5.5.8 Increase in Suburban Wildlife

The response of native wildlife to urbanisation differs between species. Many species will die or switch foraging focus in response to urbanisation whilst others increase activity in urban areas due to their competitive advantage in such situations, eg. Brushtail Possum, Noisy Miner, Australian White Ibis, Currawong. This response can result in changes to species composition within the area as they out-compete other species. Such changes in species composition will be particularly important at the bushland / urban interface with JBNP.

5.6 KEY THREATENING PROCESSES

The following Key Threatening Processes are considered relevant to this proposal:

- Clearing of native vegetation (TSC Act) and land clearance (EPBC Act) (refer *Section 5.7.1*).
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (TSC Act) (refer *Section 5.5.1*);
- Ecological consequences of high frequency fires (TSC Act) (refer *Section 5.5.1*);
- Invasion of native plant communities by exotic perennial grasses (TSC Act) (refer *Section 5.5.1*);
- Predation by feral cats (TSC Act and EPBC Act) (refer *Section 5.5.1*);
- Predation by the European Red Fox (TSC Act & EPBC Act) (refer *Section 5.5.1*); and
- Removal of dead wood and dead trees (TSC Act).

Dead wood and dead trees will be removed from development areas as a consequence of this proposal. It is recommended that removal of these resources be undertaken outside the breeding season for key threatened species and that hollows be checked and any resident fauna be removed. This should be undertaken after consultation with DEC.

5.7 IMPACTS OF CLEARANCE OF NATIVE VEGETATION

5.7.1 Vegetation Clearance and Habitat Loss

Clearance of native vegetation is listed as a key threatening process under the TSC Act and EPBC Act. The recovery plans for *Prasophyllum affine* (NPWS 2003c) and the Yellow-bellied Glider (NPWS 2003d) also list this activity as a threatening process.

This proposal will result in the removal or modification of approximately 59 % of native vegetation over the subject site (*Table 5.1*). This percentage calculation takes into consideration areas of vegetation to be removed for urban and commercial development, areas removed for parkland and open space, and areas that will be managed as APZs. The extent of removal of vegetation will range from underscrubbing in APZs to the underscrubbing and clearing of building platforms within Lot 802 to removal of vegetation within Lot 801. Vegetation removal will be complete in areas of road pavement. Road reserves retain the ability to meander the roads around areas of significant vegetation. Trees and green wedges of native vegetation will be retained within the proposed development where possible. None of the 18 vegetation communities recorded on the subject site will be completely removed as a result of this proposal.

Clearing and modification of native vegetation and fauna habitat will be gradual through staged removal across the subject site. Gradual removal and modification of vegetation will provide the opportunity for some fauna species to relocate to adjacent areas.

The remaining 41 % of areas of native vegetation will be retained in Environment Zones, including 46.4 ha in Environment Zone A, and an additional 1.1 ha in Environment Zone B along Jervis Bay Road. The management of these areas is discussed in Chapter 6.

Given the home range and specialised habitat requirements of some threatened species, clearance or modification of vegetation is likely to result in the reduction of home ranges of some species. Aerial photography and satellite image interpretation indicates that the adjacent JBNP and surrounding locality may contain habitat for some of the species impacted by the proposal and database records show that many threatened species occur elsewhere in JBNP and the locality.

Nonetheless, the proposal will result in habitat fragmentation within the locality and inhibit flora and fauna interactions between the subject site and off-site areas. In particular, connectivity between areas north / north-east and south-east of the subject site will be reduced as a result of this proposal (refer *Figure 4.1*).

Fragmentation resulting from the proposal will also increase the edge to area ratio for retained native vegetation and increase the likelihood of edge effects resulting in weed invasion, increased feral animal activity, increased fire frequency and changes in microclimate.

5.7.2 Asset Protection Zones

Of the total area of vegetation to be cleared or modified, around 12 ha will be incorporated into Asset Protection Zones (APZs) ranging in width from 20 to 40 m, to meet the requirements of the EP&A Act, the *Rural Fires Act 1997*, *Rural Fires Regulation 2002* and the NSW Rural Fire Service and PlanningNSW Guidelines (2001). This will involve the removal of the shrub layer and some trees. The retention of the majority of trees within the outer APZ will provide foraging habitat for some fauna species, including microchiropteran bats and birds. The APZs will also provide benefit in the form of vegetated buffers between the development, areas within JBNP to the west of the subject site, and areas of vegetation conserved in the EZ.

Table 5.1 Direct Impacts on Vegetation Communities

ID	Vegetation Community	Study Area* (ha)	Subject Site (ha)	Area within Urban (ha)	Area within APZO (ha)	Area within APZU (ha)	Area within Park (ha)	Total Area Cleared (Urban + APZU + Park) (ha)	Total Area Cleared (%)	Area Retained (ha)	Total Area Retained (%)
1	*Corymbia maculata/Eucalyptus globoidea* Open-forest	18.6	17.9	8.3	1	1.8	1.9	12	67.0	5.9	33.0
2	*Eucalyptus globoidea/Corymbia gummifera* Open-forest	3.6	0.9	0	0	0	0	0	0.0	0.9	100.0
3	*Eucalyptus sclerophylla/Corymbia gummifera* Woodland	15.5	15.5	12.7	0.5	0.8	0	13.5	87.1	2	12.9
4	*Eucalyptus sclerophylla/Eucalyptus globoidea* Woodland	5.5	3.7	0	0.1	0	0	0	0.0	3.7	100.0
5	*Eucalyptus sclerophylla/Corymbia gummifera/Eucalyptus globoidea* Woodland	14.7	14.7	12.4	0.7	0.7	0.3	13.4	91.2	1.3	8.8
6	*Eucalyptus sclerophylla* Woodland	4.4	4.4	3.1	0	0	0	3.1	70.5	1.3	29.5
7	*Eucalyptus robusta* Woodland (SCESFC)	2.7	1.3	0	0	0	0	0	0.0	1.3	100.0
8	*Eucalyptus sclerophylla/Corymbia gummifera* Open-woodland	28.2	17.8	6.1	1.8	1.6	0	7.7	43.3	10.1	56.7
9	*Eucalyptus sclerophylla* Open-woodland	15.9	11.1	4.8	0.3	0.3	0.03	5.13	46.2	5.97	53.8
10	*Eucalyptus sclerophylla* Open-woodland (sedge and tea-tree understorey)	2.9	2.9	0.1	0.6	0.3	0	0.4	13.8	2.5	86.2
11	*Eucalyptus longifolia* Open-	6.1	5.1	0.06	0	0.4	0.9	1.36	26.7	3.74	73.3

ID	Vegetation Community	Study Area* (ha)	Subject Site (ha)	Area within Urban (ha)	Area within APZO (ha)	Area within APZU (ha)	Area within Park (ha)	Total Area Cleared (Urban + APZU + Park) (ha)	Total Area Cleared (%)	Area Retained (ha)	Total Area Retained (%)
	woodland										
12	*Eucalyptus sclerophylla* Low Open-woodland	1	1	0	0	0	0	0	0.0	1	100.0
13	*Banksia ericifolia/Hakea teretifolia* Heathland	17.7	17.1	6.9	0.6	0.2	0	7.1	41.5	10	58.5
14	*Xanthorrhoea resinifera* Sedgeland	7.9	2.7	1.2	0.1	0.2	0	1.4	51.9	1.3	48.1
15	*Anisopogon avenaceus* Grassland	0.9	0.9	0	0	0	0	0	0.0	0.9	100.0
16	*Lepidosperma laterale* Sedgeland	1.7	1.7	0	0	0	0	0	0.0	1.7	100.0
17	*Baumea articulata* Closed Sedgeland	0.4	0.4	0.3	0	0	0	0.3	75.0	0.1	25.0
18	*Anisopogon avenaceus/Lomandra filiformis* Grassland	1.2	1.2	0	0.02	0	0	0	0.0	1.2	100.0
	Total	**148.9**	**120.3**	**56.0**	**5.7**	**6.3**	**3.1**	**65.4**	**54.4**	**54.9**	**45.6**

1. APZO = Asset Protection Zone Outer. APZU = APZ Urban.
2. Area within APZO not included in total area cleared calculations. Total area cleared / modified increases to 59% if APZO included, retained vegetation decreases to 41%
3. SCESFC = Sydney Coastal Estuary Swamp Forest Complex
4. *excluding former SEPP 14 wetlands
5. Calculations do not include areas already devoid of vegetation

5.8 *POTENTIAL IMPACTS ON THREATENED SPECIES*

Thirty-four threatened species were identified as being potentially affected by this proposal (*Table 4.6*). These species were identified by DEC, DEH, through previous studies and studies conducted for this SIS. The relative significance of potential, or direct and indirect impacts, to affect each species is discussed below. Where the potential impacts are similar for species with similar habitat requirements, these species are discussed together.

Impacts on threatened flora and fauna are based on the knowledge of the distribution, abundance, habitat requirements and known or estimated utilisation of suitable habitat on the subject site and in the study area for each of the species.

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

The precise habitat requirements of *Prasophyllum affine* are largely unknown. However, its severely restricted distribution indicates that it is highly specialised and that it is successful in only a narrow range of habitat conditions. The population of *P. affine* on the subject site is considered of major importance to the ongoing survival of this species. Due to the small size of the known populations, *P. affine* is susceptible to localised extinctions and is threatened by habitat degradation. Satellite imagery highlighted the lack of potential habitat for this species within the locality.

In addition, studies of the distribution and movement of the pollinators of *P. affine* (Bower 2004) (*Annex G*) indicate that the relationship between the orchid and its pollinators (*Ariphron* sp.) is closely evolved and is consequently tightly linked. Therefore, impacts may result from a range of processes, including direct impacts on the orchid as well as its pollinators.

Processes which threaten the survival of *P. affine* include:

- vegetation clearance and habitat destruction;
- destruction of pollinator habitat;
- altered fire regimes;
- weed invasion; and
- altered hydrogeological and hydrological conditions.

Vegetation clearance or modification will result in the loss of three known individuals of *P. affine* within Lot 802 adjacent to Moona Creek Road in *Eucalyptus sclerophylla* open-woodland. The low densities of this species west of Moona Creek Road suggests that this location and vegetation type may currently only provide marginal habitat for this species.

A total of 298 individuals (from data collected in 2003/2004) will be retained and protected on the subject site, 121 occur between the Eastern creek and Moona Creek Road, and 177 occur along the access road to the Bay & Basin Leisure Centre. All of these individuals will be protected in the EZ. Under appropriate management the overall opportunity of survival of this species on the subject site is likely to be increased.

As outlined in Bower (2004) the destruction of habitat of the breeding colonies of *Ariphron* sp. may have significant impacts on the pollination and survival of *P. affine*. In general, these areas tend to be open grassy woodlands dominated by Scribbly Gum and Red Bloodwood, especially those areas distributed along minor dirt tracks on the subject site. Recommendations within Bower (2004) will be implemented and areas identified will be retained within the EZ (refer *Figure 4.6*). This includes an important link of pollinator habitat between the subject site and JBNP.

The Jervis Bay Leek Orchid Recovery Team raised concerns regarding foraging habitat for the wasp over its entire life cycle. Further studies have been undertaken which addressed this issue. Bower (2005) recorded feeding by the wasp on a range of plant species, including *Hakea teretifolia, Leptospermum juniperinum, L. continentale, L. polygalifolium* and *Eucalyptus obstans*, across its lifespan all of which will be conserved in the Environment Zone.

Additional impacts on *P. affine* may result from a range of indirect processes, including a change in fire regimes, the impacts of which are unknown for this species.

Other indirect impacts on *P. affine* may result from increased human activity in the area resulting in the trampling of the orchids, weed invasion and changes to the noise and light regimes which could alter pollinator behaviour. Indirect impacts such as these can be managed to some extent and these management measures are discussed in *Chapter 6*.

Of considerable importance will be the maintenance of hydrogeological conditions and flow regimes. The potential impacts of these were discussed in *Sections 5.5.1* and *5.5.2*.

5.8.2 Arachnorchi tessellata *(Thick Lip Spider Orchid)*

This species was not recorded on the subject site during surveys for this SIS or previous surveys undertaken by Gunninah. This may be due to the fact that it occurs in such low densities that it would be extremely difficult to detect or that it does not occur at the subject site. Given that surveys were undertaken at the most appropriate time of year and that it should be possible to detect this species if it is present (NPWS 2003f), it is assumed that this species does not occur on the subject site. Consequently, it is considered that this proposal will not impact on a known population of this species.

However, if it should occur on the subject site, suitable habitat will be retained within the EZ, which will be conserved and managed. Ongoing monitoring of orchid species within the EZ should aid in detecting this species should it occur in this area.

5.8.3 Cryptostylis hunteriana (*Leafless Tongue Orchid*)

Cryptostylis hunteriana has been recorded on the subject site on several occasions. Gunninah (2002) identified 50 individuals within Lot 801, one group of 43 along the access road to the Bay & Basin Leisure Centre and another seven plants just south-east of Eastern creek adjacent to the transmission powerline. Surveys recorded 11 individuals in total, eight within Lot 801 and three within Lot 802 immediately west of Moona Creek Road. These individuals were recorded in the vicinity of *P. affine* plants. Surveys at other sites in the area recorded fewer flowering plants in 2003 than have been recorded previously (Alan Stephenson, *pers. comm.*). Surveys undertaken by GHD in 2004/2005 (GHD 2005a) recorded an additional 20 plants to the north of Eastern Creek and an additional three plants in the woodland to the west of Moona Creek Road. No individuals were recorded in the powerline easement.

Vegetation clearance to the west of Moona Creek Road will result in the loss of six *C. hunteriana* and the removal of around 5.2 ha of potentially suitable habitat for this species. The *Eucalyptus sclerophylla* Woodland Community in which Gunninah (2002) recorded seven plants will also be cleared, resulting in the loss of any individuals in this area.

Other areas of known habitat within the subject site will be conserved and managed within the EZ.

It is difficult to estimate the impact on the species of the removal of a small number of plants from Lot 802 and probably seven or more plants from Lot 801. This species has a much wider distribution than *P. affine* within the locality, region and across the state. Nonetheless, its status as Vulnerable under the TSC Act and EPBC Act means that the retention of all populations is important, especially given that there are likely to be genetic differences between populations. With appropriate management of the EZ, it is likely that the overall opportunity for survival of this species on the subject site may increase in the long-term.

Indirect impacts which may threaten the survival of this species on the subject site are similar to those outlined for *P. affine*, and include alterations to fire regimes, trampling from increased traffic, weed invasion and shading. Like *P. affine*, this species has a closely evolved relationship with a pollinator, and for *C. hutneriana*, an ichneumonid wasp (*Lissopimpla excelsa*) is considered to be the sole pollinator (Bell 2001). This species will also be maintained on the subject site through the retention of suitable habitat.

5.8.4 **Rizanthella slateri** ***(Underground Orchid)***

Little is known of the distribution and habitat requirements of this species as it is extremely cryptic and little studied. It may therefore be more common than is thought within its known distribution (NSW Scientific Committee 2002). This species grows in eucalypt forest near the base of trees, although it does not appear to be closely associated with any one species throughout its range (Dr. Mark Clements, *pers. comm.*).

Potential habitat on the subject site includes areas of *Eucalyptus sclerophylla* woodland communities (Alan Stephenson, *pers. comm.*) although surveys failed to record any plants. Similarly, this species was not recorded during extensive surveys carried out by Shoalhaven City Council at the Baptist Church site immediately south-east of the subject site.

Although the cryptic nature of this plant means that its occurrence on the subject site cannot be ruled out, the outcomes of both of these surveys suggests that this species does not occur in the immediate vicinity of the subject site and consequently it is considered that this proposal will not impact this species.

Should this species occur in the neighbouring JBNP, indirect processes in the form of changes in fire regimes, changes to water regimes, increase in weeds and trampling of the area through increases in human traffic may impact this species.

5.8.5 **Galium australe** ***(Tangled Bedstraw)***

This species was not recorded on the subject site despite targeted searches during the preparation of this SIS. *G. australe* was presumed extinct until recently when one population was recorded approximately 7 km to the south-east at Lake Windemere in Booderee National Park. Although this species is likely to be extremely rare with a restricted 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. *G. australe* favours slopes on friable, loamy soils with abundant ferns in the understorey, associated with an overstorey of *Eucalyptus pilularis*, *E. botryoides* and *Syncarpia glomulifera.* Friable loamy soils are restricted on the subject site to along, and adjacent to, the watercourses in areas without the *Eucalyptus* / *Syncarpia* overstorey association, suggesting that prime habitat is not present.

However, given the extreme rarity of this species, vegetation clearance which results in the loss of any plants of this species would be totally unacceptable. Although prime habitat is unlikely to occur on the subject site, areas of friable loamy soils will be retained within the riparian corridors along the Western and Central creeks.

Indirect processes which may impact on this species, should it occur on the subject site, include changes to the water regime, trampling through increase in human activity along the riparian corridors and invasion of weeds. These indirect impacts can be managed to some extent and these are discussed in *Chapter 6*.

*5.8.6 Southern Brown Bandicoot (***Isoodon obesulus obesulus***)*

The Southern Brown Bandicoot has not been recorded on the subject site (this study and Gunninah 1999, 2000a, 2000b, 2000c, 2002a), the closest record being approximately 8 km to the south-east in Booderee National Park near the village of Jervis Bay. The more common Long-nosed Bandicoot has been recorded on the subject site on several occasions during present and past studies.

Potential habitat in the form of *Eucalyptus sclerophylla* Woodland and *Banksia ericifolia / Hakea teretifolia* Heathland and Sedgeland (refer to *Figure 4.2*) occurs across the subject site. The majority of the *Eucalyptus sclerophylla* Woodland will be removed or modified under the proposal. However, around 15 ha of suitable habitat to the east of Moona Creek Road will be retained, affording some protection for the species should it occur there. This area could potentially provide habitat for one male and several females of this species. Management of feral animals and fire frequency on the subject site would reduce the potential impacts on this species should it occur on site.

Should individuals occur on the subject site, they would be part of a local population of the species, made up of individuals that occur in suitable adjacent habitat in JBNP to the north-east and south-east of the subject site. Suitable habitat within the EZ could become isolated from the surrounding JBNP due to the construction of a raised walkway that will connect Village East / Bay & Basin Leisure Centre with Village Central. Genetic drift as a consequence of isolation is a threatening process for this species.

Although numerous studies have not recorded this species on the subject site it is likely that the habitat corridor provided by the adjacent JBNP and the subject site may be important for populations of this species within the region. It provides the only link between Booderee National Park to the south of the subject site and JBNP to the immediate north of the subject site and sites to the west where this species have been recorded. This proposal would narrow the main habitat corridor between these two areas. This link is considered important to maintain movement of fauna between areas and as a habitat corridor to allow recolonisation between Booderee National Park and JBNP, should it be necessary.

5.8.7 *Long-nosed Potoroo* (Potorous tridactylus)

The Long-Nosed Potoroo has not been recorded on the subject site during numerous surveys. The nearest record is known from approximately 9 km west of the subject site near the township of Tomerong.

However, potential habitat for the Long-nosed Potoroo occurs on the subject site in *Eucalyptus sclerophylla / Corymbia gummifera / Eucalyptus globoidea* Woodland and dense scrub areas such as *Banksia ericifolia/Hakea teretifolia* Heathland, *Lepiodosperma laterale* Sedgeland and *Xanthorrhoea resinifera* Sedgeland along creeks on the subject site.

Habitat for this species, should it occur on the subject site, will be conserved (approximately 14 ha). Therefore, although direct impacts from the proposal include threatening processes such as vegetation clearance, it is unlikely that direct impacts would result in the loss of individuals should they occur on the subject site.

Important indirect impacts may occur as a consequence of a change in fire regime, increase in non-native predation and competition and isolation through habitat fragmentation. An increase in fire frequency could remove necessary habitat in the form of dense vegetation for this secretive and shy species, whilst an increase in predation by feral and domestic animals could quickly remove this species from the subject site, should it occur. Conserved habitat in the EZ will become moderately isolated from the adjacent JBNP through the construction of a raised walkway that will link Village East / Bay & Basin Leisure Centre with Village Central. Additionally, connectivity to vegetation in the northern portion of the subject site will be reduced as a result of the proposal and the local connectivity of habitat for this species will also be reduced.

On a broader scale, the subject site would be important for populations in the locality, as it provides a link between Booderee National Park to the south of the subject site and JBNP to the immediate north of the subject site and to the Yerriyong / Wandanian area where it has been recorded. This link is important to maintain movement between areas and as a corridor to allow recolonisation between Booderee National Park and JBNP, should it be necessary.

5.8.8 *White-footed Dunnart* (Sminthopsis leucopsis)

The open-woodland communities within Lot 802 do not currently provide habitat for the White-footed Dunnart. This species requires forest with dense understorey and as the subject site is only two years post-fire it is unlikely to currently provide much suitable habitat. As the open-woodland communities age, the understorey will become denser and habitat is likely to be restored. Consequently, direct impacts to this species are not expected, although the majority of potential habitat would be removed from the subject site through this proposal.

The subject site may be important for populations of this species regionally, as it provides a link between Booderee National Park to the south-east of the subject site and JBNP to the immediate north and north-east of the subject site as potential habitat for this species occurs in both national parks. This proposal would narrow the main corridor between these two areas at its narrowest point. This link is considered important to maintain movement between areas and as a corridor to allow recolonisation between Booderee National Park and JBNP should it be necessary.

5.8.9 Eastern Chestnut Mouse (Pseudomys gracilicaudatus)

Although the Eastern Chestnut Mouse was not recorded during present or previous studies it has the potential to occur in the heathland areas on the subject site. Given that the majority of this habitat will be conserved, it is unlikely that significant impacts on the Eastern Chestnut Mouse would occur through loss of habitat, as around 9 ha of suitable habitat to the east of Moona Creek Road will be retained. This area could potentially provide habitat for a couple of males and several females of this species.

Should this species occur on the subject site, impacts are more likely to occur through indirect processes. There is the possibility of isolation through construction of a raised walkway connecting Village East / Bay & Basin Leisure Centre to Village Central. As regenerating heath vegetation provides optimal habitat for the Eastern Chestnut Mouse, a reduction in the fire frequency may allow this species to be competitively displaced by the Swamp Rat as the vegetation structure ages (Fox 1995). Predation by domestic pets and feral animals would also pose a threat to this species should it occur on site. Strategies will be implemented to manage fire frequency and reduce the probability of predation by non-native species.

Regionally the subject site may be important for populations of this species, as it provides a link between Booderee National Park to the south-east of the subject site and JBNP to the immediate north and north-east of the site. This proposal would reduce the width of the main habitat corridor between these two areas at its narrowest point. This link is considered important to maintain movement between areas and as a corridor to allow recolonisation between Booderee National Park and JBNP, should it be necessary.

5.8.10 *Grey-headed Flying-fox* (Pteropus poliocephalus)

Although no camps of the Grey-headed Flying-fox have been recorded on the subject site there is little doubt that this species would forage across the subject site at least occasionally. Of particular importance may be the winter-flowering Swamp Mahogany (*Eucalyptus robusta*).

Threatening processes for this species includes:

- destruction of habitat by clearing for urban development and agriculture, particularly critical winter foraging habitat in coastal forests of north-east NSW;
- disturbance at roosting sites;
- unregulated shooting;
- electrocution on powerlines; and
- competition and hybridisation with the Black Flying-fox (*Pteropus alecto)* (NPWS 2001c).

Of the above threats the most relevant will be the destruction of habitat by clearing or modification of habitat for urban development. This proposal will involve vegetation clearance. However, the important winter-flowering species will be retained on the subject site as these species occur in the riparian corridors, especially in the Central and Western creeks. Existing native vegetation should be incorporated into the design of Village Central / West wherever possible. It is envisaged that no significant impacts on this species will occur as a consequence of this development.

Indirect threats to this species will be minimal, as the Grey-headed Flying-fox is regularly associated with urbanised areas. Powerlines which currently dissect the southern boundary of the subject site along Jervis Bay Road may be relocated underground, thus removing an existing threat to Grey-headed Flying-foxes in the area.

5.8.11 Microchiropteran Bats

The potential impacts of this development are similar for the seven species of microchiropteran bats and consequently the impacts on these species are addressed simultaneously. The following species are either known, or are likely to occur on, the subject site or in the study area and were identified as affected species:

- Fishing Bat (*Myotis adversus*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Eastern Freetail Bat (*Mormopterus norfolkensis*);
- Large Bent-wing Bat (*Miniopterus schreibersii*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Yellow-Bellied Sheathtail Bat (*Saccolaimus flaviventris*); and
- Greater Broad-Nosed Bat (*Scoteanax rueppellii*).

These bats are highly mobile and widespread in the region and bats recorded on the subject site are likely to be part of a local population inhabiting the study area and locality, as occurrences of these species have been recorded in the JBNP and broader locality.

Threatening processes for populations of bats are not well understood due to a paucity of research. However, they are likely to include:

- clearing of hollow-bearing trees;
- inappropriate logging cycles which exclude the development of tree hollows;
- habitat destruction and fragmentation;
- degradation of land; and
- reduction in prey abundance (Richards 1991).

Potential impacts on these species include removal or modification of woodland communities from Lot 802.

The Large Bentwing-bat and Large-eared Pied Bat both roost in caves and man-made structures including mines and bridges (Dwyer 1995, Hoye & Dwyer 1995, Glenn Hoye, *pers. comm.*). Consequently, this proposal is unlikely to include removal of breeding habitat for these species. All other species have potential to roost on the subject site. Therefore, the proposal could potentially impact on roosting and foraging habitat for these species.

Glenn Hoye (ERM 2005) found that of the two threatened bat species confidently identified at the subject site, the Eastern Freetail Bat and the Large Bent-wing Bat, only the Eastern Freetail Bat is likely to be roosting at the site. High levels of activity were recorded at two sites, consistent with the presence of a maternity roost at the subject site. To avoid impacts on the survival of the year's cohort, removal of any maternal roost site trees should not be undertaken during the breeding season.

Overall, impacts on all these species are likely to be through removal of woodland and hollow-bearing trees, potential degradation of habitat, reduction in prey abundance and changes to watercourses potentially important as foraging habitat for the Fishing Bat.

These impacts may be reduced by the retention of native vegetation within the residential development and the staging of the proposed development, especially within Lot 802 where the clearing and modification of vegetation will take place in 17 stages over a number of years. It is likely that during this time bats would be able to switch their focus from the areas of clearing to nearby suitable habitat available in the adjacent JBNP and the EZ.

The conservation of Spotted Gum Woodland riparian habitat within the EZ along, and adjacent to, the Central creek corridor will provide roosting, breeding and foraging habitat for most of these bat species.

Nonetheless, this proposal would decrease the overall availability of natural foraging and roosting habitat for these species in the locality. However, an indirect consequence of the proposal may be an increase in food resources through insects being attracted to artificial lighting, thereby increasing the food resources for some bat species.

Indirect impacts such as fragmentation at the local scale are unlikely to significantly affect these mobile species as the subject site borders areas of modified habitat to the west of the site across Jervis Bay Road. Other indirect impacts such as a reduction in local connectivity corridors are not likely to be considerable for these species as they will be able to move around the cleared areas to adjoining habitat.

5.8.12 Eastern Pygmy-possum (Cercartetus nanus)

This species was recorded in two areas of the subject site, one of which was located in the north-eastern corner in *Eucalyptus sclerophylla / Corymbia gummifera* Open-woodland community and the other in the *Banksia ericifolia / Hakea teretifolia* Heathland community to the southeast of Moona Creek Road. Threatening processes listed in the NSW Scientific Committee – Final Determination (2001) for the Eastern Pygmy-possum are:

- isolation of subpopulations with little opportunity for dispersal which increases the risk of local extinction;
- clearing that results in habitat loss and fragmentation;
- inappropriate fire regimes that remove nectar-producing understorey plants;
- the loss of nest sites due to past intensive forestry and firewood collection; and
- predation by foxes and cats.

Clearing and modification of native vegetation resulting in habitat loss will result from the removal of suitable open-woodland vegetation within Lot 802. The *Eucalyptus sclerophylla / Corymbia gummifera* Open-woodland community (vegetation type 8) in the northern part of the subject site, in which one individual was trapped, extends for 17.8ha within the subject site. As a result of negotiations with DEC, the current proposal includes conservation of approximately 10 ha of *Eucalyptus sclerophylla / Corymbia gummifera* Open-woodland community within the EZ. It is considered that, taking into consideration microhabitat differences, the removal of approximately 7 ha of *Eucalyptus sclerophylla / Corymbia gummifera* Open-woodland may result in the loss of several individuals of this species from the subject site.

The Eastern Pygmy-possum was also recorded in the *Banksia ericifolia / Hakea teretifolia* heathland community to the south of Moona Creek Road. Around 10 ha of this heathland community will be retained on the subject site, much of it within the EZ set aside for conservation.

Of threat to the Eastern Pygmy-possums of the subject site will be threatening processes associated with indirect impacts of this proposal. Important indirect impacts may occur as a consequence of a change in fire regimes, an increase in non-native predation and isolation through habitat fragmentation. An increase in fire frequency could remove habitat resulting in the loss of nectar-producing understorey plants whilst an increase in predation by feral and domestic animals could result in a rapid decline of this species from the subject site. These threatening processes will need to be stringently managed if this species is to survive within the EZ.

Within the locality, the subject site would be important for local populations of this species, as it provides a link between Booderee National Park to the south-east of the subject site and JBNP to the north and north-east of the site. This link is important to maintain movement between areas and as a corridor to allow recolonisation between Booderee National Park and JBNP should it be necessary.

It is not clear if the loss of several individuals from the subject site will constitute a real threat to the survival of the Eastern Pygmy-possum in the locality. Configuration of a satellite image to show areas of similar eucalypt woodland habitat within the locality suggests that potential habitat is generally widespread within the neighbouring JBNP. This is supported by mapping undertaken by Mills (1998) and mapping of vegetation communities within the study area for this SIS that confirmed this vegetation type extends into JBNP.

