F	
DO/NP	2106	2124	Ballard's Nth - drainage	ab, rl, cc0%, rh71.5%, t21.8	DOF	nil			
DO/NP	2043	2135	Ballard's nth & sth - clearing	ab, n, cc0%, rh70.4%, t22.9	DOF	nil			
DO/NP	2147	2237	Cut 27 N&S E bdy - N to Martells	ab, rl, cc0%, rh69.5%, t22.4	DOF	nil		R	
DR/DO	2020	2050	Access G triangle + opp 79100	ab, n, cc100%, rh75.6%, t24	MOF	Tawny Frogmouth	1		
						Common Ringtail Possum	1	F	
						Grey Headed Flying Fox	1	F	
						Little Red Flying Fox	2	F	
DR/DO	2120	2150	Nth Cut26 - bottom, E bdy+top	ab, n, cc100%, rh75.9, t24.3	MOF	Common Brushtail Possum	2	F	
						Brown Antechinus	1	F	
DO/NP	2209	2251	Gate 25 sth to Deep Ck	ls, rl, cc70%, rh86.2, t24.1	DOF	Litoria peronii	1	F	
						Long-nosed Bandicoot	1	C	
						Litoria fallax	numerous	C	
DR/DO	2220	2300	65240 - Deep Ck	ab, rl,	MOF	Limnodynastes peronii	1	C	

						Long-nosed Bandicoot	2	F	
BT/TW	2022	2045	74450 - 74750	ab, n, cc0%, rh75%, t23.4	MOF, DOF	nil			
BT/TW	2110	2206	Nth median	ab, nil, cc0%, rh75%, t22	MOF, DOF	Owlet Nightjar	1	T	
						Little Red Flying Fox	2	F	
						Grey Headed Flying Fox	3	F	
						Southern Boobook	1	T	
TW/ST	2030	2215	29170 - 29500	ab, rl, cc0%, rh76.6%, t22.7	MOF	Tawny Frogmouth	1	R	
						Sugar Glider	2	C	
						Owlet Nightjar	1	C	
						Grey Headed Flying Fox	numerous	F	
						Little Red Flying Fox	numerous	F	
TW/ST	2245	2315	Fill26, 74750	ab, rl, cc0%, rh78.2%, t22.8	MOF	Tawny Frogmouth	1	R	
						Little Red Flying Fox	numerous	F	
						Grey Headed Flying Fox	numerous	F	
TW/?	2115	2200	Martells South	ab, nil, rh78.7%, t23.7	MOF	Grey Headed Flying Fox	numerous	F	
						Little Red Flying Fox	numerous	F	
						Feathertail Glider	1	F	
TW/?	2220	2300	Kalang North to mid slope	ab, nil, rh84.5%, t8.5	DOF/SWF	Little Red Flying Fox	3	F	
BT/NP	2200	2232	Ballard - 72149	ls, rl, cc100%, rh93%, t21.2	DOF	Wallaby sp.	1	T	
TW/DO	2030	2100	Ballard's South	ab, rl, cc90%, rh79.8%, t24.9	DOF	Feathertail Glider	2	F	
						Tawny Frogmouth	2	R	
						Wallaby sp.	1	T	
BT/TW	2030	2125	Martells - 75222	ab, rl, cc30%, rh79%, T24.7	DOF	White Throated Nightjar	1	T	
						Bandicoot sp.	1	F	
BT/TW	2031	2105	Martells Rd - 75222	ab, nil, cc50%, rh81%, t27.4	DOF	White Throated Nightjar	1	F	
BT/TW	2117	2155	Ballard's - 72149	ab, nil, cc100%, rh82.6%, t25.8	DOF	Grey Headed Flying Fox	1	F	
						Swamp Wallaby	1	F	
BT/TW	2016	2015	Northern edge Kalang river	ls, msb, cc100%, rh85%, t23.5	MOF	nil			
TW/DO	2100	2150	Tower - 73300	ab, msb, cc0%, rh71.8%, t22.3	DOF	Southern Boobook	1	R	
						Feathertail Glider	1	F	
						Owlet Nightjar	1	C	
						Wallaby sp.	1	T	
TW/DO	2200	2240	Burkes Lane South	ab, nil, cc0%, rh76%, t22	DOF	Common Brushtail Possum	1	F	
						Sugar Glider	1	F	
						Feathertail Glider	1	F	
DR/DO	2000	2033	Property access - 67933	ab, nil, cc5%, rh68%, t23	MOF	nil			
DR/DO	2100	2135	73800 - 73700	ab, nil, cc10%, rh68%, t23	DOF	Southern Boobook	1	R	
BT/NP	2020	2055	Access G - 78000	ab, nil, cc20%, rh91%, t22.8	MOF	Tawny Frogmouth	1	R	

BT/NP	2122	2152	Martells - 75222	ab, nil, cc10%, rh90.5%, t21.8	MOF	Pseudophryne coriacea	4	C	
BT/TW	2041	2110	Martells - 75222	ls, msb, cc100%, rh87.5%, t24.4	MOF/DOF	Pseudophryne coriacea	6	C/F	
BT/TW	2117	2159	Ballard's - 72149	ls, msb, cc100% rh86%, t24	DOF/MOF	Feathertail Glider	1	T	
						Grey Headed Flying Fox	2	F	
TW/ST	2345	10	Ballard's/Highway edge	ls, rl, cc100%, rh80.4%, t21.8	DOF	Pink Tongue Skink	1	T	
						Rodent sp.	1	T	
TW/ST	2030	2130	Access G - 79150	ls, rl, cc80%, rh85.2%, t21.4	MOF	Tawny Frogmouth	1	R	
						Little Red Flying Fox	numerous	F	
TW/ST	2030	2210	Access G 79000 - 79150	ab, nil, cc0%, rh78.4, t23	MOF	Common Brushtail Possum	1	T	
						Bandicoot sp.	1	T	
						Grey Headed Flying Fox	numerous	F	
TW/ST	2230	2330	Cut 27 - Drainage Line East	ab, nil, cc0%, rh84%, t20.9	MOF	Owlet Nightjar	1	C	
						Grey Headed Flying Fox	numerous	F	
						Little Red Flying Fox	numerous	F	
NP/ST	2015	2108	Burkes South 150m	ab, rl, cc20%, rh69.7%, t24	DOF	Tawny Frogmouth	1	R/F	
NP/ST	2126	2159	Tower - South	ab, msb, cc30%, rh66.3%, t23.8	DOF	Sugar Glider	3	F	
						Microbat sp.	1	F	
						Wallaby sp.	1	T	
NP/ST	2214	2323	North Median	ab, msb, cc30%, rh67.2%, t23.4	MOF	Owlet Nightjar	1	C	
						Northern Brown Bandicoot	1	T/F	
						Microbat sp.	numerous	F	
DR/DO	2000	2045	Drainage South Burkes - 68200	ls, nil, cc25%, rh79%, t22.1	MOF	Short-eared Possum	2	F	
						Pink Tongue Skink	1	F	R
						Swamp Wallaby	1	T/F	
						Grey Headed Flying Fox	1	F	
TW/BT	2016	2026	Cut 31, 76881 - 76932	ab, mlb, cc100%, rh72%, t26.3	DOF/MOF	Little Red Flying Fox	1	F	
TW/BT	2029	2101	76780 - 76579	ab, mlb, cc100%, rh72%, t26	DOF	Little Red Flying Fox	3	F	
TW/BT	2115	2145	Tower Rd - 74470	ls, msb, cc100%, rh71%, t26.4	DOF	Little Red Flying Fox	1	F	
TW/BT	2208	2231	65693 - 65883	ls, rl, cc10%, rh74%, t26.2	DOF	nil			
NP/TW	2338	2359	81900 - 82300	ab, rl, cc70%, rh77.8%, t23.3	DOF/SWF	Litoria tyleri	numerous	C	
						Litoria fallax	numerous	C	
						Limnodynastes peronii	numerous	C	
						Purple Swamp Hen	3	C	
						Adelotus brevis	numerous	C	
TW/DO	2000	2045	Clearing front - 79200	ab, nil, cc0%, rh82%, t23.3	DOF/MOF	Little Red Flying Fox	6	F	
						Owlet Nightjar	1	C	
						Pseudophryne coriacea	numerous	C	
NP/ST	2012	2136	Burkes South 150m	ab, rl, cc10%, rh67.4%, t15	DOF	Feathertail Glider	3	F	

						Common Ringtail Possum	2	F	
						Adelotus brevis	numerous	C	
						Pseudophryne coriacea	numerous	C	
						Microbat sp.	numerous	C	
NP/ST	2151	2258	Tower Rd - 73800	ab, rl, cc20%, rh71%, t22.1	DOF	Mixophyes fasciolatus	1	C	
						Pseudophryne coriacea	numerous	C	
						Microbat sp.	numerous	F	
						Wallaby sp.	2	T/F	
						Sugar Glider	1	C	
DO/NP	2117	2213	Tower South 100m	ab, rl, cc95%, rh90%, t23.5	DOF	Owlet Nightjar	1	C	
						Litoria fallax	numerous	C	
						Mixophyes fasciolatus	numerous	C	
DO/NP	2233	2330	Cut 32	ls, rl, cc90%, rh92%, t22.9	DOF	Feathertail Glider	2	F	
						Little Red Flying Fox	2	F	
						Limnodynastes peronii	numerous	C	
						Litoria gracilenta	1	C	
DO/NP	2010	2109	Cut 32	ab, nil, cc20%, rh74%, t24.1	DOF	Black Bellied Marsh Snake	1	F	R
						Owlet Nightjar	1	C	
DO/NP	2127	2204	Tower rd - Cut 27	ls,msb, cc30%, rh73%, t23	MOF	Owlet Nightjar	1	C	
NP/DO	2225	2253	Valla Rd clearing front north 200m	ab, rl, cc10%, rh76%, t21.7	DOF	Long nosed Bandicoot	1	F/T	
NP/TW	2017	2115	Cut 32, 78700 - 79600	ab, nil, cc10%, rh80.9%, t22.8	DOF	Pseudophryne coriacea	1	F	
						Little Red Flying Fox	2	F	
						Grey Headed Flying Fox	2	F	
						Limnodynastes peronii	numerous	C	
NP/DO	2014	2102	Cut 32	ab, nil, cc5%, rh78.1%, t20.9	DOF	Grey Headed Flying Fox	numerous	F	
						Pseudophryne coriacea	numerous	C	
						Limnodynastes peronii	numerous	C	
						Adelotus brevis	numerous	C	
						Crinia signifera	numerous	C	
NP/DO	2123	2204	Cut 26	ab, rl, cc10%, rh72.1%, t22.2	MOF	Sugar Glider	3	F	
						Tawny Frogmouth	1	F/R	
						Noisy Pitta	1	C	
						Owlet Nightjar	1	C	
						Wallaby sp.	3	C	
TW/ST	2030	2115	Access G north	ab, msb, cc100%, rh68% t24	MOF	nil			
NP/DO	2230	2244	Valla Rd North 200m	ab, msb, cc30%, rh80.3%, t22.3	DOF	nil			
NP/TW	2141	2253	74200 - 73850	ab, nil, cc10%, rh85.8%, t22.7	DOF	Owlet Nightjar	1	C	

ST/NP	2134	2220	Cut 26	ls, msb, cc70%, rh78.4%, t26	MOF	Sugar Glider	1	F/T	
						Pseudophryne coriacea	1	F	
						Little Red Flying Fox	numerous	F	
						Grey Headed Flying Fox	numerous	F	
DO/NP	2020	2100	Gate 25 - Deep Crk Rd	ab, nil, cc80%, rh87.9, t24.1	DOF	Common Ringtail Possum	2	F	
						Tawny Frogmouth	1	F/R	
DO/NP	2031	2109	Cut 32 - Tysons Flat SB	hs, mc, cc100%, rh89.1%, t25.1	MOF	Little Red Flying Fox	1	F	
						Mixophyes fasciolatus	1	F	R
						Adelotus brevis	numerous	C	
						Litoria gracilenta	numerous	C	
						Pseudophryne coriacea	numerous	C	
ST/NP	2029	2116	Cut 31	ab, rl, cc60%, rh86.4, t25.9	DOF	Little Red Flying Fox	numerous	F	
						Grey Headed Flying Fox	numerous	F	
						Owlet Nightjar	1	C	
DR/ST	2030	2130	Cut 32, 89100, 100m of north median	ab, nil, cc0%, rh70%, t24.7	MOF	Noisy Pitta	1	C	
						Grey Headed Flying Fox	1	F	
						Litoria peronii	1	F	
DR/ST	2200	2230	Tower Rd North Side	ab, nil, cc0%, rh93%, t 21	DOF	Noisy Pitta	1	C	
						Litoria jervisiensis	1	C	
						Owlet Nightjar	1	C	
						Plumed Whistling Duck	multiple	T	
DR/ST	2245	2340	64435 - 64600	ab, nil, cc100%, rh92%, t20	DOF	Common Brushtail Possum	1	F	
DR/DO	2030	2210	Ballard's north and south to drainage lines	ab, mlb, cc0%, rh78.2%, t23.3	DOF/MOF	Sugar Glider	2	F	
						Feathertail Glider	1	F	
DR/DO	2230	2245	Kalang River	ab, rl, cc0%, rh74.7%, t18.6	MOF	Litoria fallax	numerous	C	
						Litoria latopalmata	numerous	C	
						Litoria peronii	numerous	C	
						Limnodynastes peronii	numerous	C	
DR/DO	2030	2130	Ballard's - McGraths Crk	ab, mlb, cc0%, rh61.5%, t23.4	DOF	Adelotus brevis	1	C/F	R
DR/TW	2040	2115	66237 - 66700 (Blackbutt Lane)	ab, nil, cc0%, rh63.2%, t26.4	DOF	Common Brushtail Possum	1	F	
DR/TW	2145	2215	Cut 26	ab, nil, cc0%, rh68.9%, t24	MOF	Southern Boobook	1	C	
						Owlet Nightjar	1	C	
DR/TW	2030	2130	75000 - 74300	ab, nil, cc100%, rh77.4%, t21.5	MOF	Owlet Nightjar	1	C	
						Pseudophryne coriacea	5	C	
DR/DO	2015	2200	Track South to Tower Rd	ab, nil, cc100%, rh72.2%, t23.7	DOF/MOF	Common Ringtail Possum	2	F	
						Fawn Footed Melomys	1	F	
						Pseudophryne coriacea	5	C	
BT/TW	2033	2120	74346 - 74525	ab, nil, cc0%, rh70%, t23.4	DOF/MOF	Grey Headed Flying Fox	1	F	

						Sugar Glider	1	T	
						Tawny Frogmouth	1	T	
BT/TW	2140	2215	76800 - 76400	ab, nil, cc0%, rh76%, t22.4	MOF	Owlet Nightjar	1	T	
BT/TW	2241	2320	66400 - 67010	ab, nil, cc0%	DOF/MOF	Tawny Frogmouth	3	R	
BT/DO	2025	2120	76800 - School Hill Rd	ab, nil, cc60% rh71%, t23.8	MOF	Sugar Glider	1	T	
BT/JE	2030	2130	76787 - 76420	ls, nil, cc100%, rh91% t19.7	MOF	Tawny Frogmouth	1	R/F	
BT/JE	2140	2230	74900 - 74550	ab, nil, cc100%	MOF	Owlet Nightjar	1	C	
BT/DO	2140	2215	Tower Rd - 74530	ab, nil, cc90%, rh70%, t23.7	DOF	Common Ringtail Possum	1	T	
						Grey Headed Flying Fox	1	F	
BT/DO	2240	2316	66993 - 67370	ab, nil, cc80%, rh74%, t23	MOF	Common Ringtail Possum	1	F	
BT/NP	2035	2108	67090 - 67420	ab, nil, cc0%, rh72%, t23	DOF/MOF	Tawny Frogmouth	3	R/C	
BT/NP	2137	2200	School Hill Rd - 76260	ab, nil, cc10%, rh78% t21.6	DOF/MOF	White Throated Nightjar	1	R/T	
ST/NP	2033	2138	Martells South to Clearing extent	ab, mlb, cc10%, rh72.7%, t24.7	MOF	nil			
ST/NP	2150	2253	Fill 30 - Cut 31	ab, msb, cc90%, rh74%, t24.2	DOF	Grey Headed Flying Fox	2	F	
						Wallaby sp.	2	F	
ST/NP	2025	2143	75030 - 75441	ab, rl, cc0%, rh60%, t28.1	MOF	nil			
ST/NP	2205	2246	Martells South to Clearing extent	ab, rl, cc10%, rh69.7%, t24.4	DOF	Red Necked Wallaby	2	F	
						Rat sp.	3	F	
BT/NP	2210	2237	75000 - 75250	ab, nil, cc60%, rh76%, t21.7	MOF	Owlet Nightjar	1	T/C	
BT/NP	2247	2259	Tower Rd edges	ab, nil, cc60%, rh76%, t21	DOF	Sugar Glider	2	F/C	
DR/JE	2050	2125	Compound - Range Road	ab, mlb, cc95%, rh74.4%, t22.8	DOF	Sooty Owl	1	P	
DR/DO	2200	2215	Tysons Flat	hs, msb, cc100%,	DOF	nil			
DR/DO	2105	2200	Tower Rd nth & sth - 74224	ls, nil, cc50%, rh88%, t20	DOF	White-throated Nightjar	1	C/F	
						Mixophyes fasciolatus	1	C	
						Pseudophryne coriacea	2	C	
DR/DO	2030	2115	Clearing limit - 79400	ab, nil, cc10%, rh88%, t20	MOF	Short-eared Possum	2	F	
						Owlet Nightjar	1	C	
						Tree Frog sp.	1	C	
						Grey Headed Flying Fox	1	F	
NP/TW	2138	2226	Tower Rd - 73850	sb, msb, cc50%, rh79.6%, t21.9	DOF/MOF	Feathertail Glider	2	F	
						Pseudophryne coriacea	numerous	C	
						Owlet Nightjar	numerous	C	
						Wallaby sp.	2	T/F	
NP/TW	2251	2340	North Cut 32 to 79200, 79400 - 79600	ab, rl, cc80%, rh81.6%, t21	MOF	Grey Headed Flying Fox	1	F	
						Pseudophryne coriacea	numerous	C	
						Limnodynastes peronii	1	C	
DR/TW	1945	2045	Tower Rd 73750 - 73825	ab, rl, cc10%, rh80% t24.3	MOF	Long-nosed Bandicoot	1	C/F	
						Owlet Nightjar	1	C	

						Pseudophryne coriacea	1	C	
						Litoria fallax	1	C	
DR/TW	2055	2130		ab, rl, cc60%, rh78%, t24.6	DOF	Common Ringtail Possum	1	F	
						Common Brushtail Possum	1	C/F	
ST/TW	2045	2140	Clearing front - East West Rd	ab, nil, cc0%, rh78%, t19.2	DOF/MOF	Common Brushtail Possum	1	F	
NP/TW	2050	2130	Tower South 100m	ls, rl cc100%, rh74%, t23.4	MOF	Long-nosed Bandicoot	1	F	
						Sugar Glider	1	C	
						Owlet Nightjar	1	C	
						Litoria fallax	1	C	
						Microbat sp.	numerous	F/T	
NP/TW	2140	2245	Swamp north of Short Cut Rd	ls, rl, cc80%, rh78%, t23	SWF, MOF	Purple Swamp Hen	2	C	
						Limnodynastes peronii	4	C/F	R
						Litoria fallax	19	C/F	R
						Eastern Water Dragon	1	P?	
						Grey Headed Flying Fox	1	F	
						Limnodynastes peronii spawn	150+ eggs		R
NP/TW	2146	2210	Blackbutt Lane	ab, rl, cc80%, rh72%, t23.3	DOF	Common Ringtail Possum	1	F	
						Purple Swamp Hen	1	C	
NP/TW	1950	2017	Blackbutt Lane	ab, rl, cc100%, rh73%, t23.5	DOF	nil			
NP/TW	1946	2038	81900 - 82050	ab, rl, cc90%, rh73%, t23.9	MOF/SWF	Limnodynastes peronii	7	C/F	R
						Crinia signifera	1	F	R
NP/TW	2053	2127	South Tower drainage lines - 73650	ab, rl, cc90%, rh71%, t23.5	MOF	Tawny Frogmouth	1	R	
						Microbat sp.	numerous	F/T	
						Owlet Nightjar	1	C	
						Litoria fallax	1	C	
						Northern Brown Bandicoot	1	T	
ST/TW	2220	2300	Driveway north to crk at Burkes	ls, nil,	DOF	Tawny Frogmouth	1	R	
						Pseudophryne coriacea	numerous	C	
ST/TW	1940	2040	74060 - 73900 and traverse drain 73950 - 74000	ab, nil, cc0%, rh76%, t20.1	DOF/MOF	nil			
ST/TW	1945	2045	79100 - 79550	ab, nil, cc10%, rh92%, t20.1	DOF/MOF	Pseudophryne coriacea	numerous	C	
ST/TW	2110	2200	Tower clearing extent - 73700	ls, rl, cc30%,	DOF/MOF	Mixophyes fasciolatus	1	C	R
TW/DO	1930	2020	73683 - 73582	ls, rl, cc80%, rh75.6%, t24.4	MOF	nil			
TW/DO	2030	2130	Blackbutt Lane	ab, rl, cc80%, rh73.3%, t24.9	DOF	nil			
ST/NP	1951	2032	Gate 25 - 66000	hs, rl, cc100%, rh93%, t21.7	DOF	Long-nosed Bandicoot	1	C/F	
						Owlet Nightjar	1	C/T	
						Litoria dentata	numerous	C	
						Litoria fallax	1	C	
						Rodent sp	1	T	

ST/NP	2049	2133	Moyles rd north 70m SB, NB	hs, mc, cc100%, rh73%, t23.6	MOF	Sugar Glider (juvenile)	1	F/T	
						Mixophyes fasciolatus	numerous	C	
ST/NP	2153	2221	81100 - 81500	ls, msb, cc100%, rh 68%, t23.8	DOF/WET	Mixophyes fasciolatus	numerous	C	
						Limnodynastes peronii	numerous	C	
						Litoria fallax	numerous	C	
						Pseudophryne coriacea	numerous	C	
						Microbat sp.	numerous	F	
						Tawny Frogmouth	1	R	
ST/TW	2200	2230	79400	ab, nil, cc0%, rh85%, t17.8	MOF	nil			
NP/TW	2015	2023	Valla Rd north to Deep Crk	ab, rl, rh74.8%, t22.9	MOF/SWF	Sugar Glider	1	T	
NP/TW	2103	2124	Burkes Lane south 150m	ab, rl, cc60%, rh74.5%, t22.7	DOF	Wallaby sp.	1	T/F	
DR/ST	2000	2100	80600 - 80200	ab, rl, cc80%, rh79.7%, t23.6	MOF	Sooty Owl	1	C	
						Short-eared Possum	1	F	
						Long-nosed Bandicoot	2	F	
						Brown tree snake	1	T	R
						Grey Headed Flying Fox	2	F	
DR/ST	2137	2207	Moyles nth to Dalhousie ck sth bnd	ab, n, cc100%, rh82.8%, t22.6	MOF	nil			
DR/DO	2000	2045	80950 - 80600	ab, n, cc75%, rh76%, t24	DOF	Sugar Glider	1	F	
						Limnodynastes peronii	1	F	
DR/DO	2103	2133	73500 -73600 ck	ls, n, cc100%, rh84%, t24.3	MOF	nil			
DR/TW	2000	2049	80550 - 80250 East 30m	ab, n, cc20%, rh74.2%, t24.2	MOF	Sooty Owl	1	C	
						Long-nosed Bandicoot	1	F	
DR/TW	2115	2159	Moyles - Dalhousie ck - 73700	ab, n, cc60%, rh74.4, t23.8	MOF	Mixophyes fasciolatus	5	F	R
						Melomys spp	1	F	
						Sugar Glider	1	F	
						Owlet Nightjar	1	C	
NP/DR	1859	1935	Boggy Creek Rd South 100m	ab, msb, cc20%, rh70.4%, t21.1	DOF/MOF	Grey Headed Flying Fox	1	F/C	
						Litoria fallax	1	C	
						Limnodynastes peronii	numerous	C	
						Crinia signifera	numerous	C	
						Litoria revelata	numerous	C	
NP/DR	1956	2019	Moyles East side 100m south	ab, mlb, cc40%, rh72.3%, t21.1	DOF/MOF	Pseudophryne coriacea	1	C	
NP/BT	1949	2013	Moyles rd 100m north of SB	hs, rl, cc100%, rh95%, t21.4	MOF	Litoria fallax	2	C	
						Mixophyes fasciolatus	numerous	C/F	R
NP/TW	1730	1912	Frosties south	ab, rl, cc40%, rh84%, t23.1	DOF/MOF	Powerful Owl	1	C/F/T	
						Limnodynastes peronii	2	F	R
						Common Ringtail Possum	1	F	

						Microbat spp.	numerous	F	
						Grey Headed Flying Fox	numerous	F/T	
						Short-eared Possum	1	F	
						Litoria peronii	3	C	
NP/TW	1939	2003	Moyles south to Dalhousie tributary	ab, rl, cc45%, rh74.8%, t24	DOF/MOF	Microbat spp.	numerous	F	
						Flying Fox spp	1	F	
NP/TW	2024	2058	Boggy Creek south	ab, rl, cc40%, rh76.8% t21.6	MOF	Sugar Glider	1	F	
						Black Flying Fox	1	T	
						Grey Headed Flying Fox	1	T	
						Litoria fallax	1	C	
TW/DR	1900	1930	80800, West BDY 80750 - 80550	ab, nil, cc90%, rh78.7%, t21.7	MOF	Microbat spp.	numerous	T/F	
TW/DR	1955	2030	Moyles Rd - Dalhousie NB, SB	ab, nil, cc90%, rh70.2%, t21.9	DOF	Tawny Frogmouth	1	R	
						Sugar Glider	1	F	
						White Striped Mastiff Bat	1	C	
TW/DR	2055	2120	North side boggy Creek	ab, nil, cc90%, rh73.6%, t22.6	DOF/MOF	Mixophyes fasciolatus	3	C	
NP/DR	1846	1930	Moyles NB south 100m	ab, rl, cc30%, rh80.9%, t21.6	MOF	Microbat spp.	3	F/T	
DR/NP	1951	2030	Boggy Crk Rd - 62760	ab, rl, cc80%, rh87.4%, t20.9	MOF	Limnodynastes peronii	4	C	
						Black Flying Fox	1	F/C	
						Crinia signifera	numerous	C	
						Rodent spp	1	F	
DR/NP	2049	2120	80630 - 80430	ls, rl cc90%, rh89%, t19.6	MOF	Sugar Glider	1	C	
						Microbat spp	3	F/T	
						Grey Headed Flying Fox	1	F	
BT/TW	2015	2145	Off Short Cut Road	hs, rl, cc100%,	SWF, MOF	Litoria fallax	14	F	R
						Limnodynastes peronii	1	F	R
NP/ST	2009	2114	Moyles north	ab, rl, cc20%, rh77.6%, t23.4	MOF	Mixophyes fasciolatus	2		R
						Microbat spp.	numerous	F/T	
						Limnodynastes peronii	1	C	
						Litoria fallax	2	C	
						Owlet Nightjar	2	C	
NP/ST	2143	2252	Frosties south to 80300	ab, rl, cc60%, rh76%, t20.2	DOF	Limnodynastes peronii	2	F	R
						Mixophyes fasciolatus	1	T	R
						Litoria fallax	1	F	R
						Ramphotyphlops nigrescens	2	T	R
NP/DR	2055	2118	80800 - 80500	ab, msb, cc60%, rh76%, t20.2	MOF	Antechinus sp	1	T	
						Sugar Glider	1	C	
						Grey Headed Flying Fox	1	C	
NP/DO	1849	1913	Boggy Creek Road	ls, msb, cc60%, rh74%, t23.3	DOF	Litoria revelata	1	C	

						Limnodynastes peronii	numerous	C	
						Crinia signifera	numerous	C	
						Black Flying Fox	3	F	
NP/DO	1938	2022	80800 - 80500	ab, mc, cc60%, rh70%, t23.8	MOF	Mixophyes fasciolatus	2	C	R
						Limnodynastes peronii	1	C/F	
						Grey Headed Flying Fox	1	F	
						Litoria peronii	1	C	
						Feathertail Glider	1	T/F	
DO/NP	1849	1926	Boggy Creek Rd - Dam area	ab, mc, cc65%, rh71%, t22.7	MOF	Grey Headed Flying Fox	1	F	
DO/NP	1949	2047	Frosties to Tysons Flat	ab, mc, cc90%, rh76%, t21.2	MOF	Short-eared Possum	2	F	
						Sugar Glider	1	F	
						Tawny Frogmouth	1	R/F	
						Microbat spp	1	F/T	
NP/TW	1954	2018	Valla Rd - 63977	ab, rl, cc0%, rh79.3%, t23.5	MOF	Common Ringtail Possum	1	F	
						Pseudophryne coriacea	numerous	C	
NP/TW	2030	2118	Moyles - Dalhousie Crk	ab, rl, cc10%, rh78.5%, t24.4	MOF	Mixophyes fasciolatus	1	C	R
						Limnodynastes peronii	1	F	R
						Owlet Nightjar	1	C	
DR/NP	1932	2035	80100 Tysons, 80500 gully	ls, msb, cc90%, rh87%, t18.5	DOF/MOF	Limnodynastes peronii	numerous	C	
						Microbat spp	numerous	F	
						Black Flying Fox	numerous	C/F	
DR/NP	2055	2134	Tower Rd South to Drainage line	ls, msb, cc80%, rh82.4%, t19.2	MOF	Microbat spp	numerous	F	
DO/NP	1930	1953	Cut 26 south to drainage line, mainline	hs, mc, cc100%, rh100%, t18.3	MOF	Microbat spp	2	F	
DO/NP	2008	2109	North Median, 80100 - 80200, 80500	hs, mc, cc100%, rh100%, t18.2	MOF	Tawny Frogmouth	1	F	
						Microbat spp	numerous	F	
						Pseudophryne coriacea	1	C	
TW/NP	2030	2135	80100 - 80200 and fence lines	ab, nil, cc20%, rh76%, t20.7	DOF/MOF	Sugar Glider	2	C	
						Tawny Frogmouth	2	F	
						Microbat spp	3	F	
						Flying Fox spp	2	F/C	
						Antechinus sp	1	T	
DO/NP	1854	1915	Boggy Crk, E of bottom dam	hs, msb, cc100%, rh90%, t18.7	DOF	Flying Fox spp	1	F/C	
NP/TW	1845	1920	Boggy Crk to Gordons Knob Rd	ab, rl, cc40%, rh76.1%, t22.4	DOF	Microbat spp	1	F	
NP/TW	1945	2020	Cut 26 south face	ab, nil, cc50%, rh68.5%, t23.7	DOF	nil			
TW/NP	1835	1954	80800 - 80600, 80300	ab, rl, cc20%, rh74.6%, t19.2	DOF/MOF	Sooty Owl	1	C	
						Tawny Frogmouth	1	F	
						Microbat spp	1	F	
						Bandicoot sp.	1	T/F/C	

						Litoria fallax	1	C	
TW/NP	2025	2045	Boggy Crk dam west to LoC	ls, rl, cc95%, rh77%, t17.7	WDL	Flying Fox spp	numerous	C/F/T	
NP/TW	1849	1944	80350 - 80050, 80200 - 80000	ab, rl, cc10%, rh69.5%, t22.1	MOF	Feathertail Glider	2	F	
						Antechinus sp	1	F	
						Long-nosed Bandicoot	1	F	
						Owlet Nightjar	1	C	
						Microbat spp	numerous	F	
						Flying Fox spp	numerous	T/C	
NP/TW	2015	2050	Boggy Crk top dam, south on W BDY	ab, rl, cc10%, rh63.3%, t22.3	DOF	Sugar Glider	1	F	
						Rodent sp	1	F	
						Grey Headed Flying Fox	3	F	
TW/DO	2030	2120	Railway 100m south and north	ab, nil, cc20%, rh87%, t19.5	MOF	Sugar Glider	1	F	
						Grey Headed Flying Fox	numerous	F	
						Microbat spp	numerous	F	
TW/DO	1940	2015	North Dalhousie	ab, nil, cc30%, rh86.5, t19	MOF	Grey Headed Flying Fox	numerous	F	
						Microbat spp	numerous	F	
						Litoria fallax	1	C	
NP/ST	2055	2137	North Median remnants	ab, rl, cc50%, rh86%, t18.1	MOF	Microbat spp	numerous	F	
						Flying Fox spp	numerous	F	
DO/NP	1850	1917	Tysons, Gully at 80200	ab, rl, cc10%, rh62.5%, t16.8	MOF	Flying Fox spp	1	F/C	
						Microbat spp	numerous	F	
						Tree Frog sp.	1	F	
NP/ST	1900	1934	Dalhousie North Riparian Strip	ls, rl, cc90%, rh89.6%, t18	MOF	Feathertail Glider	1	F/T	
						Tawny Frogmouth	1	F	
						Microbat spp	1	F	
						Black Flying Fox	1	C	
NP/ST	1951	2014	Gordons Knob rd - Railway	ls, rl, cc80%, rh84.5%, t18.4	DOF/MOF	Grey Headed Flying Fox	1	F/C	
						Microbat spp	2	F/T	
DR	1915	1940	Railway north to Gordons Knob Road	ab, rl, cc0%, rh62%, t20	DOF	nil			
DR/ST	2015	2120	80500 - 80200, 80100 NB to Tysons Flat	ab, nil, cc0%, rh82%, t18.7	MOF	Sugar Glider	1	F	
						Pteropus sp.	3	F/T	
DR/NP	1830	1910	Short Cut Rd	ab, nil, cc5%, rh76.5%, t16	MOF	Grey Headed Flying Fox	1	F	
						Long-nosed Bandicoot	1	F	
						Litoria peronii	1	F	
DR/NP	1930	2030	Rails Rd - Dalhousie Crk	ab, nil, cc0%, rh73.8%, t16.8	DOF/MOF	Bush Rat	1	F	
						Grey Headed Flying Fox	1	F	
DR/NP	2040	2110	Property access to Cow Creek	ab, nil, cc0%, rh74.5%, t16.2	DOF/MOF	nil			
DR	1810	1940	NB - Dalhousie Crk, SB - Dalhousie to 73225	ls, rl, cc60%, rh82.5%, t17.7	DOF	Grey Headed Flying Fox	numerous	F	

DR/NP	1840	1930	Valla Compound to Cow Crk	ls, rl, cc40%, rh74.9%, t18.5	DOF	Common Ringtail Possum	1	F	
						Litoria dentata	1	F	
						Wallaby sp.	2	T	
DR/NP	1950	2030	Remainder NB + 100m SB Dalhousie	ab, rl, cc25%, rh84%, t15.7	MOF	Grey Headed Flying Fox	numerous	F	
						Macropod sp	1	F	
DR/NP	1931	2010	Rails Road north 200m, 73073 - 73275	ls, rl, cc90%, rh88.8%, t15.6	DOF	Flying Fox spp	numerous	F	
DR/NP	2039	2058	Cow Crk driveway north 100m	ab, rl, cc50%, rh90.4%, t15.5	DOF	Flying Fox spp	numerous	F	
DR/NP	2044	2124	Cnr South Arm and Short Cut Rds	ab, rl, cc30%, rh76.8%, t14.8	DOF/MOF	Noisy Pitta	1	C	
						Flying Fox spp	1	F	
						Litoria dentata	1	F	
						Litoria peronii	1	F	
						Litoria fallax	1	C	
						Swamp Wallaby	1	F	
DR/NP	1842	1907	Cnr South Arm and Short Cut Rds	ls, rl, cc100%, rh83.5%, t16.4	SWF, MOF	Grey Headed Flying Fox	1	F	
						Short-eared Possum	1	F	
						Swamp Wallaby	1	F/T	
						Bandicoot sp.	1	F	
						Litoria peronii	1	F	
						Tawny Frogmouth	1	F/P	
DO/NP	1953	2039	Boggy Creek dams - Railway	ab, mc, cc5%, rh54.1%, t16.3	DOF/MOF	Sooty Owl	1	F/T/P	
						Tawny Frogmouth	2	F/P	
						Common Brushtail Possum	1	F	
						Microbat spp.	numerous	F/T	
DR/NP	1820	1905	Boggy Crk north bank hill	ab, rl, cc10%, rh78%, t12	DOF/MOF	Feathertail Glider	1	F/T	
						Sugar Glider	1	C	
						Limnodynastes peronii	1	F	R
						Black Flying Fox	numerous	F/C	
						Rodent spp	1	F	
DR/NP	1850	1945	Boggy Crk north bank - 73475	ab, nil, cc15%, rh85%, t13.7	DOF/MOF	Sugar Glider	1	C	
						Black Flying Fox	2	F	
DR/NP	2003	2026	Rails Rd north 50m NB	ab, nil, cc20%, rh12.7%, t12.7	DOF	Black Flying Fox	2	C	
ST/NP	1757	1912	Rails rd sb to Dalhousie	ab, nil, cc60%, 78.2%rh, t19.5	DOF	Flying-fox sp	numerous	F/C	
						Wallaby sp.	2	F	
						Sugar glider	1	F	
NP/ST	1810	1841	Valla rd to cow ck	ab, nil, cc10%, rh84%, t17	DOF/MOF	Common Ringtail Possum	1	F	
						Macropod sp	1	F/T	
NP/ST	1858	1922	Rails rd track sb nth 150m	ab, nil, cc20%, rh86%, t16.5	DOF/MOF	Sugar glider	1	F	
						Microbat spp	1	F/T	

