05

Studies (Part 3)

Travers

bushfire & ecology

Ecological constraints assessment

15 Mulloway Road
Chain Valley Bay
Lot 273 DP 755266

November 2016
(REF: A16015F)

Ecological Constraints Assessment

15 Mulloway Road, Chain Valley Bay
Lot 273 DP 755266

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The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

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Executive Summary

This Ecological Constraints Assessment report has been prepared by *Travers bushfire & ecology* to identify the potential ecological constraints for the purposes of a planning proposal at Lot 273 DP 755266 at 15 Mulloway Road, Chain Valley Bay.

The entire area of this lot will hereafter be referred to as the 'study area'. In some circumstances survey has however extended slightly beyond this boundary for consideration of indirect impact on surrounding habitats.

Proposed zonings

The current zoning of the site in accordance with Wyong LEP 2013 is E3 Environmental Management in the central and northern portions of Lot 273 making up approximately 80% of the study area and the remaining southern extent is E2 Environmental Conservation (see Figure 2). The proponent seeks to rezone all or most of the E3 lands to R2 low density residential development. The residual land will remain E2.

Recorded threatened flora, fauna & EECs

Ecological survey and assessment has been undertaken in accordance with relevant legislation including the *Environmental Planning and Assessment Act 1979*, the *Threatened Species Conservation Act 1995*, the *Environment Protection and Biodiversity Conservation Act 1999* and the *Fisheries Management Act 1994*.

In respect of matters required to be considered under the *Environmental Planning and Assessment Act 1979* and relating to the species / provisions of the *Threatened Species Conservation Act 1995*, six (6) threatened fauna species including Wallum Froglet (*Crinia tinnula*), Squirrel Glider (*Petaurus norfolcensis*), Large-footed Myotis (*Myotis macropus*), East-coast Freetail Bat (*Micronomus norfolkensis*), Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*Miniopterus orianae oceansis*), no threatened flora species, no endangered populations and one (1) EEC, Swamp Sclerophyll Forest on Coastal Floodplains were recorded within the study area.

The Endangered Wetland Community - Swamp sclerophyll forest on coastal floodplains has been recorded onsite and hence attracts a protective buffer of 40m in accordance with the NSW DPI - Office of Water Guidelines for Controlled Activities. A wetland assessment report is required to be submitted to NSW DPI for assessment under the Water Management Act 2000 as a controlled activity.

The Squirrel Glider was only recorded by call to a 'possible' level of certainty.

In respect of matters required to be considered under the *Environment Protection and Biodiversity Conservation Act 1999*, no threatened fauna species, one protected migratory bird species White-bellied Sea Eagle (*Haliaeetus leucogaster*), no threatened flora species, and no EECs listed under this Act were recorded within the study area.

In respect of matters relative to the *FM Act,* no threatened or protected species records on the DPI records viewer are known to the Wyong or Lake Macquarie LGA's. Therefore no suitable habitat for threatened aquatic species was observed within the study area and no matters require further consideration under this Act.

Potential ecological impacts

Flora

Remnant vegetation within the study area is of moderate-good quality or has the potential to be classed as such. Edge effects are heavily prominent along the western boundary, in close proximity to the existing dwelling and in some patches towards the central east.

Whilst no threatened flora has been observed to date, the impacts of development mean a reduction in potential habitat within the local area. Flora surveys have been conducted over all seasons for a one year period to ensure adequate survey coverage for cryptic species.

The southern portion of the site contains the EEC Swamp Sclerophyll Forest on Coastal Floodplains which is also listed as an endangered wetland community (EWC). The majority of this EEC is proposed for retention and conservation being part of the E2 zoned lands. The amount of direct impact may be negotiated by a small modification of the E2 / R2 boundary. The overall direct impact of development upon EEC vegetation is quite limited and given that it extends along the adjoining creek line at the southern boundary, the proposal will not fragment nor isolate the patch such that would likely be placed at risk of local extinction. Indirect impacts such as access, rubbish and garden refuse dumping, recreational pursuits and changes to hydrology will need to be effectively managed otherwise the EEC area would become degraded and lose function.

Fauna

The proposal has potential to impact on the following fauna species with most potential to occur and the habitat attributes present for each:

Common name	TSC Act	EPBC Act	Potential to occur	Potential habitat impact
Wallum Froglet	V	-	recorded	recorded breeding
Squirrel Glider	V	-	recorded	likely denning, breeding & foraging
Large-footed Myotis	V	-	recorded	potential roosting/breeding. recorded foraging
East-coast Freetail Bat	V	-	recorded	potential roosting/breeding. recorded foraging
Little Bentwing-bat	V	-	recorded	recorded foraging only
Eastern Bentwing-bat	V	-	recorded	recorded foraging only
Glossy Black-Cockatoo	V	-	✓	potential roosting/breeding/foraging
Little Lorikeet	V	-	✓	potential roosting/breeding/foraging
Swift Parrot	E	E	✓	high potential winter foraging
Powerful Owl	V	-	✓	potential roosting/breeding/foraging
Masked Owl	V	-	✓	potential roosting/breeding/foraging
Varied Sittella	V	-	✓	potential roosting/breeding/foraging
Koala	V	V	✓	potential part of home range
Grey-headed Flying-fox	V	V	✓	expected seasonal foraging only
Eastern Falsistrelle	V	-	✓	potential roosting/breeding/foraging
Greater Broad-nosed Bat	V	-	✓	potential roosting/breeding/foraging

Further survey is required to determine presence and or extent of habitat use by the following species which may cause constraints to development:

- fullest extent of breeding area for Wallum Froglet,
- potential nesting activity for Powerful Owl, Masked Owl and Glossy Back-Cockatoo,
- presence of Squirrel Glider in E3 areas
- confirm no home range use of site by Koala

The recorded Wallum Froglet breeding area will need to be retained and protected with sufficient buffers to ensure that development will also not indirectly impacts on water quality and quantity to this area.

Squirrel Glider was recorded by call along the creek to a 'possible' level of certainty. If this species is found present within the proposed areas for rezoning, significant habitat retention measures and mitigation measures would be required to ensure denning and foraging habitat remains well represented within the study area.

No foraging activity by Glossy Black-Cockatoo was recorded during the preliminary survey and no evidence of owl activity was noted, therefore breeding by these species is not necessarily expected. If however found to be utilising large hollows during the winter breeding season sufficient habitat retention buffers would need to be provided for such trees. Any future recording of presence of Little Lorikeet would require a search for roost/nest hollows.

Koala is not expected to occur however habitat is high quality particularly the southern portions and if found to be present this would offer significant constraint.

Microbats typically will not constrain development provided hollow retention and relocation measures can be demonstrated. Other fauna species considered are unlikely to constrain development however full seasonal use of the extensive habitats present cannot be currently completely predicted.

Riparian

The proposed rezoning is not expected to have a significant impact on the riparian corridor or watercourse quality. The location of the watercourse is along the southern boundary of the study area and a significant buffer will be provided for its protection. Being a third order stream, the likely scenario is that the watercourse would attract a riparian setback of 30m wide buffer from top of bank, The distance provided is generally 75m of greater, fulfilling the requirements under the NSW DPI - Office of Water Guidelines for Controlled Activities (2012).

In addition, it is recommended that the E2 Conservation or E3 Environmental Management zone provide a buffer of 40m to the EEC/Endangered Wetland Community and be largely fenced to limit access with a shared cycleway and walking track utilising existing tracks already in place. Sediment and erosion issues and hydrology need to be managed during the construction works to limit impacts upon retained bushland.

Stormwater measures will need to be considered and outlet works will also need to be designed in accordance with NSW DPI - Office of Water Guidelines for Controlled Activities (2012). Development will no doubt have some minor impacts upon the riparian ecology through potential changes to the hydrology and increased edge effects. Changes may be minimised through protection and regeneration of riparian embankments, water sensitive urban design, and appropriate sediment and erosion control measures at the interface between the residential area and the riparian protection zone.

Bushfire

Asset protection zones will be required adjacent to a combined EEC/EWC/Riparian protection zone and will require vegetation to be removed and maintained.

Appropriateness of the proposed zonings

The proposed R2 Low Density Residential Zone covers the majority of the study area, leaving the southern floodplain and riparian area for conservation, E2.

Further studies upon Squirrel Glider and threatened flora during late winter and spring is required before a impact determination can be made. Some habitat resources within the R2 lands may need to be retained post additional fauna survey works, particular if found to be utilised by the Squirrel Glider, as the zoning would remove a corridor link in the local area.

The boundary of the proposed zonings also need to reflect the objectives of the NSW Wetlands Policy and the presence of endangered wetland communities in regards to riparian and wetland constraints.

With respect to the residential zones, we recommend that future development be designed in accordance with:

- Water sensitive urban design principles,
- Is managed to minimise the export of sediment and implements site specific erosion controls in accordance with the *Soils and construction manual - Managing Urban Stormwater* (Landcom 2004),
- Protects waterfront lands & endangered wetland communities and implements controls in accordance with the NSW DPI Office of Water *Guidelines for Controlled Activities on Waterfront Land* (2012),
- Asset protection zones are excluded from a 40m Endangered wetland buffer that reduces the likelihood of weed invasions and loss of native vegetation within the riparian corridor.
- Maintains hollow-bearing resources where possible or allows for compensation within retained bushland.

Part(s) of the proposed residential zoned land may be required to be protected under an E3 Environmental Management zoning such that a habitat corridor connecting the southern boundary to lands north of the study area for the Squirrel Glider. Other lands may also be required for conservation of any of the cryptic threatened flora are located during target surveys later in 2016.

With respect to the proposed E2/E3 zoned lands, we recommend that future development be designed in accordance with the following mitigation measures:

- Protect vegetation within waterfront lands and endangered wetland communities and setbacks in accordance with the *NSW DPI Guidelines for Controlled Activities on Waterfront Land (2012).*
- Provides adequate separation to watercourses for effluent treatment purposes and effectively controls and treats stormwater runoff into the creek.
- Minimises the loss of trees and associated habitat due to asset protection zones, access, building sites and services.

- Applies a vegetation management plan outlining conservation management practices to protect, restore and enhance vegetation and habitat within the E2 zone.

Conclusion

It is concluded that the study area is potentially constrained by the following ecological issues:

- EEC and Endangered Wetland Community (EWC) vegetation along the southern boundary.
- Squirrel Glider habitat and loss of connectivity through the site to remnant vegetation north of Mulloway Drive.

The following further survey is required in order to provide a comprehensive assessment of impacts on threatened biodiversity and to determine the full extent of environmental protection zones that are relevant to the planning proposal:

- Further survey and assessment for Squirrel Glider.

Based on the limited fauna survey undertaken to date (which excludes comprehensive survey for most fauna species) the fauna based constraints to future development of the lands includes protection of critical hollow-bearing Squirrel Glider denning and foraging habitat and provision of a movement corridors to bushland north of Mulloway Drive.

Any future development application would need to be accompanied by an assessment of impacts as part of a 7 part test of significance. Any newly listed threatened species, endangered ecological community or endangered population listed since this advice will also need to be assessed in accordance with the requirements of the *Environmental Planning and Assessment Act 1979*, *Threatened Species Conservation Act 1995*, the *Environment Protection and Biodiversity Conservation Act 1999* and the *Fisheries Management Act 1994*.

Given the current state of flux with the current legislative review of the Threatened Species Conservation Act and the Native Vegetation Act and proposed draft Biodiversity Conservation Bill, draft Local Land Services (Amendment) Bill, *Travers bushfire & ecology* recommends that all work should be conducted to allow the preparation of a biodiversity certification assessment which will enable the net gains and losses in biodiversity values to be determined and potentially offset under future legislative changes.

List of abbreviations

APZ	asset protection zone
BPA	bushfire protection assessment
DCP	Development Control Plan
DoE	Commonwealth Department of Environment
EEC	endangered ecological community
EPA	Environmental Protection Agency
EP&A Act	*Environmental Planning and Assessment Act*
EPBC Act	*Environment Protection and Biodiversity Conservation Act*
ESMP	ecological site management plan
FF	flora and fauna assessment
FM Act	*Fisheries Management Act*
FMP	fuel management plan
HTA	habitat tree assessment
IPA	inner protection area
LEP	Local Environment Plan
LGA	local government area
NES	national environmental significance
NPWS	NSW National Parks and Wildlife Service
NSW DPI	NSW Department of Primary Industries
OEH	Office of Environment and Heritage (Part of the NSW Department of Premier and Cabinet)
OPA	outer protection area
PBP	*Planning for bushfire protection 2006*
POM	plan of management
RF Act	*Rural Fires Act*
RFS	NSW Rural Fire Service
ROTAP	rare or threatened Australian plants
SEPP 44	*State Environmental Protection Policy No 44 – Koala Habitat Protection*
SIS	species impact statement
SULE	safe useful life expectancy
TPO	tree preservation order
TPZ	tree preservation zone
TRRP	tree retention and removal plan
TSC Act	*Threatened Species Conservation Act*
VMP	vegetation management plan
WM Act	Water Management Act 2000

Table of Contents

Figures

Tables

Appendices

Introduction 1

Travers bushfire & ecology has been engaged to undertake initial flora and fauna survey and threatened species habitat assessment within Lot 273 DP 755266 at 15 Mulloway Road, Chain Valley Bay. This assessment identifies potential ecological constraints in order to guide a planning proposal for the land.

The entire area of this lot will hereafter be referred to as the 'study area'. In some circumstances survey has however extended slightly beyond this boundary for consideration of indirect impact on surrounding habitats.

1.1 Aims of the Assessment

The aims of the flora and fauna assessment are to:

- Carry out a botanical survey to describe the vegetation communities and their conditions
- Carry out a fauna survey for the detection and assessment of fauna and their habitats
- Complete target surveys for threatened species, populations and ecological communities
- Prepare a flora and fauna constraints analysis for matters listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the *Threatened Species Conservation Act 1995* (TSC Act), the *Fisheries Management Act 1994* (FM Act).

1.2 Study area

Table 1.1 provides a summary of the planning, cadastral, topographical, and disturbance details of the study area.

Table 1.1 – Site features

Location	Lot 273 DP 755266 at 15 Mulloway Road, Chain Valley Bay
Local government area	Wyong
Grid reference	366900E 6328200N
Elevation	0-15m AHD
Topography	Slopes are in the range of 0 to 5 degrees. The southern portion of the site has a southerly aspect towards the adjoining creek. The central part of the site slopes south-west and the northern portion is varied with minor knoll approximately 100m from the north-eastern boundary.
Geology and soils	Geology; There are two types present, Munmorah Conglomerate within the proposed R2 zone, and Quaternary geology in the E2 lands. Munmorah Conglomerate is comprised of conglomerate, pebbly sandstone, grey to green shale. Quaternary is comprised of gravel and sand.

	Soils; Doyalson Soil Landscape covers most of the site except for the creek line. The creek line and extended riparian area contains the Wyong Soil Landscape. Usually alluvial soils.
Catchment and drainage	Catchment - Lake Macquarie Sheaffs Creek bisects the site east to west and heads towards the north-western corner of the study area. Forest Creek goes through the very edge of the south-western corner of the study area.
Vegetation	Dry sclerophyll forest, open forest vegetation with a shrubby understorey. Vegetation grades to a hummocky floodplain open forest towards the creek along the southern boundary.
Existing land use	Residential (rural)
Clearing	Just over 20% of the study area is currently cleared

Figure 1 - Study area (Lot 273 DP 755266)

Statutory Framework 2

2.1 Environment Protection & Biodiversity Conservation Act 1999

The *EPBC Act* requires that Commonwealth approval be obtained for certain actions. It provides an assessment and approvals system for actions that have a significant impact on matters of *national environmental significance* (NES). These may include:

- World Heritage Properties and National Heritage Places
- Wetlands of International Importance protected by international treaty
- Nationally listed threatened species and ecological communities
- Nationally listed migratory species
- Commonwealth marine environment

Actions are projects, developments, undertakings, activities, and series of activities or alteration of any of these. An action that needs Commonwealth approval is known as a controlled action. A controlled action needs approval where the Commonwealth decides the action would have a significant effect on an NES matter.

Where a proposed activity is located in an area identified to be of NES, or such that it is likely to significantly affect threatened species, ecological communities, migratory species or their habitats, then the matter needs to be referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for assessment. In the case where no listed federal species are located on site then no referral is required. The onus is on the proponent to make the application and not on the Council to make any referral.

A significant impact is regarded as being:

> *Important, notable, or of consequence, having regard to its context or intensity and depends upon the sensitivity, value, and quality of the environment which is impacted and upon the duration, magnitude, and geographical extent of the impacts. A significant impact is likely when it is a real or not a remote chance or possibility.*
>
> *Source: EPBC Policy Statement*

Guidelines on the correct interpretation of the actions and assessment of significance are located on the department's web site http://www.environment.gov.au/epbc/publications.

2.2 Environmental Planning and Assessment Act 1979

The NSW Environmental Planning and Assessment Act 1979 (EP&A Act) is the principal planning legislation for the state, providing a framework for the overall environmental planning and assessment of development proposals. Various legislation and instruments, such as the NSW Threatened Species Conservation Act 1995 (TSC Act), are integrated with EP&A Act and have been reviewed separately.

In determining a development application, the consent authority is required to take into consideration the matters listed under Section 79C of the EP&A Act that are relevant to the application. Key considerations include:

- Any environmental planning instrument, including drafts
- The likely impacts of the development
- The suitability of the site for the development
- Any submissions made in accordance with the EP&A Act or regulations
- The public interest

2.3 Threatened Species Conservation Act 1995

The specific requirements of the *TSC Act* must be addressed in the assessment of impacts on threatened flora and fauna, populations and ecological communities. The factors to be taken into account in deciding whether there is a significant effect are set out in Section 5A of the *Environmental Planning and Assessment Act 1979* (*EPA Act*) and are based on a 7 part test of significance. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, a Species Impact Statement (SIS) is required to be prepared.

2.4 National Parks and Wildlife Act 1974

The NSW National Parks and Wildlife Act 1974 provides for the establishment, management and protection of National Parks and other conservation reserves, landscapes and landforms of significance, the conservation of objects, places or features of cultural value, and the protection of native flora and fauna.

2.5 Fisheries Management Act 1994

The *FM Act* provides a list of threatened aquatic species that require consideration when addressing the potential impacts of a proposed development. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, an SIS is required to be prepared. A permit is required if an activity will block fish passage.

2.6 Water Management Act 2000

The NSW Water Management Act 1948 (WM Act) aims to provide effective controls on activities that could harm sensitive waterway and foreshore environments. The Act has provisions that require a controlled activity approval for all works within 40m of the top of the bank of mapped rivers, estuaries, wetlands and lakes as it is recognised that they can have significant detrimental environmental impacts on habitat, water quality, flooding and erosion.

There are mapped watercourses and endangered wetlands present in the site that are subject to this Act (a “river” as defined under the Act generally applies to those waterways that show up on 1:25,000 topographic mapping). A controlled activity approval would be required under the WM Act for any works within waterfront lands.

2.7 Rural Fires Act 1997

The objectives of the NSW Rural Fires Act 1997 (RF Act) are to provide for:

- The prevention, mitigation and suppression of fires
- Coordination of bushfire fighting and prevention
- Protection of people and property from fires
- Protection of the environment

Section 100B of the RF Act provides for the Commissioner to issue a bushfire safety authority for subdivision of bushfire prone land that could lawfully be used for residential or rural residential purposes or for development of bushfire prone land for a special fire protection purpose.

A Bushfire Safety Authority permits development to the extent that it complies with bushfire protection standards. Application for a Bushfire Safety Authority must be lodged as part of the development application process and must demonstrate compliance with the Planning for Bushfire Protection Guidelines (RFS 2001).

The RF Act also outlines the responsibilities of land owners to manage their land for bushfire protection and provides a mechanism for the approval of hazard reduction works, through the issue of a bushfire hazard reduction certificate.

2.8 Rural Fires and Environmental Assessment Legislation Amendment Act 2002

The NSW Rural Fires and Environmental Assessment Legislation Amendment Act 2002 amends the RF Act and the EP&A Act with respect to bushfire prone lands, bushfire hazards and bushfire emergencies.

2.9 Planning for Bushfire Protection: a Guide for Councils, Planners, Fire Authorities, Developers and Home Owners 2006

This guide (NSW Rural Fire Service 2006) is the key bushfire planning document for the state. The document identifies requirements and strategies for new developments to help protect from bushfire hazards. It details the location and depth of asset protection zones, fire trails and perimeter roads, water supply and building standards in bushfire risk areas. This document is given legal force through the Rural Fires and Environmental Assessment Legislation Amendment Act 2002 (section 5.8).

