

Working Paper

Fauna Investigations

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*Pacific Highway Upgrade
Sapphire to Woolgoolga
Roads and Traffic Authority*

Fauna Investigations

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ABBREVIATIONS & DEFINITIONS

ANZECC	Australia and New Zealand Environment Conservation Council
CRAFTI	Comprehensive Regional Assessment Forest Type Inventory
DECC	NSW Department of Environment and Climate Change
DEWR	Commonwealth Department of Water Resources
EEC	Endangered Ecological Community
Endemic	Distribution restricted to a particular region or area
EP	Endangered Population
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth)
FM Act	Fisheries Management Act 1994
ha	Hectare
JANIS	Joint ANZECC/MCFFA/NFPS Implementation Sub-Committee
km	Kilometre
Local Area	Defined by NPWS (2001) as the area within a 10km radius of the study area
LGA	Local Government Area
m	Metre
MCFFA	The Ministerial Council on Fisheries, Forestry and Aquaculture
mm	Millimetre
NES	National Environmental Significance (Commonwealth)
NFPS	National Forestry Policy Statement
NP	National Park
NPWS	NSW National Parks and Wildlife Service (now included under DEC)
NR	Nature Reserve
SEPP	State Environmental Planning Policy
TSC Act	<i>Threatened Species Conservation Act 1995</i>

1. Introduction

1.1 Background to the Study

This report has been prepared by Connell Wagner Pty Ltd on behalf of the NSW Roads and Traffic Authority (RTA) to describe the investigations and findings of the fauna surveys undertaken for the Pacific Highway upgrade between Sapphire and Woolgoolga. A specialist frog survey was undertaken by Lewis Ecological Surveys with a separate working paper produced detailing these findings.

The proposed highway upgrade between Sapphire and Woolgoolga consists of:

- Duplication of the existing highway to dual carriageways from Sapphire to south of Woolgoolga;
- a bypass to the west of Woolgoolga involving construction of dual carriageways;
- provision of service roads for local traffic; and
- interchanges at Sapphire, Moonee Beach, Emerald Beach, Woolgoolga south and Arrawarra Beach Road.

This report describes the fauna and habitats of the study area from investigations undertaken during 2005. The impact of the proposed upgrade on the fauna, habitats, corridors and threatened fauna listed under the *Threatened Species Conservation Act 1995* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is described in the Environment Assessment (EA) document produced under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The study design for the field surveys was originally developed in the context of a duplication of the Pacific Highway to dual carriageway with limited interchanges and service roads. Following the undertaking of fieldwork, it was confirmed that the proposal for the upgrade was in the Class M (motorway option) with the inclusion of a full service road.

The findings of flora surveys have been documented in a separate report prepared by Ecos Environmental Pty Ltd (Ecos 2005).

1.2 Study Objectives

The objectives of the fauna study were to:

- identify and describe the fauna habitats occurring within the study area;
- document the animal species recorded within the study area, highlighting any species listed on the TSC Act, the EPBC Act and the FM Act;
- investigate potential wildlife corridors extending from the study area to adjacent natural areas;
- determine the likelihood of occurrence of any threatened species, population and ecological community listed under the TSC Act and/or EPBC Act; and
- provide an overview of the broad ecological impacts of the proposal.

1.3 Description of Study Area

1.3.1 Locality

The study area consists of a corridor extending for 25 km from Sapphire on the northern outskirts of Coffs Harbour to Arrawarra Creek north of Woolgoolga. The study area is entirely within the Coffs Harbour Local Government Area (LGA) on the NSW north coast. The study area incorporates cleared land, residential areas, banana plantations, forested land, State Forests and Nature Reserves. The majority of the highway duplication section falls within the existing road reserve, while the bypass section traverses private and public land (Wedding Bells State Forest). Several key habitats and corridors identified in the NPWS *Key Habitats and Corridors in North East NSW* study (NPWS 1999a) occur in the study area.

1.3.2 *Bioregional Context*

The study area is located in the NSW North Coast Bioregion. This Bioregion is part of a zone known as the Macleay–McPherson overlap, which covers an area from Barrington Tops in NSW to Lamington National Park in South East Queensland. This zone is characterised by an overlap in distribution of tropical species from the north east and temperate species from the south east of the eastern seaboard. The environmental characteristics allied with this overlap are associated with a highly diverse array of species with the forests of the NSW North Coast Bioregion (the ‘north eastern forests’) regarded as one of Australia’s most diverse ecosystems (NPWS 2003b).

There are numerous examples of biological diversity within the NSW North Coast Bioregion. Over 400 species of forest vertebrates are found in the region, the macropod communities being among the most diverse on the east coast (NPWS 2003). The NSW North Coast Bioregion also supports Australia’s second highest diversity of birds, containing approximately 181 species (Gilmore & Parnaby 1994). Several endemic species, including those at or approaching their distributional limits, and over 70 threatened species are found in the NSW North Coast Bioregion (Gilmore & Parnaby 1994).

NPWS (1999) identified the NSW North Coast Bioregion as containing one of the two major peaks of eucalypt diversity in Australia. In addition to this, four of the five major rainforest groups all have significant occurrences in the region (Floyd 1990). The Comprehensive Regional Assessment (CRA) of the NSW North Coast Bioregion identified 157 forest ecosystems of which 137 are eucalypt dominated. Of these, 31 meet the JANIS criteria for rarity and a further 19 meet the JANIS criteria for vulnerability.

2. Fauna Survey Methods

2.1 Survey Design

Fauna surveys were undertaken over three sessions, from February 24 to March 9 2005, May 9 to 22 2005 and December 14 to 16 2005. The aim of the fauna survey was to maximise the detection of threatened fauna species occurring within the study area. The survey was designed using '*Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft)*' (DEC 2004) as a guide, and took into consideration the following issues:

- stratification, sampling and replication;
- targeted species, Endangered Populations (EPs) and Endangered Ecological Communities (EECs);
- species-specific survey methods and minimum sampling effort;
- optimal climatic and seasonal conditions;
- migratory species movements;
- data collection; and
- the limitations of the survey approach.

The following sections discuss how these issues were addressed in the survey design.

2.1.1 Stratification, Sampling and Replication

The study area was stratified to ensure the full range of potential habitats and vegetation types were evaluated. The initial stratification process used vegetation structure (for example, forest, woodland, shrubland) to identify broad habitat types. These habitat types correlated with the broad ecological types identified in the flora survey design and followed the structural classification of Walker and Hopkins (1990). Further stratification was then undertaken on the basis of variation in biophysical attributes (such as topography, soil type and landform element) and floristics (that is, species composition). These stratification units guided sampling intensity with replication governed by Comprehensive Regional Assessment Forest Type Inventory (CRAFTI) vegetation types. Survey sites varied from 25 ha to around 7.5 ha in which survey effort was focused. Survey site locations within survey units were generally randomly selected after considering:

- the need for replicate sites to evaluate heterogeneity or relative diversity of large areas, and verify consistency within the survey unit;
- the statistical methods used to analyse the data;
- the presence of transition zones and special habitats (eg. water bodies, rocky outcrops and cliffs); and
- factors such as disturbance, fire, flooding or distance from watering points.

In accordance with DEC (2004), sample sites were selected to avoid bias from edge effects and local disturbances where possible, and were situated using the following criteria:

- away from the boundaries of an environmental stratum;
- in homogeneous vegetation considered to be representative of the strata; and
- away from, or free from, local disturbances such as roads, mines, quarries and eroded areas.

Where only one sampling site was placed within a stratification unit, it was located in an area which best represented the unit. Sites were preselected using key ecological characteristics representative of the study area, enabling an extrapolation of results to describe areas of reduced survey coverage.

2.1.2 Optimal Climatic and Seasonal Conditions

As far as possible, the survey was designed so as to incorporate the effects of seasonality and to establish baseline data covering a range of considerations such as:

- relative abundance of foraging resources (eg flowering eucalypts);

- location and relative importance of overwintering habitats (eg tree hollows);
- influence of season on species activity (eg microchiropteran bats, frogs).

Studies were completed in three parts covering the summer and autumn periods. Two round of surveys focused on the detection of species that are likely to occupy the study area during the warmer months (December and early March), with another round of surveys focusing on seasonal variations associated with the cooler months (late May). This approach has effectively provided an opportunity to examine seasonal changes, such as levels of microchiropteran bat activity, without introducing other variables such as fire, drought and chronic disturbance.

2.1.3 *Habitat Resources*

Data on habitat resources was collected to assist in the assessment of the likelihood of threatened species and in the delineation of core areas of habitat for target species. Habitat attributes targeted during the survey included:

- the location, size class and number of tree hollows, tree species and status (dead or alive);
- the location of potential roost sites for cave-roosting bats, such as culverts and bridges;
- the type and abundance of foraging resources (eg *Allocasuarina*; nectar-producing trees and shrubs; rough-barked trees; mistletoe; koala feed trees);
- the cover of fallen timber, leaf litter and rock; and
- weed cover.

General habitat data was collected in accordance with standardised habitat proformas to ensure continuity between different recorders (see Appendix A).

2.1.4 *Data Collection*

Standard proformas were used to record field data so that information was collected in a consistent format and to ensure continuity between recorders. A number of different proformas were used depending on the species or habitat being surveyed. Standard information recorded at each site included: location (using Global Positioning System), site identifier, date, and observer.

2.1.5 *Limitations*

Designing a survey to address specific outcomes (eg threatened species impact assessment) may inherently bias the resultant data set in favour of the targeted species. Therefore, the absence of a species from survey data does not necessarily mean it does not inhabit the survey area. It may simply mean that the species was not detected at that time with the survey method adopted and the prevailing seasonal or climatic conditions. Similarly, presence data, especially from animal surveys, is rarely sufficiently systematic to estimate population size or range. Such data is usually only indicative of the presence of individuals of a local population. To overcome this limitation, consideration has been given to the presence in the survey area (or surrounding land) of the known or likely habitat components for a species through habitat assessments.

Similar limitations apply to the use of databases for the interpretation of presence and absence survey data. Records of DEC's Atlas of NSW Wildlife are representative of available information, which is limited by the scope or intent of past surveys or observations. Accordingly, these databases have been used as an indication of species' presence in an area.

To overcome some of the problems associated with seasonality, bat sampling was undertaken during warmer and cooler months of summer-autumn, and Swift Parrot surveys were undertaken during the autumn session of fieldwork, the timing of which coincided with the time of year when the species was most likely to be in the study area.

2.1.6 *Target Species/Populations*

Examination of the DEC Wildlife Atlas Database and EPBC Protected Matters Report for the local area were used to identify threatened species, endangered populations and migratory species recorded or likely to occur in the local area. The preliminary list of target threatened species/populations (Table 2-1) was refined through a

general review of broad habitat types that are known to occur within the study area. Species clearly exhibiting preferences for habitats not represented in the study area were eliminated from the target species list, thereby focusing field studies and impact assessments on the remaining threatened species. Threatened species for which there were no database records, but were considered likely to occur (on the basis of habitat suitability) were also targeted.

Table 2-1: Preliminary List of Threatened Fauna Species

Scientific Name	Common Name	Conservation Status		Potential Habitat Present	Local Records	Within Known Distribution
		TSC Act	EPBC Act			
REPTILES						
<i>Coeranoscincus reticulatus</i>	Three-toed Snake-tooth Skink	V	V	√	×	√
<i>Emydura signata</i>	Bellinger River Emydura	V	V	×	×	×
<i>Hoplocephalus stephensii</i>	Stephen's Banded Snake	V	—	√	√	√
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	V	—	√	×	√
DIURNAL BIRDS						
<i>Calidris alba</i>	Sanderling	V	—	×	√	√
<i>Calidris tenuirostris</i>	Great Knot	V	—	×	√	√
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	—	√	√	√
<i>Charadrius leschenaultii</i>	Greater Sand Plover	V	—	×	×	√
<i>Charadrius mongolus</i>	Lesser Sand Plover	V	M	×	×	√
<i>Climacteris picumnus</i>	Brown Treecreeper	V	—	√	√	√
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	—			
<i>Coracina lineata</i>	Barred Cuckoo-shrike	V	—	√	√	√
<i>Cyclopsitta diophthalma coxeni</i>	Coxen's Double-eyed Fig-Parrot	E	E	√	√	√
<i>Dromaius novaehollandiae</i> NSW North Coast Bioregion and Port Stephens LGA Population	Emu	E2	—	√	√	√
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E	—	√	√	√
<i>Erythrotriorchis radiatus</i>	Red Goshawk	E	V	√	×	√
<i>Esacus neglectus</i>	Beach Stone-curlew	E	—	×	√	√
<i>Grus rubicundus</i>	Brolga	V	—	×	√	√
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V	—	×	√	√
<i>Haematopus longirostris</i>	Pied Oystercatcher	V	—	×	√	√
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	V	—	√	×	×
<i>Irediparra gallinacea</i>	Comb-crested Jacana	V	—	√	√	√

Table 2-1: Preliminary List of Threatened Fauna Species						
Scientific Name	Common Name	Conservation Status		Potential Habitat Present	Local Records	Within Known Distribution
		TSC Act	EPBC Act			
<i>Ixobrychus flavicollis</i>	Black Bittern	V	—	×	√	√
<i>Lathamus discolor</i>	Swift Parrot	E	E	√	√	√
<i>Lichenostomus fasciularis</i>	Mangrove Honeyeater	V	—	×	×	√
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	V	—	×	×	√
<i>Limosa limosa</i>	Black-tailed Godwit	V	—	×	√	√
<i>Lophoictinia isura</i>	Square-tailed Kite	V	—	√	√	√
<i>Melanodryas cucullata</i>	Hooded Robin	V	—	√	×	√
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (southeastern subspecies)					
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V	—	×	×	×
<i>Monarcha leucotis</i>	White-eared Monarch	V	—	×	√	√
<i>Pandion haliaetus</i>	Osprey	V	—	√	√	√
<i>Pezoporus wallicus wallicus</i>	Ground Parrot (eastern subspecies)	V	—	×	√	√
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	—	√	×	√
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	—	√	√	√
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V	—	√	√	√
<i>Ptilinopus superbus</i>	Superb Fruit-Dove	V	—	√	√	√
<i>Rostratula benghalensis australis</i>	Painted Snipe (Australian subspecies)	E	—	×	×	√
<i>Rostratula australis</i>	Australian Painted Snipe	—	V			
<i>Sterna albifrons</i>	Little Tern	E	—	×	√	√
<i>Sterna fuscata</i>	Sooty Tern	V	—	×	√	√
<i>Stictonetta naevosa</i>	Freckled Duck	V	—	√	√	√
<i>Todiramphus chloris</i>	Collared Kingfisher	V	—	×	√	√
<i>Turnix melanogaster</i>	Black-breasted Button-quail	E	V	√	×	√
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E	E	√	√	√
NOCTURNAL BIRDS						
<i>Botaurus poiciloptilus</i>	Australasian Bittern	V	—	×	×	√
<i>Burhinus grallarius</i>	Bush Stone-curlew	E	—	√	√	√

Table 2-1: Preliminary List of Threatened Fauna Species						
Scientific Name	Common Name	Conservation Status		Potential Habitat Present	Local Records	Within Known Distribution
		TSC Act	EPBC Act			
<i>Ninox connivens</i>	Barking Owl	V	—	√	×	√
<i>Ninox strenua</i>	Powerful Owl	V	—	√	√	√
<i>Tyto capensis</i>	Grass Owl	V	—	√	√	√
<i>Tyto novaehollandiae</i>	Masked Owl	V	—	√	√	√
<i>Tyto tenebricosa</i>	Sooty Owl	V	—	√	√	√
MAMMALS (EXCLUDING BATS)						
<i>Aepyprymnus rufescens</i>	Rufous Bettong	V	—	√	×	√
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	—	√	×	√
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	—	√	√	√
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll (SE Mainland Population)	—	E			
<i>Petaurus australis</i>	Yellow-bellied Glider	V	—	√	√	√
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	—	√	√	√
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	—	√	×	√
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo (SE Mainland Population)	—	V			
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	—	√	√	√
<i>Phascolarctos cinereus</i>	Koala	V	—	√	√	√
<i>Planigale maculata</i>	Common Planigale	V	—	√	√	√
BATS						
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	√	×	√
<i>Chalinolobus nigrogriseus</i>	Hoary Wattled Bat	V	—	√	√	√
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	—	√	√	√
<i>Kerivoula papuensis</i>	Golden-tipped Bat	V	—	√	√	√
<i>Miniopterus australis</i>	Little Bent-wing Bat	V	—	√	√	√
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V	—	√	√	√
<i>Mormopterus norfolkensis</i>	East Coast Freetail Bat	V	—	√	√	√
<i>Myotis adversus</i>	Large-footed Myotis	V	—	√	√	√
<i>Nyctophilus bifax</i>	Eastern Long-eared Bat	V	—	√	×	√
<i>Pteropus alecto</i>	Black Flying-Fox	V	—	√	×	√
<i>Pteropus poliocephalus</i>	Grey-headed Flying-Fox	V	V	√	√	√
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	—	√	×	√

