This Community corresponded to Community 3.3 *Eucalyptus longifolia – Melaleuca* forest – woodland of Mills (1993), which occurs along drainage lines and other low-lying areas. Mills (1993) identified it as a significant botanical community because it has limited occurrences, is often associated with wetlands and provides important fauna habitat.

- Low-open Woodland Communities

12. ***Eucalyptus sclerophylla*** **Low Open-woodland** occurred on the poorly drained flats in the south-east of the study area and graded into sedgeland and heathland. It often occurred as scattered *E. sclerophylla* to 3 m in height within the grassland and sedgeland communities. Dominant canopy species included *E. sclerophylla*. The shrub layer was absent or sparse and the ground layer consisted of a dense cover of native grasses and sedges. It had been disturbed by past clearing, road construction and unformed tracks and introduced species occurred along its edges. The total weed cover in the community was estimated to be 2 %.

This community corresponded to Community 5.4 *Eucalyptus sclerophylla/Eucalyptus gummifera* forest of Mills (1993), which has been mapped on broad ridges in the north of the Jervis Bay region.

- Heath Communities

13. ***Banksia ericifolia / Hakea teretifolia*** **Heathland** occurred east of Moona Creek Road and north of The Wool Road and graded into woodland, open-woodland and sedgeland communities. It was characterised by a low to tall and open to very dense shrub layer of *Banksia ericifolia*, *A. distyla*, *H. teretifolia* and *Viminaria juncea* with scattered emergent *E. sclerophylla, C. gummifera* and *E. obstans*. The structure of this community has changed in response to the fire regime. The ground layer was open to dense, depending on the shrub cover and included native grasses, sedges and herbs.

This community corresponded to Community 4.3 Mallee - heathland of Mills (1993), which is widespread on sandstone soils and is botanically significant in the Jervis Bay region because it is floristically rich and contains many rare plants. It is also important habitat for threatened fauna.

- Sedgeland and Grassland Communities

14. ***Xanthorrhoea resinifera*** **Sedgeland** occurred in the north-east of Lot 801 and graded into other sedgeland and grassland communities as well as low open-woodland. The dominant species was *Xanthorrhoea resinifera,* which had a dense cover. Despite this dense cover, there was a diverse ground layer of other sedges, grasses and herbs. Patches of taller shrubs of *H. teretifolia*, *B. ericifolia* and *V. juncea* and *Juncus pallidus* also occurred. This community had been disturbed by clearing, tracks and erosion. Introduced species occurred along the edges of this community. The total weed cover in the community was estimated to be 1%.

15. ***Anisopogon avenaceus* Grassland** occurred in the north-west of Lot 801 and graded into *Xanthorrhoea resinifera* Sedgeland to the east and heathland along Eastern creek to the west. It had open to dense ground cover and the dominant species was *A. avenaceus*. Other common species included native sedges, grasses and herbs such as *Fimbristylis dichotoma*, *Entolasia stricta* and *Burchardia umbellata*. This community had been disturbed in the past by vehicle tracks and fence construction, though there were few weeds present. The total weed cover in the community was estimated to be 1 %.

16. ***Lepidosperma laterale* Sedgeland** occurred on waterlogged soils in the north-west of Lot 801 and graded into *Anisopogon avenaceus* Grassland and *Eucalyptus sclerophylla* Low Open-woodland. This community had a dense to very dense ground layer and the dominant species included *Lepidosperma laterale*. Other common species included *Juncus pallidus* and *Entolasia stricta*. As with the above community, this community has been disturbed in the past by vehicle tracks and fence construction and had few weeds. The total weed cover in the community was estimated to be 1 %.

17. ***Baumea articulata* Closed Sedgeland** occurred in the south-west of Lot 801 on waterlogged soils adjacent to the cleared areas under the transmission line and graded into *Lepidosperma laterale* Sedgeland and *Eucalyptus sclerophylla* Low Open-woodland. The ground layer was very dense, to 1.5 m high and the dominant species was *Baumea articulata*. The diversity in the ground layer in this community was relatively low compared to a high diversity of sedges and herbs in adjacent communities. This community had also been disturbed by unformed tracks and few weeds were present along the edges. The total weed cover in the community was estimated to be 1 %.

18. ***Anisopogon avenaceus / Lomandra filiformis* Grassland** occurred within the centre of Lot 801 and graded into heathland, low open-woodland and other grassland and sedgeland communities. It contained scattered shrubs such as *Allocasuarina paludosa* and *H. dactyloides*. The ground layer was open and dominant species included *A. avenaceus* and *Lomandra filiformis*. The diverse ground layer included many other native grass, herb and sedge species such as *Lomandra obliqua*, *Hypoxis hygrometrica* and *Patersonia sericea*. The endangered orchid *Prasophyllum affine* occurred in this community. This community had been disturbed by clearing for tracks and roads and occurred adjacent to areas of bare earth. Weeds including *Andropogon virginicus* occurred along the disturbed edges. The total weed cover in the community was estimated to be 1 %.

These Sedgeland and Grassland Communities corresponded to Community 4.4 Sedgeland – heathland (fresh swamp) of Mills (1993), which is widespread on sandstone soils and is botanically significant in the Jervis Bay region because it is floristically rich and contains many rare plants including the threatened *P. affine*. It is also important habitat for threatened fauna.

4.5.1 Regional Significance of Vegetation Communities

The following vegetation communities on the subject site correspond to Botanically Significant Vegetation Communities identified by Mills (1993) and are shown in *Figure 4.2*:

- ***Eucalyptus longifolia*** **Open-woodland.** This corresponded to Community 3.3 *Eucalyptus longifolia – Melaleuca* forest – woodland of Mills (1993). It is locally significant because it has limited occurrences, is often associated with wetlands and provides important fauna habitat (Mills 1993).

- ***Eucalyptus robusta*** **Woodland.** This corresponded to Community 3.2 *Eucalyptus robusta* forest – woodland of Mills (1993). It is locally significant because it has limited occurrences and has wetland habitats.

- ***Banksia ericifolia / Hakea teretifolia*** **Heathland.** This corresponded to Community 4.3 Mallee – heathland of Mills (1993). It is locally significant because it is floristically rich and contains many rare plants and is important habitat for threatened fauna.

- ***Xanthorrhoea resinifera*** **Sedgeland,** ***Anisopogon avenaceus*** **Grassland,** ***Lepidosperma laterale*** **Sedgeland,** ***Baumea articulata*** **Closed Sedgeland and** ***Anisopogon avenaceus/Lomandra filiformis*** **Grassland.** These communities corresponded to Community 4.4 Sedgeland – heathland (fresh swamp) of Mills (1993). They are locally significant because they are floristically rich and contain many rare plants including the threatened orchids *P. affine* and *C. hunteriana* and are important habitat for threatened fauna.

4.5.2 Endangered Ecological Communities

Sydney Coastal Estuary Swamp Forest Complex

In 2003, the determination of whether *Sydney Coastal Estuary Swamp Forest Complex* (SCESFC) occurred on the subject site was assessed using the approach outlined in *Chapter 3*.

This involved consideration of the following:

- whether the subject site is within the area defined by the Determination;

- whether the subject site occurs on waterlogged estuarine alluvial soils strongly influenced by periodically poor drainage conditions;

- whether the subject site is any of the mosaic of vegetation types listed in Section 5 of the Determination;

- whether any of the listed characteristic species occur (including as part of the soil seedbank); and

- whether the subject site is similar to vegetation mapped as Coastal Swamp Forest Complex (Map Unit 27a) in Benson and Howell (1994) or part of the alluvial forest of Chafer (1997).

SCESFC is defined as occurring within the Sydney Basin Interim Biogeographic Region. The subject site is within the Sydney Basin Interim Biogeographic Region and is therefore within the area defined by the Final Determination.

Alluvial and estuarine soils were recorded from only one test pit (TPF5) and one bore hole (BHF9) (Network Geotechnics 2003). These locations are shown in *Figure 4.2*.

In TPF5, the topsoil occurred from 0 to 0.5 m and was fine-grained, grey-brown silty sand with tree roots. The alluvium occurred from 0.5 m to 2.5 m and was fine-grained, pale grey mottled, yellow brown sand/clayey sand. In BHF9, which was either in or directly adjacent to an unformed road, the upper layer was recent slopewash from 0 to 0.25 m deep and consisted of fine to medium grained, pale brown/grey sand/clayey sand of low plasticity. The next deepest layer was estuarine sediment from 0.25 to 1.7 m deep and consisted of dark grey, sandy silt of low to medium plasticity with roots.

TPF5 and BHF9 were located in or adjacent to the Eastern creek, in a seasonally waterlogged broad valley in the eastern part of the subject site. Adjacent bore holes that were located in the Eastern creek or in the broad valley in the south-east of the subject site did not record estuarine or alluvial soils. Therefore, it is likely that estuarine alluvial soils are restricted to the Eastern creek.

TPF5 occurs in *Eucalyptus robusta* Woodland, which is associated with the low-lying topography and drainage line of Eastern creek. This community extended north of the subject site into the study area towards former SEPP 14 Wetland 324 (*Figure 4.2*). The moist conditions within this creek supported *Eucalyptus robusta*, stands of *M. linariifolia* and *A. longifolia* to 3 m in height, dense stands of *Gahnia sieberiana* and *Gahnia clarkei* and patches of sedges including *Phragmites australis*, *Baumea teretifolia and Baumea juncea.* Ground layer and riparian species included *Viola hederacea* and *Gleichenia dicarpa*.

Some of the listed characteristic species of SCESFC occur in this *Eucalyptus robusta* Woodland and are dominant in some of the structural layers of this community. *Eucalyptus robusta* Woodland along Eastern creek also appears to be similar to the descriptions of Open-forest: *Eucalyptus botryoides – Eucalyptus robusta*, Scrub: *Melaleuca linariifolia – Melaleuca styphelioides* and Reedland: *Phragmites australis-Typha orientalis*, which are all sub-formations of Coastal Swamp Forest Complex (Map Unit 27a) of Benson and Howell (1994).

BHF9 occurs to the west of Eastern creek. The vegetation here is clearly not SCESFC. It was mapped as a small patch of *Eucalyptus sclerophylla* Open-woodland because it supported *E. sclerophylla*, and also the dry sclerophyll elements of the adjacent heathland communities.

Conclusion

Based on the location of alluvial estuarine soils and species composition of vegetation communities on the subject site it is concluded that *Eucalyptus robusta* Woodland is the endangered ecological community SCESFC.

Extent of SCESFC

The boundary of the *Eucalyptus robusta* Woodland was clearly defined in the field because it was restricted to Eastern creek, which lies one to two metres below the surrounding land. This community extended north-east along Eastern creek into the study area and ended at *Xanthorrhoea resinifera* Sedgeland.

The vegetation community on the higher land to the west of Eastern creek, in which estuarine or alluvial soils may be present, was *Eucalyptus sclerophylla* Open-woodland. The dominant canopy tree in this community was *Eucalyptus sclerophylla*. The shrub layer was absent to sparse and consisted of *L. polygalifolium* ssp. *polygalifolium*. However, many burnt specimens of this species and *A. littoralis* were also present. The ground layer in this area was dense to open but was dominated by sedges, grasses and herbs such as *Lepidosperma gunnii*, *Burchardia umbellata*, *A. avenaceus*, *Gonocarpus teucrioides* and *Schoenus brevifolius*. This species assemblage in this community is not characteristic of SCESFC, nor is it similar to any of the vegetation types listed in Section 5 of the Determination. Therefore, although *Eucalyptus sclerophylla* Open-woodland was potentially located on alluvial or estuarine soils, it was not considered to be SCESFC.

The vegetation to the east of *Eucalyptus robusta* Woodland was *Eucalyptus sclerophylla/Eucalyptus globoidea* Woodland, and was not determined to be SCESFC for the same reasons as noted above. Although it may have occurred on alluvial soils, it was on higher ground and included only one or two *E. robusta*. The dominant species in the understorey in this community was *A. littoralis*. The dominant low shrub and ground layer species were *Pteridium esculentum* and *Goodenia ovata*. It did not contain any riparian or aquatic species and was not similar to any of the vegetation types listed in Section 5 of the Determination.

4.5.3 Swamp Sclerophyll Forest

The Scientific Committee has made a Final Determination to list Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions as an Endangered Ecological Community and, as a result, to omit reference to SCESFC in the Sydney Basin bioregion from Part 3 of Schedule 1 of the TSC Act. As Swamp Sclerophyll Forest includes a much broader range of species than SCESFC, the species list for each vegetation community at the subject site was assessed for the potential occurrence of Swamp Sclerophyll Forest. No other areas of the subject site were found to have species assemblages diagnostic of or characteristic of Swamp Sclerophyll Forest. Therefore, it can be considered that this community occurs at the subject site only in those areas mapped as SCESFC (*E. robusta* woodland) in this report and shown in *Figure 4.2*.

4.6 FLORA

Flora surveys were conducted in the major vegetation types of the subject site. Flora species recorded at the subject site are provided in *Annex C* of this SIS.

4.6.1 Regional Significance of Flora

There is no formal list of regionally significant plant species or communities for the Sydney Basin Biogeographic Region. At a local scale, Mills (1993) has identified 'Botanically Significant' flora species and vegetation communities within the Jervis Bay region.

Sixteen of these species have previously been recorded on the subject site by Gunninah (2002a) and surveys undertaken for this SIS, and these are shown in *Table 4.3*. These species are at their approximate distributional limits in the locality, or are generally rare on the south coast.

Table 4.3 ***Botanically significant plant species of the Jervis Bay region recorded on the subject site***

Botanical Name	Common Name	Gunninah (2002a)	ERM (2003)
Acacia elongata var. *dilatata*	-	X	X
Baeckea ramosissima	-	X	
Callistemon linearis	Narrow-leaved Bottlebrush	X	X
Conospermum ericifolium	Smoke Bush	X	X
Conospermum taxifolium	Smoke Bush	X	X
Dillwynia ramosissima	-	X	
Eriostemon buxifolius subsp. *buxifolius*	-	X	
Eucalyptus obstans	Port Jackson Mallee	X	X
Eucalyptus robusta	Swamp Mahogany	X	X
Eucalyptus sclerophylla	Hard-leaved Scribbly Gum	X	X
Gompholobium grandiflorum	Wedge Pea	X	X
Mirbelia rubiifolia	-	X	X
Persoonia mollis ssp. *leptophylla*	-	X	
Platysace linearifolia	Carrot Tops	X	X
Petrophile pulchella	Conesticks	X	X
Xyris gracilis ssp. *laxa*	Slender Yellow Eye	X	

1. X = recorded on the subject site

4.6.2 Rare or Threatened Australian Plants (Rotap)

One RoTAP species, *Pultenaea villifera* var. *villifera*, has been recorded within Lot 802 in open woodland/woodland/open-forest communities (Gunninah 2002a). This species was not recorded during surveys carried out for this SIS. Nonetheless potential habitat still exists and consequently it is considered that this species may persist on the subject site.

4.6.3 Threatened Flora – TSC Act

A number of plants listed as threatened under the TSC Act were recorded at the subject site and a number of others have the potential to occur on the subject site. These species are addressed in detail in Section 4.10.

4.7 FAUNA AND FAUNA HABITAT

Fauna surveys were conducted across the subject site in all habitat types and each of the fauna groups is addressed below. Of particular importance on the subject site is the potential for tree hollows to provide habitat for a number of species. Quantification of hollow-bearing trees across the site is provided below. A list of species recorded at the subject site is provided as *Annex C*. All of the threatened species recorded at the subject site are shown on *Figure 4.3*, *Figure 4.4*, *Figure 4.5, Figure 4.6* and *Figure 4.7* and discussed in *Section 4.10* and *Section 4.11.*

4.7.1 Tree Hollow Density

Tree hollows provide potential habitat for a range of mammals including the Yellow-bellied Glider, Squirrel Glider, Brushtail Possum and microchiropteran bats, as well as a range of birds including the Glossy Black-cockatoo.

The woodland areas of the subject site were rich in tree hollows and the most common hollow-bearing tree was *E. sclerophylla*. Densities of hollow-bearing trees across the subject site are shown in *Table 4.4*. The highest density of hollow-bearing trees per hectare (20 – 25) and number of hollows per tree (up to 3.3) occured in the open-woodland communities, followed by open-forest and then woodland communities. High numbers of hollow-bearing trees were also recorded in the *Eucalyptus robusta* Woodland, which can be attributed to stags of *C. gummifera*. Those open-woodland communities with relatively high hollow-bearing tree densities are located in the northern corner of the subject site and along the Western creek in the west of the subject site.

Of lower density (18 per hectare) was the *Corymbia maculata/Eucalyptus globoidea* Open-forest. Hollows in this community were present in *E. pilularis*, *E. sclerophylla*, *E. resinifera* and stags. This community, together with the open-woodland communities noted above and the riparian areas, reflects the major distribution of the Yellow-bellied Glider on the subject site.

Eucalyptus sclerophylla/Corymbia gummifera Woodland and *Eucalyptus sclerophylla/Corymbia gummifera/Eucalyptus globoidea* Woodland occurred on the upper and middle slopes and also supported hollow-bearing trees, although at relatively lower densities than the open-woodland communities. These areas provide similar habitats for arboreal fauna, although at a lower density.

No hollow-bearing trees were recorded in Vegetation Community No. 2 *Eucalyptus globoidea/Corymbia gummifera* Open-forest within the subject site. However, only a small portion of this community occurs on the subject site and hollow-bearing trees were recorded in this community during general vegetation and habitat assessments within the study area. Yellow-bellied Gliders were also recorded in this community during spotlighting.

Hollow-bearing trees were not surveyed for in *Eucalyptus sclerophylla/Eucalyptus globoidea* Woodland, *Eucalyptus sclerophylla* Low Open-woodland and *Eucalyptus sclerophylla* Woodland communities as these small communities were delineated after transect surveys had taken place across broader vegetation and habitat types. However, they are similar to adjacent woodland communities and they can be considered part of these communities in terms of hollow-bearing tree density.

Table 4.4 Results of surveys of hollow-bearing trees across the subject site

Vegetation Community	Trees per Hectare	Hollow-bearing trees per hectare	Mean No. hollows/per hollow-bearing Tree	Hollow Diameter Range (cm)
Open-forest Communities				
1. Corymbia maculata/Eucalyptus globoidea Open-forest	275	18	3.1	10-40
2. Eucalyptus globoidea/Corymbia gummifera Open-forest *	150	0	n/a	n/a
Woodland Communities				
3. Eucalyptus sclerophylla/Corymbia gummifera Woodland	193	13	2.4	5-40
4. Eucalyptus sclerophylla/Eucalyptus globoidea Woodland *	no transects	no transects	no transects	no transects
5. Eucalyptus sclerophylla/Corymbia gummifera/Eucalyptus globoidea Woodland	262	13	2	8-30
6. Eucalyptus sclerophylla Woodland *	no transects	no transects	no transects	no transects
7. Eucalyptus robusta Woodland	120	25	2.6	10-30
Open-woodland Communities				
8. Eucalyptus sclerophylla/Corymbia gummifera Open-woodland	285	25	3	6-50
9. Eucalyptus sclerophylla Open-woodland	142	20	2	4-40
10. Eucalyptus sclerophylla Open-woodland (sedge and tick bush understorey)	85	20	3.3	4-40
11. Eucalyptus longifolia Open-woodland	no transects	no transects	no transects	no transects
Low-open Woodland				
12. Eucalyptus sclerophylla Low Open-woodland *	no transects	no transects	no transects	no transects
Heathland Communities				
13. Banksia ericifolia/Hakea teretifolia Heathland	No trees	N/A	N/A	N/A
Sedgeland and Grassland Communities				
14. Xanthorrhoea resinifera Sedgeland	No trees	N/A	N/A	N/A
15. Anisopogon avenaceus Grassland	No trees	N/A	N/A	N/A
16. Lepidosperma laterale Sedgeland	No trees	N/A	N/A	N/A
17. Baumea articulata Closed Sedgeland	No trees	N/A	N/A	N/A
18. Anisopogon avenaceus/Lomandra filiformis Grassland	No trees	N/A	N/A	N/A

1. * These communities are small in area. Hollow-bearing trees are present and their density is comparable to adjacent woodland communities.

4.7.2 Reptiles and Amphibians

Very few reptiles were detected at the subject site (*Annex C*) which may reflect its fire history. Species detected include the Eastern Blue Tongue Lizard (*Tiliqua scincoides*) and the Red-bellied Black Snake (*Pseudechis porphyriacus*). The Blue Tongue Lizard was a juvenile and was recorded in the south-east corner of Lot 801 within dense sedgeland. The Red-bellied Black Snake was recorded within Lot 802 within the heathland.

Amphibian activity was high along the creeks and ponds within Lot 802 and in puddles that had formed along tracks. A number of frog species were heard and seen during targeted surveys for the Giant Burrowing Frog. Amphibians recorded at the subject site included the Common Eastern Froglet (*Crinia signifera*), Striped Marsh Frog (*Limnodynastes peronii*), Spotted Marsh Frog (*Limnodynastes tasmaniensis*), Bleating Tree Frog (*Litoria dentata*), Freycinet's Frog (*Litoria freycineti*) and Peron's Tree Frog (*Litoria peronii*). The Common Eastern Froglet and Bleating Tree Frog were heard on numerous occasions throughout the survey period.