2.10 Bushfire Environment Assessment Code 2006

The code provides a streamlined process for assessing and approving bushfire hazard reduction works, particularly for authorities managing public land. It is intended to apply to asset protection zones and strategic fire advantage zones identified in Bushfire Risk Management Plans.

2.11 Protection of the Environment Operations Act 1997

The NSW Protection of the Environment Operations Act 1997 (POEO Act) aims to protect environment quality within New South Wales, particularly in relation to reducing or mitigating pollution, whilst having regard to the need to maintain ecologically sustainable development. The POEO Act allows for explicit environmental protection policies (see section 5.12).

2.12 Clean Waters Regulations 1972

The Clean Waters Regulations 1972 is given legal force through the POEO Act. Schedule 5 Section 6(2) of the POEO Act states that the standards applicable to classified waters are those standards prescribed by the Clean Waters Regulations. The Nepean River in the vicinity of the Menangle Park study site are classified as class 'P' waters, whilst waters downstream in the Camden region are classified as class 'C' waters. For both class 'C' and 'P' waters discharges must be by sewer, and sewerage system overflows are not permitted.

2.13 Catchment Management Act 1989

Through a network of Catchment Management Committees, the NSW Catchment Management Act 1989 aims to co-ordinate identification of land degradation, programs for rehabilitation and community awareness and to promote stable and productive environmental conditions. The Warragamba Catchment Blueprint, which commenced in 2002/03 provides strategic direction for Natural Resource Management across the catchment over the next ten years. The Catchment Blueprint identifies and sets targets with prioritised management actions and includes issues relating to natural resource and environmental management.

2.14 Local Government Act 1993

The NSW Local Government Act 1993 provides for management of land within a Local Government Area. Under the Act plans of management must be prepared for 'community land'. The plans should address a variety of factors including biodiversity conservation and management. Councils must adopt a specific plan of management for community land affected by a recovery plan, threat abatement plan or containing critical habitat identified under the TSC Act.

2.15 Local Government Amendment (Ecologically Sustainable Development) Act 1997

The NSW Local Government Amendment (Ecologically Sustainable Development) Act 1997 requires that councils consider principles of Ecologically Sustainable Development and prepare an annual State of the Environment report. The principles of ESD, as defined in the Act are the precautionary principle, intergenerational equity, conservation of biological diversity, incorporation of environmental factors in valuations and pursuit of environmental goals in a cost effective fashion.

2.16 Noxious Weeds Act 1993

The objectives of the NSW Noxious Weeds Act 1993 are to identify which noxious weeds require control measures, identify control measures suitable to those species and to specify the responsibilities of both public and private landholders for noxious weed control. Five (5) noxious weed species were observed within the study area.

2.17 State Environmental Planning Policy No.19 – Bushland in Urban Areas

This NSW State Environmental Planning Policy (SEPP) aims to protect and preserve bushland within selected local government areas. The Wyong local government area is not listed on Schedule 1 of the SEPP so is not required to be considered.

2.18 State Environmental Planning Policy No. 44 – Koala Habitat Protection

This SEPP encourages the conservation and management of natural vegetation areas that provide habitat for Koalas and to ensure permanent free-living populations will be maintained over their present range. It provides a stepped process of habitat assessment, requires the preparation of Plans of Management for development applications in core Koala habitat and supports the inclusion of areas of core Koala habitat in environment protection zones. Koalas have been recorded in the vicinity of the study area. For some vegetation on the site more than 15% of koala feed trees listed on the schedules to the policy were observed, which indicates 'potential koala habitat'. The presence of potential koala habitat triggers an assessment under SEPP44 for any proposed development in the area.

2.19 NSW Biodiversity Strategy 1999

The NSW Biodiversity Strategy has been adopted by the New South Wales Government and aims to protect the native biological diversity of NSW and maintain ecological processes and systems through a collaborative framework of government and community efforts. It aims to achieve a variety of biodiversity outcomes, including the preparation of Local Biodiversity Action Plans. The strategy includes the application of the precautionary principle so that lack of full knowledge of impacts is not be used as an excuse for postponing action.

2.20 Wyong Local Environment Plan 2013

The particular aims of the Wyong LEP are as follows:

(a) to foster economic, environmental and social well-being so that Wyong continues to develop as a sustainable and prosperous place to live, work and visit,
(b) to encourage a range of housing, employment, recreation, human services and appropriately located tourism-related development in Wyong to meet the existing and future needs of residents and visitors,
(c) to promote the efficient and equitable provision of public services, infrastructure and amenities,
(d) to provide for a range of local and regional community facilities for recreation, culture, health and education purposes,
(e) to apply the principles of ecologically sustainable development to guide future development within Wyong,
(f) to conserve, protect and enhance the environmental and cultural heritage (both indigenous and non-indigenous) values of Wyong,
(g) to protect areas of high scenic landscape value,
(h) to maintain and enhance the existing character, amenity and environmental quality of Wyong,
(i) to minimise risk to the community in areas subject to environmental hazards, including flooding, climate change and bush fires,
(j) to promote a high standard of urban design that responds appropriately to the existing or desired future character of areas,
(k) to encourage development that increases public transport patronage, walking and cycling.

In accordance with Wyong LEP 2013, the objectives of the proposed zonings, permitted and prohibited activities with or without development consent are as follows:

Zone E2 Environmental Conservation

1 Objectives of zone

- To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values.
- To prevent development that could destroy, damage or otherwise have an adverse effect on those values.
- To protect endangered ecological communities, coastal wetlands and littoral rainforests.
- To enable development of public works and environmental facilities if such development would not have a detrimental impact on ecological, scientific, cultural or aesthetic values.

2 Permitted without consent

Nil

3 Permitted with consent

Eco-tourist facilities; Environmental facilities; Environmental protection works; Flood mitigation works; Recreation areas; Research stations; Roads; Water reticulation systems.

4 Prohibited

Business premises; Hotel or motel accommodation; Industries; Multi dwelling housing; Recreation facilities (major); Residential flat buildings; Restricted premises; Retail premises; Seniors housing; Service stations; Warehouse or distribution centres; Any other development not specified in item 2 or 3.

Zone R2 Low Density Residential Development

1 Objectives of zone

- To provide for the housing needs of the community within a low density residential environment.
- To enable other land uses that provide facilities or services to meet the day to day needs of residents.
- To maintain and enhance the residential amenity and character of the surrounding area.
- To provide a residential character commensurate with a low density residential environment.

2 Permitted without consent

Home-based child care; Home occupations

3 Permitted with consent

Bed and breakfast accommodation; Boarding houses; Boat launching ramps; Boat sheds; Building identification signs; Business identification signs; Car parks; Child care centres; Community facilities; Dual occupancies; Dwelling houses; Emergency services facilities; Environmental facilities; Environmental protection works; Exhibition homes; Exhibition villages; Flood mitigation works; Group homes; Health consulting rooms; Home businesses;

Home industries; Information and education facilities; Jetties; Neighbourhood shops; Places of public worship; Recreation areas; Respite day care centres; Roads; Secondary dwellings; Semi-detached dwellings; Shop top housing; Water recycling facilities; Water reticulation systems; Water storage facilities

4 Prohibited

Any development not specified in item 2 or 3.

Zone E3 Environmental Management

1 Objectives of zone

- To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values.
- To provide for a limited range of development that does not have an adverse effect on those values.

2 Permitted without consent

Home-based child care; Home occupations.

3 Permitted with consent

Bed and breakfast accommodation; Building identification signs; Business identification signs; Community facilities; Dual occupancies; Dwelling houses; Eco-tourist facilities; Emergency services facilities; Environmental facilities; Environmental protection works; Extensive agriculture; Farm buildings; Farm stay accommodation; Flood mitigation works; Home businesses; Home industries; Horticulture; Information and education facilities; Recreation areas; Research stations; Roads; Roadside stalls; Secondary dwellings; Sewage treatment plants; Water recreation structures; Water recycling facilities; Water supply systems

4 Prohibited

Industries; Multi dwelling housing; Residential flat buildings; Retail premises; Seniors housing; Service stations; Warehouse or distribution centres; Any other development not specified in item 2 or 3

The appropriateness of the proposed zonings is discussed as part of this assessment. The existing zoning under the Wyong LEP is shown in Figure 2.

The proposal seeks to retain the E2 as is on the LEP map of 2013 (Figure 2), but change the E3 to R2.

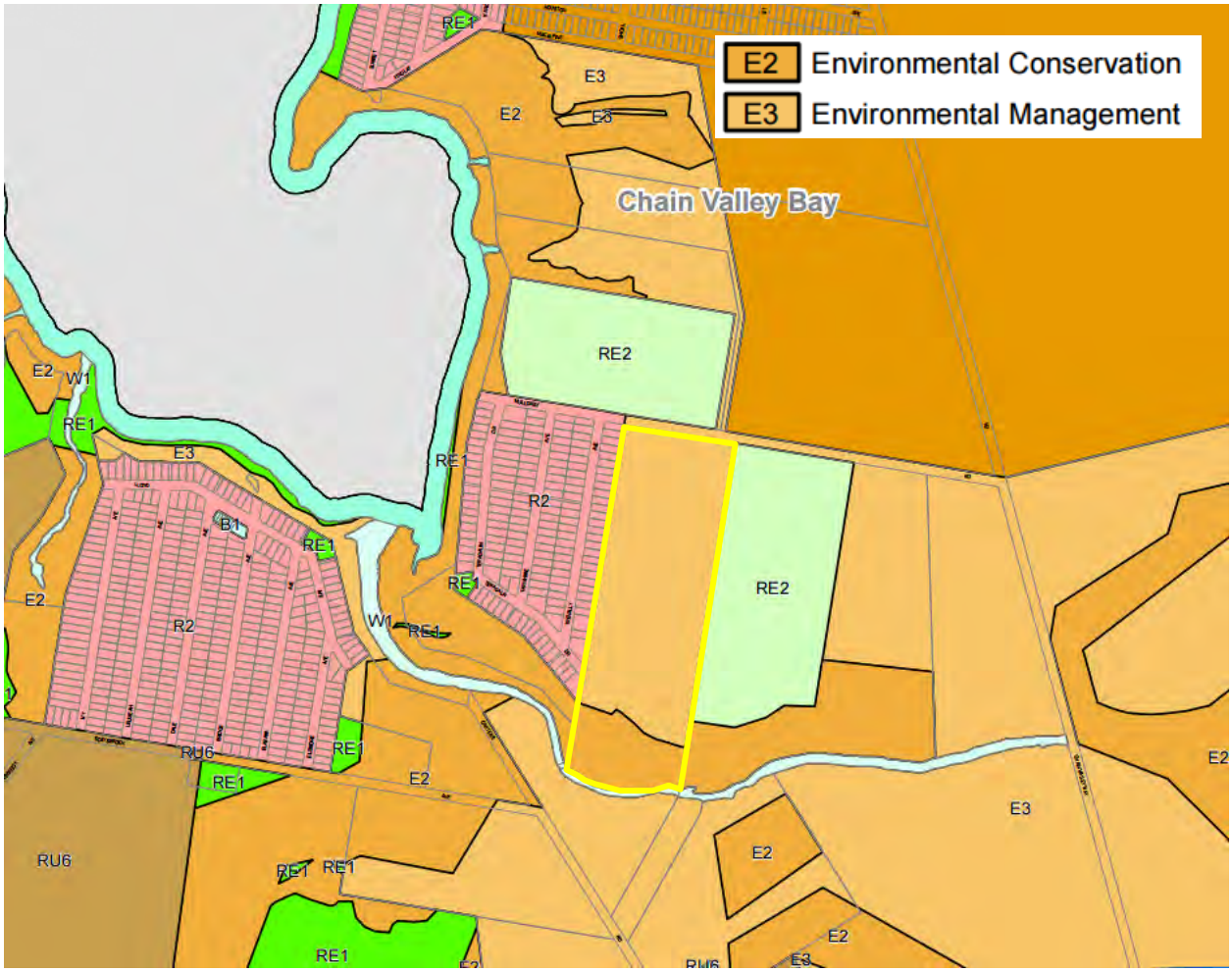

Figure 2 - Current zoning (Wyong Council LEP 2013)

Survey Methodology 3

3.1 Information collation, technical resources, desktop assessments, specialist identification and licences

A review of the relevant information pertinent to the study area was undertaken.

Standard technical resources utilised:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities 2004* (working draft), Department of Environment and Conservation (DEC)
- *Flora and Fauna Survey Guidelines* - Wyong Shire Council 2014
- Aerial photographs (Google Earth Pro / Spatial Information Exchange)
- Topographical maps (scale 1:25,000)
- *Threatened Species Conservation Act 1995* (TSC Act)
- *Fisheries Management Act 1994* (FM Act)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Rare or Threatened Australian Plants (ROTAP)
- Wyong Shire Council vegetation mapping (2008)

Desktop assessment:

To determine the likely and actual occurrence of flora species, fauna species and plant communities on the study area, desktop assessments were undertaken including:

- ***A literature review*** – A review of readily available literature for the area was undertaken to obtain reference material and background information for this survey.

- ***A data search*** – A search of the *Atlas of NSW Wildlife* (OEH 2016) was undertaken to identify records of threatened flora and fauna species located within a 10km radius of the site. Searches were also undertaken on the DOE – 'protected matters search tool' website to generate a report that will help determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in the area of interest. The search was broadened to a 10km radius like the Atlas search. These two searches combined, enabled the preparation of a list of threatened flora and fauna species that could potentially occur within the habitats found on the site (Tables A2.1, A2.2 and A2.3).

Accuracy of identification:

Specimens of plants not readily discernible in the field were collected for identification. Structural descriptions of the vegetation were made according to Specht *et al* (1995).

***Licences*:**

Individual staff members of *Travers bushfire & ecology* are licensed under Clause 20 of the *National Parks and Wildlife (Land Management) Regulation 1995* and Sections 120 & 131 of

the *National Parks and Wildlife Act 1974* to conduct flora and fauna surveys within service and non-service areas. NPWS Scientific Licence Numbers: SL100848.

Travers bushfire & ecology staff are licensed under an Animal Research Authority issued by the Department of Agriculture. This authority allows *Travers bushfire & ecology* staff to conduct various fauna surveys of native and introduced fauna for the purposes of environmental consulting throughout New South Wales.

3.2 Flora survey methodology

A review of the Atlas of NSW Wildlife was undertaken in December 2015 prior to the commencement of field studies to advise the client of cryptic flora species which would require specific targeted survey during their known flowering periods.

The first survey included botanical survey for *Acacia bynoeana* and *Cryptostylis hunteriana* over a full day in February 2016 where it was deemed there would be suitable potential habitat. It should be noted that there has been a bushfire within the southern portion of the site in 2014 which may lessen the current potential for species to occur as well as their being floodplain vegetation which may or may not be appropriate for particular species.

On March 4th and 7th, 2016, fully botanical survey was undertaken across the entire site. The application of random meanders, Biometric transect plots, and transects assisted in providing a species list, determining vegetation types and describing common species. Target threatened species searches were again undertaken but focussing upon *Corunastylis sp. Charmhaven.*

Targeted threatened flora survey for species such as *Diuris praecox* were undertaken on 8th and 23rd August 2016. No specimens of *Diuris praecox* were observed within the study area.

Targeted threatened flora survey for species such as *Tetratheca juncea, Caladenia porphyrea, Caladenia tessellata, Genoplesium insigne, Thelymitra sp. adorata and Rutidosis heterogama* were undertaken on 21st September 2016 (4 hours) and 17th October 2016 (4 hours).

Target searches have been conducted for all cryptic threatened species

3.3 Fauna survey methodology

Site survey effort accounting for techniques deployed, duration, and weather conditions are outlined in Table 2.1 and are depicted on Figure 3.

Current standard fauna survey techniques employed by *Travers bushfire & ecology* in line with relevant survey guidelines as well as current survey knowledge are provided in Appendix 1. Fauna survey techniques that have been tailored to the site are provided in Section 2.6.

For the purposes of this report fauna survey has been limited to brief survey and habitat assessment over 1 day and night as a preliminary indicator of potential threatened fauna activities.

The survey is limited and does not currently comply with recommended survey for threatened fauna species. A comprehensive trapping, remote camera and diurnal survey is recommended.

3.4 Field survey effort

Tables 3.1 and 3.2 below detail the flora and fauna survey effort undertaken for the study area.

Table 3.1 – Fauna survey effort

Fauna group	Date	Weather conditions	Survey technique(s)	Survey effort / time (24hr)
Diurnal birds	15/3/16	8/8 cloud, no wind, prev rain, temp 24°C	Diurnal opportunistic & census points	6hrs 30min 1300 - 1930
Nocturnal birds	15/3/16	1/8 cloud, no wind, no rain, ½ moon, temp 24-21°C	Spotlighting Call playback (Section 3.5 species)	2hrs 30min 1930 - 2200 Commenced @ 2000
Arboreal mammals	15/3/16	1/8 cloud, no wind, no rain, ½ moon, temp 24-21°C	Spotlighting Call playback (Section 3.5 species)	2hrs 30min 1930 - 2200 Commenced @ 2015
Terrestrial mammals	15/3/16	1/8 cloud, no wind, no rain, ½ moon, temp 24-21°C	Spotlighting	2hrs 30min 1930 - 2200
Bats	15/3/16	1/8 cloud, no wind, no rain, ½ moon, temp 24-21°C	Spotlighting Anabat II (Passive monitoring) x1	2hrs 30min 1930 - 2200 O'night from 19:30
Reptiles	15/3/16	8/8 cloud, no wind, prev rain, temp 24°C	Habitat search, opportunistic	6hrs 30min 1300 - 1930
Amphibians	15/3/16	1/8 cloud, no wind, no rain, ½ moon, temp 24-21°C	Spotlighting & call identification Call-playback (Wallum Froglet)	2hrs 30min 1930 - 2200 Commenced @ ~2100

Table 3.2 – Flora survey effort

Flora survey	Survey technique(s)	Dates
Vegetation communities	Survey of the boundaries of all communities – field verification and aerial photographic interpretation	4/3/16, 7/3/16
Stratified sampling	14x Biometric transect plots	4/3/16, 7/3/16

	2x linear transects	
Target searches	*Cryptostylis hunteriana* and *Acacia bynoeana*	2/2/16
	Corunastylis sp. Charmhaven	4/3/16, 7/3/16
	Diuris praecox	8/8/16, 23/8/16
	Genoplesium insignis, Caladenia poryphyrea, Caladenia tessellata, Rutidosis heterogama, Tetratheca juncea and *Thelymitra sp. Adorata*	21/9/16, 17/10/16

3.5 Site specific survey techniques

Diurnal birds

Ten (10) diurnal bird census points were undertaken within the study area. A minimum of 15 minutes of survey was undertaken at each census point in an area radiating out to between 30-50m. Bird census points were selected to give an even spread and representation across the site and its communities (see Figure 3). Census points were also commenced in locations where bird activity was apparent, as often different small bird species are found foraging together. Opportunistic diurnal bird survey was conducted between census points and whilst undertaking other diurnal surveys.

Seeding *Allocasuarina* trees located within the study area were opportunistically searched for chewed cones indicating foraging activity by Glossy Black-Cockatoo (*Calyptorhynchus lathami*).

Nocturnal birds

Given the suitability of habitat present Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebricosa*) and Black Bittern (*Ixobrychus flavicollis*) were targeted by call-playback techniques. Threatened owl call playback was undertaken centrally within the site and Black Bittern was targeted at two locations along Karignan Creek.

Searches for significant habitat trees included suitable hollows for owls. Where such hollows were located searches were undertaken under nearby likely perches to detect current owl activity.

Arboreal and terrestrial mammals

Given the suitability of habitat present Koala (*Phascolactos cinereus*) and Squirrel Glider (*Petaurus norfolcensis*) were targeted by call-playback techniques. Locations are shown on Figure 3.

Bats

Passive Anabat monitoring was undertaken targeting overnight concentrated bat activity over the dam in the central portion of the study area.

Amphibians

Wallum Froglet was heard calling during the afternoon survey. Nocturnal call-playback in the surrounds to this was then undertaken to stimulate calling activity and extent of breeding area during light rain after dark. Calls were played through a 15 watt Toa 'Faunatech' amplifier carried over the shoulder from a CD recording obtained from *Australian Frog Calls – Subtropical East (Nature Sound – David Stewart).*

Significant habitat trees

Significant habitat trees are defined as trees containing large hollows suitable for use by owls or cockatoos and/or containing hollows considered potentially suitable for use by Squirrel Glider. These trees were identified by GPS to determine their layout across the potential development landscape. Trees showing major use glider sap feeding were also identified at this time.

