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Studies

INTERIM ECOLOGICAL INVENTORY REPORT

Darkinjung Local Aboriginal Land Council North Wyong Land
holdings 2010-2012

Prepared for
Darkinjung Local Aboriginal Land Council

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Abbreviations

ABBREVIATION	DESCRIPTION
ALR Act	NSW <i>Aboriginal Land Rights Act</i> 1983
APZ	Asset Protection Zones
BBAM	Biobanking Assessment Methodology
BCAM	Biodiversity Certification Assessment Methodology
BOS	Biodiversity Offset Strategy
BOP	Biodiversity Offset Package
CL Act	NSW <i>Crown Land Act</i> 1993
CMA	Catchment Management Authority
DECCW	former NSW Department of Environment, Climate Change and Water (now OEH)
DLALC	Darkinjung Local Aboriginal Land Council
DoP	Former NSW Department of Planning
DP&I	NSW Department of Planning and Infrastructure
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Populations and Communities
ELA	Eco Logical Australia Pty Ltd
EP&A Act	NSW <i>Environmental Planning and Assessment Act</i> 1979
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act</i> 1999
IoM	Improve or Maintain
LALC	Local Aboriginal Land Council
LGA	Local Government Area
MNES	Matters of National Environmental Significance (EPBC Act)
NPW Act	NSW <i>National Parks and Wildlife Act</i> 1975
OEH	NSW Office of Environment and Heritage
RBVT	Revised Biometric Vegetation Type
RCP	Regional Conservation Plan
SSS Study	State Significant Site Study
TSC Act	NSW <i>Threatened Species Conservation Act</i> 1995

1 Introduction

Darkinjung Local Aboriginal Land Council (DLALC) commissioned Eco Logical Australia (ELA) in October 2010 to commence undertaking ecological investigations of its land holdings at Bushells Ridge as part of a Part 3A Development Application.

At around the same time, the then Department of Planning (DoP), now the Department of Planning and Infrastructure (DP&I), released its draft North Wyong Structure Plan („structure plan“) (DoP 2010). The structure plan identifies where and when development is planned to occur in the North Wyong area and ensures that sufficient land exists to meet regional housing and employment targets. The structure plan provides detail to the Central Coast Regional Strategy 2006-31 (DoP 2008) which also identified that a Central Coast Regional Conservation Plan (RCP) will be prepared by the NSW Office of Environment and Heritage (OEH).

Darkinjung’s Bushells Ridge land holdings represent a component of its overall land holdings which are in excess of 3,000 ha’s of which over 1,000 ha’s are in the North Wyong area, with a further 9,000 ha of yet to be determined land claims. The land council is one of the largest non-government land owners in the region.

The majority of Darkinjung’s north Wyong land holdings are identified in the structure plan as “*Green Corridor and habitat networks*”, part of which are further identified as “*strategically located, constrained sites, subject to further investigation and offset strategies to define conservation requirements and development potential*”.

Accordingly, the land council has recognised the need to establish a DLALC Land Strategy to identify development opportunities and conservation outcomes that complement and help achieve the targets in the structure plan and yet to be released RCP.

ELA brief was thus expanded to investigate development opportunities and conservation values of all DLALC land holdings in the structure plan area.

At this stage, DLALC and ADW Johnson have identified potential development precincts at Bushells Ridge and Railcorp/Link Road Employment Estate (employment lands) and Bushells Ridge East, Lake Munmorah and Halekulani (residential lands) totalling approximately 373 ha. Similarly some 719 ha of conservation lands have also been identified with a possible further 631 ha subject to land claims (**Figure 1**).

This report provides a summary of the conservation values assessed between October 2010 and November 2012 and is intended to guide ongoing discussions between DLALC, Wyong Council, the OEH and the DP&I regarding the further development of the land councils development proposal. The ecological investigations are ongoing and the analysis of current data is not yet complete.

As these lands each represent significant projects that would be developed over long timeframes (10-25 years) and require rezoning, the recently gazetted Biodiversity Certification Assessment Methodology (BCAM) (DECCW 2011) is proposed to be used to „biodiversity certify“ the proposed development lands and provide certainty for future development. The BCAM is a transparent and quantitative methodology used to assess the impacts to biodiversity for large scale projects and demonstrate conservation outcomes consistent with NSW and Commonwealth offset policies, including a „improve or maintain“ (IoM) outcome. It is noted that the proposed development areas largely avoid red flag vegetation communities and species and that the offset requirements can be fully met by the land council current land holdings and claims prioritised for determination.

The BCAM (OEH 2011) provides a framework to determine whether large scale projects such as those proposed, including proposed conservation measures, will meet an IoM outcome. If the Minister for the Environment is satisfied that an IoM outcome has been achieved, the Minister may „biodiversity certify“ the proposal, allowing development to proceed without further biodiversity assessment on the condition that certain identified lands are protected and managed as proposed in the application and in accordance with a Biodiversity Conservation Strategy. An application must be made by a planning authority (i.e. the Department of Planning or Wyong Council) and must be prepared in accordance with the rules established under the methodology.

Then following sections provide a brief overview of the surveys methods implemented and the results obtained to date. These results have been used to inform DLALC in their identification of development precincts and ongoing discussions with DP&I, OEH and Wyong Council. Once development precincts are confirmed, formal biocertification assessments will be undertaken using the results of the surveys.

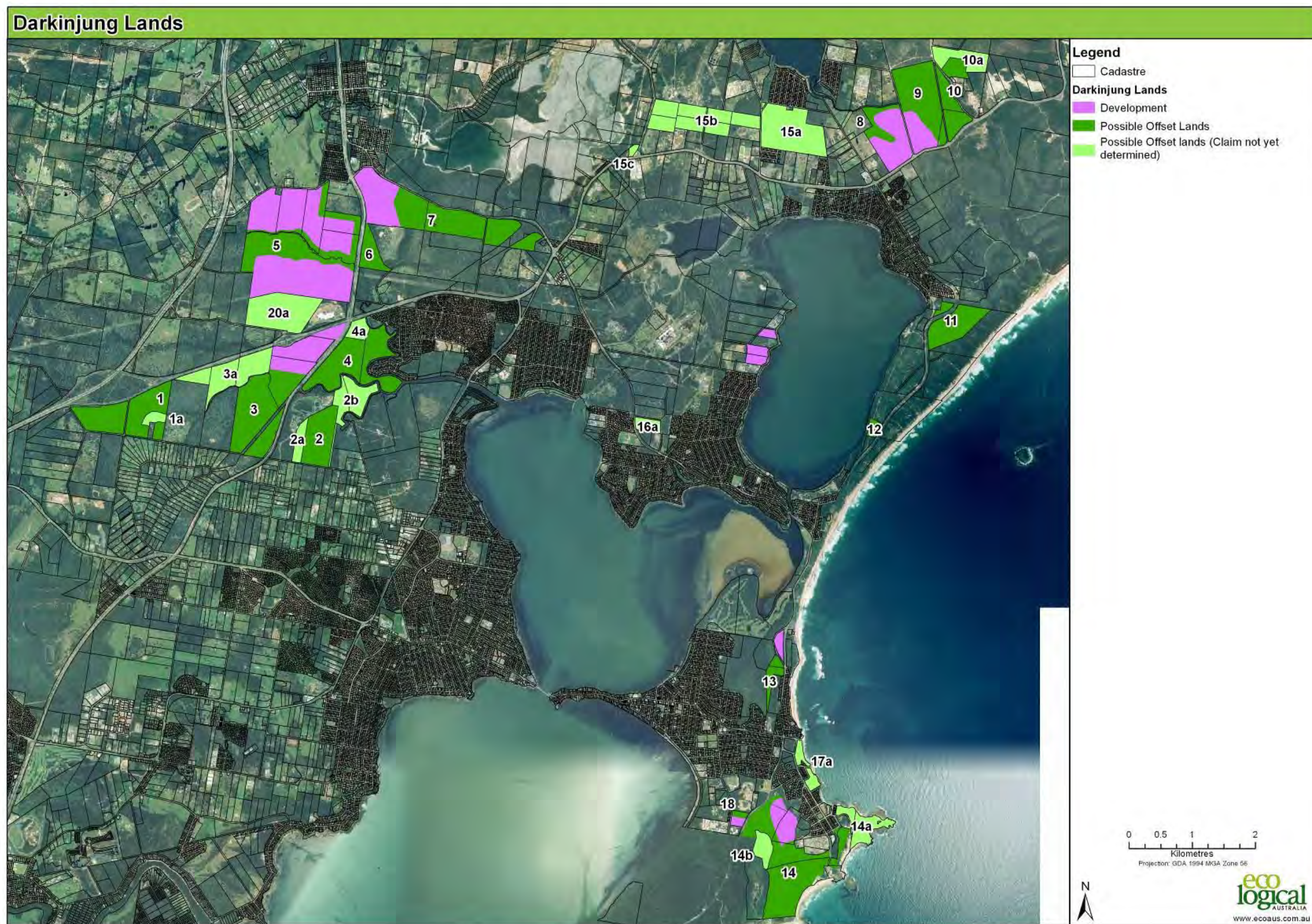


Figure 1: DLALC North Wyong Land holdings and indicative development and conservation outcomes

2 Methods

2.1 BIOCERTIFICATION

All flora and fauna investigations to date have been undertaken in accordance with the BCAM (DECCW 2011) and the „*Threatened Biodiversity Survey and Assessment Guidelines for developments and activities*“ (DEC 2004). These investigations have been undertaken by teams supervised by accredited biobanking/biocertification assessors so that a formal biocertification assessment can be undertaken.

2.2 VALIDATION OF WYONG LGA VEGETATION MAPPING

The boundaries of vegetation communities according to the Wyong Local Government Area (LGA) vegetation mapping (Bell 2002) were mapped onto high resolution, recent aerial photographs. This mapping was then extensively ground-truthed by experienced field ecologists and any updates/modifications required were marked using a GPS.

ArcMap Version 9.2, a Geographic Information System (GIS), was used to map and interpret data in this report. Vegetation communities and records of threatened species were plotted onto geo-referenced aerial photographs and other maps at scales of 1:10,000 or better.

As Revised Biometric Vegetation Types (RVBTs) are the only vegetation types used in biocertification assessments, each of the Bell 2002 map units were converted to the corresponding biometric vegetation in the Hunter Central Rivers CMA region (DECC 2008). Some vegetation observed in the field did not fit neatly into any of the RBVTs listed for the Hunter – Central Rivers CMA (e.g., where the vegetation lies in an ecotone between two types). In such cases, the professional judgment of the assessor was used to select the closest matching RBVT. The Bell 2002 map units corresponding to each biometric vegetation type are shown in **Table 1**.

Biocertification Condition Assessment

The condition of each of the RVBTs was categorised as being in either biometric „moderate – good“ or „low“ condition or „cleared“ land, thus creating „Biocertification Vegetation Zones“.

Ancillary Codes were also assigned to each of the Vegetation Zones in moderate - good condition (i.e. regrowth, recently burnt, weedy, under scrubbed etc) to create the Threatened Species Sub-zones. No Ancillary Codes were assigned to vegetation in „low“ condition.

Table 1: Biometric vegetation types and corresponding Bell 2002/Wyong Vegetation map units

Wyong LGA Map Unit (Bell 2002)	Biometric Vegetation Community	EEC	BCAM Red Flag
Coastal Sand Blackbutt - Apple Forest	Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin and South East Corner		
Coastal Sand Wallum Heath Scrub	Banksia dry shrubland on coastal sands of the North Coast		
Alluvial Riparian Blackbutt Forest	Blackbutt - Smooth-barked Apple shrubby open forest on coastal sands of the southern North Coast		
Munmorah Impeded Sand Sedgeland	Broad-leaved Paperbark - Wallum Bottlebrush - sedge wet heath on sand, southern North Coast and northern Sydney Basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
Coastal Holocene Banksia Scrub / Coastal Sand Fore-dune Acacia Scrub / Coastal Sand Beach Spinifex	Coast Banksia - Coast Wattle dune scrub, Sydney Basin and South East Corner		
Narrabeen Coastal Alluvial Sedgeland	Coastal floodplain sedgeland, rushlands, and forblands of the North Coast	Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
Alluvial Floodplain Swamp Paperbark Thicket	Coastal freshwater lagoons of the Sydney Basin and South East Corner	Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
Coastal Sand Wallum Heath-Scrub	Fern-leaved Banksia - Melaleuca sieberi Wallum Heath	Low woodland with heathland on indurated sand at Norah Head	Yes
Alluvial Floodplain Shrub Swamp Forest	Forest Red Gum - Rough-barked Apple open forest on poorly drained lowlands of the Central Coast, Sydney Basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
Narrabeen alluvial drainage line complex / Coastal Sand Wallum Heath Scrub	Melaleuca nodosa closed shrubland on alluvium of the Central Coast, Sydney Basin	Low woodland with heathland on indurated sand at Norah Head	Yes
Munmorah Impeded Sand Sedgeland	Melaleuca sieberi - Tall Saw-sedge closed shrubland in drainage lines on the Central Coast, Sydney Basin		
Alluvial Bluegum-Paperbark Mesic Palm Forest	Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin		
Munmorah Impeded Sand Sedgeland / Narabeen Impeded Wet Heath	Paperbark heath on indurated sands at Norah Head on the Central Coast, Sydney Basin	Low woodland with heathland on indurated sand at Norah Head	Yes
Coastal Sand Mahogany - Paperbark Swamp Forest / Coastal Sand Bangalay - Paperbark Forest	Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes

Narrabeen Doyalson Coastal Woodland	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin		
Narrabeen Doyalson Coastal Woodland / Coastal Sand Blackbutt Forest	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin		
Narrabeen Dooralong Spotted Gum - Ironbark Forest	Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin		
Munmorah Palm Apple Dry Drainageline Forest	Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
	Sydney Peppermint - Smooth-barked Apple shrubby open forest on coastal hills and plains of the southern North Coast and northern Sydney Basin		
Coastal Sand Littoral Rainforest	Tuckeroo - Yellow Tulipwood Littoral Rainforest	Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes

2.3 BIOMETRIC PLOTS

Quadrat surveys were 0.04ha (20m x 20m) and recorded presence of all vascular flora species (native and exotic). Habitat features were determined over 0.1 ha survey (50m x 20m quadrat); including recording of number of hollow bearing trees and length of fallen dead timber greater than 10 cm diameter. Within the 0.1 ha quadrats, projected foliage cover of each strata level and exotic flora was assessed along a 50m transect.

To date, 97 biometric vegetation condition plots have been undertaken across the investigation area. Each plot was randomly placed within each vegetation zone in accordance with the minimum number of plots required by the BCAM (see Table 11 of the BCAM).

Figure 2 shows the location of each of the vegetation quadrats throughout the investigation area. Detailed maps of each land parcel are provided separately.

Any specimens unidentifiable in the field were retained and later identified. Any specimens that were thought to be threatened species or for which identification was problematic were sent to the Herbarium at the Royal Botanic Gardens, Sydney for verification.

2.4 THREATENED SPECIES SURVEYS

2.4.1 Target Species

The Biocertification Credit Calculator requires targeted survey for threatened flora and threatened fauna that are not predicted to occur in certain vegetation types. In order to determine which species required targeted survey and what months to undertake these surveys, each of the biometric vegetation types within the investigation area were entered into the biocertification tool. **Table 2** shows which species required targeted survey in accordance with BCAM and the acceptable months to undertake these surveys. It is noted that under the BCAM, targeted surveys for many threatened fauna species known to occur in the investigation area (e.g. Powerful Owl, Masked Owl and Squirrel Glider) **are not required** as these species are considered ecosystem species and are assumed to occur in designated vegetation

types of particular patch size and condition in certain localities. However, where these species were opportunistically recorded, their presence has been noted.

Targeted threatened flora surveys have been undertaken in December 2010, January, February 2011, October and November 2011, July, September, October and November 2012 to date.

Targeted threatened fauna surveys have been undertaken in February, March, April and May 2012 to date.

Except where specifically noted, the field survey was undertaken using hand-held GPS units, which were used to take GPS point locations of flora and fauna observed in the field. It is noted that these units can have errors in the accuracy of the locations taken of approximately 20m (subject to availability of satellites on the day).

Table 2: Species requiring targeted survey and acceptable survey periods

Threatened Flora

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Acacia bynoeana</i>	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
<i>Angophora inopina</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Astrotricha crassifolia</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Caladenia porphyrea</i>	No	No	No	No	No	No	No	No	Yes	Yes	No	No
<i>Caladenia tessellata</i>	No	No	No	No	No	No	No	No	Yes	Yes	No	No
<i>Callistemon linearifolius</i>	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
<i>Corybas dowlingii</i>	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No
<i>Cryptostylis hunteriana</i>	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes
<i>Cynanchum elegans</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Diuris bracteata</i>	No	No	No	No	No	No	No	Yes	Yes	No	No	No
<i>Diuris praecox</i>	No	No	No	No	No	No	Yes	Yes	No	No	No	No
<i>Eucalyptus camfieldii</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Eucalyptus oblonga</i> - endangered population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Genoplesium insignis</i>	No	No	No	No	No	No	No	No	Yes	Yes	No	No
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Maundia triglochoides</i>	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes
<i>Melaleuca biconvexa</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Melaleuca groveana</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Prostanthera askania</i>	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
<i>Rutidosia heterogama</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Syzygium paniculatum</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Tetradlea glandulosa</i>	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No
<i>Tetradlea juncea</i>	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
<i>Thelymitra</i> sp. <i>Adorata</i>	No	No	No	No	No	No	No	No	Yes	Yes	No	No
<i>Zannichellia palustris</i>	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Threatened Fauna (excluding marine and inter-tidal species)

Scientific name	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Botaurus poiciloptilus</i>	Australian Bittern	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Callocephalon fimbriatum</i>	Gang Gang Cockatoo	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Chalinolobus dwyeri</i> (Breeding)	Large-eared Pied Bat	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
<i>Crinia tinnula</i>	Wallum Froglet	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
<i>Hieraaetus morphnoides</i>	Little Eagle	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
<i>Irediparra gallinacea</i>	Comb-crested Jacana	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Ixobrychus flavicollis</i>	Black Bittern	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Litoria aurea</i>	Green and Golden Bell Frog	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes
<i>Litoria brevipalmata</i>	Green-thighed Frog	Yes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
<i>Litoria littlejohni</i>	Littlejohn's Frog	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
<i>Lophoictinia isura</i>	Square-tailed Kite	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
<i>Miniopterus australis</i> (Breeding)	Little Bentwing-bat	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes
<i>Miniopterus schreibersii oceanensis</i> (Breeding)	Eastern Bentwing-bat	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
<i>Mixophyes iteratus</i>	Giant Barred Frog	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes
<i>Myotis macropus</i> (formally <i>Myotis adversus</i>) (Breeding)	Large-footed Myotis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Nettapus coromandelianus</i>	Cotton Pygmy-Goose	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
<i>Pandion haliaetus</i>	Osprey	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Planigale maculata</i>	Common Planigale	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Pseudomys gracilicaudatus</i>	Eastern Chestnut Mouse	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Pseudophryne australis</i>	Red-crowned Toadlet	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Pteropus poliocephalus</i> (Breeding)	Grey-headed Flying Fox	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
<i>Varanus rosenbergi</i>	Rosenberg's Goanna	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes
<i>Vespadelus troughtoni</i> (Breeding)	Eastern Cave Bat	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

2.4.2 Targeted threatened flora surveys

Random meanders for threatened flora species were undertaken in accordance with DECCW guidelines (DEC 2004). The location of random meanders were determined in the field based on suitable habitat. Existing records from the Atlas of NSW Wildlife was used to indicate previous recordings guidance to potential threatened species locations. The locations and months of all flora survey undertaken, as recorded by hand held GPS, are shown in **Figures 4-27**.