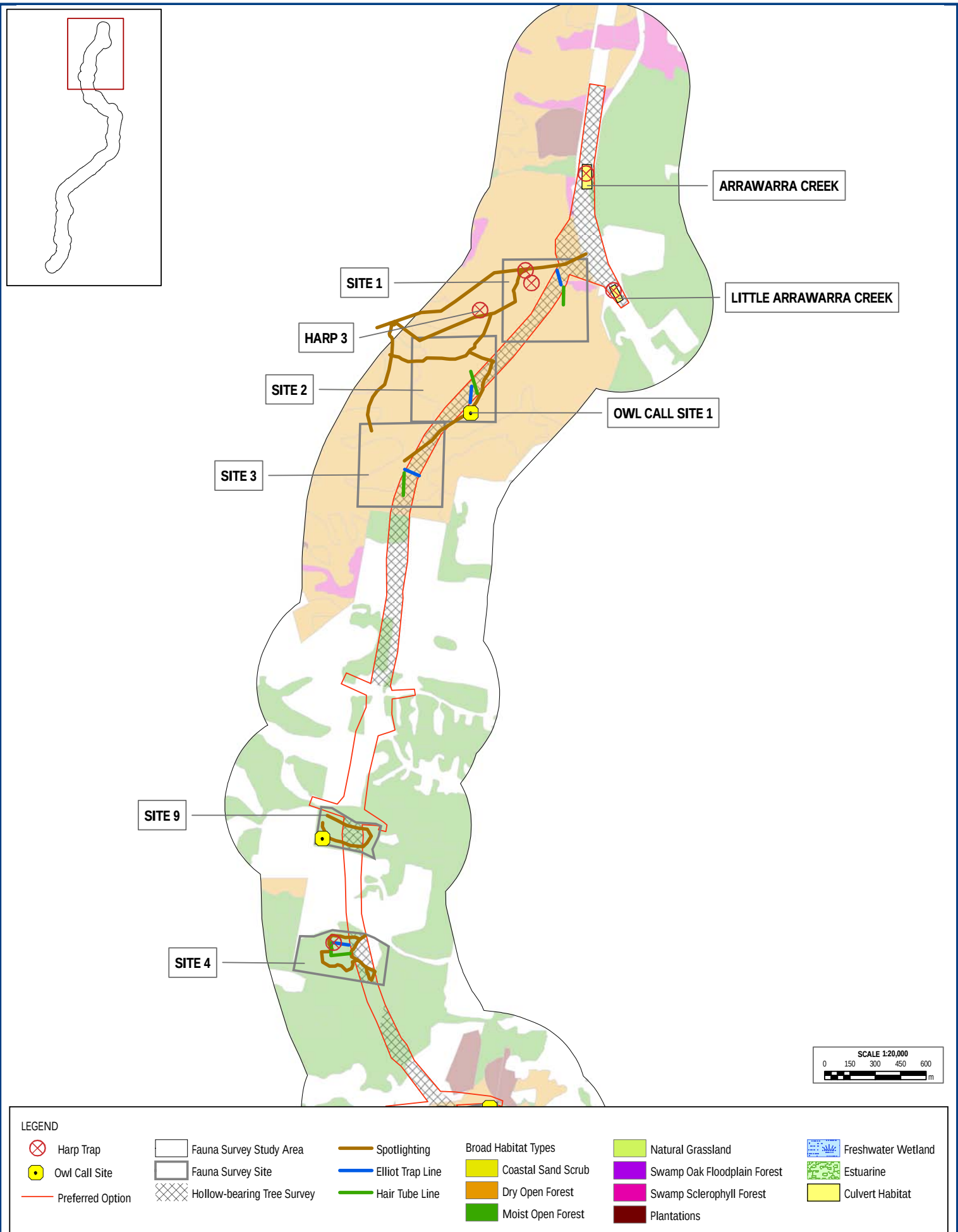
Table 2-1: Preliminary List of Threatened Fauna Species						
Scientific Name	Common Name	Conservation Status		Potential Habitat Present	Local Records	Within Known Distribution
		TSC Act	EPBC Act			
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	—	√	√	√
<i>Syconycteris australis</i>	Common Blossom-bat	V	—	√	√	√
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	—	√	×	√
INVERTEBRATES						
<i>Petalura gigantea</i>	Giant Dragonfly	E	—	√	×	√
<i>Phyllodes imperialis</i>	Moth (Southern subspecies)	E	E	×	×	√
MIGRATORY SPECIES LISTED UNDER EPBC ACT						
<i>Gallinago hardwickii</i>	Latham's Snipe	—	M	×	√	√
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	—	M	√	√	√
<i>Hirundapus caudacutus</i>	White-throated Needletail	—	M	√	√	√
<i>Monarcha melanopsis</i>	Black-faced Monarch	—	M	√	√	√
<i>Monarcha trivirgatus</i>	Spectacled Monarch	—	M	√	√	√
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	—	M	√	√	√
<i>Numenius phaeopus</i>	Whimbrel	—	M	×	√	√
<i>Rhipidura rufifrons</i>	Rufous Fantail	—	M	√	√	√
<i>Rostratula benghalensis</i>	Painted Snipe	—	M	×	×	√

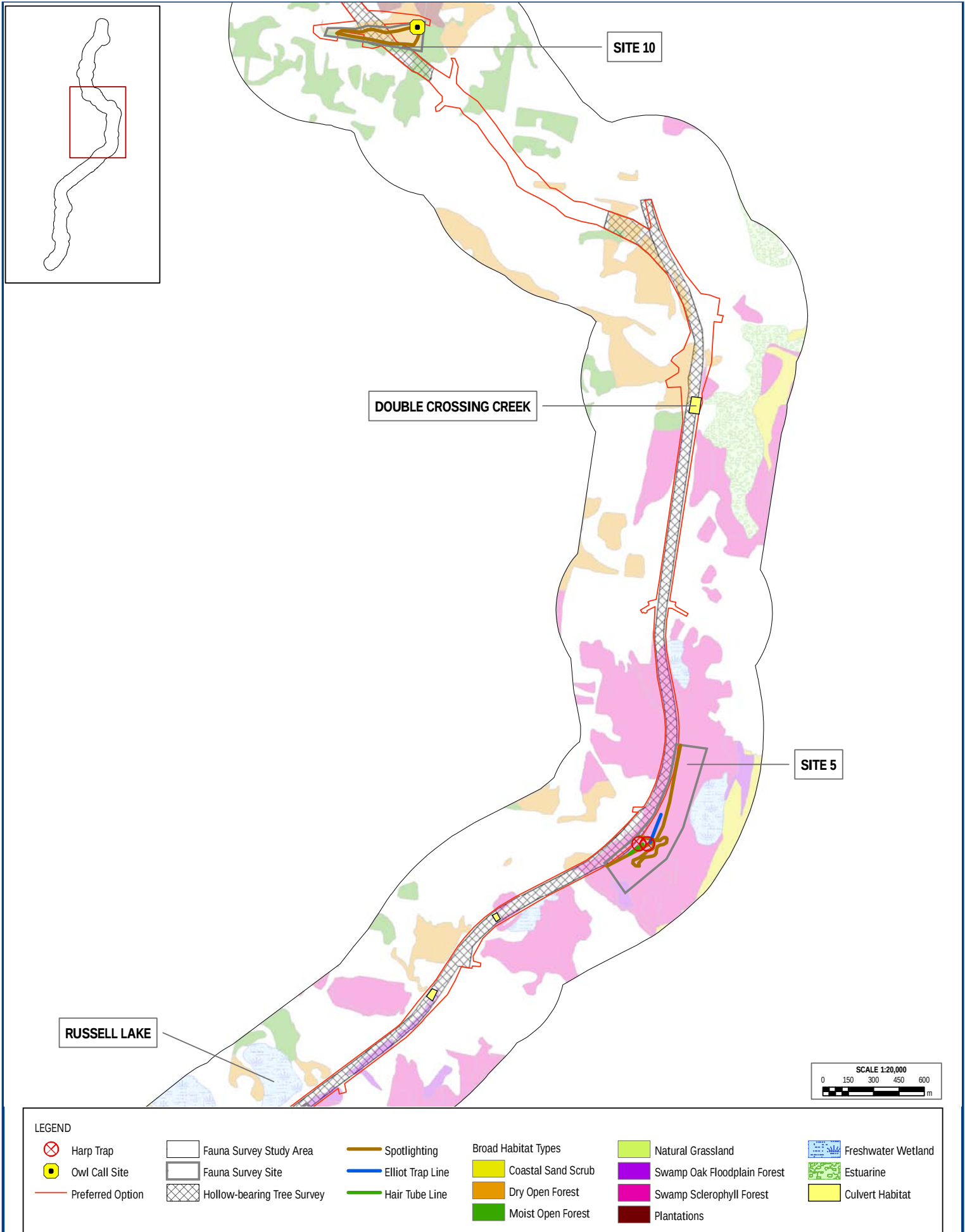
Survey Methods and Minimum Sampling Effort

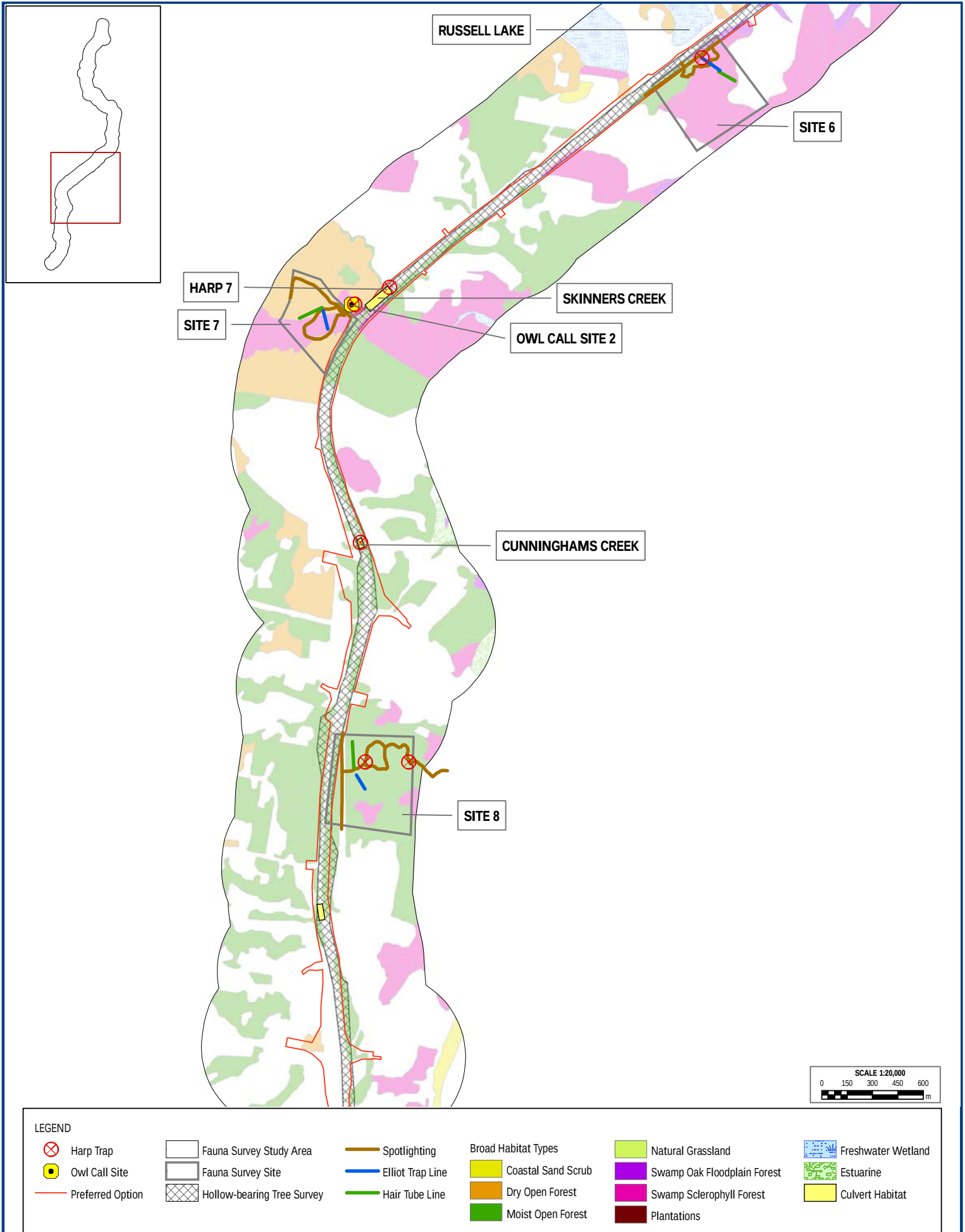
A combination of specific survey methods (designed to target particular species or faunal groups), and general survey methods (designed to record a range of faunal groups during a survey session), were used to maximise the detection of target species within the study area (Table 2-2). While a separate specialist frog survey was undertaken during optimal seasonal and climatic conditions, any observations of frog species made while undertaking other fauna surveys were noted. Fauna survey effort at each survey site is summarised in Table 2-3. The location of each survey site is illustrated in Figure 2-1 : Fauna Survey Locations

Survey techniques are described in more detail in Section 2.2 of this report.

Table 2-2: Target Threatened Fauna Survey Techniques	
Technique	Targeted Species
SPECIES-SPECIFIC TECHNIQUES	
Hair Tubes	Rufous Bettong (<i>Aepyprymnus rufescens</i>) Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) Brush-tailed Phascogale (<i>Phascogale tapoatafa</i>) Long-nosed Potoroo (<i>Potorous tridactylus</i>) Common Planigale (<i>Planigale maculata</i>)







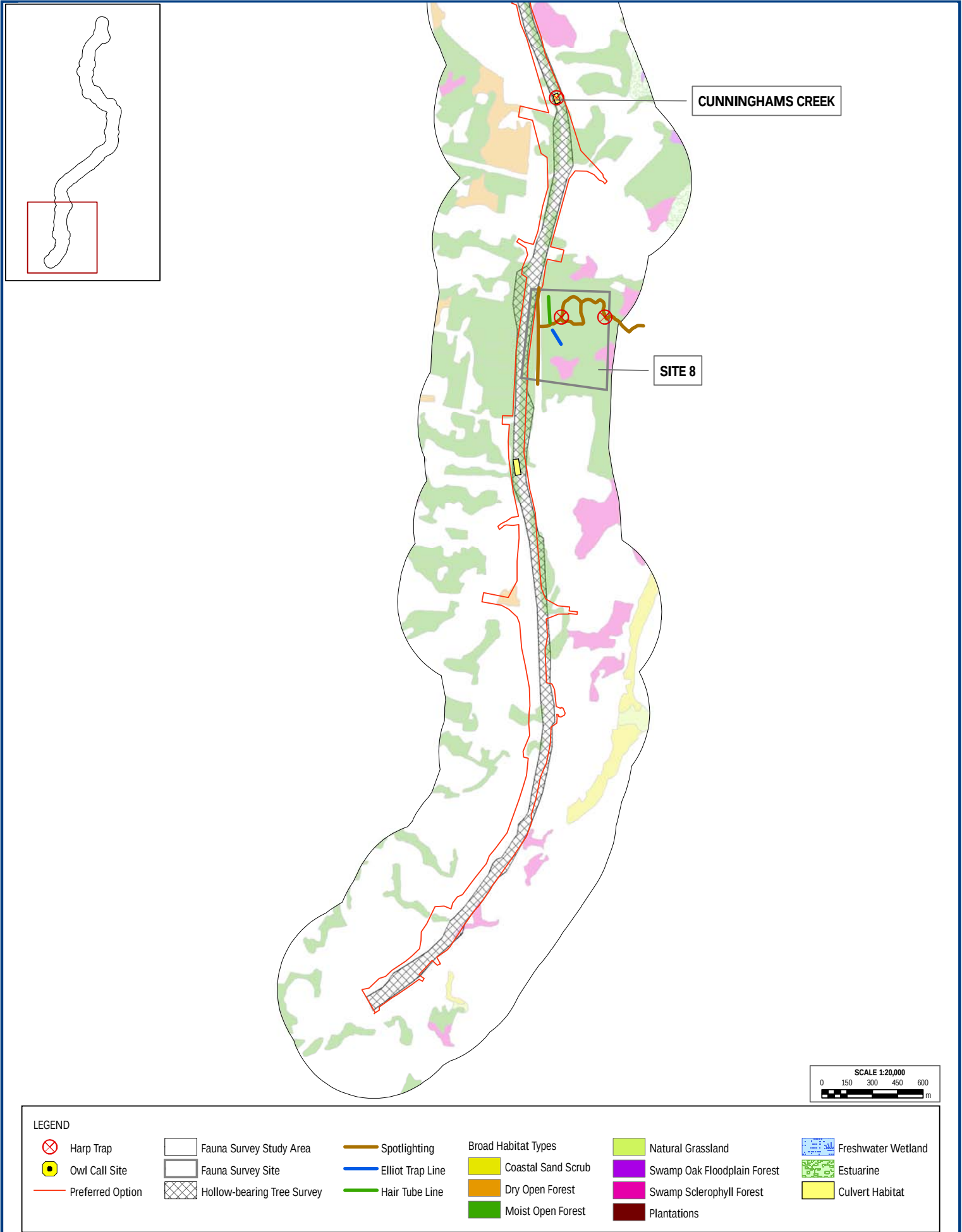


Table 2-2: Target Threatened Fauna Survey Techniques	
Technique	Targeted Species
Arboreal Elliott Trapping	Squirrel Glider (<i>Petaurus norfolcensis</i>) Brush-tailed Phascogale (<i>Phascogale tapoatafa</i>)
Harp Trapping	Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>) Hoary Wattled Bat (<i>Chalinolobus nigrogriseus</i>) Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>) Little Bent-wing Bat (<i>Miniopterus australis</i>) Eastern Bent-wing Bat (<i>Miniopterus schreibersii oceanensis</i>) East Coast Freetail Bat (<i>Mormopterus norfolkensis</i>) Large-footed Myotis (<i>Myotis adversus</i>) Eastern Long-eared Bat (<i>Nyctophilus bifax</i>) Yellow-bellied Sheathtail-bat (<i>Saccolaimus flaviventris</i>) Common Blossom-bat (<i>Syconycteris australis</i>) Eastern Cave Bat (<i>Vespadelus trougtoni</i>) Golden-tipped Bat (<i>Kerivoula papuensis</i>)
Bat Calls (recording of microbat echolocation calls)	Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>) Hoary Wattled Bat (<i>Chalinolobus nigrogriseus</i>) Little Bent-wing Bat (<i>Miniopterus australis</i>) Eastern Bent-wing Bat (<i>Miniopterus schreibersii oceanensis</i>) East Coast Freetail Bat (<i>Mormopterus norfolkensis</i>) Large-footed Myotis (<i>Myotis adversus</i>) Yellow-bellied Sheathtail-bat (<i>Saccolaimus flaviventris</i>) Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>) Eastern Cave Bat (<i>Vespadelus trougtoni</i>)

Table 2-2: Target Threatened Fauna Survey Techniques	
Technique	Targeted Species
Diurnal Bird Census	Glossy Black-Cockatoo (<i>Calyptorhynchus lathami</i>) Brown Treecreeper (<i>Climacteris picumnus</i>) Barred Cuckoo-shrike (<i>Coracina lineata</i>) Emu (<i>Dromaius novaehollandiae</i>) Red Goshawk (<i>Erythrorhynchus radiatus</i>) Black-breasted Buzzard (<i>Hamirostra melanosternon</i>) Swift Parrot (<i>Lathamus discolor</i>) Square-tailed Kite (<i>Lophoictinia isura</i>) Hooded Robin (<i>Melanodryas cucullata</i>) Osprey (<i>Pandion haliaetus</i>) Grey-crowned Babbler (<i>Pomatostomus temporalis temporalis</i>) Rose-crowned Fruit-Dove (<i>Ptilinopus regina</i>) Superb Fruit-Dove (<i>Ptilinopus superbus</i>) Freckled Duck (<i>Stictonetta naevosa</i>) Black-breasted Button-quail (<i>Turnix melanogaster</i>) Regent Honeyeater (<i>Xanthomyza phrygia</i>) White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>) White-throated Needletail (<i>Hirundapus caudacutus</i>) Black-faced Monarch (<i>Monarcha melanopsis</i>) Spectacled Monarch (<i>Monarcha trivirgatus</i>) Satin Flycatcher (<i>Myiagra cyanoleuca</i>) Rufous Fantail (<i>Rhipidura rufifrons</i>)
Call Playback	Wallum Froglet (<i>Crinia tinnula</i>) Wallum Sedge Frog (<i>Litoria olongburensis</i>) Stuttering Frog (<i>Mixophyes balbus</i>) Giant Barred Frog (<i>Mixophyes iteratus</i>) Barking Owl (<i>Ninox connivens</i>) Powerful Owl (<i>Ninox strenua</i>) Masked Owl (<i>Tyto novaehollandiae</i>) Sooty Owl (<i>Tyto tenebricosa</i>) Yellow-bellied Glider (<i>Petaurus australis</i>) Koala (<i>Phascolarctos cinereus</i>)
GENERAL SURVEY TECHNIQUES	