3.6 Survey limitations

It is important to note that field survey data collected during the survey period is representative of species occurring within the study area for that occasion. Due to effects of fire, breeding cycles, migratory patterns, camouflage, weather conditions, time of day, visibility, predatory and / or feeding patterns, increased species frequency or richness may be observed within the study area outside the nominated survey period. Habitat assessments based on the identification of micro-habitat features for various species of interest, including regionally significant and threatened species, have been used to minimise the implications of this survey limitation.

Flora survey limitations

The species list does not include all household garden / landscaping species and those species which could not be identified at the time of the survey past genus level. Cryptic species not flowering at the time of the survey may not be observed during survey outside of peak flowering periods. Likewise, cryptic orchid species are generally only accurately identifiable when flowering.

Surveys have been undertaken on at least one (1) occasion during the flowering period for all threatened species with potential habitat. Where possible, surveys have been repeated during their flowering period to minimise limitations. It should be recognised that not all species or specimens will flower each year, thus there will always be that limitation on the survey effort.

Fauna survey limitations

Habitat tree surveys have been limited to identifying the significant habitat trees only. These trees are those identified as suitable for use by threatened owls, cockatoos and Squirrel Glider. Thus trees containing other hollow types and small hollows, which are most numerous within the study area and potentially most suitable for threatened microbats, have not been identified. The locations of significant hollow-bearing trees was undertaken to provide a snapshot view of locations for constraints mapping purposes.

No trapping has been undertaken in the study area. The site has high potential for Squirrel Glider to occur and presence of this species is best determined through trapping effort as it is not reliably detected by spotlighting, call or call-playback response. This effort is best undertaken during the flowering period of Eucalypt, Corymbia or Angophora trees present. Trapping effort should be supplemented with effort to target presence of Spotted-tailed Quoll.

A second night's call-playback effort is required for large forest owl to achieve the minimum requirement. A preliminary analysis of hollows has identified two trees suitable for nesting by large forest owls therefore further survey for presence of nesting activity should be undertaken during the winter (or leading into winter) breeding period. At this time detailed searches around identified suitable nesting trees should be undertaken for signs of use. Potential for site usage by Glossy Black-Cockatoo for nesting may also be undertaken at this time.

Local Koala records do not suggest any active local population with locations to the east all from the same year possible suggesting an individual in dispersal at this time. In any case, further survey should provide more detailed spotlighting of the southern study area combined with further call-playback and isolated scat searches.

Microbat recording is limited to the dam. This location is most likely to receive concentrated microbat activity however given the relative size of the site further survey should also place ultrasonic recording devices at other foraging structure such as along forest edges and trails, the open grassland area, along the creekline and over the lower and open swamp areas. Further trapping survey should also incorporate harp trapping effort.

Wallum Froglet was recorded from a single isolated call. Further survey would be best undertaken following substantial rain to best determine the extent of the breeding area.

Survey Results 4

4.1 Flora results

4.1.1 Flora species

The plants observed within the vegetation communities of the study area are listed in the Table 4.1 below.

Table 4.1 – Flora observations for the study area

Family	Scientific Name	Common Name
Trees		
Mimosaceae	*Acacia baileyana*	Cootamundra Wattle
Casuarinaceae	*Allocasuarina littoralis*	Black She-oak
Myrtaceae	*Angophora costata*	Smooth-barked Apple
Araucariaceae	*Araucaria heterophylla**	Norfolk Island Pine
Arecaceae	*Archontophoenix cunninghamiana*	Bangalow Palm
Casuarinaceae	*Casuarina glauca*	Swamp Oak
Lauraceae	*Cinnamomum camphora**	Camphor Laurel
Myrtaceae	*Corymbia gummifera*	Red Bloodwood
Eleocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash
Myrtaceae	*Eucalyptus capitellata*	Brown Stringybark
Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark
Myrtaceae	*Eucalyptus haemastoma*	Scribbly Gum
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany
Santalaceae	*Exocarpos cupressiformis*	Native Cherry
Oleaceae	*Fraxinus angustifolia**	Claret Ash
Fabaceae	*Gleditsia triacanthos**	Honey Locust
Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree
Proteaceae	*Grevillea robusta*	Silky Oak
Lythraceae	*Lagerstroemia indica**	Crepe Myrtle
Arecaceae	*Livistona australis*	Cabbage Tree Palm
Proteaceae	*Macadamia integrifolia*	Macadamia Nut
Myrtaceae	*Melaleuca linariifolia*	Snow in Summer
Myrtaceae	*Melaleuca quinquenervia*	Broad-leaved Paperbark
Meliaceae	*Melia azedarach* var. *australasica*	White Cedar
Myrsinaceae	*Myrsine variabilis*	Muttonwood
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum
Salicaceae	*Populus alba**	White Poplar
Rosaceae	*Prunus sp.**	Stone-fruit Tree
Shrubs		
Mimosaceae	*Acacia falcata*	Sickle Wattle
Mimosaceae	*Acacia implexa*	Hickory
Mimosaceae	*Acacia longifolia* var. *longifolia*	Sydney Golden Wattle
Mimosaceae	*Acacia myrtifolia*	Red Stem Wattle
Mimosaceae	*Acacia suaveolens*	Sweet Scented Wattle
Mimosaceae	*Acacia terminalis*	Sunshine Wattle

Family	Scientific Name	Common Name
Proteaceae	*Banksia marginata*	Silver Banksia
Proteaceae	*Banksia oblongifolia*	-
Proteaceae	*Banksia spinulosa* var. *spinulosa*	Hairpin Banksia
Fabaceae	*Bossiaea heterophylla*	Variable Bossiaea
Fabaceae	*Bossiaea obcordata*	Spiny Bossiaea
Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush
Caricaceae	*Carica papaya*	Papaya
Solanaceae	*Cestrum parqui**	Chilean Cestrum
Asteraceae	*Chrysanthemoides monilifera* subsp. *rotundata**	Bitou Bush
Polygalaceae	*Comesperma ericinum*	Matchheads
Malaceae	*Cotoneaster glaucophyllus**	Grey-leaved Cotoneaster
Sapindaceae	*Dodonaea triquetra*	Hop Bush
Epacridaceae	*Epacris pulchella*	NSW Coral Heath
Fabaceae	*Gompholobium latifolium*	Broad-leaf Wedge-pea
Proteaceae	*Grevillea sericea*	Pink Spider Flower
Proteaceae	*Hakea bakeriana*	-
Proteaceae	*Hakea laevipes* subsp. *laevipes*	-
Proteaceae	*Hakea salicifolia*	Willow Hakea
Proteaceae	*Hakea sericea*	Needlebush
Malvaceae	*Hibiscus sp.* (cultivar)*	Hibiscus
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart
Myrtaceae	*Kunzea ambigua*	Tick Bush
Proteaceae	*Lambertia formosa*	Mountain Devil
Verbenaceae	*Lantana camara**	Lantana
Myrtaceae	*Leptospermum juniperinum*	Prickly Tea-tree
Myrtaceae	*Leptospermum polygalifolium* subsp. *polygalifolium*	Tantoon
Myrtaceae	*Leptospermum trinervium*	Flaky-barked Tea-tree
Proteaceae	*Lomatia silaifolia*	Crinkle Bush
Myrtaceae	*Melaleuca ericifolia*	Swamp Paperbark
Myrtaceae	*Melaleuca sieberi*	-
Myrtaceae	*Melaleuca thymifolia*	Thyme Honey Myrtle
Araceae	*Monstera deliciosa**	Fruit-salad Plant
Berberidaceae	*Nandina domestica**	Sacred Bamboo
Apocynaceae	*Nerium oleander**	Oleander Bush
Oleaceae	*Notelaea longifolia*	Mock Olive
Ochnaceae	*Ochna serrulata**	Mickey Mouse Plant
Rubiaceae	*Opercularia diphylla*	-
Proteaceae	*Persoonia lanceolata*	Lance-leaved Geebung
Proteaceae	*Persoonia levis*	Broad-leaved Geebung
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung
Euphorbiaceae	*Phyllanthus hirtellus*	Thyme Spurge
Phytolaccaceae	*Phytolacca octandra**	Inkweed
Apiaceae	*Platysace linearifolia*	Narrow-leafed Platysace
Apocynaceae	*Plumeria obtusa**	Frangipani
Fabaceae	*Podolobium ilicifolium*	Prickly Shaggy Pea
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax
Fabaceae	*Pultenaea daphnoides*	Large-leaf Bush Pea
Fabaceae	*Pultenaea retusa*	-
Fabaceae	*Pultenaea villosa*	-
Rosaceae	*Rubus anglocandicans**	Blackberry
Fabaceae	*Senna pendula* var. *glabrata**	-
Solanaceae	*Solanum mauritianum**	Wild Tobacco

Family	Scientific Name	Common Name
Bignoniaceae	*Tecoma capensis**	Cape Honeysuckle
Groundcovers		
Asteraceae	*Actinotus minor*	Lesser Flannel Flower
Liliaceae	*Agapanthus praecox**	Agapanthus
Asteraceae	*Ageratina adenophora**	Crofton Weed
Asteraceae	*Ageratum houstonianum**	Blue Billy Goat Weed
Myrsinaceae	*Anagallis arvensis**	Scarlet Pimpernel
Poaceae	*Andropogon virginicus**	Whisky Grass
Poaceae	*Anisopogon avenaceus*	Oat Speargrass
Poaceae	*Aristida vagans*	Three-awn Speargrass
Asparagaceae	*Asparagus aethiopicus**	Asparagus Fern
Poaceae	*Avena fatua**	Wild Oats
Poaceae	*Axonopus fissifolius**	Narrow-leafed Carpet Grass
Restionaceae	*Baloskion gracile*	-
Cyperaceae	*Baumea juncea*	-
Asteraceae	*Bidens pilosa**	Cobbler's Pegs
Blechnaceae	*Blechnum camfieldii*	-
Colchicaceae	*Burchardia umbellata*	Milkmaids
Cyperaceae	*Carex appressa*	Tall Sedge
Apocynaceae	*Catharanthus roseus*	Madagascar Periwinkle
Apiaceae	*Centella asiatica*	Indian Pennywort
Poaceae	*Chloris gayana**	Rhodes Grass
Asteraceae	*Cirsium vulgare**	Spear Thistle
Commelinaceae	*Commelina cyanea*	Native Wandering Jew
Asteraceae	*Conyza bonariensis**	Flaxleaf Fleabane
Asteraceae	*Conyza sumatrensis**	Fleabane
Orchidaceae	*Cryptostylis erecta*	Bonnet Orchid
Orchidaceae	*Cryptostylis subulata*	Large Tongue Orchid
Cucurbitaceae	*Cucurbita maxima**	Pumpkin
Poaceae	*Cynodon dactylon*	Common Couch
Cyperaceae	*Cyperus brevifolius**	Mullumbimby Couch
Cyperaceae	*Cyperus eragrostis**	Umbrella Sedge
Goodeniaceae	*Dampiera stricta*	Blue Dampiera
Phormiaceae	*Dianella caerulea* var. *caerulea*	Flax Lily
Convolvulaceae	*Dichondra repens*	Kidney Weed
Poaceae	*Echinopogon caespitosus* var. *caespitosus*	Tufted Hedgehog Grass
Poaceae	*Echinopogon ovatus*	Forest Hedgehog Grass
Poaceae	*Ehrharta erecta**	Panic Veldtgrass
Restionaceae	*Empodisma minus*	-
Poaceae	*Entolasia marginata*	Bordered Panic
Poaceae	*Entolasia stricta*	Wiry Panic
Asteraceae	*Epaltes australis*	-
Poaceae	*Eragrostis brownii*	Brown's Lovegrass
Asteraceae	*Erechtites valerianifolia**	Brazilian Fireweed
Asteraceae	*Euchiton sphaericus*	-
Euphorbiaceae	*Euphorbia peplus**	Spurge
Cyperaceae	*Ficinia nodosa*	-
Cyperaceae	*Fimbristylis dichotoma*	Common Fringe-rush
Cyperaceae	*Gahnia aspera*	Saw Sedge
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge
Cyperaceae	*Gahnia sieberiana*	Red-fruit Saw-sedge
Asteraceae	*Gamochaeta spicata**	Cudweed
Geraniaceae	*Geranium homeanum*	Northern Cranesbill

Family	Scientific Name	Common Name
Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort
Haloragaceae	*Gonocarpus teucroides*	Raspwort
Goodeniaceae	*Goodenia hederacea* subsp. *hederacea*	Ivy-leaved Goodenia
Goodeniaceae	*Goodenia heterophylla* subsp. *heterophylla*	Variable Leaved Goodenia
Goodeniaceae	*Goodenia ovata*	-
Haemodoraceae	*Haemodorum planifolium*	Bloodroot
Zingiberaceae	*Hedychium gardnerianum**	Ginger Lily
Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower
Dilleniaceae	*Hibbertia linearis*	-
Apiaceae	*Hydrocotyle bonariensis**	Kurnell Curse / Pennywort
Apiaceae	*Hydrocotyle peduncularis*	Pennywort
Apiaceae	*Hydrocotyle tripartita*	Pennywort
Asteraceae	*Hypochaeris radicata**	Flatweed
Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern
Poaceae	*Imperata cylindrica* var. *major*	Blady Grass
Juncaceae	*Juncus acutus**	-
Juncaceae	*Juncus kraussii*	Sea Rush
Juncaceae	*Juncus planifolius*	Broad Rush
Juncaceae	*Juncus prismatocarpus*	Branching Rush
Juncaceae	*Juncus usitatus*	Common Rush
Asteraceae	*Lagenifera stipitata*	-
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge
Lindsaeaceae	*Lindsaea linearis*	Screw Fern
Lobeliaceae	*Lobelia anceps*	-
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush
Lomandraceae	*Lomandra longifolia*	Spiky-headed Mat-rush
Lomandraceae	*Lomandra obliqua*	Twisted Mat-rush
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Grass
Malvaceae	*Modiola caroliniana**	Red-flowered Mallow
Davalliaceae	*Nephrolepis cordifolia**	Fish-bone Fern
Poaceae	*Oplismenus aemulus*	Basket Grass
Poaceae	*Oplismenus imbecillis*	-
Oxalidaceae	*Oxalis perennans*	-
Poaceae	*Panicum simile*	Two Colour Panic
Poaceae	*Paspalum dilatatum**	Paspalum
Poaceae	*Paspalum urvillei**	Vasey Grass
Iridaceae	*Patersonia glabrata*	Leafy Purple-flag
Iridaceae	*Patersonia sericea*	Wild Iris
Sinopteridaceae	*Pellaea falcata*	Sickle Fern
Poaceae	*Pennisetum clandestinum**	Kikuyu
Polygonaceae	*Persicaria strigosa*	-
Poaceae	*Phalaris aquatica**	Phalaris
Euphorbiaceae	*Phyllanthus tenellus**	-
Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*	Slender Rice Flower
Plantaginaceae	*Plantago lanceolata**	Ribwort
Lobeliaceae	*Pratia purpurascens*	Whiteroot
Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower
Dennstaedtiaceae	*Pteridium esculentum*	Bracken
Rubiaceae	*Richardia brasiliensis**	Mexican Clover
Cyperaceae	*Schoenus brevifolius*	Bog-rush
Cyperaceae	*Schoenus melanostachys*	Black Bog Rush
Selaginallaceae	*Selaginella uliginosa*	Swamp Selaginella

Family	Scientific Name	Common Name
Asteraceae	*Senecio madagascariensis**	Fireweed
Poaceae	*Setaria parviflora**	-
Malvaceae	*Sida rhombifolia**	Paddy's Lucerne
Solanaceae	*Solanum nigrum**	Black Nightshade
Poaceae	*Sporobolus africanus**	Parramatta Grass
Asteraceae	*Taraxacum officinale**	Dandelion
Orchidaceae	*Thelymitra ixioides* var. *ixioides*	Spotted Sun Orchid
Poaceae	*Themeda triandra*	Kangaroo Grass
Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily
Fabaceae	*Trifolium repens**	White Clover
Verbenaceae	*Verbena bonariensis**	Purpletop
Verbenaceae	*Verbena litoralis**	-
Asteraceae	*Vernonia cinerea* var. *cinerea*	-
Menyanthaceae	*Villarsia exaltata*	Yellow Marsh Flower
Apocynaceae	*Vinca major**	Blue Periwinkle
Violaceae	*Viola hederacea*	Ivy-leaved Violet
Xanthorrhoaceae	*Xanthorrhoea latifolia* subsp. *latifolia*	-
Vines		
Pittosporaceae	*Billardiera scandens* var. *scandens*	Apple Dumplings
Lauraceae	*Cassytha glabella* forma *glabella*	Slender Devil's Twine
Ranunculaceae	*Clematis aristata*	Old Man's Beard
Fabaceae	*Desmodium rhytidophyllum*	-
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily
Fabaceae	*Glycine clandestina*	Twining Glycine
Fabaceae	*Hardenbergia violacea*	False Sarsparilla
Dilleniaceae	*Hibbertia scandens*	Climbing Guinea-flower
Oleaceae	*Jasminum polyanthum**	Jasmine
Fabaceae	*Kennedia rubicunda*	Dusky Coral Pea
Caprifoliaceae	*Lonicera japonica**	Japanese Honeysuckle
Bignoniaceae	*Macfadyena unguis-cati**	Cat's Claw Creeper
Bignoniaceae	*Pandorea pandorana*	Wonga Vine
Apocynaceae	*Parsonsia straminea*	Common Silkpod
Passifloraceae	*Passiflora edulis**	Common Passionfruit
Smilacaceae	*Smilax glyciphylla*	Sarsaparilla
Menispermiaceae	*Stephania japonica* var. *discolor*	Snake Vine
Epiphytes		
Orchidaceae	*Cymbidium suave*	Native Cymbidium
*** denotes exotic species** **TS denotes threatened species**		

4.1.2 Vegetation communities

- Cleared Land- 3.58ha
- Narrabeen Doyalson Coastal Woodland - 9.52ha
- Riparian Forest - 3.54ha (EEC - Swamp Sclerophyll Forest on Coastal Floodplains)

Cleared Land

This describes all cleared land, managed land or landscaped land within the study area. There are five (5) main patches of cleared land. There is one (1) associated with the existing dwelling including the access off Mulloway Drive. The second patch which comes off a track from the dwelling area and is sited along the eastern boundary approximately 50-100m from

the northern boundary. The third patch occurs near the middle of the site to the east of the dam. The fourth patch occurs on the eastern boundary opposite the southern extent of residential dwellings on the mobile home allotment to the east, and the fifth patch occurs on the boundary between floodplain and non-floodplain vegetation.

Cleared landscapes provide minimal value to fauna and flora, i.e., a lack of breeding or roosting value, but may have foraging value. The likelihood of threatened species habitat in cleared areas is virtually nil.

Photo 1 – Cleared vegetation on the south side of the existing residence

Photo 2 – One of the cleared and managed patches in the central eastern portion of the study area

Narrabeen Doyalson Coastal Woodland

This vegetation community describes all non-floodplain vegetation located within the study area, and occupies approximately 9.52 ha.

Canopy

Angophora costata, Eucalyptus haemastoma, Corymbia gummifera and *Eucalyptus capitellata* are the dominant species, 15-23m tall with a projected foliage cover mostly between 25-40%.

Sub-canopy

Allocasuarina littoralis. Vegetation height to 14m tall.

Mid-storey

Pittosporum undulatum, Banksia spinulosa, Acacia terminalis, Acacia longifolia, Leptospermum trinervium, Lambertia formosa, Glochidion ferdinandi, Hakea laevipes, Hakea bakeriana, Persoonia levis, Banksia oblongifolia and within moister areas, *Melaleuca sieberi.* Vegetation 1-18m tall and projected foliage cover of 5-40%. Cover is variable due to the impacts of fire. The southern quadrats contain less diversity and lower coverage value in the mid-storey.

Ground layer

Pultenaea retusa, Epacris pulchella, Gonocarpus teucrioides, Pimelea linifolia, Lomatia silaifolia, Bossiaea obcordata, Platysace linearifolia, Mirbelia rubiifolia, Acacia myrtifolia, Billardiera scandens, Hardenbergia violacea, Xanthorrhoea latifolia, Patersonia sericea, Lomandra obliqua, Dianella caerulea, Pteridium esculentum, Lindsaea linearis, Actinotus minor, Cryptostylis subulata, Pteridium esculentum, Lepidosperma laterale and *Pratia purpurascens.* Grasses include *Entolasia stricta, Eragrostis brownii, Themeda triandra, Panicum simile, Oplismenus aemulus, Imperata cylindrica* and *Anisopogon avenaceus.*

Photo 3 – Unburnt intact vegetation in the central northern portion of the study area

Photo 4 – Vegetation just east of the dam

Riparian Forest

This vegetation community describes the floodplain vegetation in the southern portion of the study area. The vegetation is upon hummocky grounds with small areas of soaks as well as mounds, thus there is a mixture of species that occur regularly in Swamp Sclerophyll vegetation as well as others that occur more regularly in drier locations but can handle the rare flood event.