Records of this species 2 km to the south-east of the study area and around 10 km to the west near Wandandian suggests that suitable habitat would occur between these two points. Aerial photography and satellite imagery both show that the clearance and / or modification of around 70 ha of native vegetation from the subject site may effectively isolate suitable habitat in the north and west from those areas of known habitat to the south. Wetland No. 325 forms a partial barrier to movement to the north and only around 200 m of uncleared area will remain between the subject site and the wetland habitat. A further constriction point is formed by the extension of the more southerly wetland (Wetland No. 324) although at this point the area of retained vegetation will be around 300 m.

The precise impacts of any loss of individuals from the subject site on the regional population of Eastern Pygmy-possums are not easy to predict. The loss of any individuals has the potential to reduce the viability of this species in both the region and locality, especially as the most likely scenario for the population structure of this species in the area is a number of metapopulations connected through varying degrees of dispersal and recruitment , as suitable habitat is not likely to be continuous. The degree of genetic isolation would depend largely on the strength of habitat connectivity and the ability for the Eastern Pygmy-possum to move between patches. The loss of a key metapopulation may place other local populations at risk.

5.8.13 Squirrel Glider (**Petaurus norfolkensis**)

It is not considered that this current proposal will impact on any known populations of the Squirrel Glider. The individual recorded by Gunninah (2000a) is likely to have been mistakenly identified. This is consistent with the findings of surveys conducted for this SIS, as several Sugar Gliders were recorded on the subject site through both spotlighting and trapping. Independent verification was provided by Barbara Triggs (Dead Finish) through analyses of scat and hair samples.

The nearest recording of a Squirrel Glider was from around 15 km to the north of the subject site at Culburra during the 1980s. Several attempts at the independent verification of the occurrence of this species at that site have been unsuccessful (Dr Ross Goldingay, *pers. comm.*).

These data suggest that this species may have been wrongly identified on these two occasions, or that the Squirrel Glider occurs at such low densities that detection is extremely difficult. However, given the abundance of highly suitable habitat on the subject site and the extent of spotlighting, stagwatching and trapping over past and present studies, it is likely that this species would have been detected if it was resident on the subject site.

5.8.14 Yellow-bellied Glider (**Petaurus australis**)

The Yellow-bellied Glider is widespread across Lot 802 and its distribution extends into the adjacent JBNP. This species has a home-range of between 30 and 65 ha, depending on productivity of the site (Goldingay and Kavanagh 1991). Recent mapping of home-ranges of around 31 Yellow-bellied Glider family groups recorded in the St Georges Basin area suggested that the home-ranges of two family groups extend into the subject site. These home-ranges would consist of both gully, midslope and ridgetop habitats, in order to provide the mosaic of resources and feed trees necessary over the year. Evidence to support such use of Lot 802 is the occurrence of feed trees on the ridgetop, the occurrence of hollow-bearing nest trees midslope and the observations of Yellow-bellied Gliders throughout the gully areas.

This species was originally listed as threatened in NSW because it was recognised by NPWS (1992) that:

- there had been a severe reduction in population size;
- its distribution had been reduced;
- threatening processes are severe;
- this species is an ecological specialist; and
- the species has poor recovery potential.

Currently, the most important threat to its survival is a reduction in its range and an alteration of its habitat (NPWS 2003d). The key threatening processes for the Yellow-bellied Glider are known to be:

- loss and fragmentation of habitat through clearing and the activities associated with clearing;
- logging of old growth forests which removes hollow-bearing trees;
- inappropriate fire regimes which reduce available food resources and isolates populations; and
- predation by foxes and cats.

Of these threats only logging is not relevant to this proposal, although clearing or modification within Lot 802 will remove a large number of hollow-bearing trees. The species may continue to use the Central creek riparian zone, where the northern section and adjacent woodland and forest communities to the north of the creek will be conserved in the EZ and there will be an adequate buffer to development. The conservation of Spotted Gum riparian vegetation in this area will also provide foraging, nesting and breeding habitat for Yellow-bellied Gliders within the subject site.

The subject site would be important for populations of this species, as it provides a link between Yellow-bellied Gliders recorded to the south-west and those within the JBNP and adjacent areas such as Woollamia. Given the shrubland / heathland vegetation communities within Lot 801 it is unlikely that the Yellow-bellied Glider currently uses the subject site to move in a south-easterly direction. It is more likely that movement would occur along the riparian corridors of the Western and Central creeks to adjacent wooded areas where other family groups occur (SCC & DEC 2004). This link is considered important, as isolation of populations can ultimately result in genetic drift and decreased survival rates for a species. The Western creek riparian corridor will be conserved and provide a potential movement corridor from the subject site to JBNP and habitats to the south.

A population of Yellow-bellied Gliders is known to occur at Woollamia in close association with rural residential development. However, there are no known examples where populations of this species has continued to co-exist with high degrees of urbanisation (Dr Ross Goldingay, *pers. comm.*), and it is unknown whether the individuals inhabiting the subject site will continue to do so once development at the subject site is complete. There is the possibility that the young females of the resident family groups may disperse into nearby habitats of the JBNP, as some dispersal must naturally occur to avoid acute inbreeding depression.

Although this species is relatively widespread in the Shoalhaven, it occurs at low densities due to its large home range, and has a patchy distribution due to modification and removal of its habitat across much of the coastal plain. It is estimated that around 31 family groups occur in the St Georges Basin area. The direct impact of the loss of any individuals of this species from the locality is unclear, as the effective population size below which Yellow-bellied Glider populations lose viability is unknown. The cumulative impacts associated with development in the St Georges Basin area could result in the loss of a number of family groups over time. It is considered that the majority of the Yellow-bellied Glider family groups which currently occur in pockets of habitat in close proximity to residential development throughout the region will fail to reproduce and recruit in the near future due to the pressures associated with urbanisation. The most likely scenario for ongoing survival of this species is within areas of secure land tenure such as is available within JBNP and that to be conserved in the EZ on the subject site.

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

Gunninah (2000b) detected this species midslope from the Central creek within Lot 802 and during spotlighting along a transect in the north of the subject site and into JBNP. However this species was not recorded on the subject site during surveys for this SIS. This may indicate that this species is not currently utilising this site, as surveys for this study were undertaken in appropriate weather conditions (Resci 1996).

Of the identified threats to the Giant Burrowing Frog, those most relevant to this proposal include:

- habitat loss through urban development, especially of ridge top habitat sites;
- erosion and sedimentation of head water creeklines, particularly where runoff rates and flows are increased through upper catchment development;
- fire, either directly through death or indirectly through a decrease in invertebrate prey items; and
- road mortality.

The proposed development of the ridgetop areas of Lot 802 will remove potentially suitable breeding and foraging habitats. In addition, an indirect impact of removal of woodland communities may lead to a decrease in invertebrate prey available for local populations of this species.

This proposal will also modify sections of the creeklines within Lot 802. Construction of swales and holding ponds will alter the current creeklines and flow regimes. Upslope development will remove the current series of water holes along the slope.

Vehicle movements across the subject site in general, and the riparian corridors in particular, will potentially impact on suitable habitat for the Giant Burrowing Frog by dissecting the habitat and posing a road kill threat to this species.

However, recent amendments to the project plan for Village Central / West will conserve an additional 10 ha of potential habitat for the Giant Burrowing Frog within the EZ on the northern border of the subject site and within the Central creek riparian corridor. The species has been recorded in this area previously by Gunninah, and this habitat adjoins JBNP and the wetland to the north of the site. In addition, the EZ will conserve Scribbly Gum / Bloodwood Open-woodland, which provides additional potential habitat for the species.

Numerous records for this species occur in the locality, the majority of which appear to be concentrated to the south-east of the subject site, including in the adjacent JBNP and Booderee National Park. The subject site is towards the southern limit of the distribution of the northern population of this species. However, given that habitat will be conserved within the EZ for this species, and that there are numerous records of the species from the locality, including from conservation reserves, it is unlikely that the development will have an adverse impact on the survival of the species in the region.

5.8.16 *Glossy Black-cockatoo* (Calyptorhynchus lathami)

There are numerous records of Glossy Black-cockatoos using the subject site, including eight from the current study, 32 from previous surveys by Gunninah and 25 records from the NPWS Wildlife Atlas. These records represent a point in time indication of the number of birds using the subject site but the size of the regional population that may forage on the site from time to time would be much larger. The NPWS Wildlife Atlas lists 130 records from the locality.

Feeding habitat for Glossy Black-cockatoos is present on the subject site in the form of mature, cone bearing *Allocasuarina littoralis* (Forest She-oak). *A. littoralis* occurs as stands within several of the woodland communities on the subject site. These are located within Lot 802 immediately to the west of Moona Creek Road and Lot 801 at the corner of Jervis Bay Road and Moona Creek Road. Distribution of key stands of *A. littoralis* is shown in *Figure 4.8*. Regenerating stands are also present in other areas of the subject site such as along the verges of Moona Creek Road.

A total of 14.1 ha of *A. littoralis* will be progressively cleared as a result of the proposal. This will result in the direct loss of feeding habitat for the species.

Potential breeding habitat for Glossy Black-cockatoos occurs on the subject site in the form of hollow-bearing trees. No nesting sites were identified during September targeted surveys that included observations at dawn and dusk and around watering points. However, two nest sites were identified within Spotted Gum Forest along the Central creek corridor during surveys undertaken by GHD in May 2005 (GHD 2005c), with another two nests sites identified within JBNP less than 300 m from the north-eastern boundary of the subject site. The current Lot 802 project plan includes the conservation of these two recorded nest sites in the EZ, as well as conservation of *Euclayptus longifolia* Woodland and Spotted Gum Forest within the Central creek corridor, both of which provide breeding habitat for the species. In addition, 10 ha of Scribbly Gum / Bloodwood Open-woodland will be conserved adjoining these riparian areas and the adjacent JBNP, providing a buffer from the residential development of Village Central / West to Glossy Black-cockatoo habitats within the JBNP, maintaining probable flight paths between nest sites and feeding resources and conserving a high density of large hollows important as potential nest sites.

It is likely that additional breeding habitat occurs within the adjacent JBNP and that the removal of hollow-bearing trees from the subject site may not constitute a regional impact on the Glossy Black-cockatoo. It is not possible to directly quantify the significance of the loss of feeding habitat from the subject site to the regional population of Glossy Black-cockatoos without knowledge of the distribution of alternative feeding sources in the region. The species is mobile and can seek out other seed sources in the region. However, the birds rely on a mosaic of feeding habitats so that in the event of fire destroying a stand of feed trees, other stands are available to move to. Recent fires in the locality have destroyed several stands of *A. littoralis* (Mike Saxon, *pers. comm.)* and therefore the stands within the subject site may be considered a significant feeding resource on a regional scale.

5.8.17 *Eastern Bristlebird (*Dasyornis brachypterus*)*

Eastern Bristlebirds have become so specialised that availability of habitat has now become a major limiting factor (Chapman 1999). Coastal development and the increased incidence of fire, predation by foxes and cats and general human disturbance have all put pressure on the small remaining populations. Small populations still exist at Barren Grounds Nature Reserve, Budderoo National Park and JBNP.

Eastern Bristlebirds are known to occur on the subject site, and were recorded in the heathland community within Lot 802 to the west of the Eastern creek by ERM during surveys for this SIS. The subject site contains 17.1 ha of heathland vegetation, of which 7.7 ha (45 %) will be cleared or modified under the current proposal. Based on known densities (Dr. Jack Baker *pers. comm.*) this could represent loss of habitat for up to three Eastern Bristlebirds (based on a maximum density of four birds per 10 ha).

Eastern Bristlebirds have also been recorded in *Eucalyptus sclerophylla* Open-woodland and *Eucalyptus globoidea/Syncarpia glomulifera* Open-forest in the west of Lot 802 (Gunninah 2002a) and in riparian vegetation of the Western creek by ERM during surveys for this SIS. Approximately sixty-nine percent (69 %) of the open-forest community and forty-six percent (46%) of the Open-woodland community will be cleared or modified under the current proposal. The Western creek riparian corridor will be conserved under the proposal.

The subject site is important for the regional Eastern Bristlebird population as it provides a link between the populations in Booderee National Park to the south-east of the subject site, and JBNP to the immediate north and north-east. The role of the subject site as a habitat corridor connecting populations of Eastern Bristlebirds became even more important after fire destroyed large areas of Eastern Bristlebird habitat in Booderee National Park in December 2003. Recolonisation of Booderee National Park from JBNP via the subject site is now important. The site may also provide important refuge habitat for birds redistributing after the fire. The potential loss of three birds as a result of the proposal may not constitute a significant impact on the regional population. However this would depend on ensuring the site continues to function as a viable movement corridor and provide areas of suitable habitat for the species into the future.

5.8.18 *Ground Parrot* (Pezoporus wallicus wallicus)

Ground Parrots were recorded on the subject site by ERM during surveys for this SIS. At least four individuals were recorded in the grassland and sedgeland communities on Lot 801. Previous surveys by Gunninah also recorded Ground Parrots in the sedgeland vegetation on Lot 801

There is currently estimated to be less than 550 birds remaining in the Jervis Bay region (Bherwerre Peninsula and Beecroft Peninsula) (Baker 1996).

Approximately 12.4 ha of vegetation suitable for Ground Parrots will be cleared under the proposal. This could provide potential habitat for approximately two Ground Parrots, based on an estimated density of two birds per 10 ha (Dr Jack Baker, *pers comm*.). Approximately 14 ha of suitable habitat will be retained in the EZ east of Moona Creek Road. Other available habitat for the Ground Parrot within 2 km of the subject site was identified from a satellite image and these areas are shown in *Figure 4.9.*

Although a similar area of habitat is being retained, relative to that being cleared, the habitat remaining will be compromised and thus have reduced value as habitat for Ground Parrots. Ground Parrots are a shy, ground-dwelling bird, vulnerable to predation by cats, dogs and foxes. The habitat in the EZ will be surrounded by development and will have reduced functional connectivity to suitable habitat.

The proposal will impact on the Ground Parrot directly through the loss or modification of low dense heathland, grassland and sedgeland habitat and indirectly through the loss of connectivity that the subject site currently provides. The increased edge effects and the influence of non-native predators, which are often associated with urbanisation, may impact habitat for the Ground Parrot in areas to the north and south of the subject site.

The subject site is a linking habitat corridor for populations in Booderee and JBNP and also has potential as a refuge area after fire. This connectivity function may be compromised under the proposal. The potential regional impacts of the proposal on the Ground Parrot will be dependent on ensuring the subject site continues to provide protected habitat for this species and continues to function as a corridor between other identified habitats within the locality.

5.8.19 Swift Parrot (Lathamus discolor)

The Swift Parrot has not been recorded on the subject site during previous surveys and was not recorded during the surveys by ERM for this SIS. There are no NPWS Wildlife Atlas records for the species from the locality.

Eucalypt woodlands on the subject site support winter-flowering species that could provide foraging resources for the species during its over-wintering period on the NSW coast. These include *Eucalyptus robusta* (Swamp Mahogany), *E. globoidea* (White Stringybark), *E. pilularis* (Blackbutt), *Corymbia maculata* (Spotted Gum) and *C. gummifera* (Red Bloodwood). Although the species has not previously been recorded on, or in the vicinity of, the subject site, the site contains resources that could be important for the species from time to time, particularly during drought and during the winter migration period (Saunders 2003). Many of these tree species will be conserved in the EZ and it is considered unlikely that impacts on the species as a result of the proposal would be significant.

5.8.20 *Regent Honeyeater* (Xanthomyza phrygia)

The Regent Honeyeater was not recorded on the subject site during surveys for this SIS and was not recorded during previous surveys by Gunninah. The eucalypt woodlands on the subject site provide potential foraging habitat for the species, in particular a preferred feed tree species, Swamp Mahogany, occurs along drainage lines and in the north-eastern corner of Lot 802. Regent Honeyeaters are nomadic in response to flowering in particular species of eucalypt. Hence they may use the subject site from time to time.

Swamp Mahogany trees will be retained within the EZ along the creeks and in the north-west and the north-east of the subject site. Thus the proposal is not likely to have a significant impact on Regent Honeyeaters.

5.8.21 *Turquoise Parrot* (Neophema pulchella)

The Turquoise Parrot has not been recorded on the subject site during previous surveys and was not recorded during surveys conducted by ERM for this SIS. The species has been recorded in JBNP to the north of the subject site and there are several NPWS Wildlife Atlas records from the locality.

The woodlands on the subject site would provide nesting habitat for the parrots as they nest in hollows of small trees. There is potential foraging habitat on the subject site in the form of grassy and shrubby understorey within eucalypt woodlands. Several tree species listed on the DEC threatened species profile as Turquoise Parrot food plants were recorded on the subject site (*Leucopogon microphyllus* and *Dillwynia* spp.). Whilst the birds have not been recorded during previous surveys, they could potentially utilise the subject site from time to time.

The proposal will result in the loss of potential foraging and nesting habitat for the Turquoise Parrot. However, the proposal will retain hollow-bearing trees in the EZ, and given that the subject site does not support known habitat for the species and known habitat occurs in the adjacent JBNP, loss of habitat from the subject site is unlikely to constitute a significant impact.

5.8.22 *White-throated Needletail* (Hirundapas caudactus)

The White-throated Needletail has been recorded at the subject site during a number of surveys conducted by Gunninah and more recently during the ERM surveys. This species has been recorded in the woodland/forest areas at the subject site.

Approximately 96 ha of woodland/forest occur at the subject site, of which 62 ha (63%) will be cleared under the current proposal. The subject site provides roosting habitat, in the form of hollow-bearing trees, and feeding habitat for the White-throated Needletail. The current proposal will conserve hollow-bearing trees and potential foraging habitat within the EZ that adjoins JBNP. Although a proportion of the potential habitat for this species will be removed from the subject site, it is unlikely to have a significant impact as this species is migratory, inhabiting Australia as a nomadic species during spring and summer. Furthermore, large areas of potential habitat for this species occur within the nearby JBNP and therefore the habitat lost as a consequence of the proposal is unlikely to be considered significant. The proposal would not result in loss of all habitat for this species within the region.

5.8.23 Square-tailed Kite (Lophoictinia isura)

The Square-tailed Kite was recorded hovering over and perching on trees within the subject site on numerous occasions during surveys for this SIS. Although this species was not detected nesting within the subject site during these surveys, it is possible that this species may nest there on occasion as previous surveys have identified a possible nest location (Gunninah 2002a).

Whilst the population status of the species in south-eastern Australia is poorly known (Debus 1998), it is known that this species prefers a structurally diverse landscape with a broad range of habitats and appears to utilise a hunting range of over 100 km^2 (NPWS 2003e). This proposal will remove or modify foraging and nesting habitat from the subject site. However, recent amendments to the project plan for Village Central / West will see the conservation of large trees and foraging habitat for this species within the EZ adjoining JBNP.

The current proposal is unlikely to have a significant impact on the Square-tailed Kite, as ample foraging habitat is available in the locality. Low densities and recruitment rates of this species means that known nest sites should be protected if they occur on the subject site.

5.8.24 Powerful Owl (Ninox strenua)

Powerful Owls have been recorded on the subject site during previous surveys by Gunninah and by ERM during surveys for this SIS. The species may utilise hollow-bearing trees on the subject site for nesting and roosting, although no nests were recorded. The subject site also supports suitable foraging habitat for the species.

Direct impacts of this proposal are the removal and modification of foraging and potential nesting habitat from the subject site. Recent amendments to the project plan for Village Central / West will conserve an additional 10 ha of habitat within the EZ adjoining JBNP. This habitat contains large hollow-bearing trees and habitat for prey species such as Yellow-bellied Gliders.

The species will be indirectly impacted by reduction in the number of arboreal mammals (prey) in the region through the loss of hollow-bearing trees. Owls have a large home range so these impacts may not necessarily be significant in a regional context.

5.8.25 Sooty Owl (Tyto Tenebricosa)

There are no records of Sooty Owls from the locality or from the subject site and none were recorded during ERM surveys for this SIS. While the subject site supports potential foraging, roosting and nesting habitat, similar suitable habitat is available in the adjacent JBNP. Thus the impact of loss of habitat from the subject site is unlikely to be significant.

5.8.26 Masked Owl (Tyto novaehollandiae)

Masked Owls were recorded on the subject site by Gunninah in previous surveys and were recorded by ERM in surveys for this SIS. The loss of hollow-bearing trees will result in the loss of nesting and roosting habitat for the species. It is probable that there is a resident Masked Owl in the northern drainage line as this is the location of many of the records. This area will be conserved in the EZ of the subject site. The EZ in this area will also provide approximately 10 ha of suitable foraging and roosting habitat.

5.8.27 Satin Flycatcher (Myiagra cyanoleuca)

This species was not recorded on the subject site, although surveys were undertaken during the breeding season, nor is it known from the locality.

Although the species has not previously been recorded on, or in the vicinity of, the subject site, the subject site contains resources that could be utilised by this species during breeding and migration northwards. Vegetation clearance as a consequence of this proposal will remove both breeding and foraging habitat should this species use the subject site periodically. However, it is considered unlikely that impacts on the species as a result of the proposal would be significant as adjacent and nearby areas provide relatively large areas of suitable habitat for the Satin Flycatcher, and habitat for the species will be conserved in the EZ.

5.8.28 Rufous Fantail (Rhipidura Rufifrons)

Gunninah (2002a) recorded this species on this subject site. No further details were available of the location of these sightings but given this species preference for gully habitats it is likely that it was recorded in the Western and / or Central creeks.

Habitat for this species will be retained within the riparian zones of the Western and Central creeks. The habitat value of the Western creek gully may be reduced due to the proximity of urban development. However, potential habitat will be conserved in the EZ of the Central creek and it is considered unlikely that impacts on the species as a result of the proposal would be significant, as adjacent and nearby areas provide relatively large areas of suitable habitat for this species.

5.8.29 *Giant Dragonfly* (Petalura gigantea)

The Giant Dragonfly was recorded within the subject site in December 2004 by Glenn Hoye of Fly by Night Bat Surveys during field surveys for microchiropteran bats. The species was recorded within the *Eucalyptus sclerophylla / Corymbia gummifera* Open-woodland community (vegetation community 8) in the northern part of the subject site, where the site adjoins JBNP. GHD (2005d) mapped areas of potential foraging and breeding habitat for the Giant Dragonfly within Lot 802.

Potential impacts to this species are likely to result from vegetation clearance in riparian areas and within nearby foraging habitat, changes to water regimes and infilling, draining or flooding of areas of breeding habitat (GHD 2005d). Therefore, the survival of the Giant Dragonfly at the subject site would depend on the retention of both breeding habitat and adjacent foraging habitat, and the retention of current water table and surface water regimes (GHD 2005d). The current project plan will conserve breeding habitat along the Western creek and the majority of the Central creek riparian areas, as well as conserve the majority of potential foraging habitat in the open-woodland in the north of the subject site.

Disruption of water regimes may cause a local extinction across the subject site if an increase or decrease in water levels and water quality results from development of the site (GHD 2005d). In addition, disruption of the subject site population may impact on proximate populations, due to a reduction in genetic diversity amongst populations within the region. Few impacts to the species on a local or regional scale could be expected if current riparian areas are conserved and water regimes maintained (GHD 2005d).

5.9 ENDANGERED ECOLOGICAL COMMUNITIES

5.9.1 *Sydney Coastal Estuary Swamp Forest Complex (SCESFC) (now Swamp Sclerophyll Forest)*

Eucalyptus robusta Woodland along the Eastern creek was identified as Sydney Coastal Estuary Swamp Forest Complex (SCESFC) through assessment of factors outlined in the Final Determination (NSW Scientific Committee 2000). This community had previously been mapped as Community 3.2 *Eucalyptus robusta* forest – woodland of Mills (1993). Since this time 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 and replaces SCESFC, this report refers to the area within the subject site as SCESFC.

SCESFC occurs only on alluvial or estuarine waterlogged soils. This soil condition generally occurs along drainage lines and in other low-lying areas on coastal lowlands adjacent to freshwater wetlands and is therefore likely to have limited occurrences within the locality.

SCESFC is known to occur in three main areas within the locality. The smallest area of SCESFC occurs immediately north of the subject site in JBNP, and includes part of the study area and the fringes of wetlands and creeks near Moona Moona Creek. The second area is further north and is associated with low lying floodplain areas adjacent to Currambene Creek. The largest area of SCESFC in the locality is located to the north-east of Bid Bid Creek. The quality of SCESFC in these areas is unknown and only the SCESFC which occurs in JBNP is protected.

Approximately 1.3 ha of SCESFC occurs on the subject site and a total of 2.7 ha occurs in the study area. No area of SCESFC will be removed under the proposal and therefore direct impacts are likely to be minimal. In addition, recent amendments to the development footprint of Village Central / West will provide additional buffer between the residential development and this community. However there is potential for indirect impacts to this community from the proposal and these include:

- edge effects including microclimatic changes and weed invasion as a result of clearance or modification of surrounding vegetation;
- potential for construction activities and personnel to impact on the community through trampling or rubbish dumping;

- run-off from development introducing weeds and sedimentation in to the community;

- an increase in fire from arson attacks due to an increase in human activity from proposed development;

- changes to the nature of the soil from excess / reduced runoff resulting in changes to species composition of SCESFC; and

- an increase in pedestrian traffic due to the proximity of proposed development, leading to introduction of weeds and general disturbance.

SCESFC will be conserved as a part of the EZ. Recommended mitigation measures to reduce potential indirect impacts to SCESFC are discussed in *Chapter 6*.

5.10 SUMMARY OF POTENTIAL IMPACTS

Of the 18 vegetation communities recorded on the subject site, only the SCESFC is considered to be an endangered ecological community under the TSC Act. Although no area of SCESFC will be removed, it has the potential to be indirectly impacted by this proposal and consequently measures to protect this community are detailed in *Chapter 6*.

Much of the habitat for flora and fauna on the subject site is represented in nearby reserves, including JBNP. Accordingly, those fauna species that are mobile, and able to use a broad range of resources, are unlikely to be significantly impacted by the removal or alteration of habitat on the subject site. Potential impacts are therefore likely to be confined to those threatened species with highly specialised habitat requirements and /or limited distribution. Specific impact mitigation measures for these threatened species are addressed within *Chapter 6*. These measures are aimed at conserving and managing habitat for these species on the subject site and although they are aimed specifically at the affected species, other species identified on the subject site may also benefit from these measures.

The creeks, downstream wetlands and waters of Jervis Bay have the potential to be impacted by this proposal. Measures to protect the water quality of these areas are detailed in Forbes Rigby Pty Ltd (2006) and briefly outlined in *Chapter 6*.

The subject site provides an important linkage within the locality joining the Bherwerre Peninsula with areas to the north and north-west. The proposal will reduce the size of the current corridor, which may be of increasing importance in the context of further proposed development in the locality. Previously the masterplan for the site was restricting movement through the site from the north to the south. However, recent amendments to the development footprint in Lot 802 will widen the corridor through the site from approximately 130 m to 200 m at its narrowest point. In addition, the conservation of vegetation in the EZ proposal will increase the width of the HC3 corridor identified for the region.

6 IMPACT AMELIORATION MEASURES

6.1 INTRODUCTION

The proposal will have direct and indirect impacts on flora and fauna of the subject site and within the study area, and may affect connectivity within the locality and species within the region.

This chapter outlines the ameliorative measures that will be implemented to minimise the likelihood of the above impacts on species, communities or habitats of conservation significance. In particular, species-specific measures for the threatened species considered to have the potential to be impacted by the proposal are detailed within this chapter.

6.2 DIRECT IMPACT MITIGATION

6.2.1 *Vegetation Clearance*

Although approximately 71 ha of vegetation will be cleared or modified under the proposal (i.e. 59 % of the vegetation on the subject site), areas of native vegetation and habitat for targeted threatened flora and fauna will be retained on the subject site. This includes the area in the north and north-east of the subject site that will be conserved in the EZ and that will reduce potential indirect impacts on JBNP. In addition, Stockland proposes to transfer ownership of the EZ to JBNP, which will ensure appropriate management and protection of these areas into the future. Riparian zones will be retained and protected for their intrinsic value and as a source of valuable fauna habitat and movement corridors. Trees will be retained and protected where possible, especially those that have particular value as fauna habitat and overhead powerlines may be relocated to underground lines. Development at the site will occur according to a staging plan. The staged development process will allow the regeneration of areas of lower ecological value prior to development of areas identified as fauna habitats of significance.

In addition it is recommended that:

- domestic lawn and non-native plant species be discouraged to avoid their spread into adjacent JBNP and the EZ;
- plants of local provenance be used in landscaping. Where possible these should be sourced from seed collected from the subject site before earthworks begin. Greening Australia should be consulted regarding the best way to salvage soil seeds and canopy held seeds; and
- trees that provide additional fauna habitat be planted as a part of the landscaping of the subject site.

6.3 INDIRECT IMPACT MITIGATION

A range of indirect impacts have the potential to affect the remaining vegetation communities, threatened flora and fauna and habitat and these are discussed below.

6.3.1 *Hydrological Issues*

The proposal has the potential to result in increased nutrient loads and run-off from the subject site. Unless treated this may have detrimental impacts on flora and fauna, downstream wetlands and ultimately the Jervis Bay Marine Park. To mitigate these potential impacts Forbes Rigby Pty Ltd (2006) has undertaken a hydrological study and has incorporated a number of Water Sensitive Urban Design features into the proposal including water supply management, stormwater quality control and groundwater management. Of paramount importance will be ensuring water quality is maintained at predevelopment levels. Measures to address this issue are shown in *Table 6.1*.

Table 6.1 Proposed Treatment of Stormwater Runoff on the Subject Site

Treatment Measure	Purpose	Comment
General pollutant trap	Removal of coarse pollutant, e.g. Litter	Combination of different types which recognise maintenance issues.
Bio-swales	Physical filtration & capture of fine sediments Exfiltration to groundwater	Small particle sizes will be removed by the bio-swale including fine sands. Subsurface filter component of the swales is able to treat trickle flows up to a few litres per second. Will also aid in recharge of the groundwater system during dry periods.
Wetlands (deep water zone)	Sedimentation & storage of sediments	Artificially constructed wetland deepwater zones remove those particle size ranges and hydraulic loadings that are not captured & assimilated at earlier stages. A minimum of 24 hr hydraulic resident time is preferred for capture of fine sediments. Fine sediments stored in the bottom of the wetland and absorbed nutrients made available for plant uptake.
Wetlands (macrophyte zones)	Physical filtration & capture of fine sediments. Enhanced sedimentation and storage of fine sediments. Biological uptake.	This zone provides for enhanced sedimentation through provision of direct filtration by plant stems & reduced resuspension of bottom sediments. Macrophytes actively take up nutrients and convert them into a less bio-available form.