Table 2-2: Target Threatened Fauna Survey Techniques	
Technique	Targeted Species
Spotlighting	Wallum Froglet (<i>Crinia tinnula</i>) Green and Golden Bell Frog (<i>Litoria aurea</i>) Green Thighed Frog (<i>Litoria brevipalmata</i>) Wallum Sedge Frog (<i>Litoria olongburensis</i>) Stuttering Frog (<i>Mixophyes balbus</i>) Giant Barred Frog (<i>Mixophyes iteratus</i>) Stephen's Banded Snake (<i>Hoplocephalus stephensii</i>) Pale-headed Snake (<i>Hoplocephalus bitorquatus</i>) Bush Stone-curlew (<i>Burhinus grallarius</i>) Barking Owl (<i>Ninox connivens</i>) Powerful Owl (<i>Ninox strenua</i>) Grass Owl (<i>Tyto capensis</i>) Masked Owl (<i>Tyto novaehollandiae</i>) Sooty Owl (<i>Tyto tenebricosa</i>) Rufous Bettong (<i>Aepyprymnus rufescens</i>) Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) Yellow-bellied Glider (<i>Petaurus australis</i>) Squirrel Glider (<i>Petaurus norfolcensis</i>) Brush-tailed Phascogale (<i>Phascogale tapoatafa</i>) Long-nosed Potoroo (<i>Potorous tridactylus</i>) Koala (<i>Phascolarctos cinereus</i>) Black Flying-Fox (<i>Pteropus alecto</i>) Grey-headed Flying-Fox (<i>Pteropus poliocephalus</i>) Yellow-bellied Sheath-tail-bat (<i>Saccolaimus flaviventris</i>)

Table 2-2: Target Threatened Fauna Survey Techniques	
Technique	Targeted Species
Habitat Searches	Wallum Froglet (<i>Crinia tinnula</i>) Green and Golden Bell Frog (<i>Litoria aurea</i>) Green Thighed Frog (<i>Litoria brevipalmata</i>) Wallum Sedge Frog (<i>Litoria olongburensis</i>) Stuttering Frog (<i>Mixophyes balbus</i>) Giant Barred Frog (<i>Mixophyes iteratus</i>) Three-toed Snake-tooth Skink (<i>Coeranoscincus reticulatus</i>) Stephen's Banded Snake (<i>Hoplocephalus stephensi</i>) Pale-headed Snake (<i>Hoplocephalus bitorquatus</i>) Glossy Black-Cockatoo (<i>Calyptorhynchus lathami</i>) Barred Cuckoo-shrike (<i>Coracina lineata</i>) Emu (<i>Dromaius novaehollandiae</i>) Swift Parrot (<i>Lathamus discolor</i>) Osprey (<i>Pandion haliaetus</i>) Regent Honeyeater (<i>Xanthomyza phrygia</i>) Bush Stone-curlew (<i>Burhinus grallarius</i>) Barking Owl (<i>Ninox connivens</i>) Powerful Owl (<i>Ninox strenua</i>) Grass Owl (<i>Tyto capensis</i>) Masked Owl (<i>Tyto novaehollandiae</i>) Sooty Owl (<i>Tyto tenebricosa</i>) Rufous Bettong (<i>Aepyprymnus rufescens</i>) Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) Yellow-bellied Glider (<i>Petaurus australis</i>) Koala (<i>Phascolarctos cinereus</i>) Black Flying-Fox (<i>Pteropus alecto</i>) Grey-headed Flying-Fox (<i>Pteropus poliocephalus</i>)

Figure 2-1 : Fauna Survey Locations

Table 2-3: Fauna Survey Effort and Site Locations

B = B-size Elliott Trap S = Small Hair Tube L = Large Hair Tube 0 = no. of trap nights (0) = over no. of days or nights (0) = over no. of consecutive days or nights

Site Reference	Broad Habitat Type	Vegetation Type (CRAFTI)	Hair Tubes	Arboreal Trapping	Spot-lighting	Habitat Searches	Harp Trapping	Owl Call Playback	Bat Calls	Diurnal Bird Census
			Trap Nights	Trap Nights	Person Hours	Person Hours	Trap Nights	Person Hours	Person Hours	Person Hours
Site 1	Dry Open Forest	Dry Blackbutt	S40(4) L40(4) 3 rd – 7 th March	B24(4) 3 rd – 7 th March	11(4) 28 th Feb 1 st & 4 th March 15 th May	4(1) 7 th March	8(4) 3 rd – 7 th March		5.5(4) 28 th Feb 1 st & 4 th March 15 th May	2(3) 2 nd & 5 th March 18 th May
Site 2	Dry Open Forest grading into Moist Open Forest	Dry Blackbutt and Spotted Gum – Ironbark/ Grey Gum	S80(8) L80(8) 26 th Feb – 7 th March	B24(4) 26 th Feb – 2 nd March	7(3) 26 th & 28 th Feb & 3 rd March	4(1) 7 th March			3.5(3) 26 th & 28 th Feb & 3 rd March	1.5(3) 27 th Feb – 1 st March
Site 3	Dry Open Forest	Spotted Gum – Ironbark/ Grey Gum	S80(8) L80(8) 26 th Feb – 7 th March	B24(4) 26 th Feb – 2 nd March	6(2) 26 th Feb & 3 rd March				3(2) 26 th Feb & 3 rd March	1.5(3) 27 th Feb – 1 st March
Site 4	Dry Open Forest grading into Moist Open Forest (regrowth)	Flooded Gum and Narrow-leaved White Mahogany	S40(4) L40(4) 16 th – 20 th May	B24(4) 16 th – 20 th May	6(4) 16 th - 19 th May	2(1) 20 th May	2(2) 18 th - 20 th May			2(2) 17 th & 18 th May
Site 5	Swamp Sclerophyll Forest	Paperbark	S40(4) L40(4) 3 rd – 7 th March	B24(4) 3 rd – 7 th March	6(3) 7 th & 8 th March & 14 th May		4(3) 5 th - 8 th March		3(3) 7 th & 8 th March & 14 th May	1(2) 4 th & 5 th March
Site 6	Moist Open Forest grading into Swamp Sclerophyll Forest	Blackbutt-Bloodwood/ Apple and Paperbark	S40(4) L40(4) 15 th – 19 th May	B24(4) 15 th – 19 th May	6(3) 14 th 17 th & 18 th May	3(2) 16 th & 20 th May	3(3) 15 th - 18 th May		3(3) 14 th 17 th & 18 th May	6(3) 14 th 16 th & 18 th May

Table 2-3: Fauna Survey Effort and Site Locations

B = B-size Elliott Trap S = Small Hair Tube L = Large Hair Tube 0 = no. of trap nights (0) = over no. of days or nights (0) = over no. of consecutive days or nights

Site Reference	Broad Habitat Type	Vegetation Type (CRAFTI)	Hair Tubes	Arboreal Trapping	Spot-lighting	Habitat Searches	Harp Trapping	Owl Call Playback	Bat Calls	Diurnal Bird Census
			Trap Nights	Trap Nights	Person Hours	Person Hours	Trap Nights	Person Hours	Person Hours	Person Hours
Site 7	Dry Open Forest grading into Swamp Sclerophyll Forest	Brush Box (incorrectly mapped) and Dry Blackbutt	S40(4) L40(4) 10 th - 15 th May	B24(4) 10 th - 15 th May	10(5) 10 th 11 th 14 th – 16 th May	2(1) 16 th May			5(5) 10 th 11 th 14 th – 16 th May	5(3) 11 th 14 th & 16 th May
Site 8	Dry Open Forest grading into Swamp Sclerophyll Forest	Blackbutt-Bloodwood/Apple and Paperbark	S40(4) L40(4) 10 th - 15 th May	B30(4) 10 th - 15 th May	8(4) 10 th 11 th 13 th & 14 th May	2(1) 11 th May	5(3) 10 th - 13 th May		4(4) 10 th 11 th 13 th & 14 th May	8(4) 10 th 11 th 14 th & 15 th May
Site 9	Moist Open Forest				3(1) 14 th December	2(1) 14 th December		1.5(1) 14 th December	1.5(1) 14 th December	
Site 10	Dry Open Forest grading into Moist Open Forest				3(1) 15 th December	2(1) 15 th December		1.5(1) 15 th December	1.5(1) 15 th December	
Owl Call Site 1	Dry Open Forest	Dry Blackbutt						8(8) 26 th & 28 th Feb – 6 th March	8(8) 26 th & 28 th Feb – 6 th March	
Owl Call Site 2	Dry Open Forest grading into Swamp Sclerophyll Forest	Brush Box (incorrectly mapped)						8(8) 1 st – 8 th March	8(8) 1 st – 8 th March	
Double Crossing Creek	Bridge	N/A				1(1) 19 th May			12(1) 19 th May	2(1) 5 th March

Table 2-3: Fauna Survey Effort and Site Locations

B = B-size Elliott Trap S = Small Hair Tube L = Large Hair Tube 0 = no. of trap nights (0) = over no. of days or nights (0) = over no. of consecutive days or nights

Site Reference	Broad Habitat Type	Vegetation Type (CRAFTI)	Hair Tubes	Arboreal Trapping	Spot-lighting	Habitat Searches	Harp Trapping	Owl Call Playback	Bat Calls	Diurnal Bird Census
			Trap Nights	Trap Nights	Person Hours	Person Hours	Trap Nights	Person Hours	Person Hours	Person Hours
Arrawarra Creek	Bridge	N/A				1(1) 18 th May	3(3) 18 th – 21 st May			
Little Arrawarra Creek	Bridge	N/A				1(1) 19 th May	3(3) 18 th – 21 st May			
Cunninghams Creek	Bridge	N/A				1(1) 10 th May	3(3) 10 th – 13 th May		12(1) 10 th May	
Skinners Creek	Bridge	N/A				1(1) 18 th May	2(2) 16 th – 18 th May			
Russel Lake	Open Waterbody	Water								2(1) 19 th May
HARP3	Dry Open Forest	Dry Blackbutt					4(4) 3 rd – 7 th March			
HARP7	Dry Open Forest grading into Swamp Sclerophyll Forest	Brush Box (incorrectly mapped) and Dry Blackbutt					2(2) 12 th - 14 th May			
Hollow-bearing Tree Survey	N/A	N/A				80 25 th 28 th Feb, 1 st 3 rd 5 th March, 11 th & 17 th May, 14 th 15 th December				

2.2 Description of Survey Methods Used

2.2.1 Species-Specific Survey Methods

Amphibians

Prior to the decision to proceed with a specialist frog survey due to the lack of suitable weather conditions during the fauna survey periods, the following activities were undertaken to detect amphibian species.

The amphibian field surveys focused on Wallum Froglet (*Crinia tinnula*), Green and Golden Bell Frog (*Litoria aurea*), Green Thighed Frog (*Litoria brevipalmata*), Wallum Sedge Frog (*Litoria oblongburensis*), Stuttering Frog (*Mixophyes balbus*) and the Giant Barred Frog (*Mixophyes iteratus*). A total of 62 hours were spent surveying for frogs within the study area.

Nocturnal surveys for Wallum Froglet (*Crinia tinnula*) were conducted in areas of suitable habitat during wet weather in May 2005. Not all areas of potential Wallum Froglet habitat within the study area were accessed during the study, since the focus of amphibian field surveys was primarily on the proposed highway footprint. For example, an area of known Wallum Froglet habitat occurring outside the road reserve near Double Crossing Creek was not surveyed. Nocturnal surveys included call playback, spotlighting and habitat searches. Windy conditions during wet weather in May reduced the listening ability of observers and surveys were suspended when very windy conditions were encountered on the 13th May 2005.

Nocturnal streamside searches were conducted at Site 1 and Site 4 during some wet weather in May, however this was not considered adequate to detect all threatened species present due to the cooler temperatures and likely reduced activity of many targeted threatened species such as Stuttering Barred Frog (*Mixophyes balbus*), Giant Barred Frog (*Mixophyes iteratus*) and the Green Thighed Frog (*Litoria brevipalmata*). Further nocturnal streamside searches were not conducted within the study area due to unsuitable weather conditions (lack of rainfall) during surveys in February-March and the seasonality of the May surveys.

A driving transect near sites 1,2,3 was undertaken for around 2 hours during some minor rainfall in March 2005. However the small amount of rainfall experienced is unlikely to have resulted in much amphibian activity and as such the presence/absence of species during this survey could not be considered an accurate representation of the actual species present.

Due to the lack of rainfall during the February-March surveys and the cooler temperatures during the May surveys it is unlikely that the occurrence of threatened frog species such as the Green and Golden Bell Frog (*Litoria aurea*), Green Thighed Frog (*Litoria brevipalmata*), Wallum Sedge Frog (*Litoria oblongburensis*), Stuttering Frog (*Mixophyes balbus*) and the Giant Barred Frog (*Mixophyes iteratus*) was adequately examined. As such it was determined that a specialist amphibian survey be undertaken over the 2005-2006 summer period during optimal weather conditions. This survey was undertaken by Lewis Ecological Surveys with the results presented in the Frog Working Paper.

Diurnal Birds

Diurnal bird surveys were conducted using the area search method (Loyn 1986). Surveys were conducted mostly during the early morning with some surveys undertaken on dusk. The census period was extended to 30 minutes in each study site, in an area of around two hectares (20m x 1km) to increase the effectiveness of this method. Threatened diurnal birds expected to occur in the study area are listed in Table 2-1. A total of 31 hours of diurnal bird surveying was undertaken within the study area. Opportunistic bird observations were also recorded during other field investigations such as habitat searches, trap checking and hollow-bearing tree surveys.

Avian species capable of migrating to the study area were targeted during a suitable season during the fauna survey. For example, targeted searches for the Swift Parrot (*Lathamus discolor*) were undertaken during the flowering period of winter-flowering tree species such as Forest Red Gum (*Eucalyptus tereticornis*).

Nocturnal Birds

Call Playback

Owl call sites were located in areas of suitable habitat that were likely to carry sound the most effectively and where incoming birds could be detected. Call playback was undertaken after a 10 minute listening period, using a 15W

amplifier to broadcast calls for approximately five minutes for each target species. This was followed by a 10 minute listening period and then 10 minutes spent spotlighting the surrounding area. Once a target species was encountered, call playback for that species ceased at that site to reduce potential disturbance to that species.

Owl call playback was undertaken for approximately one hour each night for eight nights at two sites within the study area, eight nights being the recommended number of nights to survey for Masked Owl (*Tyto novaehollandiae*) (DEC 2004). Owl call playback was also undertaken at other sites during field surveys. A total of 19 hours of owl call playback was undertaken in the study area.

Whilst every effort was made to locate owl call sites away from traffic noises, some difficulty in hearing was experienced at Owl Call Site 2. As such it is likely that the distance from this site that owls could be heard by the observer would have been less than the 800m described by DEC (2004). Additional limitations of this survey method are that some individual owls never respond to call playback (DEC 2004) and some may not respond vocally to playback within 500m of core nesting and roosting areas.

Nocturnal bird species targeted during call playback included Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*T. tenebricosa*), Barking Owl (*Ninox connivens*), and Bush Stone-curlew (*Burhinus grallarius*).

Mammals (Excluding Bats)

Elliott Trapping

Eight arboreal B-size Elliott trap transects were set within the study area for four nights each. Each transect consisted of six traps. Traps were mounted on trees approximately two metres above the ground and baited with a mixture of rolled oats, peanut butter and honey. The tree trunk was sprayed liberally with a honey-water mix around the trap to attract arboreal mammal species. Traps were checked early in the morning, with captured individuals identified and released at the point of capture. Arboreal traps targeted Squirrel Glider (*Petaurus norfolcensis*) and Brush-tailed Phascogale (*Phascogale tapoatafa*). A total of 192 trap nights were undertaken in the study area.

Hair Tubes

Eight ground hair tube transects were set within the study area, for four days and nights, with the exception of Sites 2 and 3 which were left for 8 days and nights. Each hair tube transect consisted of 10 large (90mm diameter) and 10 small (50mm diameter) hair tubes laid in pairs (one small and one large) approximately 10m apart. A total of 800 hair tube trap nights were sampled in the study area.

Most hair tubes were baited with a mixture of rolled oats, peanut butter and honey, with the pair at the start and end of the transect baited with meat (canned Tuna). Hair samples were sent to Barbara Triggs of Dead Finish, a recognised expert in animal hair analysis, for identification.

Target species included Rufous Bettong (*Aepyprymnus rufescens*), Spotted-tailed Quoll (*Dasyurus maculatus*), Long-nosed Potoroo (*Potorous tridactylus*), Brush-tailed Phascogale (*Phascogale tapoatafa*) and Common Planigale (*Planigale maculata*).

Call Playback

Call playback was used at owl call sites to target the Yellow-bellied Glider (*Petaurus australis*) and Koala (*Phascolarctos cinereus*) in accordance with the technique described above for nocturnal birds.

Bats

Ultrasonic Echolocation Detection

Ultrasonic bat echolocation calls were recorded using three ANABAT II bat detectors, with either tape or digital (ZCAIM) recording devices. Units were generally positioned in flyways in forests, under bridges, near waterbodies or carried during nocturnal spotlighting. Typically bat detectors were used for at least one hour per night at each bat call site (Table 2-3) and left overnight in sheltered locations such as under bridges and in culverts. A total of 70 hours of bat call recording was undertaken.

It is possible that in areas where bat detectors could not be left overnight, the complete range of species present was not sampled. It is considered, however, that the combination of bat call recording with harp trapping employed in this study is likely to have produced a reasonable assessment of species occurring within the study area.

Bat call analysis was undertaken by Ray Williams (of Ecotone Ecological Consultants) a recognised expert in bat call analysis.

Harp Trapping

Harp trapping was used in combination with ultrasonic bat call detection to maximise the detection of target threatened microchiropteran bat species. Harp trapping was particularly useful for threatened species not easily detected with ultrasonic detectors such as the Golden-tipped Bat (*Kerivoula papuensis*) and the Eastern Long-eared Bat (*Nyctophilus bifax*). A total of 39 trap nights were undertaken.

Harp traps were set at survey sites containing suitable habitat, generally across flyways in forests, under bridges and across narrow creeks or drainage lines. Traps were usually set for two consecutive nights at each harp trapping site (Table 2-3), however some were removed after one night if more suitable sites were found or if adverse weather conditions were encountered. Adverse weather conditions such as strong wind, heavy rain and very cold conditions were avoided as much as possible during survey. All three harp traps were removed on 13th May 2005 due to adverse weather conditions, and reinstated on 15th May 2005 when conditions improved.

Where traps were set over water, they were placed at a sufficient height so that in the case of rainfall, rising water would not come close to the bag. In cases where a sufficient height could not be achieved, traps were not placed over water. Shade-cloth was used where necessary to block flight around the trap and direct bats into the trap. Additionally, ropes were used to tether harp traps to surrounding vegetation so they remained upright.

Traps were generally checked and cleared around two hours after dusk and on dawn. If traps were checked after dawn, bats were kept in a dark, quiet, warm place until dusk and then released at the point of capture.

2.2.2 General Survey Methods

Habitat Searches

Habitat searches were used to record:

- reptiles and amphibians sheltering under rocks, logs, peeling bark, leaf litter and dumped rubbish;
- mammal scats (including Koala, macropod and predator scats) at the base of trees or along tracks and runways;
- tracks in soft substrate;
- owl pellets beneath trees
- bat roost sites under bridges or within culverts;
- nest/den sites within logs, tree bases or tree trunks;
- guano or moth remains at the base of hollow-bearing trees (diagnostic of the presence of tree-roosting bats);
- 'V'-shaped incision marks on smooth-trunked trees (diagnostic of Yellow-bellied Glider);
- Swift Parrot and Regent Honeyeater in the canopy of flowering eucalypts;
- chewed Casuarina cones (diagnostic of Glossy Black-cockatoo);
- opportunistic bird observations; and
- other signs of fauna within the study area.