Canopy

Eucalyptus robusta, Angophora costata, Eucalyptus capitellata and *Melaleuca quinquenervia* are the dominant species 12-23m tall and with a projected foliage cover of 20-40%.

Mid-storey

Melaleuca sieberi, Melaleuca linariifolia, Acacia longifolia, Pultenaea villosa, Glochidion ferdinandi and *Dodonaea triquetra.* Vegetation 1-12m tall and average projected foliage cover of 15-40%.

Ground layer

Gahnia spp.*, Pteridium esculentum, Centella asiatica, Goodenia heterophylla, Goodenia ovata, Villarsia exaltata, Pimelea linifolia, Gonocarpus teucrioides, Pultenaea retusa.* Grasses include *Entolasia stricta, Panicum simile* and *Imperata cylindrica.*

Photo 5 – Swamp Sclerophyll vegetation near Quadrat 2

Photo 6 – Burnt vegetation on the northern tip of the Swamp Sclerophyll forest

Photo 7 – Vegetation along the southern boundary which is Karignan Creek

4.2 Fauna results

Fauna species observed throughout the duration of fauna surveys are listed in Table 4.2 below.

Table 4.2 – Fauna observations for the study area

Common name	Scientific name	Method observed
Birds		**March 2016**
Australian Magpie	*Cracticus tibicen*	O W
Australian Owlet-nightjar	*Aegotheles cristatus*	W
Australian Raven	*Corvus coronoides*	W
Australian Wood Duck	*Chenonetta jubata*	O W
Brown Thornbill	*Acanthiza pusilla*	O W
Common Myna *	*Acridotheres tristis*	O W
Crested Pigeon	*Ocyphaps lophotes*	O
Eastern Rosella	*Platycercus eximius*	O W
Eastern Spinebill	*Acanthorhynchus tenuirostris*	O W
Eastern Yellow Robin	*Eopsaltria australis*	O W
Eurasian Coot	*Fulica atra*	O W
Galah	*Cacatua roseicapilla*	O W
Golden Whistler	*Pachycephala pectoralis*	O
Grey Butcherbird	*Cracticus torquatus*	O W
Grey Fantail	*Rhipidura albiscapa*	O
Laughing Kookaburra	*Dacelo novaeguineae*	O W
Lewin's Honeyeater	*Meliphaga lewinii*	O
Little Corella	*Cacatua sanguinea*	O W
Little Pied Cormorant	*Phalacrocorax melanoleucos*	O
Magpie-lark	*Grallina cyanoleuca*	O W
Masked Lapwing	*Vanellus miles*	W
Noisy Miner	*Manorina melanocephala*	O W
Pacific Black Duck	*Anas superciliosa*	O W

Common name	Scientific name	Method observed
Pied Currawong	*Strepera graculina*	W
Rainbow Lorikeet	*Trichoglossus haematodus*	O W
Satin Bowerbird	*Ptilonorhynchus violaceus*	O W
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	O W
Spotted Turtle-Dove *	*Streptopelia chinensis*	O W
Striated Heron	*Butorides striatus*	O
Sulphur Crested Cockatoo	*Cacatua galerita*	O W
Variegated Fairy-wren	*Malurus lamberti*	O W
Welcome Swallow	*Hirundo neoxena*	O
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	W
White-breasted Woodswallow	*Artamus leucorynchus*	O[PO]
White-browed Scrubwren	*Sericornis frontalis*	O W
White-winged Chough	*Corcorax melanorhhamphos*	O
Willie Wagtail	*Rhipidura leucophrys*	O W
Yellow-faced Honeyeater	*Caligavis chrysops*	W
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	W
Mammals		
Cat *	*Felis catus*	O
Common Brushtail Possum	*Trichosurus vulpecula*	O
Common Ringtail Possum	*Pseudocheirus peregrinus*	O E
Domesticated Dog *	*Canis lupus familiaris*	W
East-coast Freetail Bat [TS]	*Micronomus norfolkensis*	U
Eastern Bentwing-bat [TS]	*Miniopterus orianae oceanensis*	U
Gould's Wattled Bat	*Chalinolobus gouldii*	U
Large-footed Myotis[TS]	*Myotis macropus*	O U
Little Bentwing-bat [TS]	*Miniopterus australis*	U
Little Forest Bat	*Vespadelus vulturnus*	U[PO]
Squirrel Glider [TS]	*Petaurus norfolcensis*	W[PO]
Sugar Glider	*Petaurus breviceps*	F[PR]
Swamp Wallaby	*Wallabia bicolor*	O P
Reptiles		
Delicate Skink	*Lampropholis delicata*	O
Amphibians		
Brown Brood Frog	*Pseudophryne bibronii*	W[PO]
Common Eastern Froglet	*Crinia signifera*	W
Dusky Toadlet	*Uperoleia fusca*	W
Striped Marsh Frog	*Limnodynastes peronii*	W
Wallum Froglet [TS]	*Crinia tinnula*	W

Note: * indicates introduced species
[TS] indicates threatened species

All species listed are identified to a high level of certainty unless otherwise noted as:

[PR] indicates species identified to a 'probable' level of certainty – more likely than not
[PO] indicates species identified to a 'possible' level of certainty – recorded to a moderate to high level of uncertainty usually applied to a threatened species of note.

E - Nest/roost	H - Hair/feathers/skin	P - Scat	W - Heard call
F - Tracks/scratchings	K - Dead	Q - Camera	X - In scat
FB - Burrow	O - Observed	T - Trapped/netted	Y - Bone/teeth/shell
G - Crushed cones	OW - Obs & heard call	U - Anabat/ultrasound	Z - In raptor/owl pellet

Figure 3 - Flora and fauna survey effort and results

Ecological Discussion 5

5.1 Flora

A total of two hundred and twenty six (226) species were identified during the botanical field survey. A number of landscaping species were observed around the existing residential dwelling in the northern portion of the study area but not necessarily added to the species list. The number of species indicate that the site contains a high diversity of species.

No threatened flora species were observed during the general February and March 2016 field survey.

All species are listed in Table 4.1.

5.1.1 Threatened flora species

TSC Act – A search of the *Atlas of NSW Wildlife* database (OEH 2016) indicated a list of species that have been recorded within a 10km radius of the study area. A review of the schedules of the *EPBC Act* indicated the potential for a list of threatened flora species to also occur within a 10km radius of the site. These species have been considered for habitat presence and potential to occur within Appendix 2.1 (Appendix 2).

Based on the habitat assessment within Appendix 2, it is considered that the study area provides varying levels of potential habitat for the following state listed threatened flora species:

Table 5.1 – Potential threatened flora habitat

Common name	TSC Act	EPBC Act	Potential to occur
Acacia bynoeana	E1	V	✓
Angophora inopina	V	V	✓
Caladenia tessellata	E1	V	low
Callistemon linearifolius	V	-	✓
Corunastylis sp. Charmhaven	CE	CE	low
Cryptostylis hunteriana	V	V	✓
Diuris praecox	V	V	✓
Eucalyptus parramattensis subsp. *decadens*	V	V	low
Genoplesium insigne (Corunastylis insignis)	E1	CE	✓
Tetratheca juncea	V	V	✓

Note: Full habitat descriptions for these species are provided in Appendix 2.

Whilst no threatened species have been observed in the surveys during February, March, and August 2016, surveys have not been undertaken in the ideal flowering period for some cryptic species. It is inconclusive regarding some of the orchids and *Tetratheca juncea* as to whether or not they occur until such survey has been undertaken.

5.1.2 Endangered flora populations

Eucalyptus parramattensis subsp. *parramattensis* population, Wyong and Lake Macquarie local government areas

The population of *Eucalyptus parramattensis* subsp. *parramattensis* in Wyong and Lake Macquarie local government areas is at the north eastern limit of the range of the species and is disjunct from other known populations of the subspecies.

The majority of the population occurs within Wyong in the Porter's Creek and the Wallarah Creek catchments.

This species is associated with low moist areas alongside drainage lines and adjacent to wetlands. It is often found in woodland on sandy soils. The endangered population occurs on sandy alluvium within a floodplain community which also supports *Eucalyptus robusta* (Swamp mahogany), *E. tereticornis* (Forest Red Gum), *C. gummifera* (Sydney Bloodwood) as well as Melaleuca (Paperbark) species.

The interface between the Riparian Forest and Narrabeen Doyalson Coastal Woodland could form potential habitat for the endangered population to occur, i.e. the southern portion of the study area.

There is one part of the population located approximately 4km away, however the rest of the known population is largely centred closer to Warnervale almost 10km away.

Surveys conducted on site have not located any specimens of *E. parramattensis* subsp. *parramattensis* within the study area. As such, endangered populations form no constraint to future development of the site.

5.1.3 Endangered ecological communities

Transect plots were placed within all remnant bushland areas on site, separated generally by with a separation of 75-125m to assist in defining all vegetation types across the study area. The four (4) quadrats at the southern end of the study area were assessed as conforming to the *EEC - Swamp Sclerophyll Forest on Coastal Floodplains*. The ground is very hummocky meaning there are multiple undulations of the ground layer where water has risen and pooled. The mounds provide a drier landscape whereby species atypical of Swamp Sclerophyll Forest may persist or thrive, such as *Angophora costata.* Although several atypical species occur within the vegetation community, it still has a strong presence of Swamp Mahogany, Melaleucas and Gahnia, which occur throughout the entire community.

The approximate extent of this EEC varies from approximately 85m to 200m in width and over an area of just over 3.5 ha north from Karignan Creek which forms the southern boundary of the study area. The EEC continues east and west along Karignan Creek but grades to another EEC, Swamp Oak Floodplain Forest towards the foreshore of Lake Macquarie.

The presence of the EEC within the study area is a constraint to future development for four (5) main reasons:

- EEC listed under the TSC Act schedules
- Parts are flood affected.
- Contains winter flowering resources for threatened fauna species
- Riparian vegetation adjacent to a mapped watercourses requires riparian setbacks in accordance with the NSW DPI - Office of Water Guidelines for Controlled Activities.
- EEC's that are also listed as endangered wetland communities under the TSC Act that require setbacks and buffers of 40m setbacks in accordance with the NSW DPI - Office of Water Guidelines for Controlled Activities.

Most of the EEC is contained within the current and proposed E2 zoning which allows for ongoing protection of the remnant along the creek line. Some of the northern extent may be suitable for development provided there is sufficient delineation and protection of the edge to limit access, dumping, weed invasion and other impacts.

5.1.3 Endangered wetland communities

Endangered wetland communities that have been listed as an 'endangered ecological community' under the NSW Threatened Species Conservation Act include:-

- *Artesian springs ecological community - endangered ecological community listing*
- *Castlereagh swamp woodland community - endangered ecological community listing*
- *Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing*
- *Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing*
- *Kurri sand swamp woodland in the Sydney Basin Bioregion - endangered ecological community listing*
- *Lagunaria swamp forest on Lord Howe Island - endangered ecological community listing*
- *Maroota Sands swamp forest - endangered ecological community listing*
- *Montane peatlands and swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions - endangered ecological community listing*
- *Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion - endangered ecological community listing*
- *Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing*
- *Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological listing*
- *Sydney Freshwater Wetlands in the Sydney Basin Bioregion - endangered ecological community listing*
- *The shorebird community occurring on the relict tidal delta sands at Taren Point - endangered ecological community listing*
- *Upland wetlands of the drainage divide of the New England Tableland Bioregion - endangered ecological community listing*

The endangered wetland community - *Swamp sclerophyll forest on coastal floodplains* has been recorded onsite and hence attracts a protective buffer of 40m in accordance with the NSW DPI - Office of Water Guidelines for Controlled Activities. A riparian & wetland assessment report is required to be submitted to NSW DPI for assessment under the Water Management Act 2000 as a controlled activity.

5.2 Fauna

All fauna species recorded during survey(s) are listed in Table 4.2.

5.2.2 Habitat trees

A complete assessment of the location of habitat trees, and the size of hollows within, was not conducted as part of surveys undertaken. The available size range and quality of hollows were noted during site visits.

Locations and data on significant habitat trees were noted during the fauna survey within the currently zoned E3 central and northern portions of the study area. For this site significant habitat trees were those medium and large sized hollows considered suitable for use by threatened species with most potential to occur, specifically large forest owls, Glossy Black-Cockatoo and Squirrel Glider. Hollows considered suitable for threatened microbat species would include small hollows which are most numerous and these have not been identified.

Given potential for Squirrel Glider, Red Bloodwood trees showing high use for sap feeding by gliders were also identified in this area.

Locations of significant habitat trees were identified by GPS and suitability for each species was noted. Figure 7 shows the locations of significant habitat trees and suitability.

5.2.1 Fauna habitat

The fauna habitats present within the site are identified within Table 5.2.

Table 5.2 – Observed fauna habitat

Topography				
Flat ✓	Gentle ✓	Moderate	Steep	Drop-offs
Vegetation structure				
Closed Forest	Open Forest ✓	Woodland ✓	Heath	Grassland ✓
Disturbance History				
Fire ✓	Under-scrubbing ✓	Cut & fill works ✓		
Tree clearing ✓	Grazing ?			
Soil Landscape				
DEPTH:	Deep ✓	Moderate ✓	Shallow ✓	Skeletal
TYPE:	Clay ✓	Loam ✓	Sand	Organic ✓
VALUE:	Foraging ✓	Denning ✓	Roosting	Digging ✓
WATER RETENTION:	Well Drained ✓	Damp / Moist ✓	Water logged ✓	Swamp / Soak ✓
Rock Habitat				
None present				
Feed Resources				
FLOWERING TREES:	Eucalypts ✓	Corymbias ✓	Melaleucas ✓	

	Banksias ✓	Acacias ✓	Angophoras ✓	
SEEDING TREES:	Allocasuarinas ✓	Conifers		
WINTER FLOWERING EUCALYPTS:	C. maculata ✓	E. crebra	E. globoidea	E. sideroxylon
	E. squamosa	E. grandis	E. multicaulis	E. scias
	E. robusta ✓	E. tereticornis	E. agglomerata	E. siderophloia
FLOWERING PERIODS:	Autumn ✓	Winter ✓	Spring ✓	Summer ✓
OTHER:	Mistletoe ✓	Figs / Fruit ✓	Sap / Manna ✓	Termites ✓
Foliage Protection				
UPPER STRATA:	Dense	Moderate ✓	Sparse ✓	
MID STRATA:	Dense	Moderate	Sparse ✓	
PLANT / SHRUB LAYER:	Dense	Moderate ✓	Sparse ✓	
GROUNDCOVERS:	Dense ✓	Moderate ✓	Sparse ✓	
Hollows / Logs				
TREE HOLLOWS:	Large ✓	Medium ✓	Small ✓	
GROUND HOLLOWS:	Large ✓	Medium ✓	Small ✓	
Vegetation Debris				
FALLEN TREES:	Large ✓	Medium ✓	Small ✓	
FALLEN BRANCHES:	Large ✓	Medium ✓	Small ✓	
LITTER:	Deep ✓	Moderate ✓	Shallow ✓	
HUMUS:	Deep ✓	Moderate ✓	Shallow ✓	
Drainage Catchment				
WATER BODIES	Soak(s) ✓	Dam(s) ✓	Drainage line(s)	Creek(s) ✓ River(s)
RATE OF FLOW:	Still ✓	Slow ✓	Rapid	
CONSISTENCY:	Permanent ✓	Perennial	Ephemeral	
RUNOFF SOURCE:	Urban / Industrial	Parkland ✓	Grazing	Natural ✓
RIPARIAN HABITAT:	High quality ✓	Moderate quality ✓	Low quality	Poor quality
Artificial Habitat				
STRUCTURES:	Sheds ✓	Infrastructure	Equipment ✓	
SUB-SURFACE	Pipe / Culvert(s)	Tunnel(s)	Shaft(s)	
FOREIGN MATERIALS:	Sheet ✓	Pile / Refuse ✓		

5.2.3 Vegetation connectivity and wildlife corridors

The Wildlife Corridors Strategy – Field Evaluation of Linkage (Payne 2002) identified regional and subregional corridors of significance within the Wyong Shire. This information was not able to be sourced from council's website. Section 7 of the Wyong Conservation Strategy (2003) indicates that Wyong Shire Council has conducted mapping and analysis based on the work by Payne and others depicting future wildlife corridors, however this mapping was not sourced and the text makes no reference to Chain Valley Bay or Gwandalan.

Figure 4 - Local connectivity

The open forest vegetation within the study area provides mostly high quality natural condition habitat with connectivity to the north, south-west and south-east. This connectivity is depicted in Figure 4 which shows that the site represents local connective values for wildlife between these aspects. The southern portion of the site currently zoned as E2 provides important connectivity from east to west along Karignan Creek. The remaining northern portions of the site contributes to provide a linkage between this riparian corridor and habitat extending north up to the Gwandalan peninsula.

It may be argued that rezoning for development within the current E3 portions of the site will not isolate this connectivity given that the east-west connectivity through the southern E2 portions will be retained and this ultimately also connects to the north (see Figures 4 & 5). The open forest habitat through the E3 portions of the study area however provides more direct connectivity at widths between 60-160m wide and passes through a wide variety of vegetation types.

As stated by Ambrose (2007) it is essential for a corridor to have the following characteristics in order to be effective:

- Vegetated corridors that comprise a mosaic of different habitats are considered more likely to contain the necessary food, shelter and nesting resources for fauna. Therefore, corridors that link patches over the entire ecological gradient from ridge to gully would conserve more species, especially those that have large home ranges and changing seasonal requirements (Lindenmayer et al. 1994).

- The quality of the habitat within the corridor is important. Some fauna would reluctantly utilise corridors of low quality, such as areas invaded by weeds or subject to frequent fires, or due to a reduction in the availability of essential resources (such as feeding, shelter, roosting and breeding sites).

- The size of the corridor is also important. For example, corridors with mature trees, but with little or no understorey may afford good habitat for birds, bats and some arboreal fauna, but not for ground-dwelling fauna.

Further to this, the meandering of Karignan Creek along the southern boundary of the study area provides a variable barrier for terrestrial fauna passage at two locations along the east-west transition however at only one location through the more direct north-south line of passage. North south and other connective roads also potentially limit connectivity throughout the landscape but not of sufficient width to limit movement of mammals and other wildlife throughout the adjoining lands. North south connectivity should be reconsidered in the context of recommended fauna studies that will more clearly ascertain the importance of remnant habitat connective vegetation for wildlife movement.

Based on the current extent of quality habitat a corridor of 30-40m in width (current minimum width of connective link) is recommended. This means that the minimum connective width is maintained through the site and will not cause a significant change in the overall connective width as assessed using the Biobanking assessment methodology. The importance of this connective link to local fauna is to be evaluated through an in-field connectivity assessment across the existing roads.

Figure 5 - Study site connectivity

5.2.4 Local fauna matters

Section 8.4.3 of the Wyong Shire Council Survey Guidelines (2014) provides a list of regionally significant fauna species. Regionally significant fauna species recorded within the study area or nearby during survey to date include:

- Yellow-tailed Black-Cockatoo
- White-bellied Sea Eagle

- Sugar Glider
- Bibron's Toadlet (Brown Brood Frog)
- Tinkling Toadlet (Wallum Froglet)

The study area provides recorded breeding habitat for the Bibron's Toadlet and Tinkling Toadlet, likely breeding habitat for Sugar Glider and suitable breeding (nesting) habitat for Yellow-tailed Black-Cockatoo. The study area does not likely provide breeding habitat for the White-bellied Sea Eagle as no nests were located during survey. Based on calls heard to the west during survey it is expected that a nest is however present in the nearby locality.

5.2.4.1 Squirrel Glider habitat assessment

Squirrel Glider habitat in the study area should be assessed according to Wyong Shire Councils *Interim Ecological Assessment Information Required to Assess Clearing Impacts within Squirrel Glider Habitat in Wyong Shire* (Wyong Shire Council, August 2000). A standardized field proforma providing consideration to this document is filled out during field surveys undertaken within the Wong LGA. This is provided in Appendix 3.