						Flying Fox spp	2	F	
NP/ST	1937	2002	School hill rd nth 150m	ab, nil, cc25%, rh88%, t16.1	DOF/MOF	Flying Fox spp	1	F	
NP/TW	1800	1834	Burkes Lane north 250m	ab, nil, cc30%, rh61, t19.7	DOF	Feathertail Glider	1	F	
						Flying Fox spp	2	F	
NP/TW	1844	1907	Rails rd to Dalhousie sb	ab, rl, cc20%, rh66%, t19.3	DOF/MOF	Flying Fox spp	numerous	F	
						Microbat spp	numerous	F/T	
NP/TW	1900	1925	school hill rd - nth 200m	ab, nil, cc30%, rh89%, t17	DOF/MOF	Flying Fox spp	2	F	
NP/TW	2000	2100	Southern end - nth 400m	ab, nil, cc30%, rh87%, t16.6	DOF/MOF	Melomys sp	1	F/T	
NP/TW	2014	2044	7300 - 73100, rails rd sb	ab, rl, cc10%, rh82%, t18.7	DOF	nil			
NP/TW	2055	2115	Burkes lane - 2nd dam	ab, rl, cc20%, 86.9%, t16	DOF/MOF	Feathertail Glider	2	F/T	
						Microbat spp	1	F/T	
						Crinia signifera	numerous	C	
						Macropod sp	1	T	
						Flying Fox spp	2	C	
NP/TW	1806	1837	clearing extent - 69300	ab, rl, cc20%, rh78%, t18.1	DOF	Crinia signifera	numerous	C	
NP/TW	1855	1917	clearing extent - rails rd and remnants	ab, rl, cc20%, rh79%, t17.9	DOF	Microbat spp	2	F/T	
NP/TW	1927	2007	waterfall way sth	ab, msb, cc0%, rh69%, t193.2	DOF	nil			
NP/TW	1824	1907	68550 - 68900	ab, rl, cc70%, rh86%, t18	DOF	Common Ringtail Possum	1	F	
						Long-nosed Bandicoot	1	F	
						Noisy Pitta	1	C	
						Flying Fox spp	numerous	C/F	
NP/TW	1917	1938	Rails rd sb to Dalhousie ck	ab, rl, cc90%, rh89%, t17	MOF	Flying Fox spp	numerous	C/F	
						microbat spp	numerous	F/T	
NP/TW	1939	1956	waterfall way remnants	ab, rl, cc10%, rh83.2, t18	DOF/SWF	Microbat spp	numerous	F/T	
						Purple Swamp hen	1	C	
NP/ST	1900	2000	Jacksons pty sth to drainage line	ab, mlb, cc30%, rh62.4%, t16.2	DOF/SWF	Tawny Frogmouth	1	F/T	
						Crinia signifera	numerous	C	
						Common Brushtail Possum	1	Trapped	
NP/ST	1906	2128	Ballard's nth 150m, full width	ab, mlb, cc5%, rh59.7%, t15.6	DOF/MOF	Koala	1	F	R
						Swamp Wallaby	1	F/T	
NP/ST	2134	2155	12b area, McGraths ck #1	ab, mc, cc0%, 63.6%, t15.5	DOF	Tawny Frogmouth	1	T	
TW/ST	1920	2010	72520 - 72711	ab, rl, cc0%, rh71%, t13.4	DOF	microbat sp	1	T	
TW/ST	2015	2050	71324 - 71660	ab, nil, cc0%, rh88.6%, t11.5	DOF	nil			
TW/ST	2100	2130	67150 - 67250	ab, nil, cc0%, rh87.6%, t11	SWF/DOF	Common Ringtail possum	2	F	
						Sugar glider	1	F	
TW/NP	1800	1850	72601 - 72751	ab, rl, cc0%, rh78%, t14.1	DOF	nil			
TW/NP	1900	1945	71250 - 71500	ab, nil, cc0%, rh77.1%, t13.4	DOF/MOF	nil			
TW/ST	1900	1930	72819 - 72644	ab, nil, cc0%, rh71.7%, t16.5	DOF/SWF	nil			

TW/ST	1942	2015	71600 - 71000	ab, msb, cc0%, rh75.3%, t16.2	DOF	nil			
TW/ST	1850	1940	76280 - 76550	ab, nil, cc40%, rh83.3, t16.3	SWF	Southern Boobook	1	T	
						Grey Headed Flying Fox	2	F/C	
TW/ST	2000	2045	69900 - 69700	ab, nil, cc60%, rh76.%, t16.5	DOF	nil			
BT/TW	1804	1833	76280 - 76550	ab, nil, cc40%, rh84.9, t16.8	SWF	Grey Headed Flying Fox	4	F/C	
BT/TW	1839	1928	69900 - 69705/69530 - 69233	ab, nil, cc40%, rh81.8, t16.6	DOF	Grey Headed Flying Fox	2	F/C	
TW/NP	2030	2120	Gordons Knob rd - 150m sth full width	ab, nil, cc0%, rh7%, t22.1	DOF	Sugar glider	1	F	
						Laughing Kookaburra	1	R	
TW/NP	1840	1915	80300-80300 w + 80350 - 80450	ab, nil, cc0%, rh77.5%, t22.2	DOF	Feathertail Glider	1	F	
						Flying Fox spp	numerous	F/C	
						microbat spp	5	F	
						Rodent spp	1	F	
NP/TW	1930	2010	Tower rd sth - base	ab, nil, cc0%, rh73.3%, t19.3	DOF	Microbat sp	6	F	
						Macropod sp	1	T/F	
TW/NP	1840	1920	80300 - tysons + tysons creek	ab, nil, cc30%, rh0.5%, t20.2	DOF/MOF	Grey Headed Flying Fox	numerous	F/C	
NP/TW	2141	2258	81400 - 81800 + 2 small dams	ab, rl, cc0%, rh76%, t22.9	MOF	Litoria fallax	7	F	R
						Limnodynastes peronii	6	F	R
						Powerful Owl	1	C	
						Owlet Nightjar	2	C	
DR/TW	1830	1900	Moyles, south to Dalhousie Tributary	ab, msb, cc60%, rh77.8%, t20.6	DOF	Microbat spp	numerous	F	
DR/TW	1925	2050	North Median, 80500 - 80100	ab, msb, cc60%, rh77.4%, t20.4	DOF/MOF	Barn Owl	1	C	
						Black Flying Fox	6	F	
DR/TW	2100	2130	Boggy Creek, Dam area	ab, nil, cc30%, rh77%, t20.5	DOF	Black Flying Fox	numerous	F	
TW/NP	1900	1929		ab, nil, cc0%, rh71%, t21.6	DOF	Microbat sp	3	F	
TW/NP	1945	2015		ab, nil, cc0%, rh76%, t18.8	DOF/SWF	Microbat sp	2	T/F	
						Wallaby sp.	1	T	
TW/NP	1800	1850	69100 - 69250	ab, nil, cc70%, rh71%, t21.2	DOF	Yellowtail black cockatoo	1	R	
					DOF	Microbat	1	T/F	
TW/NP	1915	2000	Rails road nth & nth bnd remaining	ab, nil, cc60%, rh73%, t22.5	DOF	Microbat	1	F	
						Owlet Nightjar	1	C	
TW/ST	1900	1950	waterfall way sth	ab, rl, cc10%, rh80.4%, t17.7	DOF	Long-nosed Bandicoot	2	T	
						Swamp Wallaby	2	T	
						House mouse	1	T	
TW/ST	2010	2110	68900 - 69250	ab, nil, cc, rh3%, t18.2	DOF	Feathertail Glider	4	F	
						Long-nosed Bandicoot	2	F	
						Black rat	1	F	
						Little Red Flying Fox	numerous	F/C	

TW/ST	2115	2220	Dalhousie ck, rails sth 150m	ab, nil, cc0%, rh79%, t17.3	DOF/MOF	Common Ringtail possum	1	F	
						Red-necked Wallaby	1	T	
TW/ST	1800	1840	69050 - 2nd dam	ab, nil, cc0%, rh72.2, t22.6	DOF/MOF	Long-nosed Bandicoot	1	F	
						Feathertail Glider	1	T	
						Grey Headed Flying Fox	1	F	
TW/NP	1800	1845	70060 - 70280	ab, nil, cc0%, rh79.3%, t14.2	DOF	Microbat sp	2	F	
TW/ST	1945	2040	70060 - 70280	ab, rl, cc40%, rh82%, t14.3	DOF	Microbat sp	1	F	
TW/ST	2100	2130	Gate 111 - 82500	ab, nil, cc30%, rh85.2%, t13	SWF/DOF	nil			
BT/TW	1801	1838	Burkes	ab, rl, cc0%, rh86.6, t13.1	DOF	nil			
DR/DO	1900	1930	School hill rd, w - cut 31	ab, rl, cc10%, rh80.5, t18.8	MOF/SWF	Grey Headed Flying Fox	>5	F	
						Cat	1	T	
DR/DO	1950	2040	Rails rd nb - 72900	ab, rl, cc0%, rh83.4%, t18.3	MOF	nil			
DR/DO	2050	2140	69300 - 69700	ab, rl, cc10%, rh80.4, t18.8	DOF	nil			
NP, DO	1950	2021	150m sth driveway between east/west & Burkes	ab,rl,cc45%,rh66%,t25.4		Grey-headed flying-fox	3	F	
NP, DO	2035	2100	73800-73700	ab,rl,cc75%,rh70%,t23.4		Lim. peronii	1	C	
						Pseudophyrne coriacea	Numerous	C	
NP, DO	2127	2150	79500-79800	ab,rl,cc60%,rh67.2%,t23.5		Little-red Flying-fox	1	Fl	
DO, NP	1938	2015	North from access g to Tyson's	ab,nil,cc30%,rh85.5%,t21.2		Grey-headed Flying-fox	2	F	
						Little-red Flying-Fox	1	F	
						Sugar Glider	1	C	
DO, NP	2039	2130	100m sth tower rd; 73700-73800	ab,rl,cc50%,rh73%,t21.2		Bandy Bandy	1	T	R
						Red-backed Toadlet	1	F	
						Sugar Glider	2	F	
						Small-eared Possum	1	F	
						Lim peronii	Numerous	C	
						Crinia signifera	Numerous	C	
DO, NP	2140	2210	Driveway sth to Burke's	light,rl,cc60%,rh83%,t21.6		Sugar Glider	1	F	
						Feathertail Glider	1	F	
ST, NP	2000	2100	Sth side Tower Rd	ab,rl,cc10%,rh75%,t22		Feathertail Glider	1	F	
BT, TW	2115	2225	72000-72600	ab,nil,cc90%,rh83%,t21.9		Red-backed Toadlet	1	C	R
BT, TW	1945	2045	81500-81700	an,nil,cc10%,rh82%,t22.2		Dwarf Tree Frog	2	C	R
						Lim peronii	4	C	R
BT, TW	2015	2155	74900-74500	light,nil,cc90%,rh89%,t22		Pseudophryne coriacea	1	C	R
						Owlet Nightjar	1	C	
						Common Ringtail Possum	1	F	
BT, TW	2035	2205	Ballard's rd	ab,msb,cc10%,rh36%,t25.1		Pteropus sp	1	F	
BT, TW	2025	2120	E side short cut rd	ab,rl,cc80%,rh60%,t26		Litoria fallax	11	C	R

BT, TW	2220	2310	E side short cut rd	ab,nil,cc90%,rh73%,t23		Litoria fallax	8	C	R
						Limnodynastes peronii	2	C	R
						Freshwater Crayfish	1	C	R
BT, TW	2000	nr	71900-72600	ab,mlb,cc90%,rh74%,t22.6		Grey-headed flying-fox	1	F	
						Litoria fallax	>10	C	
						Littoral peronii	5	C	
						Adelotus brevis	2	C	
DR, TW	2230	2310	76920-76750	ab,nil,cc0%,rh80%,t21.8		Nil			
DR, TW	2210	2250	Cut 26 to cut 27	ab, rl, cc100%,rh78.7,t20.9		Brown Tree Snake	1	T	R
						Pseudophryne coriacea	5	C	
						Owlet Nightjar	1	C	
						Pink Tongue Skink	1	T	R
DR, TW	2155	2235	66700-66925	ab, msb,cc100%,rh76.4,t21.6		Cat	1	T	
						Litoria fallax	1	C	
						Common Ringtail Possum	1	F	
DR, NP	1110	1145	Nth side Ballard's & car park basin	ab,nil,cc10%,rh65%,t23		Little Red Flying-fox	1	F	
DR, NP	2030	2130	78800-79250	ab,nil,cc30%,rh65%,t24		Little Red Flying-fox	Numerous	F	
						Grey-headed flying-fox	Numerous	F	
						Littoral fallax	Numerous	F	
						Mixophyes fasciolatus	1	T	R
						Carpet Python	1	T	R
						Melomys spp	2	F	
						Wallaby spp	2	T	
						Owlet Nightjar	1	C	
DR, NP	2250	2310	Nth & sth cut 27	ab,nil,cc35%,rh65%,t24		Nil			
NP/TW	1837	1924	61250 - 61450	ab,nil,cc0% 68% t13.2	DOF	Nil			
NP/TW	1932	2022	Jacksons remnants	ab,rl,cc10%,rh74%,t12.8	SWF/DOF	Microbat spp	2	F	
NP/TW	1735	1818	61250 - 61450	ab,nil,cc20%,rh71.9%,t13.6	DOF	Microbat spp	1	F	
NP/TW	1825	1917	Jacksons remnants	ab,nil,cc10%,rh76.3%,t12.2	DOF/SWF	Nil			
NP/TW	1735	1812	Old coast to railway remnants	ab,nil,cc0%,rh86.3%,t10.2	DOF	Grey Headed Flying Fox	1	F	
						Microbat spp	1	F	
NP/TW	1821	1853	Jacksons remnants	ab,nil,cc0%,rh71.2%,t12.6	SWF	Feathertail Glider	1	F	
						Grey Headed Flying Fox	1	F	
NP/TW	1803	1847	61350 - railway	ab,nil,cc20%,rh73.4%,t13.2	DOF	Southern Boobook	1	R	
						Microbat spp	1	F	
						Grey Headed Flying Fox	1	F	
NP/TW	1900	1938	Jacksons remnants	ab,nil,cc0%,rh68.9%,t12.8	SWF	Nil			
NP/TW	1811	1832	Boggy ck interchange E hwy	ab,nil,cc20%,rh80.9%,t12.5	DOF	Nil			

NP/TW	1842	1925	Jacksons rd remnants	ab,nil,cc10%,rh79.2%,t13.5	SWF/DOF	NIL			
NP/TW	1800	1848	61350 - 61650	ab, nil, cc10%, rh71%, t12.1	DOF	Macropod spp	1	T	
NP/TW	1910	1952	Mines - Jacksons	ab,nil,cc30%,rh60%,t13.3	DOF/SWF	Nil			
NP/TW	1835	1924	Jacksons remnants	ab, nil, cc0%,rh64%,t13.2	DOF/MOF	Nil			
TW/ST	1800	1842	82250 - 82450 west	ab, nil, cc0%,rh73.1,t12.2	SWF	Nil			
TW/ST	1905	1938	Jacksons remnants	ab, nil, cc20%,rh78.3,t12.9	DOF/SWF	Nil			
NP/TW	1902	1942	61330 - 61520	ab,nil,cc10%,rh72%,t13.7	DOF	Microbat spp	1	F	
NP/TW	1959	2038	Mines - Jacksons	ab,nil,cc20%,rh76.1%,t13.1	DOF	Nil			
NP/TW	1813	1836	Boggy ck riparian	ab,rl,cc0%,rh76.7%,t12.5	Riparian	Swamp Wallaby	1	F	
NP/TW	1847	1920	Ironbark trail - 61350	ab,nil,cc0%,rh74.8%,t13.2	DOF	Nil			
NP/TW	1930	2000	Mines - Jacksons	ab,rl,cc10%,rh79.4%,t13.1	SWF/DOF	Nil			
NP/TW	1812	1937	East west clearing - 66764	ls,msb,cc85%,rh88%,t14.8	DOF/MOF	Grey Headed Flying Fox	1	F/C	
						Tawny Frogmouth	1	F/R	
						Crinia signifera	3	C	
NP/DO	1804	1854	East west rd, sth 800m	ab,nil,cc10%,rh64%,t12.3	DOF/garden	Common Ringtail Possum	2	F	
						Grey Headed Flying Fox	3	T	
NP/ST	1805	1914	East west rd, sth 700m	ab,mlb,cc40%,rh76%,t14.3	DOF	Common Ringtail Possum	1	F	
						Grey Headed Flying Fox	1	F/T	
						Crinia signifera	2	C	
NP/TW	1834	1855	Mines rd sth 150m	ab,mlb,cc40%,rh46.6%,t16.8	DOF	Nil			
NP/TW	1903	1942	Ballard's rd to rails remnants	ab,mlb,cc50%,rh47%,t16	DOF	Nil			
NP/ST	1725	1830	Driveway nth burkes to Jacksons property	ls,rl,cc95%,rh81.7%,t21.3	MOF/DOF/SWF	Common Brushtail Possum	1	F	
						Common Ringtail Possum	1	F	
						Feathertail Glider	1	F	
						Tawny Frogmouth	1	R	
						Litoria peronii	1	C	R
						Crinia signifera	Numerous	C	
						Limnodynastes peronii	2	C	
NP/ST	1850	1943	School hill rd - cut 31	ls, rl, cc80%,rh79.2%, t17	SWF	Nil			
NP/TW	1850	1935	81650 - 81900	ab,nil,cc0%rh69.8%,t18.3	SWF	Flying Fox spp	Numerous	C/F	
						Purple Swamp Hen	1	F	
						Crinia signifera	Numerous	C	
						Red-browed finch	2	R	
NP/TW	1755	1819	Boggy ck riparian	ab,mlb,cc40%,rh48%,t16	DOF,RIP	Nil			
NP/TW	1725	1800	100m sth mines rd, nth to easement	ab,nil,cc80%,rh76.6%,t17.6	DOF	Flying Fox spp	1	T	
NP/TW	1808	1836	Ballard's - rails remnants	ab,nil,cc80%,rh76%,t17.1	DOF	Southern Boobook	1	F	

						Microbat spp	1	F	
						Sugar Glider	1	F	
NP/ST	2008	2058	Ballard's - rails remnants	ab,msb,cc30%,rh73.7%,t16	DOF	Short eared Possum	1	F	
						Sugar Glider	1	F	
NP/ST	2100	2150	McGraths cks, Mines rd 200m sth	ab,msb,cc30%,rh77.5%,t16.7	DOF	Crinia signifera	Numerous	C	
						Sugar Glider	1	F	
						Common Ringtail Possum	1	F	
NP/DO	1805	1900	Nth ballards rd - rails rd	ab,rl,cc0%,rh87%,t15.1	DOF/RIP	Long-nosed Bandicoot	1	F	
NP/DO	1907	937	McGraths ck, 12b	ab,rl,cc5%,rh86%,t14.38	RIP/MOF	Flying Fox spp	2	F	
						Crinia signifera	Numerous	C	
DR/NP	2050	2120	100m of NB side north of School Hill Rd.	ab,rl,cc75%,rh84.6%,t16.1	MOF	Sugar Glider	1	F	
						Grey Headed Flying Fox	1	F	
DR/NP	1900	2000	Waterfall Way to 82800	ab,rl,cc25%,rh78.1%,t18.2	DOF	Short eared Possum	1	F	
						Grey Headed Flying Fox	Numerous	F/C	
						Crinia signifera	Numerous	C	
DR/NP	2030	2100	Dalhousie - Track on ridge	ab,rl,cc25%,rh74.3%,t1.5	MOF	Sugar Glider	1	C	
						Grey Headed Flying Fox	Numerous	F	
NP/ST	1900	2100	East West Rd - 66678	ab,rl,cc90%,rh10%,t13.3	DOF	Sugar Glider	1	Emerging	
NP/ST	1900	2100	East West Rd - 66678	ab,rl,cc10%,rh68%,t12.1	DOF	Sugar Glider	1	F/T	
NP/ST	1900	2100	East West Rd - 66678	ab,msb,cc10%,rh0%,t9.5	DOF	Sugar Glider	1	F	
						Feathertail Glider	1	F/T	

Table B5: Fauna mortality recorded during the clearing phase of the N2U upgrade.

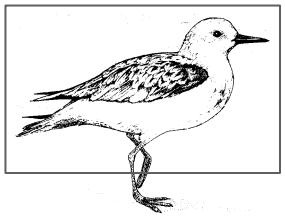
Date	Species	Individuals	Location	Clearing	Habitat Tree	Earthworks	Vehicle Movement	Comment
6.12.13	Bandy Bandy	1	Ballard's Road			x		
7.1.14	Eastern Yellow Robin	1	Cut 27 access track				x	
29.1.14	Swamp Wallaby	1	Access Rd G				x	
24.1.14	Carpet Python	1	floodplain nth Kalang				x	
24.1.14	Carpet Python	1	floodplain nth Kalang				x	
20.1.14	Red-bellied Black-Snake	1	Gossips Road				x	
1.14	Red-bellied Black-Snake	1	floodplain nth Kalang				x	
22.1.14	Sugar Gliders	3	Blackbutts Lane		x			H190; two died on impact & 1 euthanased by vet
7.3.14	Feathertail Glider	1	nth Access G		x			Top snapped off tree during removal
24.3.14	Large snake (prob python)	1	79200	x				
2.14	Dwarf Crowned Snake	1	Fill 26	x				
24.3.14	Swamp Wallaby	1	Access Rd G				x	
13.12.13	Swamp Rat	1	81600					dead in middle of ballast day after clearing
3.4.14	Land Mullet	1	Sth Deep Ck Rd	x				Euthanased
3.4.14	*Saiphos equalis*	1	Nth Deep Ck Rd	x				
4.4.14	Red-bellied Black-Snake	1	Nth Access G			x		
24.3.14	Carpet Python	1	72900	x				
26.3.14	Swamp Wallaby	1	Access Rd G				x	
9.5.14	Land Mullet	1	Cow Creek (sth of)	x				
2.4.14	*Eulamprus tenuis*	1	Blue hills rd	x				
25.3.14	Rainbow Lorikeet	1	Blackbutts Lane		x			Thrown from hollow.
11.4.14	Short Eared Possum	1	80600		x			Was spotted during spotlight survey at the top of H480 on the night before removal. Tree was taken down after only 24 hours due to LL needing to install drainage before the weekend. Euthanased by VET.
23.5.14	Green Tree Snake	1	Burkes lane		x			Euthanased
7.6.14	*Litoria peronii*	1	Cedar creek		x			Euthanased
10.7.14	Sugar Glider	2	Auld close		x			Died due to crush injury. Crushed when hollow was knocked out of HBT during initial grubbing and run over.
31.3.14	Owlet Nightjar	1	Nth median		x			Tree fell during clearing
11.4.14	Dwarf-crowned Snake	1	Moyles Road	x				Found dead near clearing front

Table B6: Results of road-kill surveys along the existing Pacific Highway between Waterfall Way and Nambucca Heads.

Date	Species	Accuracy	Location/nearest intersection (Carriageway)	Adj Clearing	Adj clearing within 48hrs	Concrete Barriers	Temp Fauna Fence
17.12.13	Swamp Wallaby	definite	100m sth Ballads Rd	no	no	no	no
17.12.13	Short-beaked Echidna	definite	100m sth Tower Rd intersection	no	no	no	no
17.12.13	Brushtail Possum	definite	sth Dorrigo interchange	no	no	no	no
13.1.14	Unidentified bird	na	Sth Urunga speed camera	no	no	no	no
16.1.14	Tawny Frogmouth	definite	Urunga Tourist Info Centre	no	no	no	no
16.1.14	Red Fox (prob)	probable	just sth Deep Ck	no	no	no	no
16.1.14	unid mammal	na	Sth Urunga speed camera	no	no	no	no
16.1.14	Swamp Wallaby	definite	Burkes Lane	no	no	no	no
28.1.14	Common Brushtail Possum	definite	100m sth Martells Rd	no	no	no	no
30.1.14	Unid black bird	na	Kalang River Bridge	no	no	no	no
2.2.14	Swamp Wallaby	definite	Burkes Lane	no	no	no	no
3.2.14	Cat	definite	Urunga BP	no	no	no	no
6.2.14	Common Brushtail Possum	definite	200m nth Ballard's	yes	no	no	no
17.2.14	Swamp Wallaby	definite	Short-cut Road	no	no	no	no
17.2.14	Catbird	probable	Sth Urunga speed camera	no	no	no	no
24.2.14	Swamp Wallaby	definite	Deep Ck	yes	no	no	no
24.2.14	Tawny Frogmouth	definite	Blackbutts Lane	yes	no	no	no
24.2.14	Unid snake	na	1km sth Urunga	no	no	no	no
24.2.14	Unid black bird	na	Urunga BP	no	no	no	no
20.2.14	Common Ringtail Possum	probable	nth side Deep Ck	yes	yes	no	no
7.3.14	Common Brushtail Possum	definite	100m sth Martells Rd	no	no	no	no
5.3.14	Common Brushtail Possum	definite	Valla Beach turnoff	yes	no	no	no
6.3.14	Unid bird	na	100m nth Ballard's rd	yes	no	no	no
17.3.14	Brushtail Possum	probable	600m sth Martells	no	no	no	no
18.3.14	Swamp Wallaby	definite	Jacksons property	no	no	no	no
18.3.14	Cat	definite	200m nth BP Urunga	no	no	no	no
24.3.14	unid mammal	na	Deep Ck rd intersection	yes	yes	no	no
24.3.14	unid mammal	na	100m sth Ballard's	yes	yes	no	no
14.3.14	Common Brushtail Possum	definite	Deep Crk bridge Sth bound	yes	yes	yes	no
1.4.14	Rainbow Lorikeet	definite	200m nth Urunga speed camera	no	no	no	no
1.4.14	Common-ringtail Possum	definite	Valla Rd intersection	yes	no	no	no
1.4.14	unid bird	na	Urunga speed camera	no	no	no	no
1.4.14	unid mammal	na	1km sth Urunga speed camera	no	no	no	no
2.4.14	Brushtail Possum	probable	200m nth East/West rd	yes	no	no	no
8.4.14	Brushtail Possum	definite	400m nth Burkes Lane	no	no	no	no
15.4.14	Brushtail Possum	definite	100m nth Deep Ck Rd	yes	yes	no	no
15.4.14	Macropod spp	definite	100m sth Valla Bch Rd	yes	no	no	no
5.5.14	Bandicoot spp	definite	250m nth Urunga BP	no	no	no	no
6.5.14	Unidentified bird	na	200m nth Urunga BP	no	no	no	no
5.5.14	Brushtail Possum	definite	200m sth Martells Rd	no	no	no	no
5.5.14	Unidentified mammal	na	200m sth Valla Bch Rd	yes	no	no	no
7.5.14	Tawny Frogmouth	definite	Boggy Ck Rd	yes	no	no	no
8.5.14	Eastern Grey Kangaroo	probable	sth side Urunga	no	no	no	no
5.5.14	Unidentified mammal	na	Deep Ck rd intersection	yes	no	no	no
13.5.14	Unidentified bird	na	Auld Close	no	no	no	no
13.5.14	Grey-headed Flying-fox	probable	Urunga speed camera	no	no	no	no
30.4.14	Goulds Wattled Bat x 2	definite	Cow Creek	no	no	no	no
15.5.14	Medium mammal (Hare)	probable	BP Urunga (SB)	no	no	no	no
15.5.14	Brushtail Possum	definite	Dalhousie Ck (NB)	no	no	no	no
15.5.14	Swamp Wallaby	definite	East/West Rd 50m sth (NB)	yes	no	no	no
15.5.14	Lace Monitor	definite	Dalhousie Ck - 50m sth (NB)	no	no	no	no
15.5.14	Bird spp	definite	Valla Bch Rd 150m sth (SB)	yes	no	no	no
16.5.14	Tawny Frogmouth	definite	Urunga visitors centre	no	no	no	no
20.5.14	Tawny Frogmouth	definite	Short Cut Rd int - 100m nth (NB)	no	no	no	no
20.5.14	Small mammal	definite	Urunga - Honey Bee (SB)	no	no	no	no
20.5.14	Swamp Wallaby	definite	Ballard's Rd int (SB)	yes	no	yes	no
20.5.14	Bird spp	definite	Jacksons property (SB)	no	no	no	yes
20.5.14	Bird spp	definite	Deep ck bridge (SB)	yes	no	no	no
20.5.14	Swamp Wallaby	definite	Link Rd (SB)	no	no	no	no
23.5.14	Unid mammal (lrg)	definite	Valla Beach Rd 100m sth (NB)	yes	no	no	no
23.5.14	Bird spp	definite	Deep Ck rd 50m sth (SB)	yes	no	no	no
27.5.14	Large mammal	definite	Hungry Head rd 100m sth (SB)	no	no	no	no
30.5.14	Tawny Frogmouth	definite	Urunga, 150m nth Pilot St (SB)	no	no	no	no
5.6.14	Unid spp (lrg)	na	Valla Rd intersection (NB)	yes	no	yes	no
5.6.14	Common Ringtail Possum	definite	Urunga 500m sth speed camera (NB)	no	no	no	no
5.6.14	Magpie Lark	probable	Urunga 500m sth speed camera (NB)	no	no	no	no
16.6.14	Swamp Wallaby	definite	Pearl Estate intersection (SB)	yes	no	no	no
17.6.14	Swamp Wallaby	definite	Martells Rd 100m sth (SB)	no	no	no	no
19.6.14	Unid mammal (lrg)	na	East/West Rd 50m nth (NB)	yes	no	no	no
19.6.14	Medium mammal	definite	Fairbrothers Rd 100m nth (NB)	no	no	no	yes
23.6.14	Medium mammal	definite	Urunga 500m nth BP (NB)	no	no	no	no
23.6.14	Swamp Wallaby	definite	Oyster Drive 300m sth (SB)	no	no	no	yes
30.6.14	Wallaby spp	definite	Deep Ck Rd 100m sth (NB)	yes	no	yes	no
4.7.14	Common Ringtail Possum	possible	Urunga Honey Bee (SB)	no	no	no	no
4.7.14	Short-beaked Echidna	definite	Martells Rd 100m sth (SB)	no	no	no	no

6.7.14	Large mammal	na	Link Rd (NB)	yes	no	no	no
6.7.14	Small mammal	na	McGraths Ck (NB)	no	no	no	yes
8.7.14	Tawny Frogmouth	probable	Cedar Ck (NB)				
8.7.14	Tawny Frogmouth	probable	East/West Rd 50m sth (SB)	yes	no	no	no
8.7.14	Red Fox	definite	Valla Beach Rd 100m sth (NB)	yes	no	no	no
9.7.14	Large mammal	na	Deep Ck rd 600m nth (SB)	yes	no	no	no
14.7.14	Large mammal	na	Burkes Lane 500m nth (SB)	yes	no	no	no
25.7.14	Wallaby spp	possible	100m nth Oyster Drive (NB)	yes	no	no	nearby
25.7.14	Medium mammal	possible	Dalhousie Ck (NB)	no	no	no	no
25.7.14	Eastern Grey Kangaroo	definite	Urunga - Honey Bee (SB)	no	no	no	no
29.7.14	Short eared possum (& joey)	definite	200m sth Valla Rd (NB)	no	no	no	no
29.7.14	Southern Boobook	probable	Deep ck bridge (NB)	no	no	no	no
1.8.14	Bird spp	definite	Urunga - Honey Bee (SB)	no	no	no	no
1.8.14	Common Ringtail Possum	probable	150m nth Short Cut Road	no	no	no	no
4.8.14	Red-necked Wallaby	definite	80m nth Oyster Drive	no	no	no	nearby
7.8.14	Large mammal	definite	Jacksons property (SB)	no	no	no	nearby
7.8.14	Small bird	probable	50m nth East/West Road	yes	no	no	no
30.8.14	Small mammal	na	Short Cut Rd 600m nth (NB)	yes	yes	no	no
30.8.14	Blue Tongue Lizard	definite	Valla Beach Rd 800m sth (SB)	yes	no	no	no
30.8.14	Tawny Frogmouth	probable	McGraths Ck (SB)	no	no	no	yes
29.9.14	Bird spp	definite	Deep Ck 100m nth (NB)	yes	no	no	no
29.9.14	Kookaburra	definite	Burkes Lane 150m nth (NB)	no	no	no	no
29.9.14	Bird spp	definite	Oyster Drive 100m sth (NB)	yes	no	no	no
29.9.14	Medium mammal	definite	McGraths Ck 200m nth (NB)	no	no	no	no
29.9.14	Common Brushtail Possum	definite	Martells Rd 100m sth (NB)	no	no	no	no
29.9.14	Medium mammal	definite	Kalang River 50m nth (NB)	no	no	no	no
29.9.14	Medium mammal	definite	Short Cut Rd 300m north (SB)	no	no	no	no

Attachment 5
Annual Flora and Fauna Monitoring Summary Report



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12 December 2014

Sandpiper Ecological Surveys

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Dear Jenny,

RE: Summary of ecological monitoring in year one of the Nambucca Heads to Urunga Upgrade.

Following is a summary of fauna related ecological monitoring undertaken in year one of the Nambucca Heads to Urunga (NH2U) Pacific Highway Upgrade. Monitoring requirements for the NH2U upgrade are summarised in the "Warrell Creek to Urunga Pacific Highway Ecological Monitoring Program" (Benchmark Environmental Management 2013). Specifically, Table 3.1 (pg 17) summarises the timing and duration of monitoring for each mitigation measure. Mitigation measures relevant to fauna are listed in Table 1 with a summary of present status and a list of reports completed. Letter reports are attached and major reports are provided separately.

Clearing report

The clearing report covers the period from December 2013 to July 2014, which encompasses virtually all clearing required for the project. Some small (<50m^2) areas of clearing have occurred since July, however, none of these has involved removal of Hollow-bearing Trees (HBT's). Survey methods applied during the clearing phase included, pre-clear inspections (active search), spotlight surveys (including wetland frog surveys), targeted ground trapping and stag watching and inspection of HBT and resulted in the relocation of 480 individuals from 54 species. Survey effort was substantial with a total of 719 habitat trees inspected, 350 preclear surveys and 310 spotlight surveys completed. The proportion of occupied HBT recorded at NH2U (35%) was equivalent to Sapphire to Woolgoolga (35%) and Glenugie (38%) but substantially greater than the Hunter Expressway (HEX) KK2B (22%) and Karuah to Bulahdelah (20%). The mortality rate during clearing at NH2U (3.3%) was comparable to several other studies, including HEX (4%), Karuah to Bulahdelah (4%), Glenugie (4%), Sapphire to Woolgoolga (3%) and Coopernook to Herons Creek (3%).

Fish salvage occurred at 22 sites between January and November 2014 (Tables 2 & 3). Twenty-five species were captured, including 4 amphibians, 14 fish, 1 crayfish, 4 shrimp and 2 reptiles (turtles). Three species of exotic fish were recorded. A total of 47,478 individuals were captured and 38,433 were released. 4384 individuals died in transit to release sites and 4661 exotic individuals were euthanased.