These searches included searching leaf litter, tree bases, tree trunks and peeling bark, looking under and in fallen logs, under moveable rocks and dumped rubbish, under bridges, and opportunistic bird surveys. Culverts were inspected only from the exterior, due to OH&S confined spaces requirements preventing these structures being entered.

Searches were generally undertaken during warm weather before mid-morning, with windy, cold and rainy conditions avoided. All efforts were made to minimise habitat disturbance and any habitat moved was put back into place as best as possible. Scats and owl pellets were sent to Barbara Triggs of Dead Finish, a recognised expert in scat and owl pellet analysis.

A total of 25 hours were spent on habitat searches within the study area. Opportunistic habitat searches were also conducted during the hollow-bearing tree survey (discussed below) and bridge inspections.

Spotlighting

Nocturnal spotlighting was undertaken by foot with 55 Watt spotlights for a minimum of two person hours (1 hr x 2 people) each night per spotlighting transect. This method targeted arboreal and terrestrial mammal species, amphibians and reptiles that may be active during the night, as well as roosting diurnal birds. Species were either identified visually or by call. A total of 66 hours were spent spotlighting within the study area.

Windy conditions during May surveys may have resulted in fewer species being active, and reduced the listening ability of observers. This may have reduced the probability of detecting some species. Additionally surveys were suspended when very windy conditions were encountered on the 13th May 2005.

Hollow-bearing Tree Survey

A survey of hollow-bearing trees was undertaken in order to determine the extent of breeding/roosting habitat for hollow-dependant fauna in the survey area (Figure 2-1). Information collected for each tree included GPS coordinates, tree species or status (dead or alive), and the number and size of hollows. Each tree was tagged and marked with flagging tape for later identification by surveyors.

Approximately 50 survey hours were spent searching for hollow-bearing trees along the route of the proposed upgrade. As can be seen in Figure 2-1, the entire road footprint was not surveyed as a result of property access constraints.

Bird observations and habitat searches were also undertaken opportunistically during hollow-bearing tree surveys.

3. Results

3.1 Broad Habitat Types

Seven broad habitat types were recorded in the survey area: Dry Open Forest, Moist Open Forest, Rainforest, Swamp Sclerophyll Forest, Swamp Oak Floodplain Forest, Freshwater Wetland and Estuarine Wetland. Dry Open Forest, Moist Open Forest and Swamp Sclerophyll Forest make up the majority of habitat types in the study area (Figure 3-1).

A description of the broad habitat types is provided below, with detailed vegetation community classifications provided in the Flora Working Paper.

3.1.1 Dry Open Forest

Dry Open Forest within the study area comprises the following three sub-types:

- Blackbutt (*Eucalyptus pilularis*) Open Forest

This sub-type is a tall to very tall open forest with a canopy dominated by Blackbutt (*Eucalyptus pilularis*), and an understorey dominated by shrub and small tree species, Blackwood Wattle (*Acacia melanoxylon*), Turpentine (*Syncarpia glomulifera*), White Bottlebrush (*Callistemon salignus*), Lantana (*Lantana camara*), Cheese Tree (*Glochidion ferdinandii*), and Common Tea Tree (*Leptospermum polygalifolium* ssp. *polygalifolium*). The dense grassy understorey is dominated by Forest Wire Grass (*Entolasia stricta*), Blady Grass (*Imperata cylindrica*), Bracken Fern (*Pteridium esculentum*) and Common Mat Rush (*Lomandra longifolia*). This habitat is common in both the northern and southern halves of the study area, and is generally in good condition with few environmental weeds, with the exception of Lantana. The Blackbutt Open Forest in the north of the study area (Wedding Bells State Forests) contains the greatest density of tree hollows within the study area.

- Grey Gum-Grey Ironbark-White Mahogany Open Forest

This sub-type is a tall open forest (15 to 28 m) with a canopy dominated by Grey Gum (*Eucalyptus propinqua*), Grey Ironbark (*Eucalyptus siderophloia*) and White Mahogany (*Eucalyptus acmenoides*). The moderately dense mid-stratum is dominated by small trees and shrubs such as Turpentine (*Syncarpia glomulifera*), Lantana (*Lantana camara*), Blackwood Wattle (*Acacia melanoxylon*) and Forest Oak (*Allocasuarina torulosa*). The dense groundcover is dominated by grassy and herbaceous species, such as Blady Grass (*Imperata cylindrica*), Bracken Fern (*Pteridium esculentum*), Common Mat Rush (*Lomandra longifolia*), Poison Pratia (*Pratia purpurascens*) and Kangaroo Grass (*Themeda australis*). This habitat occurs in the northern half of the survey area, mainly north of Woolgoolga Creek Road. This habitat is generally in good condition with few weeds, apart from Lantana.

- Spotted Gum Open Forest

This sub-type is a tall open forest (20 – 30 m) dominated by Spotted Gum. Grey Gum (*Eucalyptus propinqua*) and Broad-leaved Ironbark (*Eucalyptus siderophloia*) occur as sub-dominants. The understorey is dominated by small trees and shrubs, such as Lantana, Blackwood Wattle and Forest Oak. The dense groundcover is dominated by grass and herbaceous species such as Blady Grass, Bracken Fern, Common Mat Rush, Poison Pratia and Kangaroo Grass.

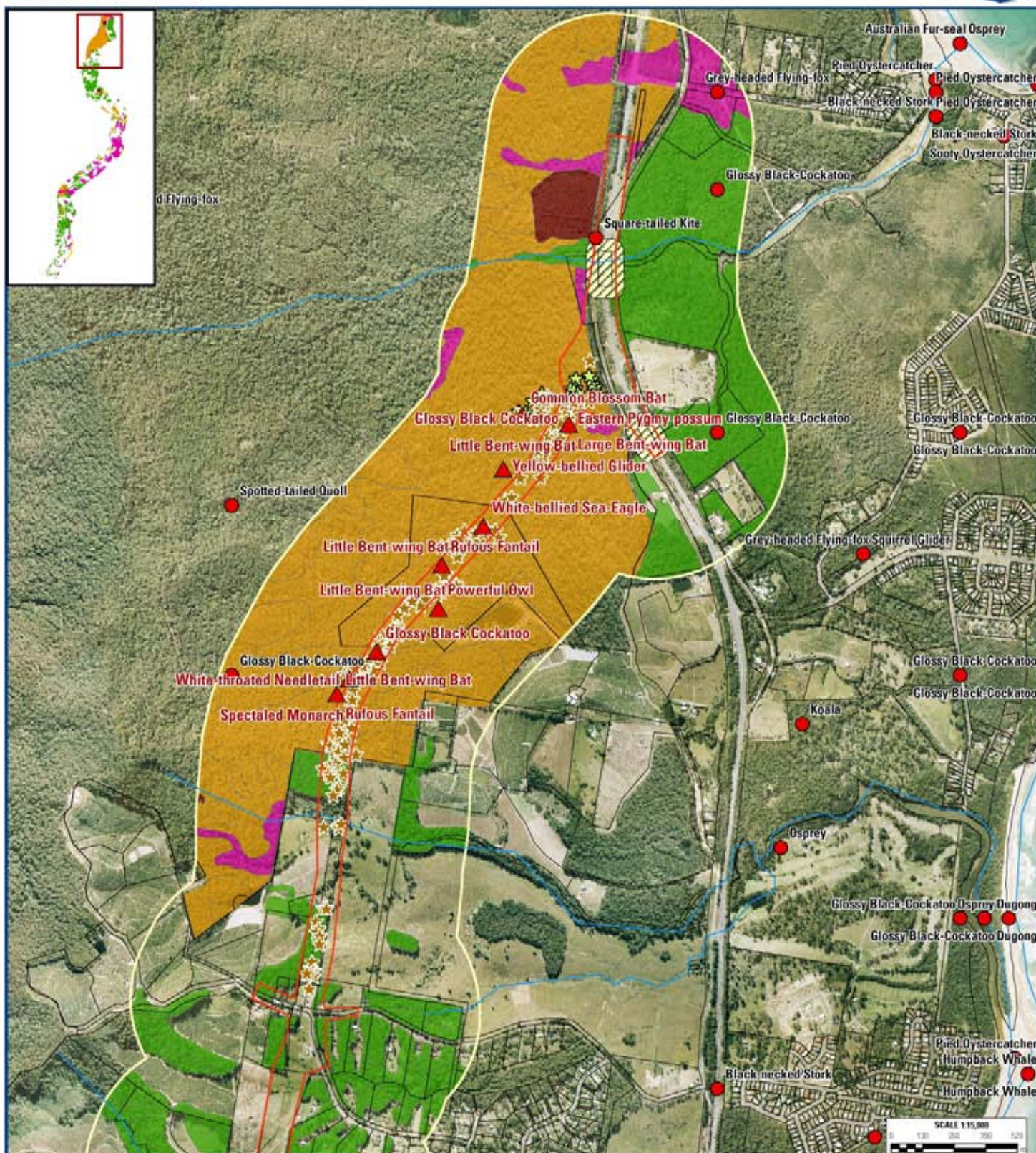
This habitat occurs on upper hill slopes in the northern half of the study area at Woolgoolga Creek Road and Wedding Bells State Forest north of Bark Hut Road, and is in a generally good condition with few weeds.

3.1.2 Moist Open Forest

Moist Open Forest habitat within the study area comprises the following two sub-types:

- Flooded Gum Open Forest

This sub-type is a tall to very tall (20 to 40 m) open forest occurring on the floodplain of larger drainage lines, sometimes extending to adjacent lower hillslopes. The canopy is dominated by Flooded Gum (*Eucalyptus grandis*), while the understorey is dominated by shrubs and vines such as Murrogun (*Cryptocarya microneura*), Morinda (*Morinda*



LEGEND

- ▲ Threatened Fauna Species Connell Wagner Survey
- Threatened Fauna Species NPWS July 2005
- Preferred Option
- Fauna Survey Study Area
- Property Boundary

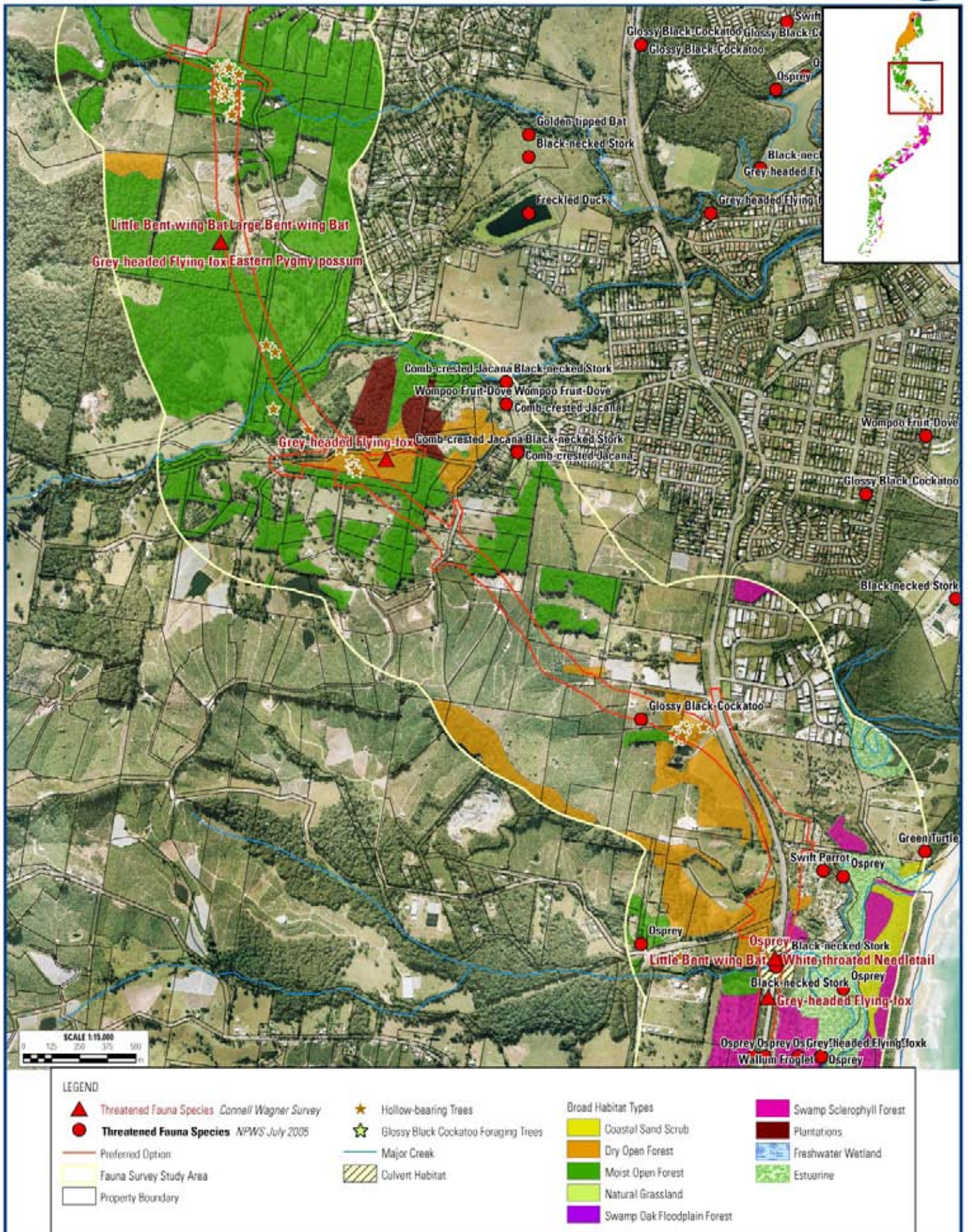
- ★ Hollow-bearing Trees
- ☆ Glossy Black Cockatoo Foraging Trees
- Major Creek
- ▨ Culvert Habitat

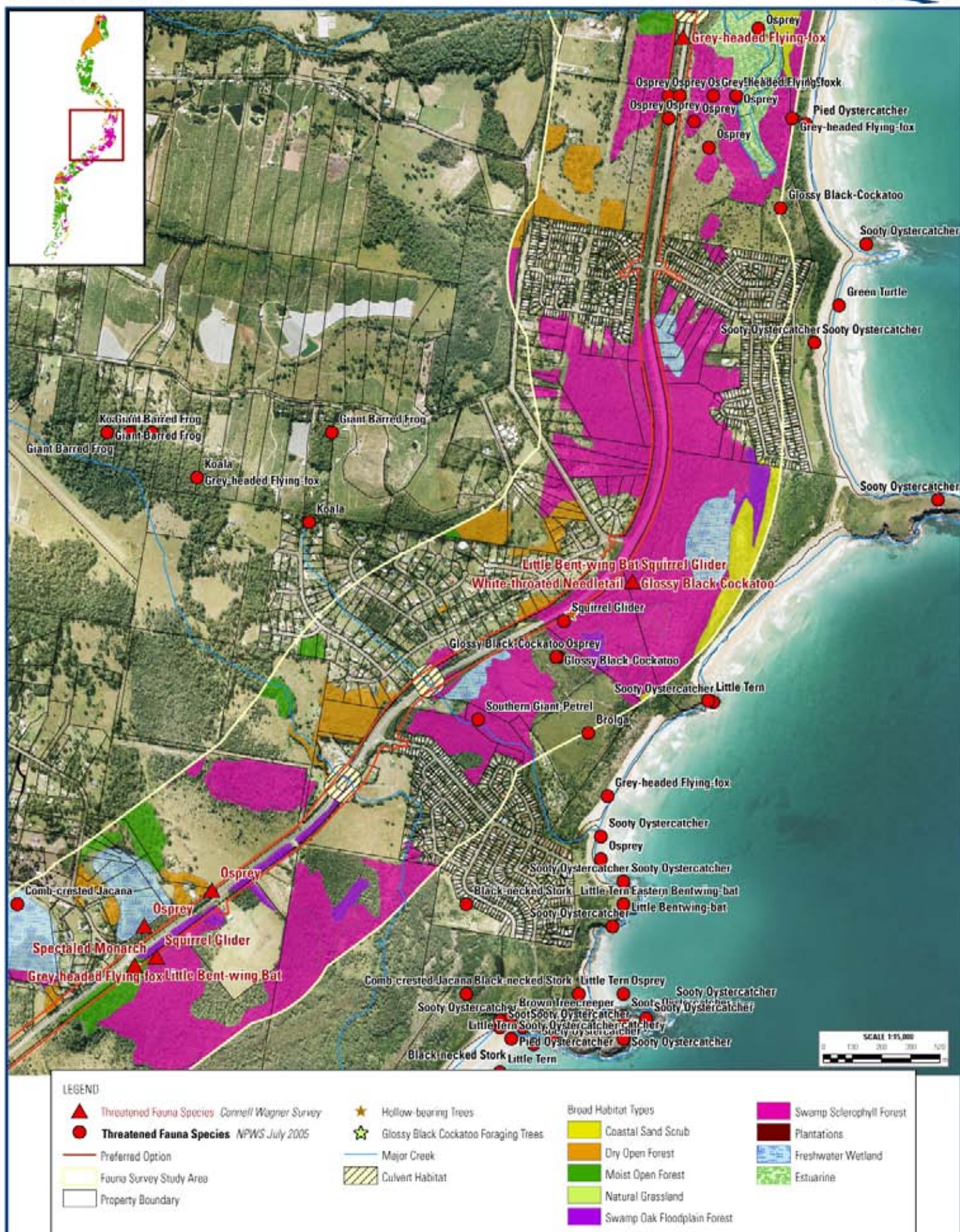
Broad Habitat Types

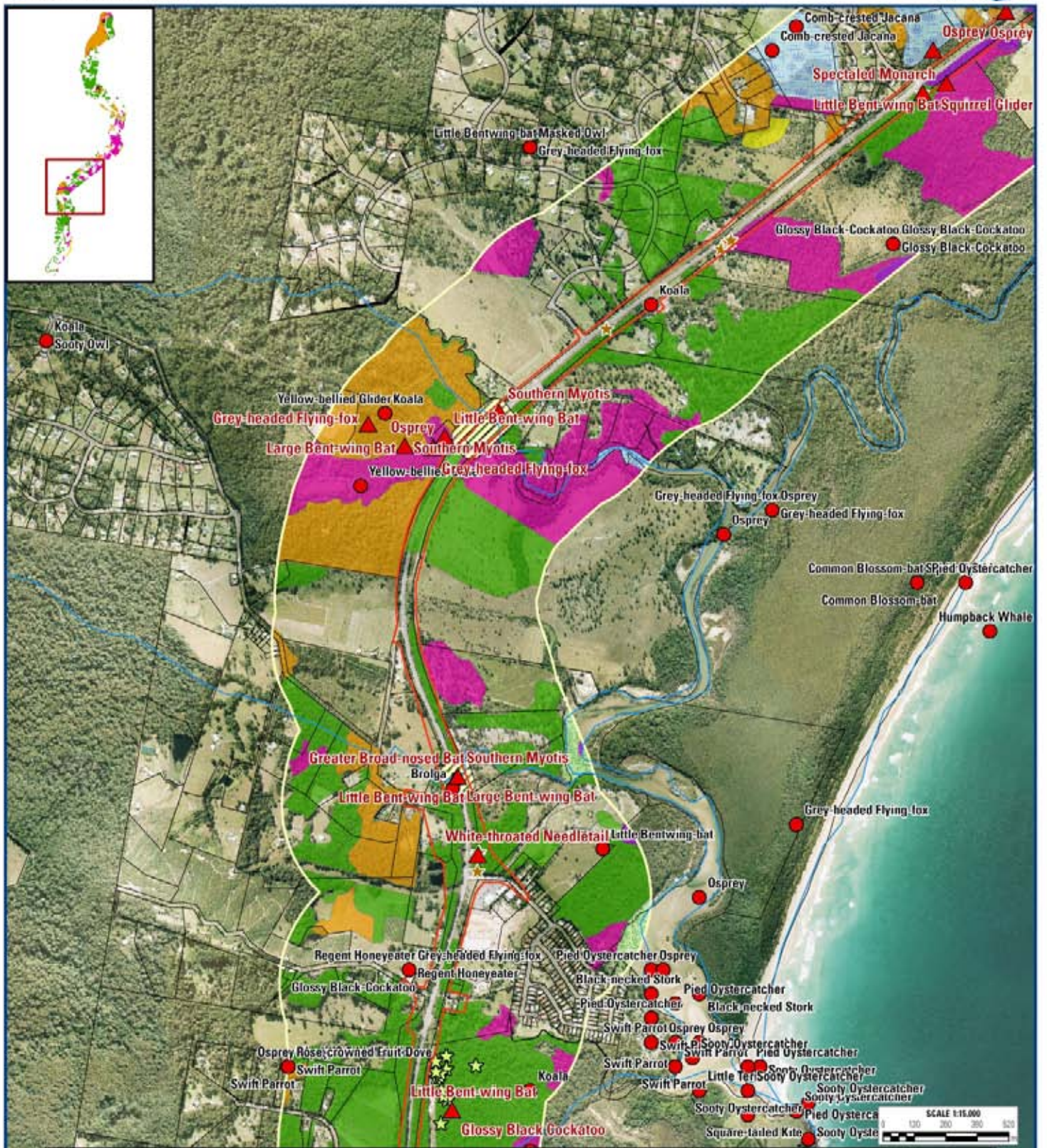
- Coastal Sand Scrub
- Dry Open Forest
- Moist Open Forest
- Natural Grassland
- Swamp Oak Floodplain Forest