The assessment of Squirrel Glider habitat considers the following:

(a) Habitat quality (vegetation type);
(b) Remnant patch size;
(c) Density of habitat trees;
(d) Abundance of food plants;
(e) Habitat vulnerability;
(f) Disturbance factors.

The available habitat for Squirrel Gliders occupies approximately 81% of the study area. All other areas are cleared and/or highly disturbed.

(a) Habitat Quality

The available habitat within the study areas and adjacent connective open forest areas is considered to be high quality for Squirrel Glider. This is considered based particularly on recordings from similar type habitat. Such habitat provides the presence of year-round foraging resources (particularly winter flowering Swamp Mahogany), the availability and density of medium hollows and the forest structure for gliding.

Prominent trees occurring within the site include *Eucalyptus robusta* (Swamp Mahogany), *Melaleuca quinquenervia* (Broad-leaved Paperbark), *Angophora costata* (Smooth-barked Apple), Scribbly Gum (Eucalyptus haemastoma), Red Bloodwood (Corymbia gummifera), Brown Stringybark (eucalyptus capitellata), Thin-leaved Stringybark (*Eucalyptus eugenioides*) and *Glochidion ferdinandi* (Cheese tree). Squirrels Gliders have been recorded foraging on the many of these species, particularly those with higher occurrence. Prominent native shrubs are *Acacia longifolia*, *Pittosporum undulatum, Leptospermum trinervium, Banksia spinulosa, Lambertia formosa, Hakea laevipes, Acacia terminalis, Banksia oblongifolia* and *Melaleuca sieberi*.

Some fringing areas of open forest have been impacted by invasive weeds, but the majority (approximately >80%) is considered of good condition.

(b) Remnant Patch Size

The remnant patch size of usable habitat for the Squirrel Glider within the study area is approximately 13 ha. This is calculated incorporating the open forest communities. Connectivity exists to the north, south-west and south-east.

(c) Density Habitat Trees

The density of habitat trees within the Open Forest remnant is greater than 1 per hectare. Trees identified as containing hollows that appear suitable or may be suitable for denning are depicted on Figure 7. In respect to the availability of suitable hollows and the density of these hollows the habitat present is therefore good quality.

(d) Abundance of Food Plants of Squirrel Glider

The abundance of Squirrel Glider food resources within the study area are summarised in Table 5.3 for the recorded vegetation communities.

Table 5.3 – Squirrel Glider food resource abundance

Food plants	Food item	Estimated Average No. of Plants / hectare in	
		Narrabeen Doyalson Coastal Woodland - 9.52ha	Riparian Forest - 3.54ha
Angophora costata	Sap, nectar & pollen	80	80
Eucalyptus haemastoma	Sap, nectar & pollen	150	40
Eucalyptus robusta	Sap, nectar & pollen	-	100
Corymbia gummifera	Sap, nectar & pollen	150	20
Melaleuca linariifolia	Nectar & insects	-	100
Melaleuca quinquenervia	Nectar & insects	-	200
Melaleuca sieberi	Nectar & insects	1	500
Acacia spp.	Seeds & gum	250	250
Banksia spinulosa	Nectar & pollen	100	50
Banksia oblongifolia	Nectar & pollen	25	100
Xanthorrhoea spp.	Nectar & gum	100	20

(e) Edge to Width Ratio

The patch shape is irregular and linear between connective options to the north and south. This is given the cleared patches within the outer edges of the rectangle study area. The result is a moderate edge: width ratio.

(f) Habitat Disturbance

Some portions of the open forest and woodland communities present are disturbed, particularly along the western boundary, surrounding the house and the dam and in edge affected areas. The southern portions have been impacted by fire. Otherwise the habitat is in good quality with little disturbance.

(g) Proximity to Existing or Future Residential Development

The study area is bounded to the east and north-west by private recreation (RE2) and to the west by low density residential (R2) which are currently cleared lands containing

development. Remaining lands to the north-east (E1 - National Parks & Reserves) and south (E2 - Environmental Conservation) containing native remnant vegetation.

Conclusion of Squirrel Glider Assessment

Survey to date has recorded Squirrel Glider by call to the south to a 'possible' level of certainty. Glider chew markings on Red Bloodwood trees are likely from the non-threatened Sugar Glider but may also be from Squirrel Glider. Trapping effort is required within the study area to best confirm site presence and use and is therefore a key recommendation in respect to fauna considerations.

The study area is considered as high quality habitat for the Squirrel Glider based on the above considerations specifically seasonal foraging attributes, density of hollows, connectivity, quality of vegetation and patch size.

It is considered that there is potential for Squirrel Gliders to be currently utilising this habitat as part of home ranges, seasonally or in future population movements.

There are one hundred and seventy-one (171) records of this species within 10km of the study area, with previous records surrounding Chain Valley Bay with the closest records between 1-1.4 km from the study area to the north, north-east, south, west and south-west. The most recent of these nearby records is from 2002 however other recent records in the locality and retention of extensive suitable habitat areas suggest that nearby populations persist.

The confirmed presence of this species and considerations to connectivity will likely provide a constraint to development within the study area.

5.2.5 Threatened fauna species

TSC Act – A search of the *Atlas of NSW Wildlife* database (OEH 2016) provided a list of threatened fauna species previously recorded within a 10km radius of the study area. A review of the schedules of the *EPBC Act* identified a list of threatened fauna species or species habitat also likely to occur within a 10km radius of the study area. These species have been considered for habitat presence and potential to occur within Table A2.2 (Appendix 2).

Based on the habitat assessment within Appendix 2, it is considered that the study area provides varying levels of potential habitat for the following state and nationally listed threatened fauna species:

Table 5.4 – Potential threatened fauna with potential to occur

Common name	TSC Act	EPBC Act	Potential to occur
Wallum Froglet	V	-	recorded
Squirrel Glider	V	-	recorded
Large-footed Myotis	V	-	recorded
East-coast Freetail Bat	V	-	recorded
Little Bentwing-bat	V	-	recorded
Eastern Bentwing-bat	V	-	recorded
Glossy Black-Cockatoo	V	-	✓
Little Lorikeet	V	-	✓
Swift Parrot	E	E	✓
Powerful Owl	V	-	✓

Common name	TSC Act	EPBC Act	Potential to occur
Masked Owl	V	-	✓
Varied Sittella	V	-	✓
Koala	V	V	✓
Grey-headed Flying-fox	V	V	✓
Eastern Falsistrelle	V	-	✓
Greater Broad-nosed Bat	V	-	✓
Black Bittern	V	-	low
Little Eagle	V	-	low
Eastern Osprey	V	-	low
Barking Owl	V	-	low
Yellow-bellied Sheathtail-bat	V	-	low
Eastern Chestnut Mouse	V	-	low
Stephens' Banded Snake	V	-	unlikely
Superb Fruit-dove	V	-	unlikely
Regent Honeyeater	E4A	CE	unlikely
White-fronted Chat	V	-	unlikely
Spotted-tailed Quoll	V	E	unlikely
Eastern Pygmy Possum	V	-	unlikely
Eastern Cave Bat	V	-	unlikely

Note: Full habitat descriptions for these species are provided in Appendix 2

Six (6) state listed threatened fauna species including Wallum Froglet (C*rinia tinnula*), Squirrel Glider (*Petaurus norfolcensis*), Large-footed Myotis (*Myotis macropus*), East-coast Freetail Bat (*Micronomus norfolkensis*), Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*Miniopterus orianae oceansis*) were recorded during the preliminary survey.

The Squirrel Glider was only recorded by call to a 'possible' level of certainty from across Karignan Creek to the south-west of the study area. .

A single Wallum Froglet was recorded by call during the late afternoon. Call-playback during light rain after dark again stimulated small call activity in the same area.

The threatened microbats were recorded by Anabat foraging over the dam. Large-footed Myotis was also spotlighted foraging along Karignan Creek.

No nationally listed threatened fauna species were recorded during the preliminary survey however Grey-headed Flying-fox is expected to seasonally utilise the site and Swift Parrot has high potential to forage within the study area during winter flowering.

FM Act – In respect of matters relative to the *FM Act,* no threatened or protected species records on the DPI records viewer are known to the Wyong or Lake Macquarie LGA's. Therefore no suitable habitat for threatened aquatic species was observed within the study area and no matters require further consideration under this Act.

5.2.6 Protected migratory species

The EPBC Act Protected Matters Report provides additionally listed terrestrial, wetland and marine migratory species of national significance likely to occur, or with habitat for these species likely to occur, within a 10km radius of the study area. These migratory species are considered for potential habitat in Table A2.3 (Appendix 2). Threatened migratory species are considered for potential habitat in Table A2.2 (Appendix 2).

One (1) protected migratory bird species White-bellied Sea Eagle (*Haliaeetus leucogaster*) was recorded during the preliminary survey. This species is not likely to offer a constraint to rezoning for development as no nest sites were found present in the study area.

5.2.7 Endangered fauna populations

There are no endangered fauna populations within the Wyong LGA.

5.2.8 SEPP 44 Koala Habitat Protection

SEPP 44 Koala Habitat Protection applies to land within Local Government Areas (LGAs) listed under Schedule 1 of the Policy. In addition, Part 2 of the Policy outlines a three (3) step process to assess the likelihood of the land in question being Potential Koala Habitat (PKH) or Core Koala Habitat (CKH). Part 2 applies to land which has an area of greater than 1ha or has, together with any adjoining land in the same ownership, an area of more than 1ha.

The study area is required to be considered under SEPP 44 as it falls within the Wyong LGA, which is listed on Schedule 1 of this Policy. The total study area is greater than 1ha, hence Part 2 – Development Control of Koala Habitats of the Policy applies.

PKH is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the Policy.

CKH is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (i.e. females with young) and recent sightings of, and historical records, of a population.

Step 1 – Is the land PKH?

Two Koala food tree species – Swamp Mahogany (*Eucalyptus robusta*) and Scribbly Gum (*Eucalyptus haemastoma),* as listed on Schedule 2 of SEPP 44 – were found within the study area. Scribbly Gum occurred at approximately 30% within the Narrabeen Doyalson Coastal Woodland community and Swamp Mahogany (with a few Scribbly Gum) occurred at likely above 15% within the Riparian Forest community. Therefore the study area is classified under SEPP 44 as 'potential Koala habitat'.

Step 2 – Is the land CKH?

No Koalas were directly observed at the time of fauna survey, which included diurnal searches of trees, nocturnal call-playback and spotlighting. In addition, there was no secondary evidence of Koala habitation in the area including characteristic scratches on smooth-barked trees and scats beneath trees.

A search of the Atlas of NSW Wildlife (OEH 2016) found twenty-two (22) records of Koala habitation within a 10 km radius of the study area. The closest four records are located just beyond 2km to the east all in 2003. It is possible that a local Koala population does persist in this area as three of these records which are separated by 200-300m were recorded on the same day. The fourth record was from 2 months later.

Given that Koala was not recorded in the preliminary survey and no records exist immediately surrounding the study area it is not expected that the site comprises CKH under the definitions of SEPP 44. Further survey should confirm this however based on findings to

date the land is not considered to comprise CKH and a Koala Plan of Management is not considered to be required.

5.2.9 Fauna constraints analysis

The proposal has varying potential to impact on the following fauna species with most potential to occur and their habitat attributes indicated:

Table 5.5 – Potential threatened fauna habitat impacts

COMMON NAME	TSC Act	EPBC Act	Potential to occur	Potential habitat impact
Wallum Froglet	V	-	recorded	recorded breeding
Squirrel Glider	V	-	recorded	likely denning, breeding & foraging
Large-footed Myotis	V	-	recorded	potential roosting/breeding, recorded foraging
East-coast Freetail Bat	V	-	recorded	potential roosting/breeding, recorded foraging
Little Bentwing-bat	V	-	recorded	recorded foraging only
Eastern Bentwing-bat	V	-	recorded	recorded foraging only
Glossy Black-Cockatoo	V	-	✓	potential roosting/breeding/foraging
Little Lorikeet	V	-	✓	potential roosting/breeding/foraging
Swift Parrot	E	E	✓	high potential winter foraging
Powerful Owl	V	-	✓	potential roosting/breeding/foraging
Masked Owl	V	-	✓	potential roosting/breeding/foraging
Varied Sittella	V	-	✓	potential roosting/breeding/foraging
Koala	V	V	✓	potential part of home range
Grey-headed Flying-fox	V	V	✓	expected seasonal foraging only
Eastern Falsistrelle	V	-	✓	potential roosting/breeding/foraging
Greater Broad-nosed Bat	V	-	✓	potential roosting/breeding/foraging

Further survey is required to determine presence and or extent of habitat use by the following species which may cause constraints to development:

- fullest extent of breeding area for Wallum Froglet,
- potential nesting activity for Powerful Owl, Masked Owl and Glossy Back-Cockatoo,
- presence of Squirrel Glider in E3 areas
- confirm no home range use of site by Koala

In summary the following threatened fauna species are most notable to provide likely or potential constraint to development:

- The recorded Wallum Froglet breeding area will need to be retained and protected with sufficient buffers to ensure that development will also not indirectly impacts on water quality and quantity to this area.
- Squirrel Glider was recorded by call along the creek to a 'possible' level of certainty. If this species is found present within the proposed areas for rezoning, significant habitat retention measures and mitigation measures would be required to ensure denning and foraging habitat remains well represented within the study area.
- No foraging activity by Glossy Black-Cockatoo was recorded during the preliminary survey and no evidence of owl activity was noted, therefore breeding by these species is not necessarily expected. If however found to be utilising large hollows during the winter breeding season sufficient habitat retention buffers would need to be provided for such trees. Any future recording of presence of Little Lorikeet would require a search for roost/nest hollows.

- Koala is not expected to occur however habitat is high quality particularly the southern portions and if found to be present this would offer significant constraint.
- Microbats typically will not constrain development provided hollow retention and relocation measures can be demonstrated. Other fauna species considered are unlikely to constrain development however full seasonal use of the extensive habitats present cannot be currently completely predicted.

Conclusion & Recommendations 6

6.1 Conclusions

It is concluded that the study area is potentially constrained by the following ecological issues:

- EEC and Endangered Wetland Community (EWC) vegetation along the southern boundary.
- Squirrel Glider habitat and loss of connectivity through the site to remnant vegetation north of Mulloway Drive.

The following further survey is required in order to provide a comprehensive assessment of impacts on threatened biodiversity and to determine the full extent of environmental protection zones that are relevant to the planning proposal:

- Target threatened flora surveys for cryptic orchids and *Tetratheca juncea* during spring.
- Further survey and assessment for Squirrel Glider.

Based on the limited fauna survey undertaken to date (which excludes comprehensive survey for fauna) the main fauna based constraints to future development of the lands includes protection of critical hollow-bearing Squirrel Glider denning and foraging habitat and provision of a movement corridors to bushland north of Mulloway Drive.

The findings of any cryptic flora survey to be conducted at a later date may require some proposed R2 lands to also be protected under an E3 Environmental management zone.

Any future development application would need to be accompanied by an assessment of impacts as part of a 7 part test of significance. Any newly listed threatened species, endangered ecological community or endangered population listed since this advice will also need to be assessed in accordance with the requirements of the *Environmental Planning and Assessment Act 1979*, *Threatened Species Conservation Act 1995*, the *Environment Protection and Biodiversity Conservation Act 1999* and the *Fisheries Management Act 1994*.

Given the current state of flux with the current legislative review of the Threatened Species Conservation Act and the Native Vegetation Act and proposed draft Biodiversity Conservation Bill, draft Local Land Services (Amendment) Bill, *Travers bushfire & ecology* recommends that all work should be conducted to allow the preparation of a biodiversity certification assessment which will enable the net gains and losses in biodiversity values to be determined and potentially offset under future legislative changes.

EPA Act and TSC Act

In respect of matters required to be considered under the *EPA Act* and relating to the species / provisions of the *TSC Act.*

- Six (6) threatened fauna species including Wallum Froglet (C*rinia tinnula*), Squirrel Glider (*Petaurus norfolcensis*), Large-footed Myotis (*Myotis macropus*), East-coast Freetail Bat (*Micronomus norfolkensis*), Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*Miniopterus orianae oceansis*) were recorded within or in close proximity to the study area. The Squirrel Glider was only recorded by call to a 'possible' level of certainty.

- Swamp Sclerophyll Forest on Coastal Floodplains is present along the southern boundary of the site which is largely covered within the existing and proposed E2 zoning.

- The Endangered Wetland Community - Swamp sclerophyll forest on coastal floodplains has been recorded onsite and hence attracts a protective buffer of 40m in accordance with the NSW DPI - Office of Water Guidelines for Controlled Activities. A wetland assessment report is required to be submitted to NSW DPI for assessment under the Water Management Act 2000 as a controlled activity.

- No endangered populations have been observed.

EPBC Act

In respect of matters required to be considered under the *EPBC Act:*

- No threatened fauna species were recorded within the study area.

- One (1) protected migratory fauna species – White-bellied Sea Eagle (*Haliaeetus leucogaster*) – was recorded within close proximity to the study area.

- No threatened flora species, endangered populations or EECs listed under the *EPBC Act* were recorded within or in close proximity the study area.

FM Act

In respect of matters relative to the *FM Act,* no threatened or protected species records on the DPI records viewer are known to the Wyong or Lake Macquarie LGA's. Therefore no suitable habitat for threatened aquatic species was observed within the study area and no matters require further consideration under this Act.

6.2 Recommendations

Further fauna and flora survey is to be undertaken as outlined in Section 3.6 - Survey limitations.

The proposed R2 Low Density Residential Zone covers the majority of the study area, leaving the southern floodplain and riparian area for conservation, E2.

Further studies upon Squirrel Glider and threatened flora during spring is required before a final determination can be made. Some habitat resources within the R2 lands may need to be retained post additional fauna survey works, particular if found to be utilised by the Squirrel Glider, as the zoning would potentially remove a good intact corridor link in the local area.

The boundary of the proposed zonings also need to reflect the objectives of the NSW Wetlands Policy and zonings in regards to riparian and wetland.

With respect to the residential zones, we recommend that future development be designed in accordance with:

- Water sensitive urban design (WSUD) principles.
- Is managed to minimise the export of sediment and implements site specific erosion controls in accordance with the *Soils and construction manual - Managing Urban Stormwater* (Landcom 2004).
- Protects waterfront lands & endangered wetland communities and implements controls in accordance with the NSW DPI Office of Water *Guidelines for Controlled Activities on Waterfront Land* (2012).
- Asset protection zones are excluded from a 40m Endangered wetland buffer that reduces the likelihood of weed invasions and loss of native vegetation within the riparian corridor.
- Connectivity assessment which maintains important habitat and hollow-bearing resources where possible or allows for compensation within retained bushland.

With respect to the proposed E2/E3 zoned lands, we recommend that future development be designed in accordance with the following mitigation measures:

- Protect vegetation within waterfront lands and endangered wetland communities and setbacks in accordance with the *NSW DPI Guidelines for Controlled Activities on Waterfront Land (2012).*
- Provides adequate separation to watercourses for effluent treatment purposes and effectively controls and treats stormwater runoff into the creek.
- Minimises the loss of trees and associated habitat due to asset protection zones, access, building sites and services.
- Applies a vegetation management plan outlining conservation management practices to protect, restore and enhance vegetation and habitat within the E2 zone.
- Maintains minimum connective links through important foraging areas for arboreal mammals.

Bibliography

Ambrose, S. (2007) *Supplementary Fauna Survey and Assessment – Proposed Plant Nursery, Enterprise Drive, Glenning Valley*, Ambrose Ecological Services.

Auld, B. A. & Medd, R. W. (1996) *Weeds.* Inkata Press.

Barker, J., Grigg, G. C. & Tyler, M. J. (1995) *A Field Guide to Australian Frogs.* Surrey Beatty & Sons.

Bennett, A. F. (1990a) *Habitat Corridors: Their Role in Wildlife Management and Conservation*. Department of Conservation and Environment, Victoria).

Benson, D. H. (1986) *The Vegetation of the Gosford and Lake Macquarie 1:100,000 Sheet.*

Bishop, T. (1996) *Field Guide to the Orchids of New South Wales and Victoria.* UNSW Press.

Briggs, J. D. & Leigh, J. H. (1995) *Rare or Threatened Australian Plants.* CSIRO.

Churchill, S. (2008) *Australian Bats*, 2nd Ed., Jacana Books, Crows Nest, Sydney.

Cogger, H. G. (1996) *Reptiles and Amphibians of Australia*. Reed Books, Australia.

DEC (2004) *Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft),* New South Wales Department of Environment and Conservation, Hurstville, NSW.