Bat box monitoring

Bat box monitoring was undertaken in winter/spring 2013, summer, autumn, winter and spring 2014. Monitoring results are positive with southern myotis (Myotis macropus) recorded at the Boggy Creek Bridge and Gould's long-eared bat (Nyctophilus gouldii) recorded at nine sites. Feathertail glider (Acrobates pygmaeus) dens have been recorded at three sites. !lthough Gould's long-eared bat is not an obligate cave dweller and was therefore not targeted by the bat box program its use of the bat boxes is positive and indicates that such boxes can provide habitat when installed in clusters.

Flyway Monitoring

Monitoring of microbat flyways on either side of the upgrade was conducted at locations corresponding to culverts situated on the existing highway. Photographs of the flyway were taken prior to or immediately after clearing. All locations (culverts) containing bats were sampled prior to clearing. Monitoring has shown no impact of initial clearing on flyway quality, although most sites either do not contain a flyway or the flyway has been totally removed by approved clearing.

Sites that contained microbats, for example, Cow Creek and Jacksons Creek north, also had flyways. However, the flyway at both sites has been removed by the approved clearing. Ongoing monitoring of flyways is not supported due to the absence of viable flyways.

Fauna Underpass and Exclusion Fence

The first stage of the construction phase underpass monitoring was conducted in Oct/Nov 2014 and the second stage is scheduled for Feb/Mar 2015. Agreement was reached with RMS that construction phase monitoring would focus on underpass structures only and exclusion fence monitoring would occur during the operational phase. Monitoring was undertaken at seven underpasses within the upgrade and one reference site. RMS, EPA and Lend Lease agreed that a single reference (control) site was appropriate given that the monitoring budget was approved prior to monitoring and the monitoring budget was approved prior to commencement of monitoring and because the Ecological Monitoring Program does not specify the number of controls required. Sample sites differed to those listed in the EMP due to differences in the construction status of the various sites (i.e. some underpasses were complete whilst others were in the early stages of construction) and the presence of temporary exclusion fence, which may influence underpass use.

Methods applied were:

- Sand pads – one sand pad was installed in the centre of each underpass cell and sampled weekly for four weeks.
- Underpass cameras – two motion activated infra-red camera was installed near the end of each underpass cell or in the centre of divided cells.
- Scat & track searches of underpasses – searches for fauna scats and tracks were conducted in each underpass on three occasions.
- Spotlight survey of underpasses – undertaken on three occasions, with the primary focus being detection of amphibians.
- Spotlight survey of adjacent forest – undertaken on two occasions within 100m either side of each underpass end.
- Camera trap survey of adjacent forest – one motion activated infra-red camera was installed in vegetation within 50m of the entrance/exit of each underpass. Cameras were aimed at a bait station and left in place for 3 weeks.
- Active searches – two active searches were undertaken within 1ha plots in forest at the entrance/exit to each underpass.
- Background review – data collected during pre-clearing surveys within 500m of each underpass and from camera trap surveys for spotted-tailed quoll within 500m of each underpass.

Data from the Oct/Nov 2014 surveys has not been summarised and the monitoring report is not due until after completion of the second stage of sampling in Feb/Mar 2015. Preliminary evidence indicates that the survey methods are adequate to detect use of underpasses, although spotlight surveys of underpasses, which are aimed at amphibians, were affected by dry weather. As a consequence only three of the planned five surveys were completed. The additional surveys will be completed during stage two.

Nest Box Assessment and Monitoring

An assessment of the remaining 40% of nest boxes to be installed is presently being undertaken as required by the EMP. The assessment is due for completion in early 2015 and the remaining nest boxes will be installed in summer/autumn 2015.

Please contact me on 0401 195 480 if you have any questions regarding the information provided. Yours

Faithfully

Dr David Rohweder
Senior Ecologist

References

Benchmark Environmental Management (2013). Warrell Creek to Urunga pacific Highway Upgrade Ecological Monitoring Program: Stage 1 Nambucca to Urunga. Report prepared for Roads and Maritime Services.

Table 1: Overview of fauna related ecological monitoring undertaken for the NH2U upgrade in 2013/14.

Mitigation Measure	Status	Documentation
Pre-clear & clearing procedures	The majority of clearing was completed by August 2014.	A clearing report has been prepared and is included as a separate document. A list of fish salvage reports is included in Table 2.
Green-thighed Frog	Monitoring required in operational phase only. Pre-clear surveys discussed in clearing report.	Refer to clearing report for details of pre-clear surveys.
Giant Barred Frog	Confirmation attained that giant barred frog does not occur within the project corridor and targeted surveys not required.	Refer to letter from Lewis Ecological dated 9 February 2013.
Microbat roost box monitoring	Monitoring has been undertaken quarterly since spring 2013.	Letter report on flyway monitoring included as a separate document.
Microbat habitat monitoring	Initial flyway monitoring was conducted prior to or immediately after clearing at sites specified in microbat management strategy.	
Fauna underpass & exclusion fence monitoring	Agreement was reached with RMS that exclusion fence monitoring would occur during the operational phase only. The first construction stage underpass monitoring event commenced in October 2014. The second construction stage underpass monitoring is scheduled for Feb/Mar 2015	A letter summarising the methods and preliminary results of the first operational phase monitoring is detailed above.
Vegetated median	Operational phase only	N/A
Nest Box monitoring	Commence in year 3 of construction phase. An assessment of remaining nest box requirements using data collected during clearing is presently being prepared.	N/A

Table 2: NH2U fish translocation reports

Report Name	Report Date
NH2U_Gossips Dam_Fish Translocation Report	8/1/2014
NH2U_Unnamed Creek Sth Arm Rd_Fish Translocation Report	11/2/2014
NH2U_Ch65500 Farm Dam_Fish Translocation Report	21/2/2014
NH2U_Access Rd G Dam_Fish Translocation Report	14/3/2014
NH2U_Oyster Creek Tributary_Fish Translocation Report	21/3/2014
NH2U_Short Cut Rd Dam_Fish Translocation Report	24/3/2014
NH2U_Blue Hills Rd Dams_Fish Translocation Report	10/4/2014
NH2U_Boggy Ck Dam_Fish Translocation Report	2/6/2014
NH2U_Gate 112 Dam_Fish Translocation Report	5/6/2014
NH2U_Tysons Flat Unnamed Ck_Fish Translocation Report	5/6/2014
NH2U_Cow Creek_Fish Translocation Report	6/8/2014
NH2U_Tysons Flat Creek Diversion_Fish Translocation Report	12/8/2014
NH2U_Cedar Creek_Fish Translocation Report	12/8/2014
NH2U_Boggy Creek_Fish Translocation Report	13/8/2014
NH2U_Gate 105 Wetland_Fish Translocation Report	14/8/2014
NH2U_Bridge 25 Channel_Fish Translocation Report	17/8/2014
NH2U_Boggy Ck Dam 2_Fish Translocation Report	9/10/2014
NH2U_McGraths Creek_Fish Translocation Report	9/10/2014
NH2U_Oyster Creek_Fish Translocation Report	23/10/2014
NH2U_Cedar Creek west_Fish Translocation Report	23/10/2014
NH2U_Gate 105 Wetland_Second Fish Translocation Report	23/10/2014
NH2U_McGraths Creek Trib_Fish Translocation Report	6/11/2014

Table 3: NH2U Fish salvage assessment reports

Report Name	Report Date
NH2U_Access Rd G Dam_Assessment Report	6/2/2014
NH2U_Short Cut Rd Dam_Assessment Report	6/2/2014
NH2U_Oyster Ck Dam_Assessment Report	6/2/2014
NH2U_Unnamed Ck Sth Arm Rd_Assessment Report	10/2/2014
NH2U_ Ch65500 Farm Dam_Assessment Report	16/2/2014
NH2U_Dalhousie Creek Tributary Assessment Report	6/3/2014
NH2U_Oyster Creek Tributary Assessment Report	20/3/2014
NH2U_Blue Hills Rd Farm Dams_Assessment Report	1/4/2014
NH2U_Boggy Ck Dam 1_Assessment Report	22/5/2014
NH2U_Cow Creek Assessment Report	22/5/2014
NH2U_Boggy Creek Assessment Report	30/5/2014
NH2U_Cedar Creek west_Fish Translocation Report	23/10/2014
NH2U_Gate 105 Wetland_Second Fish Translocation Report	23/10/2014
NH2U_McGraths Creek Trib_Fish Translocation Report	6/11/2014

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Biodiversity Survey

Project Management

Impact Assessment

Ecological Monitoring

Specialist Surveys

Jenny Butler
Environmental Manager
Nambucca Head to Urunga Upgrade
Lend Lease Engineering
Jenny.butler@lendlease.com

1 October 2013

cc. Bonney Emmett

Dear Jenny,

RE: Winter survey of culverts and bat boxes and culvert exclusion.

Sandpiper Ecological Surveys undertook a winter microbat survey of culverts and bat boxes and excluded potential microbat roosts in culverts in accordance with the *Pacific Highway Upgrade Warrell Creek to Urunga Microbat Management Strategy* (herein referred to as the strategy; Lewis 2013). Bat boxes installed as part of the strategy were removed and reinstalled >100m from the upgrade corridor upon advice from Lend Lease. Work was undertaken between 12 and 22 August and 9 and 13 September 2013. All work occurred in the Nambucca Heads to Urunga section of the Warrell Creek to Urunga project.

Methods

1. Visual inspection, using head torch and, if necessary, bore scope, of all culverts and bridges, deemed safe to enter by Lend Lease, listed in Tables 4.2 and 4.3 of the strategy (Plate 1).
2. Identification and count of bats observed roosting in the structures (Plate 2).
3. Filling of potential bat roosts (i.e. drainage holes, expansion joints, cracks, etc) with 15-40mm foam backing rod and expanding foam (Plate 3). Filling occurred in two time periods: unoccupied roosts were filled during August, whilst occupied roosts were filled in September using the exclusion procedure detailed in the strategy. September coincides with the non-breeding season of most threatened bats and is outside the winter period when suitable roosting habitat is of critical importance.
4. Use of bat detectors (Anabat SD1) to sample culverts that were unsafe to enter. Bat detectors were either installed and left overnight or manually activated during the dusk fly-out (i.e. 1730-1900hrs). Data were uploaded into Analook and interpreted to determine if bats were using the structures; and
5. Inspection of bat boxes installed near each of the subject culverts. Boxes were inspected using a pole camera (Plate 4) or via an Elevated Work Platform (EWP).

Results

Culverts

Fifteen structures were inspected, including seven pipes, five reinforced concrete box culverts (RCBC) and three bridges. Two structures, Raleigh 11 and 12 were deemed unsafe to enter by Lend Lease. Two bridges, Boggy Creek and Deep Creek, were inspected from a canoe and land, whilst the third bridge, Nambucca Railway bridge, was inspected from land and EWP. Six sites, four with RCBC and two with pipes, contained multiple structures (Table 1). Eleven structures were inspected visually and four using multiple (up to 6) bat detectors.

In August, two species of microbat, eastern bentwing (Miniopterus schreibersii) and southern myotis (Myotis macropus) were recorded at three sites, Cow Creek, Dalhousie Creek and Site 10. Cow Creek contained 15 eastern bentwing bats (Plate 2), Dalhousie Creek four southern myotis and Site 10 one southern myotis. Both species are listed as Vulnerable on the NSW *Threatened Species Conservation Act 1995.*

No bats were recorded at sites where bat detectors were used. This result is not surprising given the low quality of roosting habitat at those sites. Urunga North (3 cell RCBC) contained moderate quality foraging habitat on the east side of the existing highway and it is possible that bats fly through the culvert whilst foraging.

In September, four (bentwing) bats were recorded at Cow Creek only. Dalhousie Creek was not re-inspected.

Exclusion

Exclusion of roosting habitat was undertaken at 12 sites, seven pipes, one bridge and four culverts. One culvert, Urunga north, was partially excluded. Foam backing rod was used at eight sites (Plate 3), expanding foam at one site (Nambucca Rail Bridge) and shade-cloth screens at three sites. Shade cloth screens were installed by Lend Lease at pipes inaccessible to humans. Both shade-cloth and foam backing rod are temporary devices that could be removed at the end of the project. Exclusion was deemed impractical at Boggy Creek and Deep Creek bridges due to the type and number of gaps present and need to work over water. Boggy Creek is also situated over 250m from the upgrade alignment. At Urunga North the central cell was excluded but the outer cells were left unaltered. That site appears to be regularly flooded and its main value to bats is as foraging habitat. No exclusion occurred at Dalhousie Creek (>600m from upgrade alignment) upon advice from Lend Lease.

The process for exclusion at Cow Creek (site 4) was:

- 9 September (day) - all potential roosts were excluded except the occupied roost and two sub-optimal roosts;
- 9 September (night) - the previously occupied roost was excluded after bats had left;
- 10 September (day) – two sub-optimal roosts and excluded roosts inspected. One bat found in a

sub-optimal roost;

- 10 September (night) – sub-optimal roosts inspected and excluded once certain no bats remained;
- 11 September (day) – site re-inspected but no bats found; and
- 13 September (day) – site re-inspected but no bats found.

Bat Boxes

No bats were recorded in the 33 bat boxes inspected in winter (Table 2). Four masonry (wood-crete) boxes could not be inspected with the pole camera and the three boxes at Site 11 were not inspected as access was deemed unsafe by Lend Lease. The tree containing a masonry box at Site 9 had fallen over but the box remained intact.

In September, bat boxes were inspected and removed from five sites and re-installed >100m from the upgrade corridor and new boxes were installed at sites 6, 13 and 14. Boxes remain within 100m of the project corridor at sites 4 and 6 (Table 2). Lend Lease deemed it unsafe to remove these boxes and consequently additional boxes were installed outside the 100m restriction zone specified by Lewis (2013). No boxes have been relocated at sites 1, 9 and 10 as suitable alternative sites have not been found. Bat boxes at sites 3, 11 and 12 are outside the 100m restriction zone and relocation is therefore unnecessary.

To ensure that all bat boxes are outside the 100m restriction zone it is necessary to:

- remove and reinstall boxes at sites 1, 9, 10;
- install boxes at Urunga North and Waterfall Way;
- remove boxes at sites 4 and 6.

General Comments

The findings of the winter culvert inspection were similar to that recorded by Lewis (2013). Differences between the two surveys were eastern bentwing at Cow Creek in winter compared with southern myotis in summer and no bats at railway in winter compared with one Gould's wattled bat (Chalinalobus gouldii) in summer. Despite differences in species present the same sites were used by bats, with the exception of railway bridge. Gould's wattled bat typically roost in tree hollows (Churchill 2008) and use of concrete structures may be sporadic.

Eastern bentwing bat was not recorded or predicted to occur by Lewis (2013). All individuals sighted at Cow Creek were bentwing bats and the one removed was confirmed as an eastern bentwing based on forearm length (48.1mm) and weight (16.7gr). The occurrence of eastern bentwing bat is not unexpected as the species is an obligate cave dweller and known to use culverts. The species has fairly specific winter roost requirements and individuals typically reside within a territorial range that includes a maternity cave and over-wintering roosts (Churchill 2008).

The roost exclusion procedure specified in the management strategy was effective, however, the rationale behind roost exclusion warrants further scrutiny. The strategy does not provide a rationale for excluding microbats from roosts that will not be directly affected by construction. Evidence for indirect impacts of noise and vibration on roosting bats is scant and for instances where impact has occurred there are likely several examples of no impact. Noise and vibration impacts may vary between activities. For example, pile driving may pose a greater threat than movement of heavy machinery and compacting of fill and management measures should reflect the type of work proposed nearby. There are many examples of bats roosting in structures close to highways and quarries where they experience noise and vibration. Southern myotis are known to roost in old timber bridges on busy roads where there is considerable noise and vibration from passing traffic.

Given the noted importance of roosts, particularly those used by threatened species in winter, strong justification for exclusion is warranted. The exclusion procedure proposed in the strategy applies a permanent measure to address a temporary impact. In the present situation occupied roosts were 35-40m from the alignment, and, apart from the railway bridge, nearby construction activities would most likely be limited to movement of heavy machinery and compacting of fill. I believe that exclusion should not occur in cases where indirect impacts are more than 30m from the roost, with the possible exception of piling, unless a good justification is provided. In cases where exclusion is deemed necessary a removable material, such as foam backing rod, should be used and that material should be removed once construction is complete.

Providing bat boxes as an alternative to culverts is worthwhile but does not provide alternative roosts for eastern or little bentwing bats that are obligate cave dwellers and have not been recorded using artificial boxes.

Recommendations

- Relocate the remaining bat boxes at sites 1, 9 and 10 and install bat boxes near Urunga North and Waterfall Way.
- Leave original boxes in situ at sites 4 and 6 to provide extra bat habitat.
- Remove temporary roost exclusion material (i.e. foam backing rod) at completion of construction

If you have any questions regarding the information provided please contact me on 0401 195 480.

Yours faithfully,

Dr David Rohweder
Ecologist

Table 1: Results of winter microbat survey and roost exclusion undertaken for the Nambucca Heads to Urunga Pacific Highway Upgrade.

Site	Number	Chainage	Distance off alignment	Type	Size	Access	Previous Record	Monitoring Winter	Monitoring Pre clear	Roost Exclusion
1	599265	1500	75	Pipe	1200	Enter		No bats	NA	Yes
2 (Railway)	6697	61800	45	Bridge		EWP	Yes	No bats	NA	*Lend Lease excluded*
3 (Boggy Ck)	6696	62750	272	Bridge		Canoe		No bats	Yes(?)	Timber bridge impractical to fill the many gaps & appears to flood regularly; would require scaffolding over river to work from
4 (Cow Ck)	599271	63650	38	RBC (X3)	2000X3000	Enter	Yes	Est Bent-wing (15x)	Yes	Roosts excluded over 2 nights [4x microbats in one joint on 9.9.13; bats gone @ dusk; excluded; checked 11.9 & 13.9 & no bats present
4_near	599272	63800	28	Pipe	700	Anabat		No bats	?	*Lend Lease excluded*
5	599274	64500	48	Pipe	1050	Enter		No bats	NA	Yes
6 (Deep Ck)	6909	64900	39	Bridge		Canoe		No bats	?	No Low conservation value (Expansion joints <15mm)
7	599276	65200	45	Pipe (x2)	1200	Enter		No bats	NA	Yes
8	599282	67100	62	Pipe	1200	Enter		No bats	NA	Yes
9	599291	70070	42	RBC	1500x3000	Enter		No bats	NA	Yes
10	599293	70350	35	RBC [x2]	1500x2000	Enter	Yes	Sthn Myotis (1x)	Yes	No bats 9.9.13, excluded; checked on 13.9 & no bats present
Wenonah Place	599302	72100	320	Pipe [x3]	450	Anabat		No bats	NA	*Lend Lease excluded*
Dalhousie Ck	599306	73300	650	RBC [x3]	3000x3000	Enter	Yes	Sthn Myotis (4x)	Yes	No exclusion >200m off alignment
Urunga Nth	599323	82400	on alignment	RBC [x3]	1500(1)& 1200(2)x2400	Anabat		No bats	NA	Excluded mid-cell only
Waterfall Way	599325	83000	on alignment	Pipe	1200	Anabat		No bats	NA	*Lend Lease excluded*
11 (Raleigh)		81950	560	Viaduct				*Not to be monitored?*	NA	>200m from construction &deemed unsafe to monitor
12 (Raleigh)		82050	310	Culvert				*Not to be monitored?*	NA	>200m from construction &deemed unsafe to monitor

Table 2: Results of winter bat box inspection and relocation of bat boxes.

Site	Number	Chainage	Box Type	Winter Monitoring	Extra Boxes	Relocated Boxes	Total Boxes at New Site	New Site (UTM) Easting	New Site (UTM) Northing	Notes
1	599265	1500	3T,1M	No bats	0					State Forest – requires alternative site
2	6697	61800	4T	No bats	0	4T	4T	497655	6611449	Edge of easement; NE-NW aspect
3	6696	62750	3T,1M	No bats	0					>200m from alignment – relocation not required
4	599271	63650	3T,1M	No bats	3T	1T	4T	497942	6612871	Creek edge, S-SE aspect
5	599274	64500	3T	No bats	0	3T	3T	498201	6643509	Dam/wetland edge, SE-SW aspect
6	6909	64900	1T,2M	No bats	3T		3T	498179	6614116	Creek edge, S-SE aspect, original boxes left in situ
7	599276	65200	3T	No bats	0	3T	3T	498539	6613900	Creek edge S aspect
8	599282	67100	2T	No bats	1M	2T,1M	2T,1M	499741	6615592	Near drainage; N,NW,NE aspect
9	599291	70070	1T,2M	No bats	0					State Forest – requires alternative site
10	599293	70350	2T,2M	No bats	0					State Forest – requires alternative site
Urunga Nth	599323	82400	0	NA	3					
Waterfall Way	599325	83000	0	NA	3					
11 (Raleigh)		81950	3?	Not inspected due to safety	0					>200m from alignment – relocation not required
12 (Raleigh		82050	2T;1M	No bats	0					>200m from alignment – relocation not required
13					3T		3T	500329	6628942	Creek edge; N-NW aspect
14					3T		3T	500373	6629261	Wetland edge; N,NW,S aspect

References

Churchill, S. (2008). Australian Bats. Allen & Unwin, Crows Nest.

Lewis, B. D. (2013). *Warrell Creek to Urunga: Microchiropteran Bat Management Strategy*. Report prepared for Roads and Maritime Services by Lewis Ecological Surveys.

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28 January 2013

Cc Bonney Emmett

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Dear Jenny,

RE: Summer survey of microbat nest boxes and completion of nest box relocation.

Sandpiper Ecological Surveys undertook a summer inspection of microbat boxes (i.e. bat boxes) in accordance with the *Pacific Highway Upgrade Warrell Creek to Urunga Microbat Management Strategy* (herein referred to as the strategy; Lewis 2013). Bat boxes (12 sites within the Nambucca Heads to Urunga section) were inspected on 18 December 2013. Inspections were conducted at ground level using a pole camera, torch and binoculars. No bats were recorded within 39 boxes (Table 1). All boxes were in good condition. At site 2 (Boggy Creek), one masonry and one timber box positioned on trees overhanging the waterway were previously taken down by Lewis Ecological Surveys. Two timber boxes located under the bridge remained at that site.

Nest boxes at sites 1, 9 and 10 were relocated during January 2014. These sites were not included in previous relocation works conducted during August and September 2013 due to delay in approvals from State Forests NSW. Nest boxes were removed and reinstalled >100m from the upgrade corridor on 9 and 15 January 2014. The location of new installation sites are shown in Table 1.

If you have any questions regarding the work undertaken or require more information please contact me on 0401 195 480.

Yours faithfully,

Dr David Rohweder
Ecologist

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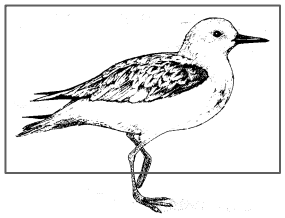
Table 1: Microbat nest box monitoring, summer 2013/14. Grey shading denotes boxes relocated in January 2014.

Site	Number	Chainage	Type	Summer Monitoring	Relocated	New Site (UTM) Easting	New Site (UTM) Northing	Notes/ Re location
1	599265	1500	Pipe	No bats	3T,1M	497652	6611107	Near drainage
2	599265	61800	Bridge – railway	No bats	4T	497655	6611449	Edge of easement; NE-NW aspect
3	6696	62750	Bridge – Boggy Ck	2T=No bats	No			Crown Land; no relocation required
4	599271	63650	RBC (x3)_Cow Ck	No bats	4T	497942	6612871	Creek edge, S-SE aspect
5	599274	64500	Pipe	No bats	3T	498201	6613509	Dam/wetland edge, SE-SW aspect
6	6909	64900	Bridge – Deep Ck	No bats	3T	498179	6614116	Creek edge, S-SE aspect
7	599276	65200	Pipe (x2)	No bats	3T	498539	6613900	Creek edge, S-SE aspect
8	599282	67100	Pipe	No bats	2T,1M	499741	6615592	Near drainage; N,NW,NE aspect
9	599291	70070	RBC	No bats	1T,2M	500597	6618502	Drainage; within flyway
10	599293	70350	RBC [x2]	No bats	2T,2M	*500623*	6618751	Drainage; within flyway
13				No bats	3T	500329	6628942	Creek edge; N-NW aspect
14				No bats	3T	500373	6629261	Wetland edge; N,NW,S aspect



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15 July 2014

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Dear Jenny,

RE: Autumn and winter 2014 survey of microbat boxes.

Sandpiper Ecological Surveys inspected microbat boxes installed as part of the impact mitigation package for the Nambucca Heads to Urunga Pacific Highway Upgrade in autumn and winter 2014. Monitoring was undertaken in accordance with the *Pacific Highway Upgrade Warrell Creek to Urunga Microbat Management Strategy* (herein referred to as the strategy; Lewis 2013). The bat box program currently totals 39 boxes installed across 12 sites within the Nambucca Heads to Urunga section.

Methods

Boxes were inspected on 28 March, except Boggy Creek (site 3) which was inspected on 14 May, and 12 June. A pole camera was used to inspect boxes and a ladder used to access occupied boxes for closer inspection and to confirm identification. Necessary safety equipment was not available during the autumn survey and consequently inspections were undertaken from the ground using the pole camera only. Four masonry boxes were not inspected in autumn as these require ladder access.

Results

Of the 35 boxes inspected in autumn, 11 contained long-eared bats (*Nyctophilus* spp, probably *Nyctophilus gouldi*) totaling 30 individuals and one contained 8-10 southern myotis *(Myotis macropus*) (Table 1). The majority of occupied boxes contained less than three individuals apart from a box at site 10 which contained 11 individuals and one at site 3 (Boggy Creek), which contained 8-10 individuals. All boxes were in good condition.

In winter, two boxes were occupied by bats and three boxes were occupied by feathertail gliders (Acrobates pygmaeus) (Table 1). One *Nyctophilus gouldii* was recorded in a timber box at site 4 and four (probable) *Myotis macropus* were recorded in a timber box at site 3 (Boggy Creek). All occupied boxes were of timber construction with both wedge and baffle (rectangular) designs used. No bats have been recorded in masonry boxes.

Discussion

Long-eared bats are an obligate tree-hollow roosting species that do not frequent culverts (or caves), whilst southern myotis use a range of roost sites including, mine shafts, caves, tree hollows and culverts (Menkhorst & Knight 2004). The later species is listed as Vulnerable on the NSW *Threatened Species Conservation Act 1995* and was a target species for the bat box program (Lewis 2013). Confirmation of species occupying the timber box at site 3 will require the use of a canoe and even then removal of bats from the box for closer inspection may be restricted by safety requirements.

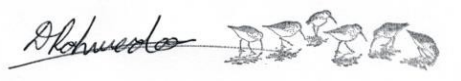
Southern myotis may have been displaced by the culvert exclusion undertaken in winter and spring 2013, although it is most likely that the bats recorded at site 3 (Boggy Creek) have other roosts along Boggy Creek and have begun using the installed boxes opportunistically. The Boggy Creek highway culvert was not excluded and the nearest exclusion site was Cow Creek, approximately 770m north. Myotis were recorded at Cow Creek by Lewis (2013), although eastern bentwing bats (Miniopterus schreibersii) were present at the time of exclusion (Sandpiper Ecological 2013). Myotis have a complex social structure in which a mature male roosts with a 'harem' of females during the breeding season and males display strong fidelity to roosts (Dwyer 1970). Loike many species of microbat Myotis may use several different roosts. Irrespective of the origin of myotis at site 3 the presence of this species in artificial bat boxes is a positive outcome of the Warrell Creek to Urunga Microbat Management Strategy. Whilst the presence of long-eared bats is positive from a general conservation perspective this species would not have been affected by culvert exclusion and was not a target species.

Bats have been recorded roosting in both wedge and rectangular timber boxes and no use of masonry boxes has been recorded. The results do not suggest a preference of timber over masonry box types, although patterns of occupancy will be interesting to monitor over time. The presence of feathertail glider nests in three boxes does not mean these are no longer available to bats. Microbats and feathertail gliders have been recorded roosting together in both natural and artificial hollows, although use by bats may depend on the size of leaf nests.

The strategy states that "corrective actions" would occur after 2 years, although it is unclear what this entails. Removing glider nests from boxes would, if occupied, create other issues as displaced individuals would need to be housed in separate nest boxes installed nearby. It is recommended that further observation of glider dens occur before any action is taken and a canoe is used during the spring survey to assist with inspecting the boxes at site 3.

If you have any questions regarding the information provided please contact me on 0401 195 480.

Yours faithfully,



Dr David Rohweder
Managing Director, Senior Ecologist

Table 1: Results of seasonal inspection of bat boxes installed for the Nambucca Heads to Urunga Pacific Highway Upgrade. T = timber; M = masonry; # masonry box not inspected; ^ boxes >200m from alignment; Timber boxes are small Hollow Log Homes rectangular box unless otherwise stated.

Site No.	Chainage	Location (UTM) Easting	Location (UTM) Northing	Property Tenure	Box Type	2013 Winter/ Spring	2014 Summer	2014 Autumn (No. ind's/box type & # occupied)	2014 Winter (No. ind's/box type & # occupied)	Condition & Notes
1	1500	497652	6611107	State Forests	3T,1M	No bats	No bats	No bats #	No bats	Good
2	61800	497655	6611449	State Forests	4T	No bats	No bats	*Nyctophilus* sp.(1/T)	No bats	Good
3^	62750	497775	6612162	Crown Reserve	2T	No bats	No bats	Myotis macropus (Pr) (8/T wedge)	*Myotis macropus (Pr)* (4/T-wedge)	Good
4	63650	497942	6612871	Private	4T	No bats	No bats	*Nyctophilus* sp.(1/T)	*Nyctophilus* sp.(1/T)	Good
5	64500	498201	6613509	Private	3T	No bats	No bats	*Nyctophilus* sp.(1/T; 2/T)	No bats	Good
6	64900	498179	6614116	Private	3T	No bats	No bats	*Nyctophilus* sp.(2/T; 5/T)	No bats	Good
7	65200	498539	6613900	RMS	3T	No bats	No bats	No bats	No bats	Good
8	67100	499741	6615592	Private	2T,1M	No bats	No bats	*Nyctophilus sp.(2/T)#*	No bats	Good
9	70070	500597	6618502	State Forests	1T,2M	No bats	No bats	*Nyctophilus sp.(1/T-wedge)#*	No bats	Good {1M=front cover broken & repaired]
10	70350	500623	6618751	State Forests	2T,2M	No bats	No bats	*Nyctophilus sp.(11/T-wedge)#*	No bats [FtG nest in T-wedge & T-baffle)	Good [2M boxes lowered to 1.8m)
13	Raleigh Sth	500329	6628942	Bellingen council	3T	NA	No bats	*Nyctophilus sp. (2/T)*	No bats (FtG nest in M Box]	Good
14	Raleigh Sth	500373	6629261	Bellingen council	3T	NA	No bats	*Nyctophilus sp. (2/T)*	No bats	Good
No. checked					na	24/40	39/39	35/39	**39/39**	
Not checked					Na	0	0	4M require ladder (sites 9&10)	**0**	

References

Dwyer, P. D. (1970). Social organization in the bat Myotis adversus. *Science:* **168,** 1006-1008.

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Jenny Butler
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29 October 2014

Cc Mike Stuyt

Dear Jenny,

RE: Spring 2014 survey of microbat boxes.

Sandpiper Ecological Surveys inspected microbat boxes installed as part of the impact mitigation package for the Nambucca Heads to Urunga Pacific Highway Upgrade in spring 2014. Monitoring was undertaken in accordance with the *Pacific Highway Upgrade Warrell Creek to Urunga Microbat Management Strategy* (herein referred to as the strategy; Lewis 2013). The bat box program currently totals 39 boxes installed across 12 sites within the Nambucca Heads to Urunga section.

Methods

Boxes were inspected on 30 September, except Boggy Creek (site 3) which was inspected on 1 October. A pole camera was used to inspect boxes and a ladder used to access occupied boxes for closer inspection and to confirm identification. To avoid disturbing the entire roost bats were not removed from boxes unless there was concern about identification.

Results

Of the 39 boxes inspected in spring, two boxes contained long-eared bats (*Nyctophilus* spp, probably *N. gouldii)* totalling seven individuals, and one box, at site 3 (Boggy Creek), contained two (probable) southern myotis (*Myotis macropus)* (Table 1). Three feathertail gliders were recorded in a masonry box at site 9. All boxes were in good condition.

Please contact me on the above number if you have any questions regarding the spring 2014 bat box monitoring.

Yours faithfully,

Dr David Rohweder
Managing Director, Senior Ecologist

Biodiversity Survey

Project Management

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Table 1: Results of seasonal inspection of bat boxes installed for the Nambucca Heads to Urunga Pacific Highway Upgrade. T = timber; M = masonry; w = wedge shape; b = rectangular box; ^ boxes >200m from alignment; Timber boxes are small Hollow Log Homes rectangular box unless otherwise stated. Nsp = Nyctophilus spp.; Mm = Myotis macropus; Pr = probable; Ftg = feathertail glider.

Site No.	Location (UTM) Easting	Location (UTM) Northing	Tenure	Box Type	2013 Winter/ Spring	2014 Summer	2014 Autumn	2014 Winter	2014 Spring	Conditions & Notes
1	497652	6611107	State Forests	3T,1M	0	0	0	0	0	Good
2	497655	6611449	State Forests	4T	0	0	Nsp. (1/T)	0	0	Good
3^	497775	6612162	Crown Reserve	2T	0	0	Mm (Pr) (8/Tw)	Mm (Pr)(4/Tw)	Mm (Pr)(2Tw)	Good
4	497942	6612871	Private	4T	0	0	Nsp. (1/T)	Ng (1/T)	0	Good
5	498201	6613509	Private	3T	0	0	Nsp.(1/T; 2/T)	0	0	Good
6	498179	6614116	Private	3T	0	0	Nsp.(2/T; 5/T)	0	0	Good
7	498539	6613900	RMS	3T	0	0	0	0	0	Good
8	499741	6615592	Private	2T,1M	0	0	Nsp.(2/T)	0	0	Good
9	500597	6618502	State Forests	1T,2M	0	0	Nsp.(1/Tw)	0	Ftg(3M,2j, 1a)	Good
10	500623	6618751	State Forests	2T,2M	0	0	Nsp.(11/Tw)	0 [Ftg nest in Tw & Tb)	0	Good
13	500329	6628942	Bellingen council	3T	NA	0	Nsp. (2/T)	0 (Ftg nest in M)	Nsp (6/T)	Good
14	500373	6629261	Bellingen council	3T	NA	0	Nsp. (2/T)	0	Nsp (1/T)	Good

References

Lewis, B. D. (2013). *Pacific Highway Upgrade: Warrell Creek to Urunga Microchiropteran Bat Management Strategy*. Report prepared by Lewis Ecological for Roads and Maritime Services.

Attachment 6

November 2014 EPBC Surveillance Checklist

ROADS AND MARITIME SERVICES

H.10 PACIFIC HIGHWAY UPGRADE

Project:

Contract No:

Report No:

Date: 27 / 11 / 2014

EPBC Act – Commonwealth Approval - Field

Commonwealth Approval EPBC 2013/6963

Location:	Site General October 2014

Cl.	PROCESS	COMMENTS	Conforms Y / N
Condition No3			
	The *person taking the action* must undertake progressive rehabilitation of *EPBC species' habitat* in areas where *temporary infrastructure* is to occur or, where *short term* impacts are anticipated. Where appropriate, the landscaping / rehabilitation of these areas must be done in a manner that targets the needs and requirements of *EPBC species*.	**Hydro mulching continues to be undertaken along the alignment**	**Y**
Condition No6			
a)	Ensure that temporary and high visibility fencing will be erected to restrict access to *exclusion zones*. Temporary fencing must be of a design appropriate to deter the passage of vehicles or placement of construction materials, equipment and waste, in *exclusion zones* where accidental incursion could reasonably occur.		Y
b)	Implement measures to prevent the spread or establishment of new or additional weed species, soil or plant pathogens into these *exclusion zones* as a result of *construction.*	Hydro mulched batters monitored for weed growth, Nil present at moment. Weeds on previously disturbed batters have been raised with LL	Y
c)	Implement stormwater management measures to prevent the unintentional diversion or discharge of stormwater during both construction and operation over *exclusion zones*; and		Y
d)	Implement targeted measures for managing construction impacts to *Cryptic Forest Twiner and Clear Milkvine* associated with dust, sedimentation and erosion.		Y
Condition No7			
	The *person taking the action* must engage a *suitably qualified expert* to undertake pre-clearing fauna searches within all areas proposed for disturbance, including: hollow bearing trees, logs, existing culverts and bridges, no earlier than 48 hours prior to the removal of vegetation occurring in that area to ensure that the area is free of the *Koala* and *Spotted-tail Quoll*	Mainline clearing completed. Minor clearing may be required for the remainder of the project	Y
Condition No8			
	The *person taking the action* must implement measures to relocate and/or ensure the appropriate care of individuals of *EPBC species* that are identified during searches referred to in condition 7.		Y
Condition No12			
	To inform the *long term success* of *fauna crossings*, fencing and road medians the *person taking the action* must engage a *suitably qualified expert* to prepare a strategy for monitoring and recording any road kill sightings of the *Koala* and *Spotted-tail Quoll* along the *Pacific Highway*. Prior to *commencement of the action*, the road kill monitoring and recording strategy must be implemented..	Long noose Potoroo sighted. EPA notified	Y

COMPLIANCE: YES NO NCPSN/MEMO #

DETAILS:

a long-nosed potoroo (Potorous tridactylus) ~50m to the west of the underpass at Ch:73800 (north of Moyles Road) was sighted in October and EPA notified.