4.7.3 Birds

A total of 76 bird species was recorded during surveys on the subject site (*Annex C*). The majority of these species are widespread and/or abundant species that commonly occur in woodland, heathland, regrowth vegetation and various other habitats. No introduced species were recorded.

A total of six birds listed on the TSC Act were recorded at the subject site and these were:

- Eastern Bristlebird (*Dasyornis brachypterus*);
- Glossy Black-cockatoo (*Calyptorhynchus lathami*);
- Ground Parrot (*Pezoporus wallicus*);
- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Square-tailed Kite (*Lophoictinia isura*).

The Eastern Bristlebird is also listed as endangered under the EPBC Act. The White-throated Needletail (*Hirundapus caudacutus*) was also recorded on the subject site and is listed as a migratory species under the EPBC Act.

4.7.4 Mammals

Macropod scats were found within all habitats across the subject site. The common macropod species Eastern Grey Kangaroo (*Macropus giganteus*) and Swamp Wallaby (*Wallabia bicolor*) were recorded most often within Lot 802.

Brown Antechinus (*Antechinus stuartii*) and Bush Rats (*Rattus fuscipes*) were recorded across the subject site in all habitat types. Long-nosed Bandicoots (*Perameles nasuta*) were detected in areas targeted for the Southern Brown Bandicoot in both Lot 801 and Lot 802. These areas were characterised by dense ground cover, such as *Lomandra longifolia,* interspersed with open areas or areas of sparse ground cover. A Short-beaked Echidna (*Tachyglossus aculeatus*) was recorded during orchid surveys within *Anisopogon avenaceus/Lomandra filiformis* Grassland within Lot 801.

Arboreal mammals detected within Lot 802 were Sugar Gliders (*Petaurus breviceps*), Brushtail Possums (*Trichosurus vulpecula*), Greater Gliders (*Petaurus volans*), Yellow-bellied Gliders (*Petaurus australis*) and Eastern Pygmy-possums (*Cercartetus nanus*). The Eastern Pygmy-possum was also recorded in the heathland of Lot 801. These species were detected by spotlighting, stagwatching, trapping and hair and scat analyses. Yellow-bellied Gliders were predominantly recorded in forested areas close to the creeks, although feed trees have been recorded in ridgetop areas and a nest tree was recorded midslope. A Common Ringtail Possum (*Pseudocheirus peregrinus*) was recorded as roadkill adjacent to the subject site on The Wool Road.

A range of insectivorous bats was detected using Anabat detectors within the wooded areas of Lot 802. Two of the species detected are listed as threatened under the TSC Act. These are the Eastern Freetail Bat (*Mormopterus norfolkensis*) and the Large Bent-wing Bat (*Miniopterus schreibersii*). Additional bat surveys were undertaken in December 2004 to further ascertain the presence of threatened bat species on the site. Fourteen bat species were recorded during the additional surveys (ERM 2005). This included the threatened species Eastern Freetail Bat (*Mormopterus norfolkensis*), Large Bent-wing Bat (*Miniopterus schreibersii),* Greater Broad-nosed Bat *(Scoteanax rueppellii),* Eastern Falsistrelle *(Falsistrellus tasmaniensis)*, and the Fishing Bat (*Myotis adversus).* However, only the Eastern Freetail Bat and the Large Bent-wing Bat could be confidently identified from echolocation calls (ERM 2005).

No Grey-headed Flying-fox (*Pteropus poliocephalus*) camps were detected during surveys. However this species would be expected to forage within the subject site. An unidentified flying-fox (potentially a Grey-headed Flying-fox) was noted flying across Lot 802.

Feral animals detected by scat analyses were Fox (*Vulpes vulpes*) and Dog (*Canis familiaris*). Scats were found in Lot 801 and Lot 802. Fox scats contained the remains of Long-nosed Bandicoot (Triggs 2004).

4.7.5 Regional Significance of Fauna

Advice from the Threatened Species Officer of Shoalhaven City Council (M. Smith, *pers. comm.)* was that no formal list of regionally significant species had been published. Threatened and migratory species listed under both the NSW TSC Act and the Commonwealth EPBC Act occurring within the Jervis Bay area are therefore considered regionally significant.

4.7.6 Threatened Fauna

A number of threatened fauna were recorded at the subject site and a number of others have the potential to occur on the subject site. These species are addressed in detail in Section 4.11.

4.8 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Matters of NES that are likely to be affected by the proposal include threatened species and communities and migratory species. These are listed in *Table 4.5*.

All of the species listed under the EPBC Act that have the potential to be affected by the proposal have been assessed as part of this SIS. Their known or potential abundance, distribution in the study area and potential impacts and amelioration measures are discussed in the following sections. Movement corridors for migratory species have been discussed.

Table 4.5 Species listed under the EPBC Act that have the potential to be affected by the proposal

Scientific Name	Common Name	Status	Presence and/or Potential Habitat in the Study Area
Birds			
Dasyornis brachypterus	Eastern Bristlebird	E	Recorded on subject site.
Lathamus discolor	Swift Parrot	E	Not recorded at the subject site or locality. Potential foraging habitat present.
Xanthomyza phrygia	Regent Honeyeater	E, M	Not recorded on subject site. Recorded in the locality. Potential habitat present.
Hirundapus caudacutus	White-throated Needletail	M,	Recorded on subject site.
Myiagra cyanoleuca	Satin Flycatcher	M	Not recorded on subject site. Potential habitat present.
Rhipidura rufifrons	Rufous Fantail	M	Recorded on subject site.
Gallinago hardwickii	Latham's Snipe	M	Not recorded on subject site. Recorded in the locality. Potential habitat in adjacent wetlands.
Frogs			
Heleioporus australiacus	Giant Burrowing Frog	V	Recorded on subject site (Gunninah 2002).
Mammals			
Chalinolobus dwyeri	Large-eared Pied Bat	V	Recorded in study area.
Isoodon obesulus obesulus	Southern Brown Bandicoot	E	Not recorded on subject site. Potential habitat present.
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	Not recorded on subject site. Potential habitat present.
Pteropus poliocephalus	Grey-headed Flying-fox	V	Not recorded on subject site. Potential habitat present.
Flora			
Arachnorchi tessellata	Thick-lipped Spider Orchid	V	Not recorded on subject site. Potential habitat present.
Cryptostylis hunteriana	Leafless Tongue-orchid	V	Recorded on subject site.
Prasophyllum affine	Jervis Bay Leek Orchid	E	Recorded on subject site.

1. EPBC Act = Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
2. E = endangered, V = vulnerable, M = migratory.

4.9 SUBJECT SPECIES AND AFFECTED SPECIES

Affected species include those species that have the potential to be affected by the proposal. Due to the extent and nature of the proposal, all species that were recorded in the study area were considered affected species. For those subject species that were not recorded during surveys, the determination of whether they were classed as affected species took into account the following considerations:

- whether the species was likely to occur in the study area based on the types of habitats in the study area;
- recent records of threatened species in the locality; and
- the known distribution and habitats utilised by threatened species in the region and locality.

Some species are highly cryptic and can only be reliably detected during appropriate conditions (e.g. season, weather) and with a very high level of survey effort. The above factors were taken into account when determining whether cryptic species would be likely to occur in the study area.

The compilation of the list of species for inclusion into the SIS relied on addressing numerous sources and these are shown below:

- the DGRs for this SIS lists the species to be considered for inclusion as a subject species (*Annex I*);
- NSW NPWS Wildlife Atlas database (dated 2003), Birds Australia database (dated 2003) and the Sydney Royal Botanic Gardens database (dated 2003). *Figure 4.3* and *Figure 4.4* show the locations of database records of threatened species within the locality;
- the results of flora and fauna surveys undertaken by Gunninah (2002a) shown in *Figure 4.5*; and
- the habitat mapping and results of flora and fauna surveys undertaken for this SIS shown in *Figure 4.6, Figure 4.7*, *Figure 4.8, Figure 4.9 and Figure 4.10.*

From these sources 34 affected species and one affected endangered ecological community were identified (see *Table 4.6*). These species and the community have either been recorded at the subject site and are therefore likely to be directly or indirectly affected, or are likely to occur within the study area and have the potential to be affected (see *Table 4.5*). Species that are restricted to marine, beach or intertidal habitats are not included in *Table 4.6* since they would not be affected by the proposal.

In addition to the affected species identified from the above sources, the Giant Dragonfly (*Petalura gigantea*) was included in this impact assessment, as the species was recorded on the subject site in December 2004 by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd. The Giant Dragonfly is listed as endangered under the TSC Act. This species was the subject of targeted surveys undertaken by GHD in May 2005 (GHD 2005d).

This SIS provides a discussion of the local and regional abundance, local and regional corridors, habitat assessment, conservation status, and assessment of likely direct and indirect impacts on the affected species identified in *Table 4.6*.

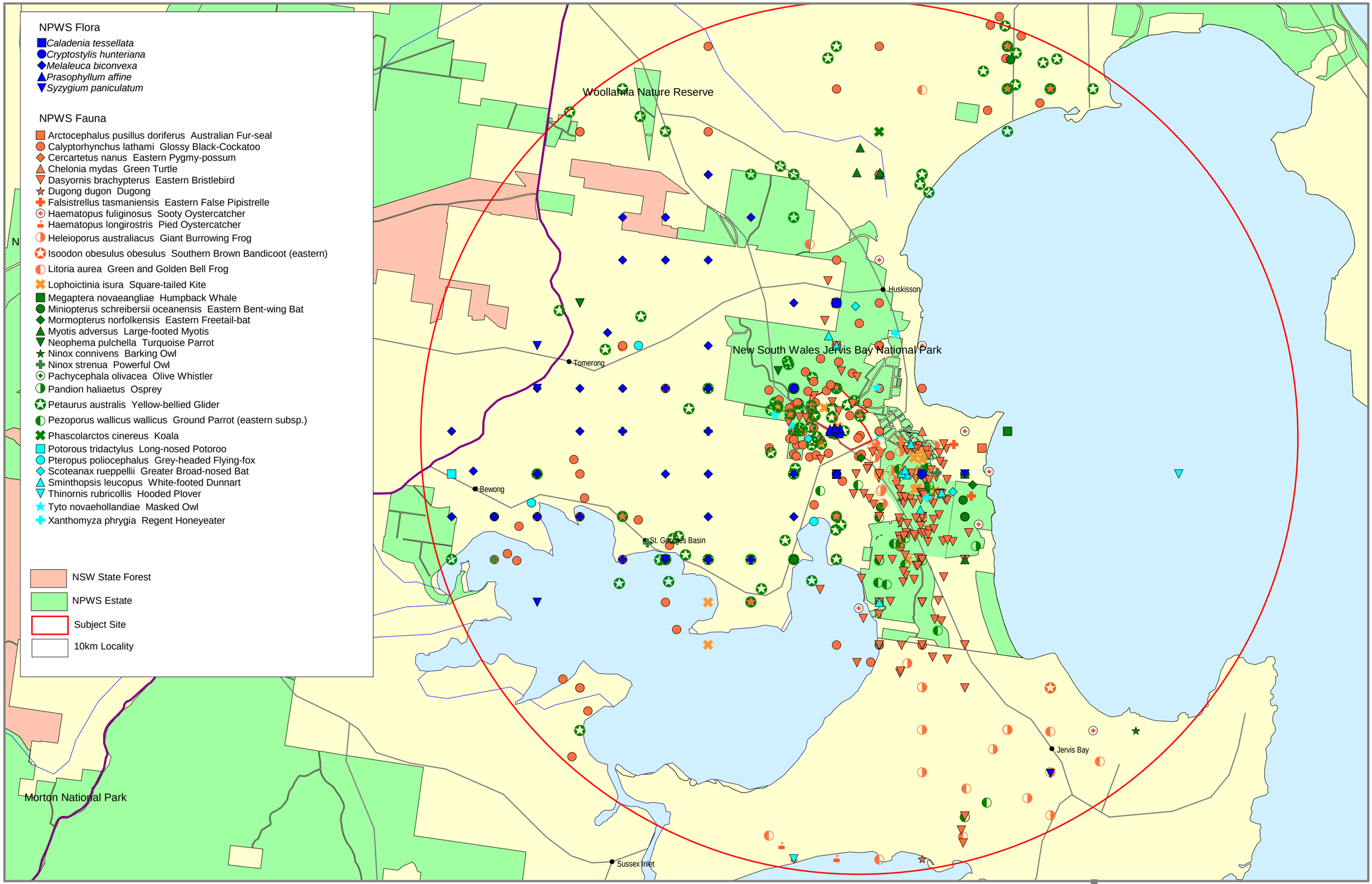

Figure 4.3 **NPWS Wildlife Atlas Database Records (2003)**

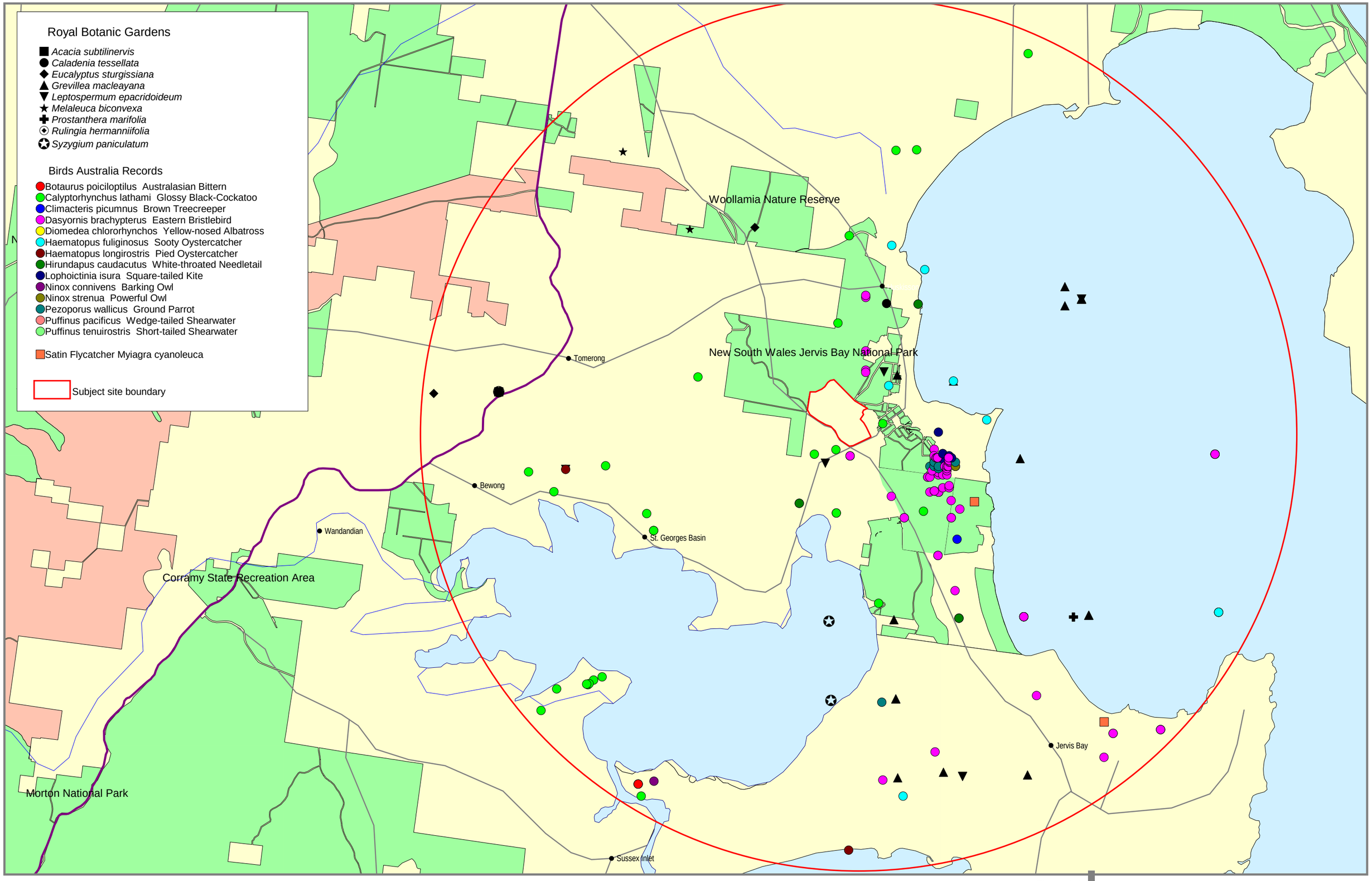

Figure 4.4 **Royal Botanic Gardens and Birds Australia Database Records**

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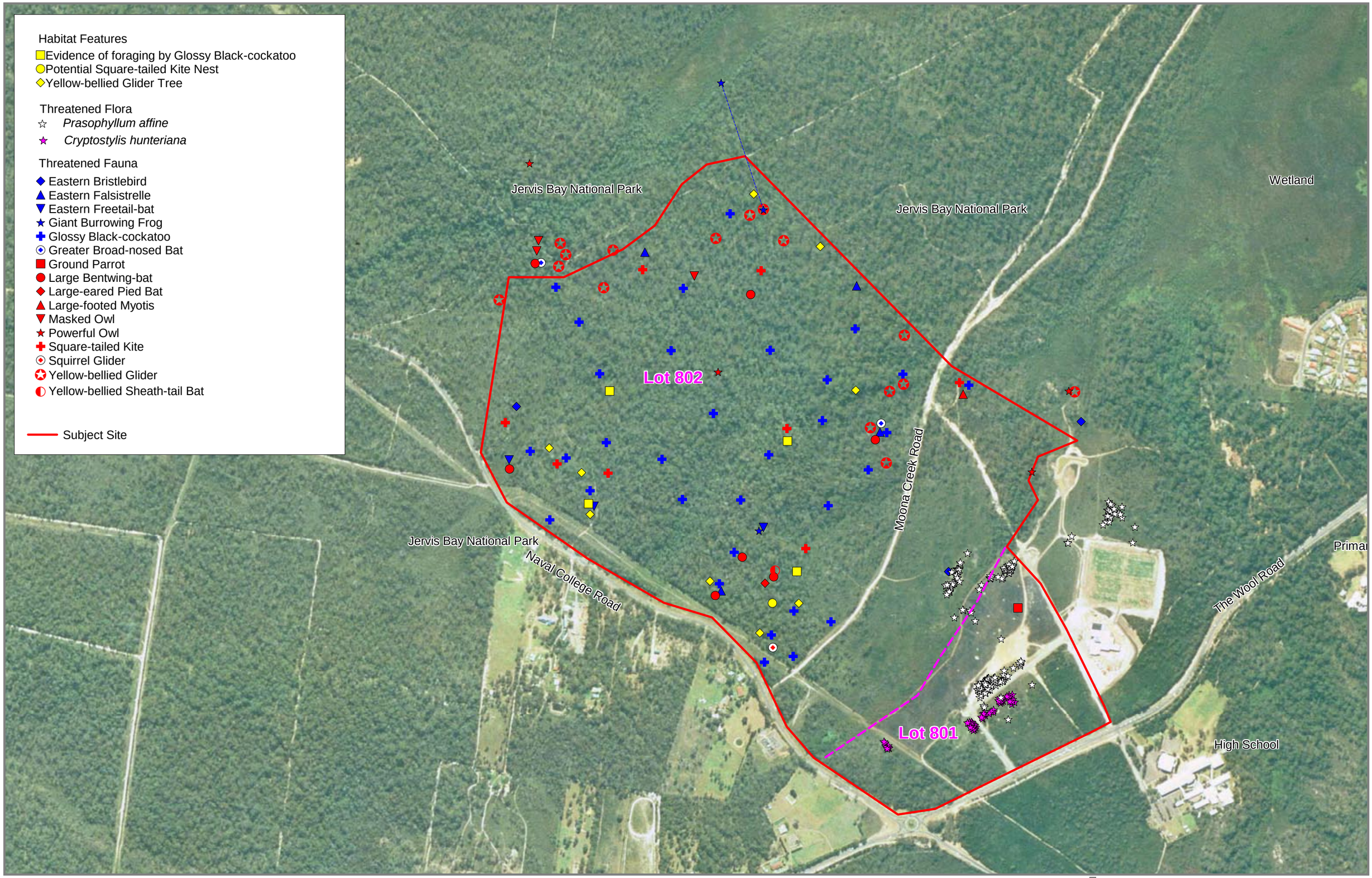

Figure 4.5 **Habitats and Threatened Species (Gunninah 1999; 2000a,b,c; 2001; 2002a, b)**