DECC (2008) *Bio-banking Methodology*.

Ehmann, H. (1997) *Threatened Frogs of New South Wales.* FATS Group.

EPBC (1999) Environmental Protection and Biodiversity Conservation Act 1999 - Interactive Map Database Search - http://epbcweb.ea.gov.au/image/otherbatch.html

WSC (2012) *Flora and Fauna Survey Guidelines*. Version 2

Griffiths, K. (1997) *Frogs and Reptiles of the Sydney Region.* University NSW Press.

Harden, G. (1993) *Flora of New South Wales.* University NSW Press.

Hoser, R. (1989) *Australian Reptiles and Frogs.* Pierson & Co.

Lamp, C. & Collett, F. (1996) *A Field Guide to Weeds in Australia.* Inkata Press.

Lunney, D., Urquart, C .A. & Reed, P. (1988) *Koala Summit,* NPWS.

Marchant, S., & P. J. Higgins (Eds) (1990) *Handbook of Australian, New Zealand and Antarctic Birds.* Volumes 1-7 Oxford University Press, Melbourne.

Morrison, R. G. B. (1981) *A Field Guide to the Tracks & Traces of Australian Animals.* Rigby.

OEH (2016) *Atlas of NSW Wildlife* – Bionet 10km search

Parnaby, H. (1992) *An interim guide to identification of insectivorous bats of south-eastern Australia.* The Australian Museum, Sydney, Technical Report, No. 8.

Phillips, S. & Callaghan, J. (2008) The *Spot Assessment Technique*: a tool for determining levels of localised habitat use by Koalas *Phascolartoc cinereus*. Aust. Koala Foundation. Manuscript submitted to: Ecological management and Restoration

Phillott AD, Skerratt LF, McDonald KR, Speare R, Hines HB, Meyer E, Cashins SD, Mendez D & Berger L (2010) Minimising exposure of amphibians to pathogens during field studies. Inter-research. Diseases of Aquatic Organisms, *Contribution to DAO Special 4: 'Chytridiomycosis: an emerging disease'*

Pizzey, G. & Knight, F. (1997) *A Field Guide to the Birds of Australia.* Angus & Robertson.

Reader's Digest (1976) *Complete Book of Australian Birds.*

Richardson, F. J., Richardson, R. G. & Shepherd, R. C. H (2007) *Weeds of the South-East: an Identification Guide for Australia.* Everbest Printing Co. Pty. Ltd. China.

Robinson, L. (1994) *Field Guide to the Native Plants of Sydney.* Kangaroo Press.

Robinson, M. (1996) *A Field Guide to Frogs of Australia.* Reed.

Schodde, R. and Tidemann, S. (Eds) (1986) *Readers Digest complete book of Australian Birds.* Second Edition. Reader's Digest Services Pty Ltd, Sydney.

Simpson & Day (1996) *Field Guide to the Birds of Australia.* Viking.

Smith (2002) Squirrel Glider (*Petaurus norfolcensis*) Conservation Management Plan: Wyong Shire. Wyong Shire Council, Wyong

Specht, R. L., Specht, A., Whelan, M. B. & Hegarty, E. E. (1995) *Conservation Atlas of Plant Communities in Australia.* Southern Cross University Press, Lismore.

Triggs, B. (1996) *Tracks, Scats & Other Traces: A Field Guide to Australian Mammals*. Oxford University Press, Melbourne.

Trounson, Donald & Molly (1998) *Australian Birds Simply Classified*. Murray David Publishing Pty Ltd, NSW.

Van Dyke, S. and Strahan, R. (Eds) (2008) *The Mammals of Australia* (3rd Edn). Reed New Holland. Sydney.

Wheeler, D. J. B., Jacobs, S. W. L. & Norton, B. E. (1994) *Grasses of New South Wales.* University of New England.

Wilson, K. W. and Knowles, D. G. (1988) *Australia's Reptiles - A Photographic Reference to the Terrestrial Reptiles of Australia*. Cornstalk Publishing.

Fauna Survey Methodologies

A1

The fauna survey methods outlined within this Appendix are techniques employed by *Travers bushfire & ecology,* based on industry standards as well as additional methods found to be effective for select fauna groups. The fauna survey techniques deployed for each specific site are outlined within the survey effort table in the main body of this report. The techniques selected will depend upon the site characteristics and extent of available habitat as well as restrictions such as available survey time and weather conditions.

If any additional or target survey techniques for fauna species are undertaken, beyond the methods outlined within this Appendix, the details of these will be described within the main body of this report.

1 Standard survey techniques

1.1 Diurnal birds

Diurnal birds are typically identified visually and / or by calls during diurnal surveys. Habitat searches to identify nests, feathers, eggs, or signs of foraging may be utilised more specifically for identifying threatened diurnal bird species.

Visual observations are made more accurate with the use of binoculars and where necessary or practical, with the use of a spotting scope. Binoculars are carried by the fauna surveyor at all times during nocturnal and diurnal fauna surveys. A birding field guide is always available in the field when required for verifications.

Calls are identified in the field by the fauna surveyor. If an unknown call is heard it is cross-matched to comprehensive bird call reference libraries taken into the field. A call library of birds occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

Diurnal bird census points may be undertaken at large sites where the total area may not be effectively covered during the survey period, or as a measure to ensure focused bird only survey.

1.2 Nocturnal birds

Searches for evidence of Owl roosts, key perches and potential Owl roosting / breeding hollows are made during diurnal site searches. Whitewash, feathers or regurgitated pellets give key information. Pellets are sent for analysis of contents to assist in identification where necessary.

The presence of nocturnal birds during the nocturnal period is first determined by quiet listening after dusk for calls by individuals emerging from diurnal roosts. Following this, and provided no calls are heard, call-playback techniques are employed for threatened species that have suitable habitat present.

Threatened nocturnal birds known to provide response to call-playback techniques include Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebricosa*), Grass Owl (*Tyto capensis*), Black Bittern (*Ixobrychus flavicollis*), Australian Bittern (*Botaurus poiciloptilus*) and Bush Stone-curlew (*Burhinus grallarius*).

Each call is typically played for five minute periods with five minute intervals of quiet listening for a response. This is followed with spotlighting and periods of quiet listening throughout the nocturnal survey.

Separation distances between broadcasting stations during a single night of survey are advised for different species within survey guidelines. These include 1km between Owl calls and 3km between Bush Stone-curlew calls. Subsequent to this, separate broadcasting stations will be deployed on the same night where sites of significant size are surveyed. Separations for bitterns are not advised and these may be broadcast at a number of stations along suitable habitat areas.

Stag-watching will be undertaken where suitable large hollows for Owl nesting / roosting show signs of activity or are located within development areas. Stag-watching of nesting trees should be undertaken during the recognised nesting period for Owls with potential to occur.

1.3 Arboreal mammals

Arboreal mammals may be surveyed using Elliott type A, B and / or C traps, small and / or large hair tubes, spotlighting, call-playback techniques, scat searches or searches for other signs of activity.

Baiting and layout for Elliott trapping and hair tubing are typically incorporated into terrestrial trapping and hair tubing effort, unless where target survey is undertaken. Standard baiting and layout is therefore described in Section A1.3.2 below within terrestrial survey methods. Where gliders are targeted, the standard bait mix may be additionally laced with a nectarivor powder mix used for feeding captive birds. Where Brush-tailed Phascogales are targeted the standard bait mix may be additionally laced with an insectivore powder mix. Where Eastern Pygmy Possum is targeted, the bait mix will be more heavily laced with honey.

Elliott traps for arboreal captures are placed onto tree mounted platforms that are attached to the trunk 2-3m above the ground, at an incline to facilitate drainage during inclement weather. Plastic sleeves are placed around or over traps when there is a possibility of wet weather in the forecast. Arboreal hair tubes are attached to the trunk of trees using rubber bands with the tube entry facing down, preventing water entry.

For all arboreal traps and hair tubes a mixture of honey and water is sprayed onto the trunk up to 8m above the trap and around the trap as a lure. Where Eastern Pygmy Possum is targeted, a high concentrate honey water mix is also sprayed from the base of trunk up and along connective branches.

Arboreal traps and hair tubes are placed in trees selected to bias target species. These are often flowering or sap flow trees for gliders, rough-barked trees for the Brush-tailed Phascogale and Banksias for the Eastern Pygmy possum.

Where habitat is suitable, the presences of Koala (*Phascolactos cinereus*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*) may be targeted by call-playback techniques. Calls are played for five minute periods during nocturnal surveys. This is followed by quiet listening and spotlighting.

1.3.1 Koala survey

Koala survey is undertaken where the site is considered to provide potential habitat under the definitions of SEPP 44 - Koala Habitat Protection, or in the presence of feed trees listed in Appendix 1 of the Recovery Plan for the Koala. Habitat may also be defined according to locally prepared Koala Plans of Management.

SEPP 44 is applied to land within Local Government Areas (LGAs) listed under Schedule 1 of the Policy. Part 2 is applied to land which has an area of greater than 1ha or has, together with any adjoining land in the same ownership, an area of more than 1ha.

To determine Potential Koala Habitat (PKH) under the definitions of SEPP 44 an estimate of the percentage density of each tree species within vegetation communities is determined by averaging the percentage of stems counted. PKH is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the Policy.

Where Koala habitat is considered to be present, the site will be surveyed on foot, with known Koala food trees being inspected for signs of use. Trees are inspected for characteristic scratch and claw marks on the trunk and scats around the base of each tree. Koalas may also be targeted during nocturnal survey involving call-playback techniques and spotlighting.

For large sites, Koala search quadrats may be employed within portions of communities where feed trees are present at suitable densities. All Koala feed trees within quadrats are searched for signs of activity including characteristic claw marks on the trunk and faecal pellets around the base. Pellet searches are undertaken according to the tree base search methods described in *Phillips & Callaghan* (2008). Search quadrats are less labour intensive than the SAT techniques described below but may only be an initial survey effort to determine presence / absence.

Where any Koala activity is recorded the complete Spot Assessment Technique (SAT) described by *Phillips & Callaghan* (2008) may be undertaken as a measure of Koala *activity*. This technique may also be employed in the first instance as an indicator of presence / absence, particularly where a site has potential Koala activity based on previous records.

For any survey technique, the location and density of Koala droppings, if found, are documented.

1.4 Terrestrial mammals

Various traps may be used to survey for the presence of terrestrial mammals. These include Elliott trapping, medium and large cage trapping, small and large hair tubing and pitfall traps. Other survey methods for terrestrial mammals include the use of camera surveillance, spotlighting and activity searches.

Arboreal and terrestrial Elliott traps and hair tubes are placed in grids, or more commonly along trap-lines of 5-10 traps separated by distances of 20-50m, depending on site size and variation of habitat. Trap or hair tube sizes selected at each trap station may alternate or may have an emphasis on certain sizes according to target species.

Selection of terrestrial Elliott trap, cage trap, hair tube or pitfall trap locations has an emphasis on nearby foliage, runways, shelters and signs of activity.

Standard bait mix for all Elliott traps, medium cage traps and hair tubes is a mixture of rolled oats, honey and peanut butter. Standard bait mix may be supplemented with sardines in large hair tubes or cage traps to simultaneously target Spotted-tailed Quoll. Cage traps may also be baited solely with meat or roadkill to target Spotted-tailed Quoll. Where Potoroos or Bandicoots are targeted, truffle oil may be used to lace the standard bait mix or used on its own.

Where difficult to access, sensitive or extended trapping periods are undertaken, surveillance cameras can be used in terrestrial mammal surveys. The surveillance camera is mounted on a tree and directed towards a closed baited cage trap. Surveillance cameras may also be used to detect use or monitor activity at burrows, hollows, nests, etc.

During diurnal site searches, assessment is made of 'found' scats, markings, diggings, runways and scratches located. Any scats or pellets not readily identifiable (particularly predator scats) may be collected and sent to Barbara Triggs for identification of contents, hair or bone fragments.

1.5 Bats

Micro-chiropteran bats are surveyed by echolocation using Anabat detectors or trapped using harp (Constantine) traps, mist nets or trip lines. Microchiropteran bats are also surveyed by searches of subterranean habitats such as caves, tunnels or shafts where present, or by searching structures such as under bridges and abandoned buildings or wall / ceiling cavities, where entry is possible.

Anabat Mk 2 and SD-1 detectors are used in fixed passive monitoring positions and / or during active nocturnal monitoring. Active monitoring is used in conjunction with spotlighting or during stag-watching for greater accuracy of recorded call identification.

Bat call recordings are interpreted through Anabat V and Anabat CF Storage and Interface Module ZCAIM devices and analysed using Anabat 6 and Analook 3.3q computer software packages.

Harp traps and mist nets are placed along suitable 'flyways' such as along open narrow road / river corridors to maximise the likelihood of captures. Traps may be purpose set to capture bats emerging from roosts by being placed at the entry of tunnels / caves or draped over the edge of bridges. Trip lines are placed over water to trip low flying drinking bats into the water. These bats are collected as they swim to the waters edge.

Harp traps are checked during early nocturnal survey, as well as each morning. Mist nets and trip lines require constant monitoring. Captured bats are identified using field identification guides. Bats are released at the point of capture after dusk or placed under trunk bark / splits of nearby trees.

Mega-chiropteran bat species, such as Grey-headed Flying-fox, are surveyed by targeting flowering / fruiting trees during spotlighting activities and by listening to distinctive vocalisations. Suitable roosting habitat is searched for presence of small or large established camps during diurnal survey periods.

1.6 Amphibians

Amphibians are surveyed by vocal call identification, call-playback, spotlighting along the edge of water-bodies, pitfall trapping, funnel trapping, by driving along sealed roads near waterways, habitat searches and collection of tadpoles.

Calls are identified in the field by the fauna surveyor. For similar calling species, or if an unknown male call is heard, it is cross-matched to frog call reference libraries taken into the field. A call library of frogs occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

All threatened frog species may be targeted by use of call-playback techniques where suitable habitat exists, with some species more reliable than others in providing a response. Red-crowned Toadlet may also be targeted by clapping and loud retort along suitable habitat drainages in order to evoke a call response.

Any amphibians found are visually identified and, when required to be examined, are handled with latex gloves and kept moist until release. Any tadpoles requiring capture are collected with a scoop net and placed within a snap-lock clear plastic bag for analysis of colour and morphological features.

Amphibian survey yields best results during or following wet periods with seasonal breeding and subsequent male calling varying according each species. Targeted survey is thus undertaken in appropriate seasons.

1.7 Reptiles

Reptiles are surveyed opportunistically during diurnal site visit(s), but also by habitat searches, pitfall trapping, funnel trapping, by driving along roads on humid nights and by camera surveillance at burrows.

Habitat searches for reptiles are undertaken in likely localities such as under logs, rocky slabs on rock surfaces, under sheet debris, under bark exfoliations and leaf litter at the base of trees and along the edge of wetlands. Aspect and land surface thermal properties are considered to determine best search locations particularly along rocky escarpments.

During warmer months spotlighting may assist survey effort particularly during humid conditions.

1.8 Invertebrates

Target survey is undertaken for the Cumberland Plain Land Snail (*Meridolum corneovirens*) when in proximity to previous *Atlas of NSW Wildlife* records and particularly where its typical host vegetation community is present. The most appropriate areas of observed habitat are searched. Dense areas of leaf litter with likely moisture retaining properties are scraped using a three pronged rake. Logs, stumps, artificial refuse and rocks are also turned over. In large survey areas, search quadrats are undertaken evenly across highest quality habitat areas to estimate population size.

The top (spiral side), side (showing aperture) and underside (showing umbilicus) of snail specimens found are photographed and sent to Michael Shea of the Australian Museum Malacology Unit for confirmation of identification.

2 Habitat trees

Hollow-bearing tree surveys use a *Trimble* handheld GPS unit to log both field reference location as well as tree data. Data such as hollow types, hollow size, tree species, diameter at breast height, canopy spread and overall height are documented. A metal tag with the tree number is placed on the trunk for field relocation purposes. Other habitat features such as nests and significant sized mistletoe for foraging are also noted.

3 Survey effort table descriptors:

Target - Where effort is specifically concentrated towards an individual species. Selected target species will be identified within the survey effort table and where necessary described within the report.

Opportunistic - Where birds are identified by observation, call or indirect methods as the opportunity arises.

Habitat search - Where suitable areas of habitat for selected fauna groups such as frogs, reptiles and invertebrates are specifically searched.

Diurnal bird census point(s) - Bird surveys are undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. Size and time will be specified in the survey effort table. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently census points are selected to adequately represent each of the habitat areas present and particularly areas designated for proposed development. Often census points are commenced at locations where bird activity is noticeably high.

Spotting-scope outlook - A *Nikon* spotting scope with 16~47 zoom at x60 magnification on a mounted tripod is used for distant inspections of diurnal birds. This is undertaken at wetlands for viewing waterfowl and waders but also other difficult to access areas. It may also be used for inspecting activity at nests, hollows and combined with spotlight for a panoramic search in open areas.

Call-playback - This involves broadcasting recorded calls through a 15 watt Toa 'Faunatech' amplifier to evoke a response from species known to reply. Species selected for call-playback will be indicated in the survey effort table.

Spotlighting - Is carried out using a hand held 55 watt spotlight powered by a 12 volt rechargeable battery. This technique involves walking amongst the woodland areas, forest fringes, along roads, trails and fence lines so that a maximum number of trees can be observed. Spotlighting around water-bodies and particularly along the shallow fringes is used for finding frogs. Spotlighting is used in combination with binoculars or spotting scope for closer night inspections.

Stag-watching - Involves watching hollows in the dusk period approximately 15 minutes prior to dark until 30 minutes following dark. Placement of the observer on the ground allows for a silhouette of any emerging fauna to be seen against the lighter sky background such that a spotlight is not required, which would likely to disrupt emergence behaviour. Where any movement is observed, a spotlight may then be used for identification purposes.

Search quadrats - Are undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently quadrats are selected to adequately represent each of the suitable habitat areas present and particularly areas designated for proposed development. The use of this technique simply as an initial time-effective suitable indicator of presence / absence of Koalas has been discussed with Koala expert, Stephen Phillips.

Koala Spot Assessment Technique (SAT) - Method outlined by *Phillips & Callaghan* (2008) and accepted by the Australian Koala Foundation to determine Koala activity levels. Activity levels are calculated from the proportion of trees showing signs of Koala use as indicated by the presence of scats as well as site location within the state.

Elliott trapping - Using *Elliott* type A (33x10x10cm) and Type B (45x15x15cm), B and / or Type C traps for trapping small sized mammals. Trapping nights' effort will be indicated in the survey effort table. Trapping layout, trap sizes, baiting and trapping period will be outlined within the site specific methodology section.

Medium cage trapping - Using medium sized cage traps (17x17x45cm foldout cages with tread-plate mechanism or 22x25x58cm rigid cage with tread-plate mechanism) for trapping up to cat/bandicoot sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Large cage trapping - Using large sized cage traps (25x25x50cm foldout cages with pull lever (meat) mechanism, 28x28x60cm foldout cages with tread-plate mechanism or 30x30x70cm rigid cage with tread-plate mechanism) for trapping up to quoll sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Hair tubing - Using small (40mm diameter x 120mm long) and/or large (90mm diameter x 200mm long) PVC pipe sections for collecting mammal hair samples. At one end of each tube is an enclosed chamber where the bait is placed and capped. Small drill holes in the inside face of the chamber allow the smell of the bait to permeate out through the tube without allowing access to the bait. At the other open entry end, double-sided tape is attached around the inner rim so hair samples of animals entering the tube are collected. Hair samples collected are sent to Barbara Triggs for identification. Trapping layout, tube sizes, baiting and trapping period will be outlined within the site specific methodology section.

Pitfall trapping - Is used to survey for small terrestrial mammals, frogs, reptiles and invertebrates. Pitfall trapping involves the use of 15cm diameter and 60cm long PVC stormwater pipe sections placed vertically into pre dug holes. The pipe is placed and set firm with surrounding soil so that the top rim is level with the ground surface. Drift fences made of damp-proof-course 270mm wide are held tight and upright by wooden and steel pegs and run along the length of each trap-line. Drift fences are run over the middle of each pit in the trap line ensuring at least 5m of fencing is run along each side of each pit. Ground fauna passing beyond the pitfall transect are diverted towards the pits along the fence line.