GHD have confirmed that the potoroo was not assessed in the MNES submission as;

- The potoroo had not been sighted in the local area
- It was not assessed in the EA and state approval had already been granted

GHD do not believe there is a requirement to go back to DoE and the conditions of approval have no requirements to notify. GHD did state that it would be a good idea to confirm that no other RMS project had notified the DoE in a similar situation.

Brian Tolhurst from the EPA who was notified in accordance with the FFMP (unexpected fauna finds). Brain has recommended further mitigation/treatment measures including the creation of pathways at culvert entrance/exits and we are currently in discussion with Lend Lease on how best to implement these mitigation measures.

SURVEILLANCE OFFICER Kris Hinkes **DATE** 27/11/14

Follow-up Action: NIL

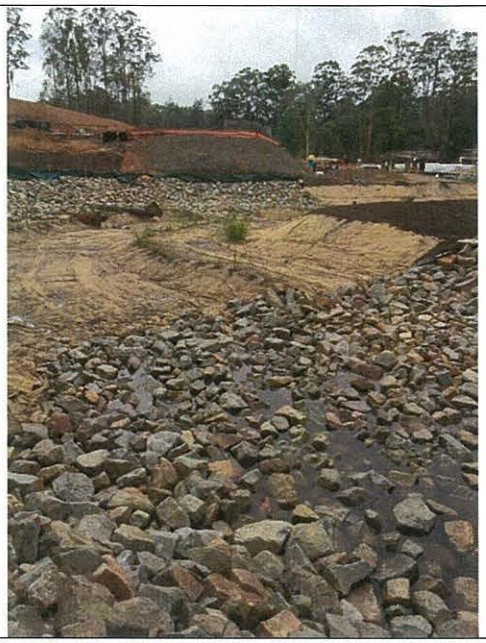
Matters arising:

NCPSN No.	Contractor's NCR No.	CAR No.
Date: / /	Date: / /	Date: / /

ENGINEER COMMENTS:

Closed out:

RESIDENT/PROJECT ENGINEER **Date:** 1/12/14

	14/11/14 Boggy Creek realignment open with plug removed
	14/11/14 Glider tree CH 80100 North Bound

	17/11/14 long-nosed potoroo (Potorous tridactylus) ~50m to the west of the underpass at Ch:73800

Attachment 7

Fauna Crossing Requirements

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Location	Fauna Crossing Type	Table 4.1 Structure Form	Proposed Table 4.1 Dimensions	Connectivity Value	Design Details (Current design status)	Vertical Poles in Culvert	Refuge Poles Under Bridge	Refuge Pole Between Structure and Clearing Limit	Comments
Twin Bridges over North Coast Rail CH: 61.80 SB1	Combined	Bridges	Provide Min 3m wide fauna passage at southern abutment, between the retaining wall and the rail corridor	Very High	No fauna refuge poles in design of fauna underpass under bridge (IFC)	--	--	1	Replacement for deleted culvert at 61km 690 Reinforced soil nail wall and railway limits options for refuge poles.

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over Boggy Creek CH: 62.75 SB3	Combined	Bridges	Minimum length 48 metres between front faces of bridge abutments including a minimum 3m wide fauna passage at each abutment and minimum total 12 metre wide fauna passage, measured between the scour protection and the mean high water level (**MHWL**)[2] , or scour protection and top of bank[3] where the crossing is located above tidal influence. Min clearance of 3m to be provided for fauna passage.	High	No Fauna refuge poles in design for fauna underpass (IFC)	--	6	8	Reduced bridge length from 70 to 48m provides no decrease in connectivity benefit

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Service Road Bridge over Boggy Creek CH: 62.75 SB4	Combined	Bridge	Minimum length 48 metres between front faces of bridge abutments including a minimum 3m wide fauna passage at each abutment and minimum total 12 metre wide fauna passage over both abutments, measured between the scour protection and the mean high water level (**MHWL**)[2] , or scour protection and top of bank[3] where the crossing is located above tidal influence. Min clearance of 3m to be provided for fauna passage.	High	No fauna refuge poles in deisgn of underpass (IFC)	--	4	4	Not previously in table 4.1 was a culvert changed to Providing a bridge, and of equal length to adjacent Twin Bridges elimates funnelling restriction and contributes to a greater overall connectivity result

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over Cow Creek and Service Road bridge over Cow Creek CH: 63.65 SB5 and SB6	Combined	No change proposed	Minimum length 30 metres between front faces of bridge abutments including a minimum 6 metre wide fauna passage at each abutment between the scour protection and the MHWL2 , or scour protection and top of bank3 where the crossing is located above tidal influence	Currently Medium, but High Potential	No fauna refuge poles in deisgn of underpass (IFC)	--	8	5	None

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over Deep Creek CH: 64.90 SB8	Combined	Bridges	Minimum length 90 metres between front faces of bridge abutments including a minimum 3 metre wide fauna passage at each abutment between the scour protection and the MHWL2 , or scour protection and top of bank3 where the crossing is located above tidal influence	Medium	No fauna refuge poles in deisgn of underpass (SDD Rev 2)	--	6	5	None
Drainage culvert under Local Access Road C CH: 66.18 SC0-1 (CH 66.23)	Incidental	Box culvert	Minimum 2700 mm wide x 900 mm high	Low	No Fauna furniture (IFC)	--	--	--	None

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Chainage 67km125	Combined	Pipe Culvert	Minimum 1 no. x 1350mm dia.	Low	No fauna furniture	--	--	--	Change to match existing pipe that this new line connects into, eliminating funnelling / trapping potential. Embankment overlap prevents separate structures being provided.

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Fauna Underpass CH: 68.405 SC3 (CH 68410)	Combined	Box culvert	Minimum 4 no. x 3600 mm wide x 1200 mm high plus 1 no. x 3600 mm wide x 2400 mm high	Low-Medium	Horizontal timber bridge furniture provided internally. No internal vertical refuge poles. One vertical refuge pole outside of culvert specified (Note on drawing additional may be required determined onsite by enviro manager) Approx. 20m from entry point of culvert to edge of clearing limit. (IFC)	--	--	--	Additional vertical poles and refuge poles not provided due to potential afflux issues with adjacent private property.
Chainage CH: 69.715	Incidental	Pipe culvert	Minimum 4 no. x 1200 mm diameter	Low	No fauna furniture. Approx 45-50m from edge of clearing limit	--	--	--	None
Chainage 70.145	Incidental	Pipe culvert	Minimum 2 no. x 1800 mm diameter	Low	No fauna furniture	--	--	--	None

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Drainage and fauna underpass CH: 70.435 SC0-2 (CH 70400)	Combined	Box culvert	Minimum 3600 mm wide x 3000 mm high	Medium to High	Horizontal timber bridge furniture provided internally. No internal vertical refuge poles. One vertical refuge pole outside of culvert specified (Note on drawing additional may be required determined onsite by enviro manager). Approx. 60-70m from entry of culvert to edge of clearing limit. (IFC)	4	--	5	None

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over McGraths Creek Floodplain No. 1 CH: 71550 SB10	Combined	Bridges	Minimum length 48 metres between front faces of bridge abutments including a minimum 3m wide fauna passage at each abutment and minimum total 12 metre wide fauna passage over both abutments, measured between the scour protection and the MHWL[2] , or scour protection and top of bank[3] where the crossing is located above tidal influence. Min clearance of 3m to be provided for fauna passage.	Medium	No fauna furniture (SDD)	--	6	8	Reduced bridge length from 70 to 48m provides no decrease in connectivity benefit. Refuge poles between structure and clearing limit on south side only.

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Drainage and fauna underpass CH: 72.72 SC0-3	Combined	Box culvert	Minimum 2100 mm wide x 900 mm high	Low	No fauna furniture. (IFC)	--	--	--	Culvert 142m long and 900mm high. Not considered approiate dimensions for fauna crossing.
Twin bridges over Dalhousie Creek CH: 73370 SB13	Combined	Bridges	Minimum length 30 metres between front faces of bridge abutments including a minimum 3 metre wide fauna passage at each abutment between the scour protection and the MHWL[2] , or scour protection and top of bank[3] where the crossing is located above tidal influence	Very High – critical link	No fauna furniture (IFC)	--	8	20	Increased bridge length from 15 to 30m provides a more open fauna passage area

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Southbound Main Carriageway at chainage CH: 73770 S0-4	Combined	Drainage and fauna underpass - Box Culvert	Minimum 2400 mm wide x 2400 mm high	Medium-High	Horizontal timber bridge furniture provided internally. No internal vertical refuge poles. One vertical refuge pole outside of culvert specified (Note on drawing additional may be required determined onsite by enviro manager). (IFC)	3	--	6	Replaces 3 no. x900 dia RCP's to encourage fauna connectivity at this location, rather than at 73km 630. Refuge poles between structure and clearing limit includes allowance for 5 refuge poles in median.

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Northbound Main Carriageway at chainage CH: 73840 S0-5	Combined	Drainage and fauna underpass - Box culvert	Minimum 2400 mm wide x 2400 mm high	Medium-High	Horizontal timber bridge furniture provided internally. No internal vertical refuge poles. One vertical refuge pole outside of culvert specified (Note on drawing additional may be required determined onsite by enviro manager). Approx 15-20m from clearing limit edge to entry point of crossing. (IFC)	3	--	1	None

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over watercourse CH: 74810 SB15	Combined	Bridge	Minimum length 25 metres between front faces of bridge abutments including a minimum 9m width between intersection of batter treatments and finished ground level.	Critical High	No fauna furniture (IFC)	--	6	10	None
Drainage culvert CH: 75250 SC0-6	Incidental	Box culvert	Minimum 3000 mm wide x 3000 mm high	High	No fauna furniture. (IFC)	5	--	2	Crossing should now be classifed as combined and fauna furniture added.
Drainage culvert CH: 75800 SC0-7	Incidental	Box culvert	Minimum 3000 mm wide x 3000 mm high	High	No fauna furniture. Approx. 15m from edge of clearing limit to crossing entry. (IFC)	6	--	5	Crossing should now be classifed as combined and fauna furniture added.

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

CH: 76300 SC0-8	Combined	Drainage and fauna underpass Box culvert	Minimum 3600 mm wide x 3600 mm high	Medium - High	Horizontal timber bridge furniture provided internally. No internal vertical refuge poles. One vertical refuge pole outside of culvert specified (Note on drawing additional may be required determined onsite by enviro manager). (IFC)	5	--	--	None
Drainage culvert CH: 76560 SC0-9	Incidental	Box culvert	Minimum 3600 mm wide x 3000 mm high	Low - Medium	No fauna furniture. (IFC)	4	--	--	Crossing should now be classifed as combined and fauna furniture added.

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over Kalang river floodplain CH: 76950 SB17	Combined	Bridges	Minimum length 89 metres between front faces of bridge abutments including a minimum 3 metre wide by 3 metre high fauna passage at each abutment between the scour protection and the MHWL[2] , or scour protection and top of bank[3] where the crossing is located above tidal influence	Low	Horizontal timber bridge furniture provided internally. No internal vertical refuge poles. One vertical refuge pole outside of culvert specified (Note on drawing additional may be required determined onsite by enviro manager) (IFC)	--	6	7	Allowance for refuge poles between structure and clearing limit on south bank only.

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

CH: 78800 SC0-10	Combined	Drainage and fauna underpass - Box culvert	Minimum 2 No 2400mm wide x 3000mm high	High	Horizontal timber bridge furniture provided internally. No internal vertical refuge poles. One vertical refuge pole outside of culvert specified (Note on drawing additional may be required determined onsite by enviro manager). Approx 10-30m from edge of clearing limit to crossing entry point. (IFC)	4	--	5	None

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over water course, northbound CH: 79860 southbound CH: 79910 SB20		Bridges	Minimum length 29 metres between front faces of bridge abutments including a minimum 3 metre wide by 3 metre high fauna passage at each abutment between the scour protection and the MHWL[2] , or scour protection and top of bank[3] where the crossing is located above tidal influence	Very High	No fauna furniture (IFC)	--	8	27	Issues with resident access under bridge to be considered.

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Northbound CH: 80220 Southbound CH: 80230 SC5-1 SC5-2	Combined	Box culvert	Minimum 2 no. x 3000 mm wide x 2100 mm high	Very High	Horizontal timber bridge furniture provided internally. No internal vertical refuge poles. One vertical refuge pole outside of culvert specified (Note on drawing additional may be required determined onsite by enviro manager). NB – approx 10-15m crossing entry point to clearing limit SB – approx 6-8m crossing entry point to clearing limit (IFC)	4	--	5	None

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over watercourse CH: 81880 SB23	Incidental	Bridges	Minimum length 13.6 metres between front faces of bridge abutments, with 2.1 metre high fauna passage at each abutment between the scour protection and the MHWL[2] , or scour protection and top of bank[3] where the crossing is located above tidal influence. Dry Passage will be provded only where existing conditions facilitiate .	Very Low	No fauna furniture (SDD)	--	6	--	None

Nambucca Heads to Urunga
Proposed Table 4.1 (Fauna Crossings) Fauna Furniture
Option A

Twin bridges over watercourse CH: 82420 SB24	Incidental	Bridges	Minimum length 16.6 metres between front faces of bridge abutments, with 2.1 metre high fauna passage at each abutment between the scour protection and the MHWL[2] , or scour protection and top of bank[3] where the crossing is located above tidal influence. Dry Passage will be provded only where existing conditions facilitiate .	Low	No fauna furniture (SDD)	--	8	--	None
Total						38	72	124	

Attachment 8

Baseline Monitoring Report for Koala and Spotted-Tailed Quoll

Benchmark
Environmental Management

Nambucca Heads to Urunga Pacific Highway Upgrade
Baseline Population Monitoring for Koala and Spotted-tailed Quoll

Prepared for: NSW Roads and Maritime Services

August 2014

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NAMBUCCA HEADS TO URUNGA PACIFIC HIGHWAY UPGRADE - BASELINE POPULATION MONITORING FOR KOALA AND SPOTTED-TAILED QUOLL

August 2014

Benchmark Environmental Management

PO Box 1944

Coffs Harbour NSW 2450

Approved By:

Project Manager

Authors: Don Owner[1] and Dr. David Rohweder[2]

Qualifications: [1] Bachelor of Applied Science (Hons) - Southern Cross University, Lismore
[2] PHD – Ecology – Southern Cross University

Relevant Licences: OEH - No.S100237;
NSW Primary Industries Animal Care and Ethics – No: 10/3050

Survey Team: Don Owner (field survey and reporting)
Dr. David Rohweder (field survey and reporting)
Tom St. Vincent Welch (field survey)
John Edwards (field survey)
Dr. Brendan Taylor (field survey)

Document Control:

Date	Status	Version	Dispatched	Clent	Client Contact
02/07/2014	Draft	1	email	RMS	Stephan Everingham
15/8/2014	Draft	2	email	RMS	Stephan Everingham
17/02/2015	Final	3	email	RMS	Kris Hincks

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1. Introduction

The Pacific Highway Upgrade Program is a joint commitment by the Federal and New South Wales State governments to improve the standard and safety of the Pacific Highway between Hexham and the Queensland border.

The NSW Minister for Planning approved the Warrell Creek to Urunga (WC2U) Pacific Highway Upgrade Project under Part 3A (now repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 19 July 2011, subject to the Minister's Conditions of Approval being met.

The WC2U Project has been divided into two stages with Stage 1 (22.5 kilometres) extending from Nambucca Heads to Urunga (NH2U) and Stage 2 (19.5 kilometres) extending from Warrell Creek to Nambucca Heads (WC2NH). This report relates to Stage 1 (NH2U) of the project, which is referred to as "the Project" (*Figure 1.1*).

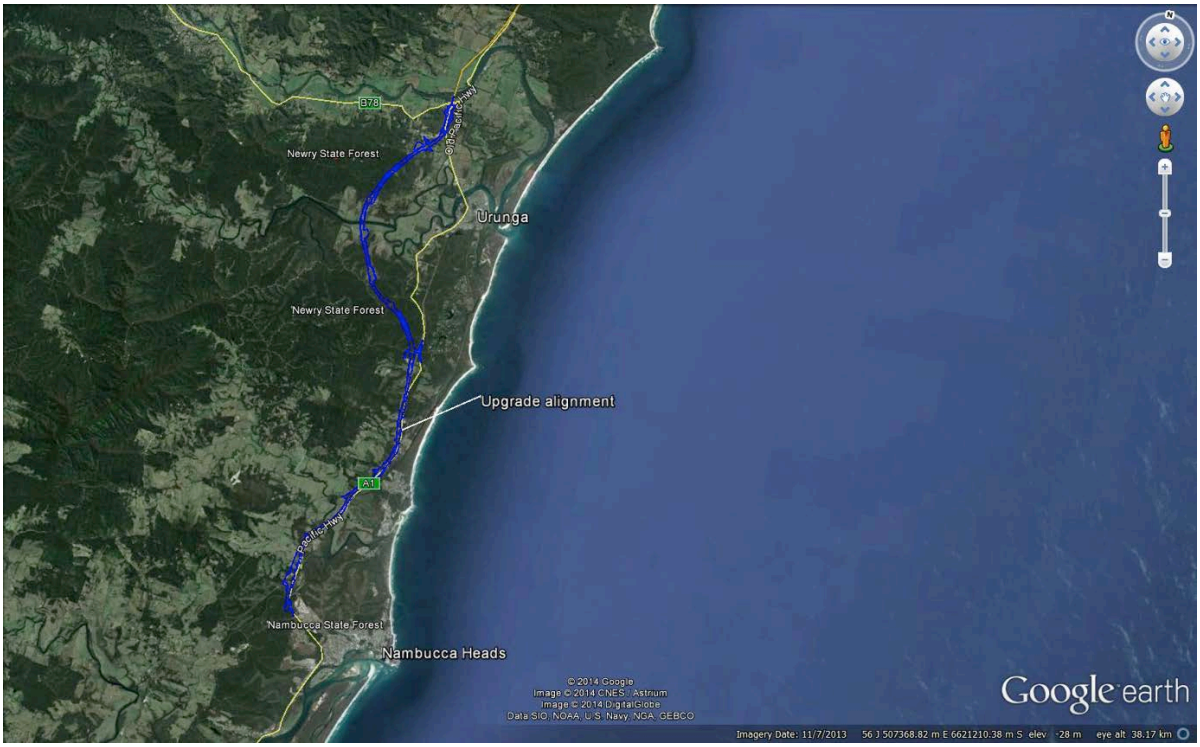

***Figure 1.1**: Location of the Nambucca Heads to Urunga Pacific Highway Upgrade corridor.*

The Environmental Assessment (EA) for WC2U (RTA 2010) included an assessment of relevant matters of National Environmental Significance (MNES) as described in Part 3, Division 1 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), which concluded that the WC2U upgrade would not have a significant impact on MNES listed under the EPBC Act.

However, after subsequent changes and additions to the relevant MNES, the RMS decided to refer the Project to DoE for determination under the EPBC Act. The DoE granted approval for the Project subject to additional Conditions of Approval. The purpose of this report is to comply with the DoE Condition of Approval #9, which states that *"Prior to commencement of the action the person taking the action must engage a suitably qualified expert to collect baseline data on local populations of the koala and spotted-tailed quoll. The data must address the likely densities and distribution of these species within all habitat areas outside the construction footprint that are likely to be adversely impacted by the action."*

2. Methods

2.1 Koala

2.1.1 Collation of existing datasets

Benchmark Environmental Management (BEM) collated existing data relating to the extent and density of koala sub-populations within habitat areas traversed by the NH2U project corridor. The purpose of the collation process was to assess the potential to use existing datasets as a source of baseline monitoring data and to identify information gaps requiring additional field survey.

2.1.2 Field survey

The field sampling methodology applied at additional sample sites identified during the desktop assessment process was based on the Spot Assessment Technique (SAT) devised by Phillips and Callaghan (2011) to ensure that baseline data collected were comparable with existing datasets. The SAT technique involves:

- selecting a 'centre tree' that meets one or more of the following criteria:
  - a tree of any species beneath which one or more Koala faecal pellets (ie. scats) have been observed; and/or
  - a tree in which a Koala has been observed; and/or
  - any other tree known or considered to be potentially important for the Koala or of interest for other assessment purposes.
- identifying and marking the 29 nearest trees to the centre tree;
- undertaking a search for Koala faecal pellets beneath each of the 30 marked trees based on a cursory inspection of the undisturbed ground surface within a distance of 100 centimetres around the base of each tree, followed by a more thorough inspection involving disturbance of leaf litter and ground cover within this area. Searches should average two person minutes per tree;
- inspecting the canopy of each search tree for Koalas; and
- calculating the proportion of trees with Koala faecal pellets at each SAT site to determine the activity level based on the 'activity categories' provided in Phillips and Callaghan (2011).

A tree was defined as a live woody stem of any plant species (excluding palms, cycads, tree ferns and grass trees) with at diameter at breast height of 100 millimetres or greater.

GHD (2013) mapped areas containing Habitat Critical to Koala Survival along the NH2U project corridor as defined by SEWPaC (2012). The spacing of sampling sites within these areas was based on a 400 metre grid (ie. approximately one sampling site per 16 hectares).

Sampling of areas situated outside mapped Habitat Critical to Koala Survival was limited to within a 500 metre radius of proposed fauna underpass locations. These areas were subject to an initial inspection to assess the proportion of primary and secondary koala feed trees present. If the proportion of potential koala feed trees was sufficient to meet the DoE criteria for Habitat Critical to Koala Survival then further assessment with the SAT technique was undertaken.

2.2 Spotted-tailed quoll

2.2.1 Assessment of habitat

To ensure that surveys targeted habitat "likely to contain" spotted-tailed quolls an assessment of potential quoll habitat within 5km of the alignment was undertaken. The assessment was undertaken by aerial photograph interpretation, vehicle and foot-based traverse (part of this study), foot traverse within the alignment (baseline koala surveys and pre-construction surveys) and review of quoll records. Quoll records were obtained from Forestry Corporation of NSW (Atlas of NSW Wildlife) and discussions with local residents. Local resident records were vetted by asking specific questions about the animal sighted.

Criteria used to assess habitat quality were: vegetation type; vegetation age; extent of vegetation and degree of fragmentation; abundance of hollow-bearing trees; abundance and size of logs; medium-sized mammal abundance; disturbance history and distribution of quoll records. Quolls have been recorded along the length of the upgrade alignment, although most records occur north of Little Newry State Forest, between chainages 71000 and 81000 (*Figure 2.1*). Clusters (2 or more) of quoll records occur:

- Near the western extent of Nambucca State Forest (2 records);
- On the east side of the highway opposite the Pacific Highway/Ballards Road intersection (4 records);
- To the east and west of the highway north of Hungry Head Road (2 records);
- North of the Kalang River (3 records); and
- In Urunga township (2 records).

A single record occurs east of the existing highway at Valla Beach. Two additional records are presented, one in the Urunga township from September 2010 and one at Schnapper Beach Road (Hungry Head) on 11 February 2003. The latter record was of an adult and juvenile observed in a chicken coup, whilst the former was of an individual photographed in a tree at the Urunga Heads Holiday Park.

Most of the habitat adjoining the highway has been subject to logging over a long period of time and forest structure has been modified to create even-aged stands of advanced regeneration with some mature forest in gullies and on private land, which has been selectively logged. The broad habitat tolerance and wide-ranging behavior of quolls means that the species could occur at many locations adjacent to the upgrade, particularly during the dispersal phase (December-January). The likelihood that the species would regularly use or reside in fragmented, road-side or heavily logged forest is low, although such habitat may occur in a home range.

2.2.2 Study area

To satisfy the conditions of approval we targeted large areas of contiguous forest intersected by the upgrade alignment. Preference was given to sections of alignment with suitably sized underpasses that could be used by quolls. By targeting areas with underpasses any data collected would be a suitable reference for operational phase monitoring proposed in the Ecological Monitoring Program (BEM 2014).

The NH2U alignment traverses four large areas of contiguous habitat, Nambucca State Forest (SF; chainage 61300-62100), Little Newry SF (Chainage 70100-71600), Newry SF (Chainage 72100-76900) and private property north of the Kalang River (Chainage 78800-81000).

To maximize the likelihood of detection and satisfy the aim of the condition (i.e. sample areas of suitable habitat) the alignment was divided into three zones (*Figure 2.1*):

1. North – large area of sclerophyll forest north of the Kalang River and containing Newry State Forest and private property;
2. Central – large contiguous area of sclerophyll forest extending from the southern boundary of Newry State Forest to the Kalang River and east to Dalhousie Creek and Hungry Head; and
3. South – area of Sclerophyll forest in Nambucca State Forest to the east and west of the alignment.

Although habitat in Nambucca State Forest was highly modified, consisting of even-aged regenerating Dry Open Forest with Swamp Sclerophyll in the drainage lines and scarce arboreal and ground hollows the area was sampled for completeness and in recognition that the dispersal behaviour of quolls means individuals can be recorded in a variety of habitats.

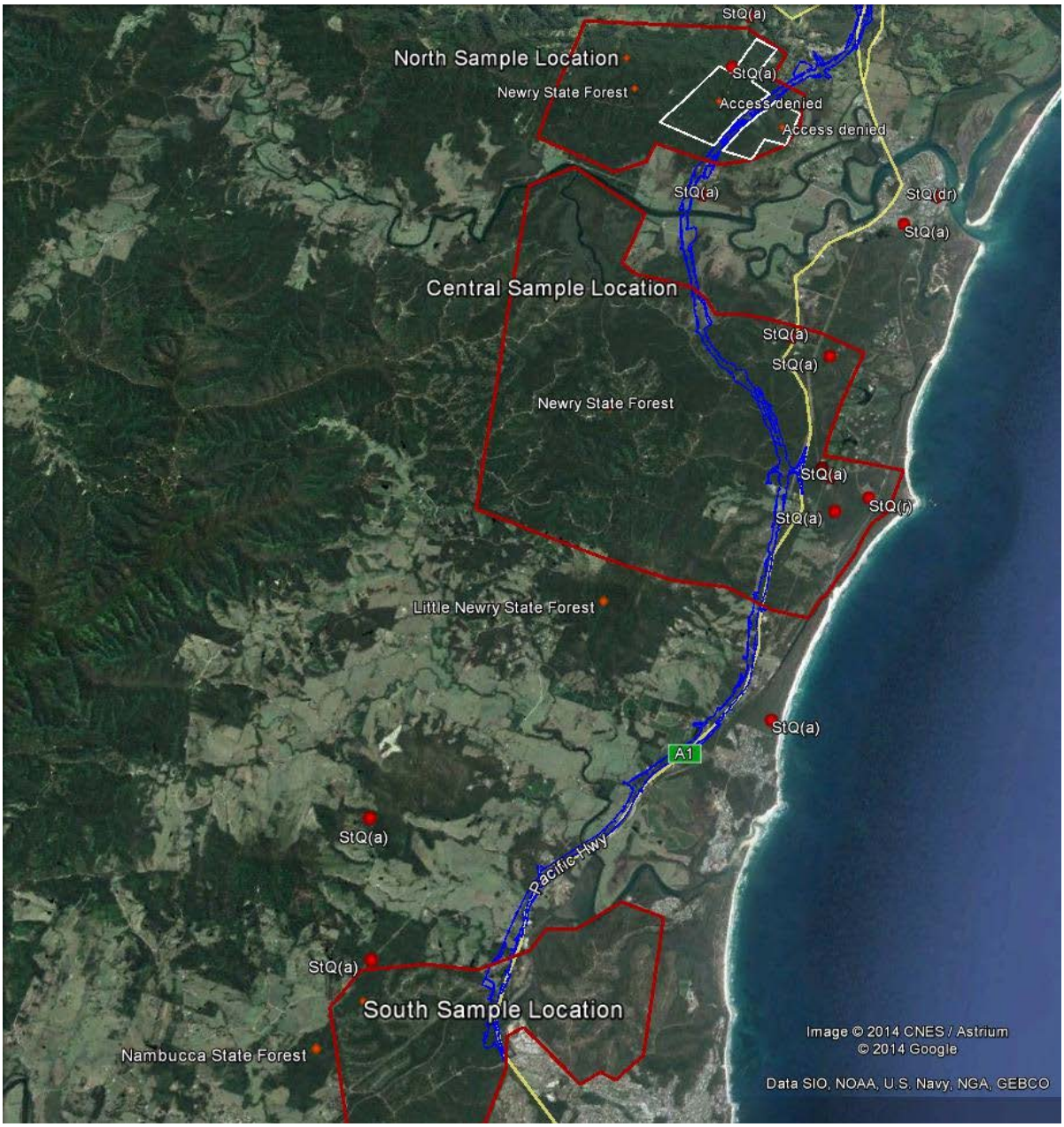

***Figure 2.1**: Location of sample zones (red polygons) in relation to forest extent and the Nambucca to Urunga Pacific Highway Upgrade (blue line). Red dots indicate spotted-tailed quoll records (a=Atlas of NSW Wildlife, dr=D. Rohweder, r=resident) and white polygons are areas of potentially important habitat where property access was denied.*

2.2.3 Property access

Approval to access Nambucca, Little Newry and Newry State Forests was obtained from the Forestry Corporation of NSW. Access was granted to a small number of private properties and a Crown Reserve east of the Ballards Road/Pacific Highway Intersection (Central Zone) and North of the Kalang River (North Zone). Access was denied to a large land holding in the northern zone. This property straddled the upgrade alignment and contained moderate to high quality moist sclerophyll habitat. There was limited time available to undertake a detailed property access program and access was gained by door knocking high priority properties.

2.2.4 Survey design

Some threatened species monitoring surveys for the Pacific Highway have adopted a Before-After-Control-Impact (BACI) design (Krebs 1989, Underwood 1991). Whereby the presence or absence of mitigation structures (i.e. underpasses or rope bridges) is regarded as the control and impact component respectively and before and after refers to sampling before and after the installation of mitigation structures. Some obvious limitations of such a design are that it ignores the effect of habitat removal (associated with construction) on target populations and the fact that crossing structures are generally sited in better quality habitat for the target species, which biases results towards sites with structures. Whilst such an effect may be overcome by adequate replication the patchy distribution and low abundance of threatened species means most datasets will contain numerous nil results and would be unsuitable for standard statistical analysis methods.

The impact of habitat removal is often difficult to predict and may depend on the target species home range size, social structure of the population and areas of different home ranges affected. The spatial scale over which the design is applied is also a limitation. Such a design would be most effective if applied over several upgrades. The feasibility of such a design for quolls in a small area is questionable given the large home range size and close proximity of crossing structures. The lack of information on the type of structures used by quolls also raises some doubt about the feasibility of partitioning an alignment into control (without underpass) and impact (with underpass) sites.

Such a design was considered unnecessary, in this instance, as the aim was to collect baseline data on local populations to determine likely density and distribution. To satisfy this aim preference was given to a broad scale program that maximised the opportunity to detect quolls. A more robust design could be implemented as part of subsequent sampling, as per the EMP, in the event that quolls are detected.

Where possible, cameras were installed on both sides of the proposed upgrade. Due to access restrictions in the north zone four cameras were installed within the upgrade alignment. Whilst this approach is contrary to the condition of approval it was done to ensure some sampling occurred in that area. The design involved the use of camera traps set at a density of two/100ha. This sample density was based on similar surveys for quolls in northern NSW (e.g. SKM 2012a). The survey timing (December-January) coincides with dispersal of juvenile quolls and is recognised as a period of high activity.

2.2.5 Field survey

Baited camera traps were set at a density of 2/100ha. Each trap consisted of a Scoutguard SG560K camera aimed at a small bait station. Cameras were attached to trees at a height of 0.5-1.0m and situated 3-4m from a bait station. Bait stations were pegged to the ground and baited with either chicken wings or fish (blue pilchards) with bait type alternated between stations in the north and central zones. Chicken was the only bait used in the southern zone. Each bait station and surrounding logs/rocks were drizzled with fish oil as an attractant. Cameras were left insitu for a minimum of three weeks. A range of topographic sequences were sampled, but emphasis was placed on sampling mature forest on drainage lines (including steep-sided gullies), moist forest

types and areas with abundant large logs, rock outcrops and hollow-bearing trees. Cameras were typically installed near large logs, clusters of logs, drainage lines, forest trails, or a combination of these elements (*Plate 2.1*). Most sites were accessed by 4WD vehicle and foot traverse except sites 36, 37, 38 and 39 which were accessed by boat. Searches for quoll scats and tracks was undertaken opportunistically whilst installing cameras and moving to and from sites.

Plate 2.1: *Typical sample sites with bait station positioned near large logs.*

Cameras in the North and Central zones were installed on 17, 18, 20 and 23 December 2013 and Southern Zone on 6 and 7 January. All camera sampling was completed before clearing commence in the vicinity. To compensate for the removal of two bait stations by a domestic dog, cameras were reset at 10 sites (C4, 9, 14, 62, 63, 64, C1H, C2H, C3H & C4H) east of the existing highway in the Central Zone. These cameras were retrieved on 30 January 2014. Camera configuration included: Mode-camera; Photo size-5MP; Photo burst-3 photo; Sensitivity-high (normal if chance of false triggers); PIR interval-nil; timer interval-off; timer switch-off; flash range-15m; time stamp-on.

3. Results

3.1 Koala

3.1.1 Existing data

In addition to historical koala records for the locality contained on the OEH Wildlife Atlas database, there were two main sources of existing data relating to occurrence of koalas along the NH2U project corridor, the Warrell Creek to Urunga Project Environmental Assessment (WC2U EA) Working Paper No. 1 – Flora and Fauna (RTA 2010) and the Bellingen Koala Habitat Study (OEH unpublished). Additional information relating to koala occurrences south of the NH2U project corridor was also obtained from the Warrell Creek to Nambucca Heads Pacific Highway Upgrade EPBC Act Koala Impact Assessment prepared by GeoLink (2013).

OEH Wildlife Atlas database records

The Wildlife Atlas records are not suitable for use as baseline data for the NH2U project. However, the records do provide an indication of the location and extent of local koala sub-populations along the project corridor (*Figure 3.1a to 3.1d*). Wildlife Atlas koala records along the NH2U corridor are concentrated in several areas including:

- forest on private property between Waterfall Way and the Kalang River (both sides of the project corridor);
- Newry State Forest (SF) (both sides of the project corridor);
- Little Newry SF (both sides of the project corridor);
- the forested coastal strip east of the project corridor between Little Newry SF and Valla; and
- Nambucca SF (sparse records).

WC2U EA sampling

Field fauna surveys undertaken as part of the WC2U EA included koala scat surveys at 12 baseline survey sites located within or adjacent to the NH2U project corridor. These surveys were undertaken between 2005 and 2008. The scat survey method undertaken at each site involved scat searches below 20 trees greater than 200 millimetres diameter at breast height (DBH) within a 50m² quadrat. Evidence of koala habitation (ie. scats and scratches) was recorded at only two sites, both within Nambucca State Forest west of the project corridor (*Figure 3.1d*).