Vincentia
Species Impact Statement

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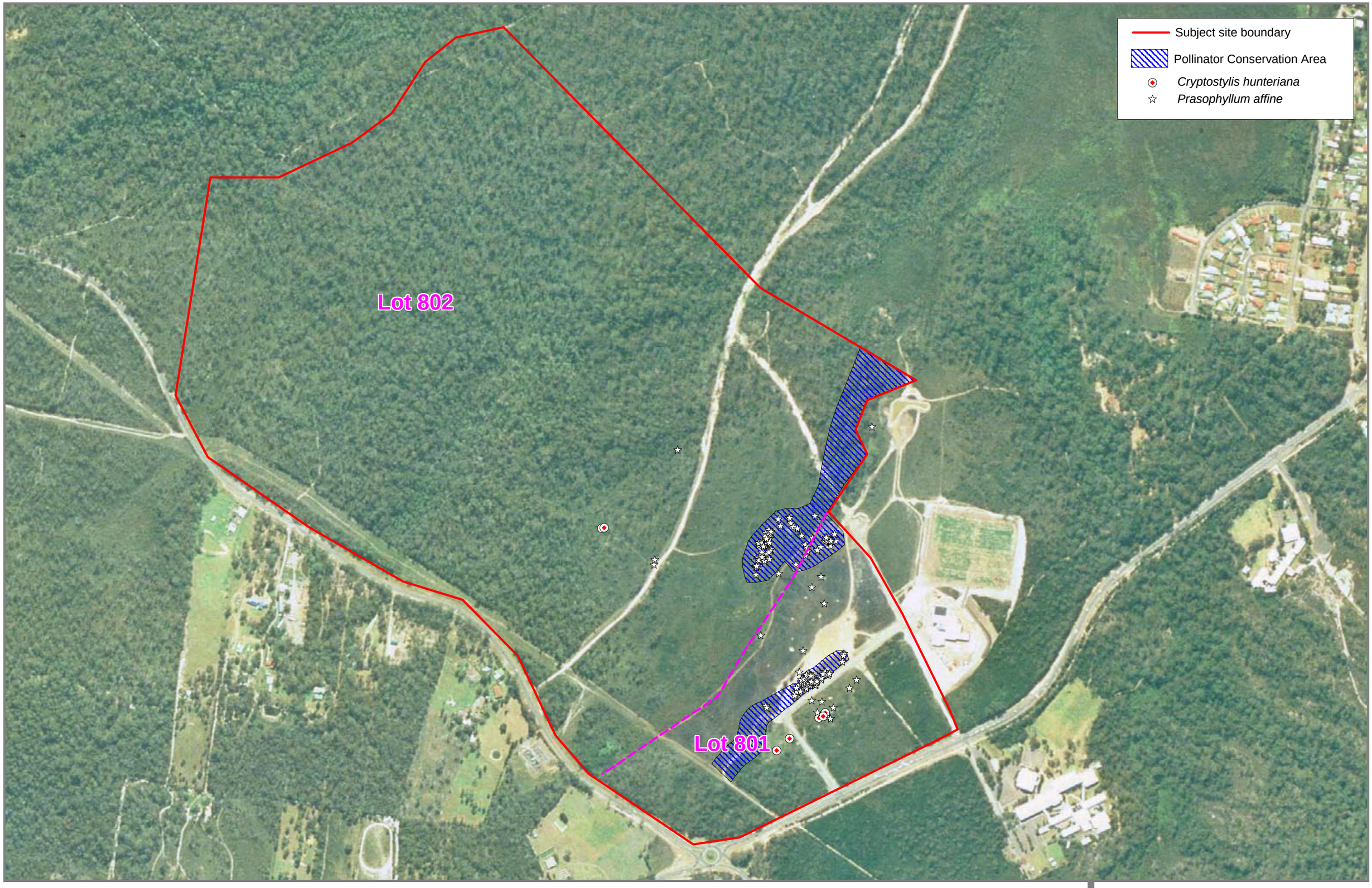

Figure 4.6 **Threatened Flora (ERM 2003 & 2004)**

Vincentia
Species Impact Statement

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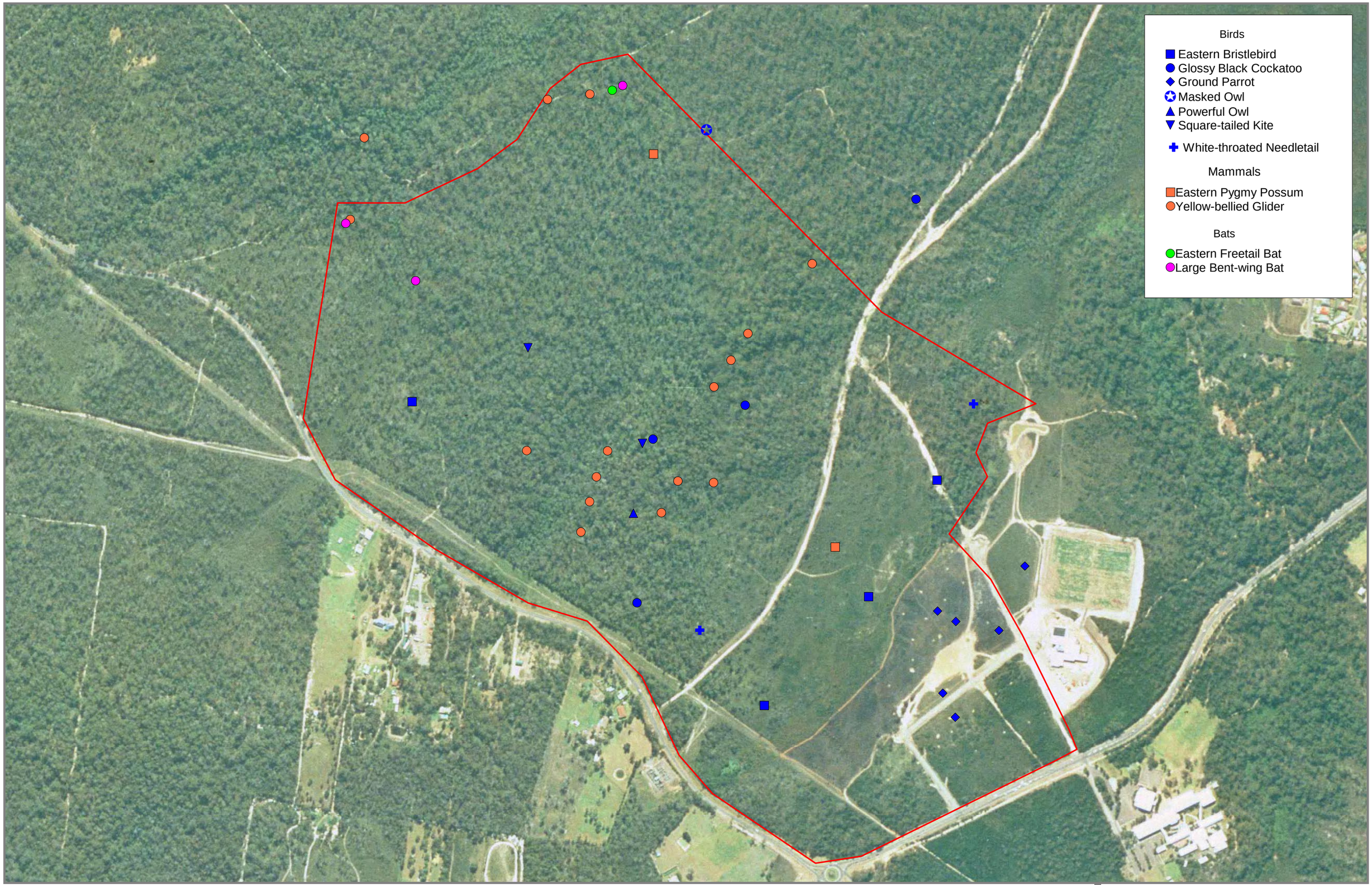

Figure 4.7 **Threatened Fauna (ERM 2003 and 2004)**

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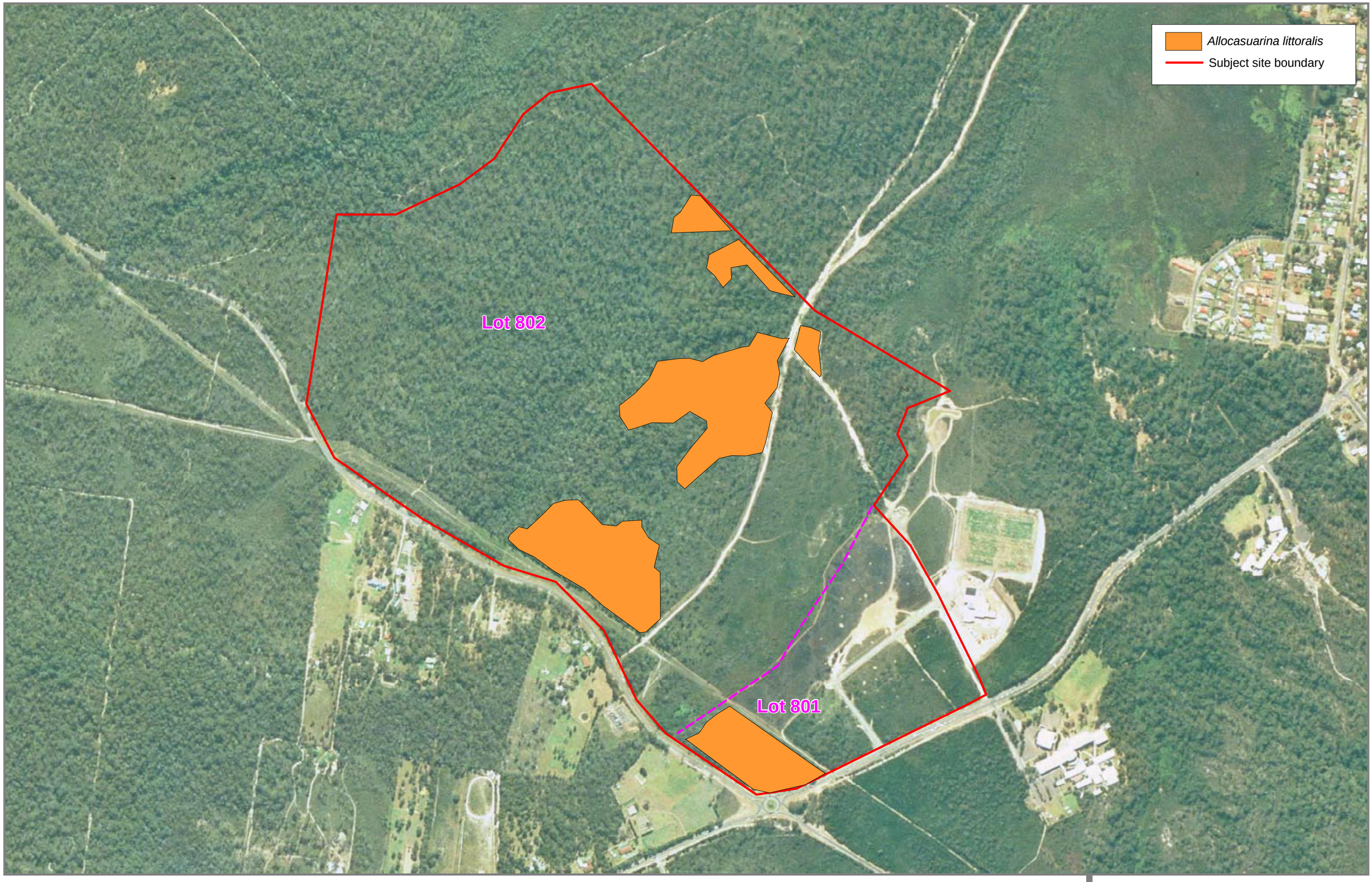

Figure 4.8 **Location of *Allocasuarina littoralis* at the Subject Site**

Vincentia
Species Impact Statement

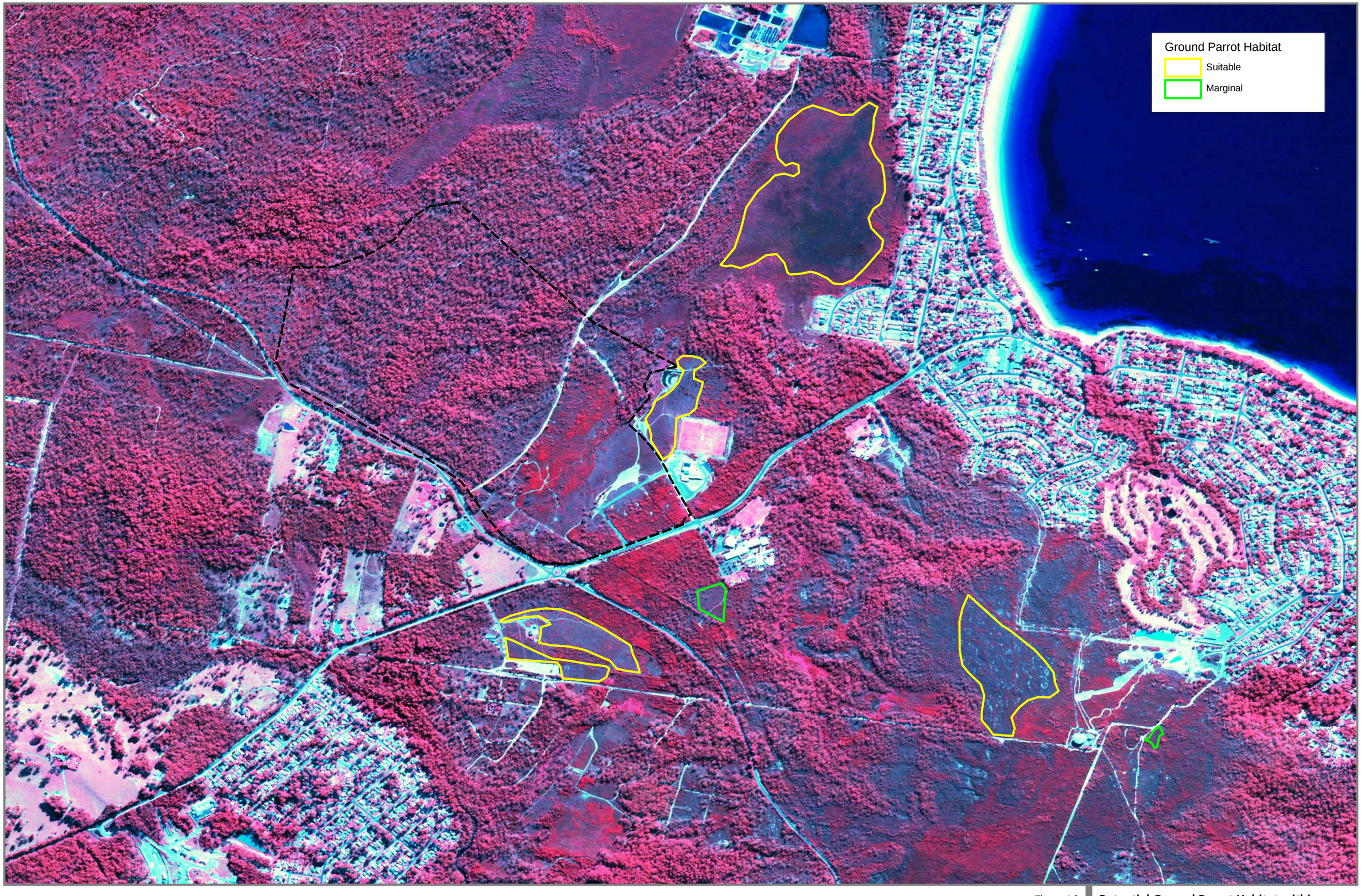

Figure 4.9 **Potential Ground Parrot Habitat within 2km of the Site**

Vincentia
Species Impact Statement

tres

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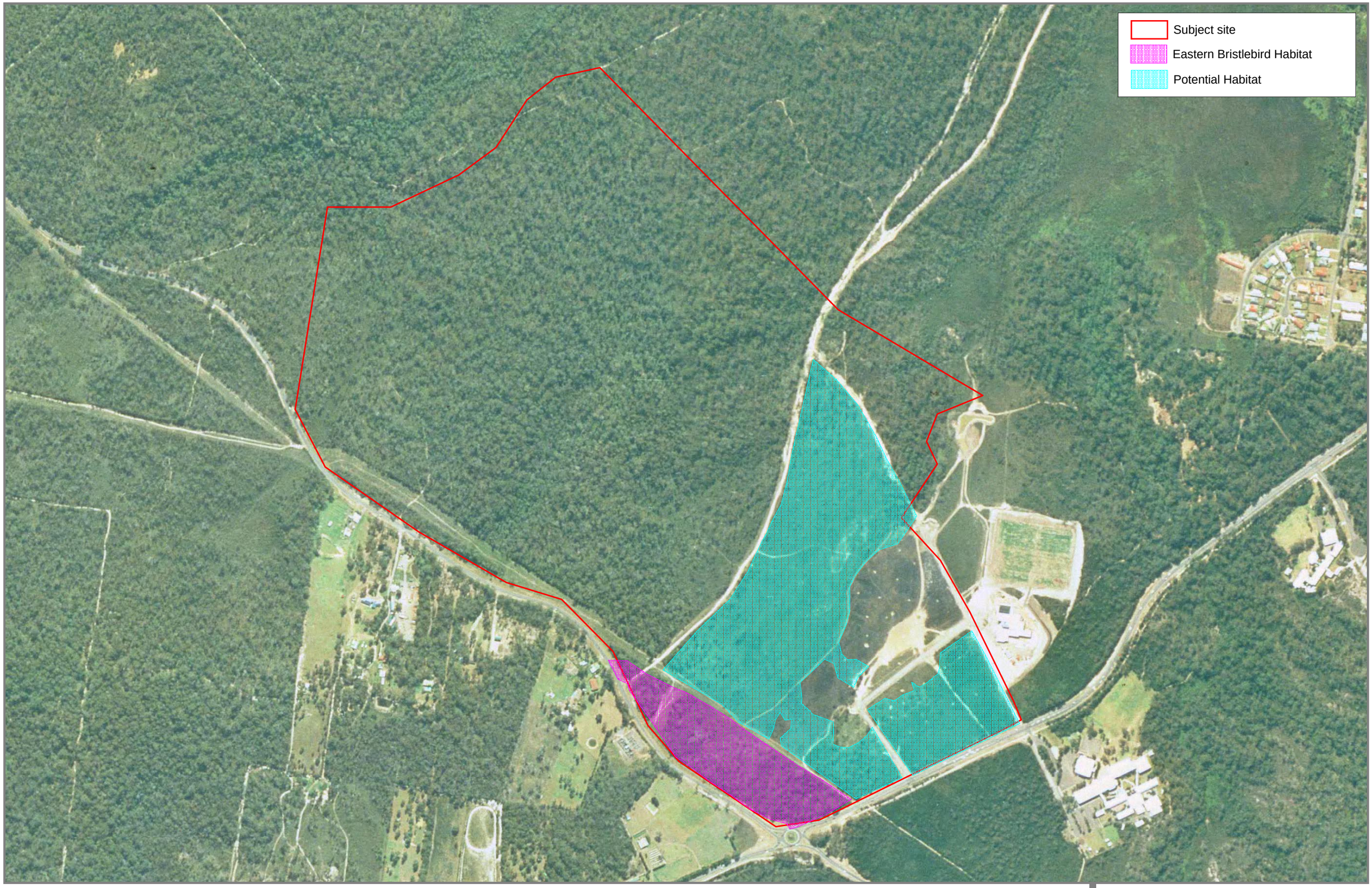

Figure 4.10 Eastern Bristlebird Habitat Boundaries

Vincentia
Species Impact Statement

Table 4.6 Identification of Affected Species

Common Name / Scientific Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Presence and Habitat Utilisation	Affected Species
FLORA					
Leafless Tongue Orchid (*Cryptostylis hunteriana*)	V	V	Swampy heaths on sandy soils and habitats ranging from scrubby swamp fringes to steep bare hillsides in eucalypt forests.	Recorded at the subject site.	**Affected species.**
Thick Lip Spider Orchid (*Arachnorchi tessellata)*	E	V	Low open forest with a heath or sometimes grassy understorey.	Not recorded at the subject site. Potential habitat at the subject site. Potential to occur.	**Affected species.**
Jervis Bay Leek Orchid (*Prasophyllum affine*)	E	E	Coastal heathland on grey-brown silty soils and avoids swampy habitats.	Recorded at the subject site.	**Affected species.**
Underground Orchid (*Rhizanthella slateri*)	V	-	Grows in eucalypt forest.	Not recorded at the subject site. Potential habitat at the subject site. Potential to occur.	**Affected species.**
Eucalyptus sturgissiana	V	-	Sandstone plateaus west and south-west of Nowra with a few small patches on nearby on the coastal plain.	Not recorded at the subject site. No potential habitat. Unlikely to occur.	Unlikely to be affected.
Albatross Mallee (*Eucalyptus langleyi*)	V	V	Poor sandy sites west and south-west of Nowra.	Not recorded at the subject site. No potential habitat. Unlikely to occur.	Unlikely to be affected.
Tangled Bedstraw (*Galium australe)*	PE	-	On slopes with friable loamy soils with ferns abundant in the understorey associated with an overstorey of *E. pilularis/E. botryoides* and *S. glomulifera*. Rediscovered at Lake Windemere at Jervis Bay in 2002.	Not recorded at the subject site despite targeted surveys in suitable habitat. Potential habitat exists. Included due to its current severely restricted distribution .	**Affected species**
Melaleuca biconvexa (*Melaleuca biconvexa*)	V	V	In dense stands forming a narrow strip adjacent to watercourses, in association with other Melaleuca species or as an understorey species in wet forest.	Not recorded at the subject site despite targeted surveys in suitable habitat. Unlikely to occur at the subject site.	Unlikely to be affected.