Over 500 person hours of targeted threatened flora survey has been undertaken to end November 2012.

2.4.3 Targeted threatened fauna surveys

The location and survey technique of all fauna survey undertaken within the investigation area to date is shown in **Figures 4-27**. Survey effort and techniques was tailored to target threatened fauna considered to potentially occur in the study area as determined by the biodiversity certification tool. DEC (2004) and other documents were then consulted to determine the most appropriate survey technique and minimum survey effort required.

Following a review of those threatened fauna species requiring targeted survey in accordance with the BCAM, hair tubes, pitfall trapping, anabat / stag watching and targeted amphibian surveys were used as the primary methods of detecting threatened fauna species. The location of survey sites using these methods is shown in **Figure 3**.

Hair tubes

Hair tubes were placed in pairs along transects with 10 stations. Hair tubes were left in place for between 10 and 14 nights resulting in between 200 and 280 trap nights per transect.

Over 3,000 hair tube trap nights have been undertaken to end November 2012.

Hans Brunner, an experienced expert in analysis of fauna hair samples, was engaged to analyse the data collected by the hairtubes, in accordance with the techniques described by Brunner and Coman (1974).

Trapping

To date Elliot traps have only been used at the Halekulani site. A total of 64 arboreal trap nights have been completed.

Pitfall Trapping

Pitfall trapping was used to target Planigale, Eastern Chestnut Mouse and Eastern Pygmy Possum at the Norah Head precinct. To date, 48 trap nights have been completed.

Frog call play back

A combination of nocturnal call playback and listening for frog calls, plus spotlighting, was used to survey for targeting frog species in specific suitable habitat. Calls were identified using reference recordings available on the Amphibian Research Centre website (online). Surveys were undertaken during optimal weather conditions, i.e. after heavy rainfall events in summer months to target Giant Burrowing Frog, Giant Bared Frog and Green-thighed Frog. Sites of aquatic habitats such as dams, wetlands, soaks and seepages were targeted.

Over 150 person hours of targeted threatened amphibian survey has been undertaken to end November 2012.

Anabat analysis

Survey for microchiropteran (microbats) bat species included the use of ultrasonic Anabat detectors equipped with ZCAIM recording devices. Recordings containing less than three pulses were not analysed (Law et al. 1999). To date, 52 anabat nights have been completed.

Stag watching

The identification of potential roosting and/or breeding sites for microchiropteran bats focused on identifying potential roosting / nesting trees during the survey period and stag watching with an Anabat directed at the stag hollow prior to dusk and 30 minutes after dusk to capture calls from any emerging microchiropteran species. To date, 52 anabat / stagwatch nights and have been completed. In addition, over 150 person hours of spotlighting has been undertaken to end November 2012.

Opportunistic bird survey

Survey for diurnal birds was opportunistic with observers moving through vegetation communities supporting potential habitat for diurnal birds over the entire survey period.

2.4.4 Limitations

The survey effort and study design optimised the potential for species to be recorded during a range of climatic situations and over a number of seasons. Nonetheless, it is not possible to record every species that may either be resident or transitory across a site as generally some species may have been inactive, dormant or with cryptic habits, or some may be nomadic or migratory in nature. Additionally, some fauna species are mobile or transient in their use of resources. Consequently, it is likely that not all species would have been recorded during the study period even though it extended from October 2010-2012 and, therefore, the likelihood of occurrence within the study area of some threatened species was assessed based on the presence of potential habitat.

Given the limitations associated with all surveys, this assessment was not intended to provide an inventory of all species present across the site but instead aims to provide an overall assessment of the ecological values of the site with particular emphasis on threatened species, endangered ecological communities and key fauna habitat features.

2.5 PROJECT STAFF AND EXPERTISE

ELA has deployed an extensive team of ecologists to undertake the field surveys. Additionally, technical specialists analysed field records to create a comprehensive anthology of high-quality scientific data.

Table 3: ELA staff, project role and key

Project Team	Role	Expertise
Robert Humphries	Project Director	BCAM/BBAM
Antony Von Chrismar	Project Planning & field work	Accredited Biobanking and Biocertification Assessor
Darren James	Advice, Credit Calculations	Accredited Biobanking and Biocertification Assessor
Gordon Patrick	Field work	Senior Botanist
Lachlan Copeland	Field work	Senior Botanist
Michael Ward	Field work	Botanists
Andrea Sabella	Field work	Ecologist
Ross Wellington	Field work	Herpetologist
Daniel McKenzie	Field work	Junior Ecologist
Niels Rueegger	Field work	Ecologist
Prudence Coffey	Field work	Ecologist
Liz Brown	Field work	Senior Botanist
Rochelle Basham	Field work	Ecologist
Peter Knock	Field work & Anabat analysis	Anabat Analysis
Hans Brunner	Hair Analysis	Hair Tube Analysis
Joanne Daly	GIS Analysis & Support Credit Calculations	GIS Analysis & Support Credit Calculations
Vivian Hamilton	GIS Analysis & Support	GIS Analysis & Support

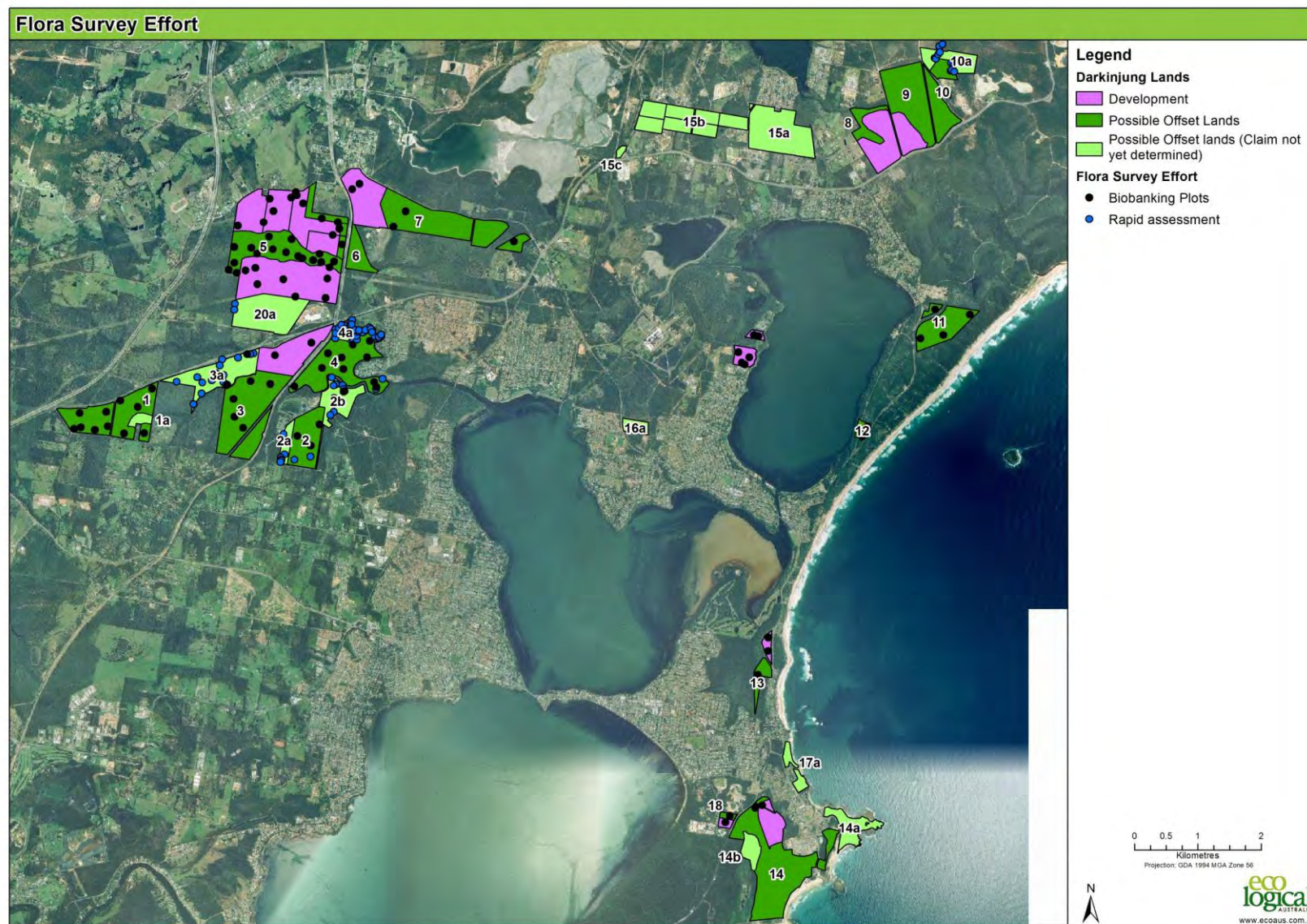


Figure 2: Distribution of biometric plots and threatened flora survey effort within the investigation area (October 2010-2102)

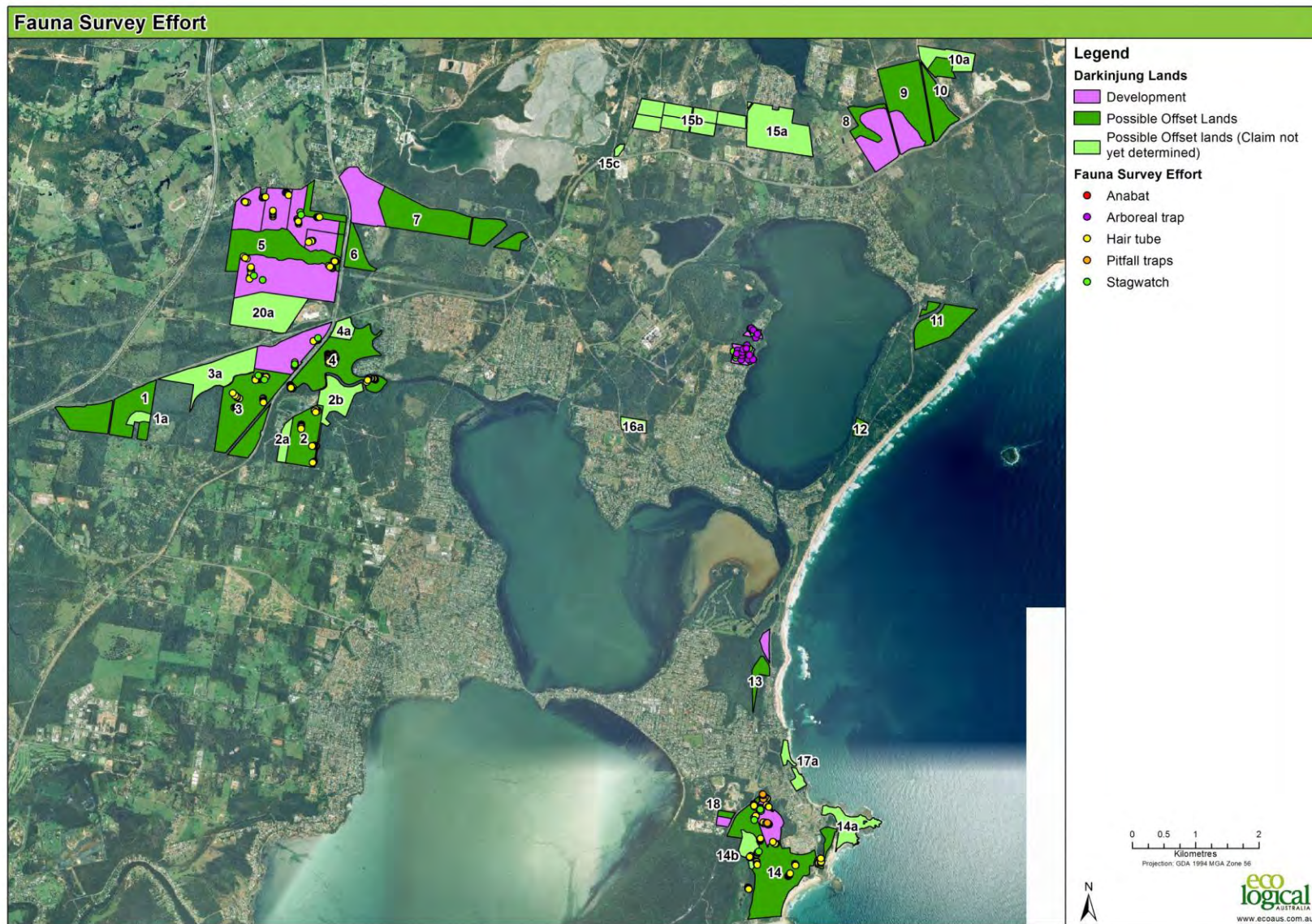


Figure 3: Threatened fauna survey effort and techniques across the investigation area (October 2010-2012)