- Swamp Sclerophyll Forest
- Plantations
- Freshwater Wetland
- Estuarine





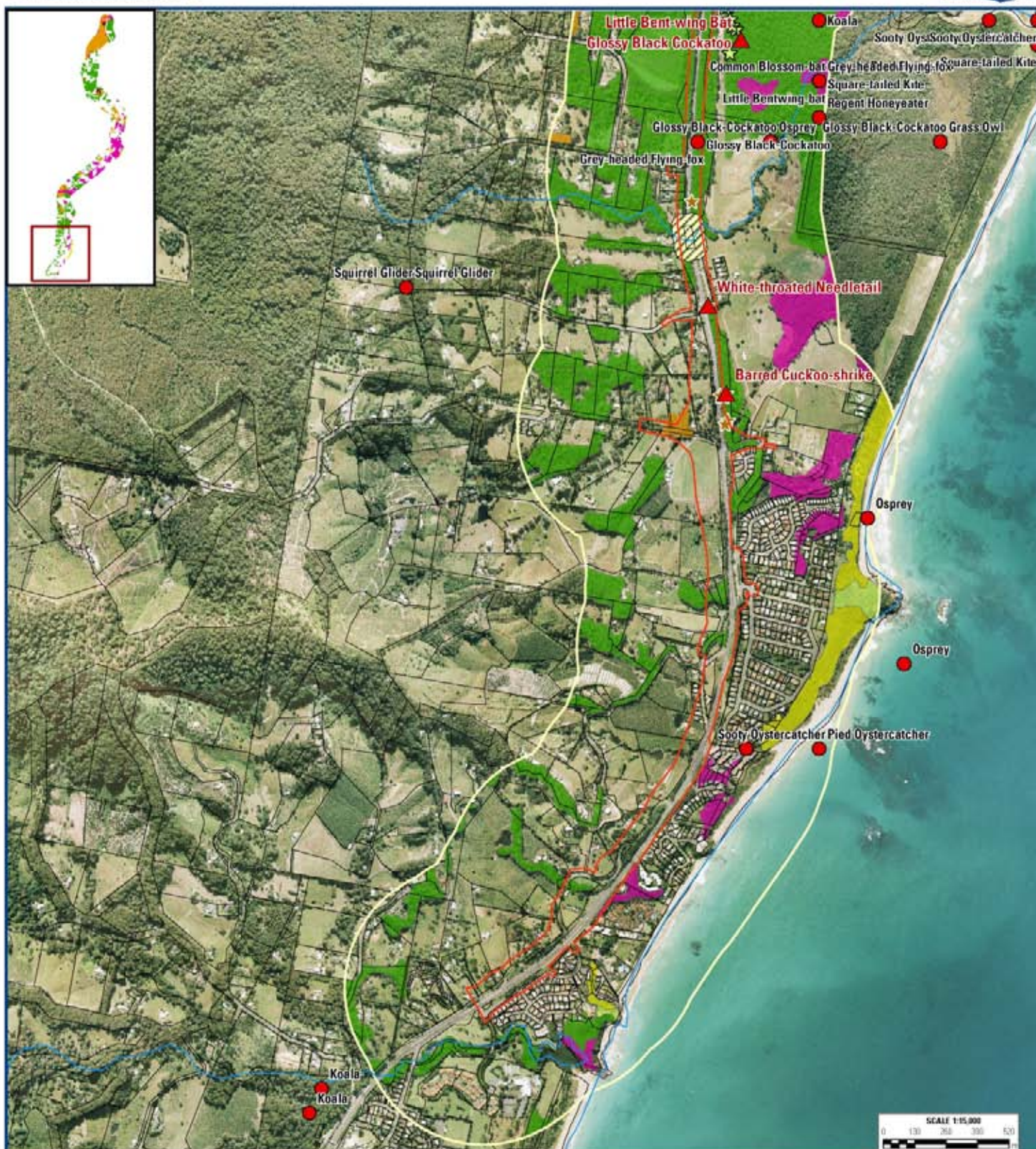




LEGEND

- | | | | |
|--|---|---|---|
| <p>▲ Threatened Fauna Species Connell Wagner Survey</p> <p>● Threatened Fauna Species NPWS July 2005</p> <p>— Preferred Option</p> <p>— Fauna Survey Study Area</p> <p>— Property Boundary</p> | <p>★ Hollow-bearing Trees</p> <p>☆ Glossy Black Cockatoo Foraging Trees</p> <p>— Major Creek</p> <p>— Culvert Habitat</p> | <p>Broad Habitat Types</p> <p>Coastal Sand Scrub</p> <p>Dry Open Forest</p> <p>Moist Open Forest</p> <p>Natural Grassland</p> <p>Swamp Oak Floodplain Forest</p> | <p>Swamp Sclerophyll Forest</p> <p>Plantations</p> <p>Freshwater Wetland</p> <p>Estuarine</p> |
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LEGEND

- ▲ **Threatened Fauna Species** Connell Wagner Survey
- **Threatened Fauna Species** NPWS July 2005
- Preferred Option
- Fauna Survey Study Area
- Property Boundary

- ★ Hollow-bearing Trees
- ☆ Glossy Black Cockatoo Foraging Trees
- Major Creek
- ▨ Culvert Habitat

- Broad Habitat Types
- Coastal Sand Scrub
 - Dry Open Forest
 - Moist Open Forest
 - Natural Grassland
 - Swamp Oak Floodplain Forest

- Swamp Sclerophyll Forest
- Plantations
- Freshwater Wetland
- Estuarine



jasminoides), Common Mock Olive (*Notelaea longifolia*), Narrow-leaf Palm Lily (*Cordyline stricta*), Lantana and Barb-wire Vine (*Smilax australis*). The understorey is dominated by ferns such as Gristle Fern (*Blechnum cartilagineum*), Rasp Fern (*Doodia aspera*), and Maidenhair Fern (*Adiantum formosusum*), with Ottochloa Grass occurring as a co-dominant. This habitat occurs in small, scattered areas in the north (e.g. Arrawarra Creek and Woolgoolga Creek) and in the south (e.g. Sugar Mill Creek) of the study area, and exhibits moderately high levels of environmental weeds in some areas.

- White Mahogany Open Forest

This sub-type is a tall open forest (15 – 28 m) occurring mostly on mid to upper hill slopes of protected aspect in the northern half of the survey area, mainly north of Woolgoolga Creek Road. The canopy is dominated by White Mahogany (*Eucalyptus acmenoides*), with Grey Gum, Broad-leaved Ironbark and Tallowwood occurring as sub-dominants. The understorey is dominated by Forest Oak, Native Guava (*Eupomatia laurina*), Lantana and Morinda. A mixture of grass and fern species, such as Gristle Fern, Ottochloa Grass, Rasp Fern, Common Mat Rush and Barbed Wire Vine dominate the groundcover.

3.1.3 Rainforest

Rainforest within the study area comprises both Littoral and Lowland Rainforest. A small area (approximately 0.5ha) of Lowland rainforest dominated by Strangler Fig (*Ficus watkinsiana*) and Native Olive (*Olea paniculata*) occurs on the floodplain of Woolgoolga Creek. Brush Cherry (*Syzygium australe*), Silky Myrtle (*Decaspermum humile*), Hard Quandong (*Elaeocarpus obovatus*), and Common Lily Pily (*Acmena smithii*) are also common. This habitat type provides potential foraging habitat for frugivorous (fruit-eating) species such as fruit-doves. Drainage lines provide suitable habitat for various frog species, including terrestrial species such as the Stuttering Frog (*Mixophyes balbus*) and Giant Barred Frog (*Mixophyes iteratus*).

Littoral Rainforest occurs within the study area as a tall to very tall (18-25m) open to closed forest dominated by Brush Box (*Lophostemon confertus*), Guioa (*Guioa semiglauc*), and Native Olive (*Olea paniculata*). It is restricted to a few gullies at the southern end of the corridor at Sapphire Beach within within 0.5km of the sea in an urban area of Coffs Harbour.

Rainforest provides habitat for a wide range of threatened fauna including, but not limited to:

<i>Coracina lineata</i>	Barred Cuckoo-shrike
<i>Cyclopsitta diophthalma</i>	Double-eyed Fig-parrot
<i>Erythrorhynchus radiatus</i>	Red Goshawk
<i>Lophoictinia isura</i>	Square-tailed Kite
<i>Monarcha leucotis</i>	White-eared Monarch
<i>Ninox strenua</i>	Powerful Owl
<i>Ptilinopus magnificus</i>	Wompoo Fruit-dove
<i>Ptilinopus regina</i>	Rose-crowned Fruit-dove
<i>Ptilinopus superba</i>	Superb Fruit-dove
<i>Tyto tenebricosa</i>	Sooty Owl
<i>Cercartetus nanus</i>	Eastern Pygmy-possum
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll
<i>Kerivoula papuensis</i>	Golden-tipped Bat
<i>Miniopterus australis</i>	Little Bentwing-bat (foraging only, cave-roosting)
<i>Miniopterus schreibersii</i>	Common Bentwing-bat (foraging only, cave-roosting)
<i>Myotis adversus</i>	Large-footed Myotis
<i>Potorous tridactylus</i>	Long-nosed Potoroo
<i>Pteropus alecto</i>	Black Flying-fox
<i>Scoteanax rueppelli</i>	Greater Broad-nosed Bat
<i>Coeranoscincus reticulatus</i>	Three-toed Snake-tooth Skink
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake
<i>Hoplocephalus stephensii</i>	Stephens' Banded Snake
<i>Mixophyes balbus</i>	Stuttering Frog
<i>Mixophyes iteratus</i>	Giant Barred Frog

Pteropus poliocephalus

Greyheaded flying fox

3.1.4 Swamp Sclerophyll Forest

Swamp Sclerophyll Forest within the study area occurs on seasonally waterlogged floodplain or swampy creek lines at the edge of coastal hills and the floodplain. It is predominantly characterised by Broad-leaved Paperbark (*Melaleuca quinquenervia*), although small areas are dominated by other species such as Red Mahogany (*Eucalyptus resinifera*) or Smooth-barked Apple (*Angophora leiocarpa*). The canopy is generally low to mid-high (8 to 15 m). This habitat is common along the low-lying central part of the corridor between the Bucca Road and Double Crossing Creek south of Woolgoolga, but also in narrow bands along swampy drainage lines in the north and south of the survey area

Swamp Sclerophyll Forest within the study area provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law *et al.* 2000). The blossoms of Swamp Mahogany (*Eucalyptus robusta*) and Broad-leaf Paperbark (*Melaleuca quinquenervia*) are also an important food source for the Grey-headed Flying Fox (*Pteropus poliocephalus*) and Common Blossom Bat (*Sycoyncotis australis*) (Law 1994), as well as the Yellow-bellied Glider (*Petaurus australis*), Squirrel Glider (*Petaurus norfolcensis*), Regent Honeyeater (*Xanthomyza phrygia*) and Swift Parrot (*Lathamus discolor*). Other species for which Swamp Sclerophyll Forest provides potential habitat include the Osprey (*Pandion haliaetus*), Australasian Bittern (*Botaurus poiciloptilus*), Large-footed Myotis (*Myotis adversus*), *Litoria olongburensis* and Wallum Froglet (*Crinia tinnula*). Swamp Sclerophyll Forest also provides potential habitat for Koala (*Phascolarctos cinereus*), which feeds on a selection of preferred eucalypt species including Swamp Mahogany.

3.1.5 Swamp Oak Floodplain Forest

This habitat types occurs as a low (8 to 15 m) woodland and open forest with a grassy understorey. The canopy is dominated by Swamp Oak (*Casuarina glauca*). This habitat is limited to the disturbed/previously cleared road reserve between the Emerald Beach intersection and Stony Creek Road, adjacent to Swamp Sclerophyll Forest dominated by Broad-leaf Paperbark.

Unlike most other coastal floodplain communities, Swamp Oak Floodplain Forest is not a significant habitat for waterbirds (Goodrick 1970). However, the Glossy Black Cockatoo (*Calyptrorhynchus lathami lathami*) may utilise food resources within this habitat (Marchant & Higgins 1990). Other fauna likely to utilise Swamp Oak Floodplain Forest include the Squirrel Glider (*Petaurus norfolcensis*) and several species of frogs in the families Myobatrachidae (southern frogs) and Hylidae (tree frogs).

3.1.6 Aquatic Habitats

The study area contains several creeks and drainage lines with intact native vegetation, providing shelter/foraging/breeding habitat for frogs including potential habitat for threatened frogs such as Green Thighed Frog (*Litoria brevipalmata*), Giant Barred Frog (*Mixophyes iteratus*) and Stuttering Frog (*M. balbus*). These habitats are also known to be used as foraging habitat by various threatened bat species.

Culverts and bridges crossing the creeklines and drainage lines are also likely to be used as roost sites for cave-dwelling bats, including the threatened *Myotis adversus* (Large-footed Myotis) and *Miniopterus australis* (Little Bent-wing Bat), which were captured in traps located under bridges.

Freshwater wetland habitat within the study area provides suitable habitat for a number of threatened species listed under the TSC Act, particularly threatened wetland birds such as the Comb-crested Jacana (*Irediparra gallinacea*) and Freckled Duck (*Stictonetta naevosa*) and frogs such as Green and Golden Bell Frog (*Litoria aurea*).

Watercourses within the study area, such as creeklines, provide potential habitat for fish. Table 3-3 details the aquatic species, populations and ecological communities listed as 'threatened' under the *Fisheries Management Act 1994* (FM Act), together with their distribution and/or habitat associations.

3.1.7 Estuarine Habitats

One very small area of estuarine vegetation was intersected by the projected footprint in the tidal zone of Double Crossing Creek south of Woolgoolga. Dominant species present included Saltwater Couch (*Sporobolus virginicus*) and Swamp Oak (*Casuarina glauca*).

Coastal Saltmarsh provides habitat for a diverse invertebrate fauna, which includes both marine (crabs and molluscs) and terrestrial (insects and spiders) elements. During tidal flooding a number of fish species utilise saltmarsh habitats. Grazing by macropods may occur between tidal events. Some coastal saltmarshes provide important high tide roosts for migratory wading birds, and a range of other birds also utilise coastal saltmarsh as habitat. Diversity of macrofauna in mangrove forests adjacent to saltmarsh has been found to be greater than in mangroves that do not border saltmarsh (Yerman & Ross 2004)

Figure 3-1: Threatened Fauna and Fauna Habitat

3.2 Fauna Habitats

3.2.1 Hollow-bearing trees

Approximately 197 trees bearing hollows ranging in size from small (less than 10 cm) to large (greater than 30 cm) were recorded during the fauna field survey. Since the entire road footprint was not surveyed the actual number of hollow-bearing trees to be impacted is likely to be greater.

Most of the hollow-bearing trees were recorded within Dry Open Forest along the four kilometre deviation through Wedding Bells State Forest in the north of the study area (Figure 3-1). Most of the hollows in this section were associated with stags (dead standing trees) which had been ring-barked during past forestry management practices.

The range of hollow sizes provides an array of nesting/roosting/shelter habitat for threatened hollow-dependent fauna, including large forest birds such as the Masked Owl, Powerful Owl and Glossy Black-cockatoo (which require large hollows), arboreal mammals such as the Brush-tailed Phascogale, Yellow-bellied Glider and Squirrel Glider (which require small to medium-sized hollows), and hollow-dependent microchiropteran bats which can roost in very small hollows, fissures and crevices.

3.2.2 Foraging resources

Several tree species which flower during winter, including Broad-leaved Paperbark (*Melaleuca quinquenervia*), Tallowwood (*Eucalyptus microcorys*) occur relatively commonly throughout the study area. A number of threatened species require winter flowering species to supply food year-round, or to coincide with migratory movements. As such, the presence or absence of winter flowering species is considered a limiting factor for a number of threatened species. It should be noted that winter flowering is not restricted to these species.

Throughout the study area, smooth-barked eucalypts, such as Spotted Gum (*Corymbia variegata*), Pink Bloodwood (*C. intermedia*), and Grey Gum (*Eucalyptus propinqua*) provide important foraging substrates for Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*P. norfolcensis*).

3.3 Threatened Fauna Species within the Study Area

Of the 156 fauna species recorded in the study area (Appendix B), 13 are listed as threatened under the TSC Act. Only one is also listed as threatened under the EPBC Act. A list of the threatened fauna species recorded in the study area, together with their essential habitat requirements, is provided in Table 3-1. In addition to these threatened species, four bird species listed as 'migratory' under the EPBC Act were recorded. Atlas of NSW Wildlife data indicates that threatened species additional to that recorded during the field surveys have the potential to occur in the study area. An assessment of the potential of these additional species occurring in the study area is provided in Table 3-2.

Frog species are addressed in a separate working paper.