Funnel trapping - Is used to survey mainly for frogs and reptiles. Funnel traps are 18cm x 18cm x 75cm long and constructed of shade cloth with an internal spring and wire frame in a similar design to yabby traps. At each end an inward facing funnel directs fauna through a 4cm hole and into the trap. Herpetofauna search the walls and corners for an exit and discover it difficult to re-find the internal exit hole. As with pitfall traps, funnel traps are used with drift fences that divert fauna towards the trap entry. At least 5m of fencing is run between each funnel trap which may be placed on either side of the fence. Trapping layout, target species, fence lengths and trapping period will be outlined within the site specific methodology section.

Passive Anabat monitoring - Involves leaving the bat recorder in a fixed mounted position to record call-sequences of passing bats. Recording locations are determined in order to represent different available foraging structures for various micro-chiropteran bat species. Dams, cleared flyways, high insect activity areas, forest edges and ecotones are particularly targeted.

Active Anabat monitoring - Is a method of active microbat recording during stag-watching or during complete nocturnal survey. Active monitoring involves an SD-1 recorder allied with a PDA for viewing call-sequences in real-time. When calls are heard the transducer microphone is actively directed towards the calling animal with the aid of a spotlight, so longer and clearer call sequences may be recorded. When calls of a potential threatened species are observed on the PDA screen a view by spotlight of the bat size and wing morphology is attempted for greater identification accuracy.

Active vehicle Anabat monitoring - Is a method of active microbat recording deployed when large distances need to be covered in a nocturnal survey period. A Hi-mic extension cable allows the transducer microphone to be placed on a bracket on the roof of a travelling vehicle so calls may be viewed whilst driving. The vehicle travels at no more than 40km/h to

prevent wind interference. When calls of a potential threatened species are observed on the dash mounted PDA screen active spotlighting is undertaken.

Harp trapping - Is used to capture microchiropteran bats. Harp traps have an aluminium frame with a two-bank 4.2m^2 area and calico capture bag set along the base area.

Mist netting - Is used to capture microchiropteran bats. The mist net capture area is 2.4m high and 9m wide and supported by two 3.5m poles which are braced with ropes and pegs. Design is a 0.08mm ultrafine nylon monofilament thread arranged in a 14x14mm mesh, with four horizontal capture pockets. These features are specific for the use to capture micro-chiropteran bat species and are provided from the only known supplier in Poland.

Trip lining - Is used to capture microchiropteran bats. Fishing line is strung tight on pegs in a zig-zag pattern across open water-bodies just above the water surface to trip drinking bats into the water.

Camera surveillance - Is used to monitor activity at burrows, hollows, etc. or to survey for species presence at baited stations. A Reconyx Hyperfire digital weatherproof camera is used with a passive infrared motion detector and a night-time infrared illuminator. The camera is mounted on a tree or tripod and takes three consecutive photo frames on the detection of movement up to 30m away or the detection of a heat/cold source different to the ambient temperature.

Weather conditions - Survey effort for each fauna group accounting for methods undertaken, duration, and weather conditions are provided in the survey effort table. Weather details are documented for all survey techniques and include:

- air temperature
- cloud cover
- rain (e.g. none, light drizzle, heavy drizzle, heavy rain)
- recent rain events (where relevant)
- wind strength e.g. calm, light (leaves rustle), moderate (moves branches), strong (moves tree crowns)
- wind direction
- moon (where relevant) (e.g. none, 1/4 moon, 1/2 moon, 3/4 moon, full moon)

Threatened & Migratory Species Habitat Assessment

A2

Table A2.1 provides an assessment of potential habitat within the study area for state and nationally listed threatened flora species recorded within 10km on the Atlas of NSW Wildlife (OEH) or indicated to have potential habitat present within 10km on the *EPBC Act* Protected Matters Tool.

Table A2.1 – Threatened flora habitat assessment

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded onsite**				**Needs to be considered in 7 part test**
					Suitable habitat present (✓)	**Nearby and / or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Acacia bynoeana OEH EPBC	E1	V	Erect or spreading shrub to 0.3m high growing in heath and dry sclerophyll Open Forest on sandy soils. Often associated with disturbed areas such as roadsides. Distribution limits N-Newcastle S-Berrima.	x	✓	✓	✓	✓	✓
Angophora inopina OEH EPBC	V	V	Small tree in open sclerophyll forest growing on deep sandy soils with associated lateritic outcrops. Distribution limits N-Wyee S-Gorokan with a disjunct population near Karuah.	x	✓	✓	✓	✓	✓

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded onsite**				**Needs to be considered in 7 part test**
					Suitable habitat present (✓)	**Nearby and / or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Caladenia porphyrea (Caladenia quadrifaria) OEH	E1	E	Terrestrial orchid, flowers September to October. From Brunswick heads to Lake Tabourie. Grows on slopes and ridges in sclerophyll forest, often scattered under Allocasuarina species, in sandy or shallow clay loams.	x	marginal	x	x	unlikely	x
Caladenia tessellata OEH EPBC	E1	V	Terrestrial orchid. Clay-loam or sandy soils. LHCCREMS guidelines suggest the species grows in Map Unit 34 – Coastal Sand Wallum Woodland - Heath. Flowers in September – November. Distribution limits N-Swansea S-south of Eden.	x	marginal	4km is nearest	x	low	✓
Callistemon linearifolius OEH	V	-	Shrub to 4m high. Dry sclerophyll forest on coast and adjacent ranges. Distribution limits N-Nelson Bay S-Georges River.	x	✓	✓	✓	✓	✓
Chamaesyce psammogeton OEH	E1	-	Prostrate herb. Coastal dunes. Distribution limits N-Tweed Heads S-Jervis Bay.	x	x	-	-	x	x
Corybas downlingii OEH	E1	-	An orchid that forms clonal colonies and typically grows in gullies in tall open forest on well-drained gravelly soil at elevations of 10-200m. Known from 4 localities including Port Stephens (2 localities), Bulahdelah and Freemans Waterhole.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded onsite**				**Needs to be considered in 7 part test**
					Suitable habitat present (✓)	**Nearby and / or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Corunastylis sp. Charmhaven OEH EPBC	CE	CE	Terrestrial orchid currently only known from the Wyong Shire of NSW in the Gorokan/Charmhaven area. It occurs within low woodland to heathland with a shrubby understorey and ground layer. Dominants include *Allocasuarina littoralis, Leptospermum juniperinum, Melaleuca nodosa, Callistemon linearis* and *Schoenus brevifolius.* Flowers likely in Feb-Mar.	x	✓	10km away	✓	low likelihood	✓
Cryptostylis hunteriana OEH EPBC	V	V	Saprophytic orchid. Grows in swamp heath on sandy soils. Distribution limits N-Gibraltar Range S-south of Eden.	x	✓	✓	✓	✓	✓
Diuris praecox OEH EPBC	V	V	Terrestrial orchid. Grows in sclerophyll forest near the coast. Distribution limits N-Nelson Bay S-Ourimbah.	x	✓	✓	✓	✓	✓
Eucalyptus camfieldii OEH EPBC	V	V	Stringybark to 10m high. Grows on coastal shrub heath and woodlands on sandy soils derived from alluviums and Hawkesbury sandstone. Distribution limits N-Norah Head S-Royal NP.	x	x	-	-	x	x
Eucalyptus parramattensis subsp. *decadens* OEH EPBC	V	V	Red gum to 15m high. Grows in dry open forest on sandy to clay soils often in lowly elevated moist sites. Distribution limits N-Port Macquarie S-Central Coast.	x	✓	Very few records, nearest is 4km away	x	low likelihood	✓

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded onsite**				**Needs to be considered in 7 part test**
					Suitable habitat present (✓)	**Nearby and / or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Genoplesium insigne *(Corunastylis insignis)* OEH EPBC	E1	CE	Terrestrial orchid. Found in *Themeda* patches among shrubs and sedges in heathland and forest. Known from 3 localities in Wyong-Charmhaven area. Occurs in vegetation dominated by Scribbly Gum, Red Bloodwood, Smooth-barked Apple and Black She-oak at Charmhaven. Flowers Sept-Oct.	x	✓	✓	✓	✓	✓
Grevillea parviflora subsp. *parviflora* OEH EPBC	V	V	Open to erect shrub to 1m. Grows in woodland on light clayey soils Distribution limits N-Cessnock S-Appin.	x	x	-	-	x	x
Melaleuca biconvexa OEH EPBC	V	V	Tall shrub. Grows in wetlands adjoining perennial streams and on the banks of those streams, generally within the geological series known as the Terrigal Formation. Distribution limits N-Port Macquarie S-Jervis Bay.	x	✓	Nearest is 9km away	✓	unlikely	x
Microtis angusii EPBC	E1	E	Terrestrial orchid which is known from two populations, Ingleside and Sunny Corner.	x	?	No records within 10km	x	unlikely	x
Pelargonium sp. *Striatellum* EPBC	E1	E	Herb to 90cm tall which grows in damp places especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. Varied distribution from SE NSW to QLD.	x	x	-	-	x	x
Pterostylis gibbosa EPBC	E1	E	Terrestrial orchid which occurs near Wollongong and in Hunter Valley in sclerophyll forest, sometimes with paperbarks.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded onsite**				**Needs to be considered in 7 part test**
					Suitable habitat present (✓)	**Nearby and / or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Pultenaea maritima OEH	V	-	Occurs in New South Wales and Queensland and is restricted to grasslands on exposed coastal headlands. Within NSW, the species has been recorded from just south of Newcastle north to Byron Bay.	x	x	-	-	x	x
Rutidosis heterogama OEH EPBC	V	V	Erect herb to 30cm. Grows mostly in heath, often along roadsides. Distribution limits N-Maclean S-Hunter Valley.	x	unlikely	nearest record is 4km away	✓	unlikely	x
Syzygium paniculatum OEH EPBC	V	V	Small tree. Subtropical and littoral rainforest on sandy soil. Distribution limits N-Forster S-Jervis Bay.	x	x	-	-	x	x
Tetratheca glandulosa OEH	V	-	Spreading shrub to 0.2m high. Sandy or rocky heath or scrub. Distribution limits N-Mangrove Mountain S-Port Jackson.	x	x	-	-	x	x
Tetratheca juncea OEH EPBC	V	V	Prostrate shrub to 1m high. Dry sclerophyll forest and heath. Distribution limits N-Bulahdelah S-Port Jackson.	x	✓	✓	✓	✓	✓
Thelymitra sp. adorata OEH	CE	CE	A ground orchid up to 60 cm tall with a single leaf. Occurs from 10-40 m a.s.l. in grassy woodland or occasionally derived grassland in well-drained clay loam or shale derived soils. The vegetation type in which the majority of populations occur (including the largest colony) is a Spotted Gum - Ironbark Forest with a diverse grassy understorey and occasional scattered shrubs	x	x	-	-	x	x

Scientific name DATABASE SOURCE	***TSC Act***	***EPBC Act***	**Growth form and habitat requirements**	**Recorded on site (✓)**	**If not recorded onsite**				**Needs to be considered in 7 part test**
					Suitable habitat present (✓)	**Nearby and / or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Thesium australe EPBC	V	V	Erect herb to 0.4m high. Root parasite. Themeda grassland or woodland often damp. Distribution limits N-Tweed Heads S-south of Eden.	x	x	-	-	x	x

OEH	- Denotes species listed within 10km of the study area on the *Atlas of NSW Wildlife*
EPBC	- Denotes species listed within 10km of the study area in the *EPBC Act* habitat search
V	- Denotes vulnerable listed species under the relevant Act
E or E1	- Denotes endangered listed species under the relevant Act
CE	- Denotes critically endangered listed species under the relevant Act
NOTE:	1. This field is not considered if no suitable habitat is present within the study area 2. 'records' refer to those provided by the *Atlas of NSW Wildlife* 3. 'nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle

Table A2.2 provides an assessment of potential habitat within the study area for state and nationally listed threatened fauna species recorded within 10km on the *Atlas of NSW Wildlife* (OEH) or indicated to have potential habitat present within 10km on the *EPBC Act* Protected Matters Tool.

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE**	**IF NOT RECORDED ON-SITE**				**TO BE CONSIDERED IN A 7 PART TEST**
					Suitable Habitat Present	**Nearby and/or high number of record(s)** *Notes 1,2 & 3*	**Record(s) from recent years** *Notes 1,2 & 3*	**Potential to occur**	
Wallum Froglet *Crinia tinnula* OEH	V	-	Found in acidic paperbark swamps and wallum country with dense groundcover. Breeds in temporary and permanent pools and ponds of high acidity. *Distribution Limit: N-Tweed Heads S-Kurnell.*	✓	-	-	-	-	✓
Giant Burrowing Frog *Heleioporus australiacus* EPBC	V	V	Inhabits open forests and riparian forests along non-perennial streams, digging burrows into sandy creek banks. *Distribution Limit: N-Near Singleton S-South of Eden.*	×	×	-	-	×	×
Green and Golden Bell Frog *Litoria aurea* OEH EPBC	E	V	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. *Distribution Limit: N-Byron Bay S-South of Eden.*	×	×	-	-	×	×
Littlejohn's Tree Frog *Litoria littlejohnii* EPBC	V	V	Found in wet and dry sclerophyll forest associated with sandstone outcrops at altitudes 280-1,000m on eastern slopes of Great Dividing Range. Prefers flowing rocky streams. *Distribution Limit: N-Hunter River S-Eden.*	×	×	-	-	×	×

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Broad-headed Snake *Hoplocephalus bungaroides* EPBC	E	V	Sandstone outcrops, exfoliated rock slabs and tree hollows in coastal and near coastal areas. *Distribution Limit: N-Mudgee Park. S-Nowra.*	×	×	-	-	×	×
Stephens' Banded Snake *Hoplocephalus stephensii* OEH	V	-	A nocturnal and partly arboreal species that inhabits open and closed forest communities sheltering under bark, in hollows and under exfoliating slabs of granite. *Distribution Limit: N-Border Ranges National Park. S-Gosford.*	×	possible	×	×	unlikely	✓
Blue-billed Duck *Oxyura australis* OEH	V	-	A completely aquatic species occurring mainly throughout the Murray-Darling basin in cool to warm temperate deep permanent freshwater lakes, lagoons and swamps with extensive reed-beds. *Distribution Limit: N-Tenterfield. S-Albury*.	×	×	-	-	×	×
Freckled Duck *Stictonetta naevosa* OEH	V	-	Occurs mainly within the Murray-Darling basin and the channel country within large cool temperate to sub-tropical swamps, lakes and floodwaters with cumbungi, lignum or melaleucas. *Distribution Limit: N- Tenterfield. S-Albury.*	×	×	-	-	×	×
Rose-crowned Fruit-dove *Ptilinopus regina* OEH	V	-	Occurs in dense rainforests with a substantial understorey where it feeds entirely on fruit. *Distribution Limit" N-Tweed Heads. S-Wollongong.*	×	×	-	-	×	×

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Superb Fruit-dove *Ptilinopus superbus* OEH	V	-	Rainforests, adjacent mangroves, eucalypt forests, scrubland with native fruits. *Distribution Limit: N-Border Ranges National Park. S-Bateman's Bay.*	×	possible	×	×	unlikely	✓
Black-necked Stork *Ephippiorhynchus asiaticus* OEH	E	-	Occurs in tropical to warm temperate terrestrial wetlands, estuarine and littoral habitats such as mangroves, tidal mudflats, floodplains, open woodlands, irrigated lands, bore drains, sub-artesian pools, farm dams and sewerage ponds. *Distribution Limit: N-Tweed Heads. S-Nowra.*	×	×	-	-	×	×
Australasian Bittern *Botaurus poiciloptilus* EPBC	E	E	Found in or over water of shallow freshwater or brackish wetlands with tall reedbeds, sedges, rushes, cumbungi, lignum and also in ricefields, drains in tussocky paddocks, occasionally saltmarsh, brackish wetlands. *Distribution Limit: N-North of Lismore. S- Eden.*	×	×	-	-	×	×
Black Bittern *Ixobrychus flavicollis* OEH	V	-	Found in shadowy, leafy waterside trees such as callistemons, casuarinas, paperbarks, eucalypts, mangroves and willows along tidal creeks, freshwater and brackish streams and ponds, sheltered mudflats and oyster slats. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	×	×	low	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Little Eagle *Hieraaetus morphnoides* OEH	V	-	Utilises plains, foothills, open forests, woodlands and scrublands; river red gums on watercourses and lakes. *Distribution Limit - N-Tweed Heads. S-South of Eden.*	×	✓	×	×	low	✓
Eastern Osprey *Pandion cristatus* OEH	V	-	Utilises waterbodies including coastal waters, inlets, lakes, estuaries and offshore islands with a dead tree for perching and feeding. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	marginal	×	✓	low	✓
Black Falcon *Falco subniger* OEH	V	-	Inhabits plains, grasslands, foothills, timbered watercourses, wetland environs, crops; occasionally over towns and cities. *N-Tweed Heads. S-South of Eden*	×	Sub-optimal	×	×	Not likely	×
Bush Stone-curlew *Burhinus grallarius* OEH	E	-	Utilises open forests and savannah woodlands, sometimes dune scrub, savannah and mangrove fringes. *Distribution Limit: N-Border Ranges National Park. S-Near Nowra.*	×	×	-	-	×	×
Red-backed Button-quail *Turnix maculosus* OEH	V	-	Inhabits grasses, sedges near water, grassy woodlands, rainforest edges, black soil plains, spinifex, cereal crops, lucerne and gardens. *Distribution Limit: N-Tweed Heads. S-Manning River, casual visitor further south..*	×	×	-	-	×	×

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Sooty Oystercatcher *Haematopus fuliginosus* OEH	V	-	Exclusively coastal in distribution foraging along rocky coastlines and estuaries. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×	×
Pied Oystercatcher *Haematopus longirostris* OEH	V	-	Inhabits coastal beaches and estuarine flats. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×	×
Australian Painted Snipe *Rostratula australis* EPBC	E	E	Most numerous within the Murray-Darling basin and inland Australia within marshes and freshwater wetlands with swampy vegetation. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×	×
Curlew Sandpiper *Calidris ferruginea* OEH	E	CE	Mainly coastal, but many inland feeding along tidal mudflats, salt marsh, salt fields, fresh, brackish or saline wetlands and sewerage ponds. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×	×
Black-tailed Godwit *Limosa limosa* OEH	V	-	Regular summer migrant that forages along tidal mudflats, estuaries, sandspits, shallow river margins, sewerage ponds, inland on large shallow fresh or brackish waters. *Distribution Limit: N-Tweed Heads. S-South of Eden*.	×	×	-	-	×	×

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Eastern Curlew *Numenius madagascariensis* TBE	-	CE	Primarily coastal especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. Often recorded among saltmarsh and on mudflats fringed by mangroves and also in coastal saltworks and sewage farms. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	Sub-optimal	×	×	Not likely	×
Gang-gang Cockatoo *Callocephalon fimbriatum* OEH	V	-	Prefers wetter forests and woodlands from sea level to > 2,000m on the Great Dividing Range, timbered foothills and valleys, timbered watercourses, coastal scrubs, farmlands and suburban gardens. *Distribution Limit: mid north coast of NSW to western Victoria.*	×	✓	×	×	Not likely	×
Glossy Black-Cockatoo *Calyptorhynchus lathami* OEH	V	-	Open forests with *Allocasuarina* species and hollows for nesting. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	×	✓	✓	✓
Little Lorikeet *Glossopsitta pusilla* OEH	V	-	Inhabits forests, woodlands; large trees in open country; timbered watercourses, shelterbeds, and street trees. *Distribution Limit: N-Tweed Heads. S-South of Eden*.	×	✓	✓	✓	✓	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Swift Parrot *Lathamus discolour* OEH EPBC	E	E	Inhabits eucalypt forests and woodlands with winter flowering eucalypts. *Distribution Limit: N-Border Ranges National Park. S-South of Eden*.	×	✓	✓	✓	✓	✓
Turquoise Parrot *Neophema pulchella* OEH	V	-	Inhabits coastal scrubland, open forest and timbered grassland, especially ecotones between dry hardwood forests and grasslands. *Distribution Limit: N-Near Tenterfield. S-South of Eden.*	×	Sub-optimal	×	×	Not likely	×
Barking Owl *Ninox connivens* OEH	V	-	Inhabits principally woodlands but also open forests and partially cleared land and utilises hollows for nesting. *Distribution Limits: N-Border Ranges National Park. S-Eden.*	×	✓	×	✓	low	✓
Powerful Owl *Ninox strenua* OEH	V	-	Forests containing mature trees for shelter or breeding and densely vegetated gullies for roosting. *Distribution Limits: N-Border Ranges National Park. S-Eden.*	×	✓	✓	✓	✓	✓
Masked Owl *Tyto novaehollandiae* OEH	V	-	Open forest and woodlands with cleared areas for hunting and hollow trees or dense vegetation for roosting. *Distribution Limit: N-Border Ranges National Park. S-Eden.*	×	✓	×	✓	✓	✓
Sooty Owl *Tyto tenebricosa* OEH	V	-	Tall, dense, wet forests containing trees with very large hollows. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	marginal	×	×	Not likely	×