Common Name / Scientific Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Presence and Habitat Utilisation	Affected Species
Prostanthera marifolia	PE	Ex	Sclerophyll forest and woodland, usually near the cost, in sandy loamy soils, on sandstone.	Not recorded at the subject site. No potential habitat. Unlikely to occur.	Unlikely to be affected.
Magenta Lilly Pilly (*Syzygium paniculatum*)	V	V	At Jervis Bay on sandy grey soils over sandstone, restricted mainly to remnant stands of littoral rainforest.	Not recorded at the subject site. Habitat not present. Unlikely to occur at the subject site.	Unlikely to be affected.
Austral Toadflax (*Thesium australe*)	V	V	Grassland or grassy woodlands often in damp sites.	Potential habitat at the subject site. This species not recorded at the subject site despite extensive surveys. Unlikely to occur.	Unlikely to be affected
BIRDS					
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	V	-	Dry forest sites with low soil nutrient status, particularly those with *Allocasuarina* species. Intact and less rugged sites preferred.	Recorded at the subject site.	**Affected species.**
Brown Treecreeper (*Climacteris picumnus victoriae*)	V	-	Eucalypt woodland (>200ha), particularly open woodland lacking dense understorey, tree hollows for breeding; trees and leaf litter for foraging.	Potential habitat at the subject site. Not recorded on the subject site despite extensive surveys. Unlikely to occur.	Unlikely to be affected.
Eastern Bristlebird (*Dasyornis brachypterus*)	E	E	Rainforest, eucalypt forest, woodland, mallee, scrubland, swamp, heathland and sedgeland where there is low dense cover.	Recorded at the subject site.	**Affected species.**
White-throated Needletail (*Hirundapus caudacutus*)	-	M	Forests, woodlands, farmlands, plains and lakes. Feeds on flying insects, such as termites, ants, beetles and flies.	Recorded at the subject site.	**Affected species.**

Common Name / Scientific Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Presence and Habitat Utilisation	Affected Species
Rufous Fantail (*Rhipidura rufifrons*)	-	M	Undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests, paperbarks, sub-inland and coastal scrubs, mangroves, watercourses.	Recorded at subject site.	**Affected species.**
Swift Parrot (*Lathamus discolor*)	E	E	A wide variety of habitats, depending on where there are flowering blossom. Drier sclerophyll forests and woodland, timbered areas, plantations, parks, gardens and city streets.	Not recorded at the subject site or locality. Potential habitat at the site. Migratory nature means that could potentially use subject site intermittently.	**Affected species.**
Ground Parrot (*Pezoporus wallicus*)	V	-	Low heathland and sedgeland.	Recorded at the subject site.	**Affected species.**
Turquoise Parrot (*Neophema pulchella*)	V	-	Open grassy woodland, with dead trees, near permanent water and forested hills, coastal heaths, pastures with exotic grasses.	Not recorded on the subject site. Recorded in the locality.	**Affected species.**
Regent Honeyeater (*Xanthomyza phrygia*)	E	E, M	Dry open forests, woodlands, especially red ironbark, yellow box, yellow gum.	Not recorded at the subject site. Potential habitat at the subject site.	**Affected species**
Square-tailed Kite (*Lophoictinia isura*)	V	-	Coastal forest and wooded lands of tropical and temperate Australia.	Recorded at the subject site.	**Affected species.**
Satin Flycatcher (*Myiagra cyanoleuca*)	-	M	Heavily vegetated gullies in forests, taller woodlands and during migration, coastal forests, woodlands, mangroves and trees in open country.	Not recorded at the subject site. Recorded in the locality. Potential habitat at the subject site.	**Affected species.**
Powerful Owl (*Ninox strenua*)	V	-	Open eucalypt, *Casuarina* or *Callitris* pine forests and open woodlands. Often roost in denser vegetation such as rainforest or exotic pine plantations.	Recorded at the subject site.	**Affected species.**

Common Name / Scientific Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Presence and Habitat Utilisation	Affected Species
Masked Owl (*Tyto novaehollandiae*)	V	-	A diverse range of wooded habitats that provide large hollow-bearing trees including forests, remnants within agricultural land or almost treeless inland plains.	Recorded at the subject site.	**Affected species.**
Olive Whistler (*Pachycephala olivacea*)	V	-	*Leptospermum* woodland and shrubland and probably adjacent forests.	Not recorded at the subject site despite extensive surveys. Unlikely to occur.	Unlikely to be affected.
Osprey (*Pandion haliaetus*)	V	-	Coasts, estuaries, bays, inlets, islands and surrounding waters, lagoons, rock cliffs and stacks.	Not recorded at the subject site despite extensive surveys. Unlikely to occur.	Unlikely to be affected.
Sooty Owl (*Tyto tenebricosa*)	V	-	Wet sclerophyll forest and rainforest that grows on fertile soils, where there are tall emergent trees. Frequently in tall old-growth forest, with a dense understorey.	Not recorded at the subject site. Unlikely to occur at the subject site.	Unlikely to be affected.
Mammals					
Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)	V	-	Heathland and in particular, dense wet heath and swampy areas.	Not recorded at the subject site. Potential habitat at site.	**Affected species.**
White-footed Dunnart (*Sminthopsis leucopus*)	V	-	Open understorey and low density vegetation in south-eastern Australia. Feeds on a wide variety of terrestrial invertebrates commonly found in ridges and in gullies in both logged and unlogged forest.	Not recorded at the subject site. Potential habitat at the subject site.	**Affected species.**
Eastern Pygmy-possum (*Cercartetus nanus*)	V	-	Coastal areas and at high elevations in the south. Feed mostly on pollen and nectar from banksias, eucalypts and understorey plants.	Recorded at the subject site.	**Affected species.**
Long-nosed Potoroo	V	V	Areas where rainfall is greater than 760 mm in	Not recorded at the subject site. Potential habitat	**Affected species.**

Common Name / Scientific Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Presence and Habitat Utilisation	Affected Species
(*Potorous tridactylus tridactylus*)			coastal heath and dry and wet sclerophyll forests. requires habitat that has thick ground cover and prefers areas where the soil is light and sandy	at the subject site.	
Southern Brown Bandicoot (*Isoodon obesulus obesulus*)	E	E	Heath, heathy forest, shrubland and woodland which is supported by well-drained soils.	Not recorded at the subject site. Potential habitat recorded at the subject site.	**Affected species.**
Spotted-tail Quoll (*Dasyurus maculatus maculatus*)	V	V	Variety of habitats including sclerophyll forest and woodlands, coastal heathland and rainforests.	Not recorded at the subject site or locality. Not likely to occur given known and estimated distribution in the locality (NPWS 2000), lack of records in the locality and habitats on the site.	Unlikely to be affected.
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps.	Recorded at the subject site. Potential foraging habitat at the subject site. No camps on the subject site.	**Affected species.**
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	Commonly found in dry sclerophyll forests and woodlands, but they also occur in sub-alpine woodland, the edge of rainforest and wet sclerophyll forest.	Recorded at the subject site.	**Affected species.**
Eastern Falsistrelle (*Falsistrellus tasmaniensis*)	V	-	Wet and dry sclerophyll forests, particularly in highland areas with high rainfall and coastal mallee.	Recorded at the subject site.	**Affected species.**
Large Bentwing-bat (*Miniopterus schreibersii*)	V	-	Caves for breeding. A range of eucalypt forest and woodland for foraging.	Recorded at the subject site.	**Affected species.**
Eastern Freetail-bat (*Mormopterus norfolkensis*)	V	-	Dry eucalypt forest and woodland, wet sclerophyll forest and rainforest.	Recorded at the subject site.	**Affected species.**

Common Name / Scientific Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Presence and Habitat Utilisation	Affected Species
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	V	-	Occurs in most wooded habitats including open woodland and mallee.	Recorded at the subject site.	**Affected species.**
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	V	-	A variety of habitats from woodland through moist and dry eucalypt forest to rainforest. Does not occur at altitudes above 500 m.	Recorded at the subject site.	**Affected species.**
Large-footed Myotis (*Myotis adversus*)	V	-	Caves for breeding (also tree hollows, vegetation & man-made structures eg. tunnels & mines); a range of forests with permanent water bodies for foraging.	Recorded at the subject site.	**Affected species.**
Yellow-bellied Glider (*Petaurus australis*)	V	-	Tall mature sclerophyll forests in regions of high rainfall. Feeds on eucalypts.	Recorded at the subject site.	**Affected species.**
Squirrel Glider (*Petaurus norfolcensis*)	V	-	Dry sclerophyll forest and woodland. Requires abundant hollow-bearing trees and a mix of eucalypts, acacias and banksias.	Recorded at the subject site.	**Affected species.**
Koala (*Phascolarctos cinereus*)	V	-	A range of eucalypt forest and woodland, including coastal forest.	Not recorded at the subject site despite targeted surveys. Unlikely to occur.	Unlikely to be affected.
Frogs					
Green and Golden Bell Frog (*Litoria aurea*)	E	V	Marshes, dams and stream sides particularly those containing *Typha* species. Optimum habitat includes waterbodies, which are unshaded, have a grassy area nearby and diurnal sheltering sites.	Not recorded at the subject site. No potential habitat. Unlikely to occur.	Unlikely to be affected.

Common Name / Scientific Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Presence and Habitat Utilisation	Affected Species
Giant Burrowing Frog (*Heleioporus australiacus*)	V	V	Sandstone ridge top habitats and broader upland valleys. In these habitats the frog is associated with small headwater creek lines and along slow flowing to intermittent creeklines. Typical vegetation is woodland, open woodland and heath.	Recorded at the subject site. Potential habitat at the site.	**Affected species.**
Invertebrates					
Giant Dragonfly (*Petalura gigantea*)	E	-		Recorded at the subject site. Potential foraging and breeding habitat at the site.	**Affected species.**

1. TSC Act = NSW *Threatened Species Conservation Act 1995*
2. EPBC Act = Commonwealth *Environment Protection & Biodiversity Conservation Act 1999*
3. V = vulnerable, E = endangered, M = migratory, PE = presumed extinct, Ma = marine

Affected species recorded at the subject site during flora and fauna surveys for this SIS include:

- Leafless Tongue Orchid (*Cryptostylis hunteriana*);
- Jervis Bay Leek Orchid (*Prasophyllum affine*);
- Giant Dragonfly (*Petalura gigantea*);
- Glossy Black-cockatoo (*Calyptorhynchus lathami*);
- Eastern Bristlebird (*Dasyornis brachypterus*);
- Ground Parrot (*Pezoporus wallicus*)
- White-throated Needletail (*Hirundapus caudacutus*);
- Square-tailed Kite (*Lophoictinia isura*);
- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*)
- Eastern Pygmy-possum (*Cercartetus nanus*);
- Large Bent-wing Bat (*Miniopterus schreibersii*);
- Eastern Freetail Bat (*Mormopterus norfolkensis*); and
- Yellow-bellied Glider (*Petaurus australis*).

Affected species that were recorded during previous surveys (Gunninah 2002a) at the subject site include:

- Eastern Bristlebird (*Dasyornis brachypterus*);
- Rufous Fantail (*Rhipidura rufifrons*);
- Masked Owl (*Tyto novaehollandiae*);
- Powerful Owl (*Ninox strenua*);
- Ground Parrot (*Pezoporus wallicus*)
- Glossy Black-cockatoo (*Calyptorhynchus lathami*);
- Square-tailed Kite (*Lophoictinia isura*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);

- Eastern Falsistrelle (Falsistrellus tasmaniensis)
- Large-footed Myotis (Myotis adversus)
- Yellow-bellied Sheathtail Bat (Saccolaimus flaviventris);
- Large-eared Pied bat (Chalinolobus dwyeri)
- Greater Broad-nosed Bat (Scoteanax rueppellii);
- Large Bent-wing Bat (Miniopterus schreibersii);
- Squirrel Glider (Petaurus norfolcensis);
- Yellow-bellied Glider (Petaurus australis);
- Grey-headed Flying-fox (Pteropus poliocephalus); and
- Giant Burrowing Frog (Heleioporus australiacus).

The fine-scale spatial and temporal variation in species distribution may have contributed to differences in species detected between surveys. Additionally, other variables, which may have been responsible include factors such as slight differences in survey techniques, surveys being undertaken in different seasons, differing weather conditions and time elapsed since fire (which has an important effect on species composition and habitats). Survey results and discussion of habitat utilisation of all affected species are provided in *Sections 4.11* and *4.12*.

4.10 AFFECTED FLORA SPECIES

*4.10.1 Jervis Bay Leek Orchid (***Prasophyllum affine***)*

Background

The Jervis Bay Leek Orchid (*Prasophyllum affine*) is a ground orchid, growing to a height of 50 cm, with a single, erect leaf (to 50 cm long). *P. affine* grows in coastal heathland and sedgeland communities on poorly drained, grey-brown, clay soils. The flowering period is from late October until late November (NPWS 1999a). However, many *Prasophyllum* species do not flower when rainfall has not occurred prior to the flowering period (NPWS 2003c). Flower colour is variable both within, and between sites. Studies on the pollinators of *Prasophyllum* species indicate that beetles pollinate larger species, while for smaller species, such as *P. affine*, wasps and native bees are important. Without suitable pollinators, most *Prasophyllum* species will not set seed (NPWS 2003c). A draft recovery plan for this species has been prepared for this restricted habitat-specific species (NPWS 2003c).

Database Search

Database records obtained from NPWS, the Royal Botanic Gardens and the Australian Museum revealed that *P. affine* has been recorded on the subject site and within the locality, south of the subject site near Wirriliko Road (*Figure 4.3* and *Figure 4.4*). This species is currently restricted to a total of three populations all of which are located around the Jervis Bay area.

Previous Studies

Prasophyllum affine is known from three locations all in the Jervis Bay area and these include: Kinghorne Point, Wowly Gully near the town of Calalla Bay and the subject site near the township of Vincentia (NPWS 2003c). The occurrence of the *P. affine* population within the subject site is therefore significant and important to the long-term viability of the species (NPWS 2003c). Monitoring plots were established within Lot 801 in November 2001 by NPWS to provide information on the population dynamics of this species.

Lot 801 contains the major concentration of *P. affine* within the Vincentia area, although there are plants between Eastern creek and Moona Creek Road and also just to the north-west of Moona Creek Road. Surveys undertaken in 2000, resulted in 33 individuals of *P. affine* being recorded on the subject site. In 2001, surveys recorded 161 individuals within Lot 801 (*Figure 4.5*). Surveys undertaken in 2002 resulted in no records of *P. affine*, which may be due to unfavourable drought conditions (NPWS 2003c).

Extensive surveys have been undertaken for this species in 2000 and 2001, over a large proportion of identified habitat in the Jervis Bay area. These surveys resulted in few additional sites being found suggesting that the distribution of this species is not expected to be substantially greater than that which is currently known even with further surveys (NPWS 2003c).

ERM Survey Results

Detailed surveys undertaken by ERM during the present study recorded a total of 301 plants of *P. affine* within Lot 801 and Lot 802 (*Figure 4.6*). In the area along the access road to the Bay & Basin Leisure Centre, 177 plants were recorded, whilst in the area surrounding the Eastern creek another 121 plants were found.

Searches of Lot 802 resulted in three additional individuals being located immediately north-west of Moona Creek Road in the Scribbly Gum Open-woodland (*Figure 4.6*).

Additional searches undertaken in similar habitat in the adjacent JBNP (refer *Figure 3.2*) did not locate any further plants of *P. affine.*

Satellite imagery was configured to highlight areas in which *P. affine* are known to occur on the subject site, through referencing to vegetation characteristics along the access road to the Bay & Basin Leisure Centre, and cross-referencing to additional areas of occurrence surrounding the Western creek. This configuration was then applied to the locality. Although the outcomes of this methodology can only be considered indicative without extensive ground-truthing, it does indicate the lack of potential habitat for this orchid in the local area. The vegetation on the corner of Jervis Bay Road and Hyams Beach Road is known to have been burnt during the fires of December 2003 and would not provide suitable habitat. Other areas of interest are the Baptist Church site directly to the south-east of the subject site. This area is known to provide habitat for *Cryptostylis hunteriana*.

Additional Surveys

Additional surveys for and monitoring of known populations of *P. affine* undertaken by GHD in October 2004 to January 2005 recorded the species in all areas previously identified and discussed above. However, numbers of individuals recorded during the additional surveys were lower in all areas (GHD 2005a). Surveys are ongoing at the subject site.

Other Known Populations

P. affine occurs only in NSW and is confined to the vicinity of Jervis Bay. Populations of *P. affine* occur in three known areas: Kinghorne Point, Wowly Gully near Calalla Bay and near the township of Vincentia. The Kinghorne Point site represents the largest known population and is mainly located on freehold land with a small section of road easement owned by Shoalhaven City Council. *P. affine* sites west of Currarong Road near Kinghorne Point and at Wowly Gully, located near the township of Calalla Bay are situated within the JBNP. The populations at Vincentia are situated east of the subject site at the Bay and Basin Leisure Centre owned by Shoalhaven City Council and south of the subject site at Wirriliko Road on freehold land.

4.10.2 Thick Lip Spider Orchid (Arachnorchi tessellata)

Background

Arachnorchi tessellata (formerly *Caladenia tessellata*) is a spider orchid that favours low, open forest with a heathy or grassy understorey. It occasionally grows in dense shrubbery in coastal areas, and is then evident only after fire (Bishop 2000). In 2002, the total population size was estimated to be less than 50 individuals and the species is not known to occur within any conservation reserves. Two populations have become extinct since the 1980s (NSW Scientific Committee 2002). Due to the small size of the populations, *A. tessellata* is susceptible to localised extinctions from stochastic events and is further threatened by pedestrian traffic and habitat degradation (NSW Scientific Committee 2002).

Database Search

Database records from the NPWS 1:100 000 map sheet, the Royal Botanic Gardens and the Australian Museum indicate that *A. tessellata* occurs in the Shoalhaven at Moona Moona Creek, Huskisson and on Pine Forest Road, Tomerong (Stephenson 2001) (*Figure 4.3* and *Figure 4.4*).

Previous Studies

Gunninah (2000, 2001, 2002) conducted targeted searches for *A. tessellata* within Lot 801 and Lot 802, and various other locations throughout the Jervis Bay Area. No further plants were recorded during the searches.

ERM Survey Results

ERM conducted targeted searches for threatened orchids across the subject site fortnightly between 21 October 2003 and 16 January 2004. These searches failed to locate the species within the subject site.

Other Known Populations

Known populations of this species are in decline as at least two populations have become extinct since the 1980s and at least 14 populations in the Sydney and South Coast area have failed to be recorded since around 1950 (NSW Scientific Committee 2002). No populations are known from national parks or reserves.

A population of this species occurs near Braidwood on the Southern Tablelands, and three extant populations occur in the Wyong area on the Central Coast. The closest known populations of *A. tessellata* to the subject site are around 1.5 km to the north at Moona Moona Creek, Huskisson and approximately 5 km to the west on Pine Forest Road, Tomerong (Stephenson 2001).

4.10.3 Leafless Tongue Orchid (Cryptostylis hunteriana)

Background

Cryptostylis hunteriana is a leafless, saprophytic tongue orchid, which is reliant on a symbiotic relationship with the microrrhizal fungus found in decaying plant matter (Bell 2001). Flowering occurs during summer, producing green, red and black flowers carried on an axillary raceme. Foliage is absent, and the leaves are reduced to scales. *C. hunteriana* often grows in swampy heaths on sandy soils, also occurring in a range of habitats from scrubby swamp fringes to bare hillsides in tall eucalypt forest (Bell 2001; Harden 1990; Jones 1993; Bishop 2000). The habitats of *C. hunteriana* are sparsely distributed and poorly represented in conservation reserves (Bell 2001).

Database Searches

The NPWS Wildlife Database shows 88 records of *C. hunteriana* within the Shoalhaven LGA (NPWS 2004). Database records from the NPWS 1:100,000 map sheet, the Royal Botanic Gardens and the Australian Museum indicated that *C. hunteriana* has been recorded within a 10 km radius of the subject site at two sites to the south (*Figure 4.3* and *Figure 4.4*).

Previous Studies

Gunninah (2002a) conducted targeted surveys for *C. hunteriana* within Lot 801 and Lot 802 and identified 50 individuals, in two groups (43 and 7 individuals) within Lot 801 (*Figure 4.5*).

ERM Results

ERM conducted targeted surveys for *C. hunteriana* fortnightly between 21 October 2003 and 16 January 2004. A total of eight plants were detected during the December 2003 and January 2004 surveys within Lot 801 and an additional three plants in the *Eucalyptus Sclerophylla* Open-woodland community adjacent Moona Creek Road (*Figure 4.6*).

Additional Surveys

Surveys undertaken by GHD in October 2004 to December 2005 (GHD 2005a) detected *C. hunteriana* in one additional area to those described above. This area is located on the northern side of Eastern creek, where 20 individuals were recorded. Surveys are ongoing at the subject site.

Other Known Populations

A further population of *C. hunteriana* is known to occur and is being monitored on the Baptist Church site immediately south-east of the subject site (Alan Stephenson, *pers. comm.*). Another site is known approximately 2 km south of the subject site.

4.10.4 Tangled Bedstraw (Galium australe)

Background

Tangled Bedstraw is a straggling or intertwining perennial, producing small, white flowers to 2mm in length, usually during Summer. This rare species was presumed extinct until it was rediscovered in 2002 at Lake Windemere, Booderee National Park approximately 7 km to the south-east of the subject site (NPWS 2003, *pers. comm.*, 17 December). *G. australe* is thought to favour slopes on friable, loamy soils with abundant ferns in the understorey, associated with an overstorey of *Eucalyptus pilularis* (Blackbutt)/*E. botryoides* (Southern Mahogany) and *Syncarpia glomulifera* (Turpentine) .