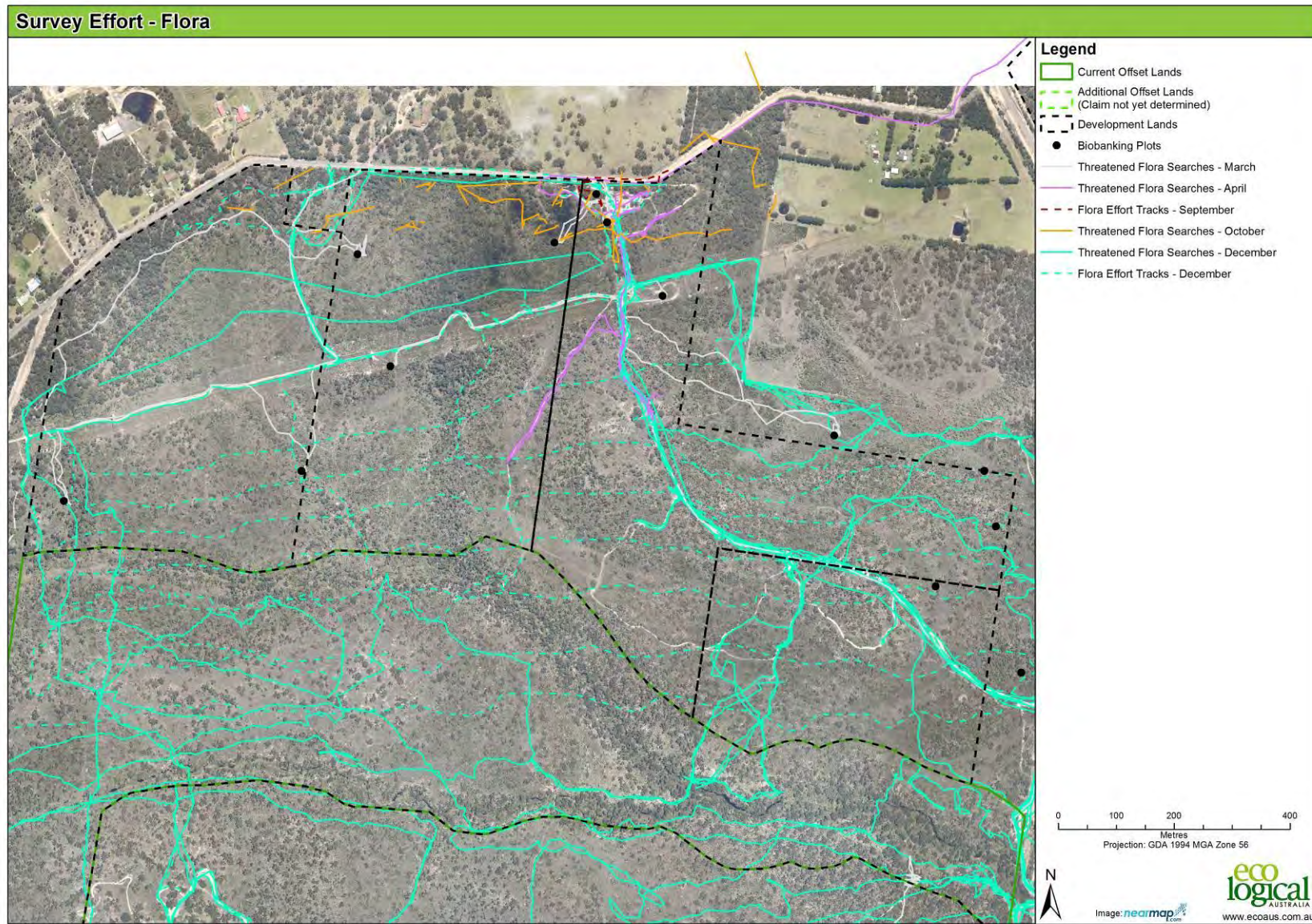


Figure 4: Flora survey effort Bushells Ridge North proposed development precinct

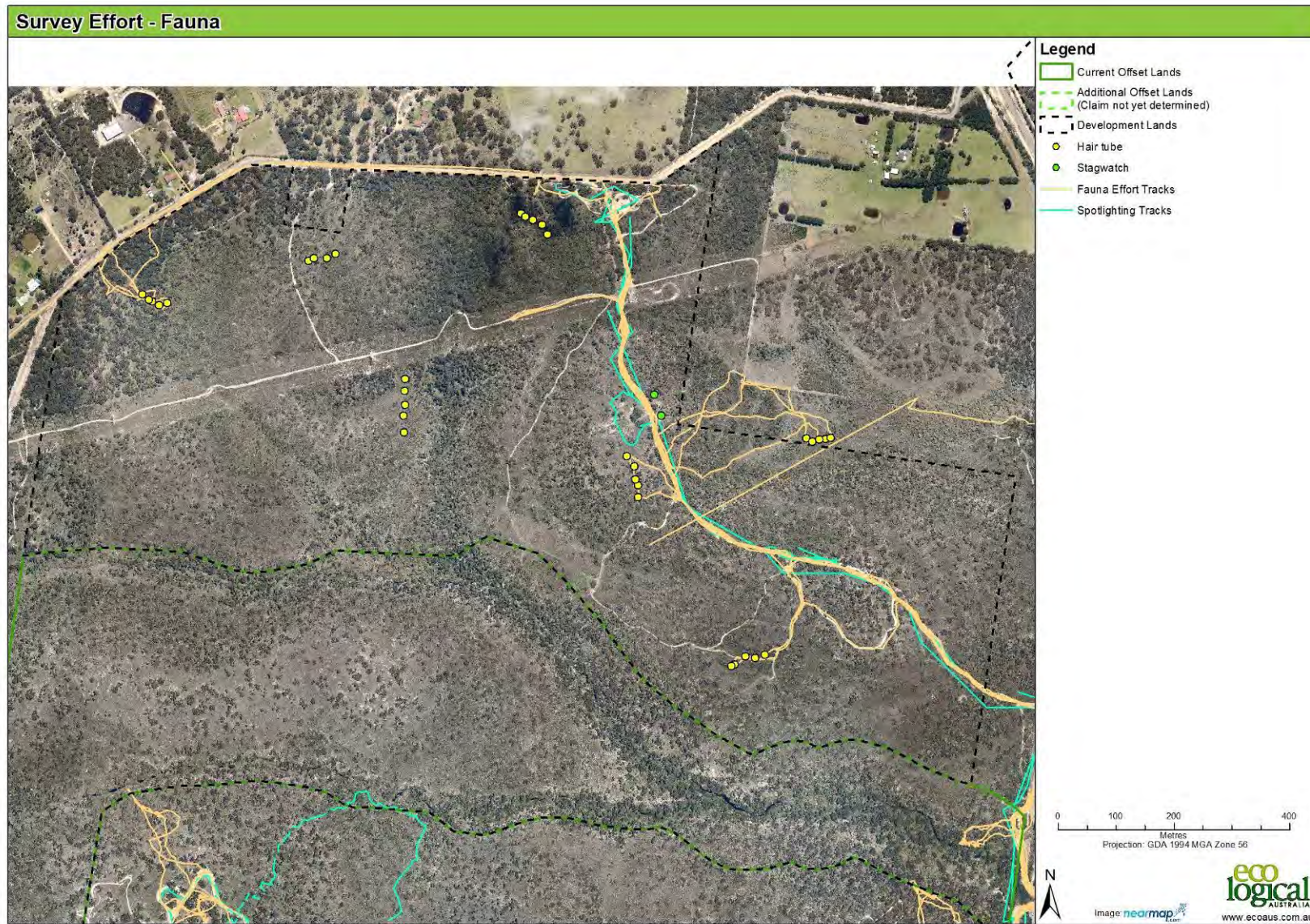


Figure 5: Fauna survey effort Bushells Ridge North proposed development precinct

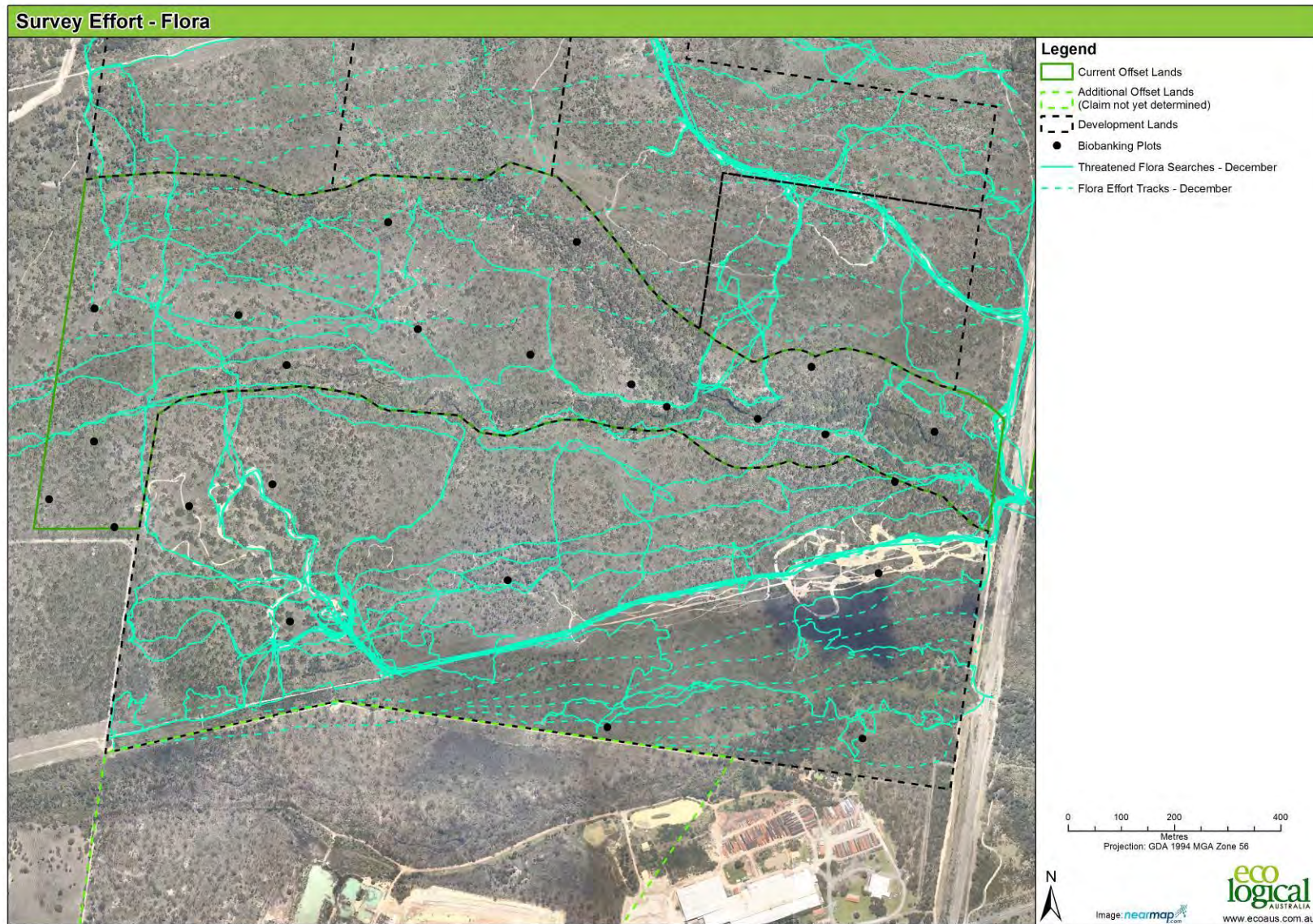


Figure 6: Flora survey effort Bushells Ridge South proposed development precinct

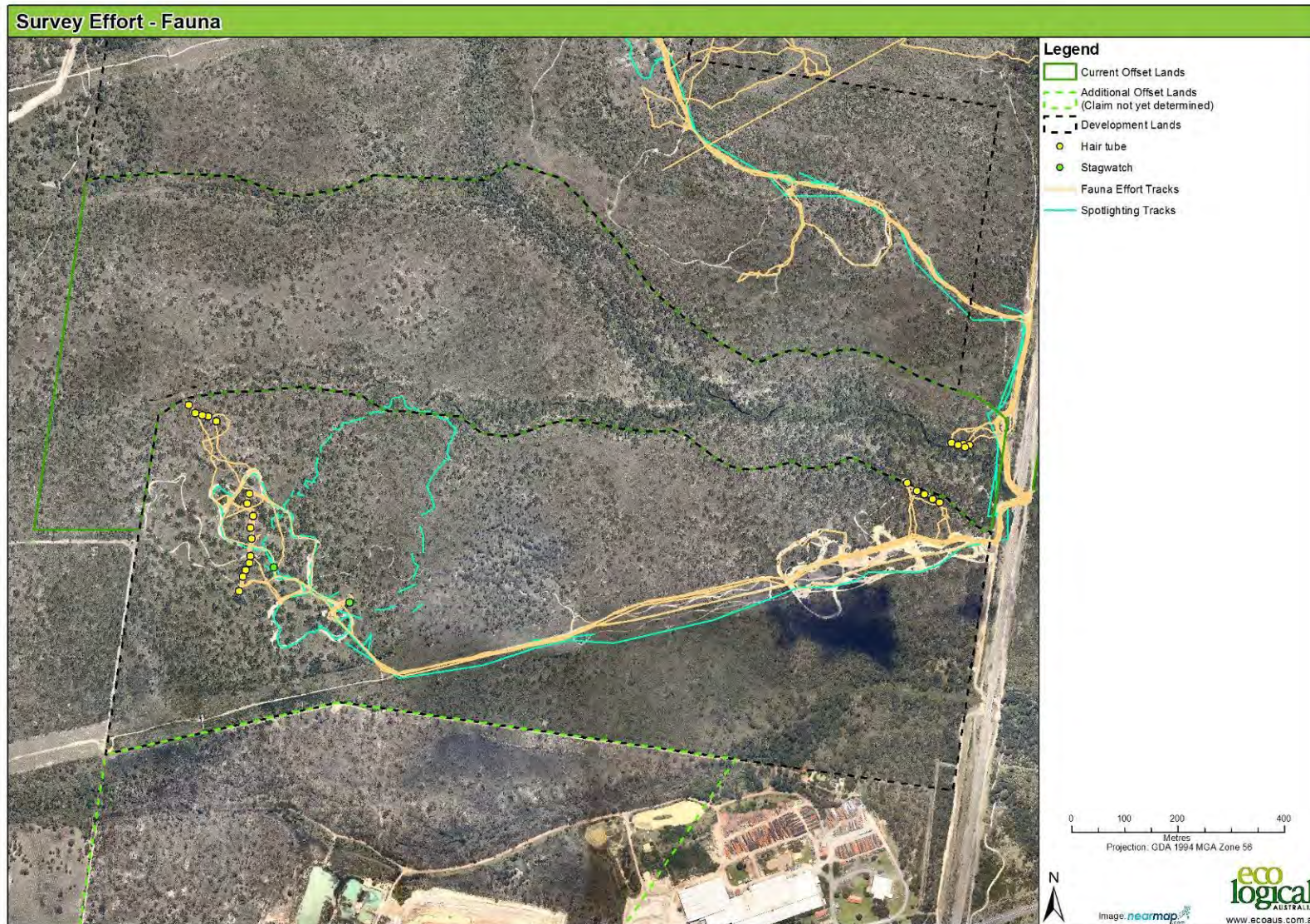


Figure 7: Fauna survey effort Bushells Ridge South proposed development precinct

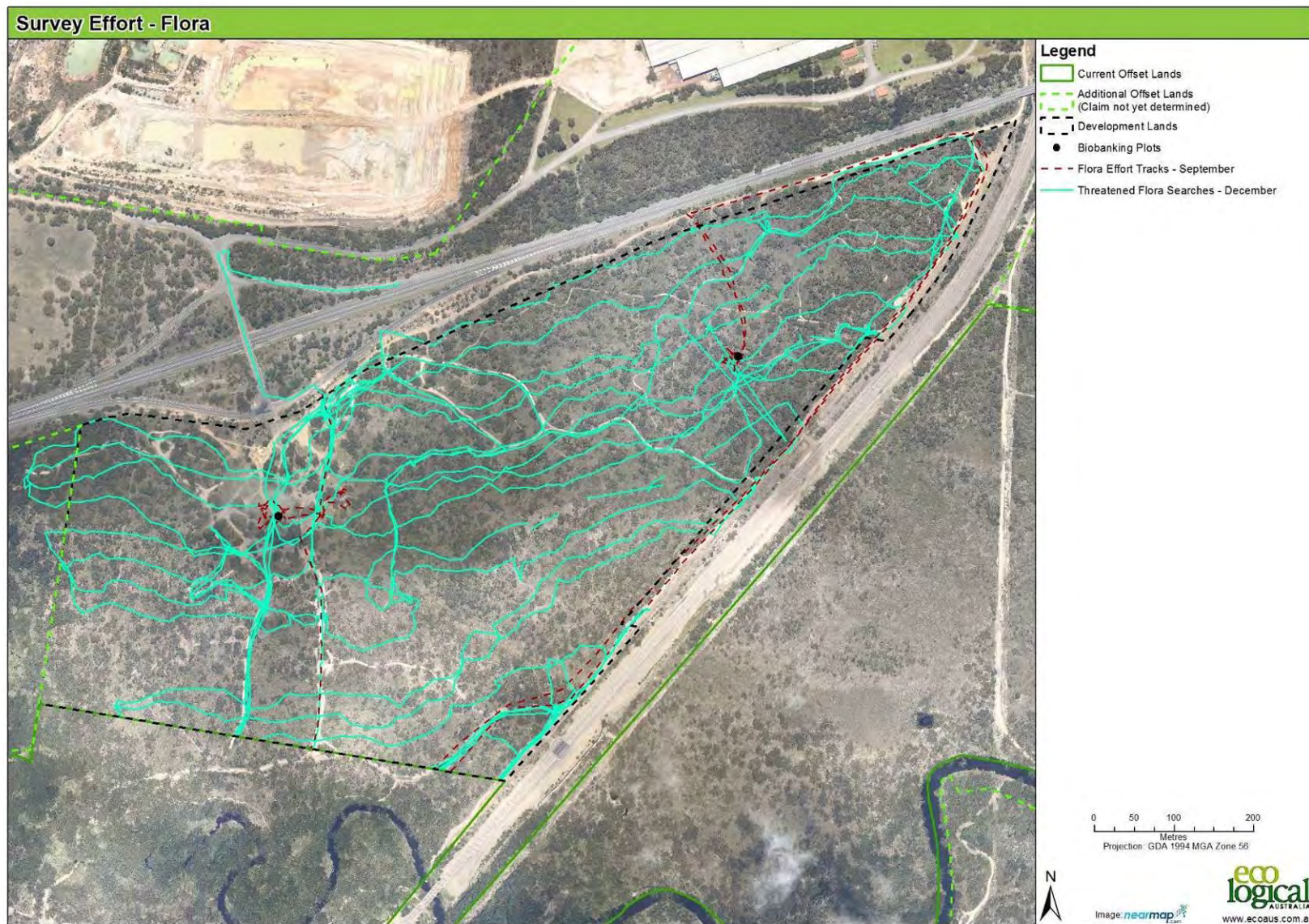


Figure 8: Flora survey effort Railcorp proposed development precinct

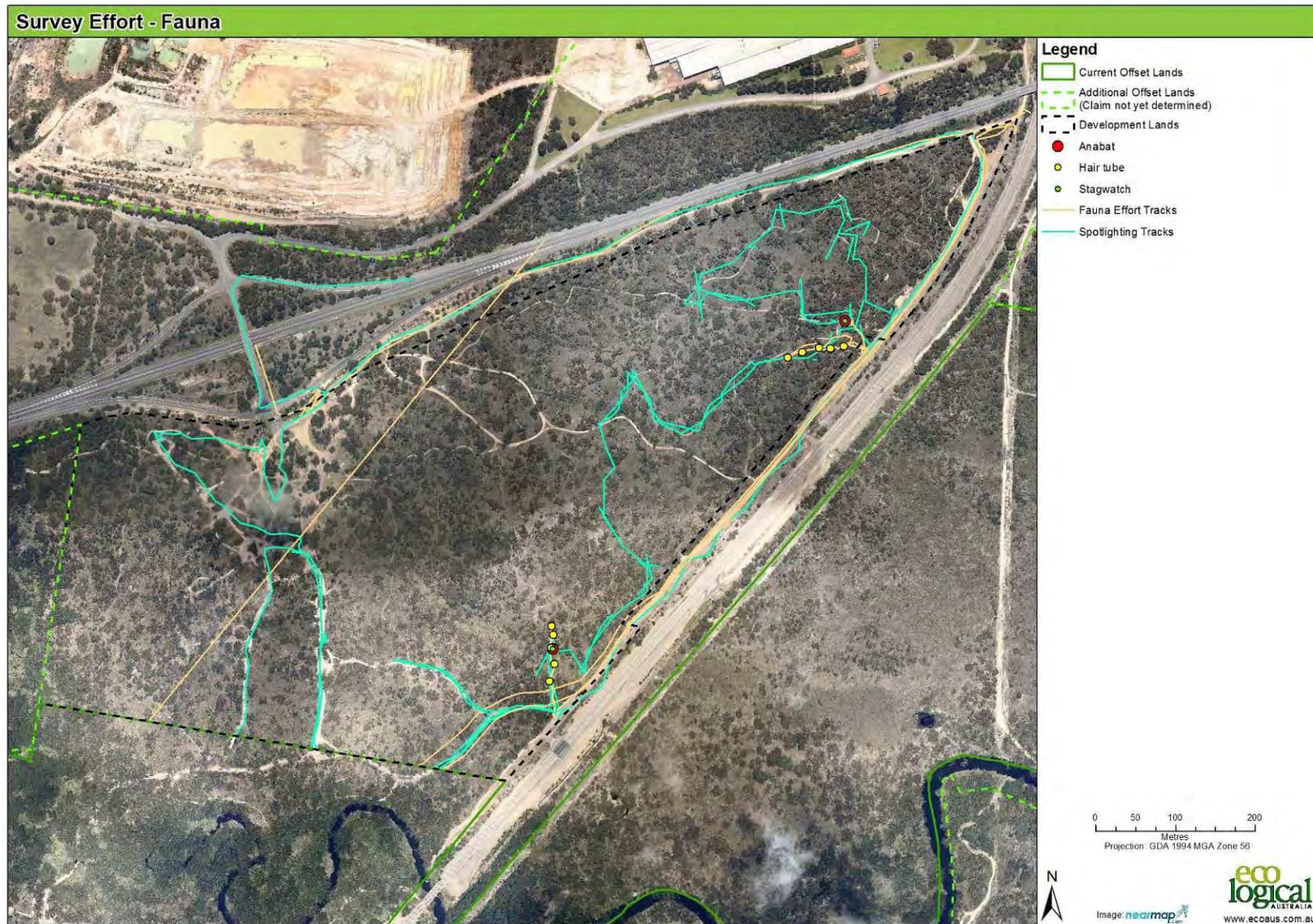


Figure 9: Fauna survey effort Railcorp proposed development precinct

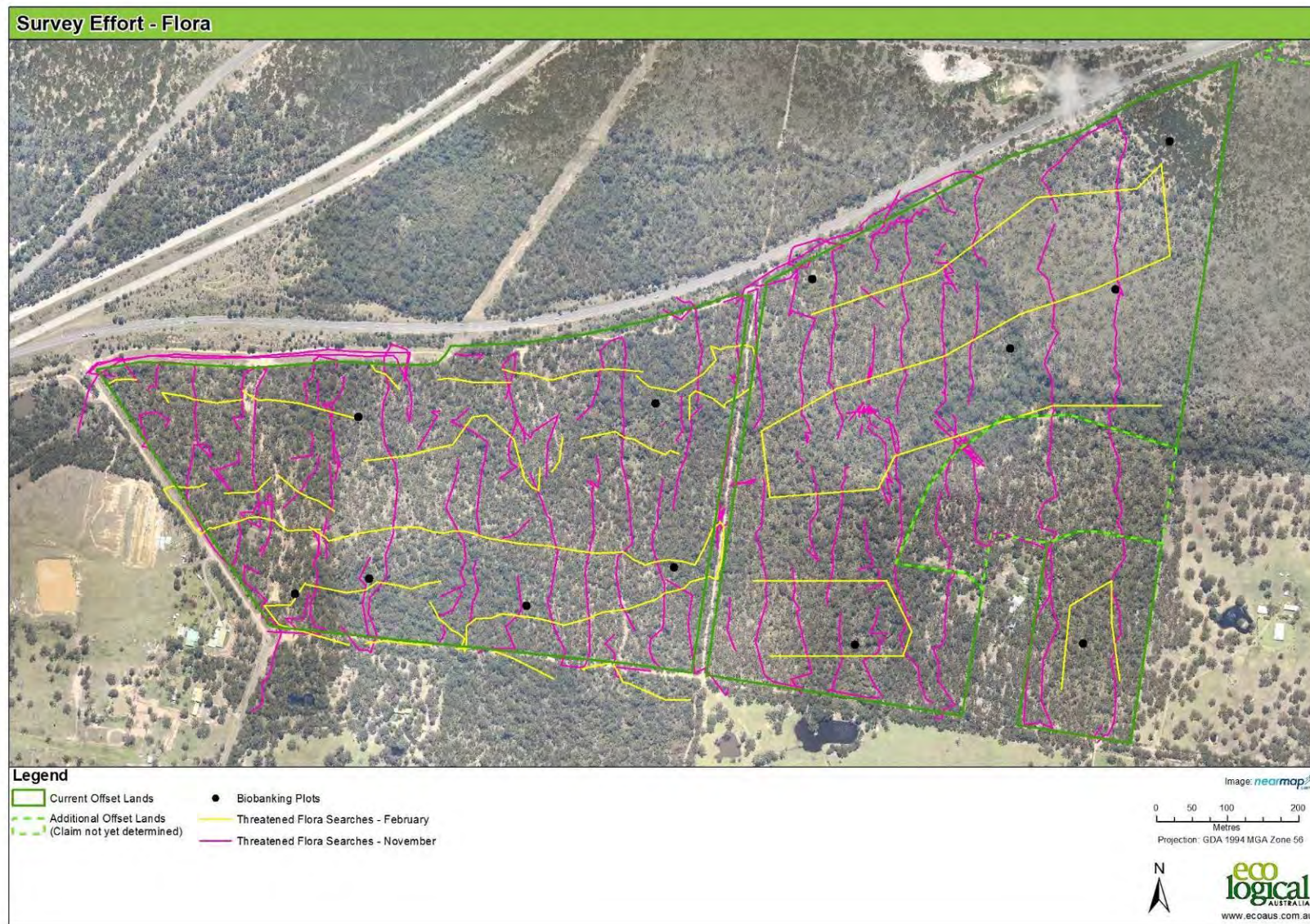


Figure 10: Flora survey effort proposed offset lands 1

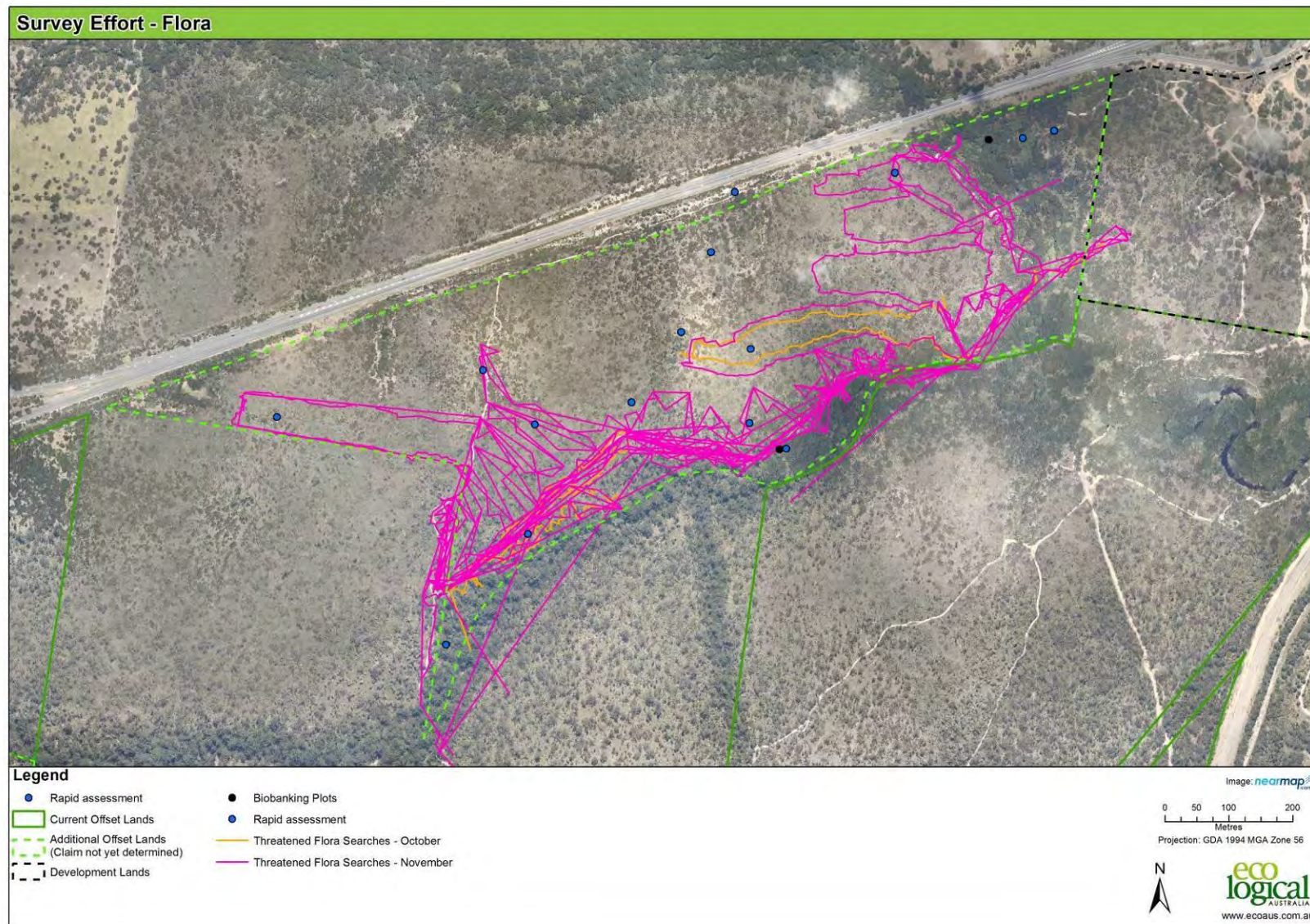


Figure 11: Flora survey effort proposed offset lands 3a

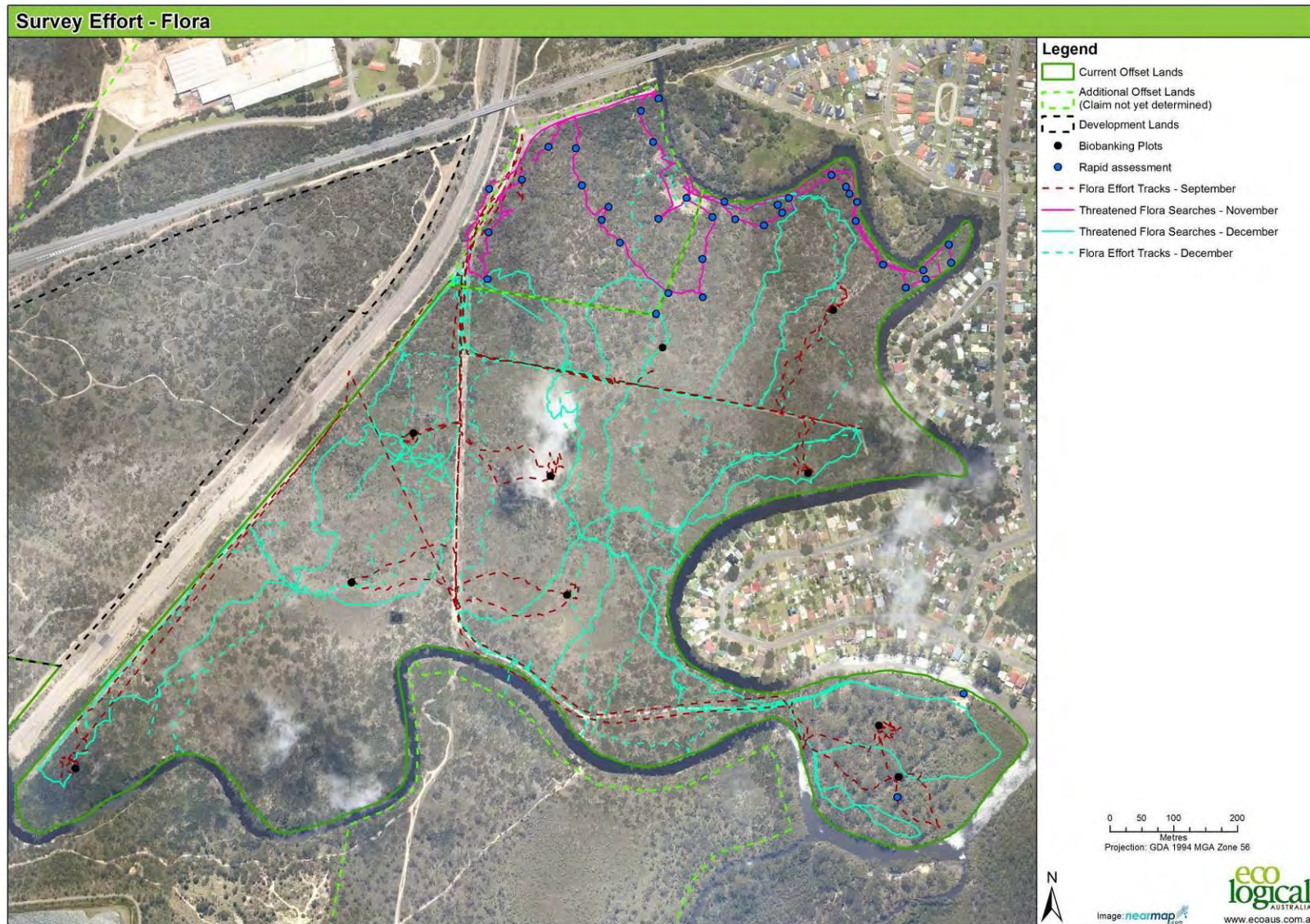


Figure 12: Flora survey effort proposed offset lands 4

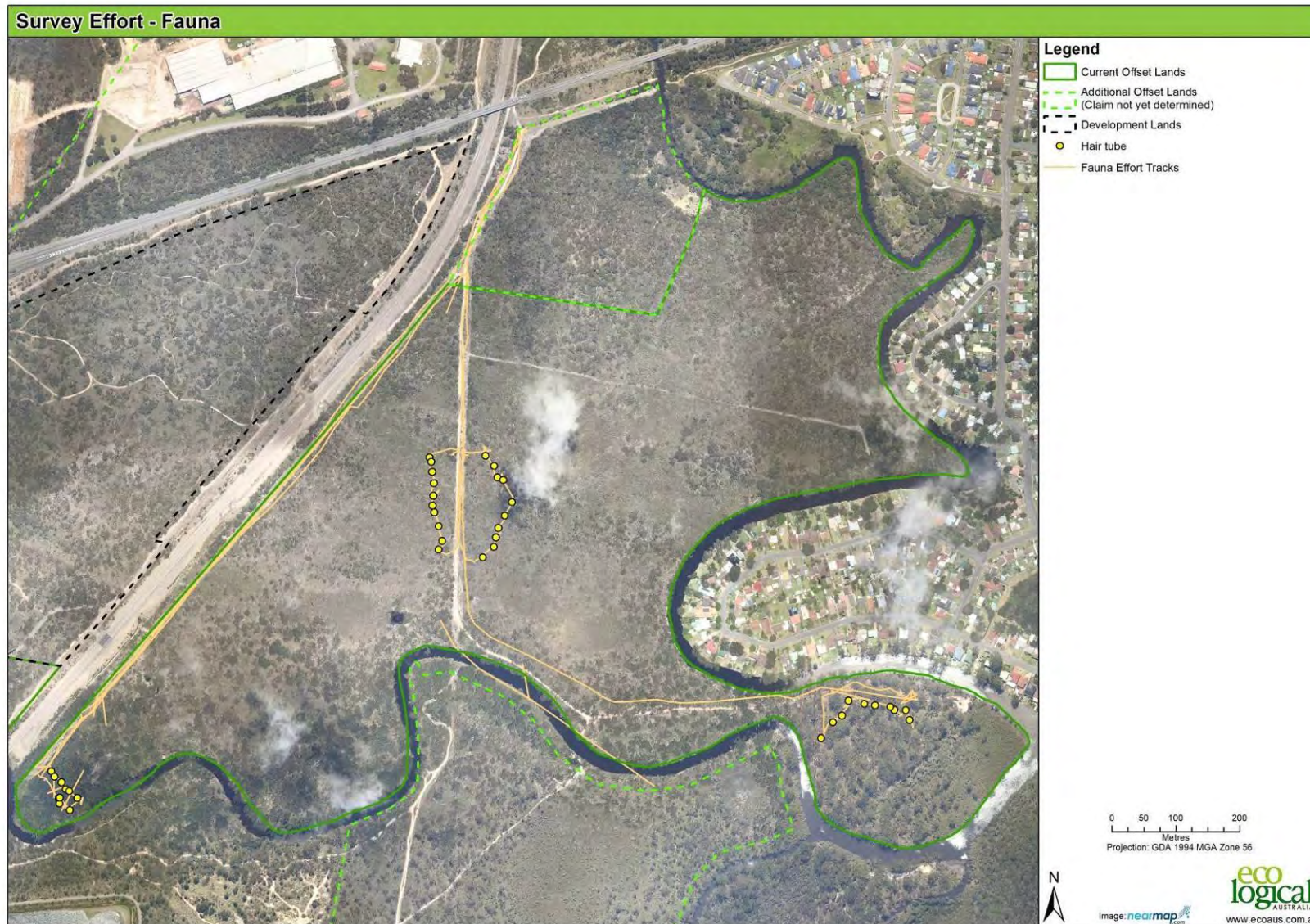


Figure 13: Fauna survey effort proposed offset lands 4

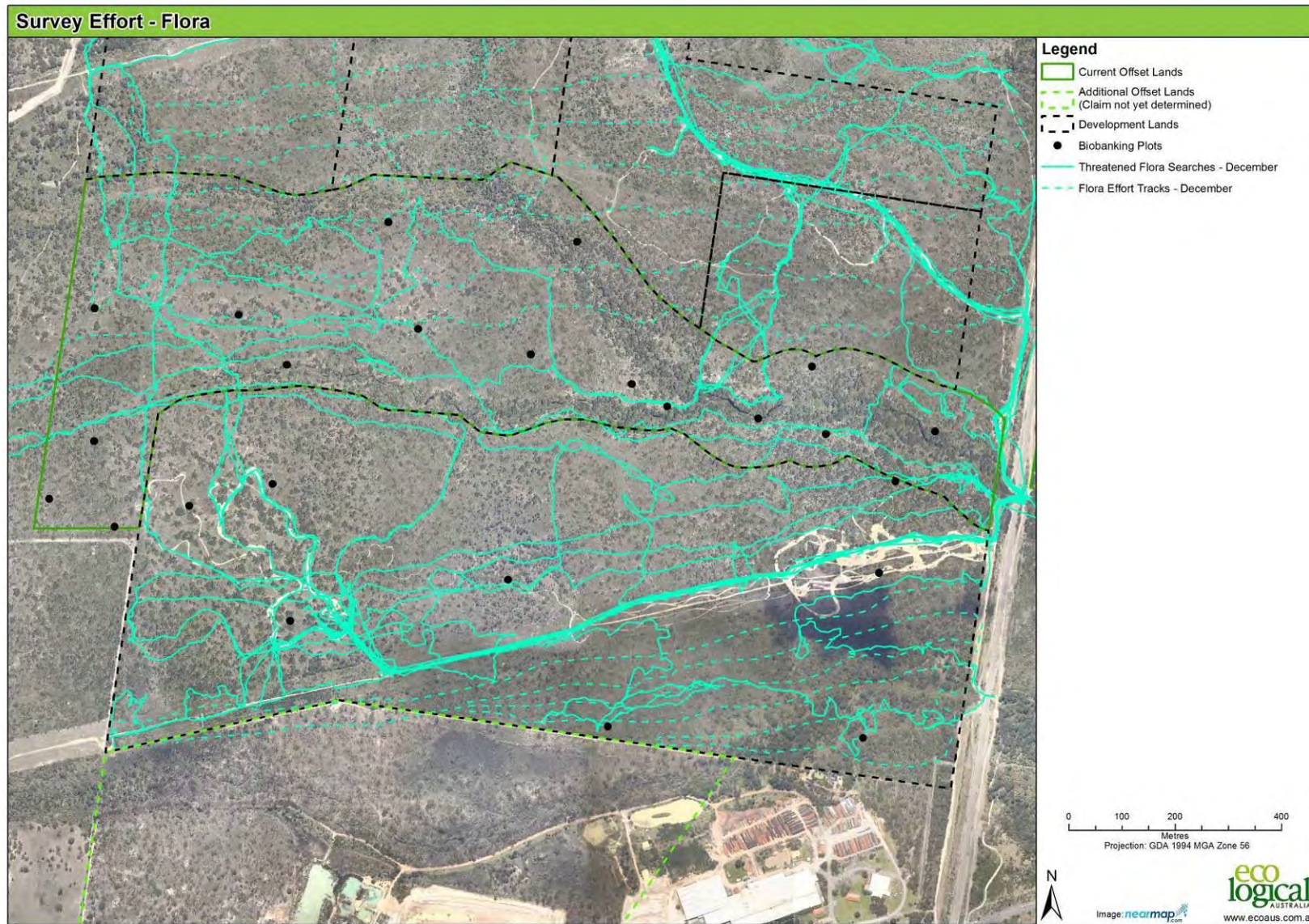


Figure 14: Flora survey effort proposed offset lands 5

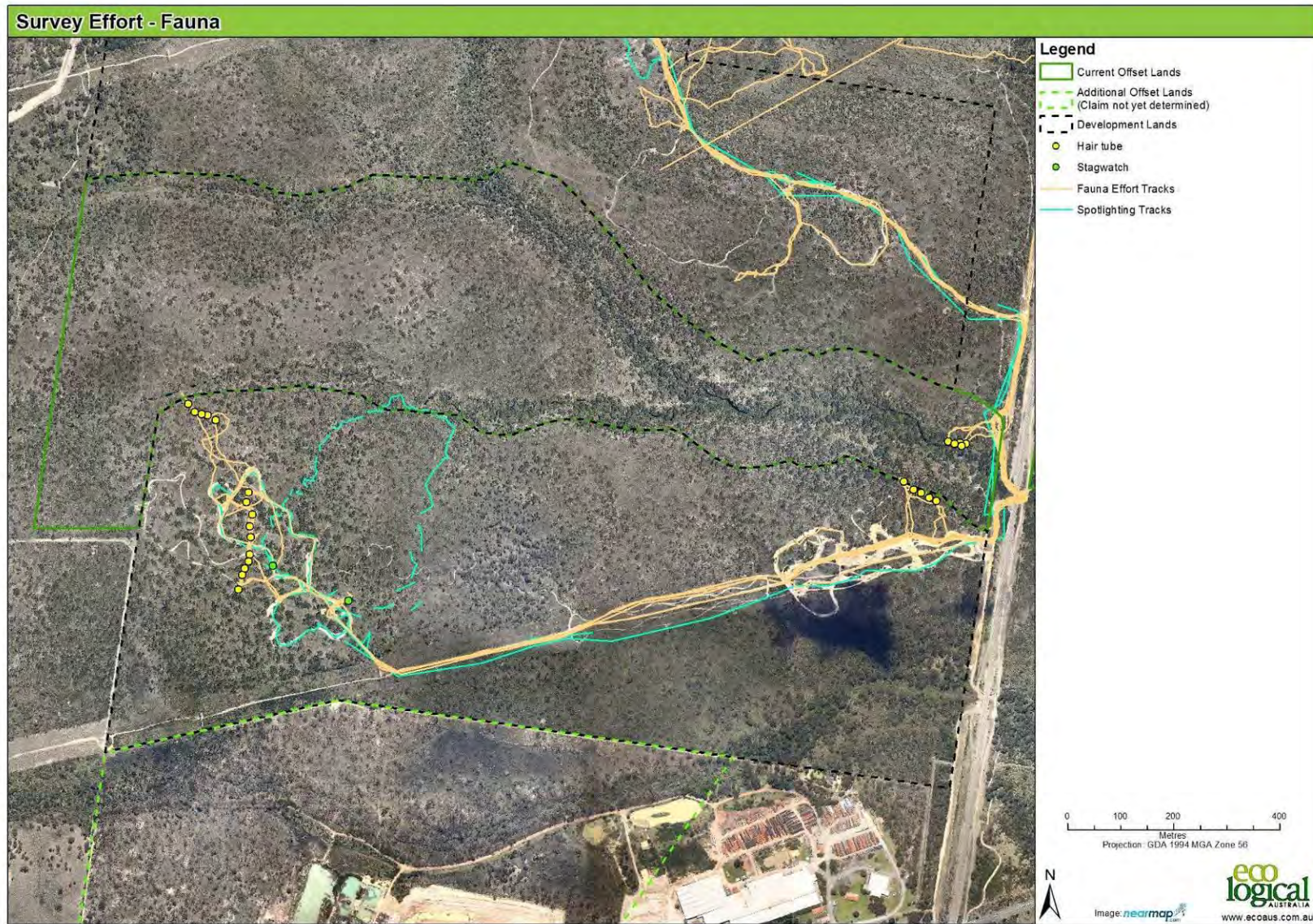


Figure 15: Fauna survey effort proposed offset lands 5

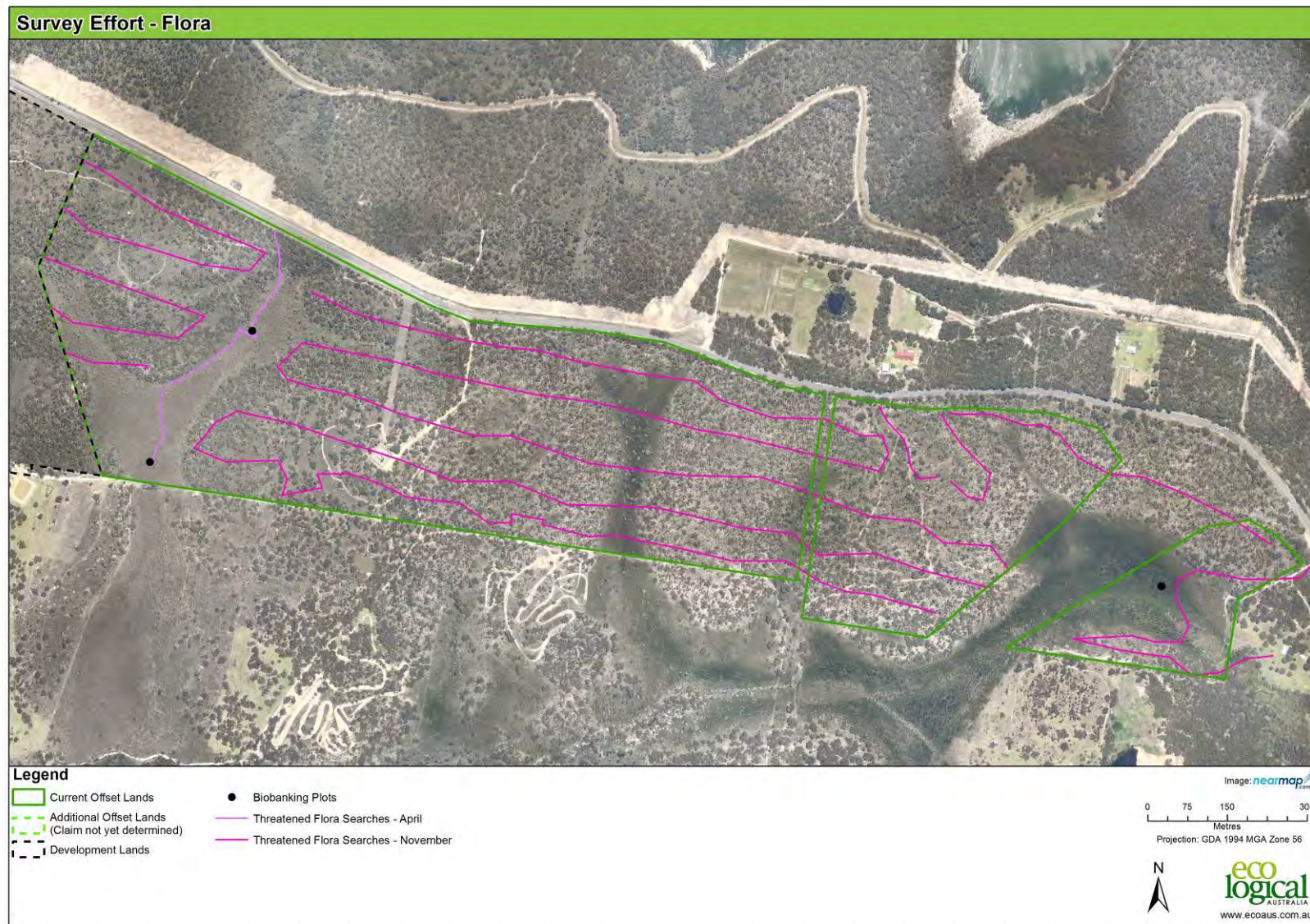


Figure 16: Flora survey effort proposed offset lands 7