1. Source: Forbes Rigby Pty Ltd 2006

Groundwater Quality Management

Forbes Rigby Pty Ltd proposes the following measures to ameliorate the impacts on groundwater:

- provision of a bio-swale within the reserve of Moona Creek Road with a 3 m wide allocation on the south-eastern side which will aid in increasing soil moisture levels and groundwater recharge on the north-western side of the *Prasophyllum affine* area;

- the District Centre wetland pond will remain unlined to assist maintenance of soil moisture levels and groundwater recharge upstream of *P. affine*; and

- ensuring flows from the modified and piped creek under the proposed District Centre are not concentrated but spread out as sheet flow to mimic natural conditions.

In the riparian zones, additional mitigation measures will need to be implemented to ensure water and habitat quality in these areas is maintained including:

- an erosion and sediment control plan is to be prepared which will address the construction and post-construction phases of the development. This plan is to be formulated in accordance with acceptable standards and is to ensure that the development does not cause environmental damage to the waterways or bushland or have a detrimental impact on air quality; and

- temporary fencing and signage of the EZ and any proposed buffers during construction, to ensure construction works for the development do not penetrate the boundaries of the setback areas.

6.3.2 Weeds

Currently, the subject site is mostly weed-free and provides a buffer between existing development along The Wool Road, Jervis Bay Road and JBNP. Development has the potential to result in weed invasion on the subject site and into JBNP. This may occur during construction when areas of vegetation are removed and through spread of weed propagules via construction activities. Weed proliferation may occur as a result of changed light regimes and increased edge effects. Development adjacent to the JBNP and watercourses will also increase the likelihood of weed invasion from garden escapees or general weeds. Therefore, it is important that management and mitigation measures are implemented to ensure that the quality of vegetation and habitat in areas conserved within the EZ are not compromised as a result of the development and that the integrity of JBNP is ensured. For this reason, the following mitigation measures are recommended:

- a Weed Management Plan for the subject site to focus on resident education, early identification of invasive weeds, monitoring of exotic plant distribution and effectiveness of management controls, particularly adjacent to JBNP and riparian corridors;

- a Vegetation Management Plan for retained vegetation;

- a Construction Management Plan focusing on worker education, ensuring areas contained with the EZ are protected and stringent guidelines detailing management of construction activities; and

- the planting of introduced plant species, particularly known environmental or noxious weeds be discouraged.

6.3.3 Feral and Domestic Animals

Non-native fauna species recorded on the subject site include the House Mouse, dog and European Red Fox. Feral and domestic animals can impact on native flora and fauna through predation, competition, soil degradation and by disturbing foraging and nesting patterns of native fauna.

Development of the subject site would have the potential to enhance feral animal populations especially as baiting programs in JBNP would need to be altered, and may result in a substantial increase in the number of domestic animals in the National Park.

It is recommended that management of feral and domestic animals within the site be addressed in a Feral and Domestic Animal Management Plan. This would include control measures during construction and post-construction phases to minimise habitats for feral animals and set out restrictions and controls for domestic cats and dogs. The plan would influence the educational material and signage that will be required as part of the proposal.

Some mitigation measures to be incorporated into the plan include:

- minimisation of rubbish and debris left at the subject site from development activities during the construction phase;

- the banning of all cats from the development;

- resident eduction to recognise the importance of dogs being kept on a lead and out of conservation areas and JBNP; and

- the use of fauna-proof bins in open space areas.

6.3.4 Fire Management

To protect property and the adjoining JBNP from fire, provisions have been made for Asset Protection Zones (APZs) to be established in perpetuity. The primary purpose of the APZs will be to ensure that a progressive reduction of bushfire fuels occurs between the bushfire hazard and any habitable structures (BES 2004). APZs vary in width from 40 m in areas of high fire potential to 20 m in areas in which wildfire is less likely to occur, such as in heathland areas. APZs will not result in complete vegetation removal and in instances where it is appropriate, canopy trees will be retained as well as ground cover. Water Sensitive Urban Design strategies will be incorporated into the APZs and weeds and feral and domestic animals would be controlled within the APZs.

The implementation of appropriate fire regimes will be required to maintain vegetation communities at levels suitable for key threatened species, especially in the EZ. These may differ between species and a Fire Management Plan will be prepared which will clearly focus on key issues for the maintenance of habitat for threatened species and communities and will take into consideration the surrounding land uses.

Recent amendments to the project plan for village central /west will ensure that all fire control activities will be undertaken within the subject site and that fire regimes and control measures in JBNP will not be impacted as a result of development of the site.

6.4 SUBJECT SITE CONSERVATION – ENVIRONMENT ZONE

Conservation of native vegetation that provides habitat for targeted threatened species on the subject site is a key mitigation measure of the proposal. All areas of native vegetation to be conserved will fall within the 47 ha of the EZ *(Figure 5.1)* and Stockland proposes to transfer ownership of the EZ to DEC, to ensure the long-term protection and appropriate management of habitats for threatened species of the subject site and the locality. The majority of vegetation communities will be represented within the EZ. These are shown in *Table 6.2*.

Table 6.2 Vegetation communities represented within the EZ

Number	Classification
1	*Corymbia maculata / Eucalyptus globoidea* Open-forest
2	*Eucalyptus globoidea / Corymbia gummifera* Open-forest
3	*Eucalyptus sclerophylla / Corymbia gummifera* Woodland
4	*Eucalyptus sclerophylla / Eucalyptus globoidea* Woodland
6	*Eucalyptus sclerophylla* Woodland
7	*Eucalyptus robusta* Woodland (SCESFC – Endangered Ecological Community)
8	*Eucalyptus sclerophylla / Corymbia gummifera* Open-woodland
9	*Eucalyptus sclerophylla* Open-woodland
10	*Eucalyptus sclerophylla* Open-woodland (Sedge & Tick Bush Understorey
11	*Eucalyptus longifolia* Open-woodland
12	*Eucalyptus sclerophylla* Low Open-woodland
13	*Banksia ericifolia / Hakea teretifolia* Heathland
14	*Xanthorrhoea* Sedgeland
15	*Anisopogon avenaceus* Grassland
16	*Lepidosperma laterale* Sedgeland
18	*Anisopogon avenaceus / Lomandra filiformis*

The EZ to the east of Moona Creek Road has been specifically set aside to provide habitat for the Eastern Bristlebird, Ground Parrot, *Prasophyllum affine* and its pollinator, *Cryptostylis hunteriana*, Eastern Pygmy-possum and the endangered ecological community, Sydney Coastal Estuary Swamp Forest Complex (now Swamp Sclerophyll Forest).

The Western creek riparian corridor is known habitat for the Yellow-bellied Glider, Eastern Bristlebird and microchiropteran bats. This corridor will be conserved in the EZ and adjoins JBNP.

Central creek provides core habitat for the Yellow-bellied Glider and Glossy Black-cockatoo. A large proportion of the Central creek corridor and adjacent riparian forest and woodland communities will be conserved in the EZ and this will conserve nest trees for the Glossy Black-cockatoo and nesting and breeding habitat for the Yellow-bellied Glider. The conservation of vegetation in this area also protects ecotonal vegetation types and a stand of *A. littoralis* feed trees.

Potential habitat for the Giant Dragonfly and Giant Burrowing Frog will be conserved in the EZ that adjoins the JBNP in the north and north-east of the subject site. In addition, the conservation of the Western creek corridor and the northern portion of the Central creek corridor within the EZ will provide potential breeding habitat for both these species.

While all of these species were considered in the layout of the EZ, the highest priority for conservation has been given to the Eastern Bristlebird and *Prasophyllum affine*, due to their extremely restricted distribution and specific habitat requirements.

Specific measures for each key threatened species are detailed in *Section 6.5*

6.5 REVIEW OF DEVELOPMENT FOOTPRINT

Since July 2003 the development footprint has evolved having regard to the species impact statement and ongoing discussions with DEC. As a result, impacts to some species have been minimised. Where potential impacts may occur, mitigation measures are recommended.

Negotiations between DEC and Stockland regarding that part of the subject site known as 'Area 5' have resulted in recent amendments to the residential development footprint within Lot 802. The conservation of vegetation within this area resulted in an increase of 10 ha of native vegetation within the EZ. Specifically, the EZ was extended to incorporate 'Area 5' to:

- conserve a stand of *A. littoralis* trees as foraging habitat for the Glossy Black-cockatoo;
- conserve known nest sites and flight paths of the Glossy Black-cockatoo;
- conserve foraging and breeding habitat for the Yellow-bellied Glider and Eastern Pygmy-possum;
- provide an additional buffer from residential development to the wetlands to the north and north east of the site and to JBNP;
- conserve habitat for the Giant Dragonfly and Giant Burrowing Frog;
- conserve hollow-bearing trees that provide potential habitat for a number of threatened species including the Powerful Owl and Yellow-bellied Glider;
- conserve ecotonal vegetation types and reduce the amount of woodland and forest vegetation types that were going to be removed as a result of the proposal; and
- to improve the habitat corridor function of the subject site.

6.6 SPECIES-SPECIFIC MITIGATION

6.6.1 *Flora*

Those flora species for which specific design and conservation measures have been incorporated into the proposed footprint include:

- Jervis Bay Leek Orchid (*Prasophyllum affine*); and
- Leafless Tongue Orchid (*Cryptostylis hunteriana*).

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

Prasophyllum affine is known to occur in the *Anisopogon avenaceus / Lomandra filiformis* Grassland within Lot 801 and the *Banksia ericifolia/Hakea teretifolia* Heathland within village central /west. All known habitat for *Prasophyllum affine* within Lot 801 is to be conserved and the *Banksia ericifolia / Hakea teretifolia* Heathland, containing *Prasophyllum affine,* within village central /west will also be conserved. A small number *of Prasophyllum affine* individuals were also recorded within village central /west within the *Eucalyptus sclerophylla* Open-woodland just north of Moona Creek Road. These individuals will not be conserved and it is recommended that they be collected by CSIRO for research purposes.

The EZ to the east of Moona Creek Road has been specifically set aside to accommodate the habitat requirements of *P. affine* and to ensure adequate protection of this species. This will assist in ensuring a long-term outcome for this species in line with the Draft Recovery Plan (NPWS 2003c) and the requirements of the Jervis Bay Leek Orchid Recovery Team. Modifications to the footprint have included:

- removal of proposed upslope development from the Bay & Basin Leisure Centre group of *P. affine* to ensure that current ground water regimes are maintained;

- reduction of the footprint of Village East reduced to ensure that a 25 m buffer outside of required APZs is maintained around all "edge" *P. affine.* Currently the access road to the Bay & Basin Leisure Centre passes within 5 m of some plants of this species;

- removal of proposed connecting road between Village East and the District Centre removed to ensure continuity of pollinator habitat; and

- areas set aside to ensure adequate pollinator foraging and breeding habitat.

It is recommended that a Vegetation Management Plan include the orchid habitat and focus on the establishment of management goals and monitoring objectives developed in consultation with DEC and the Jervis Bay Leek Orchid Recovery Team. The selection of logical and appropriate biological parameters as key indicators of vegetation condition will be critical to the ongoing survival of *P. affine* in this area.

Pollinator Wasp

As noted above an important component identified for the ongoing survival of *P. affine* is the maintenance of habitat for its wasp pollinator, *Ariphron* sp. The plant-pollinator relationship is tightly linked and consequently needs to be maintained as a high priority. Those areas of important habitat identified by Bower (2004) will become part of the EZ (*Figure 4.6*). Importantly, the EZ also retains pollinator habitat that links the EZ with the adjacent JBNP, which is considered an important movement corridor for this species of wasp. Recent studies by Bower (2005) have demonstrated that the EZ contains suitable foraging habitat across the entire life span of *Ariphron* sp.

*Leafless Tongue Orchid (*Cryptostylis hunteriana*)*

Cryptostylis hunteriana was recorded at the subject site within both the Lot 801 and Lot 802. Habitat for this species will be conserved within Lot 801 within the *Banksia ericifolia / Hakea teretifolia Heathland* and *Anisopogon avenaceus /Lomandra filiformis* Grassland areas. Village Central /West, *C. hunteriana* was recorded within the *Eucalyptus sclerophylla* Open-woodland. These areas will not be conserved as part of the proposal and it is recommended that these individuals be collected for research purposes.

The area containing *C. hunteriana* within Lot 801 will be incorporated into the EZ planned for the subject site. It is recommended that specific conservation measures for *C. hunteriana* be developed in discussion with DEC and put in place to ensure the survival of the plants within the EZ.

6.6.2 Endangered Ecological Community - Sydney Coastal Estuary Swamp Forest Complex

The endangered ecological community, Sydney Coastal Estuary Swamp Forest Complex (SCESFC) (now Swamp Sclerophyll Forest) will be conserved and protected as a part of the EZ. The design of the submission has been modified to remove the proposed road linking Village East / Bay & Basin Leisure Centre with Village Central and replaced with a walkway along the existing unformed road. This modification ensures the retention of all areas of SCESFC (previously 0.2 ha was to be removed). It is also recommended that the existing unsealed road be rehabilitated. As a consequence erosion of the roadway and sedimentation of the Eastern creek will cease. Rehabilitation of the existing road with endemic species will minimise impacts to SCESFC from edge effects such as weed invasion.

6.6.3 Fauna

Those fauna species for which specific design and conservation measures have been incorporated into the proposed footprint include:

- Eastern Pygmy-possum (*Cercartetus nanus*);
- Yellow-Bellied Glider *(Petaurus australis);*
- Glossy Black-cockatoo *(Calyptorhynchus lathami);*
- Eastern Bristlebird *(Dasyornis brachypterus);*
- Ground Parrot (*Pezoporus wallicus*);
- Giant Burrowing Frog (*Heleioporus australiacus*);
- Giant Dragonfly (*Petalura gigantea*); and
- microchiropteran bats.

Eastern Pygmy-possum (Cercartetus nanus)

Habitat for this species will be conserved within the EZ east of Moona Creek Road in *Banksia ericifolia / Hakea teretifolia* Heathland (approximately 10 ha) and within the woodland in the north of the subject site, adjoining JBNP (approximately 10 ha).

In the original submission design the potential existed for the *Banksia ericifolia / Hakea teretifolia* Heathland to become isolated from JBNP and movement corridors to the north and south through construction of a road linking Village East and Bay & Basin Leisure Centre with Village Central. To increase the opportunity for this species to move from the EZ to JBNP the proposed road is replaced with a raised walkway linking these areas. The Eastern Pygmy-possum is more likely to cross this type of structure and the risk of being killed by a vehicle during the crossing is removed.

A number of other measures are also recommended as part of the development. These include the control of domestic and feral animals on the subject site, control of weeds and maintenance of appropriate fire regimes. Fauna-sensitive lighting regimes are recommended in the District Centre development to reduce the effects of artificial lighting on the behaviour of this species. These measures should be aimed at directing light back onto the development and reducing the time that artificial lighting is used.

These mitigative measures will benefit a range of other small fauna for which potential habitat occurs in the EZ, including:

- Southern Brown Bandicoot (*Isoodon obesulus*);
- Long-nosed Potoroo (*Potorous tridactylus*); and
- Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*).

Yellow-bellied Glider (Petaurus australis)

Yellow-bellied Gliders were recorded in the *Eucalyptus sclerophylla* Open-woodland and *Eucalyptus globoidea / Corymbia gummifera* Open-forest adjacent to and along the Western creek, and within the open-woodland of the Central creek. The Western creek corridor will be conserved within the EZ, as will the northern portion of the Central creek riparian zone. Habitat conserved in these areas includes hollow-bearing trees and feed trees. The recent amendments to the residential development footprint of Village Central/ West will benefit this species by conserving an additional 10 ha of habitat and providing a buffer from development along the Central creek riparian zone, as well as widening the available habitat corridor to the north by 70 m, from 130 m to 200 m.

Glossy Black-cockatoo (Calyptorhynchus lathami)

Glossy Black-cockatoos will move into urban areas and utilise isolated trees as a foraging resource. The retention of *A. littoralis* on the subject site will minimise impacts on the species. There is some evidence that Glossy Black-cockatoos are food-limited, so retention of foraging resources would be seen as a positive contribution to protecting this threatened species.

Known nest sites and the flyways between these sites (GHD 2005c) will be conserved under the proposal, conserving habitat that will remain connected to JBNP in the north and north-east. The conservation of habitat within the EZ of Lot 802 provides existing foraging resources, and future feeding resources in the form of regenerating *A. littoralis,* as well as large hollow-bearing trees for potential breeding sites. There will be no clearance of known nest trees and it is recommended that clearing in general at the subject site be timed to avoid the nesting season of this species.

Eastern Bristlebird (Dasyornis brachypterus)

The layout of the District Centre has been designed to ensure that movement corridors across the Wool Road and through to Eastern creek are maintained. David Bain and DEC's mapping of Eastern Bristlebird habitat on the subject site indicates that both primary and secondary habitat occurs on the subject site. Three areas of specific concern were highlighted and these were:

Area Adjacent to Lot 801 and The Wool Road

Vegetation in this area was considered to have good habitat value for this species, in terms of foraging and as a habitat corridor. Development in this area has been modified to ensure good quality habitat and the functionality of the habitat corridor for this species remains intact.

Eastern Boundary of District Centre

The eastern boundary of the District Centre was shown to overlap with the habitat corridor for this species to such an extent that movement of the Eastern Bristlebird would be retarded. Although this area is considered to be secondary habitat due to the effects of the 2001 fires, it would currently be used by this species for movement and will continue to regenerate towards primary habitat over time (David Bain, *pers. comm.*). The current layout provides further modifications of the footprint to enable retention of the area adjacent to Lot 801 and The Wool Road, and redesign of the eastern boundary of the District Centre, which allows enhanced movement of this species from southern off-site areas to Eastern creek. This is considered to be one of the major movement corridors of this species through the subject site.

South-eastern Corner of Lot 801

The vegetation community adjacent to The Wool Road / Jervis Bay Road roundabout was identified as important primary habitat (foraging and habitat corridor) for this species. The ecological functionality of this area will be reduced by the placement of The District Centre immediately to the north. Eastern Bristlebirds moving into this area would be blocked from moving north and into Eastern creek due to the position of the District Centre.

A number of additional mitigation measures are recommended to aid in the conservation of this species as a part of the development and these include:

- staged development to allow the birds to move to suitable habitat unaided. The staged development plan will allow for the succession of vegetation currently considered secondary habitat, into primary habitat;

- preparation of a Weed Management Plan and Feral Animal Management Plan for the subject site;

- exclusion of cats from the development, reducing the risk of predation; and

- residents to be required to leash their dogs and all dogs be excluded from the EZ.

*Ground Parrot (*Pezoporus wallicus)

The majority of current habitat for this species will be conserved on the subject site through incorporation into the EZ.

In addition a number of mitigation measures are recommended to reduce indirect impacts on this species as follows:

- preparation of a Weed Management Plan and Feral Animal Management Plan for the subject site;
- cats to be excluded from the development; and
- residents to be required to leash their dogs and dogs should be excluded from the EZ.

Microchiropteran Bats

Several species of threatened microchiropteran bats are known to, or are likely to, forage across the subject site. A number of conservation strategies to allow conservation and ongoing utilisation of this habitat are recommended:

- vegetation clearance be appropriately timed to avoid removal of any active maternal roost sites identified;
- conservation of the riparian corridors and trees within the APZs to continue to provide foraging habitat for these species;
- incorporation of appropriate landscaping trees into the development to make foraging resources available; and
- bridges and culverts to incorporate into their design, features that provide and encourage some species to use these structures for daytime roosting. Such features can include those suitable for cave-dwelling species. Additional bat roosting habitat could be provided through the use of constructed bat houses placed in appropriate areas.

Giant Burrowing Frog (Heleioporus australiacus)

Habitat for the Giant Burrowing Frog will be retained on the subject site along the western and northern boundaries of Lot 802 and along the riparian corridor in the north of Central Creek. The chain-of-ponds associated with the Western creek will retain deep pools of water between rain events which may be suitable for development of Giant Burrowing Frog tadpoles. The retention of potential habitat on the western slope of this creek could provide breeding and foraging habitat for this species.

Giant Dragonfly (Petalura gigantea)

Giant Dragonfly habitat was identified by GHD (2005d) along the Western and Central Creek corridors and along the northern edge of the subject site. Under the proposal the breeding habitat along both riparian corridors will be retained and foraging habitat in the north of the site will be incorporated into the EZ. In addition, the proposal will aim to minimise impacts to the hydrology of the site to ensure that the water levels and quality of water at the site are not compromised as a result of development.

7 CONCLUSIONS

7.1 EVOLUTION OF THE DEVELOPMENT FOOTPRINT

During the SIS process, the development footprint has been significantly modified to address the concerns of DEC and all mitigation measures that could be reasonably undertaken are planned for implementation. A negotiation process with DEC was undertaken through a number of key stakeholder meetings, as well as regular meetings between Stockland and DEC representatives. The key changes made to the original development include:

- a staged plan for the development to allow regeneration of important habitat and gradual displacement of fauna;
- modifications to the footprint design to conserve habitats of significance and minimise impacts to threatened species;
- amendments to the footprint to conserve the threatened ecological community within the study area;
- reduction of the footprint to incorporate a buffer around known records of the Jervis Bay Leek Orchid;
- amendments to the footprint in the north of the subject site to reduce potential impacts on JBNP, and to protect threatened species and their habitats in this area; and
- amendments to the footprint of the District Centre to provide a wider habitat corridor for the Eastern Bristlebird.

7.2 SUBJECT SITE ATTRIBUTES

Extensive studies across the subject site have demonstrated that the site is ecologically important in the locality and region for the following reasons:

- supports high biodiversity;
- supports 18 intact vegetation communities;
- supports regionally significant species and communities;
- supports numerous flora and fauna species listed as threatened under the TSC Act and EPBC Acts;
- supports migratory species;

- supports an endangered ecological community;
- supports one of three remaining populations of the orchid *Prasophyllum affine*; and
- it is currently part of an ecologically important habitat corridor.

Eighteen vegetation communities including open-forest, woodland, open-woodland, low-open woodland, heathland, sedgeland and grassland, were recorded across the study area. These communities are primarily weed-free except for areas that border roads or other minor disturbances and overall biodiversity across the subject site is considered to be high. JBNP adjoins the western side of the proposed Village Central / West development area and important wetlands to the north-east are part of the catchment of the subject site. Some limited logging of selective trees has historically taken place although there is no evidence to suggest that the subject site has been cleared or utilised for agricultural purposes.

The subject site and adjacent lands are also recognised as part of an important habitat corridor that permits movement between the Booderee National Park to the south-east and JBNP towards the north, north-west and west of the subject site.

7.3 MITIGATION

The design of the development footprint has evolved in response to the outcomes of numerous ecological studies and consultation with relevant stakeholders. To minimise the potential impacts on threatened species a number of impact mitigation measures have been incorporated into the proposal. These measures are described in *Chapter 6*. In addition, a range of ameliorative measures is recommended in order to minimise adverse impacts. These measures include innovative and best-practice approaches to urban design and conservation areas.

Specific mitigation measures are recommended for key threatened species and these may reduce some of the impacts of this proposal. These measures include an EZ of 47 ha that is proposed to be dedicated to DEC. Twenty-two ha of the EZ to the east of Moona Creek Road is known habitat for the Eastern Pygmy-possum, Eastern Bristlebird, Ground Parrot, *Prasophyllum affine, Cryptostylis hunteriana* and the endangered ecological community, Sydney Coastal Estuary Swamp Forest Complex (now Swamp Sclerophyll Forest). Other habitats within the EZ will provide resources for the Yellow-bellied Glider, Glossy Black-cockatoo, Giant Dragonfly, Giant Burrowing Frog and Eastern Pygmy-possum.

7.4 *POTENTIAL IMPACTS*

The proposal will result in the removal of 56 ha of vegetation and an additional 15.2 ha of vegetation will be modified within APZs and parks. The majority of the vegetation clearance will occur in the woodland communities between Moona Creek Road and the north-western boundary of the subject site. The total area of vegetation retained under the proposal (not including areas within APZ's) is approximately 49 ha (or 41%). Vegetation clearance will impact on a range of species, including key threatened species.

Extensive mitigation measures have been incorporated into the development footprint to minimise impacts to threatened species and habitats of conservation significance and for some threatened species the outcomes of the conservation strategies planned may increase the chances of ongoing survival on the subject site over the current levels of management. However, mitigation and conservation strategies can not entirely remove the potential for direct or indirect impacts on some species. A summary of the outcomes of conservation strategies and the potential impacts of the proposal on eight key threatened species are discussed below in *Section 7.4.1*.

7.4.1 *Key Species*

Flora

Prasophyllum affine

The mitigation measures proposed for the threatened orchid, *Prasophyllum affine,* are considered to be adequate to ensure the ongoing survival of the species within the EZ provided it is maintained to levels acceptable to the Jervis Bay Leek Orchid Recovery Team and DEC. This species may benefit from those measures proposed, particularly as no protection or management of this population currently occurs.

Cryptostylis hunteriana

The habitat requirements of this species are similar to those of *P. affine* and consequently it is considered that this species will be adequately conserved on the subject site.

Fauna

Eastern Pygmy-possum (*Cercartetus nanus*)

Eastern Pygmy-possums were recorded in the heathland east of Moona Creek Road and within the woodland of Lot 802. Potential impacts on this species from the proposal include direct mortality, loss of habitat connectivity and indirect impacts associated with residential and commercial development adjacent to existing habitats.

Recent amendments to the development footprint of Village Central / West have resulted in the reduction of a number of potential impacts to this species and approximately 20 ha of known habitat (including 10 ha of heathland and 10 ha of woodland) will be conserved at the subject site.

Yellow-bellied Glider (*Petaurus australis*)

Potential impacts of the proposal on the Yellow-bellied Glider may include direct mortality and indirect impacts associated with residential and commercial development adjacent to existing habitats. It is considered likely that the proposal will result in the loss of a family group from the site.

The proposal will conserve approximately 20 ha of known Yellow-bellied Glider habitat in the north, north-east and west of the subject site. The recent amendment to the development footprint within Lot 802 has resulted in the reduction of potential impacts to this species by conserving riparian habitats and known and potential foraging and breeding habitat.

Eastern Bristlebird (*Dasyornis brachypterus*)

The Eastern Bristlebird was recorded within Lot 801 and Lot 802. The proposal will result in the loss of high quality habitat, reduction in connectivity of habitat and indirect impacts associated with residential and commercial development and it is likely that approximately three individuals will be directly impacted by the development.

The proposal will conserve habitat and retain the corridor function of the subject site for this species through the retention of secondary habitat and some primary habitat in key areas.

Ground Parrot (*Pezoporus wallicus wallicus*)

Ground Parrots were recorded within Lot 801. Potential impacts from the proposal on the Ground Parrot include indirect impacts from residential and commercial development, the potential loss of individuals through direct mortality and loss of known habitat of a species with a restricted distribution.

Habitat for this species will be retained on the subject site in the EZ east of Moona Creek Road and the habitat corridor functionality of the subject site will be retained through retention of habitat in key areas.

Glossy Black-cockatoo (*Calyptorhynchus lathami*)

Potential impacts from the proposal on the Glossy-black Cockatoo include the indirect impacts associated with residential development, such as an increase in non-native predators, and the direct loss of existing feeding resources.

Two known nest trees and an area of foraging habitat for the Glossy-black Cockatoo will be conserved in the northern portion of the site adjoining JBNP and replanting of areas of the subject site with *A. littoralis* will provide future feeding resources.

Giant Dragonfly (*Petalura gigantea*)

Potential impacts of the proposal on the survival of the Giant Dragonfly at the subject site will be dependent on the retention of both breeding habitat and adjacent foraging habitat, and the retention of current water table and surface water regimes (GHD 2005d).

The current project plan will conserve breeding habitat along the Western creek and the majority of the Central creek riparian areas, as well as conserve the majority of potential foraging habitat in the open-woodland in the north of the subject site.

7.5 CONCLUDING STATEMENT

The proposal has aimed to reduce the impacts to threatened species at the subject site through reduction of the original development footprint, through the implementation of mitigation measures and through conservation of significant habitats within Lot 801 and Lot 802.

Measures implemented to reduce the impact on threatened species include:

- the retention of habitat for key threatened species and habitat corridors along riparian zones; and
- conservation of 47 ha within an Environment Zone to provide habitat for *Prasophyllum affine, Cryptostylis hunteriana,* Eastern Bristlebird, Ground Parrot, Eastern Pygmy-possum, Yellow-bellied Glider, Glossy Black-cockatoo, Giant Burrowing Frog, Giant Dragonfly, Sydney Coastal Estuary Swamp Forest Complex (Swamp Sclerophyll Forest) and microchiropteran bats.

In addition, the following measures have been recommended to further minimise the potential for impacts on threatened species at the subject site and in the adjacent JBNP:

- implementation of a Weed Management Plan and Vegetation Management Plan;
- implementation of a Feral Animal Management Plan; and
- banning of cats from the development.

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NPWS 17 December 2003. New South Wales National Parks and Wildlife Service.