Database Searches

Database records obtained from the NPWS, Royal Botanical Gardens and the Australian Museum showed no records for this species in the locality.

Previous Studies

Previous flora studies undertaken at the subject site failed to record this species.

ERM Survey Results

This species was not recorded at the subject site during the present survey. Knowledge of the vegetation communities along with slope and soil types identified those areas adjacent to the Western and Central creek lines as having the most suitable habitat for this species on the subject site. Sites mid-slope and near the ridgelines did not have loamy friable soils nor abundant ferns in the understorey.

Other Known Populations

Tangled Bedstraw was presumed extinct until a population was recently discovered near Lake Windemere in the Commonwealth Territory at Jervis Bay growing with *Eucalyptus pilularis / E. botryoides* and *Syncarpia glomulifera*.

Although this species is likely to be extremely rare with a limited distribution, it is possible that other populations of this species may occur in suitable habitat, as it tends to be cryptic and hence difficult to detect.

4.10.5 Biconvex Melaleuca (Melaleuca biconvexa)

Background

Melaleuca biconvexa is a shrub to small tree, with papery bark and a distinctive leaf, making it relatively easy to identify. It grows in damp places, often near streams, in coastal districts north from Jervis Bay to Port Macquarie (Harden 2002). Multiple stems may arise from a single rootstock, so that population size may be indeterminable from visual inspection. *M. biconvexa* populations are disjunct, with the main concentration being in the Gosford/Wyong area. *M. biconvexa* populations are threatened by land clearing and alteration to water tables (NPWS 2003e).

Database Searches

Database records obtained from the NPWS 1:100 000 map sheet, the Royal Botanic Gardens and the Australian Museum revealed numerous records of *M. biconvexa* within 10 km of the subject site, especially in the woodland communities to the west, near Tomerong and north towards Woollamia Nature Reserve (*Figure 4.3* and *Figure 4.4*).

Previous Studies

Mills (1993) has described the distribution of *M. biconvexa* in the Jervis Bay area. Gaia Research (2002) conducted a flora and fauna assessment of Lot 1742 Naval College Road and did not identify the species within the site. Gunninah (2000a, b &c; 2001; 2002a & b) conducted flora and fauna surveys within and around the subject site and did not identify the species within the site.

ERM Survey Results

ERM conducted targeted surveys for *M. biconvexa* along the watercourses of the subject site and into JBNP (refer *Figure 3.1*). No plants were identified within the subject site.

Other Known Populations

Disjunct populations of this species occurs from Jervis Bay to Port Macquarie with the main concentration being around the Gosford / Wyong area (NPWS 2003e). It is likely that the Jervis Bay area contains the most southerly populations of this species. There are 264 records of *M. biconvexa* within Shoalhaven LGA (NPWS 2004).

4.10.6 Underground Orchid (Rhizanthella slateri)

Background

The Underground Orchid is saprophytic and almost entirely subterranean, with only the flowers, fruit and involucral bracts emerging above the soil surface (Harden 1993). The flowers are purple in colour, emerging through the leaf litter between late winter and early spring. This species may favour well-drained, shallow to deep loams in eucalypt forests. However, no specific vegetation type or preferred habitat has yet been prescribed to this species. As *R. slateri* occurs at a few isolated sites in low numbers, disturbance to these areas poses a threat to the viability of the populations (Wildscreen 2004).

Database Searches

Database records obtained from the NPWS, Royal Botanical Gardens and the Australian Museum failed to reveal any records for this species in the locality.

Previous Studies

The Underground Orchid has not been recorded at the subject site during previous studies.

ERM Survey Results

The Underground Orchid was not recorded at the subject site during the present survey.

Other Known Populations

The Underground Orchid has been recorded in the Blue Mountains, Bulahdelah, the Watagan Mountains, Wiseman's Ferry area, Agnes Bank and near Nowra. Two occurrences of this orchid have been recorded 3.5 km and 6 km from Jervis Bay (Alan Stephenson, *pers. comm.*)

4.11 AFFECTED FAUNA SPECIES

4.11.1 *Southern Brown Bandicoot* (Isoodon obesulus obesulus)

Background

The Southern Brown Bandicoot inhabits scrubby vegetation, including heath, shrubland and heathy forest and woodland. It is often associated with well-drained soils and dry heathland communities. The Southern Brown Bandicoot is a nocturnal species that feeds predominantly on invertebrates and earthworms. Individuals are usually solitary, with home ranges of up to 7 ha. The Southern Brown Bandicoot is generally found to be more abundant in areas following post-fire regeneration due to increases in vegetation diversity and insect availability. Threats to the species include predation by feral animals, habitat clearing and degradation, inbreeding depression and inappropriate fire regimes (NPWS 2001b).

Database Searches

Database records obtained from the NPWS Wildlife Atlas revealed that the Southern Brown Bandicoot has been recorded in the locality approximately 8 km south of the subject site in Booderee National Park near the village of Jervis Bay (*Figure 4.3*).

Previous Studies

Previous studies have failed to record this species at the subject site.

ERM Survey Results

The Southern Brown Bandicoot was not recorded at the subject site during the present survey. However, surveys revealed that potential habitat for this species occurs within the heathland and woodland areas of Lot 801 and Lot 802.

Other Known Populations

The Southern Brown Bandicoot has been recorded in a number of conservation reserves including, Blue Mountains, Bournda, Budderoo, Garrigal, Ku-ring-gai Chase, Morton, Myall Lakes, Nadgee and South East Forests National Park. Additionally there have been seven recorded sightings of this species in the Shoalhaven LGA (NPWS 2004) along the coastal plain.

4.11.2 Long-nosed Potoroo (Potorous tridactylus)

Background

The Long-nosed Potoroo is generally restricted to areas with high annual rainfall, inhabiting coastal heath and dry and wet sclerophyll forests. Its major habitat requirement is relatively thick ground cover where the soil is light and sandy. It is known to feed on roots, tubers, fungi, and other invertebrates in the soil. Populations are disjunct, occurring from southeast Queensland to Tasmania. Breeding season is biannual and occurs in late winter / early spring and in late summer, with one young being reared (Johnston 1995).

Database Searches

Database records obtained from the NPWS Wildlife Atlas revealed a single record for this species in the locality, approximately 9 km west of the subject site near the township of Tomerong (*Figure 4.3*).

Previous Studies

Previous studies have failed to record this species at the subject site.

ERM Survey Results

The Long-nosed Potoroo was not recorded on subject site during the present survey. Potential habitat for this species was recorded at the subject site within the heathland and dry grassy woodland areas, particularly areas with relatively thick ground cover and sandy soil.

Other Known Populations

The Long-nosed Potoroo has been recorded in the locality approximately 9 km to the west of the subject site near Bewong. This species has also been recorded in a number of conservation reserves in the region, including Barren Grounds Nature Reserve, Budderoo National Park, Deua National Park and Meroo National Park.

4.11.3 White-footed Dunnart (**Sminthopsis leucopus**)

Background

The White-footed Dunnart inhabits open understorey and low density vegetation in lowland heathy woodland and forest and coastal scrub. This small, nocturnal species is carnivorous, feeding on a variety of invertebrates and occasionally small lizards (NPWS 2000). The home range of *S. leucopus* is thought to be around 80–100 m in length but they have been recorded moving up to 1 km in a day (NPWS 2000). This species has low population densities, patchy distribution, and has shown an inability to persist in regrowth forest. A long term study of this species has shown a preference for forest with sparse ground cover, and a desertion from known habitats within three years of logging or burning has also been observed (Lunney 1995).

Database Searches

Database records obtained from the NPWS Wildlife Atlas revealed 10 records for this species in the locality. The closest records were 1 km to the south-east of the subject site in heathland and around 1.5 km to the north in JBNP (*Figure 4.3*).

Previous Studies

Previous studies have failed to record this species at the subject site.

ERM Survey Results

The White-footed Dunnart was not recorded on the subject site. However, potential habitat for this species was recorded at the subject site in the woodland areas.

Other Known Populations

The White-footed Dunnart has been recorded in the JBNP to the north and south-east of the site. The White-footed Dunnart has also been recorded in a number of conservation reserves in the region, including Booderee National Park to the south.

4.11.4 Eastern Chestnut Mouse (Pseudomys gracilicaudatus)

Background

The Eastern Chestnut Mouse is a small rodent coloured chestnut above and grey below. It can be considered a granivore-omnivore, feeding at night on a variety of seeds and other plant materials. In NSW heathland, in particular dense, wet heath and swampy areas, provide habitat for the Eastern Chestnut Mouse (Fox 1995). Optimal habitat for this species is characterised as post-fire regenerating heathland. This species quickly recolonises a heathland after a fire. However, as the heath vegetation matures this species is competitively displaced by the Swamp Rat influencing the potential for this species to be present at the study area (Fox 1995). Most individuals show strong attachment to a site and have home ranges of less than 0.5 ha.

Database Searches

Database records obtained from the NPWS Wildlife Atlas resulted in no records for this species in the locality.

Previous Studies

Previous studies have failed to record this species at the subject site.

ERM Survey Results

The Eastern Chestnut Mouse was not recorded on the subject site during the present survey. However, potential habitat for this species was recorded on the subject site specifically in the heathland between Moona Creek Road and the Eastern creek. Optimal habitat for this species is characterised as post-fire regenerating heathland. This species quickly recolonises a heathland after a fire. However, as the heath vegetation matures this species is competitively displaced by the Swamp Rat influencing the potential for this species to be present at the study area (Fox 1995).

Other Known Populations

The Eastern Chestnut Mouse is patchily distributed throughout coastal eastern Australia from Townsville, Queensland to Brisbane Waters National Park, NSW. An outlying population of this species is also known to occur in Booderee National Park approximately 10 km to the south-east of the subject site (Menkhorst and Knight 2001). This species has also been recorded in a number of conservation reserves including, Brisbane Waters and Myall Lakes National Parks.

4.11.5 Grey-headed Flying-fox (Pteropus poliocephalus)

Background

The Grey-headed Flying-fox is a canopy-feeding frugivore, blossom-eater and nectarivore that feeds in open forests, woodlands, Melaleuca swamps and Banksia woodlands (NSW Scientific Committee 2004).

Its distribution ranges from central eastern Queensland south to Victoria and in NSW this distribution mainly occurs in coastal areas and along river valleys (NPWS 2003e). Grey-headed Flying-fox show a regular pattern of seasonal movement with much of the population moving to northern NSW and Queensland during May and June where they exploit the winter flowering trees such as Swamp Mahogany, Forest Red Gum and Paperbark (NSW Scientific Committee 2004).

This species roosts in large aggregations known as 'camps' of many thousands of individuals. Camp fidelity is high and some camps are over 100 years old (NPWS 2001c).

The distribution of this species was historically wider and population size was vastly larger. The loss of numbers is thought to be a consequence of habitat loss and fragmentation through agriculture and urbanisation (NPWS 2003e).

Database Searches

Database records obtained from the NPWS 1:100 000 map sheet revealed that the Grey-headed Flying-fox has been identified several times within a 10 km radius of the subject site (NPWS 2003a) (*Figure 4.3*).

Previous Studies

Gunninah recorded this species in the vicinity of the subject site in surveys in 2001 and on the subject site in surveys in November/December 2000 (Gunninah 2002a). The exact co-ordinates of the sighting are not known so the record is not marked on Figure 4.5.

ERM Survey Results

No Grey-headed Flying-fox (*Pteropus poliocephalus*) camps were recorded across the subject site. However, this species would be expected to forage within the study area. An unidentified Flying-fox (potentially a Grey-headed Flying-fox) was noted flying across Lot 802.

Other Known Populations

Camps of this species are mostly located in rainforest gullies. The nearest camp may be located in the rainforest gullies below Wandandian approximately 13 km to the south-west (Kevin Mills & Associates & Lesryk Environmental Consultants 2003).

4.11.6 Fishing Bat (Myotis adversus)

Background

The Fishing Bat is primarily a coastal species, ranging from the Kimberley in the Northern Territory to Victoria and South Australia. Individuals are approximately 5 cm in length with variable fur colour. The species usually selects roost sites close to water including tree hollows, vegetation, bridges, mines, tunnels and stormwater drains. The Fishing Bat mostly forages over water, feeding on a variety of insects which it catches by raking its feet across the water surface (Churchill 1998). The subject site and surrounding JBNP contain waterbodies and hollow-bearing trees, providing both foraging and roosting habitat for this species.

The main threat to the Fishing Bat is disturbance to colonies when hibernating, which can cause populations to desert roosts sites, resulting in heavy mortality (Environment Australia 1999).

Database Searches

Database records obtained from the NPWS 1:100 000 map sheet revealed *M. adversus* has been identified several times within a 10 km radius of the subject site, including two records from nearby JBNP (NPWS 2003a) (*Figure 4.3*).

Previous Studies

Gunninah (2002) detected *M. adversus* to the south of Moona Creek Road in the *Eucalyptus sclerophylla* Open-woodland (*Figure 4.5*).

ERM Survey Results

ERM did not detect the species during surveys. However, less than ideal weather affected the operation of Anabats during this time and it was not possible to survey for bats each night. Given the number of records for *M. adversus* within the locality and the detection of the species in December 2000 by Gunninah (2002), it is probable that this species would have been detected within the subject area under more favourable conditions.

Additional Surveys

Additional surveys for microchiropteran bats undertaken by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd in December 2004 tentatively identified *M adversus* from echolocation calls (ERM 2005).

Other Known Populations

The abundance of permanent free-standing water in the locality along with numerous recordings in the area suggests that this species may have roost sites within the study area. Although this species is commonly a cave dweller it has also been recorded using tree hollows, mines, stormwater drains, bridges and dense vegetation (Churchill 1998). Suitable roosting habitat occurs on the subject site for the Large-footed Myotis.

4.11.7 Eastern Falsistrelle (Falsistrellus tasmaniensis)

Background

The Eastern Falsistrelle is distributed from south-eastern Queensland, NSW, Victoria and Tasmania. This species inhabits sclerophyll forests, preferring wet habitats where trees are more than 20 m in height. Diet consists of moths, beetles and other insects, which it collects within or just below the tree canopy. The Eastern Falsistrelle roosts mainly in tree hollows, occasionally utilising abandoned buildings (Churchill 1998). The loss of roosting trees has been identified as a threat to this species. The subject site and surrounding JBNP provide potential habitat for this species.

Database Searches

In the Shoalhaven region, the Eastern Falsistrelle is generally found in areas that are less than 600 m above sea level. Database records obtained from the NPWS 1:100 000 map sheet revealed the Eastern Falsistrelle has been identified within a 10 km radius of the subject site, including one record from nearby JBNP (NPWS 2003a).

Previous Studies

Gunninah (2002) tentatively identified the Eastern Falsistrelle in several locations across Lot 802 using Anabat detectors in December 2000 (*Figure 4.5*).

ERM Survey Results

ERM did not detect the species within the subject site during. However given that the subject site provides potential foraging and roosting habitat it is possible that this species would utilise the subject site, and may have been detected had more extensive survey been possible. Additional studies are currently being undertaken and will be attached as an addendum to this SIS.

Additional Surveys

Additional surveys for microchiropteran bats undertaken by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd in December 2004 tentatively identified the Eastern Falsistrelle from echolocation calls (ERM 2005).

Other Known Populations

Recordings of this species on the subject site and surrounding locality suggests that this species would have roost sites within the study area and potentially on the subject site as potential habitat occurs across Lot 802.

4.11.8 Eastern Freetail Bat (Mormopterus norfolkensis)

Background

The Eastern Freetail Bat is distributed along the east coast of NSW from south of Sydney into south-eastern Queensland near Brisbane. The Eastern Freetail Bat has been found roosting in the rooves of huts but most records are from tree hollows. Habitat for this species is dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Threatening processes for this species have not been confirmed, but it is likely that clearing for development and logging could pose serious threats (Environment Australia 1999).

Database Searches

Database records from the NPWS 1:1000 000 map sheet revealed the species has been recorded within a 10 km radius of the subject site. There are no records of this species from JBNP (NPWS 2003a) (*Figure 4.3*).

Previous Studies

Gunninah (2002) identified the Eastern Freetail Bat from a number of Anabat recordings at several locations within Lot 802 during December 2000, January 2001 and April 2001 surveys. These records identified this species using both the gully and ridgetop areas (*Figure 4.5*).

ERM Survey Results

ERM tentatively identified the species within the ridgetop between the Western creek and the Central creek (*Figure 4.7*).

Additional Surveys

Additional surveys for microchiropteran bats undertaken by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd in December 2004 resulted in the Eastern Freetail Bat being confidently identified from echolocation calls at 10 of 12 sites surveyed (ERM 2005). This indicates widespread use of the subject site by this species.

Other Known Populations

Recordings of this species on the subject site and surrounding locality suggests that this species would have roost sites within the study area and potentially on the subject site as potential habitat occurs across Lot 802.

4.11.9 Yellow-Bellied Sheathtail Bat (Saccolaimus flaviventris)

Background

The Yellow-bellied Sheathtail Bat is a wide-ranging species occurring through tropical Australia into South Australia. It is a large species with shiny black fur on the back and contrasting white or yellow fur on the belly. The Yellow-bellied Sheathtail Bat occurs in most habitats, from wet and dry sclerophyll forest, open woodland, *Acacia* shrubland, mallee, grasslands and desert. The species roosts in tree hollows and forages above the canopy (Churchill 1998). *S. flaviventris* is found in a variety of habitats, which would suggest the subject site and surrounding JBNP would provide both foraging and roosting habitat. Threats to the Yellow-bellied Sheathtail Bat include clearing of trees with hollows, grazing which reduces the regeneration of roost trees and predation by feral cats at roost sites (Environment Australia 1999).

Database Searches

Database records obtained from the NPWS 1:100 000 map sheet, and the Australian Museum revealed the species has not been identified within a 10 km radius of the subject site. There has been one record of the species within the Shoalhaven LGA, approximately 30 km north of the subject site (NPWS 2003a).

Previous Studies

Gunninah (2002) tentatively (70% reliability) identified the Yellow-bellied Sheathtail Bat in December 2000 within Lot 802 using an Anabat detector (*Figure 4.3*).

ERM Survey Results

ERM did not detect the species during surveys.

Additional Surveys

Additional surveys for microchiropteran bats undertaken by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd in December 2004 did not detect this species at the subject site (ERM 2005).

Other Known Populations

Recordings of this species on the subject site and surrounding locality suggests that this species would have roost sites within the area and potentially on the subject site as potential habitat occurs across Lot 802.

*4.11.10 Large Bent-wing Bat (***Miniopterus schreibersii*)

Background

In eastern Australia the Large Bent-wing Bat is distributed from Cape York Peninsula south to Victoria and South Australia (Churchill 1998). The Eastern Bent-wing Bat has dark reddish-brown to dark brown fur and is essentially a cave bat, but also utilises man-made habitats such as road culverts. The Large Bent-wing Bat is known from a variety of habitats along the east coast including rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grasslands (Churchill 1998). In forested areas, the Large Bent-wing Bat flies above the canopy to hunt, while in open grassland areas, flight may be within 6m of the ground. Moths form the major component of their diet (Churchill 1998).

Database Searches

Database records from the NPWS 1:100 000 map sheet and the Australian Museum reveal the species has been recorded within 10 km of the subject site. This includes two records from nearby JBNP (NPWS 2003a) (*Figure 4.3*).

Previous Studies

Gunninah (2002) identified the Large Bent-wing Bat from several Anabat recordings across Lot 802 during November 2000, December 2000 and April 2001 surveys (*Figure 4.5*).

ERM Survey Results

This species was positively identified during these surveys (Hoye 2004) in three locations within woodland communities within Lot 802 (*Figure 4.7*).

Additional Surveys

Additional surveys for microchiropteran bats undertaken by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd in December 2004 resulted in the Large Bent-wing Bat being confidently identified at the subject site from echolocation calls (ERM 2005).

Other Known Populations

Although the subject site provides abundant foraging habitat it does not provide roosting habitat for this cave-dwelling bat. There are only two known maternity sites within the Southern Region of NSW (Environment Australia 1999).

4.11.11 Large-eared Pied Bat (Chalinolobus dwyeri)

Background

The Large-eared Pied Bat is distributed between south-eastern Queensland to New South Wales from the coast to the western slopes of the divide. This species roosts in caves and mines and has been most commonly recorded from dry sclerophyll forests and woodlands. The Large-eared Pied Bat is an insectivorous species that flies relatively slowly over the canopy or along creekbeds (Churchill 1998). The subject site does not provide suitable roost sites for the Large-eared Pied Bat, but does provide woodland foraging habitat. Threats to the species are difficult to infer given the lack of information on roosting requirements and general foraging habitats and biology (Environment Australia 1999).

Database Search

Database records obtained from the NPWS 1:100 000 map sheet, and the Australian Museum revealed the species has not been identified within a 10 km radius of the subject site (*Figure 4.3*).

Previous Studies

Gunninah (2002) tentatively (70% reliability) identified the species adjacent to Lot 802 using an Anabat detector (*Figure 4.5*).

ERM Survey Results

ERM did not detect the species within Lot 802 during surveys. However, given the occurrence of potential foraging resources within the study area it is probable that this species utilises the subject site.