Table 3-1: Essential Habitat Requirements for Threatened Species Recorded in Study Area

Species	Large, contiguous habitats	Winter flowering trees	Tree Hollows	Specialist Habitat
Birds				
Glossy Black-Cockatoo (<i>Calyptrorhynchus lathamii</i>)			√	<i>Allocasuarina</i> sp.
Barred-Cuckoo-shrike (<i>Coracina lineata</i>)				Rainforest
Osprey (<i>Pandion heliaetus</i>)				Tall stags; shallow estuaries containing suitable fish 25-30cm
Nocturnal Birds				
Powerful Owl (<i>Ninox strenua</i>)			√	

Table 3-1: Essential Habitat Requirements for Threatened Species Recorded in Study Area

Species	Large, contiguous habitats	Winter flowering trees	Tree Hollows	Specialist Habitat
Mammals (excluding bats)				
Eastern Pygmy-possum (<i>Cercartetus nanus</i>)		√	√	
Squirrel Glider (<i>Petaurus norfolcensis</i>)		√	√	
Yellow-bellied Glider (<i>Petaurus australis</i>)		√	√	
Bats				
Grey-headed Flying-Fox (<i>Pteropus poliocephalus</i>)		√		
Large-footed Myotis (<i>Myotis adversus</i>)				Water bodies, roost sites in culverts & under bridges
Little Bent-wing Bat (<i>Miniopterus australis</i>)				roost sites in culverts & under bridges
Large Bent-wing Bat (<i>Miniopterus schreibersii</i>)				roost sites in culverts & under bridges
Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>)			√	
Common Blossom Bat (<i>Syconycteris australis</i>)		√		Combination of heath and coastal rainforest

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
REPTILES					
<i>Coeranoscincus reticulatus</i>	Three-toed Snake-tooth Skink	V	V	Inhabits rainforests and adjacent wet sclerophyll forests, where it is usually found in rotting logs or under fallen timber (Cogger 2000).	Potential. Suitable habitat present.
<i>Emydura signata</i>	Bellinger River Emydura	V	V	Restricted to the Bellinger River NSW	Unlikely. Outside know distribution.
<i>Hoplocephalus stephensii</i>	Stephen's Banded Snake	V	—	Found in a variety of habitats from rainforest through wet and moist sclerophyll forests to dry sclerophyll forests (NPWS 2005e). However it is most commonly found in wet to moist forests with rocky outcrops, cliffs or ridges and tends to favour ecotones between wet and dry forests (NPWS 2005e). It most frequently uses gaps in the peeling bark of large senescent or dead trees for daytime shelter (NPWS 2005e). However it can use hollow trunks, limbs, epiphytes, vine thickets, rock crevices or rock slabs (NPWS 2005e).	Unlikely. Rocky outcrops, cliffs and ridges absent from study area.
DIURNAL BIRDS					
<i>Calidris alba</i>	Sanderling	V	—	Occur in coastal areas on low beaches, near reefs and inlets along tidal mudflats and bare open coastal lagoons (NPWS 1999a). Rarely seen in near-coastal wetlands such as lagoons, hypersaline lakes, saltponds and samphire flats (NPWS 1999a)	Low Potential. Potential habitat near Double Crossing Creek.
<i>Calidris tenuirostris</i>	Great Knot	V	—	Sheltered coastal habitats containing large intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons (NPWS 1999q). Often recorded on sandy beaches with mudflats nearby, sandy spits and inlets, or exposed reefs or rock platforms (Morris 1989; Higgins & Davies 1996).	Low Potential. Potential habitat near Double Crossing Creek.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V	—	During summer in dense, tall, wet forests of mountains and gullies, alpine woodlands (Morcombe 2004). In winter they occur at lower altitudes in drier more open forests and woodlands, particularly box-ironbark assemblages (Shields & Chrome 1992). They sometimes inhabit woodland, farms and suburbs in autumn/winter (Simpson & Day 2004).	Unlikely. Suitable habitat absent.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
<i>Calyptrorhynchus lathamii</i>	Glossy Black-Cockatoo	V	—	Associated with a variety of forest types containing <i>Allocasuarina</i> species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000, NPWS 1997, NPWS 1999b). Intact drier forest types with less rugged landscapes are preferred (NPWS 1999b). Nests in large trees with large hollows (Environment Australia 2000).	Recorded in study area.
<i>Charadrius leschenaultii</i>	Greater Sand Plover	V	—	Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries, roosting during high tide on sandy beaches or rocky shores (NPWS 1999c)	Low Potential. Potential habitat near Double Crossing Creek.
<i>Climacteris picumnus</i> <i>Climacteris picumnus victoriae</i>	Brown Treecreeper Brown Treecreeper (eastern subspecies)	V V	— —	Distributed through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys. The Brown Treecreeper occupies eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows within permanent territories. (NSW Scientific Committee 2001a).	Potential. Suitable habitat present.
<i>Coracina lineata</i>	Barred Cuckoo-shrike	V	—	Associated with subtropical, dry and littoral rainforests and is restricted to below 500m elevation (NPWS 2005f).	Recorded in study area.
<i>Cyclopsitta diophthalma coxeni</i>	Coxen's Double-eyed Fig-Parrot	E	E	Associated with upland (to 1200masl) to lowland rainforests, tropical semi-deciduous vine thickets and gallery forests, usually containing fig trees (Marchant & Higgins 1993). Probably prefer subtropical lowland rainforest (Holmes 1994). Usually in large tracks of forests, particularly near edges, rarely in partly cleared or fragmented rainforest (Marchant & Higgins 1993).	Potential. Suitable habitat present.
<i>Dromaius novaehollandiae</i> NSW North Coast Bioregion and Port Stephens LGA Population	Emu	E2	—	Occupies a range of mainly open habitats including plains, grasslands, woodlands, shrubs and occasionally forest (NSW Scientific Committee 2002a). Not found in rainforest (Simpson & Day 1999).	Potential. Suitable habitat present.
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E	—	Associated with tropical and warm temperate terrestrial wetlands,	Potential. Suitable habitat

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; NPWS 2005g).	present.
<i>Erythroriorchis radiatus</i>	Red Goshawk	E	V	Associated with forests and woodlands with a mosaic of vegetation types, an abundance of birds and permanent water. In NSW, this species is thought to favour mixed subtropical rainforest, Melaleuca Swamp Forest, and open eucalypt forest along rivers, often in rugged terrain (Marchant & Higgins 1993; NPWS 1999e).	Potential. Suitable habitat present.
<i>Esacus neglectus</i>	Beach Stone-curlew	E	—	Beaches, mudflats, reefs and especially islands (Blakers et al. 1984). Open undisturbed beaches, islands, reefs, intertidal sand and mudflats, preferably with estuaries or mangroves nearby (NPWS 1999f).	Low Potential. Potential habitat near Double Crossing Creek.
<i>Grantiella picta</i>	Painted Honeyeater	V		Associated with dry woodland / forest habitats. Woodlands, which are laden with Mistletoes (esp. <i>Amyema spp.</i>), are particularly important as this species feeds almost exclusively on mistletoe nectar and fruit (Environment Australia 2000).	Unlikely. Suitable habitat absent.
<i>Grus rubicundus</i>	Brolga	V	—	During breeding season mostly near shallow freshwater marshes or freshwater meadows (Marchant & Higgins 1993). During non-breeding seasons congregates near deep, permanent freshwater marshes, mostly foraging in nearby field, pastures and fallow fields and occasionally foraging in littoral zones of marshes (Marchant & Higgins 1993).	Unlikely. Preferred habitat absent from study area.
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V	—	A coastal species that inhabits rock coastlines, coral cays, reefs and occasionally sandy beaches (Marchant & Higgins 1993; Simpson & Day 1999).	Unlikely. Suitable habitat absent from study area.
<i>Haematopus longirostris</i>	Pied Oystercatcher	V	—	Roosts and forages on sandy beaches, sand banks, mudflats and	Low Potential. Potential habitat

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				estuaries (Marchant & Higgins 1993, Simpson & Day 1999).	near Double Crossing Creek.
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	V	—	Open forests, riverine woodlands, scrubs and heathlands of inland areas(Simpson & Day 1999).	Unlikely. Preferred habitat absent from the study area.
<i>Irediparra gallinacea</i>	Comb-crested Jacana	V	—	Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation (Marchant & Higgins 1993).	Potential. Suitable habitat present.
<i>Ixobrychus flavicollis</i>	Black Bittern	V	—	Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation (NPWS 1999g). In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves (NPWS 1999g)	Unlikely. Preferred habitat absent from the study area.
<i>Lathamus discolor</i>	Swift Parrot	E	E	Associated with dry open eucalypt forests and woodlands with winter flowering eucalypts (Marchant & Higgins 1993). Often located in urban areas and farmlands with remnant eucalypts.	Potential. Suitable habitat present.
<i>Lichenostomus fasciularis</i>	Mangrove Honeyeater	V	—	Lives in mangroves, frequently visiting flowering shrubs in towns adjacent to mangroves. Spends some of its' time feeding close to the mud in mangroves (Blakers et al. 1984; NPWS 2005h).	Low Potential. Potential habitat near Double Crossing Creek.
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	V	—	Known to favour estuarine mudflats, saltmarshes and reefs as feeding and roosting habitat (NPWS 1999r). In NSW this species tends to favour intertidal sand and mudflats in estuaries (Smith 1991).	Low Potential. Potential habitat near Double Crossing Creek.
<i>Limosa limosa</i>	Black-tailed Godwit	V	—	Primarily found along the coast on sandspits, lagoons and mudflats (NPWS 1999s). The species has also been found to occur inland on mudflats or shallow receding waters of portions of large muddy swamps or lakes (Pizzey & Knight 1997; Higgins & Davies 1996).	Low Potential. Potential habitat near Double Crossing Creek.
<i>Lophoictinia isura</i>	Square-tailed Kite	V	—	In coastal areas associated with tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant & Higgins 1993, NPWS 1999h). May be recorded inland along timbered watercourses (NPWS 1999h). In NSW it is commonly associated with ridge or gully forests dominated by Woollybutt	Potential. Suitable habitat present.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				(<i>Eucalyptus logiflora</i>), Spotted Gum (<i>E. maculata</i>), or Peppermint Gum (<i>E. elata</i> , <i>E. smithii</i>) (NPWS 1999h).	
<i>Melanodryas cucullata</i> <i>Melanodryas cucullata cucullata</i>	Hooded Robin Hooded Robin (southeastern subspecies)	V	—	Associated with a wide range of Eucalypt woodlands, Acacia shrubland and open forests (Blakers et al. 1984). In temperate woodlands, the species favours open areas adjoining large woodland blocks, with areas of dead timber and sparse shrub cover (NSW Scientific Committee 2001b). Hooded Robin home ranges are relatively large, averaging 18ha for birds from the New England Tableland (NSW Scientific Committee 2001b).	Potential. Suitable habitat present.
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V	—	Predominantly associated with box-ironbark association woodlands and River Red Gum (NSW Scientific Committee 2001c). Also associated with drier coastal woodlands of the Cumberland Plain and the Hunter, Richmond and Clarence Valleys (NSW Scientific Committee 2001c).	Unlikely. Preferred habitat absent.
<i>Monarcha leucotis</i>	White-eared Monarch	V	—	Associated with lowland subtropical rainforest edges and remnants; littoral and floodplain rainforest, swamp sclerophyll with mesomorphic mid storey, coastal wet sclerophyll (Environment Australia 2000; NPWS 2005I). It is thought to avoid moving into small remnants; preferring to move through areas of continuous forest (Environment Australia 2000).	Potential. Suitable habitat present.
<i>Pandion haliaetus</i>	Osprey	V	—	Associated with waterbodies including coastal waters, inlets, lakes, estuaries, beaches, offshore islands and sometimes along inland rivers (Schodde & Tidemann 1986; Clancy 1991; Olsen 1995). Osprey may nest on the ground, on sea cliffs or in trees (Olsen 1995). Osprey generally prefer emergent trees, often dead or partly dead with a broken off crown (Olsen 1995).	Recorded in study area.
<i>Pezoporus wallicus wallicus</i>	Ground Parrot (eastern subspecies)	V	—	Predominantly restricted to coastal heath and sedgeland that provide a high density of cover and food foraging resources (Blakers et al. 1984; Simpson & Day 1999).	Unlikely. Suitable habitat absent.
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	V	—	Open woodlands dominated by mature eucalypts with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs (NSW Scientific	Unlikely. Suitable habitat