Annex A

Compliance Tables

Section	Description	Compliance	Location
109	**Form of Species Impact Statements**		
1.	A species impact statement must be in writing	Yes	This report
2.	A species impact statement must be signed by the principal author of the statement and by:	N/A	N/A
	a. the applicant for the licence, or		
	b. if the species impact statement is prepared for the purposes of the *Environmental Planning and Assessment Act 1979*, the applicant for development consent of the proponent of the activity proposed to be carried out (as the case requires), or	Yes	This report
	c. if the species impact statement is prepared for the purposes of the *Plantations and Reafforestation Act 1999*, the applicant for authorisation under that Act.	N/A	N/A
110	**Content of species impact statement**		
1.	A species impact statement must include a full description of the action proposed, including its nature, extent, location, timing and layout and, to the fullest extent reasonably practicable, the information referred to in this section.	Yes	Chapters 1 & 2
2.	A species impact statement must include the following information as to threatened species and populations:		
	a. a general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action,	Yes	Chapters 4 & 5
	b. an assessment of which threatened species or populations known or likely to be present in the area are likely to be affected by the action,	Yes	Chapters 4 and 5, Table 4.6
	c. for each species or population likely to be affected, details of its local, regional and State-wide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or threat abatement plan applying to it,	Yes	Chapters 3, 4 & 5 Annex E
	d. an estimate of the local and regional abundance of those species or populations,	Yes	Chapter 4 & 5
	e. (Repealed)	N/A	
	f. a full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region,	Yes	Chapter 4, 5 & Annex E
	g. a full assessment of the likely effect of the action on those species and populations, including, if possible, the quantitative effect of local populations in the cumulative effect in the region,	Yes	Chapter 5
	h. a description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development,	Yes	Section 2.4
	i. a full description and justification of the measures proposed to mitigate any adverse effect of the action on the species and	Yes	Chapters 6 & 7

Section	Description	Compliance	Location
	populations, including a compilation (in a single section of the statement) of those measures,		
	j. a list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population.	Yes	Table 1.2
3.	A species impact statement must include the following information as to ecological communities:		
	a. a general description of the ecological community present in the area that is the subject of the action and in any area that is likely to be affected by the action,	Yes	Chapters 4 & 5
	b. for each ecological community present, details of its local, regional and State-wide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or any threat abatement plan applying to it,	Yes	Chapters 4 & 5
	c. a full description of the type, location, size and condition of the habitat of the ecological community and details of the distribution and condition of similar habitats in the region,	Yes	Chapters 4 & 5
	d. a full assessment of the likely effect of the action on the ecological community, including, if possible, the quantitative effect of local populations in the cumulative effect in the region,	Yes	Chapter 5
	e. a description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development,	Yes	Section 2.4
	f. a full description and justification of the measures proposed to mitigate any adverse effect of the action on the ecological community, including a compilation (in a single section of the statement) of those measures,	Yes	Chapters 6 & 7
	g. a list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the ecological community.	Yes	Table 1.2
4.	A species impact statement must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement.	Yes	Annex B
	The requirements of subsections (2) and (3) in relation to information concerning the State-wide conservation status of any species or population, or any ecological community, are taken to be satisfied by the information in that regard supplied to the principal author of the species impact statement by the National Parks and Wildlife Service, which information that Service is by this subsection authorised and required to provide.	N/A	N/A

1. N/A = Not applicable

Table 1 Compliance with Director-General's Requirements (Matters to be Addressed) for this SIS

Section	Description	Compliance	Location
	Nineteen Key Threatening Processes are now listed in NSW. Of particular relevance to the proposed development are the listed Key Threatening Processes: 1. Predation by the European Fox *Vulpes vulpes*; 2. Predation by the Feral Cat *Felis cattus*; 3. Ecological consequence of high fire frequencies; 4. Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; and 5. Clearing of native vegetation. For each species likely to be affected by any of the Key Threatening Processes the SIS shall address whether the proposed activity will increase this threat, and shall address proposed ameliorative measures.	Yes	Chapters 5, 6 & 7
1.	**Form of the Species Impact Statement**		
1.1	*A species impact statement must be in writing(Section 109 (1))*	Yes	This report
1.2	*A species impact statement must be signed by the principal author of the statement and by:*		
	a. the applicant for the licence, or	N/A	N/A
	b. if the species impact statement is prepared for the purposes of the Environmental Planning and Assessment Act 1979, the applicant for development consent of the proponent of the activity proposed to be carried out (as the case requires), or	Yes	This report
	c. .if the species impact statement is prepared for the purposes of the Plantations and Reafforestation Act 1999, the applicant for authorisation under that Act.	N/A	N/A
2.	**Contextual Information**		
2.1	**Description of proposal, subject site and study area**		
	A Species Impact Statement must include a full description of the action proposed, including its nature, extent, location, timing and layout (Section 110 (1)).	Yes	Chapters 1 and 2
	A full description of the action includes a description of all associated actions, including, but not restricted to: installation and maintenance of utilities, fire protection zones (including the intended management regimes to be applied to such zones), access and egress routes; and changes in surface water flows. These actions may occur on or off the *subject site*. The type of action proposed shall be detailed, including the timetable for the construction of the proposed development. If a staged development approach is adopted then the timetable shall clearly indicate this. In describing the proposal, the proportion of the *subject site* and the *study area* that will be affected is to be provided, including details of the location of any auxiliary infrastructure and all component parts of the proposal such as roadworks, utilities such as electricity, drainage, any actions necessary for fire	Yes	Chapter 2

Section	Description	Compliance	Location
	management, stockpile areas, temporary buildings etc. The vegetation within the study area that is to be retained is to be fully documented, and shown on the relevant plans and maps. The proposed management regimes for such areas are also to be documented.	Yes	Chapters 5, 6 & 7
2.2	**Provision of relevant plans and maps**		
	A plan of the *study area*, including the scale of the plan shall be provided. An aerial photograph (preferably colour) of the locality (or reproduction of such a photograph) shall be provided. This aerial photograph shall clearly show the subject site and the scale of the photograph.	Yes	Figure 1.1
	A topographic map of the site and immediate surrounds at a scale of 1:25,000 shall be provided. This map shall detail the location of the proposal and location of works on site.	Yes	Figure 2.1
	A map of the locality, showing landscape features including rivers, swamps, wetlands, any locally significant areas for threatened species such as parks and reserves, and areas of high human activity such as townships, regional centres and major roads will also be provided. The location, size and dimensions of study area shall be provided. This map shall represent the area within at least a 3 km radius of the subject site.	Yes	Figures 1.1 & 2.1
	This map shall show the location and type of vegetation communities, including a list of dominant species, present within the subject area. This plan is to show the location of any key habitat resources for threatened species (e.g. potential and recorded habitat of *Prasophyllum affine* and the foraging and breeding habitat of its primary pollinators, Eastern Bristlebird and Ground Parrot habitat, stands of Glossy Black Cockatoo feed trees, trees used as nesting sites by the Square-tailed Kite, and stands of trees bearing hollows or trees likely to mature into hollow-bearing trees).	Yes	Figures 3.5, 4.2, 4.5, 4.6, 4.7, 4.8, 4.9
2.3	**Land Tenure Information**		
	Information about the land tenure across the *study area* shall be provided. Any limitations to sampling across the *study area* (e.g. denied access to private land) shall be noted.	Yes	Chapter 1
	Information on current activities on or usage of the *study area* shall be noted.	Yes	Chapter 1
3	**Initial Assessment**		
	A general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action (Section 110 (2)(a))	Yes	Chapters 4 & 5, Table 4.6
3.1	**Identify Subject Species**		
	In determining these species (the subject species), consideration shall be given to the habitat types present within the study area, recent records of threatened species in the locality and the known distribution and habitats utilised by threatened species in the region. The location of the subject species recorded during the SIS survey shall be represented on a map of the study area. All available historical records shall also be included. Where the habitat of each subject species within the study area can	Yes	Chapters 3 & 4 Figures 3.5, 4.2, 4.5, 4.6, 4.7, 4.8, 4.9

Section	Description	Compliance	Location
	be clearly delineated, this habitat shall be represented on a map of the study area. Databases such as the DEC Atlas of NSW Wildlife, Australian Museum and Royal Botanic Gardens may be used to assist in compiling the list. The following threatened species and Endangered Ecological Community (EEC) shall be considered for inclusion in the list of subject species: **Threatened Species** **Flora** Jervis Bay Leek Orchid *Prasophyllum affine* Thick Lip Spider Orchid *Arachnchi tessellata* Leafless Tongue Orchid *Cryptostylis hunteriana* Tangled Bedstraw *Galium australe* Biconvex Melaleuca *Melaleuca biconvexa* Underground Orchid *Rhizanthella slateri* **Endangered Ecological Community** Sydney Coastal Estuary Swamp Forest Complex **Fauna** **Mammals** Southern Brown Bandicoot *Isoodon obesulus* Long-nosed Potoroo *Potorous tridactylus* White-footed Dunnart *Sminthopsis leucopsis* Eastern Chestnut Mouse *Pseudomys gracilicaudatus* Large-footed Myotis *Myotis adversus* Eastern False Pipistrelle *Falsistrellus tasmaniensis* Eastern Freetail-bat *Mormopterus norfolkensis* Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* Greater Broad-nosed Bat *Scoteanax rueppellii* Eastern Pygmy-possum *Cercartetus nanus* Squirrel Glider *Petaurus norfolcensis* Yellow-bellied Glider *Petaurus australis* **Amphibia**	Yes	Chapter 4 and Table 4.3

Section	Description	Compliance	Location
	Giant Burrowing Frog *Heleioporus australiacus* **Birds** Glossy Black-Cockatoo *Calyptorhynchus lathami* Eastern Bristlebird *Dasyornis brachypterus* Ground Parrot *Pezoporus wallicus* Swift Parrot *Lathamus discolor* Regent Honeyeater *Xanthomyza phrygia* Turquoise Parrot *Neophema pulchella* Square-tailed Kite *Lophoictinia isura* Powerful Owl *Ninox strenua* Sooty Owl *Tyto tenebricosa* Masked Owl Tyto novaehollandiae		
	Whilst it is not a specific requirement, it is stongly recommended that, while conducting the flora survey, attention is given to the possible occurrence of the following species listed as Rare under ROTAP (Rare or Threatened Australian Plants, Briggs and Leigh 1996): *Corybas undulatus, Leptospermum epacridoideum, Pultenaea villifera,* and *Platysace stephensonii.* If any of these species are detected on the subject site, it would be appropriate that the SIS consider the impacts of the proposal on these species. This information will be necessary should any of the above species be listed on the Schedules of the TSC Act prior to a decision being made on the application.	Yes	Chapters 3 & 4 & Annex H
4.	**Survey**		
4.1	**Requirement to survey**		
	A fauna and flora survey is to be conducted in the study area. Targeted surveys shall be conducted for all subject species determined in accordance with Section 3 above. Previous surveys and assessments may be used to assist in addressing this requirement.	Yes	Chapters 3
	Flora Particular attention shall be paid to the timing of flora and fauna surveys, as many of the subject species will only be present for a few months each year. The orchid species will only be present above ground for a few months each year and can only be recognised with confidence when flowering. The timing and survey technique for the Undergound Orchid *Rhizanthella slateri* is currently being developed by the Shoalhaven City Council (SCC) and a recognised underground orchid expert. The consultant may, therefore, wish to contact the SCC to obtain this information, when it becomes avaliable. *Galium australe* can	Yes	Chapters 3

Section	Description	Compliance	Location
	only be identified from flowers and fruit and has to be surveyed for in summer.	Yes	Chapter 3
	Fauna The Eastern Bristlebird and Ground Parrot are effectively detectable from calls only from spring and summer. Special attention shall also be given to the timing of surveying for foraging and nesting habitat of the Glossy Black Cockatoo, which nests in winter. The Swift Parrot is a nectarivorous migrant that visits the Australian mainland from Tasmania from March to October and must be surveyed for during this period. The optimal time for surveying Regent Honeyeaters is spring and summer when they breed, though the species could potentially be found foraging in the winter months. Surveys for White-footed Dunnart and Eastern Pygmy-possum should be conducted with pitfall traps if possible, or small "Elliott" traps. Additional advice on these matters should be sought from the DEC contact officer detailed below if needed.		
	Identification of all species is essential. Identification to genus only is not acceptable. Species of taxonomic uncertainty shall be confirmed by a recognised authority such as the Australian Museum or National Herbarium at the Royal Botanic Gardens, Sydney.	Yes	Chapter 3
4.2	**Documentation of survey effort and technique**		
	4.2.1 Description of survey techniques and survey sites		
	Survey technique(s) shall be described and a reference given, where available, outlining the survey technique employed.	Yes	Chapter 3, Figures 3.1-3.5, Annex F
	Survey site(s) shall be identified on a clearly keyed map. The size, orientation and dimensions of quadrat or length and separation of transect shall be clearly documented for each type of survey technique undertaken. Full AMG grid references for the survey site(s) shall be noted.		
	4.2.2 Documenting survey effort and results		
	DEC survey proformas are to be used by field staff when applying a range of standard fauna survey techniques. Digital copies of these proformas are available by electronic mail. Please contact the nominated contact officer below. These proformas shall be used by field staff when undertaking fauna surveys and completed data sheets shall be included as an appendix to the SIS.	Yes	Volume 2
	The time invested each time a survey technique is applied shall be summarised in the SIS, based on completed proformas, e.g. - number of person hours / transect, duration of call playback, number of nights traps set.	Yes	Chapter 3
	It is not sufficient to aggregate all time spent on all survey techniques. Effort must be expressed each time a particular survey technique is applied.	Yes	Chapter 3
	Personnel details including name of surveyor(s) and contact phone number must be included. The person who identified records (e.g., anabat, hair tubes, scat analysis) shall also be identified.	Yes	Annex B
	Environmental conditions during the survey shall be noted at the commencement of each survey technique. These conditions	Yes	Chapter 3 & Table

Section	Description	Compliance	Location
	must be documented in the SIS. Surveys shall be undertaken during seasons and climatic conditions during which the subject species are most likely to be detected. In the case of *P. affine, Cryptostylis hunteriana, Rhizanthella slateri* and *Galium australe*, surveys must be undertaken whilst the species are known to be in flower at the known locations on the site or at nearby locations, thereby maximising the chances of detecting at least some individuals in a particular season.		3.4
	An assessment of the efficacy of each survey regime in detecting each species under the intensity utilised by the study is to be provided. The effect of the season and weather at the time of the field survey shall be considered with respect to the adequacy of survey results. An assessment will also be made of the adequacy of the survey and background information used to assess the likely area of use (home range) for each species.	Yes	Chapter 3
	Any areas which may act as corridors between the study area and adjacent areas of likely habitat for subject species shall be identified and described.	Yes	Chapters 3, 4 & 5 Figure 4.1
	A full list of all fauna and the threatened flora found during the course of surveys shall be included (such information is indicative of the habitat quality of the site).	Yes	Annex C
	Completed Atlas of NSW Wildlife cards are to be provided for each threatened species record in any survey conducted for the purposes of the SIS. For confidentiality, these cards are not to be included in the SIS but rather shall accompany the SIS when supplied to the DEC.		Will be provided with all other annual records as required as part of ERM's Scientific Investigation Licence.
4.3	**Specific survey requirements** Outlined below are details of survey methods that are necessary to determine the presence of those threatened species known or likely to be on the site. Any flora and fauna survey of the proposed site shall include the use of these survey methods.		
	Thick Lip Spider Orchid - *Caladenia tessellata* There are two historic records close to the proposed development site. Surveys need to be conducted for this species when it is most likely to be flowering. Flowering has been recorded from early September until early November. Fortnightly systematic surveys along evenly spaced transects located about 10 m apart in all areas of potential habitat shall be undertaken. *Caladenia* leaves are distinctive and it should be possible to identify the presence of *Caladenia* leaves on the subject site prior to flowering if plant of this genus are present. Species can be recognised by leaves and fruiting heads at later times, so it may be possible to survey for the species at that time.	Yes	Chapter 3

Section	Description	Compliance	Location
	Leafless Tongue Orchid - *Cryptostylis hunteriana*. This species can only be satisfactorily surveyed when it is flowering, although it is possible for experts to recognise stems of this species at the bud stage. The exact flowering time is unpredictable and the species can flower anytime between early December and mid March. Searches at about three weekly intervals over this period are, therefore, required. Systematic surveys using evenly spaced transects located about 10 m apart through all areas of heath/shrubland and low woodland with heath/shrubland understorey shall be undertaken.	Yes	Chapter 3
	Jervis Bay Leek Orchid - *Prasophyllum affine* Surveys shall be undertaken between late October and late November, once a number of individuals at known sites have commenced flowering. Systematic surveys using evenly spaced transects located about 10 m apart through all areas of heath/shrubland and low woodland with heath/shrubby understorey shall be undertaken. A detailed population count is required. The results of the 2003 survey season must be combined with the survey obtained since 2000 on the subject site. There is now evidence that only a portion of the population flowers each year. It is required that surveys also be conducted in the fringes of adjacent woodland areas, because although the current known distribution is primarily within areas of treeless heath on clay, some individuals have been recorded in sedgeland/woodland interface. Bower (2002) identified Flower and Spider Wasps as the primary pollinators of *P. affine* at Vincentia. Bower (2002) recommended that an understanding of the resources needed by the pollinators of *P. affine* may help to better define the habitat required to sustain the species in the long term. Bower (2002) noted that the location of the breeding area for the dominant Thynninae Wasp pollinator, *Neozeleboria* sp., should be determined for Vincentia. From many years of survey experience, Bower (2002) found that many *Neozeleboria* species and populations have colonies that are patchily distributed. Bower (2002) further noted that studies of other *Neozeleboria* spp indicate that they feed on the honeydew produced by psyllids on eucalypt foliage. It is, therefore, important that as much as possible of the existing eucalypt populations be maintained close to the Vincentia site. However, it is clear from the records in the Vincentia study that the Vincentia *Neozeleboria* also feeds on floral nectar. This may include *Leptospermum* blossom as well as *P. affine*, since a *Neozeleboria*-like wasp was seen on *Leptospermum*, but escaped capture and could not be formally identified. Therefore, it would also be of value to ensure that *Leptospermum* species are maintained at the site, possibly supplemented by additional plantings in regeneration areas. The role of the Spider Wasps as pollinators is not clear from this study. Four different species were collected on *P. affine* flowers, three of which were carrying pollinaria when caught. This suggests the Pepsinae are potentially important pollinators. The essential requirements of Pepsinae are: 1. Spiders for larval development and female nutrition – A sufficient area of natural habitat to support enough spiders to maintain viable Spider Wasp populations is needed. However, since Pepsinae are non-specific in their	Yes	Chapters 3 &4 Annex G

Section	Description	Compliance	Location
	prey needs, relatively small areas, of the order of a few tens of hectares, are likely to be sufficient. However, literature on this point has not been accessed. 2. Nectar sources – Nectar requirements are similar to those of the Thynninae. Bower (2002) considers that all pollinators should be conserved for two reasons: 1. As insurance against loss of one or more over time (Cane and Tepedino 2001) 2. As insurance against seasonal variations in pollinator abundance In order to address the recommendations and comments by Bower (2002) the following studies in relation to the identification of pollinator breeding and feeding habitat must be undertaken. • Identify for all pollinator species those areas of the subject site, and surrounding land if relevant, that are important sources of food for adult and larval stages of the wasps and important refuge areas. • Estimate pollinator population sizes and identify breeding and feeding areas for the wasp populations that are most likely to be pollinating the various *P. affine* populations. • Assess the minimum area and critical locations of pollinator feeding and breeding habitat that needs to be protected and maintained in order to retain a population of pollinators that will maintain adequate pollination levels of *P. affine* and remain viable in the long term. • Assess the ability of pollinators to traverse potential infrastructure obstacles such as car parks and buildings, fences, lawns etc. • Determine whether any off-site areas are important sources of pollinators, either through direct flight to the orchid plants or through recolinisation of pollinator habitat on-site following possible on-site loss of pollinators as a result of adverse conditions or events. • Identify whether any parts of the proposed development are likely to impede movement of pollinators to *P. affine* populations, or that would impede recolinization from surrounding habitat		
	Underground Orchid - *Rhizanthella slateri* There are records of this endangered plant from across the other side of Naval College Road. Survey methodology and appropriate timing for surveys are currently being formulated by the Shoalhaven City Council (SCC) and a recognised underground orchid expert. The consultant should, therefore, contact Dr Sandie Jones, Planning Officer, Shoalhaven City Council for further information when it becomes available.	Yes	Chapter 3

Section	Description	Compliance	Location
	Tangled Bedstraw - *Galium australe* Tangled Bedstraw *Galium australe* was listed as Endangered (Presumed Extinct) until it was relocated in 2002. A population was discovered near Lake Windemere in the Commonwealth Territory at Jervis Bay growing with *Eucalyptus pilularis / E. botryoides* and Turpentine (on slopes with friable loamy soil and abundant ferns in the understorey). The best time for survey seems to be summer - it is impossible to identify without flowers or fruit. This species appears to exhibit a patchy distribution and can be easily overlooked during flora surveys. It may be appropriate to use a transect survey method as required for *P. affine, C. tessellata* and *C. hunteriana.* Please note that if this species is located all sites will require total protection.	Yes	Chapter 3
	Biconvex Melaleuca - *Melaleuca biconvexa* There are records of this species in close proximity to the proposed development site and it is possible that the species occurs along drainage lines on the site. The species can be surveyed at any time. Should it be located, this would represent the most eastern population in southern NSW. There may, therefore, be a need to undertake a genetic analysis as per earlier work undertaken by DEC to determine the relationship of this population with others in the region.	Yes	Chapter 3
	Sydney Coastal Estuary Swamp Forest Complex Endangered Ecological Community The subject site has been mapped by ERM as having Woollybutt/Paperbark Forest which has Swamp Mahogany *E. robusta* as one of the component species. Swamp Mahogany is one of the indicator species of the Sydney Coastal Estuary Swamp Forest Complex. The consultant should refer to the definition of the EEC in the NSW Scientific Committee determination, which is available on the DEC Website: www.npws.nsw.gov.au. The extent and quality of the Sydney Coastal Estuary Swamp Forest Complex in the study area are to be mapped and evaluated in the context of occurrences of this Endangered Ecological Community within a 10 km radius of the study area. The relative extent of the community in the study area and the 10 km radius area and their respective importance for the conservation of the community are to be evaluated. The defining of the Sydney Coastal Estuary Swamp Forest Complex and the delineation of the boundary of this community is of critical importance. An explicit definition of this community must be given and how, in practice, this definition is used to identify the boundary of the community in the field clearly set out.	Yes	Chapter 3 & 4
	Southern Brown Bandicoot This species is Commonwealth listed and highly threatened in the region and across NSW. If this species is present on site, the impact of the proposed development is likely to be significant. Consequently, it will be essential to protect all known sites.	N/A	Not found on subject site

Section	Description	Compliance	Location
	The occurrence of *I. obesulus* at a site may be indirectly inferred from the presence of distinctive conical-shaped excavations in the soil. These excavations, which represent the forage-diggings of animals, vary in size but typically range from 5-10 cm deep and 3-10 cm wide. Occasionally, forage-diggings may be up to 30-40 cm deep and 15 cm wide. Since similarly-shaped forage-diggings can be left by the common and widely distributed Long-nosed Bandicoot (*Perameles nasuta*), and the uncommon Long-nosed Potoroo (*Potorous tridactylus*), further survey work will be necessary to identify which species is/are present. These species are variously known to occur together. Live-trapping using wire mesh 'bandicoot' traps (200 mm wide x 170 mm tall x 500 mm long) is the preferred survey method for detecting *I. obesulus* (manufactured by R.E. Walters Pty. Ltd., Sunshine, VIC). This method will allow for unequivocal identification of animals, provided the person undertaking the trapping work is experienced in identifying bandicoots. If this is not the case, then any captured animals should be photographed, measured and have hair-samples taken for later analysis (see below). Subsequent identification of the animal in question can then be made by an appropriate expert. The type of bait used to lure animals into traps may vary, but is usually based on a mixture of peanut butter and rolled oats. Various additives can be incorporated into this mixture, such as honey, golden syrup, pistachio essence (Keith Harris and Co. Ltd., Thornleigh, New South Wales), or sardines. Where possible, a range of such bait types should be used, alternated between traps with equal effort. Ideally, live-trapping survey for *I. obesulus* should be carried out during the warmer months, from early September through to late April. Outside of this period trapping should only be conducted during fine weather. Regardless of time of year, periods of inclement weather (ie. heavy rainfall) should be totally avoided. The number of traps set at a site will vary according to the extent of suitable habitat, the area over which characteristic forage-diggings are present, and the scale of the proposed development or activity. Traps should ideally be arranged in lines or transects through likely habitat types, or as indicated by the presence of forage-diggings. Traps should be spaced between 20 and 50 metres apart. As a general rule a minimum of 10 traps per ha should be set. Traps should be set for a minimum period of 4-5 consecutive nights. This duration of time is usually sufficient to determine the identity of the animals present at a site. On each day traps should be set at dusk and checked the following morning. Where possible, traps should not be left open during daylight hours, particularly during periods of hot weather. In situations were the same animals are being repeatedly trapped, individual trap stations may need to be closed. Handling of captured animals should be kept to a minimum, since bandicoots are prone to stress. Adult female animals may lose pouch young upon capture and handling. Any handling that needs to be undertaken should be done on animals restrained within the confines of an opaque bag. Thick cotton, as used in the manufacture of tracksuit pants, is an ideal material for this purpose.	Yes	Chapter 3

Section	Description	Compliance	Location
	Other survey techniques such as hair-sampling tubes (as per Scotts and Craig 1988) can also be used to detect *I. obesulus*, but these should always be viewed as a secondary option to live-trapping with wire mesh cage traps. If used, hair-sampling tubes should be set with the same attractant baits as indicated above, for a period of at least 7 and up to 10 days. As with live trapping, the spatial configuration and intensity of sampling will vary according to the particular situation. A person specialising in mammalian hair analysis should identify all hair samples collected during survey. Further specific guidance in relation to survey for *I. obesulus* should be sought from DEC via the contact addresses listed below.		
	Long-nosed Potoroo The Long-nosed Potoroo is also Commonwealth listed. Whilst there are a few records in nearby Booderee NP, the adequacy of reservation of the species is unknown. For survey techniques please refer to Southern Brown Bandicoot.	Yes	Chapter 3
	White-footed Dunnart, Eastern Pygmy-possum and Eastern Chestnut Mouse The true status of the White-footed Dunnart in the Shoalhaven region is poorly known. It is not known whether the species is widespread or localised and hence, the adequacy of reservation in the region is unknown. If the species was found on the subject site, then the consultant should survey off-site to determine the local significance of the population on the subject site. The Eastern Pygmy-possum was recorded on the subject site by ERM in December 2003. Therefore, the consultant must map the preferred habitat on the subject site and also determine the regional status of the species through off-site surveys. The Eastern Chestnut Mouse has been recently recorded in Booderee NP and Bhewerre Peninsula. However, its status in the region is not known. The species prefers wet and swampy heathlands and to a lesser extent open woodlands. Surveys for all three species should be conducted with pitfall traps wherever possible, or alternatively small "Elliott" traps.	Yes No	Chapter 3 No offiste surveys
	Squirrel Glider The consultant needs to determine the distribution and abundance of the species on the subject site and its status in the region. Squirrel Gliders may occur across a wide variety of forest and woodland vegetation types. The likelihood of occurrence of animals within a stand of native vegetation will be dependent upon a range of factors. Key features of habitat likely to increase the probability of the species occurring on-site include the presence of large hollow-bearing eucalypt trees and an understorey of flowering shrubs, particularly from the genus *Acacia*. In instances where one or both of these features are present, and the form of development proposed is likely to impact upon them, then either follow-up survey should be conducted or the species should be assumed to be present for the purpose of further assessment.	Yes	Chapter 3 & 4

Section	Description	Compliance	Location
	Live-trapping in trees is the preferred survey method for detecting Squirrel Gliders. Traps should be either large Elliott box traps or wire mesh 'bandicoot' traps (200 mm wide x 170 mm tall x 500 mm long; Figure 2) (manufactured by R.E. Walters Pty. Ltd., Sunshine, VIC). Live-trapping is a preferred sampling technique as it allows for unequivocal identification of animals. This is particularly important as the Squirrel Glider is very similar in appearance to the smaller Sugar Glider, *P. breviceps*, and both species may occur in the same or similar habitats. The Squirrel Glider may be distinguished from the latter species on the basis of the following characteristics; (i) it is up to twice the size of the Sugar Glider, (ii) its tail is bushier at the base, (iii) its facial markings are typically more distinct, (iv) it has a longer, more pointed face, (v) longer and narrower ears, and (vi) the belly fur is completely white compared to the patchy grey of the sugar glider. If definite identification cannot be made then any captured animals should be photographed and measured. Subsequent identification of the animal in question can then be made by an appropriate expert. The type of bait used to lure gliders into traps is usually based on a mixture of peanut butter, honey and rolled oats. A honey and water solution may be sprayed above and below the trap entrance. Ideally, live-trapping survey for Squirrel Gliders should be carried out during the warmer months, when there is a lower probability of occurrence of flowering eucalypts (Smith 2000). The number of traps set at a site will vary according to the extent of suitable habitat, the area over which possible den sites are present, and the scale of the proposed clearing or activity. Traps should ideally be positioned horizontally in low tree branches. Traps should be attached to trees using straps or brackets, and spaced approximately 50-100 m apart in a transect or grid layout, as the habitat allows. Traps should be set for a minimum period of 3-4 consecutive nights. This duration of time is usually sufficient to determine whether gliders are present at a site. On each day traps should be set at dusk and checked the following morning. Where possible, traps should not be left open during daylight hours, particularly during periods of hot weather. In situations where the same animals are being repeatedly trapped, individual trap stations may need to be closed. Other survey techniques such as spotlighting and stagwatching can also be used to detect the Squirrel Glider but are not preferred over live-trapping. These survey techniques require observers with experience in Squirrel Glider identification as the species can be easily confused with Sugar Glider by untrained observers, especially from afar and after dusk. Spotlighting of a given transect should be undertaken on at least three different occasions, on mild nights, generally along established trails or roads. Squirrel Gliders can be difficult to detect using this survey technique, and often the white ventral fur first attracts attention, rather than eyeshine (Menkhorst *et al*. 1988). Routine stagwatching (standing under hollow-bearing trees at dusk watching animals emerge from hollows) can focus on		