Figure 17: Flora survey effort proposed offset lands 2



Figure 18: Fauna survey effort proposed offset lands 2

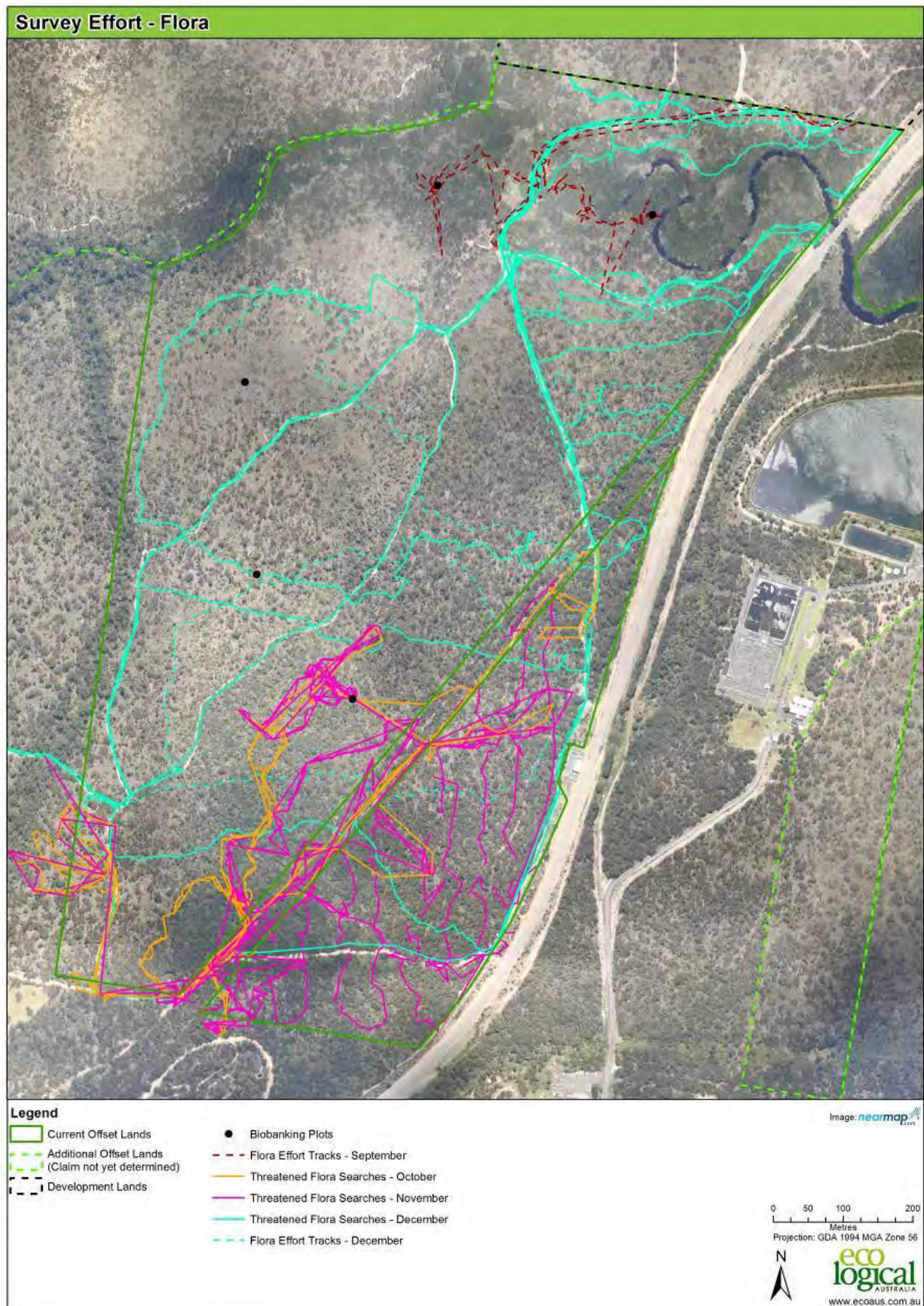


Figure 19: Flora survey effort proposed offset lands 3



Figure 20: Fauna survey effort proposed offset lands 3



Figure 21: Flora survey effort proposed offset lands 6

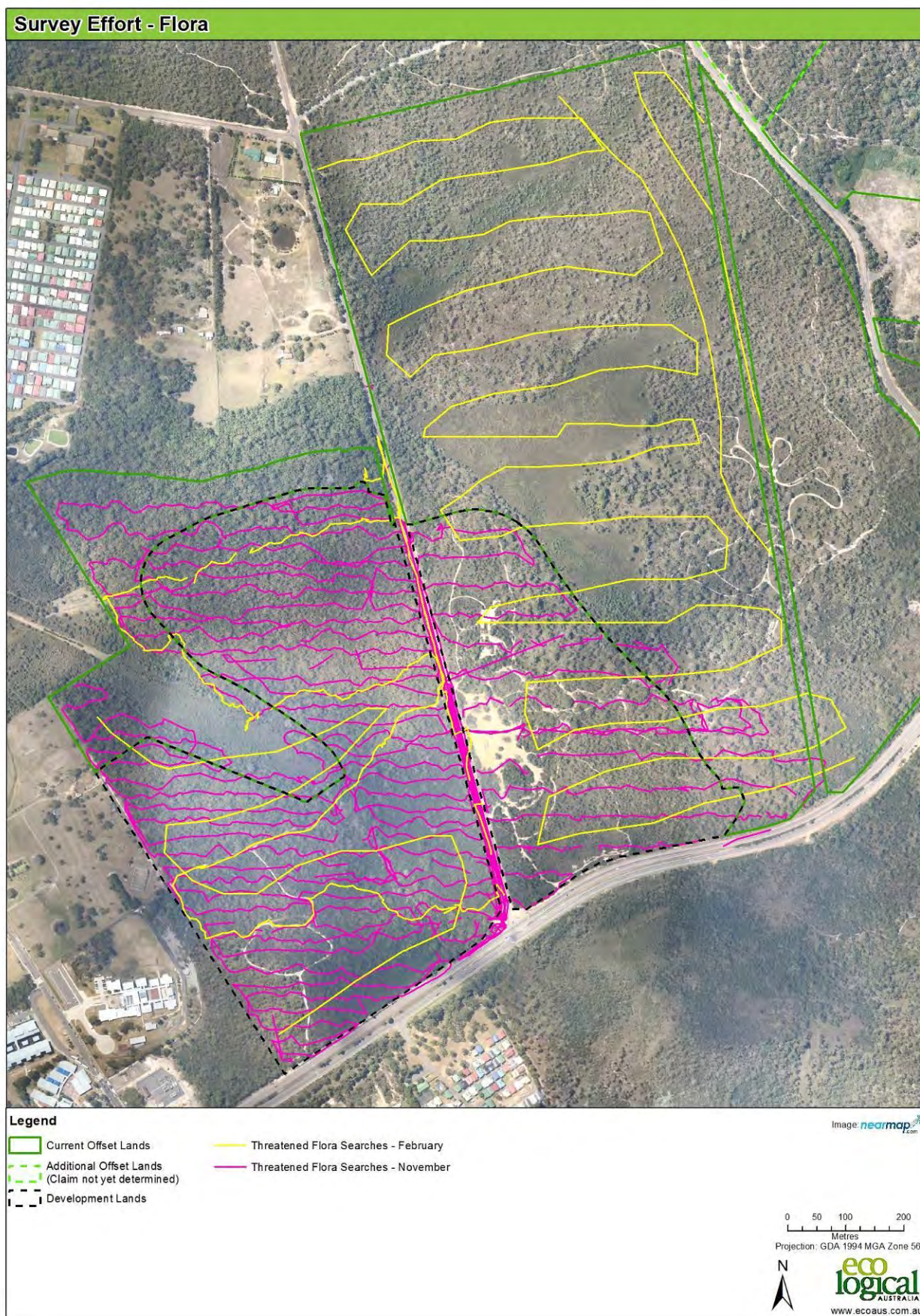


Figure 22: Flora survey effort proposed offset lands 8 & 9

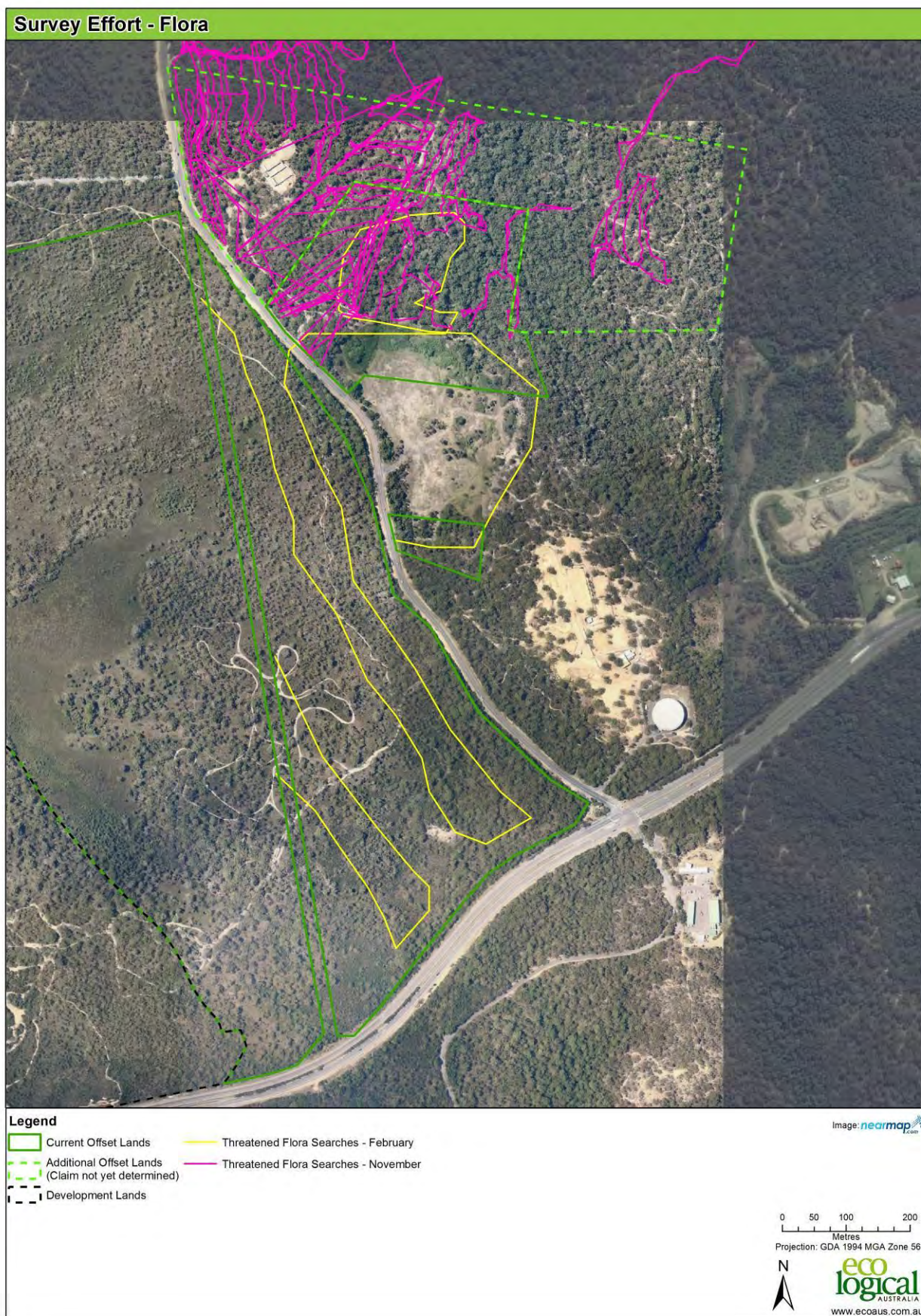


Figure 23: Flora survey effort proposed offset lands 10



Figure 24: Flora survey effort proposed offset lands 11 & 12



Figure 25: Flora survey effort proposed offset lands 13



Figure 26: Flora survey effort Norah Head proposed development precinct



Figure 27: Fauna survey effort Norah Head proposed development precinct

3 Results

Nineteen (19) Biometric Vegetation Types have been mapped across the DLALC North Wyong Land holdings. The area of each vegetation type and status (Red Flag) for each of the proposed development precincts and conservation lands was then calculated and is shown in **Table 6**.

Ten threatened flora species have been recorded across the land holdings, four within the proposed development precincts. Two of these 4 species are „Red Flags“ (**Table 4**).