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
<i>temporalis</i>	(eastern subspecies)			Committee 2001d). This species avoids very wet areas (Blakers et al. 1984).	absent.
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	—	Associated with large, undisturbed patches of tall tropical or subtropical rainforest, at all altitudes, preferably with a diversity of fruit (Marchant & Higgins 1993; NPWS 2005k). Occasionally located in patches of monsoon rainforest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Marchant & Higgins 1993; NPWS 2005k).	Low Potential. Marginal habitat present. Local records.
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V	—	Tall tropical and subtropical, evergreen or semi-deciduous rainforests, especially with a dense growth of vines trees (Marchant & Higgins 1993). Also located in closed wet sclerophyll forest, gallery forests or sclerophyll woodlands with abundant fruiting trees, near or next to rainforest (NPWS 2005l). Is thought to prefer large areas of vegetation, but has been located in patches and occasionally in parks and gardens with fruiting trees (Marchant & Higgins 1993).	Potential. Suitable habitat present.
<i>Ptilinopus superbus</i>	Superb Fruit-Dove	V	—	Lives mainly within rainforests but will feed in adjacent mangroves or eucalypt forests (Blakers et al. 1984). Nests are well hidden within the rainforest habitat and are built in trees from 10 to 30m off the ground (Recher et al. 1995).	Potential. Suitable habitat present.
<i>Rostratula benghalensis australis</i>	Painted Snipe (Australian subspecies)	E	—	Shallow fresh water for breeding (Blakers et al. 1984) forages in marshes with moderate cover (Simpson & Day 1999).	Unlikely. Suitable habitat absent.
<i>Rostratula australis</i>	Australian Painted Snipe	—	V		
<i>Sterna albifrons</i>	Little Tern	E	—	Almost exclusively coastal, preferring sheltered areas (NPWS 1999o), however may occur several kilometres inland in harbours, inlets and rivers (Smith 1990). Australian birds breed on sandy beaches and sand	Unlikely. Suitable habitat absent.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				spits (Simpson & Day 1999).	
<i>Sterna fuscata</i>	Sooty Tern	V	—	Forages offshore, usually only observed onshore in breeding season or when storms force them to shelter (NPWS 1999p)	Unlikely. Suitable habitat absent.
<i>Stictonetta naevosa</i>	Freckled Duck	V	—	Associated with a variety of wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters (NPWS 1999u).	Potential. Suitable habitat present.
<i>Todiramphus chloris</i>	Collared Kingfisher	V	—	Virtually confined to mangrove lined sheltered coastal embayment, inlets, estuaries and adjacent tidal flats (Marchant & Higgins 1993).	Unlikely. Suitable habitat absent.
<i>Turnix melanogaster</i>	Black-breasted Button-quail	E	V	Dry rainforests, vine scrub or lantana thickets (Marchant & Higgins 1993). In NSW the species inhabits dry or subtropical forests which contain Brigalow, Belah, Bottletrees, Hoop Pine, Lantana, Ironbark, Wattle, Spotted Gum, Wallaby Grass or Rhodes Grass (Bennett 1985; Hughes & Hughes 1991). Observations in Lantana thickets and hoop pine plantations indicate this species may be able to utilise human modified (Blakers et al. 1984).	Potential. Suitable habitat present.
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E	E	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of River Oak (<i>Casuarina cunninghamiana</i>) (Garnett 1993). Areas containing Swamp Mahogany (<i>Eucalyptus robusta</i>) in coastal areas have been observed to be utilised (NPWS 1997). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).	Potential. Suitable habitat present.
NOCTURNAL BIRDS					
<i>Botaurus poiciloptilus</i>	Australasian Bittern	V	—	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats (Marchant & Higgins 1993). Reedbeds, swamps, streams,	Unlikely. Suitable habitat absent.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				estuaries (Simpson & Day 2004).	
<i>Burhinus grallarius</i>	Bush Stone-curlew	E	—	Associated with dry open woodland with grassy areas, dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland (Pittwater Council 2000; Marchant & Higgins 1993). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Environment Australia 2000; Marchant & Higgins 1993). Is thought to require large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed to lightly disturbed areas.	Unlikely. Suitable habitat absent.
<i>Ninox connivens</i>	Barking Owl	V	—	Associated with a variety of habitats such as savanna woodland, open eucalypt forests, wetland and riverine forest. The habitat is typically dominated by Eucalypts (often Redgum species), however often dominated by <i>Melaleuca</i> species in the tropics (NPWS 2003). It usually roosts in dense foliage in large trees such as River She-oak (<i>Allocasuarina cunninghamiana</i>), other <i>Casuarina</i> and <i>Allocasuarina</i> , eucalypts, <i>Angophora</i> , <i>Acacia</i> and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	Unlikely. No records from Atlas of NSW Wildlife or EPBC Act Protected Matters Report, targeted during owl call surveys, with no response.
<i>Ninox strenua</i>	Powerful Owl	V	—	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000).	Recorded in study area.
<i>Tyto capensis</i>	Grass Owl	V	—	Reported habitats include tall grass, swampy, sometimes tidal areas, mangrove fringes, grassy plains, coastal heaths, grassy woodland, cane grass, lignum, sedges, cumbungi, cane fields and grain stubble (Pizzey & Knight 1997). The Grass Owl nests on the ground within dense tall grass,	Unlikely. Suitable habitat absent.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				sedges, reeds and even sugarcane plantations (Pizzey & Knight 1997). The Grass Owl primarily feeds on rodents, hunting on the wing over heathland, grassland and sedgeland, as well as along the edge of sugar cane, crops and pastureland (Pizzey & Knight 1997).	
<i>Tyto novaehollandiae</i>	Masked Owl	V	—	Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (NPWS 2005m) and especially the ecotone between wet and dry forest, and non forest habitat (Environment Australia 2000). Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).	Potential. Suitable habitat present.
<i>Tyto tenebricosa</i>	Sooty Owl	V	—	Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species (Environment Australia 2000, Debus 1994). Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows (Debus 1994, Garnett 1993, Hyem 1979).	Unlikely. Suitable habitat absent.
MAMMALS (EXCLUDING BATS)					
<i>Aepyprymnus rufescens</i>	Rufous Bettong	V	—	Prefer forests with a grassy to sparse understorey including coastal forest, tall wet sclerophyll forest and dry forests west of Great Dividing Range (NPWS 2005n). It is most commonly found on sites derived from sedimentary rock and in north eastern NSW in forests characterised by Spotted Gum (<i>Corymbia maculata</i> and <i>C. henryi</i>) (NPWS 2005n). It has been known to feed on introduced pasture species (NPWS 2005n).	Potential. Suitable habitat present.
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	—	Found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight 2004). Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit	Recorded in study area.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				(Turner & Ward 1995). The presence of <i>Banksia</i> sp. and <i>Leptospermum</i> sp. are an important habitat feature (NPWS 2005v). Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds nests and in the branch forks of tea-trees (Turner & Ward 1995).	
<i>Dasyurus maculatus</i> <i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll Spotted-tailed Quoll (SE Mainland Population)	V —	— E	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; NPWS 1999j), more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (NPWS 1999j). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).	Potential. Suitable habitat present.
<i>Petaurus australis</i>	Yellow-bellied Glider	V	—	This species is restricted to tall mature forests, preferring productive tall open sclerophyll forests with a mosaic of tree species including some that flower in winter (Environment Australia 2000, Braithwaite 1984, Davey 1984, Kavanagh 1984; NPWS 1999k). Large hollows within mature trees are required for shelter, nesting and breeding (Henry & Craig 1984; NPWS 1999k).	Recorded in study area.
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	—	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988; Quinn 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quinn 1995).	Recorded in study area.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1998).	Unlikely. Suitable habitat absent.
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	—	Preferred habitat is Dry Open forest with a sparse open understorey, however, has been located in heath, swamps and rainforest and wet sclerophyll forest (NPWS 1999l).	Potential. Suitable habitat present.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
<i>Phascolarctos cinereus</i>	Koala	V	—	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees. Some preferred <i>Eucalyptus</i> species are: <i>Eucalyptus tereticornis</i> , <i>E. punctata</i> , <i>E. cypellocarpa</i> , <i>E. viminalis</i>	Potential. Suitable habitat present.
<i>Potorous tridactylus</i> <i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo Long-nosed Potoroo (SE Mainland Population)	V —	— V	Associated with dry coastal heath and dry and wet sclerophyll forests (Strahan 1998) with dense cover for shelter and adjacent more open areas for foraging (Menkhorst & Knight 2004).	Potential. Suitable habitat present.
<i>Pseudomys oralis</i>	Hastings River Mouse		E	Open forest or woodland with a grassy sedge rush or heath understorey that is about 10-75cm above the ground (NPWS 2003a). Shelter areas such as rock piles, hollow logs, yabby burrows or cavities in the butts of large old trees are also required to be present (NPWS 2003a). Preferred habitat is in minor drainage lines, swamps, seepages, grassy flats with good soil moisture (at least seasonally) (NPWS 2003a).	Potential. Suitable habitat present.
BATS					
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; NPWS 2005p). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998; NPWS 2005p).	Potential. Suitable foraging habitat present.
<i>Chalinolobus nigrogriseus</i>	Hoary Wattled Bat	V	—	The preferred habitat of this species appears to be variable, with dry open forest, woodland, vine thickets, coastal scrub, sand dunes, grasslands and floodplains recorded (Churchill 1998). This species often forages along watercourses, swampy areas and over farm dams. In NSW, this species has been recorded in Spotted Gum (<i>Corymbia maculata</i>), Grey Box (<i>Eucalyptus moluccana</i>) and Northern Ironbark (<i>E. siderophloia</i>) and woodland characterised by Scribbly Gums (<i>E. signata</i>) and Pink	Potential. Suitable habitat present.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				Bloodwood (<i>C. intermedia</i>) and sites dominated by the Blackbutt (<i>E. pilularis</i>) (Churchill 1998). Roost sites have been identified as tree hollows, rock crevices and the roofs of buildings (Churchill 1998).	
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	—	This species is associated with forested areas with higher rainfall (Parnaby 1998), and has been located from the highlands to the coast, appearing to be less common at low altitudes, and tending to favour the cool moist forests of the ranges (Phillips 1998). While the Eastern False Pipistrelle roosts primarily in tree trunk hollows, individuals have also be found in caves and abandoned buildings (Klippel 1992).	Potential. Suitable habitat present.
<i>Kerivoula papuensis</i>	Golden-tipped Bat	V	—	The most favoured habitat for this species is moist closed forests often with a rainforest influence, however, some captures have been made in dry forests some distance from any rainforest (Lunney & Barker 1986; Parnaby & Mills 1994). It has been suggested that the amount of vines and complex tree layers allows for increased numbers of spiders and webs and such areas are sought by the Golden-tipped Bat (Schulz & Eyre 2000). This species is often caught over streams within rainforest are known to frequently roost within the pendulous nests of Yellow-throated and Large-billed Scrub Wrens and Brown Gerygone in such areas. (Schulz & Eyre 2000).	Potential. Suitable habitat present.
<i>Miniopterus australis</i>	Little Bent-wing Bat	V	—	Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, <i>Melaleuca</i> swamps and coastal forests (Churchill 1998). This species shelter in a range of structures including culverts, drains, mines and caves (Environment Australia 2000). Relatively large areas of dense vegetation of either wet sclerophyll forest, rainforest or dense coastal banksia scrub are usually found adjacent to caves in which this species is found (NPWS 2005q). Breeding occurs in caves, usually in association with <i>M. schreibersii</i> (Environment Australia 2000, NPWS 2005q).	Recorded in study area.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V	—	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and	Recorded in study area.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (AMBS 1995, Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).	
<i>Mormopterus norfolkensis</i>	East Coast Freetail Bat	V	—	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000; Allison & Hoyer 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000; Allison & Hoyer 1998).	Potential. Suitable habitat present.
<i>Myotis adversus</i>	Large-footed Myotis	V	—	Will occupy most habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, as long as they are close to water (Churchill 1998). While roosting is most commonly associated with caves, this species has been observed to roost in tree hollows, amongst vegetation, in clumps of <i>Pandanus</i> , under bridges, in mines, tunnels and stormwater drains (Churchill 1998). However the species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used (Richards 1998).	Recorded in study area.
<i>Nyctophilus bifax</i>	Eastern Long-eared Bat	V	—	This species prefers wetter habitats, ranging from rainforest and monsoon forest to riverine forests of paperbark, but may be found in open woodland, tall open forest and dry sclerophyll woodland (Churchill 1998). These forest bats have been recorded roosting under peeling bark, among epiphytes, in tree hollows and in foliage (Churchill 1998). Individuals are likely to change roost sites nightly (NPWS 2005r).	Potential. Suitable habitat present.
<i>Pteropus alecto</i>	Black Flying-Fox	V	—	Mangroves, paperbark forests and occasionally patches of rainforest are most commonly utilised for camp sites (Strahan 1998; Churchill 1998).	Potential. Suitable habitat present.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				They have been found to occupy a range of habitats of tropical and sub-tropical forests and woodlands (Churchill 1998). Preferred food includes blossoms (such as eucalypts, paperbarks and turpentines), also introduced fruits and blossoms (Strahan 1998).	
<i>Pteropus poliocephalus</i>	Grey-headed Flying-Fox	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).	Recorded in study area.
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	V	—	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies. Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).	Potential. Suitable habitat present.
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	—	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill 1998), tending to be more frequently located in more productive forests (Hoye & Richards 1998). Within denser vegetation types use is made of natural and man made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1998).	Recorded in study area.
<i>Syconycteris australis</i>	Eastern Blossom-bat	V	—	The combination of heathland and coastal rainforest is essential for this species (Churchill 1998). Breeding and sheltering habitats are in subtropical and littoral rainforests and a diverse range of nectar producing plant communities are required year round; it will occasionally eat some rainforest fruits (Churchill 1998; Environment Australia 2000).	Recorded in study area.
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	—	Inhabit tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western	Potential. Suitable habitat present.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				slopes and inland areas” (Churchill 1998). “Has been found roosting in sandstone overhand caves, boulder piles, mine tunnels and occasionally in buildings” (Churchill 1998).	
INVERTEBRATES					
<i>Petalura gigantea</i>	Giant Dragonfly	E	—	Swamps, streamlines and seepages in mainly natural condition with short to moderate vegetation and a relatively deep soil base (Trueman 2005). Larvae permanently burrow into soil and so do not survive in permanent ponds or other open water (Trueman 2005).	Unlikely. Suitable habitat absent.
<i>Phyllodes imperialis</i> (Southern subspecies)	A moth	E	E	Lower montane rainforests from QLD to NSW, where larvae appear to be dependent on the vine <i>Carronia multisepealea</i> (NSW Scientific Committee 2004). Breeding habitat is considered to be restricted to undisturbed old growth subtropical rainforest below 600m altitude (NSW Scientific Committee 2004)	Unlikely. Suitable habitat absent.
MIGRATORY SPECIES LISTED UNDER EPBC ACT					
<i>Gallinago hardwickii</i>	Latham’s Snipe	—	M	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover (Marchant & Higgins 1993). Occupies a variety of vegetation around wetlands (Marchant & Higgins 1993) including wetland grasses and open wooded swamps (Simpson & Day 1999).	Unlikely. Suitable habitat absent.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	—	M	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1993, Simpson & Day 1999). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1993).	Recorded in study area.
<i>Hirundapus caudacutus</i>	White-throated Needletail	—	M	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Marchant & Higgins 1993; Simpson & Day 1999). Has been observed	Recorded in study area.

Table 3-2: Assessment of Occurrence of Threatened Fauna Species

V – Vulnerable E – Endangered M – Migratory

Scientific Name	Common Name	Conservation Significance		Habitat Associations	Occurrence
		TSC Act	EPBC Act		
				roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant & Higgins 1993).	
<i>Monarcha melanopsis</i>	Black-faced Monarch	—	M	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984).	Potential. Suitable habitat present.
<i>Monarcha trivirgatus</i>	Spectacled Monarch	—	M	Wet forests, mangroves (Simpson & Day 1999).	Recorded in study area.
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	—	M	Associated with drier eucalypt forests, absent from rainforests (Blakers et al. 1984), open forests, often at height (Simpson & Day 1999).	Potential. Suitable habitat present.
<i>Rhipidura rufifrons</i>	Rufous Fantail	—	M	Wet forests, less often open forests (Simpson & Day 1999)	Recorded in study area.
<i>Rostratula benghalensis</i>	Painted Snipe	—	M	Shallow fresh water for breeding (Blakers et al. 1984) forages in marshes with moderate cover (Simpson & Day 1999).	Unlikely. Suitable habitat absent.

E = Endangered

E2 = Endangered population

V = Vulnerable

M = Migratory

Disclaimer: Data extracted from the Atlas of NSW Wildlife are only indicative and cannot be considered a comprehensive inventory. In recognising this, a literature review complemented by appropriate field survey has been undertaken that targets a larger number of species than is listed in Table 3-2.

3.3.1 Threatened Species Listed under Fisheries Management Act 1994

Watercourses within the study area, such as creeklines, provide potential habitat for fish. Table 2-1 details the aquatic species, populations and ecological communities listed as 'threatened' under the *Fisheries Management Act 1994* (FM Act), together with their distribution and/or habitat associations.

Table 3-3: Aquatic Species, Populations & Ecological Communities listed as Threatened on FM Act 1994

Common Name	Scientific Name	Distribution/Habitat Association ¹
<i>Schedule 4: Endangered species, populations and ecological communities and species presumed extinct</i>		
Eastern Freshwater Cod	<i>Maccullochella ikei</i>	Clarence and Richmond river systems in north-eastern NSW.
Green Sawfish	<i>Pristis zijsron</i>	Estuaries and shallow coastal waters around south-east Asia and northern Australia.
Grey Nurse Shark	<i>Carcharias taurus</i>	Deep gutters (15-40m) around rocky outcrops, bomboras and reefs along the entire coast.
Murray Hardyhead	<i>Craterocephalus fluviatilis</i>	Inland rivers and streams in southern NSW and northern Victoria.
Oxleyan Pygmy Perch	<i>Nannoperca oxleyana</i>	Small streams and lakes in coastal heath in south-eastern Queensland and north-eastern NSW.
River Snail	<i>Notopala sublineata</i>	Flowing water in inland areas.
Southern Bluefin Tuna	<i>Thunnus maccoyii</i>	Marine
Trout Cod	<i>Maccullochella macquariensis</i>	Inland rivers and streams in southern NSW and northern Victoria.
Western population of Purple Spotted Gudgeon (<i>Mogurnda adspersa</i>)		Inland areas (the Murray-Darling).
Western population of Olive Perchlet (<i>Ambassis agassizii</i>)		Inland areas (the Murray-Darling). In inland areas, found only at a few sites in the Darling drainage.
Aquatic ecological community in the natural drainage system of the lower Murray River catchment.		
Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River.		
Bennetts seaweed	<i>Vanvoorstia bennettiana</i>	Historical records (dated 1855 and 1886) for two localities in Port Jackson, Sydney Harbour. Only known from these two localities. Surveys of the entire NSW coastline have revealed no records since 1886. Species now presumed extinct.
<i>Schedule 5: Vulnerable species</i>		
Adams emerald dragonfly	<i>Archaeophya adamsi</i>	Small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation in the greater Sydney region.
Black cod	<i>Epinephelus daemeli</i>	Marine habitats in the warm temperate and subtropical parts of the south-western Pacific.
Buchanans fairy shrimp	<i>Branchinella buchananensis</i>	Waters of temporary (intermittently inundated) salt lakes, which have salinities between freshwater and seawater. Known only from Lake Buchanan in southwest Queensland, and Gidgee and Burkanoko Lakes in the north-west of NSW.
Great white shark	<i>Carcharodon carcharias</i>	Occur in marine habitats throughout the world.

Table 3-3: Aquatic Species, Populations & Ecological Communities listed as Threatened on FM Act 1994

Common Name	Scientific Name	Distribution/Habitat Association ¹
Macquarie perch	<i>Macquaria australasica</i>	Cooler parts of inland rivers and streams. Murray-Darling Basin (particularly upstream reaches) and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments.
Southern pygmy perch	<i>Nannoperca australis</i>	Vegetated areas in small streams, lakes, billabongs and other types of wetlands. Once widely distributed throughout the Murrumbidgee and Murray River systems.
Silver perch	<i>Bidyanus bidyanus</i>	Murray-Darling river system.

¹: Source of distribution/habitat information – DPI (2005)

Only two of the species or communities listed in Table 3 – 3 have a distribution encompassing or close to the Sapphire to Woolgoolga area. These are the Oxleyan Pygmy Perch and Eastern Freshwater Cod. Oxleyan Pygmy Perch are found almost exclusively in swamps, streams and lakes in coastal lowland ‘wallum’ (banksia dominated heath) ecosystems, characterised by waterbodies with low salinity and conductivity, and high organic content and acidity. The creeks and watercourses crossed by proposed route do not include any areas of this habitat type, and as such the Oxleyan Pygmy Perch and its habitat will not be affected by the project.

The Sapphire to Woolgoolga area is just outside the presumed historical distribution of the Eastern Cod and well outside the current known distribution of naturally occurring Eastern Cod. This species was once abundant in both the Clarence and Richmond river systems downstream of tablelands waterfalls, but is now considered to be extinct in the Richmond River system, and very rare or absent in the major tributaries of the Clarence River System. Since the 1960s only small numbers of Eastern Cod have been recorded from the Nymboida, Guy Fawkes, Boyd, and Mann Rivers where some pristine habitat still exists.

The preferred habitat of the Eastern Cod is clear, flowing streams with rocky beds and deep holes with plenty of boulders or large woody debris (snags). This habitat is not present within the study area, which is also outside the known distribution of this species. As such, the Eastern Cod and its habitat will not be affected by the project.

3.4 Key Habitats and Corridors

The NPWS Key Habitats and Corridors Project (NPWS 1999v) defines Regional and Sub-Regional Corridors as those that provide linkage corridors for species assemblages, and are intended to maintain ecological processes such as migration, dispersal, predation and pollination. These processes are required for the long term viability and interaction of an ecosystem.

Key Habitats and Corridors identified by NPWS as occurring within, or in the vicinity of, the study area include:

- Moonee Regional Corridor, which serves as a link between Moonee Beach NR and Avocado Heights;
- Wedding Bells - Moonee Beach Regional Corridor which serves as a link between Moonee Beach NR and Skinners Creek;
- Moonee Beach NR - Orara East Subregional Corridor, which serves as a link between the Moonee Coastal Corridor and Sugar Mill Creek;
- Moonee Beach NR - Sapphire Regional Corridor, which links Moonee Beach NR and Hills Beach; and
- Woolgoolga Coast Regional Corridor, which is a link between Woolgoolga Lake and Hearn Lake

In addition, a subregional corridor serves as a link between Moonee Beach NR and the Pacific Highway.

4. Overview of Impacts

This section provides an overview of the type of impacts that roads and road construction may have on fauna and their habitats and mitigation measures that can be employed to minimise these impacts. A specific impact assessment, including impacts on threatened species, populations and communities, is presented in the Environmental Assessment Report.

4.1 Fauna

The highway upgrade could potentially impact native fauna in several ways, including:

- Wildlife injury and mortality through collisions with vehicles.
- Removal, modification and fragmentation of habitat.
- Creation of barriers to movement and genetic dispersal and exchange.
- Effects on animal behaviour due to noise and lights
- Risk of contamination and siltation of waterways

Most of the proposed upgrade is along an existing section of the Pacific Highway, hence many, if not all of the above impacts are likely to be already operating within this part of the study area. However, widening the footprint of the existing highway is likely to increase the cumulative effect of these impacts, by removing an extensive area of habitat, and by increasing the barrier effect posed by the existing highway. A discussion of some of the anticipated impacts of the road upgrade is provided in the following sections.

4.1.1 Fragmentation of Habitats

Fragmentation of a contiguous habitat, that is the division of a single area of bushland into two or more areas, has the potential to disrupt wildlife movement corridors, sever linkages between areas of habitat, increase edge to interior ratios and decrease the amount of habitat available to threatened fauna.

Habitat contiguity is important for a number of threatened species for several reasons:

- Certain species require large, continuous areas of habitat;
- The larger the area of habitat, the larger the potential carrying capacity for populations of threatened species, and accordingly the decreased likelihood of localised extinction due to inability to recolonise a disturbed area; and
- The lower number and/or level of threats such as road kill, predation or competition from animals associated with edge environments.

Important wildlife linkages occur throughout the study area, and have been recognised in various studies by DEC and CHCC. NPWS/CHCC (1999) has identified Koala movement corridors, and regional and sub-regional movement corridors have been identified from the NPWS Key Habitats and Corridors Project.

4.1.2 Loss of Tree Hollow Resource

Hollow bearing trees are a critical habitat feature for a number of threatened species (Gibbons & Lindenmayer 2002), providing breeding and/or sheltering habitat. Gibbons and Lindenmayer (2002) found that hollow bearing trees were more common in older stands, gullies, vegetation not logged and on flat terrain. Habitats with high productivity were also noted to support a higher number of hollow bearing trees.

In the North Coast Bioregion, in a study of forests broadly similar to those in the study area, Andrews et al. (1994) found the abundance of large tree hollows (possibly greater than 30cm diameter at entrance) did not increase with the increase in productivity. Forests characterised by *Eucalyptus saligna*, *E. microcorys*, *E. acmenoides*, *E. grandis*, being species associated with more productive areas, had less hollow bearing trees than forests characterised by *Eucalyptus punctata*, *E. acmenoides*, and *Corymbia maculata* (Table 2.9). This may indicate that other factors, namely those mentioned above, are a better predictor of tree hollows than the community type.

Within the study area, the greatest density of tree hollows occur in ring-barked stags in Wedding Bells State Forest. Hence, the greatest loss of tree hollow resource for local populations of hollow-dependent fauna will result from the section of highway traversing the State Forest. Yellow-bellied Glider, Squirrel Glider and Glossy Black-cockatoo in the northern section of the study area in particular are likely to be impacted by the loss of arboreal resources such as tree hollows

4.2 *Loss of Foraging Resources*

A number of threatened species require winter flowering species to supply food year-round, or to coincide with migratory movements. As such, the presence or absence of winter flowering species is considered a limiting factor for a number of threatened species.

Within the study area, several winter-flowering tree species provide an important food resource for fauna, such as the Squirrel Glider. Nomadic and migratory species such as the Grey-headed Flying Fox, Regent Honeyeater and Swift Parrot, are also dependent on winter-flowering trees, with their seasonal movements occurring in response to the flowering cycles of such species. Winter-flowering trees occur within the Swamp Sclerophyll Forest and Moist Open Forest communities which are found throughout the study area.