Section	Description	Compliance	Location
	large hollow-bearing trees within any given stand. It must be carried out simultaneously at all potential trees to be effective. If the species is present, any proposed development should attempt to avoid direct impacts on the species in the first instance, minimise any unavoidable or indirect impacts, and then set up processes which establish long-term conservation of the species on-site.	Yes	Chapter 3 & 4
	Yellow-bellied Glider The distribution and abundance of aggregations of den sites should be determined using appropriate survey and mapping methods.	Yes	Chapter 3 & 4
	Threatened Microchiropteran Bats The subject site has an exceptionally diverse micro-bat fauna, with seven species being detected by Gunninah. Therefore, the regional significance of the subject site needs to be determined. All five subject species, Large-footed Myotis, Eastern False Pipistrelle, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat and Greater Broad-nosed Bat, will be impacted through the loss of roosting sites, and indirectly through urban impacts of light, noise, increased risk of predation by nocturnal raptors and cats. There will also be an incremental loss of urban roost trees.	Yes	Chapter 3
	Giant Burrowing Frog Surveys for this species should focus along drainage lines and also in the drier forest habitats away from riparian areas, where adults occur. This species is likely to be impacted by altered hydrology, pollution, and predation by feral and companion animals. The habitat of the Giant Burrowing Frog is poorly reserved. Aural and spotlighting surveys should be conducted during and immediately after significant rainfall events.	Yes	Chapter 3
	Ground Parrot There have been recent records (as recently as December 2003) of the Ground Parrot on the subject site. Impacts on the species include predation, fire and human disturbance. Call detection is the most appropriate method of survey for Ground Parrots. Flushing of birds in suitable habitat is also an appropriate method but requires a substantial number of people to walk in a line, with about five metres between each person, through the habitat in question. Ground Parrots in high densities call regularly at dawn and dusk, with the call being easily identified, and able to be heard for a distance of about 400 m in ideal conditions. A listening period of sixty minutes should enable the listener to maximise the chances of detecting a Ground Parrot, and determine the number and location of calling birds. For example, in an area of ten hectares, two listening surveys		

Section	Description	Compliance	Location
	should be conducted, one dawn and one dusk survey, provided that there are still, dry conditions. An area of 50 hectares would require at least four listening surveys, i.e. two dusk and two dawn surveys. For a dawn survey, the listener should begin surveying one hour before sunrise, and for a dusk survey the listener should be present at sunset and begin the survey at about fifteen minutes after sunset for one hour. It is thought that Ground Parrots call less when there is a low density of birds present in a particular area. It should be assumed that the species is present, even if calls are not detected. Surrounding suitable habitat within 2 km must also be surveyed for this species and estimates of the population resident within the area provided. The areas of suitable habitat are to be shown on the previously mentioned map.		
		Yes	Chapters 3
	Eastern Bristlebird This Endangered ground-dwelling bird has been recorded on the subject site in recent times and is threatened by further loss and fragmentation of its habitats. The loss of any viable area of individual bird is considered to be a significant impact. Surveys shall be conducted during Spring and Summer as there is little chance of birds responding to calls outside these seasons. Background information on home range sizes and habitat use is available in Baker (1998, 2001). A listening period of 30 minutes beginning at sunrise is required, before conducting a search for the species. A slow search involves walking at 2 km an hour through the study area, or along a transect representative of the study area. On completion of the slow search, call detection using a taped call to elicit a response should be used to attempt to detect the species. The Eastern Bristlebird's distinctive calls can be heard within 100 m. A call playback session consists of playing the taped call for two minutes, followed by a listening period of thirty minutes. It should be noted that the species may respond immediately, i.e. during the tape playing, or may not respond at all. Call playback sessions should be conducted at points along a given transect through the appropriate habitat (Baker 2001). The distance between survey points should be 200 m.	No	SCC has not completed
	The consultant should also give consideration to habitat mapping information that is now available for the Shoalhaven area by contacting one of the DEC contact staff listed below.		
		Yes	Chapter 3
	Powerful Owl, Masked Owl and Sooty Owl There are numerous records of the Powerful Owl on the subject site and the surrounding area. The Masked Owl is known to be resident in the northern drainage line of the subject site. There is a record of a Sooty Owl on the subject site, which may have been passing through.	No	Not undertaken
	Nocturnal call-playback surveys should focus on detection of key nesting and roosting resources. Surveys to detect likely nesting areas should be undertaken from June-September.	Yes	Chapter 3
	Drainage lines should be searched for evidence of 'white-wash' indicating roost sites. Roost sites detected during this period		

Section	Description	Compliance	Location
	may indicate nearby breeding habitat (large trees with large hollows often close to drainage lines) that should be retained and buffered from disturbance.		
		Yes	Chapter 3
	Glossy Black Cockatoo This iconic parrot is threatened by the loss of mature hollow-bearing trees and viable *Allocasuarina* foraging habitat that has been lost in the fires of late 2001. Presently, much of the foraging habitat in the St George's Basin/Vincentia area is recovering from the fire. Therefore, the subject site may be temporally significant for the Glossy Black Cockatoo. To determine the regional and temporal significance of the key foraging habitats of the Glossy Black Cockatoo in the St George's Basin/Vincentia area, DEC and the Shoalhaven City Council are considering undertaking a collaborative mapping project in 2004. The consultants should consider undertaking their own mapping or wait until this information becomes available.	No	Not undertaken
	Surveys for nesting and roosting habitat should be undertaken in autumn and winter and concentrate on identification and assessment of large hollow-bearing trees.	Yes	Chapters 3 & 4 Figure 4.8
		No	Chapters 4 & 5 Precautionary principle applied in assessment.
	Swift Parrot The regional significance of the subject site for the Swift Parrot is unknown. The site may provide suitable winter foraging habitat in Spotted Gum and Swamp Mahogany areas. Diurnal fixed-width transect or point-count surveys between March and October should be conducted across the subject site		
		No	Chapters 4 & 5 Precautionary principle applied in assessment.
	Regent Honeyeater The regional significance of the subject site for the Regent Honeyeater is unknown. There are potential breeding and foraging habitats on the subject site that should be surveyed using diurnal fixed-width transect or point-count surveys and call playback techniques, as the species responds to taped calls during the breeding season. Whilst surveys can be conducted at any time of the year, the optimal time is spring and summer during the breeding season.		
		No	Chapters 4 & 5 Precautionary principle applied in assessment.
	Turquoise Parrot There is a record of the species from the subject site in 2001. The regional status of the species is not known. Diurnal fixed-width transect or point-count surveys are best conducted in the breeding season (Spring-Summer). If the species is found on the subject site, the consultant needs to determine the regional significance of the subject site.		
		Yes	Chapter 3

Section	Description	Compliance	Location
	Square-tailed Kite There would appear to be a resident bird or pair of birds in the vicinity of the subject site. The species may operate over an entire region, so the significance of the subject site is unknown. A diurnal survey must be conducted to determine whether there is key breeding habitat on the site. A search for nesting trees must be undertaken and the home range of the resident bird(s) should be quantified to determine the significance of the subject site.		
5.	**Assessment of likely impacts on threatened species** Section 5 needs to only be addressed for those threatened species that are likely to be affected.		
5.1	**Assessment of species likely to be affected** *An assessment of which threatened species or population known or likely to be present in the area are likely to be affected by the action (Section 110(2)(c))* This requirement is asking the person preparing the SIS to refine the list of subject species (given the outcome of survey and analysis of likely impacts) in order to identify which threatened species may be affected and the nature of the impact. The remaining requirements in this section need only be addressed for those species that are likely to be affected by the proposal.	Yes	Chapters 4 & 5, Table 4.6
5.2	**Discussion of local and regional abundance** *An estimate for the local and regional abundance of those species (or populations) (Section 110 (2)(d))*		
	5.2.1 Discussion of other known local populations A discussion of other known populations in the locality shall be provided. The long term security of other habitats shall be examined as part of this discussion. The relative significance of the subject site for the identified threatened species in the locality shall be discussed. For the orchid species in particular, the results of previous surveys for other populations of the species in the region shall be considered. This shall include a summary of sites where unsuccessful searches are known to have been conducted.	Yes	Chapter 4 & 5
	The importance of the population on the subject site to the overall survival of these orchid species shall be addressed, including consideration of any likely genetic differences between the Vincentia populations and other known populations.	Yes	Chapters 4 & 5
	Particular attention shall be given to considering the indirect impact of the development on habitat and the resident individuals of the species within 2 km of the *subject site*. Specific consideration must be given to the cumulative impact of other proposed developments in the Vincentia area.	Yes	Chapter 5
	5.2.2 Discussion of habitat utilisation	Yes	Chapter 4

Section	Description	Compliance	Location
	An estimate of the numbers of individuals utilising the area and how these individuals use the area (e.g. residents, transients, adults, juveniles, nesting, foraging) and discussion of the significance of these individuals to the viability of the threatened species in the locality is required.		
	5.2.3 Description of vegetation The vegetation present within the study area and the area covered by each vegetation community shall be mapped and described. Include reference to the vegetation classification system used (e.g. Specht). Classification must have regard to both structural and floristic elements.	Yes	Chapter 3 & 4 Figure 4.2
	5.2.2 Discussion of corridors If movement corridors for threatened species or endangered populations are present within the subject site, the impact of the proposal on these areas shall be discussed.	Yes	Chapter 5 Figure 4.1
5.3	**Assessment of Habitat** *A full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region (Section 110 (2)(f))*		
	5.3.1 Description of habitat values Specific habitat features shall be described (e.g. frequency and location of hollow-bearing trees, areas of heath and woodland with heath understorey overlying clay, drainage lines, soaks etc) and the density of understorey vegetation and groundcover. The condition of the habitat within the study area shall be discussed, including the prevalence of introduced species, species of weeds present and an estimate of the total weed cover as a percentage of each vegetation community, whether trampling or grazing is apparent, effects of erosion, prevalence of rubbish dumping, history of resource extraction or other disturbances and proximity to roads.	Yes	Chapter 4
	Details of the subject site's fire history (e.g. frequency, time since last fire, intensity) and the source of fire history (e.g. observation, local records), shall be provided.	Yes	Chapters 2 & 5
5.4	**Discussion of conservation status** *For each species or population likely to be affected, details of its local, regional and State-wide conservation status,...[and]... its habitat requirements ... (Section 110(2)(c))*		
	Assessment shall include reference to the threatening processes which are generally accepted by the scientific community as affecting the species or population and are likely to be caused or exacerbated by the proposal. Assessment shall also include	Yes	Chapter 5

Section	Description	Compliance	Location
	reference to any draft Recovery Plans which may be relevant to the proposal. While no Recovery Plans or Threat Abatement Plans for the listed species and community have been approved in accordance with the TSC Act as yet, several draft Recovery Plans have been prepared. Where a plan is relevant to any subject species, consideration shall be given to the information contained in these plans and whether any recommendation is applicable to the proposal. Draft Recovery Plans are available for *P. affine,* the Yellow-bellied Glider. Draft Recovery Plans are currently in preparation for the Southern Brown Bandicoot, Squirrel Glider, Eastern Bristlebird, Ground Parrot, Regent Honeyeater. National Recovery Plans are available for the Regent Honeyeater and Swift Parrot. Once a list of species known or likely to occur in the subject area or locality has been derived, the DEC contact officers listed below shall be contacted to determine whether draft Recovery Plans or management plans are available for any additional listed species.		
5.5	**Likely impacts**		
	Assessment of impacts shall include the assessment of indirect impacts and those of associated activities, including, but not restricted to: installation and maintenance of utilities, fire protection zones, access and egress routes; and changes in surface water flows. These actions or impacts may occur on or off the subject land.	Yes	Chapter 5
	For all subject species, the SIS shall state the following:		
	• the location, nature and extent of habitat removal or modification which may result from the proposed action;	Yes	Chapter 5
	• the potential impact of the removal and/or modification of habitat and the likelihood of and extent of loss of food resources and the impact this may have on the subject fauna species;	Yes	Chapter 5
	• any indirect impacts of the proposal such as the fragmentation or isolation of populations, increased distance required for fauna and pollinator movement between habitat patches, changed fire regimes as a result of both deliberate fire management and increased incidence of wildfire, changes in soil or water regimes, disturbance to feeding or nesting/breeding of species as a result of human visitation and associated motor vehicles and increased predation by the European Red Fox and Feral Cat;	Yes	Chapter 5
	• the likely contribution of the proposed action to the threatening processes already acting on populations of those species in the locality. Particular attention shall be given to the potential for increased fox or cat predation on Eastern Bristlebirds and Ground Parrots.	Yes	Chapter 5
	In the case of *P. affine*		
	• an assessment of the threats (e.g. trampling, increased fire frequency, rubbish dumping, weed invasion, pollution, increased nutrient levels resulting from horticultural activities and dog defacations etc.), to *P. affine* and its habitat which	Yes	Chapters 4 & 5 Annex G

Section	Description	Compliance	Location
	are likely to result from a expected greatly increased concentration of people and dogs in the area;		Figure 4.6
	• the likely effect of identified likely threats on the survival of individual plants and the habitat of *P. affine*;		
	• in relation to potential impacts on the pollinators of *P. affine* the following issues raised by Bower (2002) must be addressed:		
	• identify what habitat is critical for the survival of the pollinators;		
	• the likely consequences of the potential loss or reduction in size of local populations of pollinators of *P. affine* and discuss how the development could be designed to reduce the loss to non-significant levels;		
	• the extent to which pollinator habitat diversity will be protected and maintained;		
	• the extent to which likely pollinator refugia will be protected and maintained;		
	• the extent to which retained *P. affine* habitat and pollinator habitat will remain connected to adjacent pollinator habitat and the likely effectiveness of these connections in allowing recolonisation of the subject site by pollinators if they were lost from the site during a catastrophic event;		
	• demonstrate that sufficient pollinator habitats are to be retained on the development site to ensure survival of the pollinators		
5.5	**Description of feasible alternatives** *A description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development (Section 110(2)(h))*		
	Where a Statement of Environmental Effects, Environmental Impact Statement or Review of Environmental Factors deals with these matters, the SIS may refer to the relevant section of the SEE, EIS or REF.	N/A	N/A
	Options for alternative designs relating to the layout of the Commercial Site and the proposed adjacent Residential Site shall be considered which would minimise encroachment on threatened species habitat and maximise buffer areas between proposed developments and threatened species habitats.	Yes	Chapter 2
	The feasibility of placing the Commercial Site and/or the Residential Site on other sites shall be described. The socio-economic benefits of the development shall be described.	Yes	Chapter 2
6.	**Ameliorative measures**		
6.1	**Description of ameliorative measures** *A full description and justification of the measures proposed to mitigate any adverse effect of the action on the species and populations and ecological community including a compilation (in a single section of the statement) of those measures (Section 110 (2)(i) and Section 110*		

Section	Description	Compliance	Location
	(3)(f))		
	In describing the intended ameliorative measures a clear distinction must be made between recommendations of the consultant preparing the SIS and what the applicant actually intends to implement.		
	6.1.1 Long term management strategies Consideration shall be given to developing long term management strategies to protect areas within the study area which are of particular importance for the threatened species likely to be affected. This may include proposals to restore or improve habitat on site where possible. Given the rarity of *P. affine*, it will be particularly important to detail how this population of the species can be satisfactorily managed and maintained in close proximity to a large commercial centre and residential development. Use of appropriate fencing, open space buffers and use of roads as boundaries to sensitive habitat are among matters that might be considered to ameliorate the impact of the development. Appropriate educational signage is another measure that might be considered in gaining public co-operation in avoiding the impact to habitat critical for the survival of threatened species populations.	Yes	Chapters 6 & 7
	6.1.2 Compensatory strategies Where significant modification of the proposal to minimise impacts on threatened species is not possible then compensatory strategies should be considered. These may include other offsite or local area proposals that contribute to long term conservation of the threatened species.	Yes	Chapters 6 & 7
	6.1.3 Ongoing monitoring Any proposed pre-construction monitoring plans or on-going monitoring of the effectiveness of the mitigation measures shall be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency. Generally, ameliorative strategies which have not been proved effective should be undertaken under experimental design conditions and appropriately monitored.	Yes	Chapters 6 & 7
7.	**Additional Information**		
7.1	**Qualifications and experience** *A Species Impact Statement must include details of the qualifications and experience in threatened species conservation of the person*	Yes	Annex B

Section	Description	Compliance	Location
	preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement (Section 110(4))		
7.2	**Other approvals required for the development or activity**		
	A list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population or ecological community (Sections 110(2)(j) and 110(3)(g)))	Yes	Table 1.2
	In providing a list of other approvals the following shall be included		
	• Where a consent is required under Part 4 of the *Environmental Planning and Assessment Act 1979*, the name of the consent authority and the timing of the development application shall be included; or	TBA	
	• Where an approval(s) is required under Part 5 of the *Environmental Planning and Assessment Act 1979*, the name of the determining authority(ies), the basis for the approval and when these approvals are proposed to be obtained shall be included.	TBA	
7.3	**Licensing matters relating to the survey**		
	Persons conducting flora and fauna surveys must have appropriate licences or approvals under relevant legislation. The relevant legislation and associated licences and approvals that may be required are listed below: *National Parks and Wildlife Act* 1974: • General Licence (Section 120) to harm or obtain protected fauna (this may include threatened fauna). • Licence to pick protected native plants (Section 131). *Threatened Species Conservation Act* 1995: • Licence to harm threatened animal species, and/or pick threatened plants and/or damage the habitat of a threatened species (Section 91). *Animal Research Act* 1985: Animal Research Authority to undertake fauna surveys.	Yes	N/A
8.4	**Section 110 (5) reports**		
	Section 110(5) of the *Threatened Species Conservation Act 1995* has the effect of requiring the DEC to provide that information regarding the State-wide conservation status of the subject species as it has available, in order to satisfy ss.110(2)&(3) of the Act. To this end, a number of publications have been produced:	N/A	N/A
	The DEC Biodiversity Management Unit (Biodiversity Research and Management Division) has produced a set of profiles for a	Yes	Annex E

Section	Description	Compliance	Location
	number of threatened species, populations and ecological communities. • Published profiles relevant to the suggested list of subject species for this development include: Glossy Black Cockatoo, Square-tailed Kite, Ground Parrot, Eastern Bristlebird, Regent Honeyeater, Southern Brown Bandicoot, Long-nosed Potoroo, White-footed Dunnart, Giant Burrowing Frog. • A set of these profiles, including a folder for their storage can be purchased for $50 from the DEC Information Centre. • A number of these profiles are also available for downloading from the DEC web page at www.npws.nsw.gov.au.		
	The DEC Threatened Species Unit, Queanbeyan, is also preparing draft environmental assessment guidelines for species, populations and ecological communities. Available draft guidelines relevant to the suggested list of subject species for this development are Eastern Bristlebird and Southern Brown Bandicoot.	Yes	Chapter 3
	Proponents and consultants should note that the DEC has no further published information available to satisfy s.110(5) of the Act and that purchase or receipt of the above profiles can be taken to have satisfied the requirements of ss.110(2)&(3) in relation to the State-wide conservation status of the species, populations and ecological communities.	N/A	N/A

1. N/A = Not applicable
2. TBA = To be advised

Annex B

Curricula Vitae

Alison Hunt

Senior Ecologist
Australia

Alison is a Consultant within ERM's Ecological Services Practice and is based in Sydney. She has over 15 years experience in field survey and ecological and environmental assessment in aquatic and terrestrial ecosystems in Australia and the USA. Her Honours (1987) and PhD (1993) focussed on issues of dispersal and conservation genetics of marine species. She then worked in the freshwater ecosystems of the USA before returning to Australia where she has undertaken ecological research on rare and endangered flora species and ecological assessment in terrestrial and aquatic ecosystems.

Alison's specialist area of expertise is in disturbance of both intertidal and subtidal habitats and the planning of wildlife corridors. She was one of the first in Australia to assess and suggest management strategies that would facilitate movement of native fauna through artificial corridors. She also understands the broader issues associated with environmental planning and has contributed to the preparation of Construction, Environmental and Rehabilitation Management Plans, EIS, REF, SEE and COI.

Alison is very experienced at public speaking and regularly presented scientific papers at international conferences. She has worked in an international setting undertaking ecological research, environmental assessment and as a limited-term assistant professor in the USA.

Professional Affiliations and Registrations

- Royal Zoological Society of New South Wales
- Australian Marine Sciences Association
- Ecological Society of Australia

Fields of Competence

- Terrestrial and aquatic ecology
- Flora and Fauna Assessment
- Ecological monitoring
- Environmental Impact Assessment
- Field survey and assessment

Education

- Ph.D in Marine Ecology and Population Genetics, University of Wollongong
- BSc (Hons), University of Wollongong

Languages

- English
- German

Key Industry Sectors

- Chemical
- Transport
- Mining
- Government

Publications

Hunt A 1993 Effects of contrasting patterns of larval dispersal on the genetic connectedness of local populations of two intertidal starfish, *Patiriella calcar and P. exigua*. Mar. Ecol. Prog. Ser. 92: 179-186

Hunt A & Ayre DJ 1989 Population structure in the sexually reproducing sea anemone, *Oulactis muscosa.* Mar. Biol. 102: 537-544

Hunt A, Dickens HJ & Whelan RJ 1987 Movement of mammals through tunnels under railway lines. Aust. Zool. 24: 89-93

Key Projects

Shannon Creek – Department of Commerce. Project management of ecological monitoring programs for threatened species, weeds and vertebrate pests at Shannon Creek. These studies will provide accurate data, which will allow ecologically sustainable management of the Shannon Creek catchment before, during and after construction of the Shannon Creek Storage Facility.

Seagrass Rehabilitation. Seagrass transplantation trials, monitoring and management in constructed canals, Port Macquarie, NSW for Port Shores Pty Ltd.

Proposed Mitigation Works at Coalcliff for NSW Roads and Traffic Authority. Ecological assessment and likely impacts on marine & terrestrial fauna and flora of the proposed works. Included REF preparation.

Assessment of Hydrological and Environment Studies – North Pearl Estate Area, Kahibah Creek for Gosford City Council. Included liaison with local groups and NSW NPWS to reach a compromise between flood mitigation works and environmental impact.

Replacement of Collins Bridge, Wee Waa for NSW Roads and Traffic Authority. Aquatic and terrestrial fauna and flora assessment and REF preparation, including Environmental Management and Mitigation Plans.

Replacement of Three Bridges on Newell Highway, Narrabri for NSW Roads and Traffic Authority. Aquatic and terrestrial fauna and flora assessment and REF preparation, including Environmental Management and Mitigation Plans.

Proposed Eastern Extension of Eastern Creek Waste Management Centre for Waste Service NSW. Aquatic and terrestrial fauna and flora assessment and EIS preparation. Included Section 5A Assessments and referrals under the EPBC for two endangered ecological communities and the Green and Golden Bell Frog.

Infill Proposal for Eastern Creek Waste Management Centre for Waste Service NSW. Terrestrial fauna and flora assessment.

Eastern Creek Waste Management Centre, Eastern Creek, NSW for Waste Service NSW. Landscape Rehabilitation Plan in collaboration with Greening Australia under instruction from DLWC.

Sodium Chlorate Plant, Sterling Pulp Chemicals, Muswellbrook, NSW. Ecological assessment and impact on terrestrial fauna and flora. Including EPBC referral, EIS preparation, PFM, community consultation and client liaison.

Proposed Food Processing Facility, Melton VIC. Flora and fauna assessment and preparation of an ecological management plan (EMP) for the environmentally sensitive Grey Box Woodlands and Native Grasslands and fauna that occurs on site, in accordance with the Victorian legislative requirements.

Proposed Dendrobium Mine Project, Mt. Kembla, NSW for BHP Billiton. Preparation of Primary Submission and Submission in Reply for Commission of Inquiry, including subcontractor management and client liaison.

Proposed Gas Exploration, Pilliga, NSW. Terrestrial flora and fauna assessment along proposed survey lines in Pilliga State Forest, including report preparation and statistical analyses.

Proposed World Best Practice Industry Park, Yass, NSW for Yass Shire Council. Ecological assessment of terrestrial fauna and flora, including report preparation and client liaison.

Proposed Subdivision, Silverdale, NSW. Flora assessment and recommendations for managing endangered ecological communities.

Previous Experience

- 2002 Lecturer & Demonstrator.
- 2001-2002 Senior Environmental Scientist, Anne Clements & Associates.
- 2000-2001 Senior Environmental Scientist, National Environmental Consulting Services (NECS).
- Research Associate, University of Wollongong.
- 1993–1997 Post-doctoral Fellow, University of Delaware, USA.
- 1994 Limited-term Assistant Professor, University of Delaware, USA.

Branden Haywood

Ecologist
Australia

Branden is a Consultant with ERM and is based in Sydney. He is an experienced ecologist with over 5 years experience in consulting and has previously worked throughout eastern Australia and has undertaken, managed and coordinated ecological and environmental assessment for government, private industry and non-governmental organisations, including biodiversity, catchment management, land use capability, development control, fire management, and environmental risk assessment, data collection and management projects for local and regional planning. He has a Bachelor of Applied Science degree in Environmental Resource Management majoring in Terrestrial Ecology from Southern Cross University. He also has an Advanced Certificate in Computer Technology from Wollongong TAFE. Branden is currently undertaking his Master of Environmental Engineering Management through the University of Technology Sydney.

Branden has knowledge and experience in the assessment of terrestrial flora and fauna, with a particular emphasis on terrestrial vertebrate fauna including mammals, frogs, reptiles, and birds. His previous experience with the Sydney Catchment Authority involved natural resource assessment, GIS database design and maintenance, feral animal and weeds impact assessment, monitoring, and predictive impact modelling, natural resource data management and coordination for local and regional planning for development control, strategic land capability assessment, environmental management, environmental auditing, hydrological assessment, ecological pollution risk and monitoring.

Branden has undertaken ecological studies and resource assessments for environmental impact assessments, environmental management plans, environmental audits, threatened species assessments, prepared environmental plans and policies, for government, planning, property and transport industries. This has included weed, pest animal, fire and habitat surveys and management, vegetation and use mapping, conservation assessment modelling and mapping.

Professional Affiliations and Registrations

- Modelling and Simulation Society of Australia and New Zealand (MSSANZ)
- Ecological Society of Australia (ESA)
- Australian Herpetological Society Inc.
- Frog and Tadpole Study Group of NSW Inc.

Fields of Competence

- Flora and Fauna Assessment
- Ecological monitoring
- Environmental Impact Assessment
- Field survey design and assessment
- Feral Animal and Weed Management
- Design and implementation of long term monitoring programs
- Threatened Species Surveys, Assessment and Management
- Preparation of Environmental Management plans/ policies, Ecological risk Assessments and Development Constraint reports

Education

- Bachelor of Applied Science (Environmental Resource Management) Terrestrial Ecology. Southern Cross University.
- Advanced Certificate in Computer Technology from Wollongong TAFE.
- Master of Environmental Engineering Management. University of Technology Sydney.

Languages

- English

Key Industry Sectors

- Federal Government
- Mining and Extractive
- State Government
- Private Industry

Key Projects

Noxious Weeds management Tool (2003) for Dubbo City Council

Lismore Farmland System Disposal System (for iPlan) (2003). Planning NSW

Onsite Effluent System Disposal Mapping project (2002). Sydney Catchment Authority.

GIS Coordinator for the Sydney Water Drinking Catchments Regional Plan (2001)

Catchment Information System (2002). Sydney Catchment Authority.

Fire Management Plans – Sydney Water Drinking Catchments & Warragamba Upper Nepean Catchments (2002). Sydney Catchment Authority

Breeding Biology Study of the Nankeen Kestrel (1998). Australian Bird and Bat Banding Scheme, Environment Australia.

Thermoregulation Studies of Lace Monitors (1998). University of Wollongong and CRC for Vertebrate pest Control.

Vertebrate Fauna Assessment for Mount Jeruselem National Park, Northern NSW (1997). SW NPWS.

Flora and Fauna Assessment of Cibin Margil Swamp (1997). Patterson Street Landcare Group, Byron Bay.

Dr Jacqueline Coughlan

Principal Ecologist
Australia

Jacqui's practical ecological skills in terrestrial and freshwater ecology have been developed over 15 years in several states. She has conducted and managed numerous fauna and flora surveys in New South Wales, Queensland and Western Australia and has a thorough working knowledge of State and Commonwealth legislation related to flora and fauna. She has a broad knowledge base of ecological issues and is able to provide clients with sound and practical advice regarding environmental legislation and assessment protocols. Jacqui provides both project management and mentoring advice for the environment team as well as personally contributing vital technical expertise to environment projects.

Professional Affiliations and Registrations

- Birds Australia (formerly RAOU) since 1991
- Ecological Society of Australia since 1993
- Environment Institute of Australia (EIA)
- Australian Mammal Society
- Royal Zoological Society of New South Wales
- Ecological Consultants Association

Fields of Competence

- Project management
- Peer review
- Environmental legislation
- Environmental impact assessment
- Flora and fauna assessments
- Threatened species assessments

Education

- Bachelor of Science (Hons Freshwater Ecology) (James Cook University)
- PhD (James Cook University)

Languages

- English

Key Industry Sectors

- Defence
- Government
- Utilities
- Transport

Publications

Williams S.E., Vernes K. and Coughlan J. 1999. Vertebrate fauna of Cannabullen Plateau: a mid-altitude rainforest in the Australian wet tropics. Memoirs of the Queensland Museum. 43 (2): 849-858.

Coughlan J. 2003. The Dry Rainforest Paradox: A Birds-eye View. in D. Lunney (ed) Conservation of Australia's Forest Fauna. in revision.

Key Projects

New South Wales

Westmead Nurses Quarters. Flora, Fauna and Bushfire assessments for structure planning and site re-development.

Baseline fauna assessment for a 220 hectare site within the Holsworthy Military area. Fauna survey for all terrestrial vertebrate fauna groups. The project required close liaison with botanists at Wollongong University who were concurrently mapping vegetation of the area.

Towra Beach renourishment EIS. Project management of aquatic ecology, terrestrial ecology and archaeology components of EIS. Wader bird surveys including endangered Little Tern. Preparation of EPBC Referral to Environment Australia. *Project Management, Survey and Review*.

EIS for proposed consolidation of Metalcorp facilities, Hexham. Flora and Fauna Assessment and review of previous EIS.

Provision of advice to Abigroup Leighton Joint Venture regarding fauna underpass and culvert design along the Western Sydney Orbital (M7).