Sampling limitations

The scat sampling technique applied in the WC2U EA was incompatible with other scat sampling undertaken in the locality, which was based on the Scat Assessment Technique (SAT) devised by Phillips and Callaghan in 1995 and subsequently updated in 2011. Differences in sampling methodology included:

- area sampled 50m^2 compared to approximately 400m^2 for SAT sampling;
- randomly selected quadrat rather than central koala feed tree start point;
- maximum of 20 trees sampled rather than 30 trees sampled by SAT sampling;
- minimum trunk diameter of trees sampled was 200mm compared to 100mm by for SAT sampling; and
- bias towards preferred koala feed tree species rather than non-selective sampling for SAT.

Consequently, the WC2U EA dataset was of little use as baseline data due to the incompatible sampling methodology and duration of time since sampling (ie. five to eight years old).

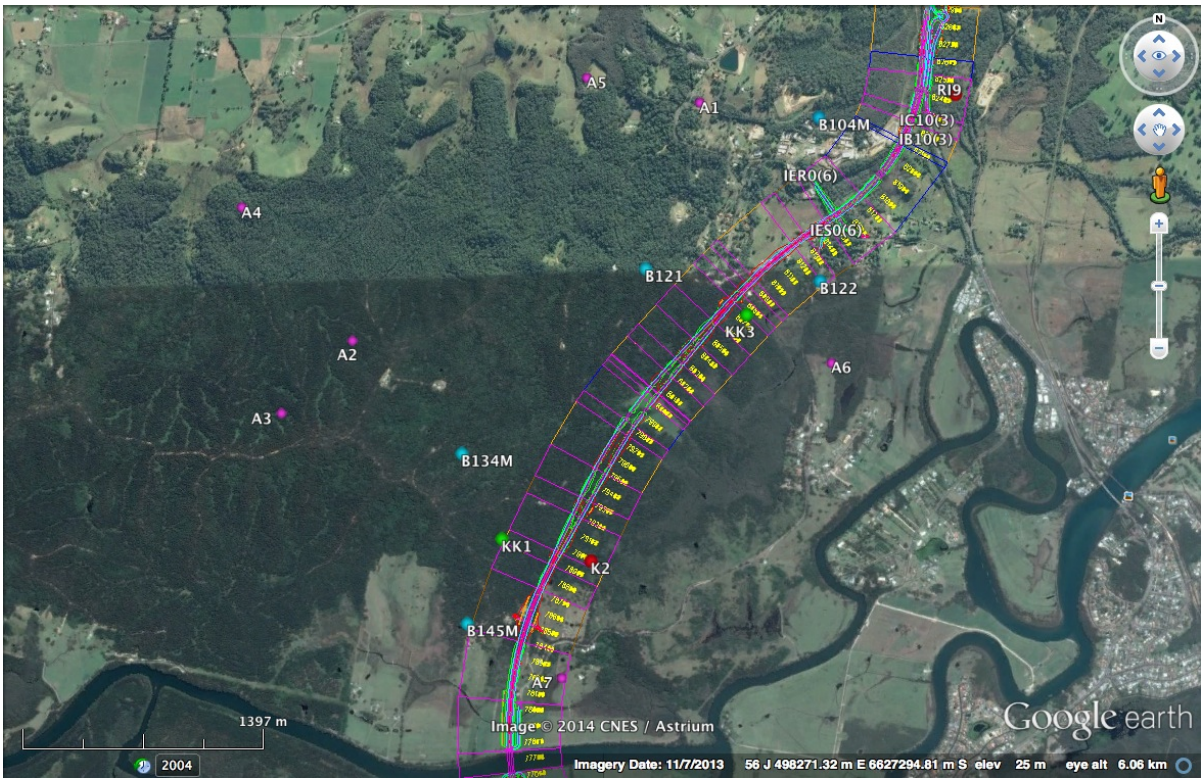

***Figure 3.1a**: Location of koala SAT sample sites and koala records north of the Kalang River.* Green dots = detailed baseline sample sites; red dots = core habitat assessment only; blue dots = Bellingen Koala Study sample sites; pink dots = Wildlife Atlas koala records.

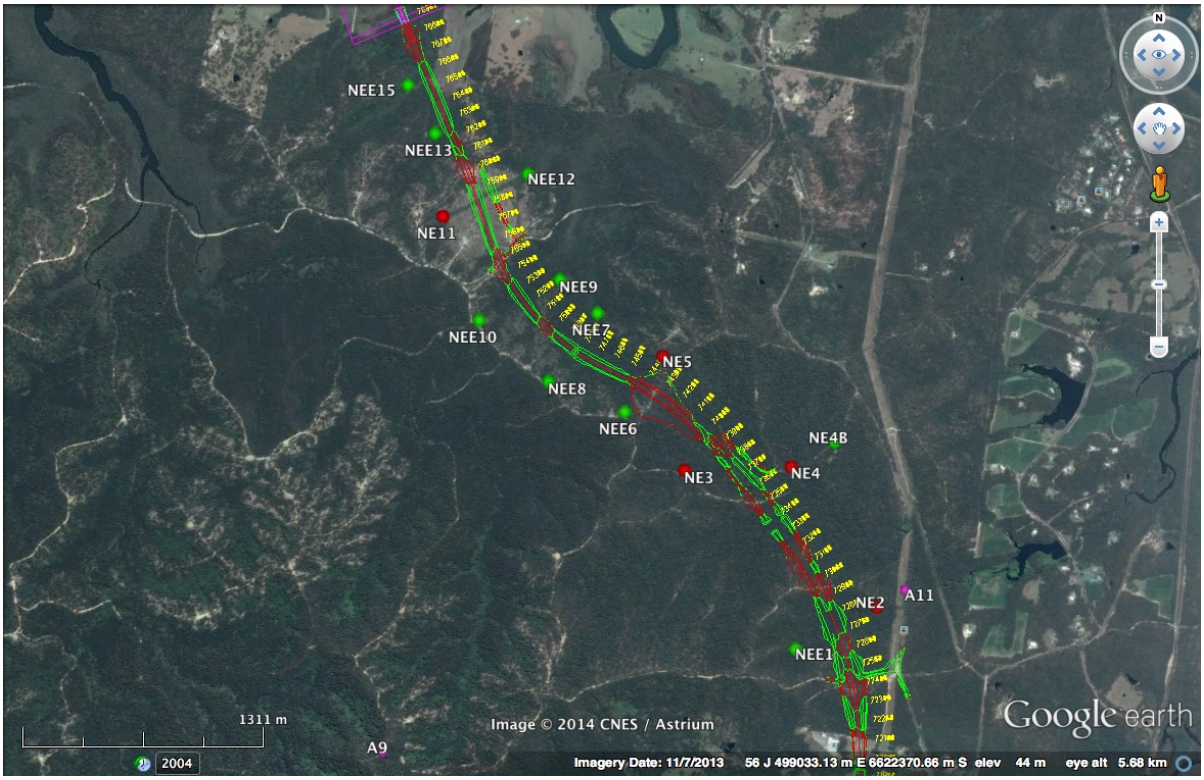

***Figure 3.1b**: Location of koala SAT sample sites and koala records in Newry SF.* Green dots = detailed baseline sample sites; red dots = core habitat assessment only; pink dots = Wildlife Atlas koala records.

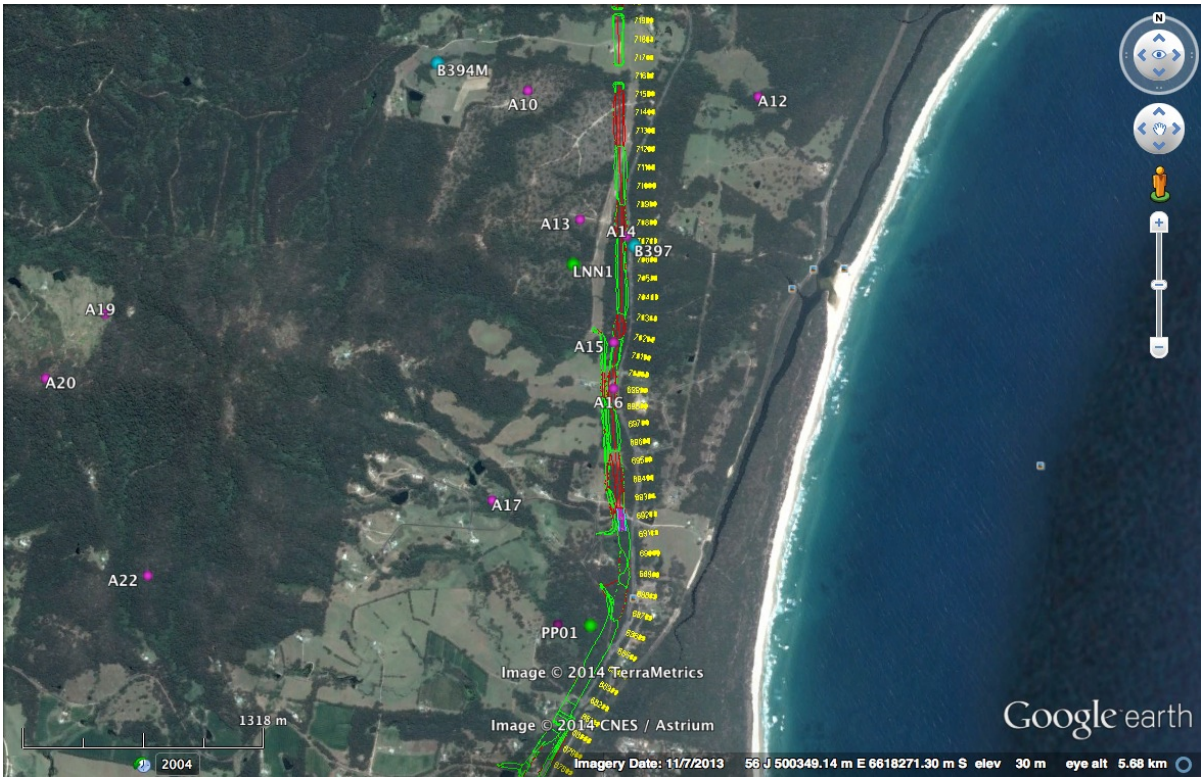

***Figure 3.1c**: Location of koala SAT sample sites and koala records in Little Newry SF and private property south to Nambucca SF.* Green dots = detailed baseline sample sites; blue dots = Bellingen Koala Study sample sites; pink dots = Wildlife Atlas koala records.

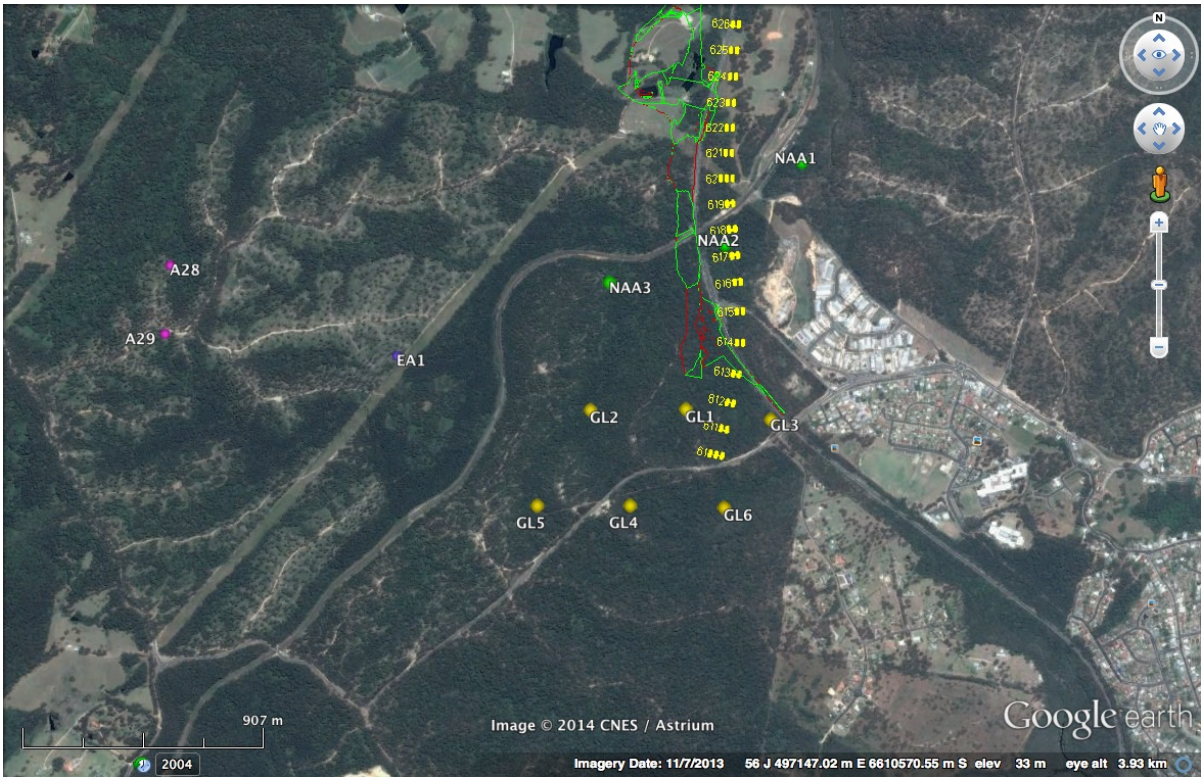

***Figure 3.1d**: Location of koala SAT sample sites and koala records in Nambucca SF.* Green dots = detailed baseline sample sites; pink dots = Wildlife Atlas koala records; purple dot = EA koala record; yellow dots = GeoLink koala habitat sample sites

Bellingen Koala Habitat Study

The Bellingen Koala Habitat Study undertaken by OEH in 2013 included koala scat surveys undertaken at 134 sites throughout the Bellingen Local Government Area (LGA). Seven of the sampling sites were located within one kilometre of the NH2U project corridor, with koala activity (ie. scats) being recorded at only one site (Site B134M) on private property north of the Kalang River (*Figures 3.1a and 3.1c; Appendix A*). The sampling methodology used for the study adhered strictly to the Spot Assessment Technique (SAT) as devised by Phillips and Callaghan (2011).

Sampling limitations

The area sampled by the Bellingen Koala Habitat Study was limited to private property within the Bellingen LGA, which extends just south of Little Newry State Forest. Therefore, a large proportion of the NH2U project corridor was not sampled by the study including Newry State Forest (SF), Little Newry SF and Nambucca SF.

SEWPAC referral for WC2NH

The SEWPaC referral for WC2NH prepared by GeoLink (2013) conducted koala scat searches at 53 sites south of the NH2U project corridor. The sampling methodology used was the same as that applied in the Bellingen Koala Study. The only koala activity recorded in the vicinity of the NH2U corridor was in Nambucca SF near Swampy Creek (*Figure 3.1d; Appendix A*).

Sampling limitations

All sampling sites were located south of the NH2U project corridor. Consequently, the dataset was of limited use as baseline data for monitoring effectiveness of mitigation measures on NH2U.

3.1.2 Selection of additional sample sites

The data collation process identified suitable existing baseline data for 10 locations along the NH2U project corridor, seven of the Bellingen Koala Study sites and six of the WC2NH DoE Referral sites (*Figures 3.1a, 3.1c and 3.1d*). Additional baseline data was considered necessary in five broad areas within the Project corridor:

- forested private property north of the Kalang River (chainage 78400 to 81100);
- Newry State Forest (SF) (chainage 72100 to 77000);
- Little Newry SF (chainage 70100 to 71600);
- Private property south of Burkes Lane (chainage 68600); and
- Nambucca SF (chainage 61300 to 62100).

The preliminary desktop assessment identified up to 28 potential sample sites within the five nominated areas. However, the subsequent field survey was limited to 17 sample sites due to site access constraints (on private property north and south of the Kalang River) and the limited number of sample sites that met the critical habitat criteria stipulated by DoE (*Figure 3.1a to 3.1d*).

3.1.3 Field survey

Koala activity assessments were undertaken at the additional sample sites along the NH2U project corridor between 26 November and 3 December 2013 (*Appendix A*). Koala activity, as indicated by the presence of koala faecal pellets (scats), was recorded at five of the additional sites sampled (*Table 3.1*). Koala activity (ie. scats)

was also recorded at one of the sites sampled during the Bellingen Koala Habitat Study (Site B134M). Details of the sites where koala activity was detected are provided in *Table 3.1*.

***Table 3.1**: Koala SAT sampling sites where koala activity (presence of scats) was recorded.*

Site No.	Easting	Northing	Chainage	Location	Koala Activity Level (%)	Trees Species Used
NEE9	498798	6622972	75200 (200m ENE of corridor)	Newry SF	3.3	*E. acmenoides (1)*
NEE7	499002	6622790	74850 (200m NE of corridor)	Newry SF	3.3	*E. acmenoides (1)*
NEE10	498361	6622750	75250 (200m WSW of corridor)	Newry SF	16.7	*E. propinqua (1); E. pilularis (2); E. siderophloia (1); S. glomulifera (1)*
LNN1	500187	6618954	70580 (230m W of corridor)	Little Newry SF	23.3	*E. microcorys (1); E. pilularis (1) E. propinqua (2); A. torulosa (1); S. glomulifera (2)*
PP1	500280	6616991	68560 (60m WNW of corridor)	Private property at Burkes Lane.	3.3	*E. robusta (1)*
B134M	497610	6626875	79300 (450m west of corridor)	Private property north of Kalang R.	3.3	*E. saligna (1)*

The koala activity level for a SAT site is the percentage equivalent of the proportion of surveyed trees within the site that had a koala faecal pellet recorded within one metre of the trunk.

Collation of existing data and results of the baseline surveys indicate that forests within the Project corridor support a koala population with low density. Therefore, the *east coast (low)* population density activity thresholds of Phillips and Callaghan (2011) are applicable whereby:

- ≥3.33% but ≤12.59% indicates medium koala use; and
- >12.59% indicates high koala use.

Based on these activity thresholds the Project corridor traverses several areas supporting medium koala use, including private property north of the Kalang River (chainage 79300), parts of Newry SF (between chainages 74850 and 75200) and private property near Burkes Lane (chainage 68560). The Project corridor also traverses two areas supporting high koala use, Newry State Forest (chainage 75250) and Little Newry State Forest (chainage 70580).

3.2 Spotted-tailed quoll

3.2.1 Habitat

Habitat types sampled included moist sclerophyll forest with a mesic understorey, riparian forest, dry sclerophyll forest with a grass and shrub understorey and coastal woodland. Overstorey vegetation at all sites was dominated by *Eucalyptus* spp. Midstorey vegetation varied from mesic (rainforest) shrubs to *Allocasuarina* spp and *Dodonaea* spp. Understorey vegetation was also variable, ranging from kangaroo grass (*Themeda australis*) to ferns and *Lomandra* spp. A small number of sites had dense thickets of *Cordyline* spp and *Gahnia* spp.

Large (>300mm diameter) woody debris was abundant at all sites, although the highest quality hollow logs were recorded in the northern sample location. Mature forest was restricted to drainage lines and some private property. These areas contained a number of mature and senescent hollow bearing trees that would make suitable den sites. The majority of the study area has been logged (or even cleared) and this was evident in the

age of canopy vegetation and abundance of arboreal hollows. Some forest has undergone several rotations and contained a low abundance of hollows. No rock outcrops were recorded during the survey.

3.2.2 Camera data

A total of 96 cameras were installed, 20 in the North Zone, 52 in Central Zone and 24 in the Southern Zone (*Table 3.2; Figures B1, B2, B3-Appendix B*). One camera in the central zone malfunctioned and did not record any pictures. A total of 10575 active images were recorded from 1415 fauna passes, including 296 passes in the northern zone, 815 in central and 304 in south. The average number of passes/camera was 14.8 in north, 16 in central and 12.7 in south (*Table 3.2*). The total area of habitat sampled was approximately 4490ha and camera density across this area was 1/47ha (*Table 3.2*). Camera density between zones was 1/34ha in North Zone, 1/55ha in Central Zone and 1/40ha in South Zone.

Forty-three species and seven species groups were recorded, although no spotted-tailed quolls were recorded (*Table 3.3; Table C2, Appendix C*). Species composition included 19 mammals, five reptiles and 19 birds. Key results included:

1. No spotted-tailed quolls were photographed or evidence (scats or tracks) of quolls recorded.
2. 3 records of koala; one on private property east of the highway and two in Newry State Forest west of the upgrade.
3. Records of four recognised prey species: common brushtail possum, short-eared brushtail possum, northern brown bandicoot and long-nosed bandicoot.
4. Similar occurrence of brushtail possums between north and central sites but lower occurrence in south and trend of decreasing abundance of bandicoots from north to south.
5. Presence of three introduced predators, dog, red fox and cat, with variable occurrence between sample locations.
6. Inverse pattern of occurrence between dog and red fox. Dog recorded at 30% of north sites, 19.6% of central and 4.2% of southern sites and red fox recorded at no north sites, 3.9% central and 25% of south sites.
7. Moderate occurrence (20-35%) of small ground mammals (Rattus spp, Antechinus spp, Melomys spp) across all sites and no obvious trend in occurrence.
8. Lace monitor was the most commonly recorded species in all three zones, with occurrence ranging from 79.2 to 85%.
9. Macropods, particularly swamp wallaby, were commonly recorded, with a general trend of increasing occurrence from north to south.
10. Most birds were recorded infrequently, with the exception of Australian brush turkey (16.7-41.2% of sites), wonga pigeon (4.2-20%) and superb lyrebird (7.8-10%).

***Table 3.2**: Number of cameras installed, active images obtained, fauna passes and average passes/camera recorded in each zone.*

Location & Area Sampled	No. Cameras & Sample Density	No. Malfunction	Active Images	Number Fauna Passes	Average Passes/Cam
North (690ha)	20 (1/34ha)	0	2125	296	14.8
Central (2850ha)	52 (1/55ha)	1	5662	815	16.0
South (950ha)	24 (1/40ha)	0	2788	304	12.7
Total (4490ha)	96 (1/47ha)	1	10575	1415	14.7

***Table 3.3**: Species recorded by cameras in each sample zone and the number of sites detected and proportion of sites. Blue shading denotes a known prey species.*

Species name	Common name	North (n=20) No. sites	North (n=20) % of sites	Central (n=51) No. sites	Central (n=51) % of sites	South (n=24) No. sites	South (n=24) % of sites
Tachyglossus aculeatus	Short-beaked Echidna	6	30.0	6	11.8	2	8.3
Antechinus spp		3	15.0	14	27.5	3	12.5
Sminthopsis murina	Common Dunnart	1	5.0	0	0.0	0	0.0
Phascolarctos cinereus	Koala	0	0	3	5.9	0	0
Trichosurus vulpecula	Common Brushtail Possum	5	25.0	16	31.4	2	8.3
Trichosurus caninus	Short-eared Possum	2	10.0	6	11.8	3	12.5
Isoodon macrourus	Northern Brown Bandicoot	11	55.0	20	39.2	8	33.3
Parameles nasuta	Long-nosed Bandicoot	3	15.0	4	7.8	0	0.0
Wallabia bicolor	Swamp Wallaby	8	40.0	29	56.9	18	75.0
Macropus rufogriseus	Red-necked Wallaby	0	0	3	5.9	0	0
Macropus giganteus	Eastern Grey Kangaroo	0	0	2	3.9	2	8.3
Hydromys chrysogaster	Water Rat	0	0	1	2.0	0	0.0
Rattus fuscipes	Bush Rat	0	0	0	0.0	2	8.3
Rattus rattus	Black Rat	2	10.0	1	2.0	4	16.7
Felis cattus	Cat	0	0	4	7.8	0	0
Canis familiaris	Dog	6	30.0	10	19.6	1	4.2
Vulpes vulpes	Red Fox	0	0	2	3.9	6	25.0
Equus caballus	Horse	1	5.0	0	0.0	0	0.0
Homo sapien	Human	0	0	1	2.0	0	0.0
Homo sapien	Macropod spp	1	5.0	0	0.0	1	4.2
Trichosurus spp.	Bandicoot spp	11	55.0	20	39.2	1	4.2
Trichosurus spp.	Brush-tailed Possum	6	30.0	10	19.6	2	8.3
Trichosurus spp.	Wallaby spp	3	15.0	10	19.6	2	8.3
Thylogale spp.	Pademelon spp	1	5.0	3	5.9	0	0.0
Melomys spp		1	5.0	3	5.9	1	4.2
Rattus spp		7	35.0	24	47.1	9	37.5
Rattus spp	Rodent spp	6	30.0	11	21.6	6	25.0
Egernia major	Land Mullet	2	10.0	16	31.4	5	20.8
Varanus varius	Lace Monitor	17	85.0	41	80.4	19	79.2
Physignathus lesueurii	Eastern Water Dragon	3	15.0	1	2.0	0	0.0
Dendrelaphis punctulata	Green Tree Snake	0	0	1	2.0	0	0.0
Pseudechis spp.	Black Snake	0	0	1	2.0	0	0.0
Turnix varius	Painted Button Quail	0	0	1	2.0	0	0.0

Alectura lathami	Australian Brush Turkey	6	30.0	21	41.2	4	16.7
Chaloophaps indica	Emerald Dove	2	10.0	0	0.0	0	0.0
Leucosaria picata	Wonga Pigeon	4	20.0	5	9.8	1	4.2
Geopelia humeralis	Bar-shouldered Dove	0	0	1	2.0	0	0.0
Dacelo novaeguineae	Laughing Kookaburra	0	0	1	2.0	1	4.2
Menura novaehollandiae	Superb Lyrebird	2	10.0	4	7.8	0	0.0
Orthonyx temminckii	Australian Logrunner	1	5.0	1	2.0	1	4.2
Ailuroedus crassirostris	Catbird	0	0	1	2.0	2	8.3
Climacteris spp.	Treecreeper spp	0	0	0	0.0	1	4.2
Sericornis citreogularis	Yellow-throated Scrubwren	0	0	0	0.0	2	8.3
Malurus lamberti	Variegated Fairy Wren	0	0	1	2.0	0	0.0
Ptilonorhynchus violaceus	Satin Bowerbird	0	0	1	2.0	0	0.0
Eopsaltria australis	Eastern Yellow Robin	0	0	3	5.9	2	8.3
Rhipidura rufifrons	Rufous Fantail	1	5.0	0	0.0	0	0.0
Colluricincla harmonica	Grey Shrike-Thrush	0	0	1	2.0	0	0.0
Psophodes olivaceus	Eastern Whipbird	0	0	2	3.9	1	4.2
Cracticus torquatus	Grey Butcherbird	1	5.0	0	0.0	0	0.0
Corvus orru	Torresian Crow	0	0	1	2.0	0	0.0
Sericornis spp.	Scrubwren spp	0	0	1	2.0	0	0.0
Pachycephala spp.	Whistler spp	0	0	1	2.0	0	0.0

4. Discussion

4.1 Koala

The collated records and results of additional sampling confirm that the local koala population in the vicinity of the Project corridor is of low density. Consequently, the available information is insufficient to determine an accurate estimate of the koala population. However, assuming there is a low density of koalas in the locality, the Project corridor appears to traverse only a small number of home ranges of individual koalas.

The project design incorporates a combination of fauna exclusion fencing and fauna underpass structures within 500 metres of each sample site where koala activity was recorded (*Table 4.1*). Therefore, in conjunction with other mitigation measures such as daily diurnal and nocturnal pre-clearing searches, the Project is expected to have minimal impact on the viability of the local koala population by preventing direct mortalities during

vegetation clearing and by maintaining opportunities for safe koala movement across the Project corridor once operational.

***Table 4.1**: Location of nearest fauna underpass structures to sample sites where koala activity was recorded.*

Sample Site	Chainage Location	Chainage of Nearest Underpass Structure	Approximate Distance to Recorded Koala Activity (m)
NEE9	75200	75162	38
NEE7	74850	74697	153
NEE10	75250	75162	88
LNN1	70580	70332	248
PP1	68560	68302	258
B134M	79300	79717	417

4.2 Spotted-tailed quoll

The absence of quolls during this study is not definitive evidence that the species does not occur in the study area. Whether there is a resident population is uncertain but the distribution of records and presence of recent (2010) records is sufficient to conclude that quolls utilise the study area. Quolls are predicted to occur at low densities and with heightened awareness records may be obtained during construction or in the operational phase. Given the predicted occurrence of quolls the implementation of specific measures, such as underpasses, to enable quolls to cross the upgraded highway is warranted. The best quality quoll habitat (i.e. mature moist forest with abundant hollows, large logs and drainage lines) was recorded on private property to the east of the existing Pacific Highway (central zone), west of the northern median (north zone) and along Dalhousie Creek (central zone). Habitat in Nambucca State Forest was generally of low quality. The high occurrence of prey (possums and bandicoots) in the North and Central Zones coupled with a higher occurrence of dogs, low occurrence of foxes, and moderate quality habitat makes these zones the most likely to support quolls. The higher abundance of wild dogs may suppress fox and cat numbers (Glen *et al.* 2007) thereby reducing predation and competition between these species and quolls.

Limitations of this survey must be considered when interpreting results. Sampling over a longer period (i.e. breeding and dispersal periods over two years) and increased sampling intensity (i.e. 4 cameras/100ha) may be required to obtain an accurate indication of quoll occurrence in coastal northeastern NSW. Recent targeted surveys have not detected quolls (e.g. Warrell Creek, Glenugie, Devils Pulpit) but road-killed individuals have been recorded nearby, either before or after these surveys. Present evidence suggests that quolls occur at low densities and many areas of forest do not support resident populations. During this study sample coverage was extensive and occurred during juvenile dispersal, a period of greater activity. Although the survey would have benefited by greater access to private property the results provide a reliable indication of quoll presence at the time of the study.

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Appendix A: Koala baseline monitoring data and results.

Table A1: Location details of sample sites.

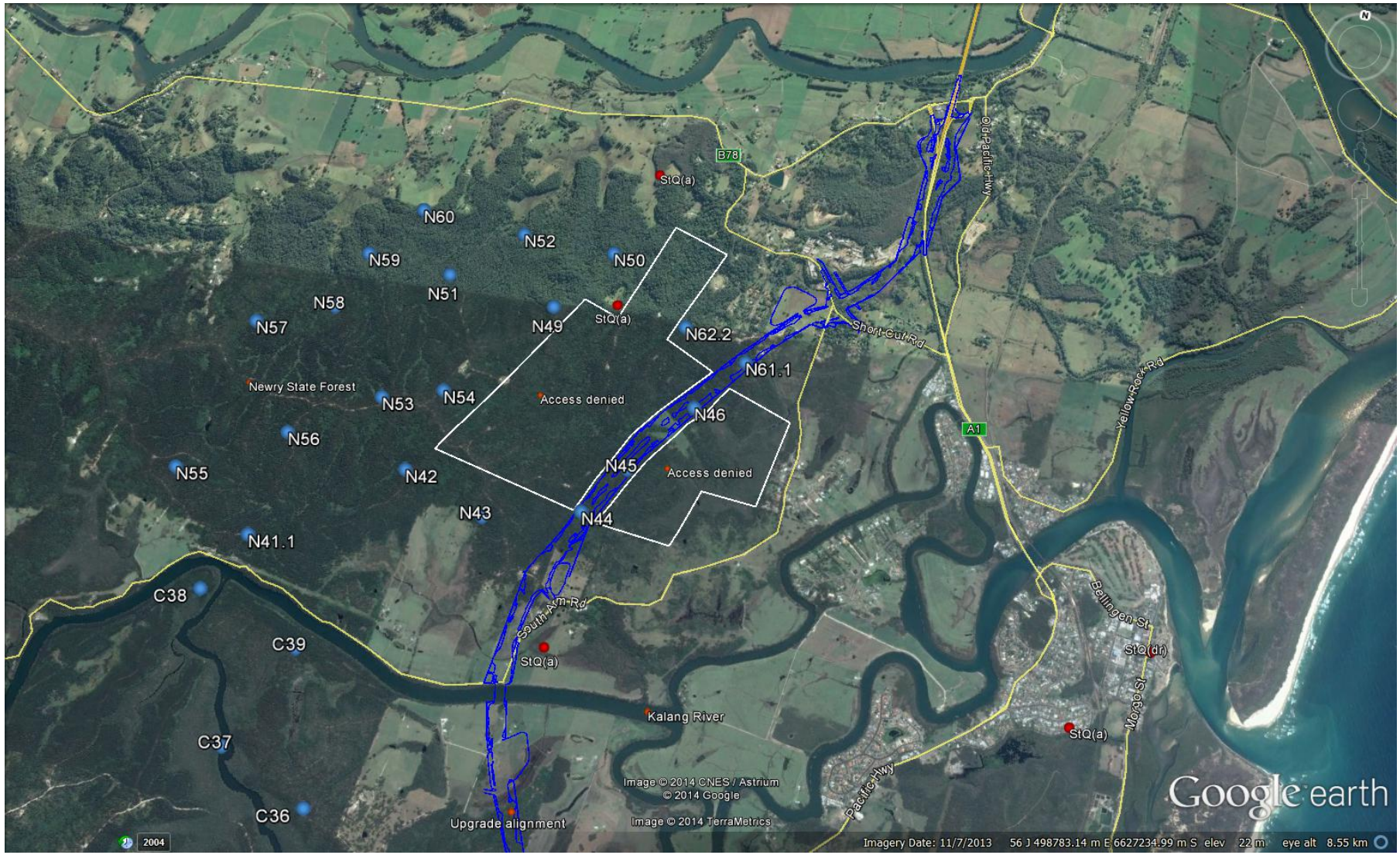
Sample Site	Easting (UTM WGS84)	Northing
KK1	497686	6626445
KK3	499104	6627739
NAA1	497897	6611428
NAA2	497606	6611118
NAA3	497172	6610976
NEE1	500075	6620974
NE4b	500289	6622090
NEE6	499150	6622254
NEE7	499002	6622790
NEE8	498737	6622419
NEE9	498798	6622972
NEE10	498362	6622750
NEE12	498624	6623545
NEE13	498118	6623765
NEE15	497971	6624029
LNN1	500187	6618954
PP01	500281	6616996
GL1	497457	6610501
GL2	497099	6610498
GL3	497775	6610462
GL4	497248	6610142
GL5	496900	6610142
GL6	497601	6610133
B394M	499447	6620047
B397	500520	6619054
B145M	497484	6625957
B134M	497453	6626938
B121	498517	6628005
B122	499529	6627935
B104M	499522	6628879

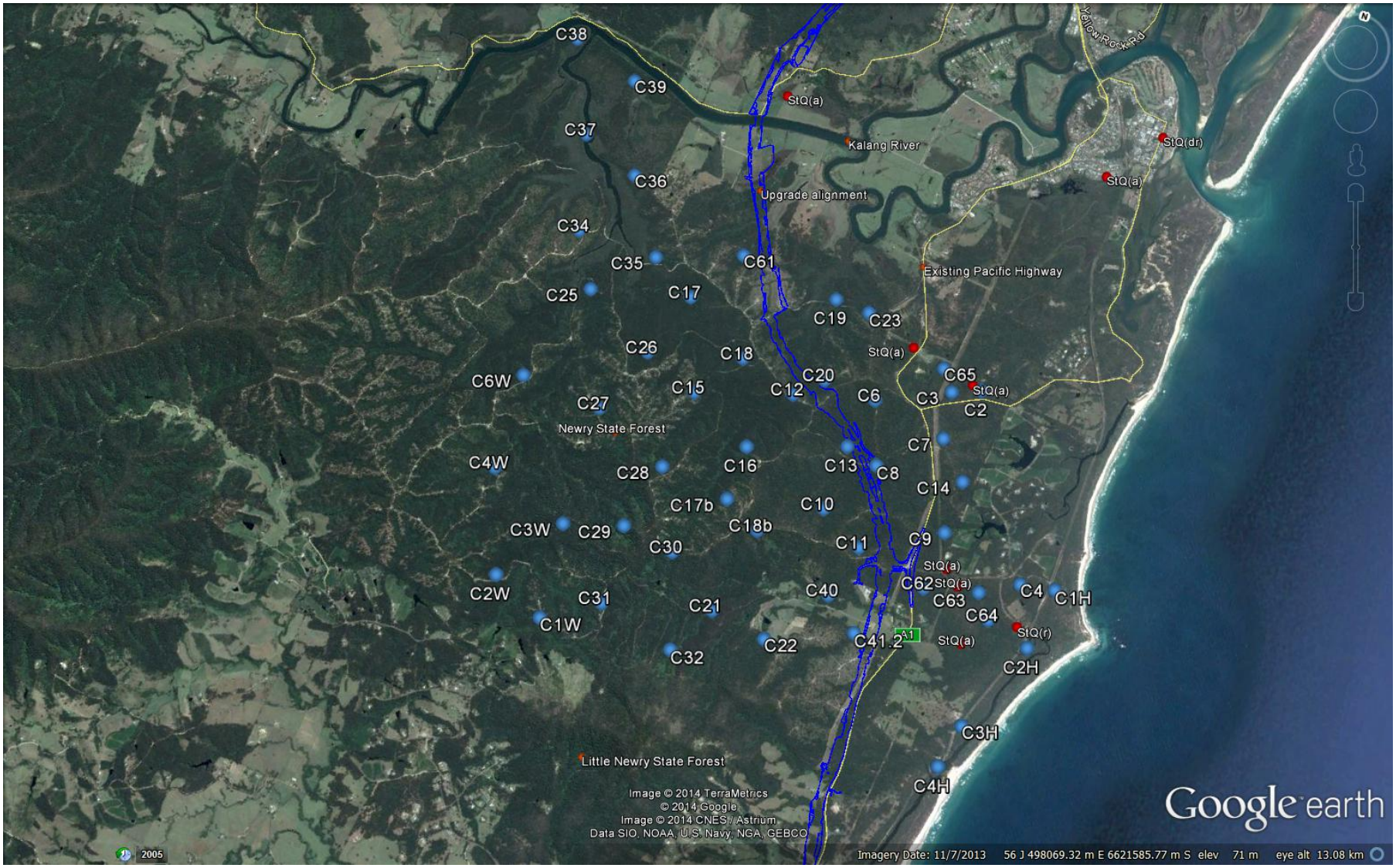
Table A2: Results of koala activity baseline monitoring.