4.3 *Mitigation and Amelioration Measures*

Mitigation and amelioration measures may include but not be limited to:

- Reducing construction zones to keep vegetation clearance and disturbance to a minimum;
- Minimising the road footprint to avoid significant habitat areas, such as concentrations of hollow-bearing trees, where possible;
- Incorporating fauna underpasses and/or overpasses into the road design;
- Minimising the disturbance to bat roost sites, such as culverts and bridges;
- Development of dual purpose drainage structures that can act as 'default' fauna underpasses;
- Directional/exclusion fencing;
- Landscaping and revegetation;
- Site rehabilitation;
- Compensatory habitat; and
- Traffic control and driver education (measures to reduce risk of road kill).

Most of the measures listed above are typically employed in highway planning to reduce ecological impact.

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Appendix A

Habitat Proformas

Detailed Site Description	
Name(s) of observers	
Plot number / unique identifier	
Date & time	

Locality description to assist relocation (eg, distances from road, track or distinctive landmark, giving walking distance and direction. Include property name or reserve name if known)

Precise Location		
Method	6 digit easting (AMG)	7 digit northing (AMG)
Topographic Map Reading		
GPS		
Accuracy (GPS)	√	√

Physical Features				
Altitude (range)				
Aspect (range) (using compass bearing)				
Landform type				
Geology (rock outcrops)				
Soil Texture	clay	loam	sand	organic
Disturbance History				
Trampling				
Logging				
Grazing				
Fire				
Clearing				
Rubbish Dumping				
Soil Disturbance				
Nutrient Enrichment				
Altered Hydrology				
Other				
Land tenure				

FAUNA					
Terrestrial FAUNA					
Hollow density estimated per 400m ² (ranges: 0 = absent; 1-2 = occasional; 2-5 moderate; 5- 10; >10 abundant)					
Item	Location of hollow				
	On trunk	Broken trunk or split	Large branch	Medium branch	Small branch
Tree hollows > 30 cm diameter	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant		
Tree hollows 10 – 30 cm diameter	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	
Tree hollows <10 cm diameter	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant
Stag trees	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant				
Hollow logs	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant				
Caves	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant				
Termite Mounds	⊖ Absent ⊖ Rare ⊖ Occasional ⊖ Moderate ⊖ Abundant				
Rock Outcrops	% Cover				
Leaf litter	% Cover				

Abundance, size and breeding condition of any fauna plant food resources						
Survey area 400m ² (Diversity = described in ranges of 0-5, 6-10, 11-15, etc)						
Vegetation Layer	% Projective Foliage Cover	Diversity	Age Structure			
Canopy and emergent			Juvenile Dominant	Semi-mature Sub Dominant	Mature Trace	Over-mature Absent
Shrubs and young trees			Juvenile Dominant	Semi-mature Sub Dominant	Mature Trace	Over-mature Absent
Ground layer (<1m)			Juvenile Dominant	Semi-mature Sub Dominant	Mature Trace	Over-mature Absent

Community 1			
General location: Upper - Mid - Lower Slopes; Mesic (swamp or rainfall) or Xeric;			
Canopy species			
PFC %			
Shrub species			
PFC %			
Ground layer species			
PFC %			
Community 2			
Canopy species			
PFC %			
Shrub species			
PFC %			
Ground layer species			
PFC %			
Community 3			
Canopy species			
PFC %			
Shrub species			
PFC %			
Ground layer species			
PFC %			
Community 4			
Canopy species			
PFC %			
Shrub species			
PFC %			
Ground layer species			
PFC %			

AQUATIC FAUNA HABITATS				
Type	Stream (Ephemeral or Perennial) / Soak / Waterbody (Ephemeral or Perennial)			
Flow Rate	Rapids Riffles Ponding			
Dimensions of Waterbody				
Substrate Type	Gravel / Sand / Silt / Rock () / Rubble / Concrete /			
Shading (%)				
Disturbances				
Predatory Species				
Snags				
Aquatic flora species				
Riparian vegetation	%Cover	Complexity:	High Medium Low	Absent
Aquatic vegetation	% Cover	Complexity:	High Medium Low	Absent
Aquatic fauna species observed				

Appendix B

Fauna Species List

Table 1: Fauna Species Observed During Survey

E = Endangered V = Vulnerable M = Migratory O = Listed Overfly

Group	Family	Scientific Name	Common Name	Conservation Status	
				TSC Act	EPBC Act
Amphibians	HYLIDAE	<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	–	–
Amphibians	HYLIDAE	<i>Litoria peronii</i>	Peron's Tree Frog	–	–
Amphibians	HYLIDAE	<i>Litoria phyllochroa</i>	Leaf Green Tree Frog	–	–
Amphibians	MYOBATRACHIDAE	<i>Crinea signifera</i>	Common Eastern Froglet	–	–
Amphibians	MYOBATRACHIDAE	<i>Limnodynastes peronii</i>	Striped Marsh Frog	–	–
Amphibians	MYOBATRACHIDAE	<i>Mixophyes fasciolatus</i>	Giant Barred Frog	–	–
Amphibians	MYOBATRACHIDAE	<i>Pseudophryne coriacea</i>	Red-backed Toadlet	–	–
Birds	ACCIPITRIDAE	<i>Accipiter novaehollandiae</i>	Grey Goshawk	–	–
Birds	ACCIPITRIDAE	<i>Elanus axillaris</i>	Black-shouldered Kite	–	–
Birds	ACCIPITRIDAE	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	–	M
Birds	ACCIPITRIDAE	<i>Haliastur sphenurus</i>	Whistling Kite	–	–
Birds	ACCIPITRIDAE	<i>Pandion haliaetus</i>	Osprey	V	–
Birds	ACEDINIDAE	<i>Todiramphus sanctus</i>	Sacred Kingfisher	–	–
Birds	AEGOTHELIDAE	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	–	–
Birds	ALCEDINIDAE	<i>Alcedo azurea</i>	Azure Kingfisher	–	–
Birds	ALCEDINIDAE	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	–	–
Birds	ANATIDAE	<i>Anas superciliosa</i>	Pacific Black Duck	–	–
Birds	ANATIDAE	<i>Aythya australis</i>	Hardhead (White-eyed) Duck	–	–

Birds	ANATIDAE	<i>Biziura lobatus</i>	Musk Duck	–	–
Birds	ANATIDAE	<i>Chenonetta jubata</i>	Australian Wood Duck	–	–
Birds	ANHINGIDAE	<i>Anhinga melanogaster</i>	Darter	–	–
Birds	APODIDAE	<i>Hirundapus caudacutus</i>	White-throated Needletail	–	M
Birds	ARDEIDAE	<i>Ardea ibis</i>	Cattle Egret	–	O
Birds	ARDEIDAE	<i>Ardea pacifica</i>	White-necked (Pacific) Heron	–	–
Birds	ARDEIDAE	<i>Egretta novaehollandiae</i>	White-faced Heron	–	–
Birds	ARTAMIDAE	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	–	–
Birds	ARTAMIDAE	<i>Cracticus nigrogularis</i>	Pied Butcherbird	–	–
Birds	ARTAMIDAE	<i>Cracticus torquatus</i>	Grey Butcherbird	–	–
Birds	ARTAMIDAE	<i>Gymnorhina tibicen</i>	Australian Magpie	–	–
Birds	ARTAMIDAE	<i>Strepera graculina</i>	Pied Currawong	–	–
Birds	CACATUIDAE	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	–	–
Birds	CACATUIDAE	<i>Cacatua roseicapilla</i>	Galah	–	–
Birds	CACATUIDAE	<i>Calyptorhynchus fumereus</i>	Yellow-tailed Black Cockatoo	–	–
Birds	CACATUIDAE	<i>Calyptorhynchus lathami</i>	Glossy Black Cockatoo	V	–
Birds	CAMPEPHAGIDAE	<i>Coracina lineata</i>	Barred Cuckoo-shrike	V	–
Birds	CAMPEPHAGIDAE	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	–	–
Birds	CAMPEPHAGIDAE	<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike	–	–
Birds	CAMPEPHAGIDAE	<i>Coracina tenuirostris</i>	Cicadabird	–	–
Birds	CHARADRIIDAE	<i>Vanellus miles</i>	Masked Lapwing	–	–
Birds	CLIMACTERIDAE	<i>Cormobates leucophaeus</i>	White-throated Treecreeper	–	–
Birds	COLUMBIDAE	<i>Geopelia humeralis</i>	Bar-shouldered Dove	–	–

Birds	COLUMBIDAE	<i>Leucosarcia melanoleuca</i>	Wonga Pigeon	–	–
Birds	COLUMBIDAE	<i>Ocyphaps lophotes</i>	Crested Pigeon	–	–
Birds	CORVIDAE	<i>Corvus mellori</i>	Little Raven	–	–
Birds	CORVIDAE	<i>Corvus orru</i>	Torresian Crow	–	–
Birds	CUCULIDAE	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	–	–
Birds	CUCULIDAE	<i>Centropus phasianinus</i>	Pheasant Coucal	–	–
Birds	CUCULIDAE	<i>Eudynamys scolopacea</i>	Common Koel	–	–
Birds	CUCULIDAE	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	–	–
Birds	DICAEIDAE	<i>Dicaeum hirundinaceum</i>	Mistletoebird	–	–
Birds	DICRURIDAE	<i>Dicrurus bracteatus</i>	Spangled Drongo	–	–
Birds	DICRURIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark	–	–
Birds	DICRURIDAE	<i>Monarcha trivirgatus</i>	Spectacled Monarch	–	M
Birds	DICRURIDAE	<i>Myiagra rubecula</i>	Leaden Flycatcher	–	–
Birds	DICRURIDAE	<i>Rhipidura fuliginosa</i>	Grey Fantail	–	–
Birds	DICRURIDAE	<i>Rhipidura leucophrys</i>	Willie Wagtail	–	–
Birds	DICRURIDAE	<i>Rhipidura rufifrons</i>	Rufous Fantail	–	M
Birds	HIRUNDINIDAE	<i>Hirundo neoxena</i>	Welcome Swallow	–	–
Birds	MALURIDAE	<i>Malurus cyaneus</i>	Superb Blue Fairy-wren	–	–
Birds	MALURIDAE	<i>Malurus lamberti</i>	Variegated Fairy-wren	–	–
Birds	MELIPAGIDAE	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	–	–
Birds	MELIPAGIDAE	<i>Anthochaera carunculata</i>	Red Wattlebird	–	–
Birds	MELIPAGIDAE	<i>Anthochaera chrysoptera</i>	Little Wattlebird	–	–
Birds	MELIPAGIDAE	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	–	–

Birds	MELIPAGIDAE	<i>Lichenostomus fuscus</i>	Fuscous Honeyeater	–	–
Birds	MELIPAGIDAE	<i>Lichenostomus leucotis</i>	White-eared Honeyeater	–	–
Birds	MELIPAGIDAE	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	–	–
Birds	MELIPAGIDAE	<i>Manorina melanocephala</i>	Noisy Miner	–	–
Birds	MELIPAGIDAE	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	–	–
Birds	MELIPAGIDAE	<i>Melithreptus lunatus</i>	White-naped Honeyeater	–	–
Birds	MELIPAGIDAE	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	–	–
Birds	MELIPAGIDAE	<i>Philemon corniculatus</i>	Noisy Friarbird	–	–
Birds	MELIPAGIDAE	<i>Phylidonyris nigra</i>	White-cheeked Honeyeater	–	–
Birds	MELIPHAGIDAE	<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater	–	–
Birds	MENURIDAE	<i>Menura novaehollandiae</i>	Superb Lyrebird	–	–
Birds	NEOSITTIDAE	<i>Daphoenositta chrysoptera</i>	Varied Sittella	–	–
Birds	PACHYCEPHALIDAE	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	–	–
Birds	PACHYCEPHALIDAE	<i>Pachycephala rufiventris</i>	Rufous Whistler	–	–
Birds	PACHYCEPHALIDAE	<i>Pachycephala pectoralis</i>	Golden Whistler	–	–
Birds	PARDALOTIDAE	<i>Acanthiza lineata</i>	Striated Thornbill	–	–
Birds	PARDALOTIDAE	<i>Acanthiza pusilla</i>	Brown Thornbill	–	–
Birds	PARDALOTIDAE	<i>Gerygone olivacea</i>	White-throated Gerygone	–	–
Birds	PARDALOTIDAE	<i>Pardalotus punctatus</i>	Spotted Pardalote	–	–
Birds	PARDALOTIDAE	<i>Pardalotus striatus</i>	Striated Pardalote	–	–
Birds	PARDALOTIDAE	<i>Sericornis frontalis</i>	White-browed Scrubwren	–	–
Birds	PLOCEIDAE	<i>Neochima temporalis</i>	Red-browed Finch	–	–
Birds	PETROICIDAE	<i>Eopsaltria australis</i>	Eastern Yellow Robin	–	–

Birds	PHALACROCORACIDAE	<i>Phalacrocorax carbo</i>	Great Cormorant	–	–
Birds	PHALACROCORACIDAE	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	–	–
Birds	PODARGIDAE	<i>Podargus strigoides</i>	Tawny Frogmouth	–	–
Birds	PODICIPEDIDAE	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	–	–
Birds	PSITTACIDAE	<i>Alisterus scapularis</i>	Australian King Parrot	–	–
Birds	PSITTACIDAE	<i>Glossopsitta concinna</i>	Musk Lorikeet	–	–
Birds	PSITTACIDAE	<i>Platycercus elegans</i>	Crimson Rosella	–	–
Birds	PSITTACIDAE	<i>Platycercus eximius</i>	Eastern Rosella	–	–
Birds	PSITTACIDAE	<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet	–	–
Birds	PSITTACIDAE	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	–	–
Birds	PSOPHODIDAE	<i>Psophodes olivaceus</i>	Eastern Whipbird	–	–
Birds	PTILONORHYNCHIDAE	<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird	–	–
Birds	RALLIDAE	<i>Fulica atra</i>	Eurasian Coot	–	–
Birds	RALLIDAE	<i>Porphyrio porphyrio</i>	Purple Swamphen	–	–
Birds	STRIGIDAE	<i>Ninox novaeseelandiae</i>	Southern Boobook	–	–
Birds	STRIGIDAE	<i>Ninox strenua</i>	Powerful Owl	V	–
Birds	THRESKIORNITHIDAE	<i>Threskiornis molucca</i>	Australian White Ibis	–	–
Birds	ZOSTEROPIDAE	<i>Zosterops lateralis</i>	Silvereeye	–	–
Mammals	BURRAMYIDAE	<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	–
Mammals	CANIDAE	<i>Canis lupus familiaris</i> *	Dog*	–	–
Mammals	CANIDAE	<i>Vulpes vulpes</i> *	Fox*	–	–
Mammals	DASYURIDAE	<i>Antechinus stuartii</i>	Brown Antechinus	–	–
Mammals	DASYURIDAE	<i>Antechinus</i> sp	Antechinus sp	–	–

Mammals	FELIDAE	<i>Felis catus*</i>	Cat*	–	–
Mammals	MACROPODIDAE	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	–	–
Mammals	MACROPODIDAE	<i>Macropus rufogriseus</i>	Red-necked Wallaby	–	–
Mammals	MACROPODIDAE	<i>Wallabia bicolor</i>	Swamp Wallaby	–	–
Mammals	MACROPODIDAE		Wallaby sp	–	–
Mammals	MOLOSSIDAE	<i>Nyctinomus australis</i>	White-striped Freetail-Bat	–	–
Mammals	MURIDAE	<i>Rattus fuscipes</i>	Bush Rat	–	–
Mammals	MURIDAE	<i>Rattus rattus*</i>	Black Rat*	–	–
Mammals	PERAMELIDAE	<i>Isoodon macrourus</i>	Northern Brown Bandicoot	–	–
Mammals	PERAMELIDAE	<i>Perameles nasuta</i>	Long-nosed Bandicoot	–	–
Mammals	PERAMELIDAE		Bandicoot sp.	–	–
Mammals	PETAURIDAE	<i>Petaurus australis</i>	Yellow-bellied Glider	V	–
Mammals	PETAURIDAE	<i>Petaurus breviceps</i>	Sugar Glider	–	–
Mammals	PETAURIDAE	<i>Petaurus norfolcensis</i>	Squirrel Glider	V	–
Mammals	PHALANGERIDAE	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	–	–
Mammals	PSEUDOCHEIRIDAE	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	–	–
Mammals	PTEROPODIDAE	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V
Mammals	PTEROPODIDAE	<i>Syconycteris australis</i>	Common Blossom Bat	V	–
Mammals	RHINOLOPHIDAE	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	–	–
Mammals	TARSIPEDIDAE	<i>Acrobates pygmaeus</i>	Feathertail Glider	–	–
Mammals	TACHYGLOSSIDAE	<i>Tachyglossus aculeatus</i>	Short- beaked Echidna	–	–
Mammals	VESPERTILIONIDAE	<i>Chalinolobus gouldi</i>	Gould's Wattled Bat	–	–
Mammals	VESPERTILIONIDAE	<i>Chalinolobus morio</i>	Chocolate Wattled Bat	–	–

Mammals	VESPERTILIONIDAE	<i>Miniopterus australis</i>	Little Bent-wing Bat	V	–
Mammals	VESPERTILIONIDAE	<i>Miniopterus schreibersii</i>	Large Bent-wing Bat	V	–
Mammals	VESPERTILIONIDAE	<i>Myotis adversus</i>	Southern Myotis	V	–
Mammals	VESPERTILIONIDAE	<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat	–	–
Mammals	VESPERTILIONIDAE	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	–
Mammals	VESPERTILIONIDAE	<i>Scotorepens</i> sp.1	Broad-nosed Bat	–	–
Mammals	VESPERTILIONIDAE	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	–	–
Mammals	VESPERTILIONIDAE	<i>Vespadelus pumilus</i>	Eastern Forest Bat	–	–
Mammals	VESPERTILIONIDAE	<i>Vespadelus regulus</i>	Southern-Forest Bat	–	–
Mammals	VESPERTILIONIDAE	<i>Vespadelus vulturnus</i>	Little Forest Bat	–	–
Mammals	VOMBATIDAE	<i>Vombatus ursinus</i>	Wombat	–	–
Mammals		<i>Bos taurus</i> *	Cattle*	–	–
Reptiles	AGAMIDAE	<i>Physignathus lesueurii</i>	Eastern Water Dragon	–	–
Reptiles	BOIDAE	<i>Morelia spilota</i>	Diamond Python	–	–
Reptiles	ELAPIDAE	<i>Cacophis squamulosus</i>	Golden Crowned Snake	–	–
Reptiles	ELAPIDAE	<i>Hemiaspis signata</i>	Black-bellied Swamp Snake	–	–
Reptiles	ELAPIDAE	<i>Rhinolophus nigrescens</i>	Eastern Small-eyed Snake	–	–
Reptiles	ELAPIDAE	<i>Vermicella annulata</i>	Bandy-Bandy	–	–
Reptiles	SCINCIDAE	<i>Calyptotis ruficauda</i>		–	–
Reptiles	SCINCIDAE	<i>Ctenotus taeniolatus</i>	Copper-tailed Skink	–	–
Reptiles	SCINCIDAE	<i>Lampropholis delicata</i>	Grass Skink	–	–
Reptiles	SCINCIDAE	<i>Saiphos equalis</i>	Three-toed Skink	–	–
Reptiles	VARANIDAE	<i>Varanus varius</i>	Lace Monitor	–	–

EPBC Act	Environmental Protection and Biodiversity Conservation Act
TSC Act	Threatened Species Conservation Act
V	Listed as Vulnerable
M	Listed as Migratory
O	Listed Overfly Marine Area
*	Introduced Species