Of the 29 threatened fauna species requiring targeted survey (excluding those marine/intertidal species) only two (Wallum Froglet and possible Eastern Chestnut Mouse) have been recorded to date (**Table 5**). However, there are a number of hollow roosting microchiropteran bats species that may be recorded and it is likely that one or more of the threatened reptile and amphibian species may also be recorded following additional survey in suitable weather conditions. Several of the species predicted by the biocertification assessment tool are unlikely to occur in the DLALC lands (Broad-headed Snake, Brush-tailed Rock-wallaby, Red-crowned Toadlet).

Table 4: Threatened flora species recorded within the investigation area.

Species	Status	Red Flag	Negligible loss	Recorded within proposed development areas	Number in proposed development lands#	Numbers in proposed offset lands
<i>Acacia bynoeana</i>	V	Yes		Yes	27	
<i>Angophora inopina</i>	V	No		Yes	19,115	13,962
<i>Caladenia porphyrea</i>	E	Yes		Yes	35	17
<i>Callistemon linearifolius</i>	V	Yes	Up to 5	No		8
<i>Cryptostylis hunteriana</i>	V	Yes	Up to 2	Yes	1	
<i>Eucalyptus camfieldii</i>	V	Yes		No		3
<i>Eucalyptus parramattensis</i>	V	Yes	Up to 5	No		440
<i>Grevillea parviflora</i>	V	Yes		No		138
<i>Maundia triglochmoides</i>	V	Yes		No		75
<i>Tetratheca juncea</i>	V	No		Yes	203	2,065

Boundaries of development precincts still to be finalised.

Table 5: Threatened fauna species recorded within the investigation area.

Species recorded in development precincts to data are in **bold**.