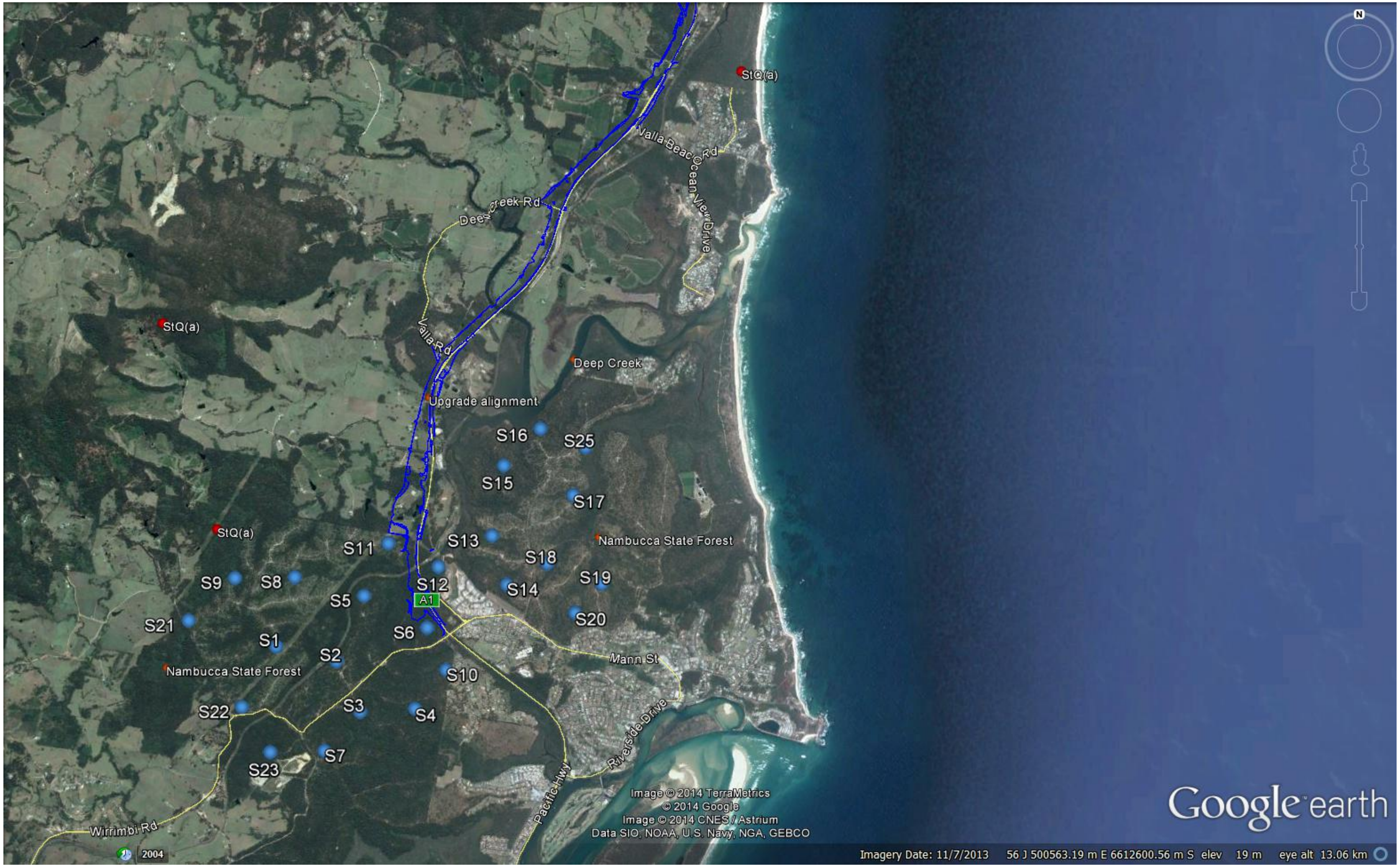
Tree Species	Koala Feed Tree	KK1	KK3	NAA1	NAA2	NAA3	NEE1	NE4b	NEE6	NEE7	NEE8	NEE9	NEE10	NEE12	NEE13	NEE15	LNN1	PP01	GL1	GL2	GL3	GL4	GL5	GL6	B394M	B397	B145M	B134M	B121	B122	B104M
Acacia melanoxylon	No				1			1							1		1	3													
Allocasuarina littoralis	No	5																			1										
Allocasuarina torulosa	No		14		13	2	1	3	2	4		4	3				3	2	1	1		2	1	2				1	1		
Callicoma serratifolia	No															1															
Callistemon salignus	No		3	6										3	4					1											
Claoxylon sp.	No													2	1																
Corymbia intermedia	No	2	2	1	2	3	3	3	7	4	1	2	2			2			4	1	1	1	2	3	3	9		5	3	5	1
Eucalyptus acmenoides	No	3				2		8		7	7	8	3				1						10		1				4		
Eucalyptus grandis	No				2	1												1		2											
Eucalyptus microcorys	**Primary**		**2**		**10**	**11**	**7**	**7**	**11**	**6**	**7**	**5**	**6**				**3**		**6**	**3**	**2**	**9**	**8**	**6**	**10**	**1**		**6**	**5**	**13**	
Eucalyptus pilularis	No		1			4	7	3	4				5				11			3	1	13	3	3		9				5	
Eucalyptus propinqua	Secondary		6				7	2	3	3	13	1	3				4			1		1	1		4			7	7		
Eucalyptus resinifera	Secondary											2		2		4		2			1								2		
Eucalyptus robusta	**Primary**			**7**										**12**	**18**	**20**		**9**												**2**	**11**
Eucalyptus saligna	No																											4			
Eucalyptus siderophloia	No	3					4	3		4	2	1	1				2			3			4		2			2	2		
Eucalyptus signata	No	12																			5			2							
Glochidion ferdinandii	No														1	1		4													

Lophostemon confertus	No	1	1		1				1															2	1			1		
Lophostemon suaveolens	No			4																										11
Melaleuca linariifolia	No													3	1															
Melaleuca quinquenervia	No			12									8	1			7													2
Melaleuca styphelioides	No												3	1																
Syncarpia glomulifera	No	4	1		1	7	1		2	2		7	7			1	5		19	15	19	4	1	14	2	5		5			
Unidentified tree	No																	2												
Total		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	24	25	n/a	30	25	25	25
Trees with scats		0	0	0	0	0	0	0	0	1	0	1	5	0	0	0	0	1	0	0	0	0	0	0	0	0	n/a	1	0	0	0
Proportion Primary Koala Food Trees (%)		0	6.7	23.3	33.3	36.7	23.3	23.3	36.7	20	23.3	16.7	20	40	60	66.7	10	30	20	10	6.7	30	26.7	20	41.6	4	n/a	20	20	52	44
Proportion Secondary Koala Food Trees (%)		0	20	0	0	0	23.3	6.7	10	10	43.3	10	10	6.7	0	13.3	13.3	6.7	0	3.3	3.3	3.3	3.3	0	16.7	0	n/a	23.3	36	8	0
Proportion primary/secondary koala food trees (%)		0	26.7	23.3	33.3	36.7	46.6	30	46.7	30	66.6	26.7	30	46.7	60	80	23.3	36.7	20	13.3	10	33.3	30	20	58.3	4	n/a	43.3	56	60	44

Appendix B: Location of spotted-tailed quoll sample sites **Figure B1:** Location of camera sites (blue circles), quoll records (red circles) and excluded property (white polygon) in the north zone.




C38
C39
StQ(a)
C37
Kalang River
StQ(dr)
C36
Upgrade alignment
StQ(a)
C34
C35
C61
Existing Pacific Highway
C25
C17
C19
C23
C26
C18
StQ(a)
C6W
C20
C65
C15
C12
C6
StQ(a)
C27
C3
C2
Newry State Forest
C7
C4W
C28
C16
C13
C8
C14
C17b
C10
C3W
C29
C18b
C11
C9
C30
StQ(a)
C62
StQ(a)
C2W
C31
C21
C40
C4
C1H
C63
C64
C1W
StQ(r)
C22
C41.2
StQ(a)
C32
C2H
C3H
Little Newry State Forest
C4H
Image © 2014 TerraMetrics
© 2014 Google
Image © 2014 CNES / Astrium
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth
2005
Imagery Date: 11/7/2013 56 J 498069.32 m E 6621585.77 m S elev 71 m eye alt 13.08 km


StQ(a)
Valla Beach Rd
Ocean View Drive
Dees Creek Rd
StQ(a)
Valla Rd
Deep Creek
Upgrade alignment
S16
S25
S15
S17
StQ(a)
S11
S13
Nambucca State Forest
S18
S19
S9
S8
S12
S14
S5
A1
S21
S20
S6
S1
S2
Mann St
Nambucca State Forest
S10
S22
S3
S4
Riverside Drive
S7
S23
Pacific Hwy
Image © 2014 TerraMetrics
© 2014 Google
Image © 2014 CNES / Astrium
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Wirrimbi Rd
2004
Google earth
Imagery Date: 11/7/2013 56 J 500563.19 m E 6612600.56 m S elev 19 m eye alt 13.06 km

Appendix C: Camera Installation Data and Results

Table C1: Camera installation data.

Location	Site	Easting	Northing	Settings	Install Date	Retrieve Date	Pictures
North	C61.1/304	499019	6627736	normal	19.12.13	24.1.14	159
North	C61.2/305	498543	6627935	normal	19.12.13	24.1.14	684
North	C46/306	498705	6627353	normal	19.12.13	24.1.14	103
North	C45/308	498333	6626822	high	19.12.13	24.1.14	120
North	C43/313	497378	6626316	high	23.12.13	24.1.14	1128
North	C41.1	495776	6625897	high	17.12.13	10.1.14	760
North	C42	496780	6626555	high	19.12.13	15.1.14	113
North	C44	497856	6626463	high	19.12.13	24.1.14	144
North	C49	497579	6627924	high	19.12.13	15.1.14	1178
North	C50	497920	6628396	high	20.12.13	10.1.14	2303
North	C51	496762	6628017	high	19.12.13	15.1.14	93
North	C52	497225	6628438	high	19.12.13	15.1.14	1734
North	C53	496494	6627036	normal	17.12.13	11.1.14	63
North	C54	496924	6627150	high	19.12.13	15.1.14	2269
North	C55	495146	6626306	high	17.12.13	10.1.14	240
North	C56	495859	6626688	normal	17.12.13	10.1.14	57
North	C57	495461	6627435	high	17.12.13	10.1.14	138
North	C58	495997	6627634	high	17.12.13	10.1.14	81
North	C59	496141	6628096	high	17.12.13	10.1.14	69
North	C60	496472	6628491	high	19.12.13	15.1.14	249
Central	C10	499593	6621172	high	18.12.13	8.1.14	3162
Central	C11	500071	6620877	high	17.12.13	8.1.14	183
Central	C12	498942	6622276	high	17.12.13	8.1.14	303
Central	C13	499662	6621892	high	17.12.13	8.1.14	2820
Central	C14	500969	6621899	high	18.12.13	30.1.14	2487
Central	C15	497901	6622003	high	17.12.13	11.1.14	1004
Central	C16	498611	6621588	high	18.12.13	11.1.14	2546
Central	C17	497572	6623001	high	17.12.13	11.1.14	46
Central	C17b	498562	6620986	high	18.12.13	11.1.14	141
Central	C18	498310	6622507	high	17.12.13	8.1.14	1521
Central	C18b	498965	6620751	high	18.12.13	8.1.14	1869
Central	C19	499117	6623420	high	17.12.13	8.1.14	195
Central	C1H	502218	6621020	high	20.12.13	28.1.14	507
Central	C1w	496985	6619225	high	20.12.13	8.1.14	224
Central	C2	500905	6622875	high	18.12.13	10.1.14	1194
Central	C20	499231	6622520	high	17.12.13	9.1.14	397
Central	C21	498735	6619803	high	19.12.13	9.1.14	131
Central	C22	499353	6619666	high	19.12.13	9.1.14	141
Central	C23	499502	6623373	high	17.12.13	8.1.14	177
Central	C25	496484	6622788	high	17.12.13	8.1.14	173
Central	C26	497288	6622285	high	17.12.13	8.1.14	0

Location	Site	Easting	Northing	Settings	Install Date	Retrieve Date	Pictures
Central	C27	496958	6621551	high	17.12.13	9.1.14	213
Central	C28	497795	6621127	high	17.12.13	9.1.14	1330
Central	C29	497575	6620408	high	18.12.13	9.1.14	532
Central	C2h	502089	6620348	high	20.12.13	28.1.14	3735
Central	C2W	496400	6619531	high	20.12.13	11.1.14	528
Central	C3	500599	6622776	high	17.12.13	10.1.14	2282
Central	C30	498152	6620281	high	18.12.13	9.1.14	167
Central	C3W	496936	6620249	high	20.12.13	11.1.14	35
Central	C9	500910	6621351	high	18.12.13	30.1.14	462
Central	C61/303	498003	6623555	normal	18.12.13	10.1.14	423
Central	C62/309	500862	6620650	high	20.12.13	7.2.14	111
Central	C31	497577	6619555	high	20.12.13	10.1.14	746
Central	C63 (310)	501422	6620786	high	20.12.13	7.2.14	1386
Central	C64/311	501601	6620521	high	20.12.13	7.2.14	1006
Central	C32	498420	6619286	high	20.12.13	11.1.14	3003
Central	C34	496178	6623379	high	17.12.14	8.1.14	3121
Central	C35	497076	6623325	high	17.12.13	8.1.14	404
Central	C36	496356	6623817	high	23.12.13	15.1.14	1305
Central	C37	496155	6624555	high	23.12.13	15.1.14	2885
Central	C38	495502	6625394	high	23.12.13	15.1.14	198
Central	C39	496397	6625288	high	23.12.13	15.1.14	3508
Central	C3H	501624	6619365	high	20.12.13	29.12.13	2633
Central	C4	501842	6620975	normal	20.12.13	30.1.14	3691
Central	C40	499891	6620301	high	18.12.13	14.1.14	271
Central	C41.2	500262	6619991	high	18.12.13	14.1.14	1821
Central	C4W	496049	6620622	high	20.12.13	10.1.14	1398
Central	C4H	501489	6618892	high	20.12.13	18.1.14	3120
Central	C65	500458	6623002	high	20.12.13	10.1.14	462
Central	C6w	496055	6621670	high	20.12.13	11.1.14	306
Central	C7	500671	6622129	high	17.12.13	8.1.14	681
Central	C8	500019	6621781	high	17.12.13	8.1.14	183
South	N1	495985	6610316	high	6.1.14	28.1.14	238
South	N10	497816	6610061	high	6.1.14	28.1.14	2762
South	N11	497196	6611424	high	6.1.14	28.1.14	1002
South	N12	497732	6611170	high	6.1.14	28.1.14	124
South	N13	498312	6611504	high	6.1.14	28.1.14	1204
South	N14	498472	6610979	high	6.1.14	28.1.14	2784
South	N15	498439	6612259	high	6.1.14	28.1.14	901
South	N16	498834	6612655	high	6.1.14	28.1.14	1115
South	N17	499189	6611940	high	6.1.14	28.1.14	1078
South	N18	498909	6611207	high	6.1.14	28.1.14	2955
South	N19	499496	6610989	high	6.1.14	28.1.14	839
South	N2	496636	6610157	high	6.1.14	28.1.14	155

Location	Site	Easting	Northing	Settings	Install Date	Retrieve Date	Pictures
South	N20	499210	6610678	high	6.1.14	28.1.14	3235
South	N21	495066	6610604	high	6.1.14	28.1.14	2745
South	N22	495624	6609672	high	6.1.14	28.1.14	425
South	N23	495919	6609179	high	6.1.14	28.1.14	483
South	N25	499321	6612456	high	6.1.14	28.1.14	382
South	N3	496892	6609616	high	6.1.14	28.1.14	1961
South	N4	497482	6609647	high	6.1.14	28.1.14	3365
South	N5	496932	6610859	high	6.1.14	28.1.14	592
South	N6	497613	6610517	high	6.1.14	28.1.14	1380
South	N7	496507	6609196	high	6.1.14	28.1.14	175
South	N8	496190	6611062	high	6.1.14	28.1.14	510
South	N9	495550	6611054	high	6.1.14	28.1.14	216

Table C2: Raw camera data

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
North	C41.1	20.12.13	0207	Rattus spp.	Pr	6	127
		21.12.13	1752	Emerald Ground Dove	D	3	175
		22.12.13	0229	Rattus spp.	Pr	6	178
		22.12.13	2107	Bandicoot spp.	D	6	205
		23.12.13	2100	Pademelon	Po	3	259
		23.12.13	2144	Rodent spp.	Po	3	262
		23.12.13	2148	Swamp Wallaby	D	6	271
		24.12.13	0018	Northern Brown Bandicoot	D	51	277
		24.12.13	0323	Rodent spp.	D	3	328
		24.12.13	2256	Rattus spp.	Pr	3	331
		24.12.13	2304	Bandicoot spp.	D	9	334
		25.12.13	0333	Rodent spp.	D	3	343
		26.12.13	0206	Rodent spp.	D	6	349
		28.12.13	1423	Lace Monitor	D	9	364
		28.12.13	2240	Northern Brown Bandicoot	D	3	415
		28.12.13	2321	Bandicoot spp.	D	6	418
		29.12.13	0226	Northern Brown Bandicoot	Pr	3	424
		29.12.13	2338	Rattus spp.	D	3	460
		1.1.14	1302	Lace Monitor	D	6	493

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		5.1.14	2109	Bandicoot spp.	D	6	628
		7.1.14	0400	Bandicoot spp.	D	6	733
		9.1.14	2254	Brush-tailed Possum	Po	6	739
North	C42	21.12.13	1419	Lace Monitor	D	18	12
		22.12.13	2119	Rattus spp.	Pr	6	30
		22.12.13	2121	Rattus spp.	D	15	36
		30.12.13	1908	Short-beaked Echidna	D	6	57
		30.12.13	2338	Bandicoot spp.	Pr	3	66
		31.12.13	1550	Lace Monitor	D	3	69
		5.1.14	1326	Wonga Pigeon	D	3	75
		5.1.14	2303	Rattus spp.	Pr	6	78
		8.1.14	0621	Scrub Turkey	D	9	87
		8.1.14	2329	Northern Brown Bandicoot	D	9	96
		15.1.14	0247	Long-nosed Bandicoot	Pr	7	111
North	C43(313)	24.12.13	2152	Black Rat	D	3	52
		26.12.13	0115	Rodent spp.	D	18	58
		26.12.13	0713	Wonga Pigeon	D	4	76
		28.12.13	0115	Rodent spp.	D	6	94
		28.12.13	1318	Wonga Pigeon	D	3	109
		29.12.13	1146	Lace Monitor	D	60	187
		29.12.13	1309	Wonga Pigeon	D	3	247
		29.12.13	1349	Lace Monitor	D	96	250
		30.12.13	1058	Emerald Ground Dove	D	3	379
		31.12.13	0002	Rattus spp.	D	3	382
		31.12.13	0003	Rattus spp.	D	6	385
		31.12.13	1346	Emerald Ground Dove	D	3	394
		31.12.13	1521	Lace Monitor	D	87	424
		1.1.14	0033	Rattus spp.	D	3	514
		2.1.14	0041	Rattus spp.	D	3	547
		3.1.14	1040	Rufous Fantail	D	3	550

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		3.1.14	1734	Lace Monitor	D	24	553
		4.1.14	1129	Lace Monitor	D	42	577
		4.1.14	1214	Lace Monitor	D	39	628
		5.1.14	1550	Scrub Turkey	D	3	715
		6.1.14	1019	Lace Monitor	D	6	718
		6.1.14	1524	Lace Monitor	D	28	757
		11.1.14	1118	Lace Monitor	D	12	799
		14.1.14	1136	Lace Monitor	D	9	832
		14.1.14	1644	Lace Monitor	D	9	856
		14.1.14	2131	Rattus spp.	D	6	865
		15.1.14	1102	Lace Monitor	D	9	871
		15.1.14	1357	Lace Monitor	D	15	880
		16.1.14	1145	Lace Monitor	D	3	934
		16.1.14	1433	Lace Monitor	D	18	937
		19.1.14	0948	Dog	D	9	1033
		19.1.14	1337	Log Runner	D	3	1045
		19.1.14	2239	Rodent spp.	D	3	1051
		20.1.14	2047	Rodent spp.	D	6	1069
		21.1.14	1432	Lace Monitor	D	30	1079
		24.1.14	1046	Lace Monitor	D	6	1117
North	C44	20.12.13	1050	Lace Monitor	D	12	19
		20.12.13	1248	Lace Monitor	D	9	34
		21.12.13	1027	Lace Monitor	D	6	43
		22.12.13	1414	Lace Monitor	D	3	49
		23.12.13	0829	Wallaby spp.	D	6	52
		23.12.13	1149	Lace Monitor	D	6	58
		23.12.13	1614	Lace Monitor	D	6	88
		23.12.13	2340	Brush-tailed Possum	D	3	94
		26.12.13	1352	Eastern Water Dragon	D	3	97
		26.12.13	1502	Lace Monitor	D	3	100

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		27.12.13	1248	Lace Monitor	D	6	103
		30.12.13	1242	Lace Monitor	D	3	109
		31.12.13	0401	Short-beaked Echidna	D	3	112
		2.1.14	0134	Bandicoot spp.	D	3	115
		5.1.14	1539	Lace Monitor	D	3	118
		6.1.14	1027	Lace Monitor	D	3	121
		7.1.14	0452	Antechinus spp.	D	3	124
		9.1.14	1510	Unid bird	-	3	130
		19.1.14	0251	Common Brush-tailed Possum	D	3	139
North	C45(308)	21.12.13	1009	Water Dragon	D	3	25-27
		22.12.13	2028	Swamp Wallaby	D	12	33-44
		23.12.13	1658	Lace Monitor	D	3	49-51
		26.12.13	1418	Lace Monitor	D	6	52-57
		28.12.13	1523	Lace Monitor	D	3	58-60
		28.12.13	2204	Unid		1	61
		30.12.13	0933	Lace Monitor	D	6	64-69
		1.1.14	0900	Lace Monitor	D	3	70-72
		4.1.14	2113	Macropod spp.	D	3	76-78
		6.1.14	2113	Northern Brown Bandicoot	Pr	3	79-81
		9.1.14	2029	Brush-tailed Possum	D	2	109-110
		11.1.14	0144	Melomys spp.	Pr	3	118-120
North	C46	18.12.13	2258	Northern Brown Bandicoot	D	12	19
		19.12.13	2300	Swamp Wallaby	D	9	31
		20.12.13	0431	Northern Brown Bandicoot	D	27	43
		20.12.13	1854	Northern Brown Bandicoot	D	3	73
		21.12.13	1902	Northern Brown Bandicoot	D	6	79
		21.12.13	2229	Northern Brown Bandicoot	D	6	85
		22.12.13	2004	Northern Brown Bandicoot	D	3	91
	malfunction	23.12.13	0027	Short-beaked Echidna	D	3	97
North	C49	19.12.13	2313	Rattus spp.	D	3	99-101

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		22.12.13	0307	Rattus spp.	D	6	144-149
		28.12.13	2212	Northern Brown Bandicoot	Pr	12	363-174
		29.12.13	0415	Northern Brown Bandicoot	Pr	6	375-380
		29.12.13	2328	Rattus spp.	D	3	450-452
		31.12.13	1512	Dog	D	16	543-558
		1.1.14	0431	Northern Brown Bandicoot	Pr	6	603-608
		4.1.14	2308	Short-beaked Echidna	D	6	948-923
		5.1.14	1339	Lace Monitor	D	31	924-954
		9.1.14	0356	Northern Brown Bandicoot	Pr	6	1068-1073
		11.1.14	0235	Northern Brown Bandicoot	Pr	3	1077-1079
		12.1.14	1045	Lace Monitor	D	21	1137-1157
		13.1.14	0433	Northern Brown Bandicoot	Pr	3	1164-1166
		14.1.14	1311	Dog	D	6	1170-1175
		15.1.14	0421	Northern Brown Bandicoot	Pr	3	1176-1178
North	C50	20.12.13	1049	Swamp Wallaby	D	3	143
		26.12.13	0009	Antechinus spp.	Pr	3	641
		29.12.13	0003	Bandicoot spp.	D	9	917
		1.1.14	1401	Lace Monitor	D	6	1433
		3.1.14	0058	Common Brush-tailed Possum	D	3	1448
		3.1.14	0208	Northern Brown Bandicoot	Pr	3	1458
		5.1.14	0300	Rodent spp.	Pr	6	1772
		8.1.14	0012	Rodent spp.	D	4	2020
		9.1.14	0225	Long-nosed Bandicoot	D	3	2024
		9.1.14	0327	Rodent spp.	D	18	2027
		10.1.14	0143	Bandicoot spp.	D	9	2045
		10.1.14	1223	Lace Monitor	D	3	2066
		11.1.14	1705	Lace Monitor	D	6	2117
North	C51	28.12.13	0624	Scrub Turkey	D	3	37-39
		1.1.14	1144	Lace Monitor	D	3	43-45
		3.1.14	1135	Lace Monitor	D	3	46-48

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		12.1.14	1205	Lace Monitor	D	15	64-78
		14.1.14	1422	Dog	D	6	88-93
North	C52	20.12.13	1052	Horse	Po	3	171-173
		21.12.13	2016	Swamp Wallaby	Po	3	442-444
		22.12.13	0845	Lace Monitor	D	3	445-447
		27.12.13	1154	Lace Monitor	D	15	607-620
		29.12.13	1625	Lace Monitor	D	3	832-834
		29.12.13	2044	Swamp Wallaby	Pr	9	835-843
		30.12.13	1159	Lace Monitor	D	6	844-849
		31.12.13	1210	Lace Monitor	D	3	866-862
		3.1.14	0350	Short-beaked Echidna	D	3	1132-1134
		3.1.14	1549	Lace Monitor	D	3	1237-1239
		4.1.14	2223	Northern Brown Bandicoot	Pr	3	1240-1242
		6.1.14	1202	Lace Monitor	D	3	1330-1332
		10.1.14	1113	Lace Monitor	D	6	1510-1515
		11.1.14	1223	Lace Monitor	D	3	1600-1602
		11.1.14	1350	Lace Monitor	D	3	1708-1710
		12.1.14	0416	Short-beaked Echidna	D	3	1729-1731
		12.1.14	0959	Lace Monitor	D	3	1732-1734
North	C53(297)	18.12.13	1858	Scrub Turkey	D	3	16
		27.12.13	1243	Lace Monitor	D	3	25
		30.12.13	2344	Bandicoot spp.	Po	2	32
		1.1.14	0040	Rodent spp.	Pr	3	37
		3.1.14	0533	Wallaby spp.	Pr	3	40
		4.1.14	2343	Bandicoot spp.	D	9	43
		7.1.14	2051	Bandicoot spp.	D	3	61
North	C54	21.12.13	2301	Common Dunnart	Po	3	521
		24.12.13	2350	Rodent spp.	D	3	725
		25.12.13	0419	Antechinus spp.	Pr	3	728
		1.1.14	0133	Northern Brown Bandicoot	D	6	989

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		9.1.14	0338	Antechinus spp.	D	3	1646
		11.1.14	0159	Antechinus spp.	D	6	1718
North	C55	17.12.13	1729	Lace Monitor	D	3	22
		17.12.13	2021	Northern Brown Bandicoot	Pr	3	25
		17.12.13	2043	Northern Brown Bandicoot	D	3	31
		18.12.13	0039	Northern Brown Bandicoot	D	3	34
		18.12.13	1612	Lace Monitor	D	18	40
		19.12.13	2136	Northern Brown Bandicoot	Pr	21	67
		20.12.13	1535	Lace Monitor	D	3	91
		20.12.13	1708	Lace Monitor	D	6	94
		22.12.13	0940	Lace Monitor	D	24	100
		23.12.13	1235	Lace Monitor	D	6	127
		23.12.13	1539	Lace Monitor	D	9	133
		24.12.13	0739	Scrub Turkey	D	3	142
		26.12.13	1459	Lace Monitor	D	9	145
		27.12.13	1152	Lace Monitor	D	10	154
		27.12.13	1208	Lace Monitor	D	18	103
		27.12.13	1545	Lace Monitor	D	12	181
		28.12.13	0943	Swamp Wallaby	D	3	193
		29.12.13	1157	Lace Monitor	D	3	196
		29.12.13	1547	Lace Monitor	D	15	199
		30.12.13	0439	Bandicoot spp.	D	6	214
		4.1.14	0413	Bandicoot spp.	D	3	229
		4.1.14	2054	Northern Brown Bandicoot	D	3	232
North	C56(293)	19.12.13	2042	Common Brush-tailed Possum	DD	3	19
		19.12.13	2124	Rodent spp.	D	11	22
		21.12.13	1720	Land Mullet	Pr	3	34
		23.12.13	2053	Rattus spp.	Pr	3	37
		25.12.13	0849	Lyrebird spp.	D	3	40
		28.12.13	0243	Bandicoot spp.	D	3	46

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		2.1.14	0516	Rodent spp.	D	3	49
		3.1.14	1156	Land Mullet	D	3	52
North	C57	20.12.13	1131	Lace Monitor	D	9	40
		22.12.13	1220	Lace Monitor	D	9	49
		23.12.13	0506	Short-eared Brush-tailed Possum	D	4	64
		23.12.13	0507	Superb Lyrebird	D	1	69
		25.12.13	0738	Dog	D	3	70
		29.12.13	2347	Short-eared Brush-tailed Possum	Pr	3	82
		2.1.14	0455	Short-eared Brush-tailed Possum	Pr	3	85
		2.1.14	2202	Short-eared Brush-tailed Possum	D	3	88
		2.1.14	2238	Rattus spp.	D	3	91
		3.1.14	0057	Short-eared Brush-tailed Possum	D	3	94
		3.1.14	2207	Rattus spp.	D	3	97
		5.1.14	0405	Brush-tailed Possum	D	3	103
		7.1.14	0507	Short-eared Brush-tailed Possum	D	3	112
		7.1.14	2108	Rattus spp.	D	3	115
		7.1.14	2354	Rattus spp.	D	3	118
		8.1.14	0434	Short-eared Brush-tailed Possum	D	3	121
		8.1.14	2032	Short-eared Brush-tailed Possum	D	3	124
		9.1.14	0101	Rattus spp.	D	3	127
North	C58(295)	23.12.13	1525	Lace Monitor	D	9	34
		27.12.13	1305	Dog	D	15	43
		28.12.13	2309	Bandicoot spp.	D	3	58
		29.12.13	0852	Lace Monitor	D	3	61
		29.12.13	1035	Dog	D	3	64
		31.12.13	1217	Lace Monitor	D	3	70
		1.1.14	0829	Dog	D	3	73
North	C59(298)	27.12.13	2229	Brush-tailed Possum	D	3	52
		28.12.13	0149	Rattus spp.	D	3	55
		29.12.13	1139	Land Mullet	D	3	58

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
North	C60	19.12.13	1255	Lace Monitor	D	9	4-13
		19.12.13	2139	Short-beaked Echidna	D	3	16-18
		20.12.13	1020	Lace Monitor	D	3	22-24
		20.12.13	1529	Lace Monitor	D	3	25-27
		22.12.13	1137	Lace Monitor	D	3	28-30
		23.12.13	0913	Wonga Pigeon	D	3	31-33
		23.12.13	2124	Short-beaked Echidna	D	30	34-63
		24.12.13	0310	Black Rat	Pr	20	64-83
		24.12.13	2049	Black Rat	Pr	6	88-93
		25.12.13	0054	Black Rat	Pr	6	94-99
		27.12.13	0254	Northern Brown Bandicoot	D	3	106-108
		30.12.13	0205	Rattus spp.	D	3	115-117
		30.12.13	0324	Northern Brown Bandicoot	Pr	3	121-123
		30.12.13	1814	Unid bird	D	3	130-132
		31.12.13	2215	Black Rat	Pr	12	133-144
		1.1.14	2334	Long-nosed Bandicoot	D	3	145-147
		2.1.14	0355	Rattus spp.	D	6	148-153
		3.1.14	1226	Lace Monitor	D	6	154-159
		3.1.14	1514	Wonga Pigeon	D	6	160-165
		4.1.14	1212	Lace Monitor	D	3	166-168
		5.1.14	0256	Bandicoot spp.	D	3	169-171
		5.1.14	0758	Wonga Pigeon	D	3	172-174
		6.1.14	1918	Wonga Pigeon	D	3	175-177
		7.1.14	1720	Wonga Pigeon	D	3	178-180
		8.1.14	1654	Unid bird	D	6	184-189
		9.1.14	0215	Rattus spp.	D	3	190-192
		10.1.14	0725	Grey Butcherbird	D	3	199-201
		11.1.14	0218	Black Rat	D	3	205-207
		11.1.14	1822	Wonga Pigeon	D	3	208-210
		11.1.14	2145	Short-beaked Echidna	D	6	211-216

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		12.1.14	2145	Rattus spp.	D	3	217-219
		12.1.14	2325	Long-nosed Bandicoot	D	3	222-224
		13.1.14	0620	Unid	D	3	226-228
		14.1.14	0312	Rattus spp.	D	12	229-240
		14.1.14	1700	Wonga Pigeon	D	6	244-249
North	C61.1	20.12.13	1419	Lace Monitor	D	3	22
		27.12.13	1455	Lace Monitor	D	12	25
		28.12.13	2124	Common Brush-tailed Possum	D	3	37
		28.12.13	2152	Northern Brown Bandicoot	D	9	40
		30.12.13	1947	Swamp Wallaby	D	6	49
		31.12.13	1020	Swamp Wallaby	D	21	58
		1.1.14	1631	Lace Monitor	D	9	82
		9.1.14	0401	Bandicoot spp.	D	3	97
		10.1.14	0005	Bandicoot spp.	D	3	103
		10.1.14	1328	Lace Monitor	D	3	106
		15.1.14	2218	Bandicoot spp.	D	3	124
		17.1.14	0309	Wallaby spp.	Pr	3	127
		18.1.14	0942	Lace Monitor	D	15	130
		20.1.14	0518	Common Brush-tailed Possum	D	3	145
		21.1.14	1342	Wonga Pigeon	D	3	148
		21.1.14	1403	Lace Monitor	D	6	151
North	C61.2	19.12.13	1245	Eastern Water Dragon	D	6	2
		21.12.13	0417	Swamp Wallaby	Pr	10	103
		23.12.13	0111	Swamp Wallaby	D	6	163
		24.12.13	2301	Swamp Wallaby	D	12	169
		26.12.13	1529	Lace Monitor	D	3	181
		27.12.13	1345	Eastern Water Dragon	D	12	185
		27.12.13	2236	Dog	D	3	196
		28.12.13	0930	Swamp Wallaby	D	3	199
		28.12.13	1129	Eastern Water Dragon	D	3	205