Review of Species Impact Statement and Offset Strategy for threatened bird species to be impacted by proposed extension of Warkworth Coal Mine, Hunter Valley, NSW.

Review of REF's for Transgrid Central Region transmission line maintenance activities in Sydney Catchment Authority and NPWS land (*Project Management and Review*).

Preparation of consolidated report on rezoning of abandoned B2/B3 corridor lands, Turramurra, Sydney. Identification of constraints related to threatened flora and fauna species and endangered vegetation communities. Project Manager and Report Author.

Referral to Environment Australia under EPBC Act for Black-shouldered Kite and Nankeen Kestrel, as matters of National Environmental Significance.

Flora assessment for Cumberland Plain Woodland, Shale-Sandstone Transitional Forest and *Acacia pubescens* under the EPBC Act, 1999 for the proposed sewerage reticulation scheme, Oaks, Oakdale and Belimbla Park for Sydney Water *(Project Manager)*

An investigation of the movements of Koalas in relation to major roads in north-east New South Wales - Project Management, field work, client liaison, meetings, presentations, monitoring reports.

Investigation of the movements of vertebrate fauna in relation to the Pacific Highway and an assessment of the efficacy of road underpass structures for RTA - Project Management, client liaison, report writing.

Flora and fauna assessment of the proposed re-alignment and re-construction of 5 timber bridges on the Oxley Highway west of Wauchope Project Management, field work, report review.

Flora and fauna assessment of the proposed re-alignment and re-construction of 4 timber bridges on the Bruxner Highway, Tenterfield *(Project Manager)*

Flora and fauna assessment of proposed market garden development at Joshua Rd, Freemans Reach (Project Manager)

Biodiversity survey for the Mulgoa Nature Reserve in western Sydney for NPWS *(Project Manager)*

Preparation of bird species profiles for Sydney Olympic Park Authority for use on their web site.

Analysis of watercourse crossings along Western Sydney Orbital Route. Assessment of proposed mitigation measures.

Queensland

Reviews of Environmental Factors Cooktown Developmental Road, Cape York Peninsula, including Hell's Gate, Trevethan Creek, Moorehead River Crossing and Annan River road for re-alignments, widening and installation of bridges.

Review of Environmental Factors for re-alignment of 10 km of range road, Byerstown Range, Peninsula Development Road, Cape York Peninsula.

Baseline Monitoring for upgrades and re-alignments along the Cooktown Development Road (Annan River section) including reptile and small mammal trapping, amphibian census, spotlighting for nocturnal fauna, bird census, vegetation assessments (riparian, mangrove and woodland habitats).

Review of Environmental Factors for Queensland Department of Main Roads – North West District for re-alignments and road sealing along a 31 km section of Herveys Range Developmental Road west of Townsville.

Review of Environmental Factors for Queensland Department of Main Roads – North West District for the installation of several overtaking lanes, floodways and bridges on the Barkly Highway between Cloncurry and Mt Isa and an intersection at the junction of Barkly Highway and Burke Developmental Road.

Review of Environmental Factors for Queensland Department of Main Roads – North West District for road upgrades and widening of 10 km section of Flinders highway between Hughenden and Richmond in western Queensland.

Review of Environmental Factors for Queensland Department of Main Roads – North West *District* for re-alignments and widening of 10 km of Kennedy Highway between Ravenshoe and Mt Garnet, North Queensland.

Review of Environmental Factors for Rex Range Road between Mt. Molloy and Mossman. Identification of sensitive issues, pertaining to the flora and fauna of the wet tropics World Heritage Area. Identification of constraints and mitigation procedures.

Environmental Impact Assessment for installation of 60 km of optic fibre cable, Herveys Range Developmental Rd, west of Townsville. Vegetation survey and identification of plant species or vegetation communities of conservation significance along the route. Assessment of potential for fauna of conservation significance to occur along the route and potential impacts. Description of level of weed infestation and vegetation intactness.

Environmental Impact Assessment for installation of 60 km of optic fibre cable, Exmouth, Western Australia. Assessment of regional conservation significance of vegetation communities along the route and the potential for rare plant species to occur in those communities.

Environmental Impact Assessment for proposed location of a gas fired power station and evaporation ponds, Townsville. Fauna survey including small mammal trapping, spotlighting, bird census, pitfall trapping for reptiles, amphibians and small mammals. Survey of vegetation types, extent and conservation status. Assessment of level of disturbance and weed infestation. Identification of control measures for declared weeds. Targeted sampling and design of monitoring program for endangered Red Goshawk.

Environmental Impact Assessment – Ross River Sands, Townsville. Vegetation and weed assessment, mapping and description of marine plant communities and fauna habitat assessment. Assessment of regional conservation significance of vegetation communities on the site.

Environmental Impact Assessments for construction and operation of 120 km of 220 kV powerlines between Mt Isa and Gunpowder, far-western Queensland. Survey and description of vegetation communities and assessment of terrestrial flora and fauna, including the identification of rare, threatened or poorly known species and communities and the potential for impacts to occur.

Ergon Energy. Environmental Impact Assessment for installation of 24 km of 220 kV powerlines from Mica Creek power station (Mt Isa) to Hilton substation.

Ergon Energy. Environmental Impact Assessment for installation of 350 km of 220 kV powerlines from Hughenden to Winton and Richmond in western Queensland.

Environmental Impact Assessment for the construction of an all weather boat ramp and access channel at Molongle Creek, Upstart Bay (North Queensland). Work involved survey and identification of mangroves for assessment under Section 51 C of Fisheries Act, survey of intertidal invertebrates and waterbirds, sampling of seagrass beds and water quality monitoring.

Preparation of Environmental Management Plans (EMP's) - Townsville Field Training Areas 350 Man Camp and Range Control.

Impact Assessment Study for 30 km Southern Corridor access to city of Cairns as part of an Integrated Land Use and Transport Study. Fauna sampling of habitats along the proposed route and assessment of connectivity and viability of urban vegetation remnants. Project Manager of Ecology component of multidisciplinary project.

Baseline fauna assessment on Keswick Island, North Queensland. Intensive survey of all habitats for birds,

reptiles, mammals, and systematic searches of beaches for signs of turtle hatching activity.

Preliminary fauna survey of the Mount Isa region - Bird censusing, small mammal live trapping, reptile searches and trapping, vegetation descriptions and insect sampling (including sorting and identification of insects from samples).

Identification and assessment of compensatory wetland habitat for Townsville Town Common Conservation Park in line with RAAF intentions to fill existing deep water habitat borrow pits. Liaison with members of Borrow Pits Relocation Working Group comprised of representatives from local council, local fish and bird experts, client representatives and other stakeholders.

Jemma Sargent

Marine and Aquatic Ecologist
Australia

Jemma is a Consultant with ERM and is based in Brisbane. She is an experienced marine and aquatic ecologist with over seven years experience in consulting and has previously worked at Australian Museum Business Services (AMBS). She has a Bachelor of Science degree in marine and aquatic ecology from James Cook University and post graduate qualifications in applied statistics and information systems.

Jemma has knowledge and experience in the design, survey, identification and analysis of marine and aquatic flora and fauna. These include: macroinvertebrates, diatoms, macrophytes, macroalgae fish and seagrass surveys and freshwater, marine and estuarine habitat assessments. She is experienced in the identification of aquatic flora and fauna to family, genus and species levels.

Jemma has undertaken marine and aquatic ecological studies and resource assessments for government, mining, property and transport industries.

Professional Affiliations and Registrations

- Australian Society of Limnology

Fields of Competence

- Marine and aquatic ecology
- Flora and Fauna Assessment
- Ecological monitoring
- Environmental Impact Assessment
- Field survey and assessment
- Design and implementation of long term monitoring programs

Education

- Bachelor of Science (Marine and Aquatic Ecology) James Cook University, Townsville.

Languages

- English

Key Industry Sectors

- Federal Government
- Mining and Extractive
- State Government

Key Projects

Marine and Aquatic Assessments & Statistical Analysis

Macroinvertebrate Survey of Canungra Training Area. (macroinvertebrates and analysis using SIGNAL2 and AUSRIVAS models). Department of Defence, Queensland 2003.

Aquatic Surveys of Weiambelah Creek and the Condamine River (macroinvertebrates, fish, turtles, macrophytes and water quality), Chinchilla Qld. Confidential Client, Queensland 2003. Using SIGNAL2 and AUSRIVAS.

Aquatic Surveys of Durham Creek (macroinvertebrates, fish, turtles, macrophytes and water quality), Roma Qld. Confidential Client Queensland, 2003. Using SIGNAL2.

Previous Experience

Listed below some of the projects undertaken prior to joining ERM Australia:

Aquatic Surveys of the Proposed Oxley High Upgrades (fish, macroinvertebrates and habitat surveys). RTA, NSW 2003. Using SIGNAL2.

Macroinvertebrate and Diatom Monitoring, Hornsby Shire Council, 2002 – 2005. Using SIGNAL2 and Multivariate & Univariate Statisitical Analysis.

Aquatic Survey of Tributary Four of Breakfast Creek (macroinvertebrates, fishes, macrophytes and habitat assessment), Robinson GRC Consulting 2002. Using SIGNAL2.

Aquatic REF for the Proposed Widening of the Spit Bridge (seagrass, macroalgae, fishes, rocky intertidal invertebrates), GHD Pty Ltd for the RTA, 2002. Using Multivariate Statistical Analysis.

Aquatic Survey of Eastern Creek (macroinvertebrates, fishes, macrophytes and habitat assessment), Blacktown City Council, 2002. Using SIGNAL2.

Macroinvertebrate Identification and Analysis using SIGNAL of urban creeks. Bankstown City Council, 1999 - 2003.

Macroinvertebrate sampling of Jericho Creek Windsor Downs Nature Reserve to monitor recovery after a sewage spill, Department of Public Works, 2001-2002. Using SIGNAL2.

Additions to the Assessment and Monitoring of Experimental Environmental Flow Strategy for the Hawkesbury-Nepean River. Sydney Catchment Authority, 2000-2002 (GIS database and literature review of Urban and Blue Mountains dams);

Macroinvertebrate, macrophyte and fish sampling and identification and water quality parameter measurements analysis and report writing, Devils Pinch. Roads and Traffic Authority, 2000. Using SIGNAL2.

Assessment and Monitoring of Experimental Environmental Flow Strategy for the hawkesbury-Nepean River. Sydney Catchment Authority, 1997-2001, Using SIGNAL2.

Provision of Data for National Flora and Fauna Survey Standards – Fish. Environment Australi,a 2003.

Macroalgae survey of Lake Macquarie. Office of the Lake Macquarie Catchment Co-ordinator, 1999 - 2005.

Seagrass Monitoring in Lake Macquarie. Pacific Power, 1999.

Monitoring of the Green and Golden Bell Frog. Olympic Co-ordination Authority, 2000.

Fish Survey of a dam at New Line Road, Dural. Claron Construction, 2002 – 2003.

Aquatic Survey of the Myall Quays Lake (macroalgae, seagrasses, fishes and habitat assessment). Crighton Properties, 2002.

Macroinvertebrate Communities and Willow Removal Text site. Sydney Catchment Authority, 2001.

Aquatic Survey of Eastern Creek (macroinvertebrates, fishes, macrophytes and habitat assessment). Blacktown City Council, 2002.

Seagrass Environmental Impact Assessment Survey of Soldiers Point. D'alboro Marinas, 2001.

Macroinvertebrate Survey of Unnamed Tributary of Farmers Creek, Lithgow. Sydney Catchment Authority, 2001.

CRIMP Port Survey for Introduced marine Species, Port Jackson. Sydney Ports Authority.

Seagrass Survey, Lake Illawarra. Pacific Power, 2000 – 2001.

Environmental Impact Survey of Highway Upgrade, macroinvertebrate, macrophyte and fish sampling and identification and water quality parameter measurements analysis and report writing. Devils Pinch, Roads and Traffic Authority, 2000.

Macroinvertebrate Identifications in the Blue Mountains. National Parks and Wildlife, 1999.

Additional Sygnathid Species to the Provision of data for the Species Profile and Threats Database (marine and freshwater fish). Environment Australia, 2001.

Provision of data for the Species Profile and Threats Database (marine and freshwater fish). Environment Australia, 2002.

Macrophytes in the Hawkesbury – Nepean River. Australian Water Technologies, 1998 – 1999.

Aquatic and Terrestrial Flora and Fauna Study of Parklea Correctional Centre. Department of Public Works and Servies, 1999.

Lyell Reservior Environmental Flows Study. Pacific Power, 1995 – 1999.

Nicole Gerrard

Ecologist
Australia

Nicole Gerrard is an ecologist in ERM's Hunter Valley office. She has a Bachelor of Science majoring in environmental biology from Newcastle University and a Diploma in Applied Science majoring in microbiology from Newcastle Technical College.

Nicole has conducted targeted threatened flora and fauna surveys for environmental assessments, species impact assessments and management plans. She has also responded to public submissions for a range of proposals in her previous employment.

Since joining ERM, Nicole has undertaken and prepared a number of bushfire hazard assessments and plans of management. She has also undertaken SEPP 44- Koala Habitat assessments in the Port Stephens area.

Prior to joining ERM Nicole worked in a small environmental consulting firm in Sydney. She worked on a range of projects with most from the waste and concrete industries. Nicole also has experience in quality control for the food industry. Prior to entering the environmental consulting sector Nicole worked as a Laboratory Technician in a quality assurance laboratory.

Fields of Competence

- Ecological and biodiversity assessments
- Targeted threatened species surveys
- Ecological research and data analysis
- Species impact statements and impact monitoring
- SEPP 44 Assessments
- Bushfire Hazard Assessments
- Project Management

Education

- Bachelor Of Science
- Diploma in Applied Science

Languages

- English

Key Industry Sectors

- Food Quality Assurance
- Property Development
- Waste Management

Key Projects

Flora and Fauna Assessments

Project Plan. Flora and Fauna Assessment of a proposed residential development at Fennel Bay, NSW.

Fireline Rehabilitation, Department of Defence. Preparation of a report for a fireline rehabilitation assessment. This involved preparing graphs and interpreting the results.

Environmental Impact Assessments

Rooty Hill Concrete Batching Plant Environmental Impact Statement, Readymix. An EIS for a proposed concrete batching plant and major distribution centre for Readymix at Rooty Hill. There were a number of major environmental issues as the site contained a creek, supported Cumberland Plain Woodland and was in close proximity to a major recreational reserve.

Stage 2 Environmental Impact Statement Eastern Creek Waste Management Centre, Waste Service NSW. An EIS for a proposed landfill at the Eastern Creek Waste Management Centre.

Bushfire Hazard Assessments

Elermore Vale Bushfire Hazard Assessment, Monteath & Powys. Bushfire hazard assessment of an approved subdivision surrounded on three sides by remnant bushland.

Fletcher Bushfire Assessment, Monteath & Powys. Bushfire hazard assessment of a large approved subdivision bordered by a vegetated creek, Summerhill Waste Management Centre and public reserves.

Glendale Bushfire Assessment, Monteath & Powys. A bushfire hazard assessment of a proposed subdivision. Recommendations were provided on the best design to minimise bushfire threats.

Medowie Bushfire Hazard Assessment. A bushfire hazard assessment on a parcel of land proposed to be subdivided.

SEPP 44 – Koala Assessments

Medowie Koala Habitat Assessment. A koala habitat assessment on a parcel of land proposed to be subdivided in Medowie.

Rehabilitation Plans

Eastern Creek Waste Management Centre Landfill Rehabilitation Plan, Waste Service Australia. This report focused on the rehabilitation of a past landfill site. The report described the best practice methods for the revegetation of the former landfill site.

Environmental Management Plans

Construction EMP for the proposed concrete batching plant and associated infrastructure at Rooty Hill, Readymix. Major issues were surface water management as the site had a tributary of Eastern Creek run through it and flora issues as the site also contained Cumberland Plain Woodland.

Production EMP for the proposed concrete batching plant and associated infrastructure at Rooty Hill, Readymix. Major issues were surface water management as the site contained a tributary of Eastern Creek and flora issues as the site also contained Cumberland Plain Woodland. Noise issues where of major concern as the proposal involved constructing a railsiding for the delivery of aggregate.

Occupational Health and Safety

National Environmental Consulting Services (NECS). Preparation of the company's OHS&E manual.

Durantes Restaurant. Preparation of an OH&S manual for a food restaurant.

Project Management

Rooty Hill Concrete Batching Plant EIS, Readymix

Elermore Vale Bushfire Hazard Assessment, Monteath & Powys

Fletcher Bushfire Assessment, Monteath & Powys

Glendale Bushfire Assessment, Monteath & Powys

Renae Baker

Ecologist
Australia

Renae is an ecologist with ERM and is based in Sydney. Renae graduated with 1st Class Honours in Bachelor of Science from Macquarie University.

Renae's Honours program required two studies be undertaken. Her research focused on environmental changes and weed invasion as a consequence of edge effects in Cumberland Plain Woodland, and the impact of alternative control burning patterns on the activity of small mammals. During her Honours research Renae gained experience in experimental design, statistical analyses, plant identification, environmental parameter measurement, small mammal trapping, spotlighting, habitat assessment, control-burning techniques and fire ecology.

Renae has undertaken volunteer work including Penguin radiotracking with NSW NPWS and Zookeeping with Taronga Park Zoo.

Since joining ERM Renae has participated in and managed projects involving ecological community identification and mapping, plant identification, fauna survey, environmental impact assessments, species impact statements and bushfire risk assessments. Renae has also worked with Landcom in developing Triple Bottom Line methodology for native vegetation and riparian corridor management.

Fields of Competence

- Vegetation classification and mapping
- Flora and fauna surveys
- Ecological monitoring
- Triple Bottom Line development and reporting
- Flora identification
- Bushfire Risk Assessment

Education

- Bachelor of Science (Honours Class 1), Biodiversity and Conservation, Macquarie University, Sydney, 2002, Sydney, Australia.

Languages

- English

Key Projects

Mapping of Cumberland Plain Woodland (CPW), Western Sydney. Ground-truthed vegetation mapping and conservation significance classification of bushland remnants in Blacktown, Western Sydney. Assisted in identification of opportunities and constraints for rezoning of 150ha of land in Western Sydney.

Cooks Cove, Sydney. Undertook fine scale mapping of wetland vegetation.

Parramatta Rail Link. Participated in threatened species targeted surveys.

Ballast Point Flora and Fauna Assessment. Assessment of the constraints and opportunities associated with Ballast Point, Sydney Harbour.

Prestons Threatened Flora and Fauna. Conducted threatened vegetation community and threatened flora and fauna species mapping and identification of development options of land at Wonga Road, Prestons.

Soil Translocation at Belrose. Management of a soil translocation project involving the seedbank of the endangered species *Grevillea caleyi*.

Triple Bottom Line Reporting – Landcom. Undertook first and second year reporting of Landcom's environmental bottom line indicators – native vegetation and riparian corridor management. Developed the methodology for reporting to be used by ecological consultants employed by Landcom.

Species Impact Statement, Vincentia. Participated in flora and fauna surveys and reporting for a species impact statement for development at Vincentia, NSW.

Environmental Impact Statement, Hunter Valley. Participated in flora and fauna surveys for an environmental impact statement at a proposed coal mine site in the Hunter Valley.

Environmental Impact Statements, Bega Valley. Undertook ecological assessments and reporting for Sewerage Treatment Plant works in the Bega Valley and Goulburn, NSW.

Endemic Species Planting Guidebook. Developed and produced an endemic species planting guidebook for the ACT to be used by landscapers and horticulturalists on Defence properties.

Tammy Haslehurst

Ecologist
Australia

Tammy is an ecologist with ERM and is based in Sydney. Tammy graduated with 1st Class Honours in Environmental Biology from Macquarie University.

Tammy has gained experience in research and field ecology through volunteer work with NSW NPWS and her honours research. Volunteer work with NPWS included penguin radiotracking and assistance at the wildlife shelter at Lane Cove National Park. Tammy's Honours research focused on the remeditation of stormwater sites using native vegetation. She is also familiar with plant identification, vegetation classification using aerial photograph interpretation and field assessment of structure and composition.

Since joining ERM, Tammy has participated in and managed projects involving ecological studies and impact assessments, fauna monitoring / survey, bushfire risk assessments, vegetation and watercourse management plans and species impact statements. She has experience in scientific method, flora and fauna survey, information and data analysis and constraints assessments.

Fields of Competence

- Research
- Flora and fauna surveys
- Ecological monitoring
- Bushfire Risk Assessments
- Flora Identification

Education

- Bachelor of Environmental Science (Honours Class 1), Environmental Biology, Macquarie University, Sydney, 2002, Sydney, Australia.

Languages

- English

Key Projects

Environmental Impact Assessments

A number of small assessment reports for subdivision of land.

Clarence Valley Coffs Harbour Ecological Monitoring Project. Ongoing participation in flora and fauna surveys, target searches for threatened species, ecological monitoring and reporting.

Defence Housing Authority. Flora and fauna survey and bushfire risk assessment report for subdivision of land. Identification of hazard reduction measure for proposed development.

Boral. Flora and fauna surveys, preparation of eight part tests and referral to comply with State and Commonwealth Legislation.

Claremont Meadow Flora and Fauna Assessment. Flora and fauna survey, preparation of eight parts tests and referral to comply with State and Commonwealth Legislation.

Sampling for *Phytophthora cinnamoni* and preparation of management plan.

Species Impact Statement. Participated in flora and fauna surveys, target searches for threatened species and reporting for a species impact statement, for a development at Vincentia, NSW.

Ecological and bushfire constraints assessment. Identification of development constraints and opportunities for a development at Marulan, NSW.

St Marys ADI Site. Assisted with the preparation of the biodiversity assessment report, monitoring of macrofauna and preparation of macrofauna management plans. Flora and fauna surveys and preparation of eight part tests and referrals to comply with State and Commonwealth Legislation.

Parramatta Rail Link (PRL). Threatened species targeted surveys and flora and fauna surveys.

Environment Impact Statement: Participated in flora and fauna surveys and target searches for threatened species within Riverview and Cheshunt pre-mining areas in the Hunter Valley, NSW.

Preparation of Management Subplans

Preparation of a Vegetation Management Plan for a Conservation area at Hoxton Park.

Artazan. Preparation of a Watercourse Rehabilitation Plan.

Annangrove Flora and Fauna Assessment. Undertook ecological assessment and threatened species search for installation of a mobile network. Preparation of eight part test to comply with State Legislation.

Defence Projects

Holsworthy Program of Works EIA. Flora and fauna constraints assessment.

Temperate Grasslands and Yellow Box Red Gum Grassy Woodland Monitoring. Monitoring of Natural Temperate Grasslands and mapping of threatened flora at Majura Field Firing Range, Campbell Park Offices and HMAS Harman.

Environmental Options Analysis (EOA) for the Additional Trooplift Helicopter (ATH). Options Analysis for location of additional. Trooplift Helicopter.

Environmental Assessment – Stage 1, Living-In Accommodation: Holsworthy Barracks. Flora and fauna Constraints and Opportunities Assessment at Holsworthy Army Barracks.

William Introna

Ecologist
Australia

Will is a consultant with ERM and is based in Sydney. He has over seven years experience in ecology, environmental impact assessment and environmental management. He has a good working knowledge of State and Commonwealth legislation related to flora and fauna and is able to provide clients with sound and practical advice regarding environmental legislation and assessment protocols.

He has worked throughout eastern Australia and has planned, managed and undertaken ecological projects for government and private industry at the state, national and international level. These have included impact assessments, management and monitoring projects for mining, urban, tourism, transmission line, transport, water supply and infrastructure industries and biodiversity conservation and management projects.

He has undertaken terrestrial and freshwater aquatic flora and fauna surveys for environmental impact assessment, environmental management, ecological risk assessment, threatened species assessments and ecological monitoring. He has prepared bushland and threatened species management plans, environmental risk and constraint reports, weed, pest animal and fire management plans, biological monitoring plans and threatened species monitoring protocols.

He has also undertaken negotiations and provided advice about the level of mitigation measures required for developments, including green offset measures to offset potential impacts to biodiversity and to meet ecologically sustainable development requirements. His previous experience with the New South Wales National Parks and Wildlife Service involved natural resources assessment, pest and fire management, impact assessment and community consultation.

Professional Affiliations and Registrations

- Environment Institute of Australia and New Zealand
- Ecological Society of Australia
- Birds Australia

Fields of Competence

- Ecological assessment and advice
- Terrestrial and aquatic flora and fauna surveys
- Threatened species surveys, advice and management.
- Environmental impact assessment
- Environmental management plans
- Biodiversity assessment
- Ecological monitoring

Education

- Bachelor of Science (Environmental Biology), University of Technology, Sydney (UTS), 1993.
- Master of Science (Thesis) (UTS), 2004.

Languages

- English
- Italian

Key Industry Sectors

- Federal Government
- State Government
- Mining and Extractive
- State Government
- Utilities

Key Projects

Project Land, Australia, AAP, 2004.
Ecologist
Ecology due diligence of four Department of Defence properties prior to sale to government department Landcom for residential development. Assessment of flora and fauna issues and constraints gaps in flora and fauna information and recommendations to address issues.

UTS Ku-ring-gai Phase II Rezoning and Masterplan Ecological Summary Report, Australia, CRI Australia 2004.
Project Manager
Assessment and summarisation of ecological constraints. Input into the development masterplan and rezoning application. Identification of ecological, threatened species and corridor issues and provision of strategic options and solutions to deal positively with ecological issues including management and mitigation measures. Liaison with local and state agencies and a community reference group.

Vincentia Species Impact Statement, Australia, Stockland, 2003 – 2004.
Ecologist
Preparation of preliminary flora and fauna impact assessment report. Two-week flora and fauna survey with a team of nine ecologists, including targeted surveys for threatened orchids, ground mammals, birds, frogs and arboreal mammals. Vegetation surveys, mapping and impact assessment.

Wollar – Wellington Proposed Transmission Line and Wollar Switching Station Corridor Selection Report Recommendation, Australia, TransGrid, 2003.
Ecologist
Mapping of ecological constraints, including National Parks, State Forests, Crown Land, endangered ecological communities and habitat for state and federally listed threatened species and other areas of high ecological sensitivity. Assessment by flight inspection, aerial photographs and on ground field assessment. Evaluation of the preferred route in terms of ecology by ranking and comparison of ecological constraints. Liaison with state and federal agencies and stakeholders.

Majura Training Area Vegetation Mapping and Campbell Park Endangered Vegetation Assessment, Australia, Department of Defence, 2003.
Ecologist
Design and implementation of data collection and monitoring program to determine the extent of endangered vegetation communities (grasslands and woodlands) on two sites totalling over 5, 000 hectares in size. Yearly monitoring and statistical analysis of vegetation community distribution and Geographical Information System mapping.

Holsworthy Program of Works Environmental Impact Assessment and Referral, Australia, Department of Defence, 2003.
Ecologist
Vegetation mapping and assessment of potential impacts to state and federally listed endangered ecological communities and threatened species. Recommendation of amelioration and green offset measures. Preparation of Referral to the federal agency Environment Australia.

Bundaleer Street Statement of Evidence, Australia, Woolf and Associates Solicitors, 2003.
Ecologist
Summarisation of ecology issues and responses for the Land and Environment Court in relation to the potential impact on flora and fauna and fire management issues of the proposed construction of a dwelling.

Regional Water Supply Project Management Plans, North Coast Water, Australia, 2002 – 2003.
Project Manager
Preparation of habitat, threatened species management and monitoring, weed, pest animal and fire management plans for construction and operation of water storage facility. Provision of maps, works schedule and statistically sound monitoring strategies. Consultation with relevant agencies including National Parks and Wildlife Service.

Extension to Warkworth Coal Mine Environmental Impact Statement, Species Impact Statement, Referral to Environment Australia and Green Offsets Strategy, Australia, Coal & Allied, 2002.
Ecologist and Project Manager
Seasonal flora and fauna surveys in woodland in the Hunter Valley, New South Wales, including targeted surveys for a number of state and nationally threatened woodland birds, mammals, reptiles, amphibians and plants. Detailed consultation with relevant state and federal agencies, local ecologists and interest groups. Preparation of general flora and fauna impact assessments, threatened species impact assessments, and green offsets strategies. The Green Offsets Strategy was a finalist in the Hunter Coal Industry Environmental Management Awards.

ACT Properties Weed Control Program, Riverina Murray Valley Defence Properties Weed Management Strategy, South Coast Weed Management Strategy, Department of Defence, Australia, 2001.
Project Manager
Detailed surveys and mapping of Noxious Weeds, Weeds of National Significance and significant weeds over 13 bases in New South Wales which supported endangered ecological communities and threatened species. Ranking and risk assessment for each base. Identification of control measures, works schedules and monitoring strategies including a computer database to track weed distribution and control efforts.

PROFESSIONAL PROFILE

FULL NAME:	**Peter Andrew EKERT**
DATE OF BIRTH:	3rd April, 1973
POSTAL ADDRESS:	4 Bowen Street Wallsend NSW 2287
TELEPHONE:	02 49500573 0410 566104
E-MAIL:	peter@ekerlogic.com.au
TERTIARY EDUCATION:	1995-1997 Southern Cross University, Lismore, NSW Bachelor of Applied Science (Environmental Resource Management)

EMPLOYMENT

I have eight years professional experience researching fauna and flora, specialising in birds and investigating their long-term management. I have been manager of a number of bird monitoring projects, many community based, with Federal and State government agencies, non-governmental conservation organisations, and volunteer groups including Environment Australia, Olympic Co-ordination Authority, NSW National Parks and Wildlife Service, Birds Australia, and Wetland Care Australia, and North Sydney Council. I have produced a number of scientific reports and publications.

The following is a summary of projects I am currently and have successfully managed:

2003-current Ekerlogic Consulting Services; NSW National Parks and Wildlife Service: A Review of the Status of the Osprey in NSW

2003-current Ekerlogic Consulting Services; Liverpool Plains Land Management Committee (LPLMC): Woodland Bird Monitoring Program and Focal Species Analysis

2003-current Ekerlogic Consulting Services, NSW National Parks and Wildlife Service and NSW Dept Commerce: Lower Hunter Estuary Rehabilitation Program (LHERP)

2002-current Ekerlogic Consulting Services & NSW National Parks and Wildlife Service: 'Warragamba Special Area Fauna Survey Program'

2000-current Ekerlogic Consulting Services & NSW National Parks and Wildlife Service Monitoring Rufous Scrub-birds in Central Eastern Rainforest Reserves in NSW.