Scientific name	Common Name	Likelihood of occurrence
<i>Botaurus poiciloptilus</i>	Australian Bittern	No, no suitable habitat in proposed development precincts
<i>Callocephalon fimbriatum</i> (Breeding)	Gang Gang Cockatoo	Potentially
<i>Chalinolobus dwyeri</i> (Breeding)	Large-eared Pied Bat	Potentially
<i>Crinia tinnula</i>	Wallum Froglet	Yes
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	No, no suitable habitat in proposed development precincts
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	Potentially
<i>Hieraaetus morphnoides</i>	Little Eagle	Potentially
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	Potentially
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	Unlikely, no records in area
<i>Irediparra gallinacea</i>	Comb-crested Jacana	No, no suitable habitat in proposed development precincts
<i>Ixobrychus flavicollis</i>	Black Bittern	No, no suitable habitat in proposed development precincts
<i>Litoria aurea</i>	Green and Golden Bell Frog	Unlikely, no records in area
<i>Litoria brevipalmata</i>	Green-thighed Frog	Potentially
<i>Litoria littlejohni</i>	Littlejohn's Frog	Potentially
<i>Lophoictinia isura</i>	Square-tailed Kite	Potentially
<i>Miniopterus australis</i> (Breeding)	Little Bentwing-bat	Potentially
<i>Miniopterus schreibersii oceanensis</i> (Breeding)	Eastern Bentwing-bat	Potentially
<i>Mixophyes iteratus</i>	Giant Barred Frog	Potentially
<i>Myotis macropus</i> (formally <i>Myotis adversus</i>) (Breeding)	Large-footed Myotis	Potentially
<i>Nettapus coromandelianus</i>	Cotton Pygmy-Goose	No, no suitable habitat in proposed development precincts
<i>Pandion haliaetus</i>	Osprey	Potentially
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Unlikely, no records from area
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Potentially
<i>Planigale maculata</i>	Common Planigale	Potentially
<i>Pseudomys gracilicaudatus</i>	Eastern Chestnut Mouse	Hair record to be confirmed
<i>Pseudophryne australis</i>	Red-crowned Toadlet	Unlikely given location
<i>Pteropus poliocephalus</i> (Breeding)	Grey-headed Flying Fox	No known camps
<i>Varanus rosenbergi</i>	Rosenberg's Goanna	Potentially
<i>Vespadelus troughtoni</i> (Breeding)	Eastern Cave Bat	No caves

Table 6: Area and status of each vegetation type in proposed development and conservation area

Proposed development lands

Biometric Vegetation Community	BCAM Red Flag (EEC or >70% Cleared)	PROPOSED DEVELOPMENT SITES										
		Bushells Ridge North (DP&I)	Bushells Ridge North	Bushells Ridge South	Railcorp	Norah Head	Halekulani	Bushells Ridge East	Munmorah	Canton Beach	Lakes Beach	Total
Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin and South East Corner											2.06	2.06
Banksia dry shrubland on coastal sands of the North Coast						12.69				0.40		13.09
Blackbutt - Smooth-barked Apple shrubby open forest on coastal sands of the southern North Coast					0.07							0.07
Coastal floodplain sedgeland, rushlands, and forblands of the North Coast									0.63			0.63
Fern-leaved Banksia - Melaleuca sieberi wallum heath on coastal sands, southern North Coast and northern Sydney Basin						0.46						0.46
Forest Red Gum - Rough-barked Apple open forest on poorly drained lowlands of the Central Coast, Sydney Basin	Yes						0.39					0.39
Melaleuca nodosa closed shrubland on alluvium of the Central Coast, Sydney Basin						0.18						0.18
Melaleuca sieberi - Tall Saw-sedge closed shrubland in drainage lines on the Central Coast, Sydney Basin	Yes	0.23	1.19	0.26	1.44			2.16	0.08			5.38
Paperbark heath on indurated sands at Norah Head on the Central Coast, Sydney Basin	Yes					0.58						0.58
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin	Yes					1.80				1.44	1.03	4.26

Biometric Vegetation Community	BCAM Red Flag (EEC or >70% Cleared)	PROPOSED DEVELOPMENT SITES										
		Bushells Ridge North (DP&I)	Bushells Ridge North	Bushells Ridge South	Railcorp	Norah Head	Halekulani	Bushells Ridge East	Munmorah	Canton Beach	Lakes Beach	Total
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin		40.95	56.35	76.41	42.12	0.54	12.84	41.09	57.15			327.46
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin				11.87		4.01				0.01	1.56	17.46
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin												0.00
Sydney Peppermint - Smooth- barked Apple shrubby open forest on coastal hills and plains of the southern North Coast and northern Sydney Basin										0.99		0.99
Cleared/planted vegetation							0.03			0.20	0.12	0.35
Total		41.19	57.54	88.55	43.63	20.25	13.25	43.26	57.86	3.05	4.77	373.34

Proposed Conservation lands (# Wyong LGA Veg mapping yet to be validated for some parcels).

Biometric Vegetation Community	CURRENT OFFSET LANDS																	ADDITIONAL OFFSET LANDS (Claims yet to be determined)															Total Possible Offset lands
	Total DLALC land	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	18	1a	2a	2b	3a	4a#	10a#	14a#	14b	15a#	15b#	15c#	17a#	20a#	Total Claims		
Banksia dry shrubland on coastal sands of the North Coast	32.40														31.98		0.42														0.00	32.40	
Blackbutt - Smooth-barked Apple shrubby open forest on coastal sands of the southern North Coast	33.16	1.76		16.49	14.90															1.67	9.66				19.38						30.71	63.87	
Broad-leaved Paperbark - Wallum Bottlebrush - sedge wet heath on sand, southern North Coast and northern Sydney Basin	0.00																									12.49					12.49	12.49	
Coast Banksia - Coast Wattle dune scrub, Sydney Basin and South East Corner	75.93											39.29	4.51		25.75	6.39								13.17							13.17	89.10	
Coastal floodplain sedgeland, rushland, and forblands of the North Coast	3.66								3.66																						0.00	3.66	
Coastal freshwater lagoons of the Sydney Basin and South East Corner	1.43														1.43										0.96						0.96	2.40	
Melaleuca nodosa closed shrubland on alluvium of the Central Coast, Sydney Basin	31.85	2.83			29.02																										0.00	31.85	
Melaleuca sieberi - Tall Saw-sedge closed shrubland in drainage lines on the Central Coast, Sydney Basin	36.41		0.35	0.72	0.37	1.81	1.98	15.22		15.85	0.12								0.51	1.25	2.12	0.03									3.91	40.32	
Paperbark heath on indurated sands at Norah Head on the Central Coast, Sydney Basin	3.44														3.44																0.00	3.44	

Biometric Vegetation Community	CURRENT OFFSET LANDS																		ADDITIONAL OFFSET LANDS (Claims yet to be determined)															Total Possible Offset lands
	Total DLALC land	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	18	1a	2a	2b	3a	4a#	10a#	14a#	14b	15a#	15b#	15c#	17a#	20a#	Total Claims			
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin	14.60													7.82	6.29	0.20	0.29					6.78	7.16		2.41	49.95	50.66	0.68		33.88	151.53	166.13		
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin	0.00																							2.67						2.67	2.67			
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	396.37	11.82	38.59	74.85	28.94	62.10	15.42	73.48	10.03	46.96	34.00				0.19				9.54	23.60	32.75		7.29						28.05	101.23	497.61			
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	82.78	53.20			1.40	0.65								1.82	25.32		0.39	5.76	0.08		4.39									10.23	93.00			
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	0.77	0.77																				6.60			1.80				4.59	12.99	13.76			
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	1.39										1.39																		5.73	5.73	7.12			
Sydney Peppermint - Smooth-barked Apple shrubby open forest on coastal hills and plains of the southern North Coast and northern Sydney Basin	0.86																0.86						4.12					7.20		11.32	12.19			
Tuckeroo - Yellow Tulipwood Littoral Rainforest	0.08															0.08					6.81	21.04	17.29		64.24	50.66	0.68	7.20	38.48	206.40	206.48			
TBC	0.00																												7.34	7.34	7.34			
Bitou Bush	4.23														3.53	0.71														0.00	4.23			
Cleared/planted vegetation	0.47																0.47												0.33	0.33	0.80			
Grand Total	719.85	70.38	38.94	92.07	74.64	64.55	17.40	88.70	13.69	62.80	35.51	39.29	4.51	9.64	97.93	7.38	2.43	5.76	10.12	26.53	48.92	13.62	42.09	34.59	25.42	128.48	101.32	1.36	14.40	118.41	571.01	1,290.86		

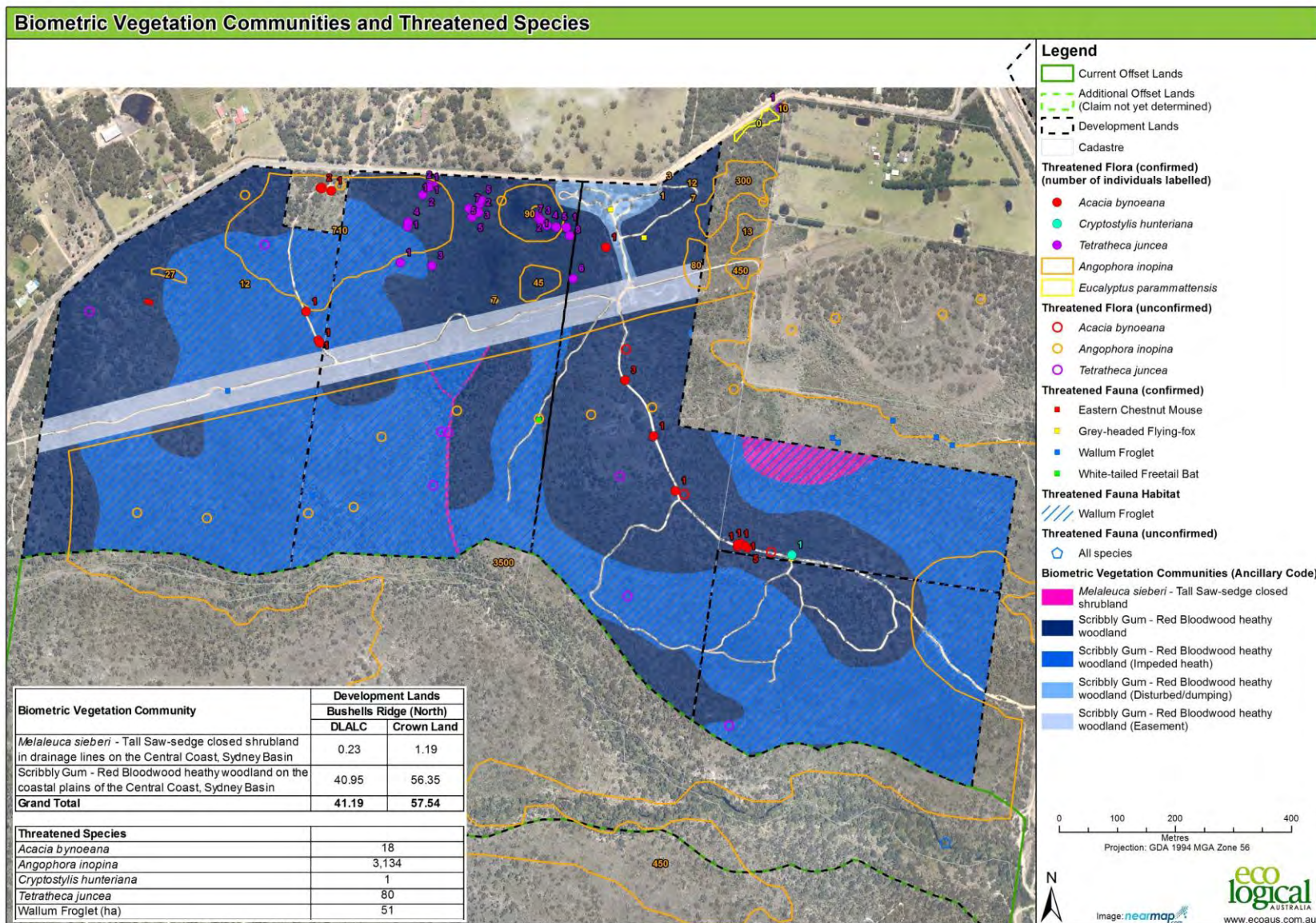


Figure 28: Validated Vegetation mapping and threatened species records – Bushells Ridge North

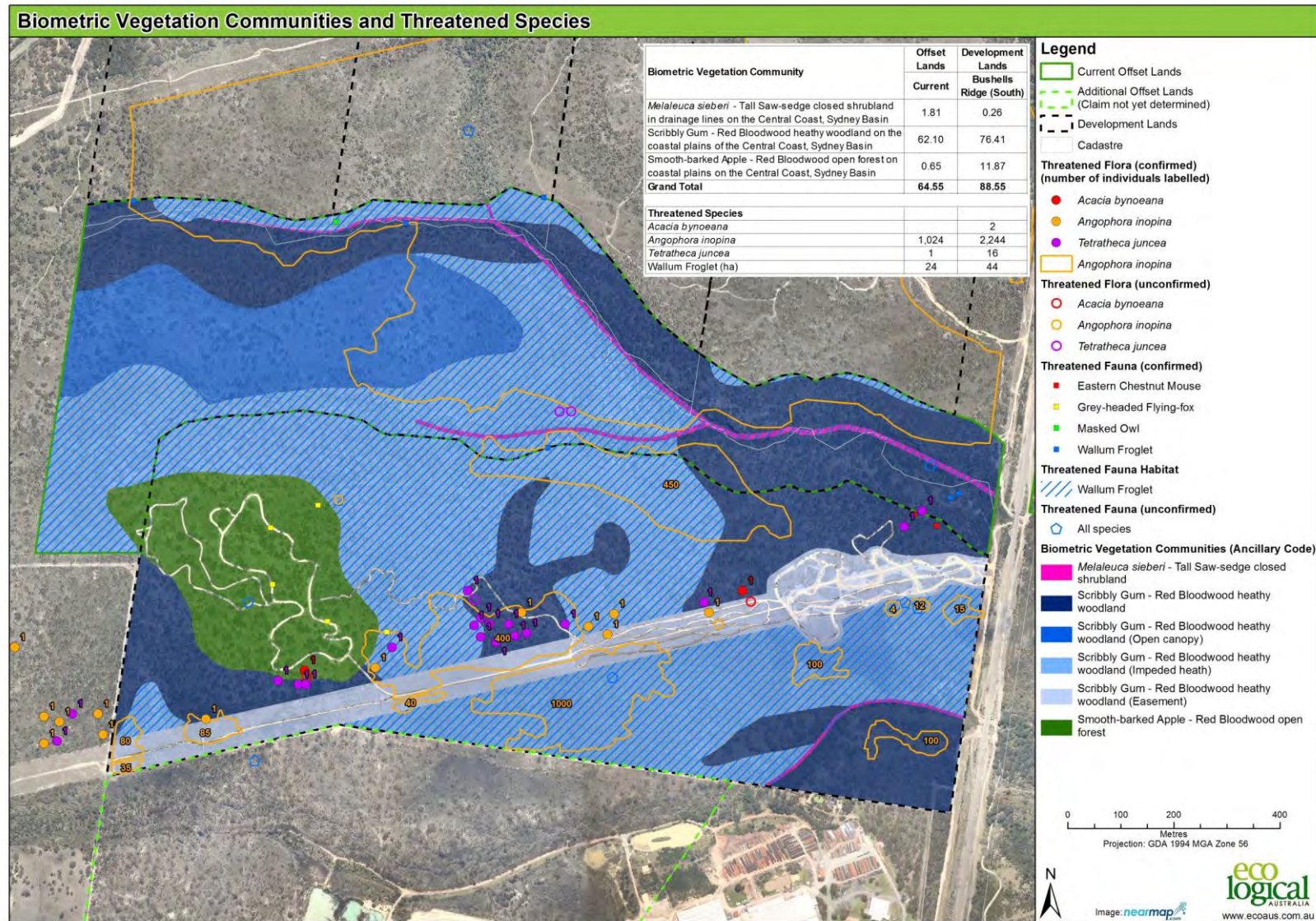


Figure 29: Validated Vegetation mapping and threatened species records – Bushells Ridge South

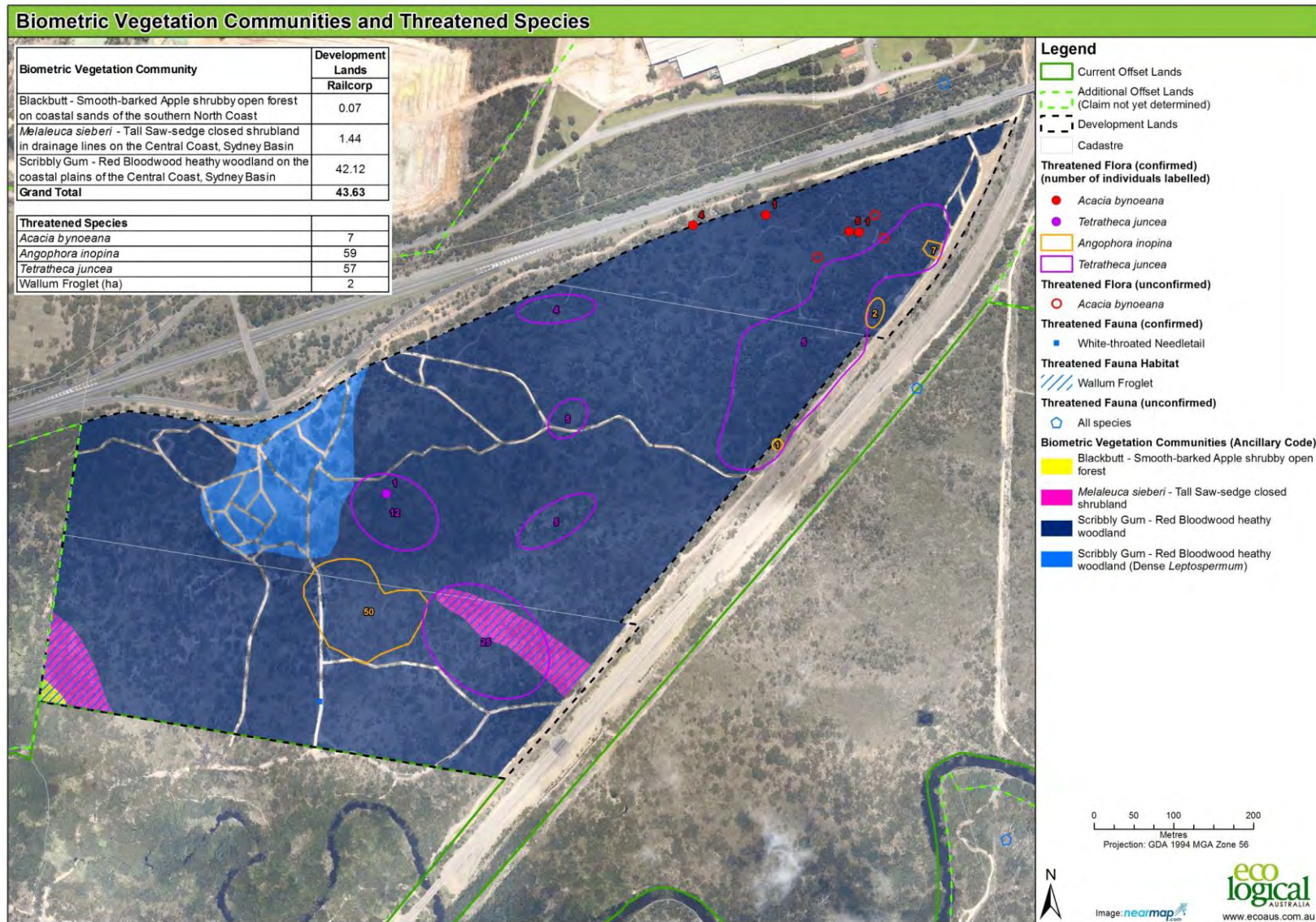


Figure 30: Validated Vegetation mapping and threatened species records – Railcorp