Additional Surveys

Additional surveys for microchiropteran bats undertaken by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd in December 2004 failed to detect this species at the subject site (ERM 2005).

Other Known Populations

Recordings of this species on the subject site and surrounding locality suggests that this species would have roost sites within the area and potentially on the subject site as potential habitat occurs across Lot 802.

*4.11.12 Greater Broad-nosed Bat (***Scoteanax rueppellii***)*

Background

The Greater Broad-nosed Bat is a large and robust species which feeds on slow-flying prey such as large moths and beetles. It hunts from above rows of trees lining creeks and the edges of woodland in otherwise cleared paddocks. The Greater Broad-nosed Bat roosts in hollow tree trunks and branches as well as the roofs of old buildings (Churchill 1998). The Greater Broad-nosed Bat is distributed from the Atherton Tableland in North Queensland, along the coastal regions to southern New South Wales, preferring moist gullies in mature coastal forest or rainforest. The species is only found at low altitudes (below 500 m) (Churchill 1998). The subject site contains three watercourses, two of which are lined with trees, providing suitable foraging habitat for this species. The presence of hollow-bearing trees within the subject site and surrounding JBNP would also indicate suitable roosting habitat. Suspected threats to the species include clearing and fragmentation of forests in coastal and lowland areas, and the effects of logging activities including direct mortality and reduction of suitable hollows.

Database Search

Database records obtained from the NPWS 1:100 000 map sheet revealed this species has been identified within a 10 km radius of the subject site (*Figure 4.3*). There is one record of the species from JBNP (NPWS 2003a).

Previous Studies

Gunninah (2002) tentatively identified the species in December 2000 within Lot 802 during Anabat surveys (*Figure 4.5*).

ERM Survey Results

ERM did not detect the species during surveys. However, less than ideal weather affected the operation of Anabats during this time and it was not possible to survey for bats each night of the two week survey period. Given that the study area supports habitat for this species and Gunninah detected the species in 2000, it is considered likely the species would have been detected within the subject site during more favourable weather conditions.

Additional Surveys

Additional surveys for microchiropteran bats undertaken by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd in December 2004 tentatively identified the Greater Broad-nosed Bat from echolocation calls (ERM 2005).

Other Known Populations

Recordings of this species on the subject site and surrounding locality suggests that this species would have roost sites within the study area and potentially on the subject site as potential habitat occurs across Lot 802.

4.11.13 Eastern Pygmy-possum (Cercartetus nanus)

Background

The Eastern Pygmy-possum is a small arboreal marsupial distributed along the coast of southern Queensland, NSW and Victoria and south-eastern South Australia and is present throughout Tasmania (Bowen and Goldingay 2000) Studies have shown that this species is patchily distributed within its range and its overall abundance is low (NSW Scientific Committee 2001). Recent studies have shown that there are only six localities in which more than 10 individuals have been trapped and these are the Pilliga, New England Tablelands, Barren Grounds Nature Reserve-Budderoo National Park, Royal and Heathcote National Parks, Kioloa State Forest and the Eden area (Bowen and Goldingay 2000).

Banksia spp. and myrtaceous shrubs and trees are favoured as food sources and nesting sites in drier habitats and the Eastern Pygmy-possum's diet consists largely of pollen and nectar from *Banksia* spp., *Eucalyptus* spp. and *Callistemon* spp. and insects (Turner and Ward 1995). It nests in hollows in trees but its small size allows it to nest in a variety of places including under the bark of Eucalypts, forks of tea-trees and in abandoned bird nests (Turner and Ward 1995). The majority of births occur in late spring to early autumn, however, if abundant food supplies are available breeding will continue on the mainland throughout the year (Turner and Ward 1995).

C. nanus is an agile climber and a very mobile species and may undergo short-term seasonal migration possibly in response to food availability (Bowen and Goldingay 2000). A movement of 125 m in one night has been recorded for one individual (Turner and Ward 1995). This species is generally solitary with home ranges of the males around 0.68 ha and females around 0.35 ha although these are not considered exclusive territories (Turner and Ward 1995). Consequently there is potential for a number of family groups to occur on the subject site.

Database Searches

A search of the NPWS Wildlife Atlas revealed one record for the Eastern Pygmy-possum within a 10 km radius, approximately 1 km to the south-east of the subject site in heathland similar to that in which this species was trapped during this study (*Figure 4.3*).

Previous Studies

This species had not previously been recorded on the subject site.

ERM Survey Results

During these surveys the Eastern Pygmy-possum was recorded on three occasions in two different areas of the subject site (*Figure 4.7*).

ERM trapped the Eastern Pygmy-possum on two occasions in Vegetation Community No. 13 *Banksia ericifolia / Hakea teretifolia* Heathland just south-east of Moona Creek Road within Lot 801. The Brown Antechinus was the only other native species trapped in this area, although on one occasion the introduced House Mouse was also captured.

The same vegetation community also occurs on the Commerical Site in the areas between The Wool Road and the *P. affine* population although the density of ground cover differs, with The Wool Road area having much denser ground cover than the community off Moona Creek Road. These structural differences may be attributable to differences in fire history for these two areas of Lot 801. Eastern Pygmy-possums were not trapped in this area but instead 28 Bush Rats, four Swamp Rats and one introduced House Mouse were trapped over eight nights of trapping. The differences in fauna trapped between these two sites may reflect the differences in density of the ground cover as the Bush Rat favours areas of dense vegetation (Lunney 1995b).

The Eastern Pygmy-possum was also recorded in the *Eucalytpus sclerophylla / Corymbia gummifera* Open-woodland in the northern most corner of Lot 802. This vegetation community occurs midslope in the northern corner of the subject site. It is dominated by mature *E. sclerophylla* and *C. gummifera* and graded into open forest and woodland communities. It had a low shrub layer and an open ground layer of native grasses, sedges and herbs.

Other Known Populations

There are an additional 31 records of the Eastern Pygmy-possum from the Shoalhaven local government area (LGA) with the majority of these records being concentrated to the west of the LGA around Morton National Park (NPWS 2004).

The individual recorded 1 km to the south-east of the subject site could possibly be part of the same local population as those individuals occurring on the subject site.

4.11.14 Squirrel Glider (Petaurus norfolcensis)

Background

The Squirrel Glider is a medium sized gliding possum larger than the closely related Sugar Glider (*Petaurus breviceps*) (NPWS 2000). This species dens in tree hollows and utilises woodland, although in the Shoalhaven it has been recorded in tall open forest (NPWS 2000). The Squirrel Glider is considered an ecological specialist, feeding on nectar, pollen, flowers, acacia gum and insects (NPWS 1999e) and consequently requires a diverse mix of trees including eucalypts, acacias and banksias. Home-ranges for this species have been estimated to range from 0.65 and 8.55 ha depending on the type and quality of the habitat. Family groups are normally comprised of one male and two or more females and juveniles (NPWS 1999e).

Database Searches

A search of the NPWS Wildlife Atlas showed no records of this species within a 10 km radius (*Figure 4.3*).

Previous Studies

Gunninah (2000a) recorded a Squirrel Glider in the *Eucalyptus sclerophylla / Corymbia gummifera / Eucalyptus globoidea* Woodland community within Lot 802 between Moona Creek Road and the Central creek (*Figure 4.5*). There is some doubt of the validity of this record and it is thought that it is likely to have been mistakenly identified and that it was probably a Sugar Glider (*Petaurus breviceps*) (Dominic Fanning (Gunninah) *pers. comm.* to Neil Hargreaves (Stockland Developments Pty. Ltd.).

ERM Survey Results

Despite extensive spotlighting, stagwatching and trapping in suitable habitat this species was not recorded. However, several Sugar Gliders (a species very similar in appearance to the Squirel Glider) were recorded on the subject site through both spotlighting and trapping. Independent verification of the species trapped during ERM surveys as Sugar Gliders was provided by Barbara Triggs (Dead Finish) through scat and hair samples collected from the trapped individuals.

Other Known Populations

The Squirrel Glider is sparsely and patchily distributed along the east coast and neighbouring inland districts from Western Victoria to north Queensland (NPWS 1999e). In the Shoalhaven most records come form the Kioloa State Forest around 30 km south of the subject site. A Squirrel Glider was also reportedly spotlighted around 15 km to the north of the subject site at Culburra by Norm Robinson during the 1980s. Several attempts at the independent verification of the occurrence of this species at that site have been unsuccessful (Ross Goldingay, *pers. comm.*).

4.11.15 Yellow-bellied Glider (Petaurus australis)

Background

The Yellow-bellied Glider is a large, arboreal mammal that occurs in coastal and escarpment forests along the east coast of Australia and which relies upon hollow-bearing trees for shelter and nesting. It occurs in a variety of habitats but prefers resource-rich forests where mature trees provide nesting hollows and tree species composition ensures year-round continuity of food resources (Goldingay & Kavanagh 1991). In southern NSW, its preferred habitat at low altitudes is moist gullies and creek flats in mature coastal forests.

This species is considered widespread but is found at low population densities in habitat that is patchily distributed (Goldingay & Kavanagh 1991). Typical densities in coastal areas of southern NSW range from 0.1 – 0.16 individuals per hectare depending on the productivity of the forest and food availability (Goldingay 1992). This species lives in long-term family groups which occupy large home ranges of approximately 20 – 85 ha (Goldingay 1992). The home range is considered exclusive to a family group, with little overlap occurring between adjacent home ranges. The loud vocalisations of this species are used to advertise and maintain these territories (Goldingay 1994).

Plant and insect exudates provide the bulk of this glider's diet and these include nectar, sap, honeydew and manna, whilst protein is obtained from arthropods and some pollen. The Yellow-bellied Glider incises tree trunks and branches to obtain phloem sap. Tree selection and usage is complex and a large number of tree species are used as sap trees throughout the range of this glider.

The Yellow-bellied Glider utilises a number of hollow-bearing trees in their home range for nesting

Database Searches

Searches of the NPWS Wildlife Atlas revealed numerous records for the Yellow-bellied Glider within a 10 km radius of the study area including JBNP and the Woollamia Nature Reserve (*Figure 4.3*).

Previous Studies

This species was recorded by Gunninah (2002b) within Lot 802 in Scribbly Gum / Bloodwood Woodland and Scribbly Gum / Casuarina Forest. These records were visual, auditory and indicated by the presence of a sap tree on the ridge top between the Western and Central creeks (*Figure 4.5*).

ERM Survey Results

ERM surveys during November / December recorded Yellow-bellied Gliders on all six nights of spotlighting (*Figure 4.7*). Multiple individuals were spotlighted in the gullies and slopes along the length of the Western and Central creeks of Lot 802. Individuals were also heard vocalising on all survey occasions.

Stagwatching on each of these nights revealed two nest sites, one adjacent to the northern boundary of the subject site and JBNP and the other at the southern end of the Central creek (*Figure 4.7*). These observations were made on two different nights and on each occasion one individual was seen to emerge from a tree hollow, one from a stag tree in JBNP and the other from a large eucalypt located midslope from the creekline.

One feed tree was identified on the ridgetop between the Western and Central creeks adjacent to the unformed track that runs along the ridgeline. The wet weather during the survey period made identification of feed trees difficult due to the blackening of the bark through moisture. It is considered likely that this species would at least periodically use much of Lot 802 due to its high energy requirements and preference for a mosaic of tree species.

There is no suitable habitat for this species within Lot 801.

Other Known Populations

This species is relatively widespread on the coastal plain and the Shoalhaven River escarpment (NPWS 2000). Records exist for JBNP and the nearby Woollamia Nature Reserve.

It is estimated that 31 family groups are currently active within the St Georges Basin area (SCC & DEC 2004) and that two family groups have home ranges which extend onto the subject site.

4.11.16 Giant Burrowing Frog (**Heleioporus australiacus**)

Background

The Giant Burrowing Frog is a large rotund frog that can spend significant periods of time underground during unfavourable conditions and to avoid detection (NPWS 2001).

This species is distributed in south-eastern NSW and Victoria and appears to exist as two distinct populations. The northern population appears to be confined to the sandstone geology of the Sydney Basin and extends as far south as Jervis Bay whilst the southern population occurs as disjunct pockets from around Narooma to eastern Victoria (NPWS 2001). There appears to be morphological differences between individuals in the northern and southern regions of this species distribution. The northern population has a marked preference for sandstone ridgetop habitats and broader upland valleys along slow flowing to intermittent creeklines in woodland, open woodland and heath (NPWS 2001). They have been recorded occupying artificial ponded structures but do not appear to inhabit areas that have been cleared for agriculture or for urban development.

This species has on occasion been found at considerable distance from suitable riparian breeding or other moist habitat indicating an ability to move about relatively freely.

The Giant Burrowing Frog calls mainly in spring and autumn with calling bouts after rains in late summer (Anstis 2002) although Recsei (1996) concluded that the Giant Burrowing Frog could be sampled at any time of the year, providing it is raining. It is thought to breed through summer and autumn (Cogger 1992) after rains (Robinson 1996). Tadpoles are relatively large and the larval life span in the field varies from 3 – 11 months (Anstis 2002).

Database Searches

Searches of the NPWS Wildlife Atlas revealed 20 records for the Giant Burrowing Frog within a 10 km radius of the subject site. These records are concentrated to the south of the study area along the coastal fringe with no records stretching inland (*Figure 4.3*).

Previous Studies

Gunninah (2002b) recorded a tadpole of this species in a pool upslope of the Central creek within Lot 802 whilst spotlighting on 7 January 2000 and recorded the species whilst spotlighting along a transect in the north of the site in December 1999 (*Figure 4.5*).

ERM Survey Results

Despite repeated spotlighting and call playback surveys during rain events in late spring / early summer 2003 no adult Giant Burrowing Frogs were recorded on the subject site, including areas where tadpoles had previously been recorded by Gunninah (2002b). Tadpoles were not recorded during additional searches in January, February and September 2004. However, the occurrence of this species on the subject site three years ago means that potential habitat exists and the potential impacts of this development on this species need to be considered.

Additional Surveys

Additional targeted surveys for the Giant Burrowing Frog were undertaken by GHD in May 2005 (GHD 2005b). These additional surveys targeted adults and tadpoles and focused on the northern section of the subject site, as well as a reference site. These additional surveys failed to detect the species at the subject site.

Other Known Populations

This species has been recorded in several conservation reserves within the locality and region including Booderee National Park, JBNP, Morton National Park and Red Rocks Nature Reserve (NPWS 2000 & 2001). It is unclear whether this represents adequate conservation within the region.

4.11.17 Giant Dragonfly (Petalura gigantea)

Background

The Giant Dragonfly is listed as an endangered species under the TSC Act. The Giant Dragonfly is a large and unusual species of dragonfly, considered to be largely terrestrial throughout its life cycle. It is one of the few extant members of an ancient family, the Petaluridae (DEC 2004). The larval stage of the species is extremely long, from at least 10 to 30 years. Larvae occupy long chambers under swamps, emerging at night to feed. Larvae do not swim and avoid open water. Adults emerge between October to November and fly until late January. They are poor flyers and do not readily disperse. The Giant Dragonfly has been recorded from permanent wetlands from Moss Vale in NSW to southern Queensland, but has not been recorded in most areas for many years. A number of sites from which old records exist are no longer wetlands. Threats to the survival of the species include the declining population size and loss or degradation of wetland habitats in which it occurs (DEC 2004).

ERM Survey Results

The Giant Dragonfly was recorded on the subject site by Glenn Hoye of Fly by Night Bat Surveys Pty Ltd, who sighted an adult on two occasions whilst undertaking bat surveys in December 2004. The species was recorded in the north of the subject site where it borders JBNP. Consequently, GHD undertook an impact assessment for this species that was based on habitat mapping. This assessment found that breeding habitat for the Giant Dragonfly occurs along the riparian corridors of Western and Central creeks, and foraging habitat for adults occurs in the north of subject site (GHD 2005d).

*4.11.18 Glossy Black-cockatoo (***Calyptorhynchus lathami*)

Background

The Glossy Black-cockatoo is a highly specialised species feeding almost exclusively on the seeds extracted from the wooden cones of *Allocasuarina* species. Additionally, this species also needs suitable hollows in living and dead trees for nesting. Hollow-bearing trees and *Allocasuarina littoralis* stands occurring on the subject site represent important habitat for this species within the study area. Tree hollows found on the subject site represent potential breeding habitat for this species.

Forest She-oak (*Allocasuarina littoralis*) is a preferred feed tree for the Glossy Black-cockatoo and occurs as scattered stands across the study area and in large stands within Lot 801 and Lot 802. Evidence of foraging (chewed cones) indicates that the subject site is widely used by this species where *A. littoralis* occurred in medium-high densities.

Extensive fires in the locality have resulted in the loss of mature *A. littoralis* trees, thus reducing the short-term availability of foraging habitat for this species. Therefore, the large mature stands of *A. littoralis* on the subject site may temporarily represent important foraging habitat for this species until other stands within the locality regenerate to sufficient maturity to produce viable seed cones.

Database Searches

Searches of the NPWS Wildlife Atlas revealed 25 records for the Glossy Black-cockatoo on the subject site. An additional 130 database records were recorded on the NPWS Wildlife Atlas for this species in the locality to the north, south, east and west of the subject site. This species has been recorded in the north-west and south-east corners and along Moona Creek Road within Lot 802 and twice within Lot 801 adjacent to the Bay & Basin Leisure Centre access road (*Figure 4.3*).

Previous Studies

The Glossy Black-cockatoo was recorded on the subject site in previous surveys by Gunninah (December 1999 – January 2000, April 2000 and November – December 2000). There are 32 records for this species from surveys undertaken by Gunninah across Lot 802 (*Figure 4.5*).

ERM Survey Results

The Glossy Black-cockatoo was recorded through the observation of seven individuals feeding in A*llocasuarina littoralis* west of Moona Creek Road (*Figure 4.7*). Additionally, field surveys conducted at the subject site recorded widespread evidence of foraging (chewed cones) of this species throughout Lot 802 in all vegetation communities containing mature *A. littoralis* trees. All bird survey results are shown in *Figure 4.7* and *Table 4.7*.

Additional Surveys

Additional targeted bird surveys undertaken by ERM in September 2004 resulted in numerous additional records of the species foraging across the subject site and in the study area including:

- a group of four birds including one male, one female and one juvenile were recorded foraging on the north eastern boundary of the study area;
- several birds feeding at Bird Site 6;
- calling off-site from bird Site 3;
- several birds heard and seen foraging north of Bird Site 2; and
- numerous crushed cones on the ground at Bird Site 5.

Additional Surveys

Glossy Black-cockatoo nest surveys were undertaken by GHD in May 2005 (GHD 2005c). The species was recorded using the site in the late afternoon and early morning. In addition, four nest sites were recorded – two within the centre of the subject site near the Central creekline, one approximately 100 m beyond the north-western boundary of the subject site in JBNP, and one approximately 300 m from the north-western boundary of the subject site in JBNP. In addition to nest sites, other evidence of breeding activity was observed within the subject site including courtship feeding, eggshells and copulation.

Other Known Populations

This species has been recorded in the JBNP to the north, south, east and west of the subject site. This species has also been recorded in a number of conservation reserves within the region including: Barren Grounds Nature Reserve, Booderee National Park, Bournda National Park, Budawang National Park, Conjola/Cudmirrah National Park, Meroo National Park and Murramarang National Park.

4.11.19 *Ground Parrot* (Pezoporus wallicus)

Background

The Ground Parrot has a patchy distribution through coastal eastern Australia, from southern Queensland to Victoria. The eastern subspecies inhabits low heathlands and sedgelands, building nests on the ground beneath dense vegetation (Garnett & Crowley 2000). Heathland becomes unsuitable for the Ground Parrot immediately following fire and may also become unsuitable if left unburnt for more than 15 years. A mosaic of burning therefore suits the species and allows movement for recolonisation of suitable vegetation. Suitable habitat for this species occurs at the subject site within the heathland and sedgeland communities of Lot 801.

Database Searches

The database searches yielded no records for the Ground Parrot on the subject site. The locality search of the NPWS Wildlife Atlas resulted in 25 Ground Parrot records to the south and south-east of the subject site (*Figure 4.3* and *Figure 4.4*).

Previous Surveys

The Ground Parrot has been detected once in previous surveys of the subject site undertaken by Gunninah (2000). One individual was recorded in the sedgeland community within Lot 801 (*Figure 4.5*).

ERM Survey Results

The Ground Parrot was recorded during the surveys for this SIS on the subject site and in the adjacent area. This species was recorded during the targeted field surveys and orchid surveys in November, December 2003 and January 2004. At least four separate individuals were recorded calling from the grassland and sedgeland communities within Lot 801 and adjacent to the Bay & Basin Leisure Centre site (*Figure 4.7*). Three separate individuals were flushed from the grassland and sedgeland communities on a number of occasions while conducting orchid transect surveys across Lot 801 in November, December 2003 and January 2004. A Ground Parrot was heard calling from heath just off the road at Bird Site 1 on 10 September 2004. Details of the observations of this species are provided in *Table 4.7.*

Suitable Ground Parrot Habitat was mapped within a 2 km radius of the subject site in September 2004. The results of that mapping are shown in *Figure 4.9*, overlaid on the satellite image. Approximately 48 ha of vegetation was considered to be suitable Ground Parrot habitat. The assessment of suitability was based on the presence of vegetation of suitable height, density and moisture. Whether or not a previous record of a Ground Parrot existed for the subject site was also considered.