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		28.12.13	1325	Lace Monitor	D	9	214
		31.12.13	1338	Eastern Water Dragon	D	3	358
		9.1.14	0214	Northern Brown Bandicoot	D	3	493
		14.1.14	0258	Northern Brown Bandicoot	D	9	514
		18.1.14	1836	Scrub Turkey	D	3	601
		19.1.14	0032	Swamp Wallaby	D	12	604
		21.1.14	2151	Common Brush-tailed Possum	D	6	673
Central	C4H	20.12.13	2310	Rattus spp.	D	12	1503-1514
		20.12.13	2348	Bandicoot spp.	D	6	1515-1520
		21.12.13	0102	Rattus spp.	D	6	1527-1532
		21.12.13	0232	Swamp Wallaby	D	12	1533-1544
		21.12.13	0346	Rattus spp.	D	12	1545-1556
		22.12.13	2248	Bandicoot spp.	D	3	2436-2438
		23.12.13	0202	Brush-tailed Possum	D	3	2439-2441
		25.12.13	1905	Swamp Wallaby	D	9	2616-2624
		27.12.13	0118	Bandicoot spp.	D	3	2625-2627
		27.12.13	2147	Rattus spp.	D	3	2718-2720
		28.12.13	1106	Land Mullet	D	6	2733-2739
		3.1.14	2009	Rattus spp.	D	1	3115
Central	C39	NIL					
Central	C1W	22.12.13	0437	Rattus spp.	D	9	65-73
		24.12.13	0347	Rattus spp.	Pr	2	93-94
		24.12.13	2121	Common Brush-tailed Possum	D	3	95-97
		24.12.13	2339	Rattus spp.	D	3	101-103
		25.12.13	0551	Eastern Whipbird	D	3	104-106
		29.12.13	0303	Rattus spp.	D	9	116-124
		31.12.13	1030	Wallaby spp.	D	2	134-135
		7.1.14	0324	Common Brush-tailed Possum	D	6	209-215
Central	C2(299)	23.12.13	0053	Rattus spp.	D	3	637-639
		23.12.13	0438	Bandicoot spp.	D	3	640-642

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		24.12.13	2027	Wallaby spp.	D	15	718-732
		28.12.13	0316	Wallaby spp.	D	3	760-762
		28.12.13	1717	Red-necked Wallaby	D	6	802-807
		1.1.14	1151	Lace Monitor	D	3	895-897
		4.1.14	1120	Lace Monitor	D	3	991-993
		4.1.14	1125	Lace Monitor	D	3	994-996
		5.1.14	0005	Bandicoot spp.	D	3	1000-1002
		6.1.14	1458	Wallaby spp.	D	17	1156-1172
Central	C2W	21.12.13	1552	Lace Monitor	D	15	15-29
		21.12.13	1600	Lace Monitor	D	20	31-50
		21.12.13	1749	Lace Monitor	D	14	51-64
		22.12.13	0950	Lace Monitor	D	10	56-65
		22.12.13	1108	Lace Monitor	D	98	78-175
		22.12.13	2302	Rattus spp.	D	9	180-188
		13.12.13	1015	Lace Monitor	D	3	195-197
		25.12.13	2113	Northern Brown Bandicoot	Pr	3	202-204
		27.12.13	1217	Lace Monitor	D	12	204-215
		27.12.13	1618	Scrub Turkey	D	6	216-221
		28.12.13	1442	Lace Monitor	D	48	240-287
		31.12.13	0746	Scrub Turkey	D	3	309-311
		31.12.13	1141	Lace Monitor	D	21	312-332
		31.12.13	2136	Rattus spp.	D	6	339-345
		1.1.14	0532	Antechinus spp.	D	3	345-347
		1.1.14	1342	Scrub Turkey	D	6	387-392
		1.1.14	1348	Lace Monitor	D	21	363-383
		2.1.14	0326	Bandicoot spp.	D	6	384-389
		3.1.14	0946	Lace Monitor	D	9	390-398
		5.1.14	1420	Lace Monitor	D	3	474-476
		6.1.14	0147	Rattus spp.	Pr	9	477-485
		6.1.14	1338	Lace Monitor	D	12	504-515

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		7.1.14	0217	Rattus spp.	Pr	3	516-518
		7.1.14	2246	Rattus spp.	Pr	3	519-520
Central	C3W	20.12.13	1312	Superb Lyrebird	D	3	9-11
		21.12.13	0402	Rattus spp.	D	3	12-14
		21.12.13	1030	Scrub Turkey	D	3	15-17
		27.12.13	2302	Common Brush-tailed Possum	D	3	21-23
		5.1.14	0950	Scrub Turkey	D	3	24-26
		9.1.14	2211	Bandicoot spp.	D	3	27-29
Central	C3	18.12.13	1521	Lace Monitor	D	9	98-106
		20.12.13	2212	Bandicoot spp.	D	3	620-622
		22.12.13	0256	Antechinus spp.	Pr	3	797-799
		23.12.13	1558	Lace Monitor	D	30	1292-1321
		24.12.13	0347	Swamp Wallaby	Pr	36	1337-1372
		26.12.13	0022	Short-beaked Echidna	D	9	1373-1381
		27.12.13	1318	Lace Monitor	D	6	1388-1393
Central	C4	2.1.14	0703	Swamp Wallaby	D	23	148-170
		8.1.14	0241	Short-beaked Echidna	D	3	187-189
		17.1.14	0518	Antechinus spp.	D	3	376
		18.1.14	1123	Land Mullet	D	6	973
		20.1.14	0317	Antechinus spp.	D	6	2011
		20.1.14	0400	Antechinus spp.	D	6	2017
		20.1.14	0800	Painted Button Quail	Pr	3	2023
		27.1.14	0644	Eastern Yellow Robin	Pr	3	3058
Central	C4W	22.12.13	1326	Lace Monitor	D	45	300-344
		26.12.13	2328	Rodent spp.	D	15	462-476
		31.12.13	1517	Lace Monitor	D	30	882-911
		31.12.13	1638	Land Mullet	Pr	5	918-922
		31.12.13	2318	Rodent spp.	D	3	924-926
		1.1.14	0006	Rattus spp.	D	6	927-932
		1.1.14	1222	Lace Monitor	D	15	933-947

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		1.1.14	1315	Land Mullet	D	3	948-950
		2.1.14	1917	Lace Monitor	D	9	1125-1133
		3.1.14	1210	Lace Monitor	D	9	1134-1142
		3.1.14	2115	Rattus spp.	D	3	1194-1196
		3.1.14	2204	Common Brush-tailed Possum	D	3	1200-1202
		4.1.14	2333	Common Brush-tailed Possum	D	3	1215-1217
		6.1.14	1339	Lace Monitor	D	15	1266-1280
		10.1.14	0439	Rattus spp.	D	5	1375-1379
		10.1.14	1234	Lace Monitor	D	15	1380-1394
Central	C6W	20.12.13	1218	Scrub Turkey	D	3	18-20
		20.12.13	2017	Rattus spp.	D	3	27-29
		21.12.13	0522	Antechinus spp.	D	3	30-32
		21.12.13	2308	Bandicoot spp.	D	3	36-38
		22.12.13	2101	Rattus spp.	D	6	48-53
		22.12.13	2229	Long-nosed Bandicoot	D	3	57-59
		23.12.13	0006	Rattus spp.	D	3	60-62
		23.12.13	1033	Land Mullet	D	3	63-65
		23.12.13	1210	Lace Monitor	D	9	66-74
		23.12.13	2219	Rattus spp.	D	12	81-92
		26.12.13	1448	Lace Monitor	D	9	96-104
		27.12.13	2210	Bandicoot spp.	D	3	105-107
		27.12.13	2352	Rattus spp.	D	12	108-119
		29.12.13	0445	Rattus spp.	D	3	138-140
		29.12.13	0501	Lace Monitor	D	18	150-167
		31.12.13	0444	Rattus spp.	D	3	168-170
		1.1.14	0845	Eastern Yellow Robin	D	3	180-182
		2.1.14	0509	Antechinus spp.	Pr	3	183-185
		2.1.14	1729	Lace Monitor	D	6	186-191
		3.1.14	0914	Lace Monitor	D	15	192-206
		3.1.14	1013	Lace Monitor	D	6	207-212

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		4.1.14	1205	Lace Monitor	D	24	213-236
		6.1.14	1257	Lace Monitor	D	9	240-248
		6.1.14	1512	Lace Monitor	D	9	249-257
		9.1.14	2210	Long-nosed Bandicoot	Pr	6	258-263
		10.1.14	0511	Rattus spp.	D	6	264-269
		11.1.14	1505	Lace Monitor	D	18	273-290
		13.1.14	0641	Scrub Turkey	D	3	294-296
		13.1.14	2015	Antechinus spp.	D	3	297-299
Central	C7	18.12.13	0455	Cat	D	6	6-11
		18.12.13	1552	Lace Monitor	D	8	45-52
		19.12.13	0625	Dog	D	15	54-68
		23.12.13	2358	Dog	D	3	354-356
		23.12.13	2359	Dog	D	3	360-362
		24.12.13	1235	Lace Monitor	D	3	363-365
		24.12.13	2144	Dog	D	6	366-371
		26.12.13	1512	Lace Monitor	D	9	372-380
		27.12.13	0053	Cat	D	12	381-392
		27.12.13	1331	Lace Monitor	D	3	396-398
		27.12.13	1913	Lace Monitor	D	6	402-407
		29.12.13	0223	Bandicoot spp.	D	3	426-428
		3.1.14	0058	Bandicoot spp.	D	3	555-557
		3.1.14	1225	Torresian Crow	Pr	6	561-566
Central	C8	18.12.13	1511	Lace Monitor	D	15	12-26
		18.12.13	2013	Antechinus spp.	D	3	27-29
		20.12.13	0152	Black Rat	Pr	3	30-32
		20.12.13	1616	Lace Monitor	D	3	33-35
		20.12.13	2105	Bandicoot spp.	D	3	36-38
		22.12.13	0237	Common Brush-tailed Possum	D	3	39-41
		23.12.13	2049	Rattus spp.	D	3	42-44
		24.12.13	2247	Common Brush-tailed Possum	D	3	45-47

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		25.12.13	1626	Scrub Turkey	D	3	51-53
		27.12.13	0335	Black Rat	Pr	3	54-56
		28.12.13	1517	Lace Monitor	D	30	57-86
		29.12.13	1435	Lace Monitor	D	33	96-128
		30.12.13	1836	Scrub Turkey	D	3	129-131
		31.12.13	0948	Scrub Turkey	D	3	132-134
		1.1.14	0735	Eastern Yellow Robin	D	6	135-140
		4.1.14	0528	Antechinus spp.	Po	3	141-143
		4.1.14	1007	Lace Monitor	D	15	147-161
		4.1.14	1129	Lace Monitor	D	3	165-167
		5.1.14	1214	Lace Monitor	D	3	171-173
Central	C10	19.12.13	0940	Lace Monitor	D	30	8-37
		19.12.13	1408	Lace Monitor	D	58	720-777
		21.12.13	1408	Lace Monitor	D	12	??
Central	C11	18.12.13	0333	Unid mammal		3	9-11
		21.12.13	0145	Unid mammal		5	48-52
		21.12.13	1007	Lace Monitor	D	7	54-60
		28.12.13	1008	Lace Monitor	D	3	96-98
		30.12.13	0435	Common Brush-tailed Possum	D	3	102-104
		1.1.14	2102	Swamp Wallaby	D	12	123-134
Central	C12	17.12.13	2127	Rattus spp.	Pr	6	9-14
		18.12.13	0038	Rattus spp.	Pr	3	15-17
		18.12.13	1231	Lace Monitor	D	15	18-32
		18.12.13	1554	Land Mullet	D	6	33-38
		19.12.13	1102	Lace Monitor	D	26	39-64
		19.12.13	1320	Lace Monitor	D	12	63-74
		20.12.13	0855	Lace Monitor	D	3	153-155
		20.12.13	1458	Lace Monitor	D	2	157-159
		21.12.13	0021	Northern Brown Bandicoot	Pr	6	159-164
		21.12.13	0950	Lace Monitor	D	3	165-167

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		21.12.13	1448	Lace Monitor	D	6	174-179
		22.12.13	1200	Lace Monitor	D	9	180-188
		22.12.13	2240	Rattus spp.	D	6	189-194
		24.12.13	2044	Rattus spp.	D	6	201-206
		27.12.13	2136	Northern Brown Bandicoot	Pr	3	213-215
		28.12.13	0921	Lace Monitor	D	6	216-221
		29.12.13	0243	Rattus spp.	D	6	222-227
		30.12.13	1318	Lace Monitor	D	3	252-254
		31.12.13	0107	Rattus spp.	D	6	255-260
		31.12.13	1337	Land Mullet	D	3	261-263
		31.12.13	1424	Variegated Fairy Wren	D	3	265-267
		7.1.14	2243	Rattus spp.	D	3	291-293
Central	C13	18.12.13	0929	Land Mullet	D	3	29-31
		18.12.13	1338	Land Mullet	D	12	173-184
		19.12.13	1337	Land Mullet	D	9	827-835
		19.12.13	1640	Land Mullet	D	3	1393-1395
		19.12.13	2311	Bandicoot spp.	D	6	1397-1402
		20.12.13	0655	Swamp Wallaby	D	9	1403-1411
Central	C14	20.12.13	0122	Red-necked Wallaby	Pr	9	28-36
		24.12.13	0507	Cat	D	3	43-45
		28.12.13	1934	Swamp Wallaby	Pr	3	49-51
		2.1.14	1555	Lace Monitor	D	12	115-126
		16.1.14	2049	Rattus spp.	Pr	3	7
		24.1.14	0626	Dog	D	3	1642
		25.1.14	1808	Satin Bowerbird	Pr	6	1850
		26.1.14	1025	Satin Bowerbird	D	12	1861
		29.1.14	1029	Green Tree Snake	D	3	2035
		30.1.14	0351	Swamp Wallaby	D	6	2266
Central	C15	17.12.13	2039	Unid		9	23-31
		19.12.13	0242	Wallaby spp.	D	3	41-43

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		20.12.13	0357	Rattus spp.	D	15	131-145
		20.12.13	2107	Rattus spp.	D	6	218-223
		21.12.13	1538	Lace Monitor	D	15	236-250
		21.12.13	2016	Swamp Wallaby	D	15	254-268
		21.12.13	2232	Northern Brown Bandicoot	Pr	6	272-277
		22.12.13	2100	Rattus spp.	Pr	3	341-343
		23.12.13	1056	Lace Monitor	D	3	344-346
		23.12.13	1207	Land Mullet	D	3	347-349
		25.12.13	0113	Common Brush-tailed Possum	D	3	353-355
		25.12.13	0233	Bandicoot spp.	D	9	356-364
		26.12.13	0146	Rattus spp.	D	6	365-370
		26.12.13	2148	Northern Brown Bandicoot	D	9	371-379
		27.12.13	2354	Northern Brown Bandicoot	D	12	380-391
		28.12.13	1008	Scrub Turkey	D	2	392-393
		28.12.13	1024	Land Mullet	D	3	395-397
		28.12.13	1135	Lace Monitor	D	6	413-418
		30.12.13	2151	Northern Brown Bandicoot	Pr	6	518-523
		31.12.13	0238	Unid mammal		3	524-526
		31.12.13	0327	Rattus spp.	Pr	3	527-529
		31.12.13	0656	Wonga Pigeon	D	3	530-532
		31.12.13	2356	Bandicoot spp.	D	3	551-553
		1.1.14	0434	Northern Brown Bandicoot	Pr	21	554-574
		1.1.14	1604	Land Mullet	D	6	719-724
		3.1.14	1524	Lace Monitor	D	6	731-736
		5.1.14	0246	Rattus spp.	D	6	752-757
		5.1.14	0450	Bandicoot spp.	D	6	758-763
		5.1.14	1108	Lace Monitor	D	9	767-775
		5.1.14	2313	Cat	D	3	947-949
		8.1.14	1150	Swamp Wallaby	Pr	6	992-997
Central	C16	19.12.13	0808	Swamp Wallaby	D	3	11-13

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		19.12.13	1247	Scrub Turkey	D	3	14-16
		19.12.13	1458	Lace Monitor	D	18	68-85
Central	C17	20.12.13	2134	Swamp Wallaby	D		video
		21.12.13	0007	Northern Brown Bandicoot	D		video
		23.12.13	1856	Wallaby spp.	D		video
		24.12.13	0001	Common Brush-tailed Possum	D		video
		29.12.13	1943	Scrub Turkey	D		video
		29.12.13	2145	Long-nosed Bandicoot	D		video
		30.12.13	0200	Swamp Wallaby	D		video
		8.1.14	0156	Swamp Wallaby	D		video
Central	17b	22.12.13	0920	Scrub Turkey	D	3	36-38
		23.12.13	1716	Superb Lyrebird	Pr	3	42-44
		26.12.13	1315	Scrub Turkey	D	3	45-47
		28.12.13	0930	Lace Monitor	D	3	51-53
		28.12.13	1845	Scrub Turkey	D	12	54-65
		1.1.14	1523	Scrub Turkey	D	5	67-71
		2.1.14	1632	Lace Monitor	D	3	72-74
		5.1.14	0722	Swamp Wallaby	D	21	87-107
		6.1.14	1042	Lace Monitor	D	21	108-128
		7.1.14	0109	Common Brush-tailed Possum	D	3	129-131
		8.1.14	1047	Wonga Pigeon	D	3	132-134
		9.1.14	1216	Scrub Turkey	D	3	140-142
Central	C18	18.12.13	2034	Northern Brown Bandicoot	Pr	3	105-107
		19.12.13	0848	Swamp Wallaby	D	6	108-113
		20.12.13	2210	Common Brush-tailed Possum	D	3	489-491
		21.12.13	1808	Lace Monitor	D	3	585-587
		25.12.13	0007	Swamp Wallaby	D	3	720-722
		27.12.13	1309	Lace Monitor	D	3	732-734
Central	C18b	21.12.13	0012	Rattus spp.	D	9	114-122
		21.12.13	1104	Lace Monitor	D	42	127-168

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		21.12.13	1403	Lace Monitor	D	15	174-188
		21.12.13	2304	Swamp Wallaby	D	3	189-191
		27.12.13	0020	Swamp Wallaby	D	3	213-215
		27.12.13	1236	Lace Monitor	D	18	238-254
		27.12.13	1452	Land Mullet	D	3	261-263
		28.12.13	1428	Land Mullet	D	9	300-308
		9.1.14	0011	Rattus spp.	D	3	1860-1862
Central	C19	17.12.13	2146	Rattus spp.	Pr	6	15-20
		17.12.13	2237	Common Brush-tailed Possum	D	6	21-26
		20.12.13	1503	Land Mullet	D	3	36-38
		20.12.13	2159	Bandicoot spp.	D	9	29-47
		21.12.13	1402	Swamp Wallaby	D	15	54-68
		22.12.13	2213	Northern Brown Bandicoot	Pr	3	87-89
		25.12.13	2246	Rodent spp.	Pr	3	90-92
		27.12.13	0238	Antechinus spp.	Po	4	95-98
		28.12.13	2200	Rodent spp.	D	3	99-101
		31.12.13	0354	Rodent spp.	D	3	147-149
		2.1.14	2035	Northern Brown Bandicoot	D	3	159-160
Central	C20	18.12.13	1710	Land Mullet	D	6	20-25
		19.12.13	1645	Land Mullet	D	2	42-43
		19.12.13	2049	Rattus spp.	D	8	44-51
		20.12.13	19+40	Wonga Pigeon	D	3	65-67
		21.12.13	0358	Unid		3	68-70
		22.12.13	0250	Northern Brown Bandicoot	Pr	5	95-99
		22.12.13	1354	Land Mullet	D	3	125-127
		22.12.13	1431	Lace Monitor	D	15	128-142
		23.12.13	1513	Lace Monitor	D	14	151-164
		23.12.13	2110	Rattus spp.	D	12	167-178
		26.12.13	2249	Bandicoot spp.	D	6	182-187
		26.12.13	2356	Rattus spp.	D	3	188-190

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		27.12.13	1502	Lace Monitor	D	9	198-205
		27.12.13	2135	Rodent spp.	D	3	206-208
		27.12.13	2244	Northern Brown Bandicoot	PR	6	209-214
		28.12.13	0246	Bandicoot spp.	D	3	215-217
		28.12.13	1605	Lace Monitor	D	6	221-226
		28.12.13	1645	Land Mullet	D	3	227-229
		29.12.13	0331	Bandicoot spp.	D	3	236-238
		30.12.13	1431	Lace Monitor	D	3	278-280
		4.1.14	0554	Dog	D	3	296-298
		4.1.14	1242	Lace Monitor	D	12	302-313
		5.1.14	0154	Northern Brown Bandicoot	Pr	9	315-323
		6.1.14	0226	Rattus spp.	D	6	335-340
		6.1.14	1714	Lace Monitor	D	6	380-385
		7.1.14	0423	Bandicoot spp.	D	6	386-391
Central	C21	20.12.13	1345	Lace Monitor	D	9	5-13
		20.12.13	2206	Bandicoot spp.	D	3	20-22
		21.12.13	0713	Scrub Turkey	D	3	23-25
		21.12.13	1054	Lace Monitor	D	3	26-28
		22.12.13	0811	Scrub Turkey	D	3	29-31
		25.12.13	0056	Swamp Wallaby	D	7	35-41
		26.12.13	0720	Scrub Turkey	D	3	44-46
		28.12.13	1123	Lace Monitor	D	3	50-52
		29.12.13	1341	Lace Monitor	D	6	53-58
		30.12.13	0747	Scrub Turkey	D	3	62-64
		1.1.14	0616	Scrub Turkey	D	3	71-73
		2.1.14	0618	Scrub Turkey	D	3	86-88
		2.1.14	0814	Scrub Turkey	D	3	89-91
		3.1.14	0318	Swamp Wallaby	D	6	92-97
		7.1.14	0205	Northern Brown Bandicoot	Pr	6	113-118
		9.1.14	0101	Northern Brown Bandicoot	Pr	3	119-212

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
Central	C22	20.12.13	1505	Lace Monitor	D	9	12-20
		23.12.13	1124	Lace Monitor	D	3	39-41
		24.12.13	0008	Rodent spp.	D	3	45-47
		27.12.13	2316	Short-eared Brush-tailed Possum	D	3	48-50
		28.12.13	0017	Short-eared Brush-tailed Possum	D	6	51-56
		30.12.13	1002	Lace Monitor	D	6	66-71
		31.12.13	1311	Lace Monitor	D	6	72-77
		4.1.14	1337	Swamp Wallaby	D	6	96-101
		6.1.14	1439	Land Mullet	Pr	3	123-125
Central	C23	20.12.13	2111	Rodent spp.	D	12	42-53
		21.12.13	0120	Swamp Wallaby	Po	6	60-65
		22.12.13	0143	Rattus spp.	Pr	3	66-68
		22.12.13	0517	Antechinus spp.	Pr	3	69-71
		22.12.13	2319	Rattus spp.	Pr	3	72-74
		23.12.13	2320	Wallaby spp.	Pr	3	75-77
		24.12.13	2055	Rattus spp.	Pr	3	84-86
		25.12.13	0129	Rattus spp.	Pr	6	96-98
		26.12.13	1200	Eastern Whipbird	D	3	99-101
		28.12.13	0449	Rattus spp.	Pr	3	105-107
		28.12.13	1008	Unid bird		3	108-110
		29.12.13	0445	Rattus spp.	Pr	3	111-113
		31.12.13	1543	Lace Monitor	D	6	126-128
		4.1.14	2217	Rattus spp.	Pr	3	144-146
		6.1.14	0734	Swamp Wallaby	Po	3	153-155
		8.1.14	0414	Bandicoot spp.	D	9	159-167
Central	C25	19.12.13	0151	Common Brush-tailed Possum	D	9	36-44
		21.12.13	0357	Brush-tailed Possum	D	3	57-59
		21.12.13	2219	Antechinus spp.	D	3	63-65
		22.12.13	0516	Long-nosed Bandicoot	Pr	3	66-68
		25.12.13	1948	Unid		1	72

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		26.12.13	2144	Northern Brown Bandicoot	D	3	75-77
		27.12.13	0054	Northern Brown Bandicoot	D	3	78-80
		27.12.13	0054	Antechinus spp.	Pr	3	78-80
		27.12.13	0609	Scrub Turkey	Pr	3	81-83
		27.12.13	1408	Black Snake	D	3	87-89
		28.12.13	1427	Lace Monitor	D	6	93-98
		28.12.13	1819	Scrub Turkey	D	3	99-101
		30.12.13	2139	Northern Brown Bandicoot	D	3	105-107
		31.12.13	1355	Lace Monitor	D	3	114-116
		2.1.14	0835	Scrub Turkey	D	3	117-119
		4.1.14	0241	Swamp Wallaby	Pr	9	120-128
		4.1.14	0945	Lace Monitor	D	3	129-131
		5.1.14	0115	Northern Brown Bandicoot	D	3	132-134
		5.1.14	2204	Antechinus spp.	Pr	3	135-137
		6.1.14	0341	Northern Brown Bandicoot	D	3	138-140
		6.1.14	0805	Scrub Turkey	D	3	141-143
		6.1.14	1216	Lace Monitor	D	3	144-146
		7.1.14	0202	Northern Brown Bandicoot	Pr	6	159-164
Central	C26	EMPTY					
Central	C27	19.12.13	0317	Brush-tailed Possum	D	3	12-14
		24.12.13	0008	Northern Brown Bandicoot	D	3	18-20
		30.12.13	1329	Lace Monitor	D	18	48-65
		31.12.13	0935	Lace Monitor	D	5	59-73
		31.12.13	2122	Rattus spp.	Pr	9	75-83
		1.1.14	0853	Lace Monitor	D	27	87-113
		1.1.14	1028	Lace Monitor	D	9	117-125
		2.1.14	1334	Lace Monitor	D	18	132-149
		3.1.14	1153	Lace Monitor	D	3	153-155
		5.1.14	1251	Lace Monitor	D	6	183-188
		5.1.14	2233	Northern Brown Bandicoot	Pr	3	189-191

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		6.1.14	1340	Lace Monitor	D	6	195-200
		6.1.14	1422	Lace Monitor	D	9	201-209
		8.1.14	0736	Scrub Turkey	D	3	210-212
Central	C28	17.12.13	1946	Scrub Turkey	D	16	40-55
		18.12.13	0901	Scrub Turkey	D	3	55-57
		19.12.13	1253	Lace Monitor	D	18	151-168
		19.12.13	2317	Rattus spp.	Pr	6	223-228
		20.12.13	0526	Scrub Turkey	D	3	229-231
		20.12.13	2010	Swamp Wallaby	D	9	352-360
		21.12.13	0100	Rattus spp.	D	6	361-366
		21.12.13	0254	Koala	D	3	367-369
		21.12.13	0613	Scrub Turkey	D	3	370-372
		22.12.13	2148	Northern Brown Bandicoot	D	9	610-618
		23.12.13	1510	Land Mullet	Pr	3	643-645
		23.12.13	2318	Brush-tailed Possum	D	6	646-651
		26.12.13	1548	Lace Monitor	D	12	652-663
		26.12.13	1815	Scrub Turkey	D	3	664-666
		27.12.13	1953	Scrub Turkey	D	3	670-672
		28.12.13	0013	Northern Brown Bandicoot	Pr	9	673-681
		29.12.13	0013	Swamp Wallaby	Pr	3	769-771
		1.1.14	1157	Lace Monitor	D	21	862-882
		1.1.14	1532	Lace Monitor	D	27	1000-1026
		3.1.14	1541	Lace Monitor	D	6	1048-1053
		4.1.14	2137	Rattus spp.	Pr	6	1081-1086
		4.1.14	2147	Short-eared Brush-tailed Possum	Pr	3	1087-1089
		5.1.14	0622	Scrub Turkey	D	3	1090-1092
		6.1.14	0659	Wonga Pigeon	D	2	1186-1188
		6.1.14	0710	Scrub Turkey	D	3	1189-1191
		6.1.14	0935	Superb Lyrebird	D	3	1195-1197
		7.1.14	0158	Rattus spp.	Pr	6	1264-1269

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		7.1.14	0550	Scrub Turkey	D	3	1270-1272
		7.1.14	1254	Superb Lyrebird	D	3	1273-1275
		7.1.14	1933	Scrub Turkey	D	30	1276-1305
		8.1.14	0154	Northern Brown Bandicoot	D	3	1309-1311
Central	C29	19.12.13	2226	Koala	Pr	3	31-33
		21.12.13	1427	Lace Monitor	D	3	85-87
		21.12.13	2132	Possum spp.	Po	3	88-90
		23.12.13	2235	Melomys spp.	Pr	3	166-168
		26.12.13	1504	Lace Monitor	D	3	172-174
		27.12.13	2215	Pademelon	Po	3	210-212
		27.12.13	2349	Long-nosed Bandicoot	Pr	3	214-216
		29.12.13	0105	Long-nosed Bandicoot	Pr	6	298-303
		29.12.13	1834	Lace Monitor	D	3	334-336
		30.12.13	0356	Long-nosed Bandicoot	Pr	6	337-342
		30.12.13	2017	Bandicoot spp.	D	3	361-363
		30.12.13	2021	Swamp Wallaby	D	9	364-372
		2.1.14	0143	Short-eared Brush-tailed Possum	Pr	3	415-417
		3.1.14	2154	Brush-tailed Possum	D	3	418-420
		9.1.14	0000	Possum spp.	Po	6	517-522
Central	C30	18.12.13	2212	Short-eared Brush-tailed Possum	Pr	3	11-13
		19.12.13	1446	Lace Monitor	D	35	14-48
		20.12.13	0324	Short-eared Brush-tailed Possum	D	3	50-52
		20.12.13	0524	Antechinus spp.	Pr	3	53-55
		21.12.13	0950	Lace Monitor	D	34	56-89
		22.12.13	1407	Lace Monitor	D	15	89-103
		23.12.13	1043	Lace Monitor	D	27	104-130
		29.12.13	0146	Short-eared Brush-tailed Possum	D	3	131-133
		30.12.13	0855	Scrub Turkey	D	3	143-145
		2.1.14	0003	Antechinus spp.	Pr	3	146-148
		2.1.14	2143	Antechinus spp.	Pr	3	155-157

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		7.1.14	0620	Superb Lyrebird	D	3	158-160
Central	C31	19.13.13	1852	Scrub Turkey	D	3	8
		20.12.13	1024	Scrub Turkey	Pr	1	11
		20.12.13	1201	Lace Monitor	D	15	14
		20.12.13	1722	Lace Monitor	D	44	32
		21.12.13	0603	Scrub Turkey	D	2	80
		21.12.13	0904	Scrub Turkey	D	3	83
		21.12.13	0914	Lace Monitor	D	12	89
		21.12.13	2211	Short-eared Brush-tailed Possum	Pr	6	107
		22.12.13	1930	Scrub Turkey	D	15	113
		22.12.13	1857	Scrub Turkey	D	6	128
		23.12.13	0927	Scrub Turkey	D	12	137
		23.12.13	1859	Scrub Turkey	D	3	156
		24.12.13	0936	Scrub Turkey	D	3	159
		24.12.13	1137	Scrub Turkey	D	1	162
		25.12.13	0944	Scrub Turkey	D	3	167
		25.12.13	1514	Lace Monitor	D	9	170
		26.12.13	0605	Scrub Turkey	D	3	179
		26.12.13	0723	Scrub Turkey	D	8	182
		26.12.13	1302	Scrub Turkey	D	3	191
		26.12.13	1432	Lace Monitor	D	15	194
		27.12.13	0629	Scrub Turkey	D	3	209
		27.12.13	1031	Lace Monitor	D	3	218
		27.12.13	1127	Scrub Turkey	D	3	221
		28.12.13	0019	Brush-tailed Possum	D	3	224
		28.12.13	0612	Scrub Turkey	D	3	227
		28.12.13	0630	Scrub Turkey	D	3	230
		28.12.13	0730	Scrub Turkey	D	6	233
		28.12.13	0917	Lace Monitor	D	3	239
		28.12.13	1045	Lace Monitor	D	3	245

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		28.12.13	1225	Lace Monitor	D	6	248
		28.12.13	1356	Lace Monitor	D	6	254
		28.12.13	1811	Lace Monitor	D	9	260
		29.12.13	0134	Scrub Turkey	D	3	269
		29.12.13	0918	Scrub Turkey	D	3	272
		29.12.13	1322	Lace Monitor	D	33	278
		29.12.13	1626	Lace Monitor	D	3	413
		29.12.13	1704	Scrub Turkey	D	6	416
		30.12.13	0624	Scrub Turkey	D	11	422
		30.12.13	0917	Scrub Turkey	D	3	434
		30.12.13	1046	Lace Monitor	D	12	437
		31.12.13	0166	Brush-tailed Possum	D	3	449
		31.12.13	0221	Short-eared Brush-tailed Possum	Pr	10	452
		31.12.13	0702	Dog	D	12	467
		31.12.13	1758	Lace Monitor	D	6	482
		31.12.13	2108	Brush-tailed Possum	D	6	491
		1.1.14	0653	Scrub Turkey	D	9	500
		1.1.14	1021	Lace Monitor	D	3	509
		1.1.14	1032	Scrub Turkey	D	3	530
		1.1.14	1512	Scrub Turkey	D	3	533
		1.1.14	1644	Lace Monitor	D	6	545
		2.1.14	1403	Lace Monitor	D	6	551
		2.1.14	1828	Scrub Turkey	D	3	557
		2.1.14	1851	Scrub Turkey	D	3	560
		3.1.14	0954	Lace Monitor	D	3	563
		3.1.14	1203	Lace Monitor	D	6	569
		4.1.14	0904	Scrub Turkey	D	6	575
		4.1.14	1532	Lace Monitor	D	3	581
		4.1.14	1830	Scrub Turkey	D	72	584
		4.1.14	2352	Short-eared Brush-tailed Possum	D	6	656

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		5.1.14	0853	Scrub Turkey	D	3	662
		5.1.14	1747	Scrub Turkey	D	3	671
		6.1.14	0712	Scrub Turkey	D	9	674
		6.1.14	2011	Dog	D	6	701
		7.1.14	0617	Scrub Turkey	D	3	707
		7.1.14	0829	Scrub Turkey	D	3	713
		7.1.14	1844	Scrub Turkey	D	3	716
		8.1.14	0746	Scrub Turkey	D	3	719
		8.1.14	0921	Scrub Turkey	D	3	722
		9.1.14	1832	Scrub Turkey	D	3	731
		10.1.14	0011	Brush-tailed Possum	D	3	734
		10.1.14	0700	Scrub Turkey	D	3	737
Central	C32	24.12.13	Nil				
Central	C34	20.12.13	Nil				
Central	C35	19.12.13	11.03	Land Mullet	D	12	23
		19.12.13	21.33	Rodent spp.	D	19	38
		20.12.13	0044	Northern Brown Bandicoot	Pr	3	56
		20.12.13	1124	Land Mullet	D	3	59
		20.12.13	2212	Rattus spp.	D	15	62
		21.12.13	1014	Land Mullet	D	3	77
		21.12.13	12.42	Scrub Turkey	D	3	80
		21.12.13	1341	Lace Monitor	D	21	83
		21.12.13	2247	Rattus spp.	D	12	107
		22.12.13	0802	Scrub Turkey	D	3	119
		22.12.13	0939	Lace Monitor	D	9	122
		22.12.13	1056	Land Mullet	D	3	131
		22.12.13	2107	Northern Brown Bandicoot	D	6	134
		22.12.13	2209	Rattus spp.	D	3	140
		22.12.13	2344	Antechinus spp.	Pr	12	143
		23.12.13	1135	Lace Monitor	D	45	155