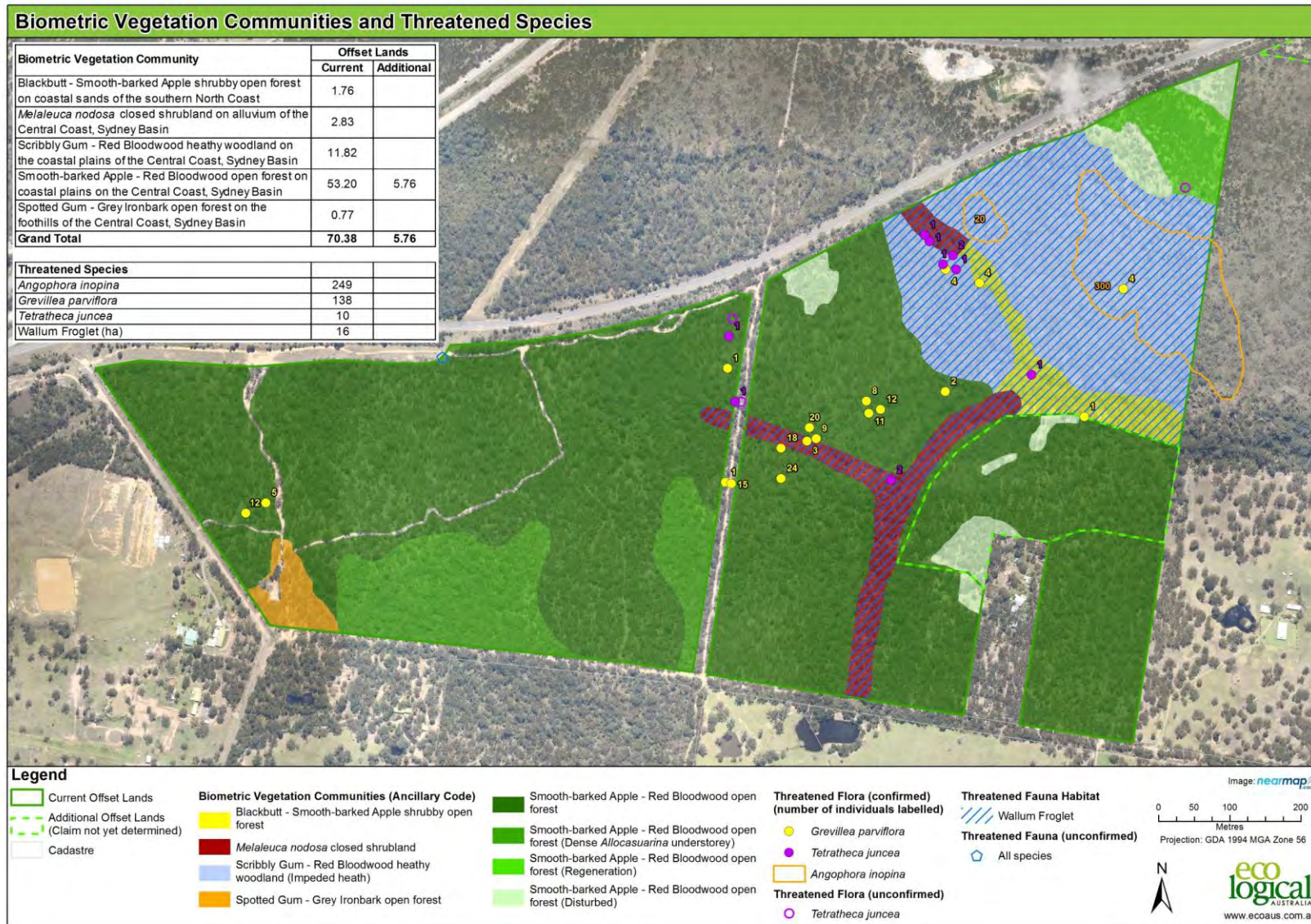


Figure 31: Validated Vegetation mapping and threatened species records – Offset lands 1

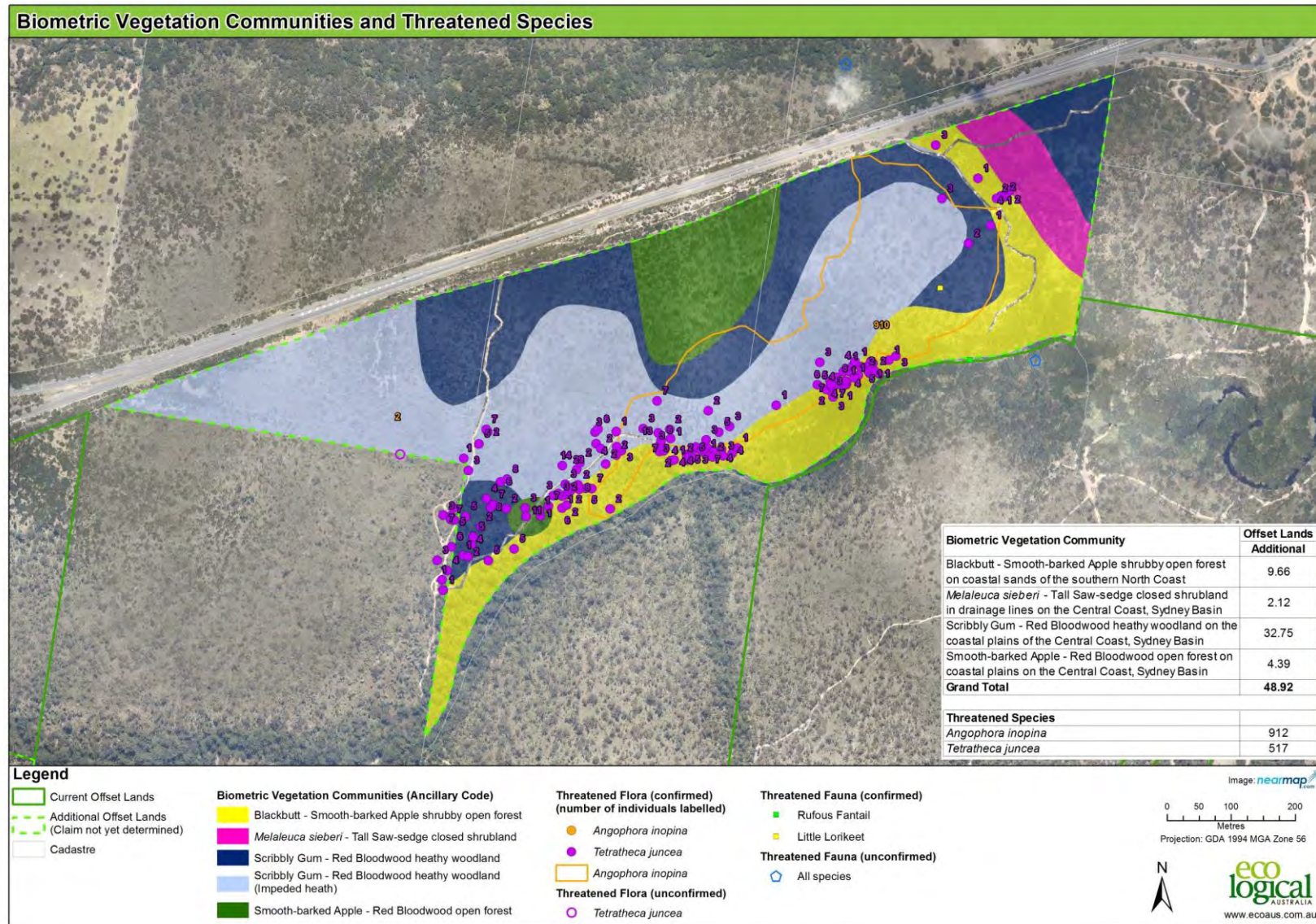


Figure 32: Validated Vegetation mapping and threatened species records – Offset lands 3a

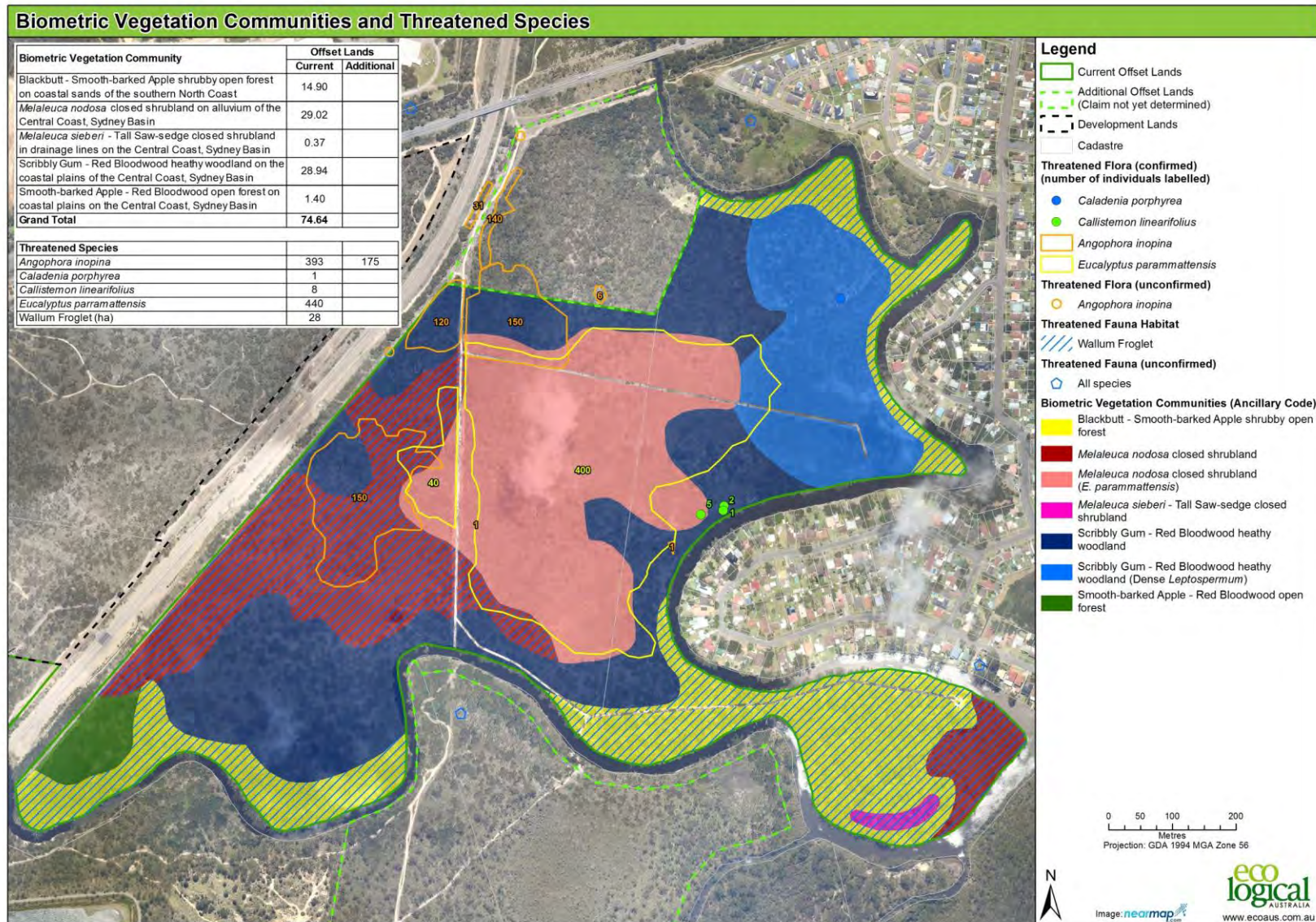


Figure 33: Validated Vegetation mapping and threatened species records – Offset lands 4

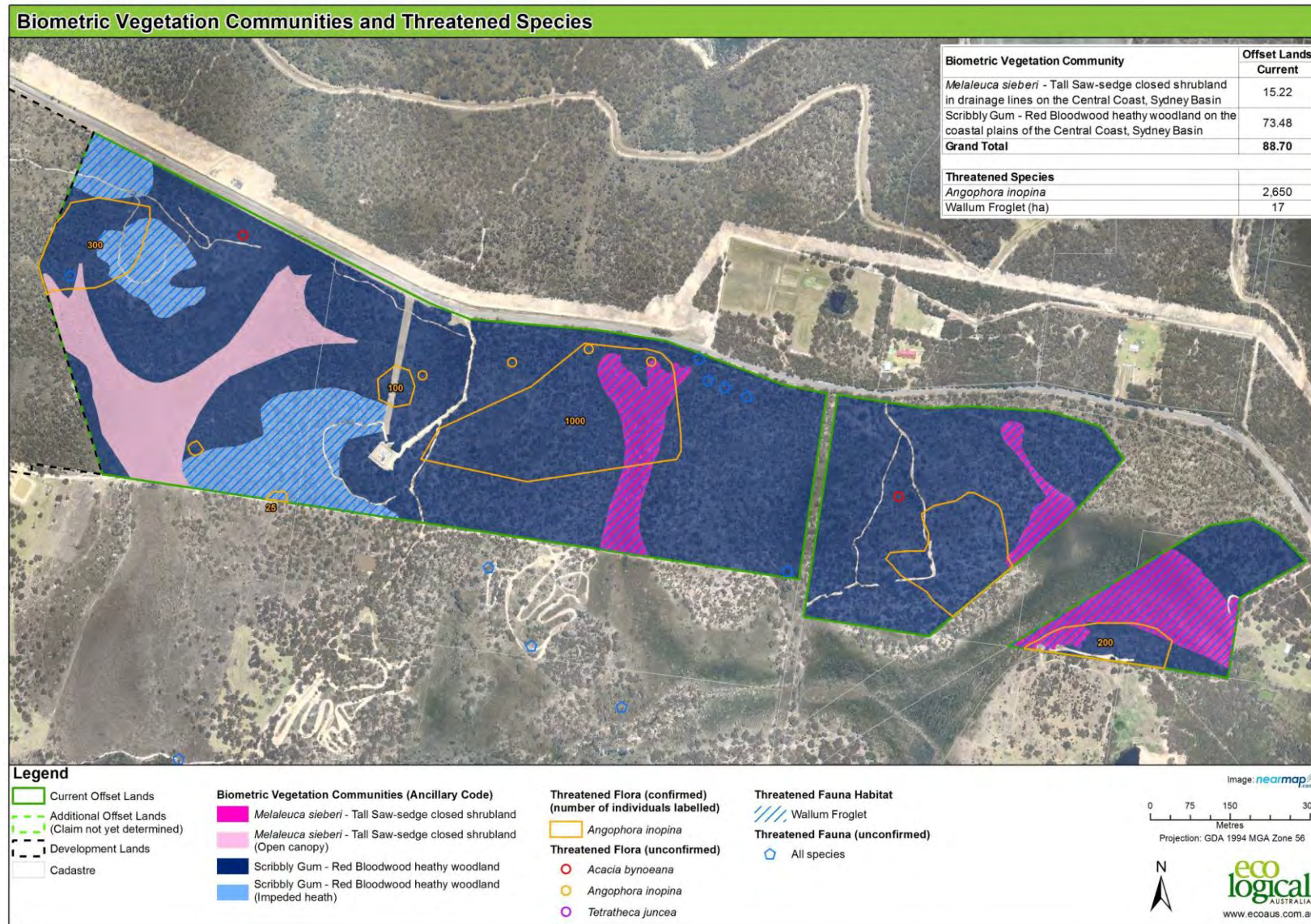


Figure 34: Validated Vegetation mapping and threatened species records – Offset lands 7

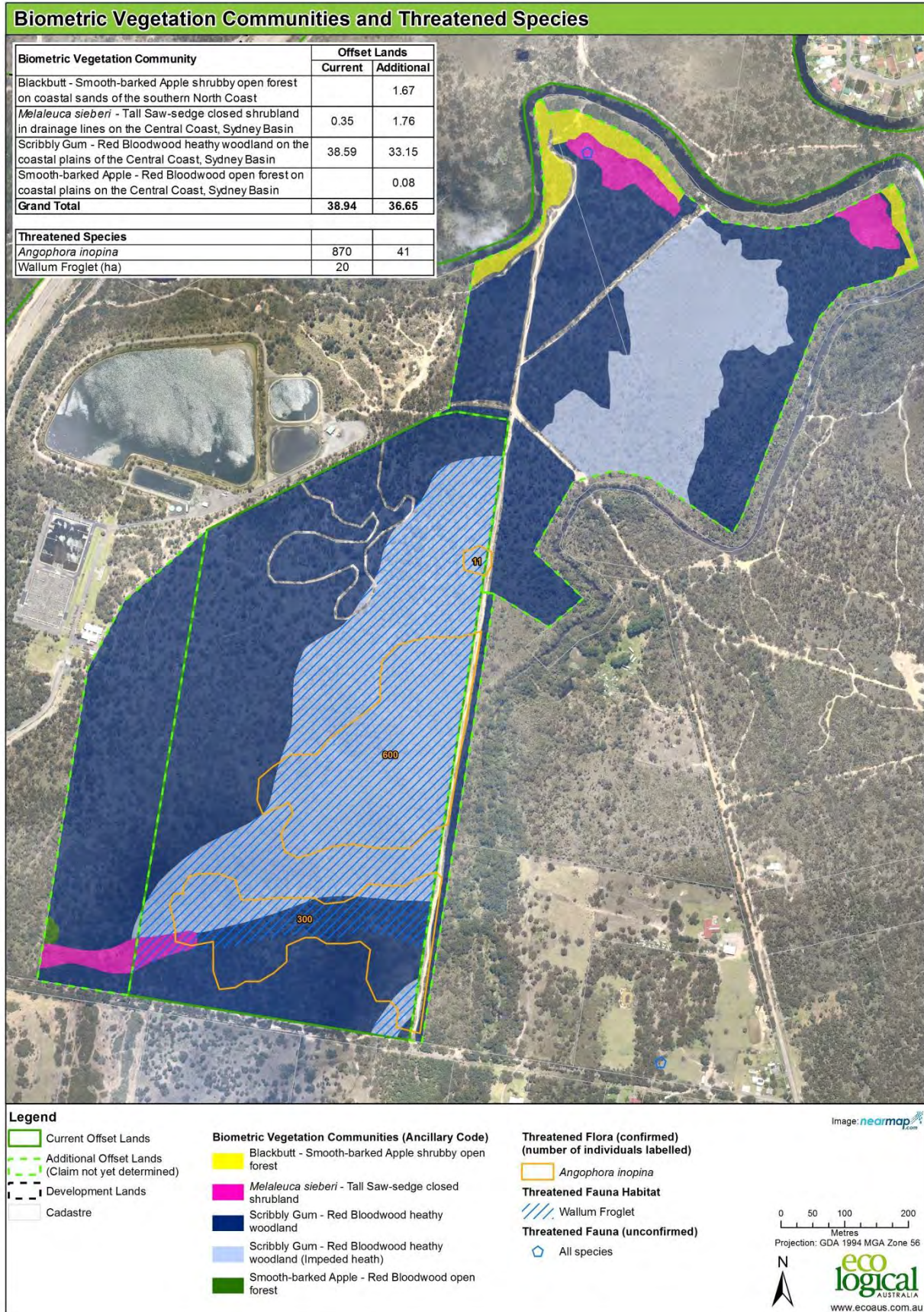


Figure 35: Validated Vegetation mapping and threatened species records – Offset lands 2