Other Known Populations

The Ground Parrot has been recorded in the JBNP to the south of the subject site. The Ground Parrot has also been recorded in a number of conservation reserves in the region including Barren Grounds Nature Reserve, Budderoo National Park, and the Murramarang Aboriginal Area.

4.11.20 Eastern Bristlebird (Dasyornis brachypterus)

Background

The Eastern Bristlebird is a cover-dependent and fire-sensitive species, inhabiting a wide range of vegetation communities including rainforest, eucalypt forest, woodland, mallee, shrubland, swamp, heathland and sedgeland where there is low, dense cover (Baker 2000). Local extinctions of populations of this species have been attributed to fire. Recent fires have burnt much of Lot 802 reducing the density of low cover and the amount of potential habitat for this species. Areas of unburnt vegetation which are currently being used by this species are restricted to the Heath-leaved Banksia/Dagger Hakea Heathland within Lot 801 and Lot 802. Following further post-fire regeneration of the low cover, there is potential that the woodland community within Lot 802 would support potential habitat for this species.

This sedentary species is generally detected singly or in pairs and occupies a home range of more than 10 hectares (NPWS 1999b). Potential threats to this species include loss and destruction of habitat from bushfire, grazing and development, habitat fragmentation and isolation resulting in local extinctions and predation from native and introduced species.

Database Searches

Searches of the NPWS Wildlife Atlas revealed four records of the Eastern Bristlebird on the subject site. An additional 220 database records were recorded on the NPWS Wildlife Atlas for this species throughout the locality to the north, south, east and west of the subject site. This species has been recorded in the north-eastern corner of the site, along Central creek and along Moona Creek Road within Lot 802 (*Figure 4.3*).

Previous Surveys

This species has been detected during previous surveys by Gunninah (2000) in the heathland community within Lot 802, adjacent to Eastern creek (*Figure 4.5*).

ERM Survey Results

The Eastern Bristlebird was recorded during the surveys for this SIS. This species was recorded in the south-western corner and middle section of the Heath-leaved Banksia/Dagger Hakea Heathland community adjacent to the Eastern creek (*Figure 4.7*). On the 10 September 2004 an Eastern Bristlebird was recorded calling from Bird Site 7 adjacent to the western drainage line. Another one was seen at Bird Site 1 in heath adjacent the road.

Results from the present survey are shown in *Table 4.7.*

Habitat Mapping

During surveys for this SIS, David Bain, an ecologist who has extensively studied the Eastern Bristlebird, walked over the subject site recording habitat suitability. Habitat was divided into primary and secondary. Much of the secondary habitat was considered to be regenerating and had potential to become primary habitat. These results are presented in *Figure 4.10*.

Other Known Populations

This species has been recorded in the JBNP to the north, south, east and west of the subject site. This species has also been recorded in a number of conservation reserves within the region including, Barren Grounds Nature Reserve, Booderee National Park, Budawang National Park and Budderoo National Park.

4.11.21 Satin Flycatcher (**Myiagra cyanoleuca**)

Background

The Satin Flycatcher is a migratory bird which breeds from around the Calliope Ranges in Queensland southward to Tasmania during September / October to January / February before migrating north to southern and eastern Papua New Guinea and adjacent islands to over-winter (Reader's Digest 1993). It prefers heavily vegetated gullies in forests, tall woodlands and during migration, coastal forests, woodlands, mangroves, trees in open country and even gardens (Pizzey & Knight 1998).

Fragmentation of habitat and land-clearing for agriculture and urban and coastal development has resulted in the restriction of the range and distribution of this species.

Database Searches

An EPBC Act Protected Matters database search listed the locality as providing potential breeding habitat for this species. There were no records of the Satin Flycatcher breeding or overflying on any of the other database searches.

Previous Surveys

The Satin Flycatcher has not been recorded on the subject site during any pervious surveys.

ERM Survey Results

The Satin Flycatcher was not recorded at the subject site during surveys for this SIS although surveys were undertaken during the breeding season for this bird species. The forested gully areas and mature forested woodlands may provide potential over-wintering foraging and breeding habitat for this migratory species.

Other Known Populations

The Satin Flycatcher has not been recorded within the Shoalhaven region although the coastal forests provide suitable habitat.

4.11.22 Rufous Fantail (Rhipidura rufifrons)

Background

The Rufous Fantail is a breeding migrant to south-eastern Australia during July to December. This species over-winters in Papua New Guinea. It prefers wetter eucalypt forests, gullies, coastal scrub, watercourses and rainforests where it feeds on insects. It has also been recorded in parks and gardens during migration (Pizzey & Knight 1998).

The gully areas of the subject site and in the locality provide suitable habitat for this species. Fragmentation of habitat and land-clearing for agriculture and urban and coastal development has resulted in the restriction of the range and distribution of this species.

Database Searches

An EPBC Act Protected Matters database listed the locality as providing potential breeding habitat for this species. There were no records of the Rufous Fantail breeding or overflying on any of the other database searches.

Previous Surveys

Gunninah (2002a) recorded the Rufous Fantail on two occasions with the subject site.

ERM Survey Results

The Rufous Fantail was not recorded at the subject site during the present survey although surveys were undertaken during the breeding season. The forested gully areas and mature forested woodlands provide potential over-wintering foraging and breeding habitat for this migratory species.

Other Known Populations

The Rufous Fantail has not been recorded elsewhere within the Shoalhaven region although the coastal forests provide suitable habitat.

4.11.23 Swift Parrot (Lathamus discolor)

Background

The Swift Parrot breeds only in Tasmania and migrates in autumn to south-east mainland Australia. Box-ironbark forests and woodlands provide winter foraging habitat for this species, particularly in Victoria and New South Wales. The species is semi-nomadic, foraging on nectar from flowering eucalypts and lerps (Swift Parrot Recovery Team 2000).

Eucalypt woodlands and forests on the subject site and in the locality provide potential over-wintering foraging habitat for this species. Fragmentation of habitat and land-clearing for agriculture and urban and coastal development has resulted in the restriction of the range and distribution of this species.

Database Searches

Database searches for the Swift Parrot yielded no records in the locality.

Previous Surveys

The Swift Parrot was not recorded at the subject site during previous surveys.

ERM Survey Results

The Swift Parrot was not recorded at the subject site during surveys for this SIS. The forested woodland containing mature eucalypts provides potential over-wintering foraging habitat for this migratory species. Swamp Mahogany was flowering at Bird Site 2 during targeted surveys in early September. Musk and Little Lorikeets were recorded foraging on this resource.

Other Known Populations

The Swift Parrot has been recorded in a number of conservation reserves in the region including, Barren Grounds Nature Reserve and the Murramarang National Park.

4.11.24 Regent Honeyeater (**Xanthomyza phrygia**)

Background

The Regent Honeyeater is a semi-nomadic species that inhabits temperate eucalypt woodlands and open forest in south-eastern Australia. This species predominantly inhabits box-ironbark eucalypt associations and lowland coastal forests dominated by Swamp Mahogany, Spotted Gum and Riverine Casuarina woodlands (NPWS 1999).

Database Searches

Database searches yielded no records for the Regent Honeyeater on the subject site. Searches of the NPWS Wildlife Atlas resulted in two records for the Regent Honeyeater within the locality, located north-east and south-east of the subject site (*Figure 4.3*).

Previous Surveys

The Regent Honeyeater has not been recorded at the subject site during previous surveys. The eucalypt woodlands and open forests on the subject site provide potential habitat for this semi-nomadic species.

ERM Survey Results

The Regent Honeyeater was not recorded at the subject site during survey surveys for this SIS. No response was elicited from call playback in September 2004 surveys. Temperate eucalypt woodlands and open forests provide the preferred habitat for this species in NSW. However, wet lowland coastal forests dominated by Swamp Mahogany and Spotted Gum and Riverine Casuarina woodlands are also important habitats for this species, especially at times of food shortage.

Other Known Populations

The Regent Honeyeater has been recorded in the locality and in JBNP, north-east and south-east of the subject site. The Regent Honeyeater has also been recorded in a number of conservation reserves in the region including, Murramarang National Park and Seven Mile Beach National Park.

4.11.25 Turquoise Parrot (Neophema pulchella)

Background

The Turquoise Parrot inhabits open eucalypt woodlands and forests, typically with a grassy understorey. It favours the edges of woodlands adjoining grasslands or timbered creeklines and ridges. A granivorous species, the Turquoise Parrot feeds on the seeds of native and introduced grasses and other herbs. Grasslands and open areas provide important foraging habitat for this species. Woodlands provide important roosting and breeding habitat for this species.

Database Searches

Database searches resulted in no records for this species on the subject site. NPWS Wildlife Atlas records for this species recorded three observations for this species in the locality, north-west of the subject site (*Figure 4.3*).

Previous Surveys

The Turquoise Parrot has not been recorded on the subject site during previous surveys.

ERM Survey Results

The Turquoise Parrot was not recorded at the subject site during surveys for this SIS (December 2003 and September 2004). However, the eucalypt woodlands and open forests, with a ground cover of grasses and low understorey shrubs provide potential habitat for this species.

Other Known Populations

This species has been recorded in the JBNP north-west of the subject site.

4.11.26 Square-tailed Kite (Lophoictinia isura)

Background

The Square-tailed Kite is a solitary bird, typically inhabiting heathlands, coastal forests and woodlands, tropical and subtropical rainforests, timbered watercourses, ranges and hills, often dominated by Woollybutt (*Eucalyptus longiflora*), Spotted Gum (*Corymbia maculata*) or Peppermint Gum (*E. elata, E. smithii*).

The Square-tailed Kite is a specialised predator, taking small passerines, especially honeyeaters and their eggs and nestlings as well as large insects in the tree canopy. It generally hunts low over open forest, woodlands and mallee communities, heaths and other low scrubby habitats that are rich in passerines. This species prefers a structurally diverse landscape with a broad range of habitats and appears to utilise a large hunting range greater than 100 square kilometres (NPWS 2003e).

It is likely that this species uses the subject site for foraging and / or nesting. Although this species was not detected nesting on the subject site during this survey, it is possible that this species was not nesting this year as previous surveys have identified a possible nest location at the subject site.

Database Searches

Searches of the NPWS Wildlife Atlas returned four records for the Square-tailed Kite on the subject site. An additional 29 database records were recorded on the NPWS Wildlife Atlas for this species in the locality. This species has been recorded in the south-east corner and middle portion of Lot 802, west of Moona Creek Road (*Figure 4.3* and *Figure 4.4*).

Previous Surveys

Previous surveys undertaken by Gunninah (December 1999 – January 2000, April 2000 and November – December 2000) recorded this species flying over the subject site on numerous occasions. A potential nest site was identified by Gunninah in the central part of Lot 802. Previous results for this species are shown in *Figure 4.5.*

ERM Survey Results

The Square-tailed Kite was recorded on numerous occasions during surveys for this SIS in November/ December 2003 flying over the woodland and heath/sedgeland communities.

During surveys in September 2004 two individuals were recorded flying over Bird Site 6 on 9 September and a pair of birds was recorded soaring over Bird Site 6 after alighting from a perch on site on 10 September 2004.

The observations from both survey periods are detailed in *Table 4.7.*

Other Known Populations

This species has been recorded in the JBNP and surrounding locality to the west, south, south-west and south-east of the subject site. This species has also been recorded in a number of conservation reserves in the region including, Barren Grounds Nature Reserve, Booderee National Park and the Murramarang Aboriginal Area.

4.11.27 Powerful Owl (**Ninox strenua**)

Background

The Powerful Owl is a nocturnal, solitary and sedentary species, occupying large home ranges of between 600 and 1,000 ha, dependant on the quality of habitat. Preferred habitat is tall open moist forests, however they also inhabit open eucalypt and casuarina forests and woodlands. They often roost in closed forest and open forest where there is sufficient canopy density and understorey trees, including rainforest. Roost trees are often identified by their large lower limb structure and dense crowns.

Large hollow-bearing trees and the open eucalypt forest and woodland on Lot 802 and in the adjacent National Park represent suitable foraging habitat and potential roost sites for this species.

The Powerful Owl has a variety of vocal calls and is known to 'dawn call' when returning from its night hunting activities to mark the position of its daytime roost (Parks Victoria 2003).

Database Searches

Database searches returned no records for the Powerful Owl on the subject site. Searches of the NPWS Wildlife Atlas for this species, resulted in 15 observations recorded in the locality, to the west, south-west, south and south-east of the subject site (*Figure 4.3* and *Figure 4.4*).

Previous Surveys

The Powerful Owl was recorded during previous surveys undertaken by Gunninah, upslope of the middle drainage line within Lot 802 (December 1999 – January 2000 and April 2000) (*Figure* 4.5). The Powerful Owl was also recorded immediately north of the eastern corner of the subject site.

ERM Survey Results

The Powerful Owl was detected at the subject site during surveys for this SIS. This species was heard on mornings of 1 and 3 December 2003 within Lot 802 while undertaking pre-dawn Ground Parrot surveys within Lot 801. A Powerful Owl call was also heard following Owl Call playback surveys at Owl Site 1 on Moona Creek Road in September 2004. The call was distant and was possibly coming from off-site. The results are provided in *Table 4.7* and *Figure 4.7*.

Other Known Populations

This species has been recorded in the JBNP and the locality to the north, south, east and west of the subject site. This species has also been recorded in a number of conservation reserves in the region including, Booderee National Park, Conjola / Cudmirrah National Park, Meroo National Park, Murramarang National Park and Seven Mile Beach National Park.

4.11.28 White-throated Needletail (Hirundapas caudactus)

Background

The White-throated Needletail is a migratory species listed under the EPBC Act. The species migrates from Siberia, the Himalayas and Japan to Australia in the summer, arriving in mid-October and departing by mid-April. It is known to inhabit a variety of habitats including forests, woodlands, farmlands, plains, lakes, coasts and towns (Pizzey and Knight 1999). The White-throated Needletail nests in tree hollows and feeds on insects during flight chiefly ahead of weather changes. In Australia this species is nomadic, responding to local weather changes (Reader's Digest 1993). Threats to the White-throated Needletail include loss and destruction of habitat from bushfire, grazing and development.

Database Searches

This species was listed on the EPBC Act search tool as likely to occur in the study area.

Previous Surveys

Gunninah (2000) detected the White-throated Needletail during previous surveys within the woodland with Lot 802.

ERM Survey Results

Two White-throated Needletails were recorded within Lot 802 during the ERM surveys. Locations of the records for this species during surveys for this SIS are illustrated on *Figure 4.7*.

Other Known Populations

The White-throated Needletail has been observed in the Shoalhaven Region. Potential habitat for this species occurs within the woodland areas of Lot 802.

*4.11.29 Masked Owl (***Tyto novaehollandiae*)

Background

The Masked Owl is known to inhabit forests, open woodlands, timbered waterways and open farmlands with tall trees and prefers partially cleared areas with eucalypt forest edges for hunting. The main requirements for this species are tall trees with hollows suitable for nesting and roosting adjacent to foraging areas. The species is sparsely distributed from southern Queensland to South Australia and Western Australia. The species has also been recorded on the Nullarbor Plain. Prey items are principally terrestrial mammals but arboreal species may also be taken. Clearing for agriculture is the principal reason for listing of the species (Garnett and Crowley 2000). Tree hollows found on the subject site represent potential nesting and roosting habitat for this species.

Database Searches

Searches of the NPWS Wildlife Atlas returned one record for the Masked Owl on the subject site. An additional eight records were recorded on the NPWS Wildlife Atlas for this species in the locality and in the adjacent JBNP. This species has been recorded in the north-east corner of Lot 802 (*Figure 4.3*).

Previous Surveys

This species has been previously recorded in the north of Lot 802 in surveys undertaken by Gunninah (2000). This species was also recorded twice during surveys undertaken by Gunninah in the JBNP, adjacent to the north-western boundary of Lot 802 (*Figure 4.5*).

ERM Survey Results

The Masked Owl was recorded at Owl Site 2 during the owl call playback surveys conducted in September 2004. A single owl responded to a taped call and flew in close to the observers. Owl Site 2 is located in the north of the subject site close to the north-eastern boundary of the subject site (*Figure 3.6*). Further surveys were conducted on subsequent nights along the northern drainage line but no further Masked Owl responses were heard.

Other Known Populations

This species has been recorded in the JBNP to the north, south, east and west of the subject site. This species has also been recorded in a number of conservation reserves in the region including, Booderee National Park, Conjola / Cudmirrah National Park, Meroo National Park, Murramarang National Park and Seven Mile Beach National Park.

Table 4.7 Survey Results for Targeted Bird Species

Species	Date	Time	Location	Number recorded	Survey method	Observation type	Notes
Glossy Black-cockatoo	4/11/03		Lot 802. North-west of Moona Creek Road.	5	Incidental observation	Observed	Observed feeding in *Allocasuarina littoralis.*
	24/11/03	12:00	Lot 802, start of B1 Transect. North-west of Moona Creek Road.	3	Incidental observation	Observed	Observed feeding in *A. littoralis.*
	7/9/04	07:35	North-eastern boundary of Lot 802	4	opportunistic	Observed	Observed feeding in *A. littoralis.*
	7/9/04	10:20	Lot 802, Bird Site 6	1-2	2 ha area search	Call heard	Feeding.
	7/9/04	15:30	Lot 802, Bird Site 2	Not determined	Incidental during area search	Call heard	Feeding.
	May 2005		Lot 802, Lot 801 and JBNP (GHD 2005c)		Nest Survey	Observed, Heard	Breeding and courtship behaviour, nest sites recorded
Eastern Bristlebird	27/11/03	06:22 – 07:07	Lot 802, adjacent to creek in Heath-leaved Banksia/Dagger Hakea Heathland.	1	Transect	Call heard	
	27/11/03	07:15 – 07:30	As above.	1	Call playback	Call heard / observed	
	28/11/03	05:55	South-west corner Lot 802, adjacent to creek in Heath-leaved Banksia/Dagger Hakea Heathland.	1	Point survey	Call heard	
	28/11/03	06:20	As above.	1	Transect	Call heard	
	28/11/03	07:05 – 07:45	As above.	1	Call playback	Call heard / observed	Individual responded to call playback and circled position, calling continuously for 30 minutes.
	9/9/04	06:20	Lot 802, Bird Site 1	1	2 ha area search	Call heard / observed	Perched atop a 1m high *Banksia ericifolia.*
	10/9/04	08:05	Lot 802, Bird Site 7	1	2 ha area search	Call heard	Calling from Western creek.
Ground Parrot	24/11/03	20:00 – 21:00	Lot 801, west of Sewer Pumping Station (SPS) access road (286700 6116060)	1	Point	Call heard	
	25/11/03	04:45 – 05:45	Lot 801, west of SPS access road (286750 6116300, 286630 6116000)	2	Point	Call heard	
	25/11/03	20:00 – 21:00	Lot 801, west of SPS access road (286750 6116500, 286650 6116100)	2	Point	Call heard	

Species	Date	Time	Location	Number recorded	Survey method	Observation type	Notes
	26/11/03	04:45 – 05:45	Middle of Lot 801, north-west of Leisure Centre access road.	1	Point	Call heard	
	1/12/03	04:45 – 05:45	North-east corner of Lot 801 near Leisure Centre access road.	3 (2 on site, 1 offsite)	Point	Call heard	One bird heard calling 75 m east of SPS access road on the Leisure Centre site (offsite).
	2/12/03	04:45 – 05:45		4	Point	Call heard	
	3/12/03	04:45 – 05:45	First bird called from Leisure Centre site. Two birds called from north-east corner near the Leisure Centre access road. One bird called from middle of Lot 801.	4 (3 onsite, 1 offsite)	Point	Call heard	
	3/12/03	04:45 – 05:45	Eastern side on north side of College Road.	2	Point	Call heard	
	4/12/03	04:45 – 05:45		2	Point	Call heard	
	4/12/03	04:45 – 05:45	One bird called south-east of Leisure Centre access road. One bird called north-west of Leisure Centre access road near NPWS quadrat. One bird called from middle of Lot 801.	3	Point	Call heard	
	4/12/03	20:00 – 21:00	One call heard offsite near oval east of SPS access road. One call heard on Lot 801.	2 (1 onsite, 1 (offsite)	Point	Call heard	
	15/1/04	20:00 – 21:00	In the Grass Tree Sedgeland in Lot 801.	3	Opportunistic	Observed	Birds were flushed while conducting orchid surveys.
Powerful Owl	1/12/03	05:00	Lot 801.	1	Opportunistic	Call heard	Call repeated five to six times from Lot 802. Bearing recorded and source of call estimated as central Lot 802.
	3/12/03	05:00	Lot 801.	1	Opportunistic	Call heard	Call repeated five times from Lot 802. Bearing recorded and source of call estimated as central Lot 802.
	6/9/04		Lot 802	1	Call playback	Call heard	Distant. Bearing Recorded.
Masked Owl	6/9/04	21:20	Lot 802	1	Response to Call	Call heard	Bird flew in from north-east, called 3 times,

Species	Date	Time	Location	Number recorded	Survey method	Observation type	Notes
					Playback		first distant then came closer.
Square-tailed Kite	1/12/03	12:00	Lot 801, south-eastern corner of site	1	Incidental	Observed	Flying above canopy.
	1/12/03	13:10	Lot 802 Moona Creek Road	1	Incidental	Observed	Flying above canopy.
	25/11/03	05:50	Lot 802 East of Moona Creek Road	1	Incidental	Observed	Flying above canopy.
	25/11/03	05:45	Lot 802Over Moona Creek Road	1	Incidental	Observed	Flying above canopy.
	27/11/03	06:00	South-east of Moona Creek Road	1	Incidental	Observed	Flying above canopy.
	27/11/03	07:00	Lot 802, north western corner woodland	1	Incidental	Observed	Flying above canopy.
	3/12/03	06:00	Lot 802 south of ridge road	1	Incidental	Observed & heard	In stag
	10/9/04	05:00	Lot 802, Bird Site 6	2	2 ha area search	Observed	Alighted from perch and circled over site.