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Brown Treecreeper *Climacteris picumnus victoriae* OEH	V	-	Occupies Eucalypt woodlands, open woodland lacking a dense understorey with fallen dead timber. *Distribution Limit:(Sub species victoriae) Central NSW west of Great Div. Cumberland Plains, Hunter Valley, Richmond, Clarence, and Snowy River Valleys.*	×	×	-	-	×	×
Eastern Bristlebird *Dasyornis brachypterus* EPBC	E	E	Coastal woodlands, dense scrubs and heathlands, especially where low heathland borders taller woodland or dense tall tea-tree. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×	×
Speckled Warbler *Chthonicola sagittata* OEH	V	-	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. *Distribution Limit: N-Urbanville. S-Eden.*	×	×	-	-	×	×
Regent Honeyeater *Xanthomyza Phrygia* OEH EPBC	E4A	CE	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. *Distribution Limit: N-Urbanville. S-Eden.*	×	✓	×	×	unlikely	✓
White-fronted Chat *Epithianura albifrons* OEH	V	-	Found in open damp ground, grass clumps, fence lines, heath, samphire saltmarshes, mangroves, dunes, saltbush plains. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	Sub-optimal	×	×	unlikely	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Painted Honeyeater *Grantiella picta* EPBC	V	V	A nomadic bird occurring in low densities within open forest, woodland and scrubland feeding on mistletoe fruits. Inhabits primarily Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. *Distribution Limit: N-Boggabilla. S-Albury with greatest occurrences on the inland slopes of the Great Dividing Range.*	×	Sub-optimal	×	×	Not likely	×
Grey-crowned Babbler *Pomatostoomus temporalis* OEH	V	-	Found in dry open forests, woodland scrubland, farmland with isolated trees. Distribution Limit mostly west of Great Dividing Range except Hunter Valley. *Distribution Limit: N-Qld widespread. S-Mornington Pen. E-se SA.*	×	Sub-optimal	×	×	Not likely	×
Varied Sittella *Daphoenositta chrysoptera* OEH	V	-	Open eucalypt woodlands / forests (except heavier rainforests); mallee, inland acacia, coastal tea-tree scrubs; golf courses, shelterbelts, orchards, parks, scrubby gardens. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	✓	✓	×	✓	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Dusky Woodswallow *Artamus cyanopterus cyanopterus* OEH	V	-	Found in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests. Prefers habitat with an open understorey. Often observed in farmland tree patches or roadside remnants. *Widespread in eastern, southern and southwestern Australia.*	x	Sub-optimal	-	-	unlikely	x
Scarlet Robin *Petroica boodang* OEH	V	-	Found in foothill forests, woodlands, watercourses; in autumn-winter, more open habitats: river red gum woodlands, golf courses, parks, orchards, gardens. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	Sub-optimal	×	×	unlikely	×
Diamond Firetail *Stagonopleura guttata* OEH	V	-	Found in Eucalypt woodlands, forests and mallee where there is grassy understorey west of the Great Div. also drier coastal woodlands of the Cumberland Plain and Hunter Richmond and Clarence River Valleys. *Distribution Limit: N-Rockhampton Q. S-Eyre Pen Kangaroo Is. SA.*	×	×	-	-	×	×

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Spotted-tailed Quoll *Dasyurus maculatus* OEH EPBC	V	E	Dry and moist open forests containing rock caves, hollow logs or trees. *Distribution Limit: N-Mt Warning National Park. S-South of Eden.*	×	✓	×	✓	unlikely	✓
Koala *Phascolarctos cinereus* OEH EPBC	V	V	Inhabits both wet and dry eucalypt forest on high nutrient soils containing preferred feed trees. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	✓	×	✓	✓
Eastern Pygmy Possum *Cercatetus nanus* OEH	V	-	Found in a variety of habitats from rainforest through open forest to heath. Feeds on insects but also gathers pollen from banksias, eucalypts and bottlebrushes. Nests in banksias and myrtaceous shrubs. *Distribution Limit: N-Tweed Heads. S-Eden.*	×	Sub-optimal	×	×	unlikely	✓
Squirrel Glider *Petaurus norfolcensis* OEH	V	-	Mixed aged stands of eucalypt forest & woodlands including gum barked & high nectar producing species & hollow bearing trees. *Distribution Limit: N-Tweed Heads. S-Albury.*	✓	-	-	-	-	✓
Brush-tailed Rock-wallaby *Petrogale penicillata* EPBC	E	V	Found in rocky gorges with a vegetation of rainforest or open forests to isolated rocky outcrops in semi-arid woodland country. *Distribution Limit: N-North of Tenterfield. S-Bombala.*	×	×	-	-	×	×

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Grey-headed Flying-fox *Pteropus poliocephalus* OEH EPBC	V	V	Found in a variety of habitats including rainforest, mangroves, paperbark swamp, wet and dry open forest and cultivated areas. Forms camps commonly found in gullies and in vegetation with a dense canopy. *Distribution Limit: N-Tweed Heads. S-Eden.*	×	✓	✓	✓	✓	✓
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* OEH	V	-	Rainforests, sclerophyll forests and woodlands. *Distribution Limit: N-North of Walgett. S-Sydney.*	×	✓	×	✓	low	✓
East-coast Freetail Bat *Micronomus norfolkensis* OEH	V	-	Inhabits open forests and woodlands foraging above the canopy and along the edge of forests. Roosts in tree hollows, under bark and buildings. *Distribution Limit: N-Woodenbong. S-Pambula.*	✓	-	-	-	-	✓
Large-eared Pied Bat *Chalinolobus dwyeri* EPBC	V	V	Warm-temperate to subtropical dry sclerophyll forest and woodland. Roosts in caves, tunnels and tree hollows in colonies of up to 30 animals. *Distribution Limit: N-Border Ranges National Park. S-Wollongong.*	×	Sub-optimal	×	×	Not likely	×
Eastern Falsistrelle *Falsistrellus tasmaniensis* OEH	V	-	Recorded roosting in caves, old buildings and tree hollows. *Distribution Limit: N-Border Ranges National Park. S-Pambula.*	×	✓	×	✓	✓	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Little Bentwing-bat *Miniopterus australis* OEH	V	-	Roosts in caves, old buildings and structures in the higher rainfall forests along the south coast of Australia. *Distribution Limit: N-Border Ranges National Park. S-Sydney.*	✓	-	-	-	-	✓
Eastern Bentwing-bat *Miniopterus orianae oceansis* OEH	V	-	Prefers areas where there are caves, old mines, old buildings, stormwater drains and well-timbered areas. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	✓	-	-	-	-	✓
Large-footed Myotis *Myotis macropus* OEH	V	-	Roosts in caves, mines, tunnels, buildings, tree hollows and under bridges. Forages over open water. *Distribution limits: N-Border Ranges National Park. S-South of Eden.*	✓	-	-	-	-	✓
Greater Broad-nosed Bat *Scoteanax rueppellii* OEH	V	-	Inhabits areas containing moist river and creek systems, especially tree lined creeks. *Distribution Limit: N-Border Ranges National Park. S-Pambula.*	×	✓	✓	✓	✓	✓
Eastern Cave Bat *Vespadelus troughtoni* OEH	V	-	Inhabits drier open forests and woodlands. Roosts in well-lit parts of caves and mineshafts. *Distribution Limit: Along GDR from N-Tweed Heads. S-Kempsey.*	×	Sub-optimal	×	✓	unlikely	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	
Eastern Chestnut Mouse *Pseudomys gracilicaudatus* OEH	V	-	Inhabits heathland including dense wet heath and swampy areas, occasionally in woodland with grassy understorey. *Distribution Limit: N-Border Ranges National Park. S-Brisbane Water National Park.*	×	Sub-optimal	×	✓	low	✓
New Holland Mouse *Pseudomys novaehollandiae* EPBC	-	V	Occurs in heathlands, woodlands, open forest and paperbark swamps and on sandy, loamy or rocky soils. Coastal populations have a marked preference for sandy substrates, a heathy understorey of leguminous shrubs less than 1m high and sparse ground litter. Recolonise of regenerating burnt areas. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	Sub-optimal	×	×	unlikely	N/A
Giant Dragonfly *Petalura gigantean* OEH	E	-	Inhabits large relatively deep permanent swamps and bogs with high water quality and moss or other soft vegetation along the edge for egg laying. *It occurs in the far NE NSW, south to Kempsey, & in a patch between Gosford & Nowra.*	×	×	-	-	×	×
Australian Greyling *Prototroctes maraena* EPBC	Part 2, Section 19 – Protected Fish (FM Act 1994)	V	Clear, moderate to fast flowing water in the upper reaches of rivers (sometimes to altitudes above 1,000m). Typically found in gravel bottom pools. Often forming aggregations below barriers to upstream movement (e.g. weirs, waterfalls).	×	marginal	×	×	Not likely	N/A
OEH	- Denotes species listed within 10km of the study area on the *Atlas of NSW Wildlife*								

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE	IF NOT RECORDED ON-SITE				TO BE CONSIDERED IN A 7 PART TEST
					Suitable Habitat Present	Nearby and/or high number of record(s) *Notes 1,2 & 3*	Record(s) from recent years *Notes 1,2 & 3*	Potential to occur	

EPBC	-	Denotes species listed within 10km of the study area in the *EPBC Act* habitat search
V	-	Denotes vulnerable listed species under the relevant Act
E	-	Denotes endangered listed species under the relevant Act
NOTE:	1.	This field is not considered if no suitable habitat is present within the study area
	2.	'records' refer to those provided by the *Atlas of NSW Wildlife*
	3.	'nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle

Table A2.3 provides an assessment of potential habitat within the study area for nationally *protected* migratory fauna species recorded within 10km on the *EPBC Act* Protected Matters Tool. Nationally *threatened* migratory species are considered in Table A2.2.

Table A2.3 – Migratory fauna habitat assessment

COMMON NAME ***Scientific Name***	**PREFERRED HABITAT** ***Migratory Breeding***	**Suitable Habitat Present (✓)**	**Recorded on Site (✓)**	**COMMENTS**
Oriental or Horsfield's Cuckoo (*Cuculus optatus*)	It mainly inhabits forests, occurring in coniferous, deciduous and mixed forest. It feeds mainly on insects and their larvae, foraging for them in trees and bushes as well as on the ground.	✓	×	-
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Coasts, islands, estuaries, inlets, large rivers, inland lakes, reservoirs. *Sedentary; dispersive.*	✓	✓	Sea Eagle was not seen bu heard to the west of the study area during survey. It is possible that a nearby nest is present due to the calls however no nests are present within the study area or nearby that may be impacted.
White-throated Needletail (*Hirundapus caudacutus*)	Airspace over forests, woodlands, farmlands, plains, lakes, coasts, towns; companies forage often along favoured hilltops and timbered ranges. *Breeds Siberia, Himalayas, east to Japan. Summer migrant to eastern Australia.*	✓	×	-
Rainbow Bee-eater (*Merops ornatus*)	Open woodlands with sandy, loamy soil; sandridges, sandspits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves, rainforest, woodlands, golf courses. *Breeding resident in northern Australia. Summer breeding migrant to south east and south west Australia.*	✓	×	-
Spectacled Monarch (*Monarcha trivirgatus*)	Understorey of mountain / lowland rainforest, thickly wooded gullies, waterside vegetation, mostly well below canopy. *Summer breeding migrant to south-east Qld and north-east NSW down to Port Stephens from Sept/Oct to May. Uncommon in southern part of range.*	×	-	-
Black-faced Monarch (*Monarcha melanopsis*)	Rainforests, eucalypt woodlands; coastal scrubs; damp gullies in rainforest, eucalypt forest; more open woodland when migrating. *Summer breeding migrant to coastal south east Australia, otherwise uncommon*.	✓	×	-

COMMON NAME *Scientific Name*	PREFERRED HABITAT *Migratory Breeding*	Suitable Habitat Present (✓)	Recorded on Site (✓)	COMMENTS
Yellow Wagtail (*Motacilla flava*)	The yellow wagtail typically forages in damp grassland and on relatively bare open ground at edges of rivers, lakes and wetlands, but also feeds in dry grassland and in fields of cereal crops.	×	-	-
Satin Flycatcher (*Myiagra cyanoleuca*)	Heavily vegetated gullies in forests, taller woodlands, usually above shrub-layer; during migration, coastal forests, woodlands, mangroves, trees in open country, gardens. *Breeds mostly south east Australia and Tasmania over warmer months, winters in north east Qld.*	✓	×	-
Rufous Fantail (*Rhipidura rufifrons*)	Undergrowth of rainforests / wetter eucalypt forests / gullies; monsoon forests, paperbarks, sub-inland and coastal scrubs; mangroves, watercourses; parks, gardens. On migration, farms, streets buildings. *Breeding migrant to south east Australia over warmer months. Altitudinal migrant in north east NSW in mountain forests during warmer months.*	✓	×	-
Great Egret (*Ardea alba*)	Shallows of rivers, estuaries; tidal mudflats, freshwater wetlands; sewerage ponds, irrigation areas, larger dams, etc. *Dispersive; cosmopolitan.*	✓	×	-
Cattle Egret (*Ardea ibis*)	Stock paddocks, pastures, croplands, garbage tips, wetlands, tidal mudflats, drains. *Breeds in summer in warmer parts of range including NSW*.	✓	×	-
Latham's Snipe (*Gallinago hardwickii*)	Soft wet ground or shallow water with tussocks and other green or dead growth; wet parts of paddocks; seepage below dams; irrigated areas; scrub or open woodland from sea-level to alpine bogs over 2,000m; samphire on saltmarshes; mangrove fringes. *Breeds Japan. Regular summer migrant to Australia. Some overwinter.*	✓	×	-
Swinhoe's Snipe (*Gallinago megala*)	During the non-breeding season Swinhoe's Snipe occurs at the edges of wetlands, eg. wet paddy fields, swamps and freshwater streams. Also known in grasslands, drier cultivated areas and market gardens. Habitat specific to Australia includes the dense clumps of grass and rushes around the edges of fresh and brackish wetlands. This includes swamps, billabongs, river pools, small streams and sewage ponds. Also found in drying claypans and inundated plains pitted with crab holes. *Breeds in central Siberia and Mongolia and moving south for the boreal winter.*	×	-	-

COMMON NAME *Scientific Name*	PREFERRED HABITAT *Migratory Breeding*	Suitable Habitat Present (✓)	Recorded on Site (✓)	COMMENTS
Pin-tailed Snipe (*Gallinago stenura*)	During non-breeding period the Pin-tailed Snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as claypans in more arid parts of species' range. It is also commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands. *Breeds in Russia. Australian distribution is not well understood. There are confirmed records from NSW, with a single banded bird reported near West Wyalong.*	×	-	-
Bar-tailed Godwit (*Limosa lapponica*)	The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh.	×	-	-
Common Greenshank (*Tringa nebularia*)	Found in a wide variety of inland wetlands and sheltered coastal habitats (with large mudflats and saltmarsh, mangroves or seagrass) of varying salinity, Habitats include embayments, harbours, river estuaries, deltas and lagoons. It uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. Also artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. In NSW the Hunter River estuary has been identified as a site of international importance. *Breeds in Eurasia, the northern British Isles, Scandanavia, east Estonia and north-east Belarus, through Russia and east.*	×	-	-
Little Curlew (*Numenius minutus*)	Feeds in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of estuaries or beaches on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses and verges of roads and airstrips are also used. When resting, congregates around pools, river beds and water-filled tidal channels, and shallow water at edges of billabongs. Prefers pools with bare dry mud and they do not use pools if they are totally dry, flooded or heavily vegetated. *Breeds in Russia.*	×	-	-

COMMON NAME *Scientific Name*	PREFERRED HABITAT *Migratory Breeding*	Suitable Habitat Present (✓)	Recorded on Site (✓)	COMMENTS
Osprey (*Pandion haliaetus*)	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. Feeds on fish over clear, open water. Breeds from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometer of the sea.	✓	×	-
Fork-tailed Swift (*Apus pacificus*)	Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities. *Breeds Siberia, Himalayas, east to Japan south east Asia. Summer migrant to east Australia. Mass movements associated with late summer low pressure systems into east Australia. Otherwise uncommon.*	✓	×	-

Squirrel Glider Habitat Assessment A3

Job No……A16015F**……..…..Date…**15/3/16**……..**
Assessor …Corey Mead**……Location……**Mulloway Road, Chain Valley Bay.

HABITAT QUALITY (VEGETATION TYPE)	Available Habitat Area	% Habitat Type
Stringybark / Gum with Acacia / Melaleuca / Grass Understorey		Nil
Spotted Gum / Ironbark / Gum		Nil
Stringybark with Banksia / Allocasuarina / Melaleuca understorey		
Sydney Red Gum / Scribbly Gum with Allocasuarina / Melaleuca understorey		Nil
Sydney Red Gum / Scribbly Gum with Banksia understorey	9.84ha	59%
Other 1:- Riparian Forest	3.64ha	22%

REMNANT PATCH SIZE – (Measured from Air Photo / Topographic Map)	
Patch <5 hectares	
Patch >5 and <10 hectares	
Patch >10 and <30 hectares	✓ within site
Patch >30 and <90 hectares	

DENSITY OF HABITAT TREES – (Refer to Habitat Tree Assessment)	
Average number of Habitat Trees / hectare **<2** Habitat Trees / hectare	
Average number of Habitat Trees / hectare **>2** Habitat Trees / hectare	✓

ABUNDANCE OF FOOD PLANTS – (From Transect & Quadrat Data)			
Food Plants	**Food Item**	**Avg No of Plants / hectare**	**% of Vegetation Assemblage**
Angophora costata	Sap, nectar & pollen	80	80
Eucalyptus haemastoma	Sap, nectar & pollen	150	40
Eucalyptus racemosa	Sap, nectar & pollen	-	-
Eucalyptus robusta	Sap, nectar & pollen	-	100
Eucalyptus siderophloia	Sap, nectar & pollen	-	-
Eucalyptus paniculata	Sap, nectar & pollen	-	-
Eucalyptus fibrosa	Sap, nectar & pollen	-	-
Corymbia gummifera	Sap, nectar & pollen	150	20
Corymbia maculata	Nectar & pollen	-	-
Melaleuca linariifolia	Nectar & insects	-	100
Melaleuca nodosa	Nectar & insects	-	-
Melaleuca quinquenervia	Nectar & insects	-	200
Melaleuca sieberi	Nectar & insects	1	500
Acacia spp.	Seeds & gum	250	250
Banksia spinulosa	Nectar & pollen	100	50
Banksia serrata	Nectar & pollen	-	-
Banksia integrifolia	Nectar & pollen	-	-
Banksia oblongifolia	Nectar & pollen	25	100
Xanthorrhoea spp.	Nectar & gum	100	20

HABITAT VULNERABILITY

Describe adjoining land uses:

North = Residential/ native vegetation,
South = local tidal creek along native vegetation riparian corridor,
East = Retirement Village,
West = Residential.

Describe impacts of adjoining land use on the study area.

Main residential access road along the northern boundary
Removal of direct east-west connectivity
Exotic weeds / introduced species
Presence of cats and dogs
Rubbish dumping

Edge to Width Ratio:

Describe the shape of the patch (e.g. square, round, oval, rectangular, triangular, narrow/linear), and relationships to adjoining land.

No isolated patches occur; irregularly shaped within the site. No narrow portions. Greater than 50% edge connectivity beyond patches present. Connective potential to extensive areas of habitat is possible from all suitable areas of habitat within the study area.

DISTURBANCE FACTORS	% of Patch
Weed Invasion	5%
Underscrubbing	5%
Fire intensity → circle - Low (Med) High	50%
Fire Frequency → circle – (Low) Med High	50%
Rubbish Dumping	0%
Other (Please Describe: e.g landfilling, draining) :– cut & fill for dam	5%
Other (Please Describe: e.g landfilling, draining) :–	

Is the patch within 200m of an existing or future residential development?

☑ Yes ☐ No

Are there any Squirrel Gliders present in the patch?

☐ Yes ☐ No ☑ Unknown

Are the Squirrel Gliders Breeding? N/A

☐ Yes ☐ No ☑ Unknown

These vegetation communities were described in the previous Sections. The area of available habitat for Squirrel Gliders is considered to incorporate the Open Forest communities to an estimated total of 13.48 hectares.