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		23.12.13	1513	Lace Monitor	D	9	200
		25.12.13	0851	Scrub Turkey	D	6	209
		26.12.13	2301	Rattus spp.	D	15	215
		27.12.13	0136	Rattus spp.	Pr	9	230
		27.12.13	0244	Common Brush-tailed Possum	D	3	239
		27.12.13	2345	Rattus spp.	D	24	242
		29.12.13	1015	Swamp Wallaby	D	3	269
		29.12.13	1050	Lace Monitor	D	12	272
		29.12.13	1129	Land Mullet	D	3	284
		29.12.13	2222	Rattus spp.	D	24	287
		30.12.13	0203	Rattus spp.	D	3	311
		30.12.13	1133	Land Mullet	D	6	314
		31.12.13	0936	Lace Monitor	D	12	320
		2.1.14	1658	Lace Monitor	D	6	335
		2.1.14	1907	Swamp Wallaby	Po	3	341
		3.1.14	0958	Land Mullet	D	9	344
		4.1.14	1235	Lace Monitor	D	6	353
		7.1.14	0215	Brush-tailed Possum	D	3	395
		7.1.14	0357	Bandicoot spp.	D	3	398
Central	C40	18.12.13	2206	Rodent spp.	D	9	19
		19.12.13	0303	Rodent spp.	D	6	34
		19.12.13	0312	Rodent spp.	D	1	40
		19.12.13	0343	Rodent spp.	D	3	43
		20.12.13	0011	Bandicoot spp.	D	3	49
		20.12.13	0237	Rodent spp.	D	3	52
		20.12.13	0937	Lace Monitor	Pr	6	58
		20.12.13	2342	Rodent spp.	D	3	67
		22.12.13	0653	Swamp Wallaby	D	6	73
		22.12.13	1019	Lace Monitor	D	9	85
		23.12.13	2125	Rodent spp.	D	3	106

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		24.12.13	0646	Log Runner	D	2	110
		25.12.13	0338	Swamp Wallaby	D	3	115
		26.12.13	0451	Melomys spp.	Pr	3	118
		27.12.13	1454	Whistler	Pr	5	124
		29.12.13	2125	Northern Brown Bandicoot	Pr	6	133
		29.12.13	211	Rodent spp.	Pr	3	139
		29.12.13	2235	Bandicoot spp.	D	3	142
		31.12.13	2140	Northern Brown Bandicoot	D	6	145
		1.1.14	2310	Rodent spp.	D	3	154
		2.1.14	0232	Melomys spp.	Pr	3	160
		5.1.14	1753	Swamp Wallaby	D	9	175
		6.1.14	1820	Swamp Wallaby	D	12	187
		7.1.14	0723	Swamp Wallaby	D	14	198
		9.1.14	1948	Swamp Wallaby	D	3	220
		9.1.14	2133	Rodent spp.	Pr	3	223
		11.1.14	0457	Rattus spp.	Pr	5	229
		11.1.14	1853	Shrike Thrush	Po	3	238
		11.1.14	2227	Unid sml mammal	-	3	241
		12.1.14	0215	Rodent spp.	D	3	245
		12.1.14	1819	Cat Bird	Pr	3	252
		13.1.14	0584	Cat Bird	D	3	256
		13.1.14	2342	Rodent spp.	D	1	259
		14.1.14	0039	Short-eared Brush-tailed Possum	Pr	3	262
Central	C41.2	22.12.13	2021	Wallaby spp.	Pr	2	924
		22.12.13	2022	Dog	D	3	927
		23.12.13	1937	Swamp Wallaby	D	9	945
		30.12.13	0513	Antechinus spp.	Pr	3	1089
		30.12.13	1529	Wallaby spp.	Pr	6	1173
		4.1.14	1007	Bar-shouldered Dove	D	3	1389
		5.1.14	2354	Brush-tailed Possum	D	3	1584

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		10.1.14	0534	Dog	D	3	1809
Central	C9(301)	20.12.13	2010	Pademelon	Pr	3	37
		23.12.13	1849	Wallaby spp.	D	9	67
		31.12.13	2258	Swamp Wallaby	Pr	3	88
		4.1.14	0211	Rodent spp.	D	3	100
		4.1.14	1159	Lace Monitor	D	3	103
		6.1.14	1748	Land Mullet	D	3	118
		9.1.14	0357	Cat	D	3	124
		9.1.14	0423	Cat	D	3	127
		9.1.14	0544	Cat	D	3	130
		9.1.14	1406	Scrub Turkey	D	13	133
		18.1.14	0331	Antechinus spp.	D	3	28
		18.1.14	0344	Rattus spp.	D	12	31
		19.1.14	1540	Lace Monitor	D	27	85
		20.1.14	1032	Lace Monitor	D	15	112
		23.1.14	0119	Rattus spp.	D	6	130
		23.1.14	1927	Scrubwren spp.	Pr	3	139
		23.1.14	2312	Rattus spp.	Pr	1	142
		24.1.14	0028	Rattus spp.	Pr	3	145
		24.1.14	1852	Scrubwren spp.	Pr	6	151
		26.1.14	2335	Rattus spp.	Pr	6	160
		28.1.14	2214	Swamp Wallaby	D	3	166
Central	C63(310)	20.12.13	1929	Dog	D	12	16
		21.12.13	1809	Dog	D	9	34
		28.12.13	0959	Swamp Wallaby	D	9	46
		8.1.13	1852	Scrub Turkey	D	3	109
		16.1.14	2137	Antechinus spp.	D	6	46
		17.1.14	2131	Antechinus spp.	Pr	3	160
		18.1.14	0112	Rattus spp.	Pr	27	163
		18.1.14	0218	Rodent spp.	D	3	193

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		18.1.14	0314	Rodent spp.	D	32	202
		18.1.14	0505	Rattus spp.	Pr	3	238
		18.1.14	1101	Lace Monitor	D	33	244
		18.1.14	1723	Land Mullet	D	6	388
		19.1.14	0853	Wonga Pigeon	D	12	394
		19.1.14	0931	Lace Monitor	D	18	406
		20.1.14	0514	Rattus spp.	Pr	9	481
		20.1.14	1307	Land Mullet	D	3	490
		21.1.14	0139	Dog	D	6	565
		21.1.14	0117	Lace Monitor	D	9	571
		21.1.14	1407	Land Mullet	D	3	586
		22.1.14	0319	Rattus spp.	D	3	622
		23.1.14	0434	Rattus spp.	Pr	3	625
		24.1.14	0258	Rattus spp.	Pr	9	628
		25.1.14	1354	Lace Monitor	D	12	676
		26.1.14	1336	Land Mullet	D	3	754
		27.1.14	0136	Rattus spp.	D	6	766
		27.1.14	1549	Land Mullet	D	6	772
		28.1.14	1100	Land Mullet	D	3	778
		28.1.14	2232	Rattus spp.	Pr	3	832
		30.1.14	1404	Land Mullet	D	6	943
		2.2.14	1036	Land Mullet	D	3	1105
		3.2.14	1135	Land Mullet	D	3	1165
		3.2.14	2311	Rodent spp.	Pr	3	1201
		5.2.14	0605	Dog	D	3	1240
		6.2.14	0327	Rattus spp.	D	3	1243
		6.2.14	2205	Wallaby spp.	D	3	1246
		7.2.14	1200	Land Mullet	D	15	1249
Central	C61	18.12.13	1511	Lace Monitor	D	12	22
		18.12.13	1740	Swamp Wallaby	D	12	37

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		18.12.13	2330	Water Rat	D	31	49
		19.12.13	0000	Water Rat	D	12	70
		19.12.13	0119	Rattus spp.	Pr	9	88
		19.12.13	2106	Water Rat	Pr	3	118
		20.12.13	0223	Rattus spp.	Pr	18	121
		20.12.13	2330	Rattus spp.	Pr	9	142
		21.12.13	0359	Rattus spp.	Pr	15	151
		21.12.13	1221	Lace Monitor	D	9	166
		21.12.13	1258	Lace Monitor	D	3	175
		22.12.13	1028	Lace Monitor	D	9	178
		22.12.13	2305	Northern Brown Bandicoot	Pr	3	193
		23.12.13	1221	Lace Monitor	D	6	196
		23.12.13	1333	Lace Monitor	D	24	202
		25.12.13	0854	Scrub Turkey	D	6	226
		25.12.13	1649	Lace Monitor	D	3	232
		26.12.13	1407	Lace Monitor	D	6	235
		27.12.13	1147	Eastern Water Dragon	D	17	241
		27.12.13	1252	Lace Monitor	D	12	259
		27.12.13	1528	Lace Monitor	D	3	271
		29.12.13	1031	Eastern Water Dragon	D	6	283
		29.12.13	1034	Lace Monitor	D	6	289
		30.12.13	0933	Lace Monitor	D	3	298
		30.12.13	1221	Eastern Water Dragon	D	6	301
		31.12.13	0445	Northern Brown Bandicoot	D	9	310
		31.12.13	0507	Bandicoot spp.	D	3	319
		31.12.13	1130	Eastern Water Dragon	D	6	322
		1.1.14	0919	Lace Monitor	D	9	337
		1.1.14	2318	Bandicoot spp.	D	3	352
		5.1.14	1716	Eastern Water Dragon	D	3	388
		6.1.14	1547	Lace Monitor	D	6	403

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		9.1.14	2230	Melomys spp.	Pr	3	415
Central	C65	22.12.13	0245	Short-beaked Echidna	D	6	79
		23.12.13	0142	Northern Brown Bandicoot	D	3	130
		27.12.13	1057	Lace Monitor	D	52	157
		27.12.13	1411	Lace Monitor	D	30	211
		28.12.13	1157	Lace Monitor	D	9	250
		1.1.14	1108	Lace Monitor	D	27	361
		1.1.14	1552	Land Mullet	D	3	412
		3.1.14	1131	Lace Monitor	D	12	418
		4.1.14	1056	Lace Monitor	D	9	430
		5.1.14	1512	Lace Monitor	D	3	445
Central	C62 (309)	23.12.13	1308	Lace Monitor	D	3	34
		7.1.14	0321	Brush-tailed Possum	D	6	40
		20.1.14	2101	Rattus spp.	D	3	10
		24.1.14	1128	Lace Monitor	D	6	13
		27.1.14	0206	Koala	D	3	22
		28.1.14	0619	Swamp Wallaby	D	3	28
		28.1.14	0649	Swamp Wallaby	D	3	31
		29.1.14	0430	Common Brush-tailed Possum	D	3	37
		1.2.13	0041	Bandicoot spp.	D	6	40
		3.2.14	0759	Swamp Wallaby	D	3	46
		5.2.14	0026	Common Brush-tailed Possum	D	9	49
Central	C36	25.12.13	0209	Rodent spp.	D	12	22
		25.12.13	0341	Bandicoot spp.	D	3	34
		25.12.13	2045	Bandicoot spp.	D	3	43
		24.1.14	1441	Lace Monitor	D	3	796
		27.1.14	0425	Bandicoot spp.	D	6	862
		30.1.14	1157	Lace Monitor	D	6	1123
Central	C38	22.12.13	1731	Scrub Turkey	D	3	22
		23.12.13	0119	Pademelon	Pr	3	25

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		24.12.13	0154	Common Brush-tailed Possum	D	6	28
		26.12.13	0721	Dog	D	3	37
		26.12.13	1151	Lace Monitor	D	6	40
		27.12.13	1727	Lace Monitor	D	3	46
		28.12.13	0139	Northern Brown Bandicoot	D	6	49
		31.12.13	0040	Antechinus spp.	D	3	61
		2.1.14	0416	Northern Brown Bandicoot	D	3	67
		2.1.14	2342	Northern Brown Bandicoot	D	3	73
		3.1.14	1259	Laughing Kookaburra	D	3	76
		5.1.14	0037	Brush-tailed Possum	Pr	1	79
		5.1.14	1422	Laughing Kookaburra	D	6	85
		5.1.14	2316	Bandicoot spp.	Pr	3	91
		7.1.14	0040	Red Fox	Pr	3	97
		9.1.14	2218	Red Fox	Pr	6	109
		11.1.14	0347	Unid sml mammal	-	1	118
		11.1.14	1104	Lace Monitor	D	3	121
		11.1.14	1513	Scrub Turkey	D	3	127
		12.1.14	2209	Red Fox	Pr	3	133
		12.1.14	2252	Dog	Po	3	136
		13.1.14	0812	Scrub Turkey	D	3	139
		13.1.14	2045	Common Brush-tailed Possum	D	3	142
		14.1.14	2059	Red Fox	D	9	145
		24.1.14	2229	Red Fox	D	3	178
		25.1.14	0133	Red Fox	Pr	3	181
		26.1.14	0746	Canid spp.	D	3	184
		28.1.14	0250	Red Fox	D	3	187
		29.1.14	1619	Lace Monitor	D	3	193
Central	C1H	21.12.13	0151	Swamp Wallaby	D	3	16
		21.12.13	0336	Rodent spp.	D	3	22
		21.12.13	2127	Rattus spp.	Pr	3	76

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		21.12.13	2341	Rattus spp.	Pr	3	79
		22.12.13	0023	Northern Brown Bandicoot	Pr	3	82
		22.12.13	2247	Rattus spp.	D	3	154
		23.12.13	0312	Short-beaked Echidna	D	3	157
		23.12.13	1023	Lace Monitor	D	6	172
		24.12.13	1610	Red-necked Wallaby	D	3	181
		25.12.13	0035	Short-beaked Echidna	D	3	190
		28.12.13	2219	Wallaby spp.	Pr	9	196
		31.12.13	0505	Rattus spp.	Pr	3	244
		2.1.14	1612	Eastern Grey Kangaroo	D	6	250
		3.1.14	0400	Rodent spp.	Pr	3	256
		6.1.14	0549	Red-necked Wallaby	D	6	274
		6.1.14	2133	Rodent spp.	Pr	3	280
		14.1.14	1546	Lace Monitor	D	3	313
		17.1.14	2259	Rodent spp.	D	12	373
		21.1.14	0202	Red-necked Wallaby	D	3	466
		21.1.14	1833	Red-necked Wallaby	D	3	469
		25.1.14	1255	Lace Monitor	D	12	484
		26.1.14	0019	Rodent spp.	D	3	496
Central	C2H	21.12.13	0045	Swamp Wallaby	D	4	33
		21.12.13	1653	Lace Monitor	D	3	55
		21.12.13	1701	Lace Monitor	D	4	59
		22.12.13	0156	Unid spp.	-	4	63
		23.12.13	0243	Short-beaked Echidna	D	2	95
		23.12.13	2000	Dog	D	12	129
		28.12.13	0851	Lace Monitor	D	2	145
		30.12.13	1107	Swamp Wallaby	D	4	223
		31.12.13	0445	Common Brush-tailed Possum	D	2	227
Central	C3H	1.1.14	1129	Lace Monitor	D	2	245
		5.1.14	1201	Lace Monitor	D	2	253

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		5.1.14	1609	Lace Monitor	D	2	257
		5.1.14	2209	Northern Brown Bandicoot	D	2	259
		6.1.14	1608	Lace Monitor	D	2	261
		8.1.14	1754	Swamp Wallaby	D	16	263
		12.1.14	1755	Dog	D	2	285
		18.1.14	0114	Northern Brown Bandicoot	Pr	2	315
		18.1.14	0651	Human	D	2	319
		18.1.14	1355	Lace Monitor	D	6	335
		18.1.14	0807	Human	D	2	347
		19.1.14	1518	Swamp Wallaby	D	2	403
		24.1.14	1313	Lace Monitor	D	2	447
		25.1.14	0042	Wallaby spp.	D	2	449
		25.1.14	0141	Common Brush-tailed Possum	D	2	451
		28.1.14	1121	Lace Monitor	D	2	401
Central	C64 (311)	20.12.13	1904	Dog	D	51	16
		22.12.13	1228	Lace Monitor	D	3	241
		23.12.13	0341	Dog	Pr	3	280
		25.12.13	0920	Eastern Grey Kangaroo	D	2	298
		25.12.13	1833	Dog	D	3	301
		30.12.13	1523	Dog	D	3	320
		2.1.14	2140	Short-beaked Echidna	D	3	403
		8.1.14	0734	Scrub Turkey	D	3	517
		10.1.14	1516	Lace Monitor	D	3	520
		18.1.14	1752	Lace Monitor	D	33	172
		19.1.14	0942	Lace Monitor	D	4	205
		19.1.14	1332	Lace Monitor	D	12	23
		21.1.14	0124	Swamp Wallaby	D	15	316
		23.1.14	0829	Scrub Turkey	D	3	349
		24.1.14	1416	Lace Monitor	D	12	352
		25.1.14	1314	Lace Monitor	D	9	361

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		26.1.14	0525	Short-beaked Echidna	D	3	355
		28.1.14	1117	Lace Monitor	D	3	391
		28.1.14	1729	Lace Monitor	D	3	403
		31.1.14	1844	Lace Monitor	D	3	436
		3.2.14	2204	Rattus spp.	D	3	472
Central	C37	23.12.13	0312	Red Fox	D	6	25
		23.12.13	1611	Scrub Turkey	D	3	31
		26.12.13	2355	Brush-tailed Possum	D	3	61
		27.12.13	0528	Scrub Turkey	D	3	64
		27.12.13	1031	Lace Monitor	D	3	82
		27.12.13	1038	Lace Monitor	D	6	103
		28.12.13	2001	Scrub Turkey	D	3	496
		29.12.13	1947	Scrub Turkey	D	3	526
		31.12.13	0138	Northern Brown Bandicoot	D	3	580
		3.1.14	0550	Scrub Turkey	D	3	1060
		3.1.14	2258	Northern Brown Bandicoot	D	3	1180
		3.1.14	2345	Bandicoot spp.	D	1	186
		4.1.14	2257	Northern Brown Bandicoot	D	9	1381
		5.1.14	0015	Brush-tailed Possum	D	3	1390
		6.1.14	0223	Northern Brown Bandicoot	Pr	3	1531
		6.1.14	2302	Red Fox	D	6	1357
		11.1.14	0437	Northern Brown Bandicoot	D	3	1789
		11.1.14	2245	Northern Brown Bandicoot	D	6	2044
		13.1.14	2138	Brush-tailed Possum	D	3	2152
	?	23.12.13	0202	Water Rat	Pr	3	1613
South	N1	10.1.14	0040	Rodent spp.	Pr	3	8
		10.1.14	1145	Lace Monitor	D	15	11
		10.1.14	1300	Lace Monitor	D	9	29
		11.1.14	1537	Lace Monitor	D	3	38
		13.1.14	0058	Rodent spp.	D	3	41

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		13.1.14	1234	Swamp Wallaby	D	36	44
		14.1.14	1141	Lace Monitor	D	36	92
		19.1.14	1241	Lace Monitor	D	18	170
		25.1.14	1216	Swamp Wallaby	D	10	228
South	N2	7.1.14	0218	Rodent spp.	D	12	8
		8.1.14	0100	Rodent spp.	D	9	23
		8.1.14	0315	Rodent spp.	D	6	32
		8.1.14	2305	Rodent spp.	D	3	38
		11.1.14	1528	Land Mullet	D	3	41
		14.1.14	1300	Land Mullet	D	3	50
		15.1.14	0348	Land Mullet	D	3	53
		16.1.14	1241	Lace Monitor	D	3	56
		18.1.14	0033	Rodent spp.	D	6	62
		19.1.14	1059	Lace Monitor	D	15	71
		19.1.14	2201	Rodent spp.	D	3	86
		20.1.14	2347	Rattus spp.	D	3	92
		21.1.14	0111	Rattus spp.	D	3	95
		25.1.14	2304	Rattus spp.	D	3	98
		26.1.14	2306	Rattus spp.	D	3	104
		27.1.14	2135	Rattus spp.	D	3	107
South	N3	16.1.14	1717	Eastern Yellow Robin	D	3	780
South	N4	8.1.14	2237	Northern Brown Bandicoot	D	3	588
		12.1.14	0551	Wallaby spp.	D	3	1266
		12.1.14	1039	Lace Monitor	D	3	1269
		12.1.14	1651	Swamp Wallaby	Pr	3	1686
		15.1.14	0130	Common Brush-tailed Possum	D	3	2343
South	N5	7.1.14	0035	Rattus spp.	D	6	11
		7.1.14	0837	Swamp Wallaby	D	3	20
		8.1.14	0237	Bandicoot spp.	D	3	26
		9.1.14	0015	Rattus spp.	D	3	29

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		10.1.14	1222	Lace Monitor	D	42	32
		18.1.14	1338	Lace Monitor	D	27	317
		20.1.14	1515	Lace Monitor	D	15	467
		21.1.14	1202	Lace Monitor	D	18	488
		24.1.14	2042	Swamp Wallaby	D	9	521
		26.1.14	0403	Red Fox	D	6	581
South	N6	7.1.14	2352	Rattus spp.	D	6	15
		8.1.14	0132	Rattus spp.	D	6	22
		8.1.14	0335	Rattus spp.	D	12	31
		9.1.14	0031	Northern Brown Bandicoot	D	3	43
		9.1.14	0318	Black Rat	Pr	3	46
		9.1.14	2109	Rattus spp.	D	3	52
		9.1.14	2206	Rattus spp.	D	6	55
		9.1.14	2328	Rattus spp.	D	3	61
		10.1.14	0102	Rattus spp.	D	3	64
		10.1.14	0133	Rattus spp.	D	3	67
		11.1.14	0152	Rattus spp.	D	3	82
		11.1.14	0927	Lace Monitor	D	9	85
		11.1.14	1119	Lace Monitor	D	15	94
		11.1.14	1557	Lace Monitor	D	24	163
		11.1.14	2141	Swamp Wallaby	D	3	187
		12.1.14	0128	Rattus spp.	Pr	15	193
		12.1.14	0904	Lace Monitor	D	36	208
		12.1.14	1045	Lace Monitor	D	54	247
		12.1.14	1144	Lace Monitor	D	12	316
		12.1.14	1523	Lace Monitor	D	35	352
		12.1.14	1537	Lace Monitor	D	6	388
		13.1.14	0144	Rattus spp.	D	3	394
		13.1.14	0318	Bush Rat	D	24	397
		13.1.14	0842	Scrub Turkey	D	3	421

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		14.1.14	0934	Lace Monitor	D	9	436
		14.1.14	1054	Lace Monitor	D	15	451
		14.1.14	1153	Lace Monitor	D	24	508
		14.1.14	1533	Lace Monitor	D	6	574
		14.1.14	1821	Lace Monitor	D	6	580
		15.1.14	0302	Bush Rat	Pr	3	586
		15.1.14	1058	Lace Monitor	D	12	592
		16.1.14	1227	Lace Monitor	D	3	739
		17.1.14	0351	Rattus spp.	D	6	817
		17.1.14	0936	Lace Monitor	D	6	823
		17.1.14	1241	Lace Monitor	D	3	889
		17.1.14	1349	Lace Monitor	D	3	895
		17.1.14	1943	Wonga Pigeon	D	3	955
		18.1.14	0330	Black Rat	Pr	3	964
		18.1.14	2138	Antechinus spp.	D	3	1138
		19.1.14	0946	Lace Monitor	D	3	1147
		19.1.14	1059	Lace Monitor	D	15	1150
		19.1.14	1515	Lace Monitor	D	12	1216
		19.1.14	2247	Northern Brown Bandicoot	D	3	1128
		22.1.14	0304	Red Fox	D	6	1291
		25.1.14	0126	Rattus spp.	D	3	1300
		25.1.14	0342	Melomys spp.	Pr	6	1302
		27.1.14	2054	Eastern Grey Kangaroo	Pr	3	1372
South	N7	6.1.14	1451	Lace Monitor	D	9	14
		7.1.14	0500	Rattus spp.	D	9	23
		8.1.14	0352	Rattus spp.	D	3	32
		10.1.14	1433	Land Mullet	D	6	38
		11.1.14	1206	Lace Monitor	D	9	50
		11.1.14	1257	Land Mullet	D	3	59
		11.1.14	1944	Catbird	Pr	9	62

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		14.1.14	1209	Lace Monitor	D	9	74
		14.1.14	1508	Lace Monitor	D	18	83
		18.1.14	0532	Rattus spp.	Pr	3	116
		18.1.14	1101	Lace Monitor	D	9	119
		18.1.14	1301	Lace Monitor	D	3	131
		21.1.14	1356	Lace Monitor	D	27	134
South	N8	8.1.14	1744	Scrub Turkey	D	3	7
		9.1.14	0037	Antechinus spp.	Pr	3	10
		10.1.14	0542	Swamp Wallaby	D	6	13
		10.1.14	1305	Land Mullet	D	3	19
		11.1.14	0952	Lace Monitor	D	21	22
		11.1.14	1419	Lace Monitor	D	55	46
		11.1.14	1729	Land Mullet	D	3	100
		12.1.14	1047	Lace Monitor	D	12	106
		12.1.14	1333	Land Mullet	D	3	130
		13.1.14	1015	Lace Monitor	D	3	133
		13.1.14	1050	Lace Monitor	D	12	139
		14.1.14	0421	Rattus spp.	D	6	151
		14.1.14	1406	Lace Monitor	D	28	159
		15.1.14	1116	Lace Monitor	D	3	190
		15.1.14	1217	Lace Monitor	D	6	193
		16.1.14	1205	Lace Monitor	D	6	205
		16.1.14	1348	Lace Monitor	D	3	250
		17.1.14	1429	Land Mullet	D	3	301
		18.1.14	1253	Lace Monitor	D	3	304
		20.1.14	0501	Bush Rat	Pr	3	379
		20.1.14	1239	Land Mullet	D	12	385
		20.1.14	1921	Yellow-throated Scrubwren	D	3	415
		21.1.14	1142	Lace Monitor	D	3	418
		23.1.14	0027	Bush Rat	Pr	3	439

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		24.1.14	0930	Lace Monitor	D	9	442
		26.1.14	1607	Yellow-throated Scrubwren	D	3	454
		27.1.14	0341	Bush Rat	Pr	12	460
		27.1.14	0906	Yellow-throated Scrubwren	D	9	472
		27.1.14	1906	Swamp Wallaby	D	6	481
		27.1.14	2241	Rattus spp.	D	6	493
South	N9	9.1.14	0107	Rodent spp.	Pr	9	16
		10.1.14	0031	Northern Brown Bandicoot	Pr	3	25
		10.1.14	1217	Lace Monitor	D	6	28
		11.1.14	1102	Lace Monitor	D	6	34
		11.1.14	1855	Scrub Turkey	D	3	46
		12.1.14	0045	Short-eared Brush-tailed Possum	D	3	49
		12.1.14	1516	Lace Monitor	D	3	52
		14.1.14	1150	Lace Monitor	D	6	55
		15.1.14	1034	Lace Monitor	D	12	61
		18.1.14	1934	Swamp Wallaby	D	3	136
		21.1.14	0458	Swamp Wallaby	Pr	6	160
		21.1.14	1012	Swamp Wallaby	D	6	169
		22.1.14	0143	Swamp Wallaby	D	6	175
		24.1.14	0027	Short-eared Brush-tailed Possum	Pr	3	181
		24.1.14	2325	Short-eared Brush-tailed Possum	Pr	3	187
		25.1.14	2317	Short-eared Brush-tailed Possum	Pr	7	193
		28.1.14	1241	Lace Monitor	D	3	208
South	N10	11.1.14	2049	Common Brush-tailed Possum	D	6	271
		12.1.14	2239	Common Brush-tailed Possum	D	12	496
		14.1.14	1236	Lace Monitor	D	18	535
		18.1.14	1047	Lace Monitor	D	9	1858
		19.1.14	1015	Lace Monitor	D	3	2314
		21.1.14	0348	Common Brush-tailed Possum	D	3	2762
South	N11	7.1.14	1657	Swamp Wallaby	D	3	22

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		7.1.14	2101	Rattus spp.	D	3	25
		7.1.14	2330	Rattus spp.	D	15	28
		9.1.14	0219	Rattus spp.	D	3	49
		9.1.14	0304	Rattus spp.	D	18	55
		9.1.14	2146	Rattus spp.	D	6	76
		10.1.14	1018	Lace Monitor	D	45	82
		10.1.14	1335	Lace Monitor	D	45	133
		11.1.14	0150	Rattus spp.	D	3	178
		11.1.14	1052	Lace Monitor	D	15	187
		11.1.14	1440	Land Mullet	D	3	226
		12.1.14	0314	Rodent spp.	D	6	229
		12.1.14	1250	Treecreeper spp.	Pr	3	238
		14.1.14	1359	Lace Monitor	D	21	301
		16.1.14	1102	Laughing Kookaburra	D	3	270
		17.1.14	0951	Swamp Wallaby	D	3	538
		17.1.14	1237	Land Mullet	Pr	9	577
		18.1.14	1034	Lace Monitor	D	3	649
		19.1.14	2245	Antechinus spp.	D	3	859
		20.1.14	0822	Eastern Yellow Robin	D	3	862
		24.1.14	1904	Log Runner	D	3	937
		24.1.14	2227	Rodent spp.	D	9	940
		25.1.14	0528	Rodent spp.	D	3	949
		25.1.14	0536	Swamp Wallaby	D	6	952
		25.1.14	1737	Eastern Yellow Robin	D	3	973
		25.1.14	2316	Brush-tailed Possum	D	3	979
		27.1.14	0041	Short-beaked Echidna	D	3	985
South	N12	10.1.14	0504	Red Fox	D	21	8
		10.1.14	1233	Lace Monitor	D	9	41
		14.1.14	0520	Brush-tailed Possum	D	3	56
		14.1.14	1519	Lace Monitor	D	3	59

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		16.1.14	0647	Swamp Wallaby	D	3	62
		18.1.14	0710	Swamp Wallaby	D	12	68
		20.1.14	0733	Swamp Wallaby	D	10	83
		20.1.14	1001	Swamp Wallaby	D	3	98
		22.1.14	0259	Red Fox	D	6	104
		25.1.14	0631	Scrub Turkey	D	3	116
		26.1.14	0831	Swamp Wallaby	D	3	119
South	N13	21.1.14	2207	Northern Brown Bandicoot	D	3	1124
		24.1.14	1531	Lace Monitor	D	6	1127
		24.1.14	2011	Swamp Wallaby	Pr	3	1133
		25.1.14	1018	Swamp Wallaby	D	6	1139
South	N14	7.1.14	2038	Northern Brown Bandicoot	D	3	11
		9.1.14	1421	Swamp Wallaby	D	3	14
		14.1.14	1712	Swamp Wallaby	D	21	1540
		17.1.14	2332	Black Rat	D		2784
South	N15	12.1.14	2147	Red Fox	D	6	86
		15.1.14	0814	Swamp Wallaby	D	27	137
		18.1.14	1014	Lace Monitor	D	24	416
		18.1.14	2036	Red Fox	D	3	638
		21.1.14	0612	Swamp Wallaby	D	6	737
		27.1.14	0054	Red Fox	D	6	893
South	N16	11.1.14	1159	Lace Monitor	D	6	27
		23.1.14	1933	Swamp Wallaby	Pr	2	966
		24.1.14	1853	Swamp Wallaby	D	6	984
		26.1.14	0741	Swamp Wallaby	D	6	1089
South	N17	10.1.14	0031	Short-beaked Echidna	D	5	6
		10.1.14	1142	Lace Monitor	D	9	12
		10.1.14	1237	Land Mullet	D	6	24
		10.1.14	1708	Lace Monitor	D	18	30
		11.1.14	1137	Lace Monitor	D	39	51

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		14.1.14	1032	Lace Monitor	D	15	141
		15.1.14	1403	Lace Monitor	D	9	174
		16.1.14	0906	Lace Monitor	D	6	222
		16.1.14	1012	Lace Monitor	D	15	228
		17.1.14	0501	Short-beaked Echidna	D	6	414
		17.1.14	0914	Lace Monitor	D	9	420
		17.1.14	1157	Lace Monitor	D	3	453
		17.1.14	1249	Lace Monitor	D	9	456
		18.1.14	1036	Lace Monitor	D	9	606
		19.1.14	1116	Lace Monitor	D	16	759
		19.1.14	1140	Lace Monitor	D	12	774
		19.1.14	1242	Lace Monitor	D	3	786
		20.1.14	1024	Lace Monitor	D	9	843
		20.1.14	1127	Lace Monitor	D	6	852
		21.1.14	1248	Lace Monitor	D	12	934
		24.1.14	0340	Northern Brown Bandicoot	D	21	963
		24.1.14	0350	Red Fox	D	3	984
		24.1.14	1104	Lace Monitor	D	9	987
		24.1.14	1108	Lace Monitor	D	3	1000
		24.1.14	1229	Lace Monitor	D	9	1002
		24.1.14	1321	Lace Monitor	D	6	1011
		28.1.14	0400	Northern Brown Bandicoot	D	4	1068
South	N18	8.1.14	1528	Swamp Wallaby	D	3	11
		12.1.14	1120	Lace Monitor	D	27	1977
South	N19	14.1.14	0630	Swamp Wallaby	D	3	18
		14.1.14	0631	Swamp Wallaby	D	12	21
		18.1.14	0041	Swamp Wallaby	D	3	462
		19.1.14	1427	Swamp Wallaby	D	3	711
		27.1.14	0921	Swamp Wallaby	D	3	831
South	N20	9.1.14	0132	Northern Brown Bandicoot	D	3	11

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		9.1.14	2218	Unid mammal	*	2	54
South	N21	Nil					
South	N22	9.1.14	1923	Swamp Wallaby	D	3	9
		11.1.14	1116	Lace Monitor	D	9	18
		12.1.14	1337	Lace Monitor	D	48	33
		15.1.14	0128	Short-eared Brush-tailed Possum	D	3	81
		17.1.14	1120	Lace Monitor	D	3	195
		19.1.14	0347	Wallaby spp.	D	3	369
		22.1.14	2124	Rodent spp.	D	3	411
		26.1.14	2152	Rodent spp.	D	3	414
South	N23	6.1.14	1803	Red Fox	D	3	7
		7.1.14	0132	Black Rat	Pr	45	10
		7.1.14	0658	Yellow-throated Scrubwren	D	3	55
		8.1.14	0018	Rattus spp.	D	6	61
		8.1.14	1015	Yellow-throated Scrubwren	D	3	67
		9.1.14	0328	Rattus spp.	D	3	70
		9.1.14	0550	Swamp Wallaby	D	6	73
		9.1.14	0613	Dog	D	8	95
		9.1.14	1114	Yellow-throated Scrubwren	D	1	103
		9.1.14	1915	Yellow-throated Scrubwren	Pr	3	109
		10.1.14	1034	Yellow-throated Scrubwren	D	4	112
		10.1.14	1927	Yellow-throated Scrubwren	D	3	118
		11.1.14	0617	Macropod spp.	D	3	121
		11.1.14	0838	Eastern Whipbird	D	3	124
		11.1.14	1713	Swamp Wallaby	Pr	3	1713
		11.1.14	1714	Red Fox	D	3	1714
		12.1.14	0700	Catbird	D	2	0700
		12.1.14	0737	Yellow-throated Scrubwren	D	3	142
		12.1.14	1007	Yellow-throated Scrubwren	D	3	145
		12.1.14	1355	Lace Monitor	D	27	151

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		13.1.14	0510	Red Fox	D	3	178
		14.1.14	1607	Lace Monitor	D	18	184
		15.1.14	0904	Swamp Wallaby	D	3	202
		15.1.14	1509	Lace Monitor	D	12	214
		15.1.14	1810	Yellow-throated Scrubwren	D	3	232
		16.1.14	0210	Rattus spp.	Pr	3	235
		16.1.14	1051	Lace Monitor	D	6	241
		16.1.14	1243	Lace Monitor	D	15	253
		19.1.14	0739	Red Fox	D	3	361
		19.1.14	1045	Yellow-throated Scrubwren	D	3	364
		19.1.14	2056	Short-eared Brush-tailed Possum	D	3	376
		21.1.14	1154	Yellow-throated Scrubwren	D	3	409
		21.1.14	1251	Lace Monitor	D	15	415
		21.1.14	1835	Yellow-throated Scrubwren	D	3	430
		25.1.14	0807	Yellow-throated Scrubwren	D	3	439
		25.1.14	2248	Red Fox	D	3	460
		25.1.14	2306	Black Rat	Pr	3	463
		26.1.14	1252	Red Fox	D	6	466
		27.1.14	2355	Rattus spp.	D	3	475
South	N25	9.1.14	1057	Eastern Grey Kangaroo	D	3	8
		10.1.14	1328	Lace Monitor	D	46	11
		11.1.14	1334	Lace Monitor	D	3	56
		14.1.14	1206	Lace Monitor	D	9	62
		14.1.14	1215	Lace Monitor	D	240	71
		15.1.14	1137	Lace Monitor	D	15	311
		16.1.14	0930	Lace Monitor	D	6	326
		16.1.14	1047	Lace Monitor	D	12	332
		18.1.14	1033	Lace Monitor	D	15	347
		18.1.14	1442	Lace Monitor	D	6	366
		23.1.14	2125	Northern Brown Bandicoot	D	6	374

Location	Site	Date	Time	Species	Accuracy	Active Images	Image No.
		27.1.14	0845	Eastern Grey Kangaroo	D	3	380