2003-current Ekerlogic Consulting Services; Dept. Infrastructure, Planning and Natural Resources (DIPNR), Dora Creek Catchment Committee: Dora Creek Wetland Action Plan

2002-2003 Ekerlogic Consulting Services & North Sydney Council: 'The North Sydney Bushland Continuing Bird Survey'

2001-2002 Wetland Care Australia: 'Bungawalbin Bird Monitoring Project'

2001-2003 2000-2002 Birds Australia 'Saving the Woodland Birds of The Liverpool Plains Project'

1999-2001 Birds Australia Project Co-ordinator: 'Homebush Bay Bird Monitoring Project'

1999-2000 Birds Australia and NSW National Parks and Wildlife Service Project 'Glossy Black Cockatoo Baseline Study'

1999-2000 Birds Australia and NSW National Parks and Wildlife Service Monitoring Rufous Scrub-birds in Central Eastern Rainforest Reserves in NSW.

1997-1999 Project Officer Environment Australia (Australian Bird and Bat Banding Scheme) Canberra, ACT

PUBLICATIONS, PRESENTATIONS & MEDIA

Ekert, P.A., Barrett, G. and Weston, M. (2002). Woodland Birds of NSW. In: 'Conservation Directions' *Wingspan*, **12(3)**.

Ekert, P.A. (2002). *The Woodland Birds of The Liverpool Plains, NSW*. RAOU Report Series Monograph. Birds Australia, Melbourne.

Ekert, P.A. & Aitchison, H. (2002). *Ramsar Wetlands in NSW.* Brochure published for The Wetlands Centre, Australia.

Ekert, P.A. & Aitchison, H. (2002). *The Wetlands of the Lower Hunter.* Brochure published for The Wetlands Centre and the Natural Heritage Trust, Environment Australia and Newcastle City Council.

Ekert, P.A. & Weston, M. (2001). Conservation Auction (The Role of Birds). In: 'Conservation Directions' *Wingspan*, **11(4)**.

Ferrier, S., McIntyre, A., & **Ekert, P.A.** (2000). Monitoring the Rufous Scrub-bird (*Atrichornis rufescens*) in Central Rainforest Reserves in NSW. Poster presentation by Birds Australia and the NSW NPWS at the Southern Hemisphere Ornithological Congress, Brisbane 2000.

Ekert, P.A. & Bucher, D.J. (1999). Winter use of large-leafed privet *Ligustrum lucidum* (Family: Oleaceae) by birds in suburban Lismore, New South Wales. *Proceedings of the Linnean Society of New South Wales* **121**, 29-38.

ABC Local Radio (Newcastle – October 2000) – Interview with Phil Ashley Brown informing the general public about the Rufous Scrub-bird surveys and the biology of the species

ABC Local Radio (Tamworth – Feburary 2002) - Morning Show With Peter Gunders - interview informing the general public about the Liverpool Plains Woodland Bird Project ands the widespread decline of woodland birds in s/e Australia

ABC North Coast (July 2003) – Morning Show with Fiona Wiley – interview on the biology, distribution and abundance of Osprey.

The Wetlands Centre Australia Ramsar Website 2002. http://www.wetlands.org.au – an informative electronic resource providing information to the community on the values of Australia's newest internationally recognised Ramsar site.

Totally Wild (Network Ten, Sydney – March 2003) – Interview and filming of bird census techniques and summary of North Sydney Council Continuing Bird Survey.

CONTRACTUAL REPORTS (SUMMARY)

Brady, A.M and **Ekert, P.A.** (2003). Management Priorities for the Flora and Fauna of Goolawah Reserve. Report prepared on behalf of Ekerlogic Consulting Services (ECS) for Wetland Care Australia, Natural Heritage Trust.

Ekert, P.A. (2003). Shorebird Monitoring in Kooragang Nature Reserve Stage 1. Report prepared on behalf of Ekerlogic Consulting Services (ECS) for the NSW National Parks and Wildlife Service.

Ekert, P.A. (2002). The Woodland Birds of The Liverpool Plains, NSW. Final Project Report 2002. Report on behalf of Birds Australia for World Wide Fund for Nature, Natural Heritage Trust, Threatened Species Network.

Ekert, P.A. (2002). The Wetlands Centre Australia Plan of Management 2002-2009. Report to Wetlands Centre funded by Natural Heritage Trust.

Ekert, P.A. (2001). Saving the Woodland Birds of The Liverpool Plains. Interim Progress Report October 2001 for Birds Australia to World Wide Fund for Nature (WWF), Natural Heritage Trust, and Threatened Species Network.

Ekert, P.A. (2001). Homebush Bay bird monitoring project. Report on behalf of the Royal Australasian Ornithologists Union to The Olympic Co-ordination Authority (OCA), Homebush Bay, NSW.

Ekert, P.A. (2000). Homebush Bay bird monitoring project. Final Report: Review of Monitoring 1996-2000. Report on behalf of the Royal Australasian Ornithologists Union to The Olympic Co-ordination Authority (OCA), Homebush Bay, NSW.

Ekert, P.A. (2000). Monitoring Rufous Scrub-birds in north-east NSW. Final Progress Report (January 2000). Report on behalf of the Royal Australasian Ornithologists Union to the New South Wales National Parks and Wildlife Service (Northern Zone – Threatened Species Unit).

Ekert, P.A. (1999). Weed Risk Assessment of *Citrus latifolia*. In: Import Risk Analysis for the Importation of Tahitian Lime. Australian Quarantine & Inspection Service (AQIS), Canberra.

Ekert, P.A. (1997). Report on ecological study: territory/home range size and pair fidelity in the Australian Kestrel (*Falco cenchroides*). Report to the Australian Bird & Bat Banding Scheme (ABBBS), Environment Australia, Canberra.

Ekert, P.A. (1997). The use of Large-leafed privet (*Ligustrum lucidum*) by avifauna in Lismore, northern NSW. Southern Cross University, Lismore. (Major Thesis)

REFEREES

Mr G.B. (Barry) Baker (Executive Officer/ Assistant Director)
Australian Bird and Bat Banding Scheme/ Wildlife Management Section.
Environment Australia, Biodiversity Group. Canberra, ACT
(02) 62742402 barry.baker@ea.gov.au

Michael Weston (Manager, Research and Conservation Department)
Birds Australia (Royal Australasian Ornithologists Union)
415 Riversdale Rd
Hawthorn East, Vic., 3123
03-9882-2622 m.weston@birdsaustralia.com.au

RELEVANT EXPERIENCE

ENVIRONMENTAL MANAGEMENT

- Demonstrated knowledge of: the ecology of Australian terrestrial plant and animal communities; environmental management and processes involved in the protection of biodiversity;
- Demonstrated ability to collect, collate and report on ecological data in scientific format and to provide management recommendations;
- Demonstrated knowledge of relevant State, National and International legislation, Policies and Agreements pertaining to the protection of threatened species and their habitats;
- Effective communication and liaison skills with government agencies and clients.

FLORA/ FAUNA SAMPLING

- Highly skilled in the identification of avifauna from both visual sightings and call interpretation;
- Skilled in the identification of a wide range of Australian flora and fauna;
- Demonstrated use of sampling methods for fauna: (radio telemetry, Bal-chatri traps, mist nets, harp traps, hair tubes, Elliott traps, cage traps, pitfall traps, spotlighting, playback for nocturnal avifauna and active searches);
- Demonstrated ability to work in a team environment and to work in remote locations for extended periods.

INFORMATION TECHNOLOGY

- Demonstrated use of operating software - MS-DOS, MS Windows 3.11/95/98/NT, MS Word 6.0/95/97/2000, MS Excel 5.0/6.0/97/2000, MS Access, MS PowerPoint, SPSS, Statview Student V.1.0;
- Skilled in GIS and Remote sensing (PC ARC INFO; Idrisi and ARCVIEW);
- Skilled in the use of the internet (Netscape; MS Internet Explorer) and email (Eudora, Lotus Mail, MS Outlook) software;
- Skilled in a range of literature search engines (internet, catalogues, libraries, databases);
- Fast and accurate keyboard skills; data input and analysis; report formatting.

PROJECT MANAGEMENT

- Demonstrated ability to liaise with a wide range of Government agencies, and volunteers from the general public to conduct surveys;
- Demonstrated ability to address tender submissions, formulate project proposals, manage project budget, and regular report submission to government clients, project steering committees and fellow staff.

OTHER

- Demonstrated ability to drive a 4WD vehicle in remote locations under extreme weather conditions;
- Demonstrated ability to work and perform professionally as an individual or within a group framework

MEMBERSHIPS & JOURNAL SUBSCRIPTIONS

ORNITHOLOGY

- Birds Australia (Royal Australasian Ornithologists Union (RAOU))
- Bird Observers Club of Australia
- Hunter Valley Bird Observers Club
- Tweed Bird Observers Club

ECOLOGY

- Australian Ecological Society
- The Linnean Society of New South Wales

Annex C

Species Lists

Table C.3 Plant Species List

Scientific Name	Common Name	Quadrat Number												
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Inc.
DICOTYLEDONS														
Acanthaceae														
Pseuderanthemum variabile	Pastel Flower				2	2	2			2	2			
Apiaceae														
Actinotus minor			1					1						
Centella asiatica	Swamp Pennywort													x
Hydrocotyle laxiflora	-													x
Platysace linearifolia	Carrot Tops	2	2	2	1	2			1	1				
Xanthosia tridentata	Rock Xanthosia	1	1	1	2	2	2	1	1	2	2	1	2	
Asclepiadaceae														
*Gomphocarpus fruticosus**	Narrow-leaved Cotton Bush													x
Asteraceae														
*Ageratina adenophora**	Crofton Weed													x
*Bidens pilosa**	Cobbler's Peg													x
*Conyza bonarienis**	-													x
*Hypochaeris radicata**	Cat's Ear													x
Cassythaceae														
Cassytha glabella	Devil's Twine		1											
Cassytha pubescens	Slender Devil's Twine					1		2	1	2		2	2	
Casuarinaceae														
Allocasuarin distyla	-													x
Allocasuarina littoralis	Black She-oak	2	1	1	2	3	2	2	2	1	2			
Allocasuarina paludosa	-											1	1	
Clusiaceae														
Hypericum gramineum	Small St John's Wort										1			
Convolvulaceae														
Dichondra repens	-													x
Cunoniaceae														
Bauera ruboidies	River Rose								2			2		
Dilleniaceae														
Hibbertia aspera	Rough Guinea Flower	2		1		1	2			3	1			
Hibbertia riparia	-	1	2	2				1					2	
Droseraceae														
Drosera peltata	Sundew							1	1					
Epacridaceae														
Epacris microphylla	Coral Heath		1									2	2	
Epacris obtusifolia	-											3	2	
Epacris paludosa	Swamp Epacris	1												
Epacris pulchella	NSW Coral Heath			2										
Leucopogon juniperinus	Bearded Heath													
Leucopogon microphyllus	-							2				3	2	
Sprengelia incarnata	-											2	2	
Styphelia triflora	-		1					2	1					
Woollsia pungens	-							1				4		
Euphorbiaceae														
Breynia oblongifolia	Breynia													
Phyllanthus hirtellus	Thyme Spurge				2	1	2		1	1	2			
Poranthera ericifolia		1	1	2				2		1				
Fabaceae (Faboideae)														
Desmodium rhytidophyllum	-				1									
Dillwynia floribunda	-			2				2	1					
Glycine clandestina species complex	Love Creeper				1	1	2				2			
Glycine microphylla	Love Creeper									2	2			
Gomopholobium grandifolium	-	1	2			1	1	1		1				

Table C.3 Plant Species List

Scientific Name	Common Name	Quadrat Number												
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Inc.
Gompholobium pinnatum	-	1		1						2			1	
Hardenbergia violacea	False sarsarilla					1	1				1			
Hovea linearis	-	1												
Mirbelia rubiifolia		2	1						2	2				
Platylobium formosum ssp. *formosum*	Handsome Flat-Pea	2								2				
Pultenaea retusa	-	1	1		2									
Pultenaea rosmarinifolia	-	I			2	2		1		1	1			
Viminaria juncea	Golden Spray											1		
Fabaceae (Mimosoideae)														
Acacia elongata var. dilatata	-								2					
Acacia longifolia	Sydney Golden Wattle				1				2		1			
Acacia myrtifolia	Myrtle Wattle	2		1	1	1			1	2	1			
Acacia suaveolens	Sweet-scented Wattle		2						1			1		
Acacia ulicifolia	Prickly Moses	1								1				
Goodeniaceae														
Dampiera stricta		2	2	2	2	2		2	2	1	1	2	2	
Goodenia bellidifolia ssp. *bellidifolia*	Daisy-leaved Goodenia					2	2	1		2	2		2	
Goodenia paniculata	-	3	I		2									
Goodenia heterophylla ssp. *heterophylla*	-						2				1			
Scaevola ramossisima	-							2						
Holoragaceae														
Gonocarpus tetratgynus	-		1											
Gonocarpus teucrioides	Germander Raspwort	1		1	2	2	2			2	3			
Iridaceae														
Patersonia sericea	Silky Purple Flag	2	1	1	2	3	2	2	1	1	1		2	
Loganiaceae														
Mitrasacme polymorpha	-		1	2				2				1	1	
Malvaceae														
*Sida rhombifolia**	Cobbler's Peg													x
Myrtaceae														
Baeckea diosmifolia	-							2						
Callistemon linearis	Narrow-leaved Bottlebrush											1		
Darwinia leptantha	-								1			3	1	
Eucalyptus globoidea	White Stringybark	1			2	3	2				2			
Eucalyptus obstans			2									1		
Eucalyptus robusta	Swamp Mahogany													x
Eucalyptus resinfiera ssp. *resinifera*	Red Mahogany					1								
Eucalyptus scias ssp. *callimastha*	Large-fruited Red Mahogany											1		
Eucalyptus sclerophylla	Hard-leaved Scribbly Gum			4	1	2		2	3	3	1		1	
Corymbia gummifera	Red Bloodwood	2		3	3				2	2	2			
Corymbia maculata	Spotted Gum						3							
Kunzea capitata	Tick Bush		2	3										
Melaleuca linariifolia	Snow-in-summer													x
Melaleuca thymifolia	-										1	1		
Leptospermum continentale	-								1	2				
Leptospermum juniperinum	-		2	2		1			1					
Leptospermum polygalifolium	Lemon-scented Tea-tree	3			1				2		3	1		
Leptospermum laevigatum	Coastal Tea-tree	3												
Leptospermum trinervium			3			2		3	2					
Syncarpia glomulifera	Turpentine				1									
Pittosporaceae														
Billardiera scandens	Apple Berry				1		1							
Plantaginaceae														
*Plantago lanceolata**	Lamb's Tongue													x

Table C.3 Plant Species List

Scientific Name	Common Name	Quadrat Number												
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Inc.
Proteaceae														
Banksia ericifloia	Heath-leaved Banksia								1			5	1	
Baknsia oblongifolia	-		2					2					1	
Banksia spinulosa var. *spinulosa*	Hair-pin Banksia	3		4	2	2			3	3	3			
Conospermum ericifolium	Smoke Bush											1	2	
Conospermum taxifolium														x
Hakea dactyloides	Finger Hakea	2	2	3		2		2	2	2				
Hakea gibbosa	-											4	1	
Hakea teretifolia	-		1				1	2	2			3		
Isopogon anemonifolius	Drumsticks		2					2				1	2	
Isopogon anethifolius	Drumsticks			2										
Lambertia formosa	Mountain Devil	3	3	3		2		2	2	2			2	
Lomatia ilicifolia	-	1	1	2	1	1				1				
Petrophile pulchella	Conseticks	2												
Petrophile sessilis	Conseticks		2	2										
Persoonia levis	Braod-leaved Geebung	2	2	3				1	2	2			2	
Persoonia linearis	Narrow-leaved Geebung								1		1			
Rubiaceae														
Opercularia aspera	Thin Stink Weed				2	2			1	1	1			
Opercularia diphylla		1		1										
Pomax umbellata	Pomax													x
Rutaceae														
Boronia barkeriana	-		1		1									
Boronia parviflora	-				2					2	2			
Boronia pinnata	-	2	1	1		1	1			2			1	
Philotheca buxifolia ssp. *falcata*	-	1												
Santalaceae														
Leptomeria acida	-											1	2	
Sapindacaea														
Dodonaea triquetra	Hop-bush													x
Selaginaceae														
Selaginella uliginosa			2	2										
Stylidiaceae														
Stylidium graminifolium	Trigger Plant	2	2	2		1	1	1		1				
Thymelaeaceae														
Pimelea linifolia ssp. *linifolia*	Tall Rice Flower	2	2	2	2	2	1	2	2	2	2	1	2	
Violaceae														
Hybanthus monopetalus													1	
Viola hederacea	Purple Violet				2	1				2	2			
MONOCOTYLEDONS														
Anthericaceae														
Dichopogon fimbriatus	Nodding Chocolate-lily	1												
Sowerbaea juncea	Rush Lily											1	2	x
Cyperaceae														
Baumea articulata	-													x
Baumea juncea	-													x
Baumea rubiginosa	-													x
Cyathochaeta diandra	-	3	2					3	3				2	
Fimbristylis dichotoma	-		1											
Gahnia clarkei	-													x
Gahnia sieberiana	-								1		1			
Lepidosperma filiforme	Rapier Sedge								1					
Lepidosperma quandrangulatum	-											1		

Table C.3 Plant Species List

Scientific Name	Common Name	Quadrat Number												
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Inc.
Lepidosperma laterale	-	1			2	2	2	1		2	2		4	
Lepidosperma concavum	-					3	2	1	2		4			
Lepidosperma neesii	-		1							2				
Ptilothrix deusta	-	4	2	2	1			2		2	1		1	
Schoenus brevifolius	-										3			
Schoenus lepidosperma ssp. *pachylepis*	-												1	
Juncaceae														
Juncus usitatus	-													x
Lilaceae														
Blandfordia nobilis	Christmas Bells	1						1	2					
Burchardia umbellata	Milkmaids							2		1		1	2	
Caesia parviflora var. *parviflora*	Pale Grass-lily	1			1			2	2	1	1	1	1	
Haemodorum corymbosum	Blood Root	1		1				2	2		1		1	
Hypoxis graminea	-					1					1			
Hypoxis hygrommetrica	Yellow-stars				2		2			2				
Thelionema umbellatum	-					1		1						
Thysanotus tuberosus	-							1	1	2	2		2	
Lomandraceae														
Lomandra cylindrica	-		2											
Lomandra filiformis ssp. *filiformis*	-		2		1	1	1	2	2	2	2	2	3	
Lomandra glauca ssp. *glauca*	-				2									
Lomandra longifolia	Mat Rush			1	2		3				1			
Lomandra multiflora ssp. *multiflora*	-	2		2	1	1	1				2			
Lomandra obliqua	Fishbones	2	2	2	1		1	2	1	2	1		2	
Lomandra micrantha ssp. *tuberculata*	Small-flowered Mat-rush		1											
Orchidaceae														
Calochilus campestris	Copper Beard													x
Calochilus paludosus	Copper Beard													x
Calochilus grandoflorus	Copper Beard													x
Cryptostylis erecta	Bonnet Orchid													x
Cryptostylis subulata	Tongue Orchid			1						1	2			
Cryptostylis hunteriana	Leafless Tongue Orchid													x
Diuris aurea	Golden Donkey Orchid													x
Diuris sulphurea	Tiger Orchid													x
Microtis parviflora	Slender Onion Orchid									1			1	
Orthoceras strictum	Horned Orchid													x
Prasophyllum affine	Jervis Bay Leek Orchid												2	
Prasophyllum odoratum - P. patens complex	Scented Leek Orchid													x
Thelymitra aristata	Great Sun Orchid													x
Phormiaceae														
Dianella caerulea var. *caerulea*	Blue Flax Lily					2	2		1		1			
Dianelle caerulea var. *producta*	Blue Flax Lily				2									
Dianella revoluta var. *revoluta*	Blue Flax Lily									1				
Poaceae														
Aira caryophyllea	Silvery Hair Grass												1	
*Andropogon virginicus**	Whiskey Grass													x
Anisopogon avenaceus	Oat Speargrass	3		3	2	2	2	3	3	3	2		3	
Aristida ramosa var. *ramosa*	-						1			1	1			
Aristida vagans	-				1	1								
Austrodanthonia tenuior	-									1	1		2	
Austrostipa nodosa	-													x
Austrostipa pubescens	-			2										
Briza maxima	Quaking Grass													x
Chloris ventricosa	Tall Chloris													x

Table C.3 Plant Species List

Scientific Name	Common Name	Quadrat Number												
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Inc.
Cynodon dactylon	Common Couch													x
Deyeuxia quadriseta	Reed Bent Grass			1					1	1	3			
Echinopogon caespitosus var. *caespitosus*	Hedgehog Grass													x
Entolasia stricta	-	3		2	3	4	3	2	4	2	3		2	
Entolasia marginata						1	2	1		3	1			
Eragrostis brownii	Brown's Lovegrass			2		2		2						
Imperata cylindrica var. *major*	Blady Grass				2		2				2			
Microlaena stipoides	Weeping Grass			2	2		1				2			
Panicum simile	Two Colour Panic	2			1	2				2	1			
Phragmites australis	Native Reed													x
Sporobolus elongatus	Slender Rat's Tail Grass	1												
Themeda australis	Kangaroo Grass	3		3	2	1	1		1	2	2			
Restionaceae														
Empodisma minus	-			3				2	3					
Leptocarpus tenax	-											1	2	
Lepyrodia scariosa	-	2	2	3	2			3	4			1		
Typhaceae														
Typha orientalis	Bull-rush													x
Xanthorrhoeaceae														
Xanthorrhoea resinifera	-		1											
Xanthorrhoea concava	-											3	2	
Xyridaceae														
Xyris operculata	Tall Yellow-eye					3		3						
FERNS														
Dennstaediaceae														
Pteridium esculentum	Bracken				2	1				1	1			
Gleicheniaceae														
Gleichenia dicarpa	Pouched Coral Fern													x
Lindsaeaceae														
Lindsea linearis	Screw Fern	1	2	2	2	2		1	2	2	1			
Schizaeaceae														
Schizea bifida	Forked Comb Fern		1					1						

Note:
1 = cover less than 5% of quadrat and uncommon
2 = cover less than 5% of quadrat and common
3 = cover 6-20%
4 = cover 21-50%
* = introduced species
x = recorded as incidental

Bird Species List		November/December 2003		September 2004
Scientific Name	**Common Name**	**Residential Site**	**Commercial Site**	
WETLAND BIRDS				
Anatidae			O	
Anas superciliosa	Pacific Black Duck			
Chenonetta jubata	Australian Wood Duck		O,W	
BIRDS OF PREY				
Accipitridae				
Accipiter fasciatus	Brown Goshawk		O	O
Accipiter novaehollandiae	Grey Goshawk	W		
Haliastur sphenurus	Whistling Kite	O		
Lophoictinia isura	**Square-tailed Kite**	**O,W**	**O**	**O**
Falconidae				
Falco berigora	Brown Falcon	O		
Podargidae				
Podargus strigoides	Tawny Frogmouth	O		
Strigidae				
Ninox strenua	**Powerful Owl**		**W**	**W**
Tyto novaeseelandiae	Southern Boobook	O,W	O,W	W
Tyto novaehollandiae	Masked Owl			W
Aegotheles cristatus	Owlet Nightjar			W
FOREST/WOODLAND BIRDS				
Alcedinidae				
Dacelo novaeguineae	Laughing Kookaburra	W	W	O,W
Todiramphus sanctus	Sacred Kingfisher	W	W	
Artamidae				
Cracticus torquatus	Grey Butcherbird		O,W	O,W
Cracticus nigrogularis	Pied Butcherbird			O
Cacatuidae				
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo	O,W	O, W	O, W
Calyptorynchus lathami	**Glossy Black Cockatoo**		**O**	**W**
Cacatua galerita	Sulphur-crested Cockatoo	O,W	O	O,W
Cacatua roseicapilla	Galah	O	W	W
Campephagidae				
Coracina novaehollandiae	Black-faced Cuckoo Shrike	W		O,W
Cinclosomatidae				
Psophodes olivaceus	Eastern Whipbird	O,W	W	O
Climacteridae				
Cormobates leucophaeus	White-throated Treecreeper	O,W	W	O W
Corvidae				
Corvus coronoides	Australian Raven		O,W	O,W
Cracticidae				
Gymnorhina tibicen	Australian Magpie	W	W,O	O
Cuculidae				
Cacomantis flabelliformis	Fan-tailed Cuckoo	W	W	O,W
Cacomantis variolosus	Brush Cuckoo		W	
Chrysococcyx basalis	Horsefield's Bronze-cuckoo			O
Chrysococcyx lucidus	Shining Bronze-cuckoo	W		O,W
Cuculus pallidus	Pallid Cuckoo	W		O
Eudynamys scolopacea	Common Koel		W	
Dicaeidae				

Bird Species List		November/December 2003		September 2004
Scientific Name	**Common Name**	**Residential Site**	**Commercial Site**	
Dicaeum hirundinaceum	Mistletoebird			O,W
Dicruridae				
Grallina cyanoleuca	Australian Magpie-lark	O,W		O
Myiagra rubecula	Leaden Flycatcher	W		
Rhipidura fuliginosa	Grey Fantail	O,W	O, W	O,W
Hirundinidae				
Hirundapus caudacutus	**White-throated Needletail**	**O**		
Hirundo neoxena	Welcome Swallow			O
Loriidae				
Trichoglossus haemotodus	Rainbow Lorikeet	O,W	O, W	O,W
Meliphagidae				
Acanthorhynchus tenuirostris	Eastern Spinebill	O	O	O,W
Anthochaera carunculata	Red Wattlebird		W	O,W
Anthochaera chrysoptera	Little Wattlebird			O,W
Lichenostomus chrysops	Yellow-faced Honeyeater	W		O,W
Lichenostomus fuscus	Fuscous Honeyeater			O
Melithreptus brevirostris	Brown-headed Honeyeater			O
Melithreptus lunatus	White-naped Honeyeater		W	O,W
Philemon corniculatus	Noisy Friarbird	O,W	W	O,W
Phylidonyris nigra	White-cheeked Honeyeater			O
Phylidonyris novaehollandiae	New Holland Honeyeater	O,W	O,W	O,W
Neosittidae				
Daphoenositta chrysoptera	Varied Sitella		O	O
Oriolidae				
Oriolus sagittatus	Olive-backed Oriole	W	W	O,W
Pachycephalidae				
Colluricincla harmonica	Grey Shrike Thrush	W	W	O,W
Pachycephala pectoralis	Golden Whistler			O,W
Pachycephala rufiventris	Rufous Whistler	O,W	O,W	
Paradisaeidae				
Ptilinorhynchus violaceus	Satin Bowerbird			W
Pardalotidae				
Acanthiza lineata	Striated Thornbill	O		O, W
Acanthiza nana	Yellow Thornbill			O, W
Acanthiza pusilla	Brown Thornbill		W	O,W
Acanthiza reguloides	Buff-rumped Thornbill			O
Dasyornis brachyopterus	**Eastern Bristlebird**	**O,W**	**W**	**W, O**
Pardalotus punctatus	Spotted Pardalote	O,W	W	O,W
Pardalotus striatus	Striated Pardalote			O
Sericornis frontalis	White-browed Scrubwren	O,W	W	O,W
Petroicidae				
Eopsaltria australis	Eastern Yellow Robin		W	O,W
Petroica rosea	Rose Robin			O
Microeca fascinans	Jacky Winter			O
Phalacrocoracidae				
Phalacrocorax carbo	Great Cormorant			O
Ploceidae				
Neochmia temporalis	Red-browed Firetail			W
Psittacidae				
Glossopsitta concinna	Musk Lorikeet	O		O,W
Glossopsitta pusilla	Little Lorikeet		O	O
Platycercus elegans	Crimson Rosella	O,W	O, W	O,W

Bird Species List		November/December 2003		September 2004
Scientific Name	**Common Name**	**Residential Site**	**Commercial Site**	
Purpureicephalus spurius	Australian King Parrot		O	O,W
Nymphicus hollandius	Cockatiel			W
Zosteropidae				
Zosterops lateralis	Silvereye			O,W
SCRUBLAND BIRDS				
Maluridae				
Malurus cyaneus	Superb Fairy Wren		W	O,W
Malurus lamberti	Variegated Fairy-wren	O,W	W	O,W
Stipiturus malachurus	Southern Emu Wren	O,W	W	O
Psittacidae				
Pezoporus wallicus wallicus	**Ground Parrot**		**W**	**W**

Key

Observed	O
Heard Call	W

Scientific Name	Common Name	Site / Transect Number																		
		Commercial Site					Residential Site													
		A1	A2	C1	C2	Inc	A3	A4	A5	A6	A7	A8	B1	B2	B3	B4	C3	C4	C5	Inc
GROUND MAMMALS																				
Dasyuridae																				
Antechinus stuartii	Brown Antechinus	T	T				T			T	T	T								
Macropodidae																				
Macropus giganteus	Eastern Grey Kangaroo																			O
Macropus rufogriseus	Red-necked Wallaby																			O
Wallabia bicolor	Swamp Wallaby																			
Muridae																				
*Mus musculus**	House Mouse	T					T													
Rattus fuscipes	Bush Rat	T	T	T	T					T	T							T		
Rattus lutrelous	Swamp Rat	T	T	T																
Canidae																				
*Vulpes vulpes**	Red Fox	K																		
ARBOREAL MAMMALS																				
Petauridae																				
Petaurus australis	**Yellow-bellied Glider**															**O**				**O,W**
Petaurus breviceps	Sugar Glider												T			T				O
Petauroides volans	Greater Glider																			O
Cecartetus nanus	**Eastern Pygmy Possum**						**T**													
Trichosurus vulpecula	Brush-tailed Possum																	T		
Pseudocaheris peregrinus	Ringtail possum																			R
Peramelidae																				
Perameles nasuta	Long-nosed Bandicoot			T														T		
MICROCHIROPTERAN BATS																				
Molossidae																				
Mormopterus norfolkensis	**Eastern Freetail Bat**															AR				
Tadarida australis	White-striped Freetail Bat					W														
Vespertilionidae																				
Chalinolobus gouldii	Gould's Wattle Bat															AR				AR
Chalinolobus morio	Chocolate Wattled Bat																		AR	AR
Miniopterus schreibersii	**Large Bent-wing Bat**															AR			AR	AR
Vespadelus darlingtoni	Large Forest Bat															AR			AR	AR
Vespadelus vulturnus	Little Forest Bat								AR							AR			AR	AR

Scientific Name	Common Name	Site / Transect Number																		
		Commercial Site					Residential Site													
		A1	A2	C1	C2	Inc	A3	A4	A5	A6	A7	A8	B1	B2	B3	B4	C3	C4	C5	Inc
REPTILES																				
Scincidae																				
Tiliqua scinciodes	Blue Tongue Lizard																			
Agamidae																				
Amphibolurus muricatus	Jacky Lizard					W														
Elapidae																				
Pseudechis porphyriacus	Red-bellied Black Snake						0													
AMPHIBIANS																				
Myobatrachidae																				
Crinia signifera	Common Eastern Froglet																			
Limnodynastes peronii	Stripped Marsh Frog																			
Limnodynastes tasmaniensis	Spotted Marsh Frog (?)																			
Hylidae																				
Litoria dentata	Bleating Treefrog					W														
Litoria peronii	Peron's Treefrog					W														
Litoria freycineti	Freycinet's Frog					W														
Observaiton Type																				
0	Observed																			
W	Heard Call																			
X	In Scat																			
T	Trapped																			
H	Hair / feathers																			
R	Road Kill																			
F	Tracks, scratching																			
M	Miscellaneous																			
AR	Anabat Recording of Call																			

Annex D

Vegetation Community Descriptions

Vegetation Community Descriptions

- Open-forest Communities

***1. Corymbia maculata*/*Eucalyptus globoidea* Open-forest**

Approximately 17.9 ha of this vegetation type occurred on the subject site. It was located on the lower and upper slopes on either side Creek 2 within the centre of the Residential Site. The canopy was 20 – 25 m, had a cover of approximately 25 percent and dominant species included *Corymbia maculata* and *Eucalyptus globoidea*. Other canopy species included *E. pilularis*, *E. sclerophylla* and *C. gummifera*. The upper understorey layer was 10 – 12 m, had a cover of approximately 5 percent and the dominant species included *Allocasuarina littoralis*. The lower understorey layer was less than 1 m and dominant species included *Banksia spinulosa* var. *spinulosa*. The ground layer was less than 1 m, had a cover of approximately 75 percent and dominant species were *Lomandra longifolia*, *Anisopogon avenaceus*, *Lepidosperma laterale*, *Entolasia stricta* and *L. concavum*. Other common ground layer species included *Gonocarpus teucrioides*, *Hypoxis hygrometrica* var. *hygrometrica*, *Goodenia heterophylla* ssp. *heterophylla*, *Dianella caerulea* var. *caerulea* and *Hibbertia aspera*. The cover of the leaf litter, logs and bare ground was approximately 55, 4 and 5 percent respectively. *Gahnia clarkei*, native grasses and *B. spinulosa* var. *spinulosa* were dominant in shallow waterlogged drainage lines in this community.