4.12 CONSERVATION SIGNIFICANCE

The results of the conservation significance assessment suggest that the study area, subject site and major habitats in the study area are of roughly equivalent conservation significance, reflecting the fact that the study area and all areas within the study area are relatively good quality habitat that is connected to other areas of intact native vegetation. Most areas of the subject site have attributes of conservation significance including habitat for, and presence of, threatened species and relatively undisturbed vegetation. The conservation significance assessment is presented in *Table 4.8.*

Table 4.8 Conservation Significance in the Study Area

Conservation Significance Criteria	Wood-land/ Forest	Sedge-land/ Grassland	Heath-land	Wet-lands	Subject Site	Study Area
Size (ha)	119.1	12.1	17.7	90.6	119.8	148.9
Connectivity	2	2	2	2	2	2
Significant Species	2	2	2	1	2	2
Significant Vegetation Communities /Habitat	0	1	0	1	1	1
Conservation Status	1	1	1	1	1	1
Ecological Integrity	3	2	3	3	2	2
Sum (possible total = 10)	**8**	**8**	**8**	**8**	**8**	**8**

Where the parameters are:

- **Connectivity**: 0 – 2 from cleared to contiguous;
- **Significant Species**: 0 – 2 from not present to records or likely occurrence;
- **Significant Vegetation Communities/Habitat**: 0 – 1 from not present to present;
- **Conservation Status**: 1 – 2 wide distribution to limited distribution; and
- **Ecological Integrity:** 0 – 3 from poor to high.

Overall the size and ecological integrity of the subject site is large enough to support a number of family groups of threatened species such as the Yellow-bellied Glider and Eastern Pygmy-possum as well as locally significant vegetation communities. However, when viewed in a local and regional context, such a high conservation significance is only valid whilst the subject site is connected to, and is part of a larger expanse of native vegetation. If viewed in isolation, the subject site would be unlikely to support viable populations of some of these species and would also be more susceptible to other degrading processes such as weed invasion, feral and domestic animal predation and potential inappropriate fire regimes.

The subject site is of particular importance as its supports one of only three remaining populations of *Prasophyllum affine*. The subject site also provides important habitat for Eastern Bristlebirds and Ground Parrots and is part of an important north-south fauna movement corridor. These two species have a restricted distribution and specialised habitat requirements.

Overall, the subject site is considered to be of high regional conservation significance for the following reasons:

- it provides habitat for a large number of regionally significant and threatened fauna and flora species;
- it is contiguous with vegetation to the north and south ;
- it provides a corridor function for flora and fauna of the region;
- it is relatively weed-free;
- it contains habitats of conservation significance including hollow-bearing trees and riparian areas; and
- disturbance to the site has been limited, and its ecological integrity is considered to be high.

5 ASSESSMENT OF LIKELY IMPACTS

5.1 INTRODUCTION

The purpose of this section is to identify potential impacts of the proposal on the flora and fauna of the subject site, study area, locality and region.

The proposal has the potential to have a range of direct and indirect impacts on native flora and fauna and their habitats.

Direct impacts will be contained on the subject site and will include:

- vegetation clearance or modification; and
- loss of fauna habitat.

Indirect impacts have the potential to occur both on the subject site, within the study area and within the locality and may include:

- fragmentation of habitat and loss of regional connectivity;
- edge effects on JBNP;
- weed invasion;
- increase in predation by non-native species;
- change in hydrogeology;
- change in hydrology;
- changes to the downstream wetlands;
- microhabitat changes; and
- alteration to fire regimes.

Potential impacts will vary depending on the species and their degree of dependence on the subject site for habitat.

5.2 POTENTIAL LOCAL AND REGIONAL IMPACTS

5.2.1 Habitat Fragmentation and Regional Connectivity

Habitat fragmentation will result from the clearance or modification of native vegetation for this proposal as areas of currently interconnecting vegetation, both on and off the subject site, will become isolated and / or fragmented. Changes to vegetation are likely to impact on the dispersal ability of many plant species and it may also result in the fragmentation of habitat for threatened fauna species.

The area between the Vincentia and Erowal Bay township has been identified as an important linkage between areas to the north and north-east, including JBNP, with areas to the south and south-east including Booderee National Park (refer *Figure 4.1*). Surrounding development, including Vincentia and Erowal Bay townships and the Bay & Basin Leisure Centre, has resulted in a choke point to dispersal through this area.

5.2.2 Regional Biodiversity

Through mapping of threatened species records a number of threatened species "hotspots" have been identified by DEC (2004) the majority of which are confined to coastal areas. One of the largest concentrations of recorded threatened species occurs around the Huskisson / Vincentia area and down into the Bherwerre Peninsula.

The high level of threatened species richness also corresponds to overall high biodiversity in the area due partly to the large tracts of intact native vegetation and limited development in the region. Fragmentation of vegetation and an increase in development in the region and locality will erode overall biodiversity and may eventually decrease the number of threatened species supported in the area.

5.3 POTENTIAL IMPACTS ON THE STUDY AREA

5.3.1 JBNP

The proposal may have impacts on the adjacent JBNP. These impacts would mainly be associated with edge effects at the bushland / urban interface. At present the subject site provides a buffer from The Wool Road and Jervis Bay Road and rural residential development along Jervis Bay Road. Modification of this buffer may have a number of impacts and these could include:

- changes to the management regime of JBNP by DEC;
- increased human pressure on the JBNP;
- an increase in fire frequency due to accidental ignition and arson, resulting in death of animals and changes to vegetation communities;
- increase in competition and predation by non-native animals through introduction of domestic pets and increased feral animal activity;
- an increase in abundance of suburban native wildlife such as Currawongs, and Noisy Miners, potentially resulting in changes to the species composition in the locality;
- home range reductions through habitat removal, modification and isolation;
- habitat fragmentation through the creation of informal tracks;
- introduction of weeds; and
- changes to water flow regimes and nutrient levels.

Recent amendments to the development footprint in Lot 802 have reduced the potential for impacts from the proposal on JBNP. In addition, the proposal includes dedication of the 47 ha EZ of the subject site to JBNP. Specific management and mitigation of potential impacts of the proposal are discussed in *Chapter 6*.

5.3.2 Wetlands

Prior to inclusion into the JBNP, two wetlands to the north of the subject site were previously listed as SEPP 14 Wetlands No. 324 and 325. These wetlands are downstream of the subject site and are in the catchment of the Jervis Bay Marine Park (Marine Parks Authority 2003).

Potential impacts on these wetlands include:

- changes to the hydrological regime and / or water quality of the wetland;
- changes to the saltmarsh / mangrove associations;
- effects on the habitat or lifecycle of native species dependant upon the wetland; and
- invasion and establishment of non-native flora and fauna species in the wetland.

The management and mitigation of these impacts through the implementation of Water Sensitive Urban Design is discussed in *Chapter 6*.

5.3.3 Jervis Bay Marine Park

The ecological and hydrological connectivity amongst watercourses on the subject site, wetlands and Jervis Bay Marine Park means that there is the potential for impacts on Jervis Bay. These could include:

- changes in hydrology;
- changes in nutrient and toxicant status;
- sedimentation; and
- changes in marine ecology.

However, the hydrological study undertaken by Forbes Rigby aims to address these issues through Water Sensitive Urban Design (Forbes Rigby Pty Ltd 2006).

5.4 POTENTIAL IMPACTS ON THE SUBJECT SITE

5.4.1 Lot 801

Direct Impacts

The proposal for Lot 801 involves clearance of native vegetation, removal or modification of habitat in the north-east and south and south-west of the lot and alteration to the flow of Eastern creek (refer to *Figure 5.1*).

Direct impacts will include the removal of native vegetation that provides known habitat for several threatened species, including the Eastern Pygmy-possum, Ground Parrot, Eastern Bristlebird, *Cryptostylis hunteriana* and microchiropteran bats.

Indirect Impacts

Indirect impacts will include habitat fragmentation through construction of raised walkways across the EZ, linking Village East with the District Centre and linking Village East with Village Central. Changes could also occur to water flow regimes. However, these changes are to be minimised through the implementation of Water Sensitive Urban Design. Changes to water flow regimes have the potential to impact the population of *Prasophyllum affine* and ultimately the downstream wetlands. An increase in human activity in the area may also result in weed establishment and spread, and an increase in the numbers and activities of feral animals and suburban wildlife. There is also the potential for vandalism, rubbish dumping and accidental fire ignition to affect remaining vegetation on the subject site and the neighbouring JBNP. Noise and light regimes will also be changed.

5.4.2 Lot 802

Direct Impacts

The proposal for Lot 802 will result in the removal or modification of native vegetation and changes to the current flow regimes of Western and Central creeks. Vegetation communities within the subject site are generally weed-free and according to the conservation significance rating (refer to *Chapter 4*), are considered to be of high conservation value. These vegetation communities also provide a diversity of habitat for flora and fauna species.

Direct impacts include the removal or modification of vegetation known to be habitat for threatened fauna species, including the Yellow-bellied Glider, Eastern Pygmy-possum, Glossy Black-cockatoo, Eastern Bristlebird, Giant Dragonfly, several species of microchiropteran bats and individuals of the threatened orchids, *P. affine* and *C. hunteriana*. Lot 802 also contains a diversity of native flora and fauna species not listed as threatened.

Indirect Impacts

Potential indirect impacts of the proposal include isolation of habitat in the riparian corridors of the Central and Western creeks and impacts resulting from alterations to the flow regimes of creeks, increased feral animal activity, introduction of weeds, roadkill, home range reductions and habitat fragmentation. Microhabitat disturbance, such as changes to noise and light regimes, may also alter habitat suitability for some species and may adversely impact on fauna resident on the site.

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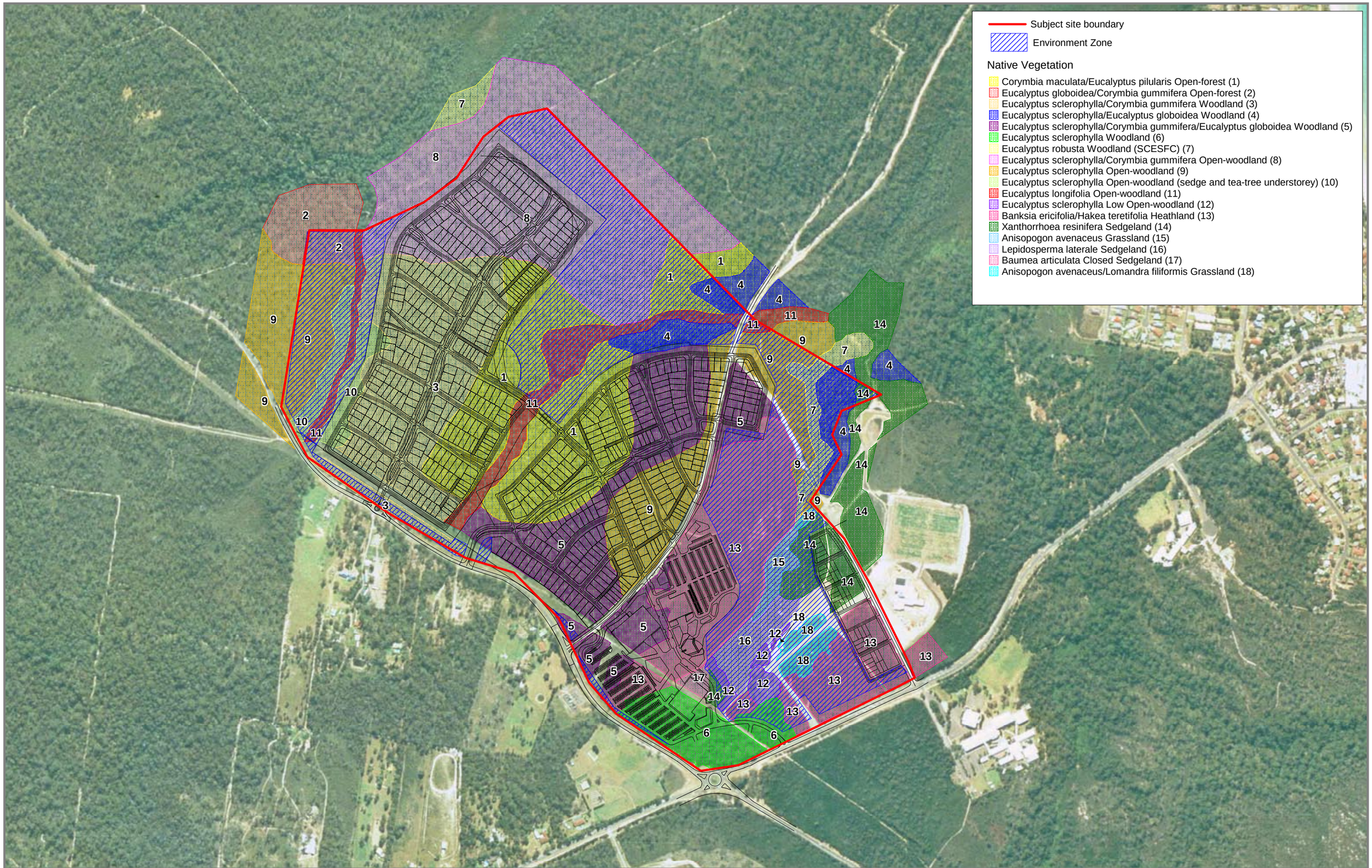

Figure 5.1 **Proposed Concept Plan and Vegetation Communities**

Vincentia
Species Impact Statement

5.5 SPECIFIC AREAS OF IMPACT

This section addresses specific impacts that could potentially affect the vegetation and fauna habitat on the subject site, terrestrial environments in JBNP and JBNP wetlands.

5.5.1 Hydrogeology

There appear to be two groundwater regimes present in the upper lithological profile at the subject site; a perched water table that occurs within the shallow unconsolidated sediments (most likely at the interface with weathered bedrock), and a deeper, confined/semi-confined aquifer system within the weathered bedrock profile. Analysis of hydrographs indicates that hydraulic head values in both systems have declined over the investigation period, due to the below average rainfall conditions (ERM 2006).

While the relatively minor storm events during the study period did not appear to produce a significant response in water level fluctuations in the two aquifer systems, it is anticipated that the deeper system, within the bedrock profile, would have a slower response to storm events than the shallow aquifer. In addition, the water levels in the monitoring wells screened in the shallow unconsolidated sediments averaged approximately 2.5 to 3 m bgl (below ground level), which would presumably be much lower than the root zone of *P. affine*. It is possible that the growth of *P. affine* may be stimulated by periods of consistent rainfall, during which times the soil moisture in the shallow aquifer would be expected to increase (ERM 2006).

5.5.2 Hydrology

The proposal will result in alterations to the natural drainage and flow patterns of water across the subject site and changes to water quality and water levels through the piping of the Eastern creek, construction of stormwater retention ponds and the introduction of hard surfaces on the subject site. These have the potential to affect on site flora and fauna as well as the downstream JBNP Wetlands and Jervis Bay Marine Park.

The hydrological study that addressed the potential impacts of this proposal (Forbes Rigby 2006) concluded that:

- an increase in the coefficient of roughness (Manning's "n") after vegetation clearance will have minimal impact on inundation limits; and
- various water sensitive urban design measures will ensure that water quality will be maintained at levels prior to development.

Nonetheless, the proposal will change the hydrology on the subject site as several permanent ponds will be constructed within the upper reaches of the riparian zones of two of the three creeks. Several additional ephemeral ponds will also be constructed in the APZs as will swales to aid infiltration before water is released into the drainage areas.

The potential indirect impacts associated with changes to the subject site's hydrology if appropriate mitigation measures are not implemented include:

- changes in the flow regimes which will alter vegetation patterns along the three creeks as water-sensitive species associated with those vegetation communities within the gullies may disappear;

- increased nutrient loads which could result in the loss of fish and macroinvertebrate fauna from the wetlands and allow the colonisation of the area by weeds. This could change the utilisation of this area by wetland birds; and

- ephemeral ponding associated with swales constructed within the APZs, which may result in the death of at least some of the trees within these areas.

Flow-on effects to those fauna species associated with the riparian areas may occur. These may include a reduction in habitat suitability and consequently a reduction in numbers of amphibians and changes to the foraging habitat available for bats and birds.

5.5.3 Microhabitat Impacts

The construction of buildings, roads and bridges may impact on a number of microhabitat variables, including shading, wind flow and direction and temperature. Changes to wind flows and direction may affect insect behaviour and indirectly impact pollinator activity. Localised changes in temperatures on the subject site may occur as a consequence of heat retention in structures such as masonry walls and may result in changes to fauna movement patterns and flora composition adjacent to these areas.

5.5.4 Alteration of Light, Noise and Dust Levels

Artificial noise and light levels are likely to increase during construction and remain elevated above current ambient levels thereafter.

During the construction phase, altered noise, dust and light levels would result in disturbance to some species during daylight hours. Ongoing noise will be generated by several sources, such as traffic associated with the residences and supply trucks to the District Centre. Most traffic noise will be during daylight hours although this will be more continuous within Lot 802 with peaks during morning and evening. General noise associated with urbanisation will also result from this proposal.

Little is known of the impacts of noise on most species. However, in general short, sharp noises, such as those associated with sirens or the use of compressed air, are thought to be more disturbing than low level background noise to which species can become habituated. Noise may disturb birds and mammals, and may result in some roosting and foraging areas close to proposed development becoming unsuitable for ongoing habitation. This may be especially important for species that vocalise to establish territories, (eg. Yellow-bellied Gliders), or to contact mates (eg. Eastern Bristlebirds).

Alteration to the light regime on the subject site may change the way in which fauna use this area. Some species, such as insects and bats, may be attracted to light sources whilst other species will avoid lit areas. Light may impact on the behaviour of insects, some of which may be pollinators of plants on the subject site. Insectivorous bats may be attracted to the subject site through the increase in the number of insects gathering around light sources. Without appropriate measures, altered light regimes may disrupt the movement patterns of a number of species including the Eastern Bristlebird and Ground Parrot.

Airborne dust levels are likely to increase during the construction phase. Dust can smother plants and could result in the loss of some species. The accumulation of dust on the subject site during construction may be washed into streams during rain events causing increased levels of turbidity and impacts on aquatic fauna and wading birds.

5.5.5 Weed Invasion

Without appropriate management there is the potential for weeds to colonise and invade areas of retained terrestrial and aquatic native vegetation on the subject site and the adjacent JBNP. These areas currently have a very low density of weed species. Potential weed sources resulting from development of the subject site include residential garden escapees (shrubs, trees and grasses), dumping of garden refuse and invasion during construction through the movement of vehicles and disturbance of soils. Weed invasion could result in:

- a change in the composition of vegetation through superior competitive advantages of weeds; and
- smothering / shading of sensitive species, including *P. affine*.

Invasion of aquatic weeds could also have detrimental downstream impacts on wetlands and Jervis Bay Marine Park.

5.5.6 Alteration of Fire Frequency

Development of the subject site is likely to alter fire regimes. Changes may include:

- overall reduction in fire frequency on the site through fire management and suppression in an urbanised setting; and
- increase in fire frequency through vandalism and accidental ignition, especially along the border with JBNP and within the EZ.

High frequency fire has been listed as a Key Threatening Process under the TSC Act. A change in fire regime, either an increase or decrease, is known to alter the types and composition of vegetation communities (Whelan 1995). Currently, there are a number of successional stages of the *Banksia ericifolia / Hakea teretifolia* vegetation community within Lot 801 and this provides a mosaic of fauna habitats available for species such as the Eastern Bristlebird and Eastern Pygmy-possum, and this is most likely due to time since fire. Appropriate fire regimes are instrumental in maintaining this structure.

5.5.7 Increase in Non-Native Predators

Non-native fauna species recorded on the subject site include the House Mouse, dog and European Red Fox. It is also likely that cats from adjacent farmland would hunt on site, at least along the boundary with Jervis Bay Road. The proposal is likely to increase the occurrence of all of these species on the subject site and provide the opportunity for them to spread further into the JBNP through movement along roads. Residential development also has the potential to increase predation and competition for resources with native fauna by domestic cats. These animals have the potential to significantly impact on both ground and tree dwelling species, including the Eastern Pygmy-possum, Eastern Bristlebird, Ground Parrot, Yellow-bellied Glider and many non-threatened species of native fauna.

DEC currently conduct a fox baiting program in JBNP. The proposed development will mean that the program of baiting will need to be altered as baits cannot be laid within 500 m of an urban interface due to risks to pets and people. Changes to the program may further increase the occurrence of feral animals within those areas.