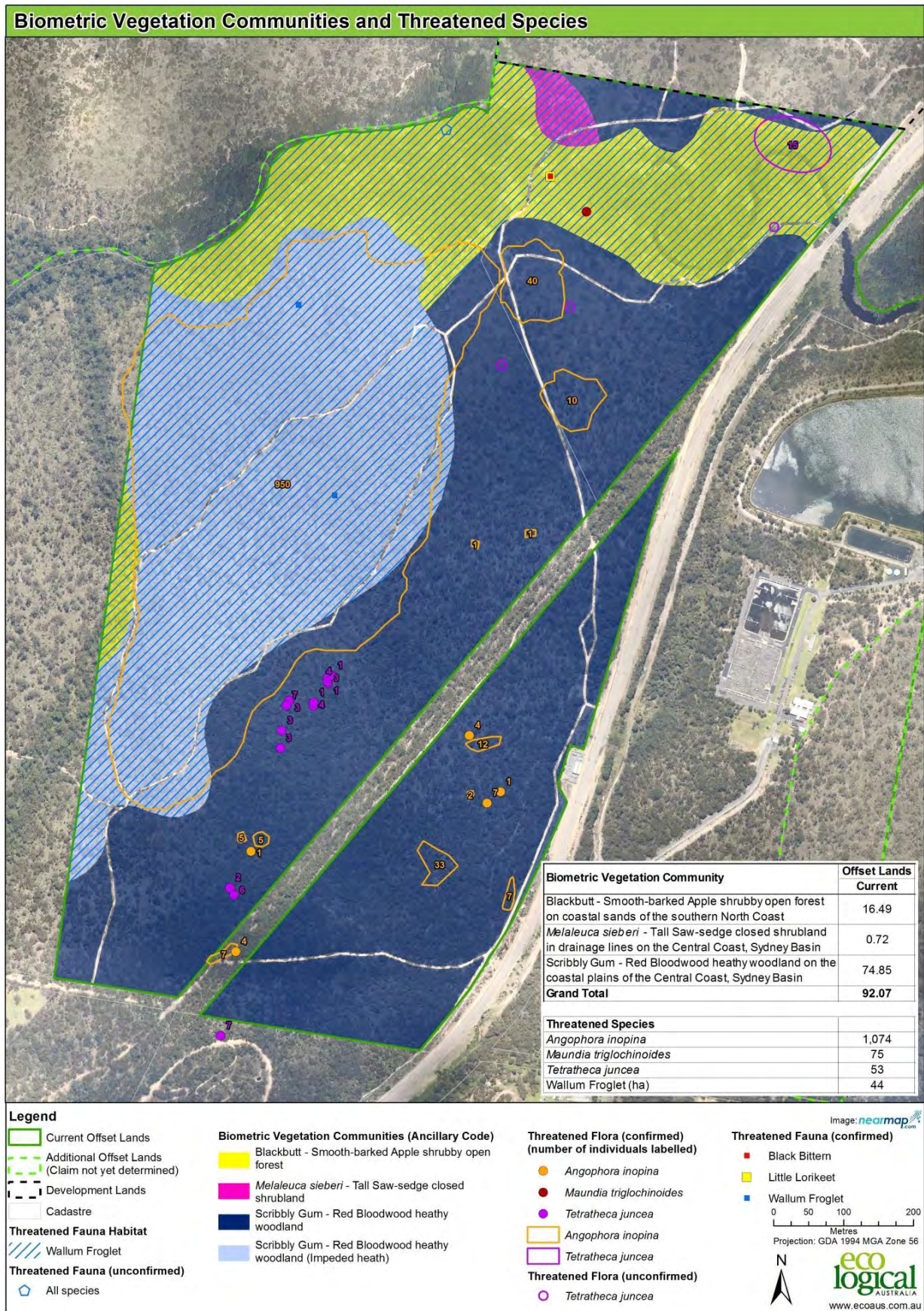


Figure 36: Validated Vegetation mapping and threatened species records – Offset lands 3

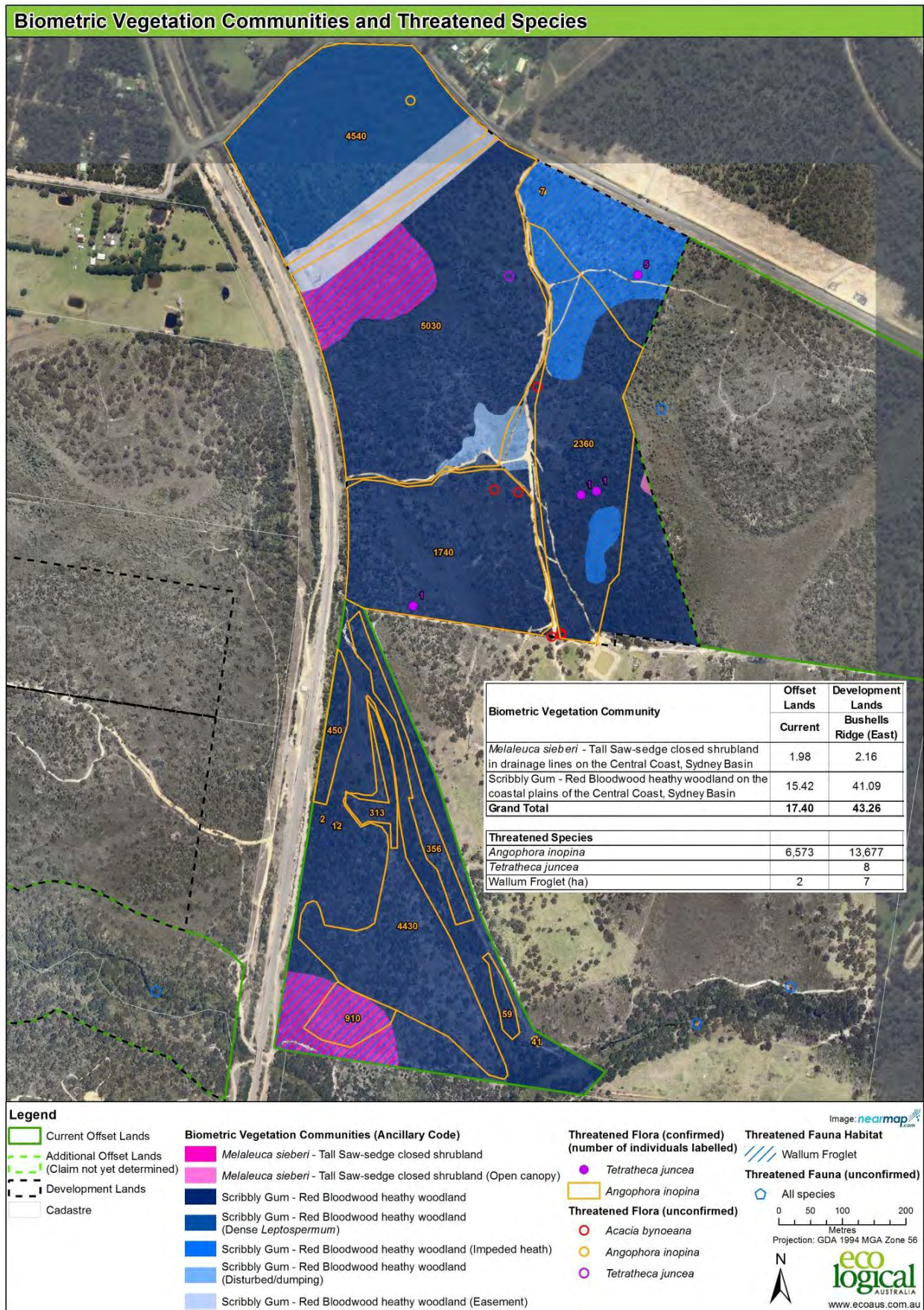


Figure 37: Validated Vegetation mapping and threatened species records – Offset lands 6

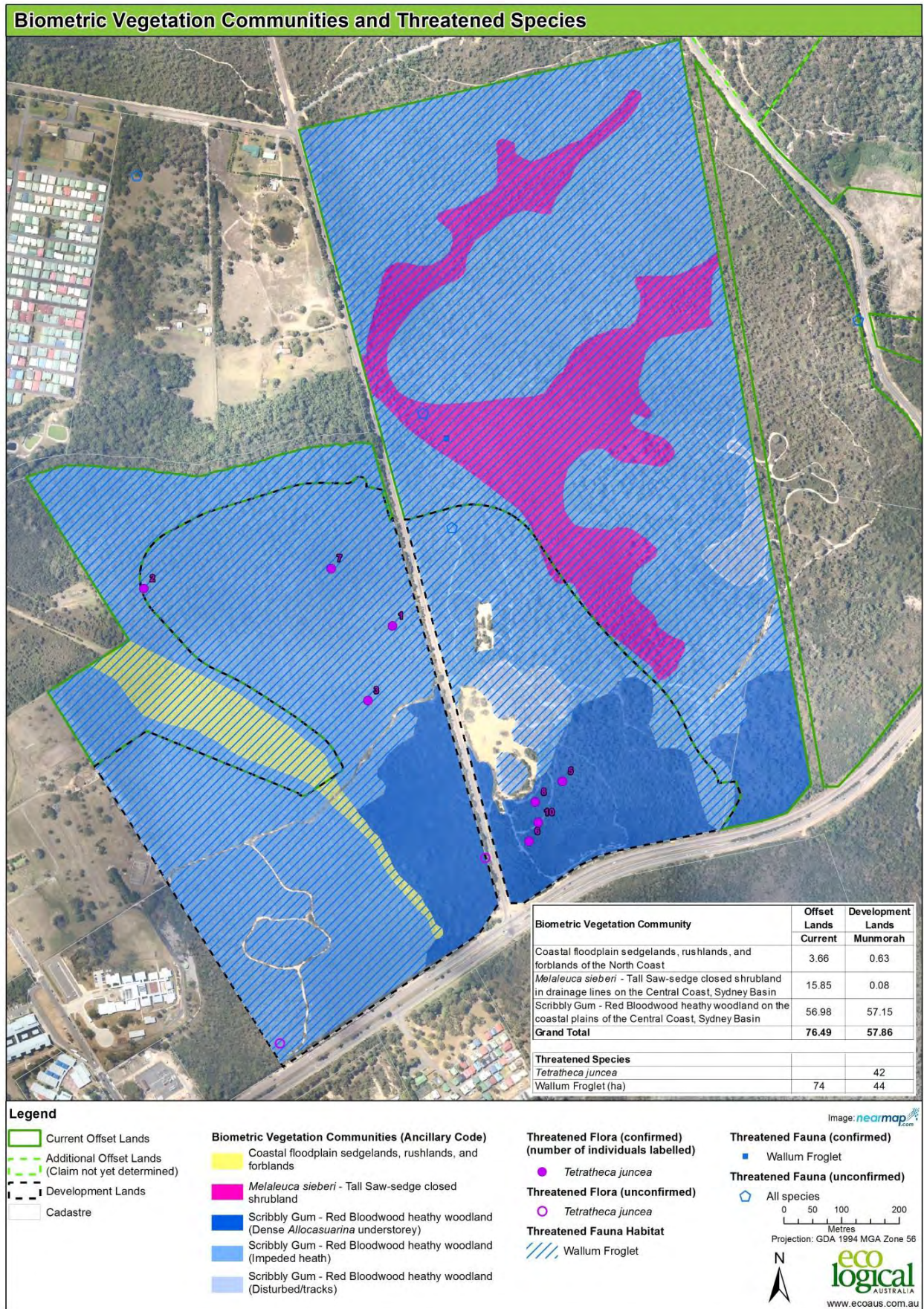


Figure 38: Validated Vegetation mapping and threatened species records – Offset lands 8 & 9

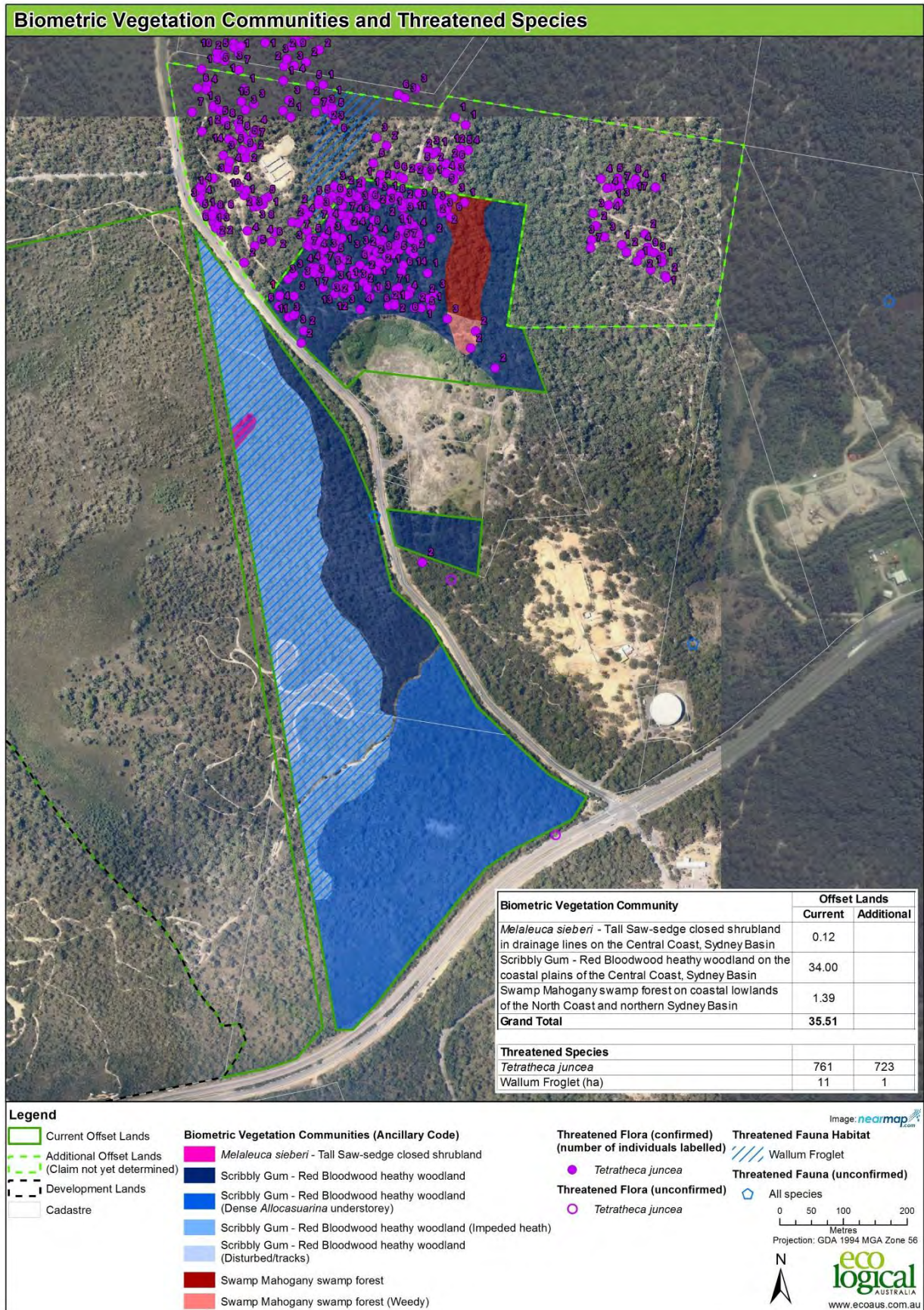


Figure 39: Validated Vegetation mapping and threatened species records – Offset lands 10



Figure 40: Validated Vegetation mapping and threatened species records – Offset lands 11 & 12

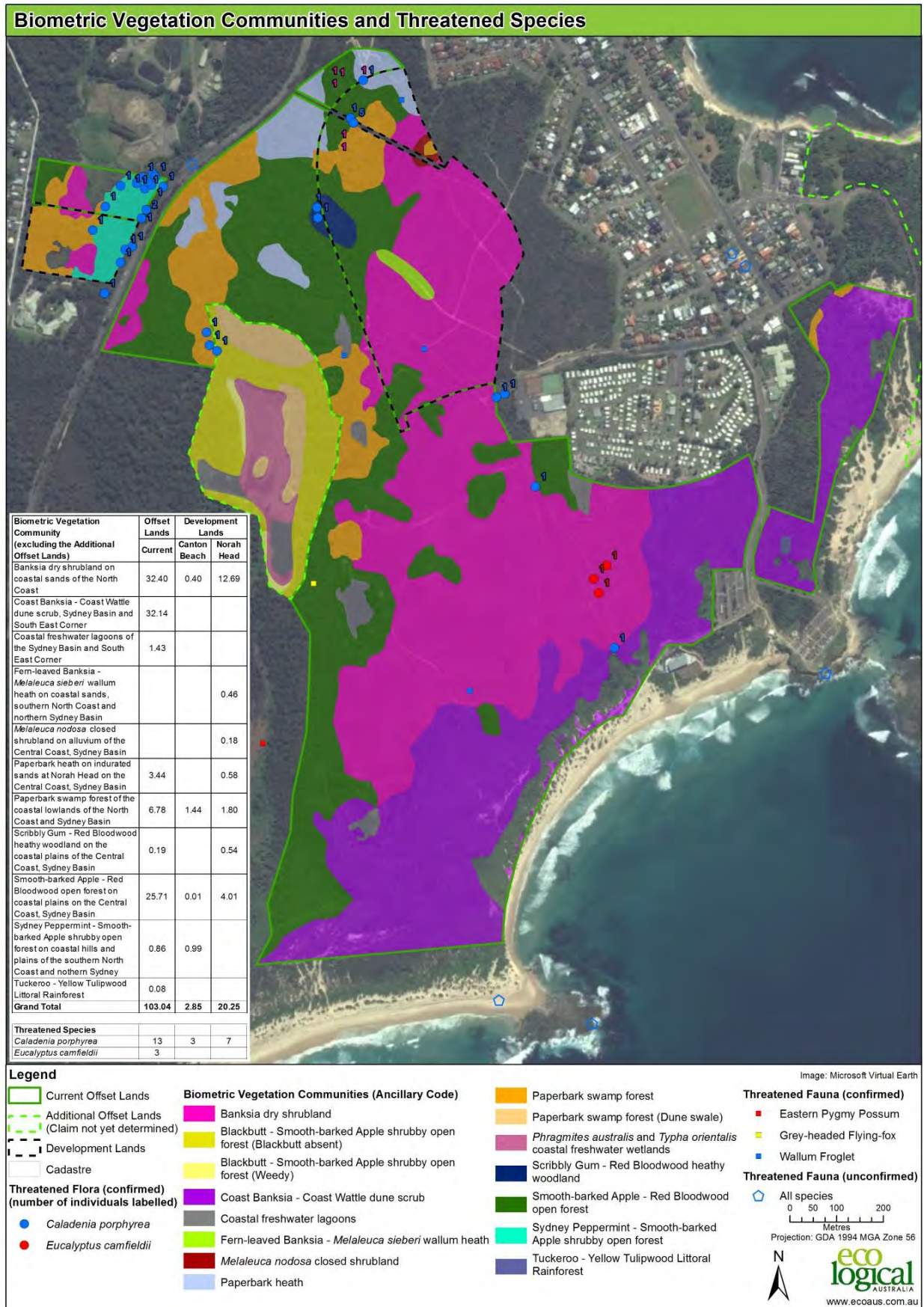


Figure 41: Validated Vegetation mapping and threatened species records – Norah Head and offset lands

4 References

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