***2. Eucalyptus globoidea*/*Corymbia gummifera* Open-forest**

Approximately 0.9 ha of this vegetation type occurred on the subject site. It was located on the lower slopes adjacent to Creek 3 in the north west of the Residential Site. The canopy was 20 – 25 m, had a cover of approximately 25 percent and dominant species included *E. globoidea* and *C. maculata*. Other canopy species in this community included *C. maculata*, *E. sclerophylla* and *Syncarpia glomulifera*, of which the latter species was dominant towards the creekline. The upper understorey layer was 8 – 12 m, had a cover of 5 percent and was dominated by *C. gummifera*. The next understorey layer was 1 – 4 m, had a cover of 2 percent and dominant species included *C. gummifera* and *Persoonia levis*. The lower understorey layer was 0 – 1 m, had a cover of 35 percent and dominant species included *B. spinulosa* var. *spinulosa*, *Hakea dactyloides* and *Lambertia formosa*. The ground layer was less than 1 m, had a cover of 80 percent and dominant species included *Themeda australis*, *Lepyrodia scariosa*, *A. avenaceus* and *Empodisma minus*. Other common ground layer species included *Platysace lineariifolia*, *H. riparia*, *L. obliqua*, *L. multiflora* ssp. *multiflora*, *Epacris pulchella* and *Lindsea linearis*. The cover of the leaf litter, logs and bare ground was approximately 5, 1 and 2 percent respectively.

- Woodland Communities

***3. Eucalyptus sclerophylla*/*Corymbia gummifera* Woodland**

Approximately 15.5 ha of this vegetation type occurred on the subject site. It was located on the ridge and northwest facing slopes between Creek 2 and 3 on the Residential Site. The canopy was 20 – 25 m, had a cover of approximately 10 percent and dominant species included *E. sclerophylla* and *C. gummifera*. Other canopy species included *E. globoidea*. The upper understorey layer was 8 – 12 m, had a cover of 2 – 8 percent and dominant canopy

species include *C. gummifera*. The next understorey layer was 1 – 4 m, had a cover of 2 percent and dominant species were *C. gummifera*, *Leptospermum polygalifolium* and *Persoonia levis*. The lower understorey layer was less than 1 m, had a cover of 20 percent and dominant species included *B. spinulosa* var. *spinulosa, L. formosa* and *H. dactyloides*. The ground layer was less than 1 m, had a cover of 80 – 90% and dominant species included *Ptilothrix deusta*, *E. stricta*, *A. avenaceus*, *L. laterale* and *L. concavum*. Other common ground layer species include *Pseuderanthemum variabile*, *Xanthosia tridentata*, *H. aspera*, *G. teucrioides*, *Deyeuxia quadriseta*, *L. filiformis* ssp. *filiformis* and *Entolasia marginata*. The cover of the leaf litter, logs and bare ground was approximately 5 – 8, 1 – 5 and 1 – 10 percent respectively.

***4. Eucalyptus sclerophylla*/*Eucalyptus globoidea* Woodland**

Approximately 3.7 ha of this vegetation type occurred on the subject site. It was located adjacent to Creeks 1 and 2 on both the Residential and Commercial Sites in the northeast of the subject site. The canopy was 20 m, had a cover of approximately 10 percent and dominant species included *E. sclerophylla* and *E. globoidea*. Other canopy species included *C. gummifera* and *E. robusta*. The upper understorey layer was 8 – 12 m, had a cover of 2 – 10 and dominant species included *A. littoralis*. The lower understorey layer was 1 – 1.5 m had a cover of 40 percent and dominant species included *Goodenia ovata*. The ground layer was less than 1 m, had a cover of 80 percent and dominant species included *Pteridium esculentum*, *E. stricta* and *Microlaena stipoides*. Other ground layer species included *L. obliqua*, *Pimelea linifolia* ssp. *linifolia* and *L. scariosa*. The cover of the leaf litter, logs and bare ground was approximately 20, 5 and 2 percent respectively.

***5. Eucalyptus sclerophylla*/*Corymbia gummifera*/*Eucalyptus globoidea* Woodland**

Approximately 14.7 ha of this vegetation type occurred on the subject site. This is a floristically and structurally variable community and was located on upper slopes and graded into open-woodland and heathland communities. The canopy was 20 – 25 m, had a cover of 20 percent and dominant species included *E. sclerophylla*, *E. globoidea* and *C. gummifera*. Other canopy species included *E. resinifera* ssp. *resinifera*. The upper understorey layer was 6 – 15 m, had a cover of 2 – 30 percent and dominant species included *A. littoralis* and *C. gummifera*. The lower understorey layer was 0.3 – 2 m, had a cover of 5 – 30 percent and dominant species included *B. spinulosa* var. *spinulosa*, *L. formosa* and *Acacia longifolia*. Other common understorey species included *Pultenaea rosmarinifolia*, *H. dactyloides* and *P. levis*. The ground layer was less than 1 m, had a cover of approximately 70 percent and dominant species included *E. stricta*, *Xyris operculata*, *A. avenaceus*, *L. scariosa* and *E. minus*. Other common ground layer species included *Patersonia sericea*, *Cyathochaeta diandra* and *L. concavum*. The cover of the leaf litter, logs and bare ground was approximately 10 – 40, 5 and 2 percent respectively.

***6. Eucalyptus sclerophylla* Woodland**

Approximately 4.4 ha of this vegetation type occurred on the subject site. It was located on the mid slopes adjacent to Jervis Bay road. This community had been patchily burnt and some parts had not been burnt for a relatively long time, as evidenced by wet sclerophyll species and relatively tall shrubs of *H. teretifolia*. The canopy was 20 m, had a cover of approximately 15 percent and dominant species included *E. sclerophylla*. Other canopy

species included *C. gummifera*. The upper understorey was 2 – 8 m, had a cover of 5 – 50 and dominant species included *H. teretifolia*, *B. ericifolia* and *L. polygalifolium*. The lower understorey was 1 – 2 m, had a cover of 5 – 10 percent and dominant species included *B. ericifolia*, and *Kunzea capitata*. The ground layer was less than 1 m, had a cover of 95 percent and dominant species included *E. stricta*, *L. longifolia*, *P. esculentum*, *X. tridentata* and *L. scariosa*. This community graded into heathland and occurred adjacent to sedgeland. Wet sclerophyll species occurred in a poorly drained area on the corner of the Wool Road and Jervis Bay Road and included *Adiantum aethiopicum*, *Cyathea australis* and *Blechnum cartilagineum*. The cover of the leaf litter, logs and bare ground was approximately 50, 5 and 2 percent respectively.

***7. Eucalyptus robusta* Woodland**

Approximately 1.3 ha of this vegetation type occurred on the subject site. It was located along the northern end of Creek 1 on the Residential Site. The canopy was 20 – 24 m tall, had a cover of 20 percent and dominant species included *E. robusta*. Other canopy species included *E. sclerophylla* and *S. glomulifera*. The understorey layer was 2 – 4 m, had a cover of 2 – 50 and dominant species included *Melaleuca linariifolia* and *A. longifolia*. The lower understorey layer was 0.5 – 2 m, had a cover of 5 – 50 and dominant species included *M. linariifolia*, *G. sieberana* and *G. clarkei*. Patches of sedges also occurred along the creek and on the banks and included *Phragmites australis*, *Baumea teretifolia*, *B. juncea* and *Eleocharis sphacelata.* Ground layer and riparian species included *Viola hederacea* and *Gleichenia dicarpa*. The cover of the leaf litter, logs and bare ground was approximately 50, 5 and 2 percent respectively.

- Open Woodland Communities

***8. Eucalyptus sclerophylla*/*Corymbia gummifera* Open-woodland**

Approximately 17.8 ha of this vegetation type occurred on the subject site. It was located on the lower and upper slopes in the north of the Residential Site. The canopy was 20 – 25 m, had a cover of approximately 5 percent and dominant species included *E. sclerophylla* and *C. gummifera*. The upper understorey was 1 – 10 m, had a cover of approximately 15 percent and dominant species included *C. gummifera* and *E. sclerophylla*. The lower understorey layer was 0 – 1 m, had a cover of approximately 15 percent and the dominant species included *L. formosa*, *B. spinulosa* var. *spinulosa* and *P. levis*. Other common shrub species included *L. polygalifolium* and *L. laevigatum*. The ground layer was 0 – 1 m, had a cover of approximately 80 percent and dominant species included *A. avenaceus*, *P. deusta* and *E. stricta*. Other common ground layer species included *C. diandra*, *L. obliqua*, *E. stricta*, *G. paniculata*, *L. multiflora* ssp. *multiflora* and *L. scariosa*. The cover of the leaf litter, logs and bare ground was approximately 40, 5 and 5 percent respectively.

***9. Eucalyptus sclerophylla* Open-woodland**

Approximately 11.1 ha of this vegetation type occurred on the subject site. It was located on the mid slopes to the west of Creek 3 on the Residential Site. The canopy was 8 – 12 m, had a cover of approximately 5 percent and dominant species included *E. sclerophylla*. The upper understorey was 1 – 2 m, had a cover of approximately 25 percent and dominant species included *E. scleropylla*. The lower understorey was 0 – 1 m, had a cover of 10 – 15 percent

and dominant species included *L. formosa*, *L. trinervium*, *B. oblongifolia* and *B. spinulosa* var. *spinulosa*. The ground layer was less than 1 m, had a cover of approximately 40 percent and dominant species included *A. avenaceus*, *P. deusta*, and *L. scariosa*. Other common ground layer species included *P. lineariifolia*, *Gompholobium grandiflorum* and *Dampiera stricta*. The cover of the leaf litter, logs and bare ground was approximately 5, 1 and 50 percent respectively.

***10. Eucalyptus sclerophylla* Open-woodland** (sedge and tick bush understorey)

Approximately 2.9 hectares of this vegetation type occurred on the subject site. It was located on either side of the drainage line in the north west of the subject site. This community grades into the above vegetation type and has many similar species. However, closer to the waterlogged soils along Creek 3, sedges and shrubs were dominant in the ground layer. The canopy was 8 – 12 m, had a cover of approximately 5 percent and dominant species included *E. sclerophylla*. The ground layer near the creek was less than 1 m, had a cover of 60 – 80 percent and dominant species included *K. capitata*, *L. scariosa*, *L. laterale*, *E. minus* and *B. rubiginosa*. The cover of the leaf litter, logs and bare ground was approximately 10, 1 and 10 percent respectively.

***11. Eucalyptus longifolia* Open-woodland**

Approximately 5.1 hectares of this vegetation type occurred on the subject site. It was located along Creek 2 and 3 on the Residential Site. The canopy was 20 – 25 m, had a cover of approximately 5 percent and dominant species included *E. longifolia*. Other canopy species include *E. sclerophylla* and *E. robusta*. The upper understorey was 1 – 10 m, had a cover of approximately 15 percent and dominant species included *C. gummifera* and *E. sclerophylla*. The lower understorey layers was 0 – 1 m, had a cover of 10 – 80 percent and dominant species included *M. linariifolia* and *K. capitata*. The ground layer was 0 – 2 m, had a cover of 5 – 40 and dominant species included *L. longifolia*, *Hydrocotyle laxiflora*, *Centella asiatica*, *Juncus continuus*, *Dampiera stricta* and *L. scariosa*. This vegetation type included patches of riparian species including *P. australis*. The cover of the leaf litter, logs and bare ground was approximately 5, 10 and 2 percent respectively.

- Low-open Woodland Communities

***12. Eucalyptus sclerophylla* Low Open-woodland**

Approximately 1 hectare of this vegetation type occurred on the subject site. It was located on the flats between the sedgeland and grassland and heathland vegetation types on the Commercial Site. The canopy was 8 – 12 m, had a cover of 5 percent and dominant species included *E. sclerophylla*. The understorey layer consisted of clumps of *B. ericifolia* and *A. longifolia* to 2 m high. The ground layer was similar to adjacent vegetation types and was 0 – 1 m, had a cover of approximately 60 percent and dominant species included a variety of grasses, herbs and sedges including *A. avenaceus*, *L. obliqua*, *X. tridentata*, *Phyllanthus hirtellus*, *E. stricta*, *L. concavum* and *L. scariosa*. The cover of the leaf litter, logs and bare ground was approximately 10, 1 and 5 percent respectively.

- Heath Communities

13. Banksia ericifolia/*Hakea teretifolia* Heathland

Approximately 17.1 ha of this vegetation type occurred on the subject site. It was located east of Moona Creek Road on the Residential Site and north of the Wool Road on the Commercial Site. This community graded into woodland, open-woodland and sedgeland communities. The canopy was 0.5 – 2 m, had a cover of 90- 100 percent and dominant species included *B. ericifolia*, *H. teretifolia*, *H. gibbosa* and *A. distyla.* Other canopy species included *A. paludosus*, *L. trinervium* and *Viminaria juncea*. Other shrub species included *E. obtusifolia*, *E. microphylla*, *Leucopogon microphylla*, *Sprengelia incarnata*, *Woollsia pungens* and *Darwinia leptantha*. Scattered emergent mallee trees included *E. sclerophylla*, *E. obstans*, *E. scias* ssp. *callimastha* and *C. gummifera*. The ground layer was 0 – 0.5 m, had a cover of approximately 90 percent and dominant species consisted of *L. scariosa*, *E. stricta*, *Xanthorrhoea concava*, *L. filiformis* ssp. *filiformis*, *Cassytha pubescens* and *Mitrasacme polymorpha*. Other common ground layer species included *P. linifolia* ssp. *linifolia* and *Bauera rubioides*. The cover of the leaf litter, logs and bare ground was approximately 20, 1 and 2 percent respectively.

- Sedgeland and Grassland Communities

14. Xanthorrhoea resinifera Sedgeland

Approximately 2.7 ha of this vegetation type occurred on the subject site. It was located in the flat low-lying areas on the Commercial Site and graded into adjacent sedgeland and grassland communities. The upper layer was 1 m, had a cover of approximately 60 percent and dominant species included *X. resinifera*. Scattered emergent shrubs included *V. juncea* and *B. ericifolia*. Other herbs, grasses and sedges in the ground layer included *Sowerbaea juncea*, *Conospermum ericifolium*, *A. avenaceus*, *L. filiformis* ssp. *filiformis*, *M. polymorpha*, *G. bellidifolia* ssp. *bellidifolia* and *L. tenax*.

15. Anisopogon avenaceus Grassland

Approximately 0.9 ha of this vegetation type occurred on the subject site. It was located on the low-lying areas adjacent to the Creek 1 on the Commercial Site and graded into *Xanthorrhoea resinifera* Sedgeland to the east. It had an 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*, *T. australis*, *E. stricta*, *B. umbellata*, *Prasophyllum odoratum – P. patens* complex, *Melaleuca thymifolia* and *G. bellidifolia* ssp. *bellidifolia*.

16. Lepidosperma laterale Sedgeland

Approximately 1.7 ha of this vegetation type occurred on the subject site. It was located on waterlogged soils in the northwestern centre of the Commercial Site and graded into *Anisopogon avenaceus* Grassland and *Eucalyptus sclerophylla* Low Open-woodland. It had a dense to very dense ground layer with a cover of 60 – 80 percent and dominant species included *L. laterale*. Other common species included *Juncus pallidus*, *L. quadrangulatum*, *A. avenaceus* and *E. stricta*.

17. Baumea articulata Closed Sedgeland

Approximately 0.4 ha of this vegetation type occurred on the subject site. It was located in the southwest of the Commercial Site on waterlogged soils adjacent to the cleared areas under the transmission line and graded into *L. laterale* Sedgeland and *E. sclerophylla* Low Open-woodland. The ground layer was very dense, to 1.5 high and the dominant species was *B. articulata*. The diversity in the ground layer in this community was relatively low compared to high diversity of sedges and herbs in adjacent communities. Other common species included *L. laterale*.

18. Anisopogon avenaceus/*Lomandra filiformis* Grassland

Approximately 1.2 ha of this vegetation type occurred on the subject site. It was located in the centre of the Commercial Site and as a small patch in the north of Commercial Site and graded into heathland, low open-woodland and other grassland and sedgeland communities. Scattered emergent shrubs included *A. paludosus*, *H. dactyloides*, *L. formosa* and *P. pulchella*. The ground layer was less than 0.5 m, had a cover of 90 percent and dominant species included *X. concava*, *A. avenaceus*, *L. laterale* and *L. multiflora* ssp. *multiflora*. Other common ground layer species included *L. obliqua*, *H. hygrometrica*, *P. sericea*, *L. tenax*, *E. stricta*, *P. affine*, *Thysanotus tuberosus*, *B. umbellata*, *C. diandra*, *S. juncea*, *L. acida*, *E. microphylla* and *E. obtusifolia*.

Annex E

Threatened Species Profiles

Caladenia tessellata (a terrestrial orchid) - endangered species listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the terrestrial orchid *Caladenia tessellata* Fitzg. as an ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act, and, as a consequence, to omit reference to *Caladenia tessellata* Fitzg. from Schedule 2 (Vulnerable species) of the Act. Listing of endangered species is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. *Caladenia tessellata* Fitzg. (family Orchidaceae) is described by P. Bernhardt (1993) in Harden, G. (ed). Flora of New South Wales. UNSW Press. Vol. 4. p. 200 as: Terrestrial herb. Leaf linear to lanceolate, to 6 cm long and 5 mm wide, sparsely hairy. Inflorescence to 25 cm high, rarely >2-flowered, hairy. Sepals and lateral petals c. 2 cm long, cream-coloured with reddish stripes (lateral sepals often crossing); tails short, filiform or merely acuminate, with dark glandular hairs, less than a third of the length of the segments; tails of the lateral petals and lateral sepals often held stiffly and horizontally or petals deflexed. Labellum broad-cordate, 10-15 mm long, 10-20 mm wide, more or less unlobed, yellowish with a few darker striations; margins with thick, short, dark, teeth. Central calli thick and dark in 4-6 rows becoming crowded and overlapping towards the base and grading into short rows towards the apex. Column base with 2, prominent yellow glands. Flowers Sept.-Nov.

2. Within NSW, *Caladenia tessellata* is currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. The total population size is estimated to be less than 50 individuals.

3. The species is not known to occur within any conservation reserves.

4. There are continuing declines in the number of individuals and in the number of populations, with at least two populations becoming extinct since the 1980's and at least 14 populations in the Sydney and South Coast areas not recorded since the mid 20th Century.

5. Due to small population size, *Caladenia tessellata* is susceptible to catastrophic events and localised extinction. The species is also threatened by pedestrian activity and habitat degradation.

In view of the above the Scientific Committee is of the opinion that *Caladenia tessellata* Fitzg. is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Proposed Gazettal date: 13/12/02

Exhibition period: 13/12/02 – 31/01/03

Threatened Species Information

Leafless Tongue Orchid

Cryptostylis hunteriana

Conservation Status

The Leafless Tongue Orchid is listed as a **Vulnerable Species** under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Description

This species is a rare leafless saprophytic, terrestrial orchid, which is reliant on the symbiotic relationship with a microrrhizal fungus found in decaying plant matter (Bell 2001). The following stem in this species is pale yellow lacking leaves, to 45 cm, bearing up to 10 flowers. Flowers are deep maroon with linear petals and sepals and a labellum that points upwards. The labellum is oblong with strongly recurved margins and five dark lines. The most upper surface is densely and conspicuously hairy (Bishop 2000).

Distribution

The Leafless Tongue Orchid occurs in NSW and Victoria from the Orbost area around the coast through NSW as far north as Gibraltar Range, extending onto the Northern Tablelands but otherwise coastal (Bishop 2000).

Habitat

The Leafless Tongue Orchis is found in swampy heaths on sandy soils, and in habitats ranging from scrubby swamp fringes to steep bare hillsides in tall eucalypt forest (Bell 2001; Harden 1993; Jones 1993; Bishop 2000). It will often appear with *C. erecta* and *C. subulata* in small localised colonies and flowers from November to February (Bell 2001, ANOS 2001, Jones 1993).

Ecology

Pollination of the orchid is dependent solely on the ichneumonid wasp (*Lissopimpla excelsa*) (Bell 2001). Flowering occurs from November to February.

References

ANOS (2001) **Cryptostylis Orchids**. Australian Native Orchid Society, www.anos.org.au.

Bell (2001) Notes on populations size and habitat of the vulnerable Cryptostylis hunteriana (Orchidaceae) from the Central Coast of New South Wales. **Cunninghamia** 7(2): 195-204.

Bishop T (2000) **Field Guide to the Orchids of New South Wales and Victoria. Second Edition.** UNSW Press.

Harden G (1993) **Flora of New South Wales. Volume 4**. New South Wales University Press.

Jones D (1993) **Native Orchids of Australia. Second Edition.** Reed, Chatswood.

Threatened Species Information

Eastern Chestnut Mouse

Pseudomys gracilicaudatus

Conservation Status

The Eastern Chestnut Mouse is listed as a **Vulnerable Species** under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

Description

The Eastern Chestnut Mouse has dense spiky brown fur on its upper body tipped with buff. The underparts are dark grey tipped whitish and the tail is dark brown and sparsely haired. The upper surface of the feet are covered with long grey hairs (Menkhorst and Knight 2001).

Distribution

The Eastern Chestnut Mouse is patchily distributed throughout coastal eastern Australia from Townsville, Queensland to Brisbane Waters National Park, NSW. An outlining population of this species is also known to occur in Jervis Bay, NSW (Menkhorst and Knight 2001).

Habitat

In northern Queensland the Eastern Chestnut Mouse inhabits open woodland with a grassy understorey. Heathland and in particular, dense wet heath and swampy areas provide habitat for the Eastern Chestnut Mouse in New South Wales. Optimal habitat for this species is provided by young regenerating heath vegetation and presence of this species may be influenced by fire history (Strahan 1995).

Ecology

The Eastern Chestnut Mouse is a nocturnal species that uses runway systems among dense sedge cover with a home range of less than 0.5 ha. This species feeds largely on seeds and plant material and in particular stems. Fungi is also an important part of the diet especially during winter (Strahan 1995).

Breeding for the Eastern Chestnut Mouse occurs from September to March with up to three litters being reared (Menkhorst and Knight 2001).

References

Menkhorst, P. and Knight, F. (2001) **A Field Guide to the Mammals of Australia** Oxford University Press, South Melbourne, Australia

Strahan, R. (ed) (1995) **Mammals of Australia** Australian Museum**,** Reed New Holland, Sydney, Revised Edition

Threatened Species Information

Eastern False Pipistrelle

Falsistrellus tasmaniensis

Conservation Status

The Eastern False Pipistrelle is listed as a **Vulnerable Species** under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

Description

The Eastern False Pipistrelle is reddish brown above and paler below, with elongated ears. Four upper incisors distinguish it from the similar *Scoteanax rueppellii* (Strahan 1995).

Distribution

The Eastern False Pipistrelle occurs in tall forest on the Great Dividing Range and adjacent coastal plains from south-eastern Queensland to south-eastern South Australia and throughout Tasmania (Menkhorst and Knight 2001).

Habitat

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) inhabits wet and dry sclerophyll forests, particularly in highland areas with high rainfall and coastal mallee. It roosts by day in tree hollows, caves and abandoned buildings (Churchill 1998).

Ecology

The ecology of the Eastern False Pipistrelle is poorly understood and is thought to hibernate during winter months (Strahan 1995). Reproduction occurs in December with only a single young born (Menkhorst and Knight 2001). Lactation continues in this species throughout January and February (Churchill 1998).

The diet of the Eastern False Pipistrelle comprises moths, rove beetles, chafers, weevils, plant bugs, flies and ants (Churchill 1998).

References

Churchill, S. (1998) **Australian Bats** New Holland Publishers, Sydney

Menkhorst, P. and Knight, F. (2001) **A Field Guide to the Mammals of Australia** Oxford University Press, South Melbourne, Australia

Strahan, R. (ed) (1995) **Mammals of Australia** Australian Museum**,** Reed New Holland, Sydney, Revised Edition

Threatened Species Information

Eastern Freetail-bat

Mormopterus norfolkensis

Conservation Status

The Eastern Freetail-bat is listed as a **Vulnerable Species** under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

Description

The Eastern Freetail-bat has uniformly rich brown fur (Menkhorst and Knight 2001).

Distribution

The Eastern Freetail-bat occurs in coastal areas, east of the Great Dividing Range, from Maryborough, Queensland to Sydney (Churchill 1998).

Habitat

This species of bat has been recorded in dry eucalypt forest and woodland, wet sclerophyll forest and rainforest (Churchill 1998).

Ecology

The Eastern Freetail-bat roosts by day alone or in small colonies in tree hollows and crevices, under loose bark, in caves and buildings. Reproduction in this species is poorly understood but a single young is usually born some time around late November (Churchill 1998).

The Eastern Freetail-bat is an insectivorous species, feeding on bugs, ants, beetles and moths (Churchill 1998).

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Eastern pygmy-possum - vulnerable species listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Eastern Pygmy-possum *Cercartetus nanus* (Desmarest, 1818) as a VULNERABLE SPECIES on Schedule 2 of that Act. Listing of vulnerable species is provided for by Part 2 of the Act.

The Scientific Committee found that:

1. The Eastern Pygmy-possum *Cercartetus nanus* (Desmarest, 1818) is a small arboreal marsupial that is distributed in the south-eastern corner of mainland Australia and in Tasmania. In New South Wales the species is found in coastal areas and at higher elevation in the south, but north of Newcastle at higher elevation only. Pygmy-Possums are agile climbers that feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit.

2. Although the Eastern Pygmy-possum is broadly distributed, recent studies have shown that within this range the species appears to be patchily distributed and its overall abundance is low.

3. Despite a large number of intensive trapping programs undertaken in the eastern forests and woodlands of New South Wales in recent years, only a small number of captures (154) have resulted from a total trapping effort of 315,000 Elliott trap-nights and 57,000 pitfall trap-nights (Bowen and Goldingay 2000).

4. Other detection techniques such as spotlighting, predator scat analysis, hair tubes and trapping in trees have produced similar low rates of detection. Capture rates are highest for installed nest-boxes and traps set in flowering banksias. This may reflect a habitat preference or a more successful trapping method.

5. From these and more recent studies (A. Tulloch, pers. comm.) there were only six, localities where more than 10 observations of Pygmy-Possums have been made. These were the Pilliga area, New England Tablelands, Barren Grounds Nature Reserve-Budderoo National Park, Royal and Heathcote National Parks, Kioloa State Forest and the Eden area.

6. The factors threatening the survival of the Eastern Pygmy-possum include isolated sub-populations with little opportunity for dispersal which increases the risk of local extinction, clearing that results in habitat loss and fragmentation, inappropriate fire regimes that remove nectar-producing understorey plants, the loss of nest sites due to past intensive forestry and firewood collection, and predation by foxes and cats.

7. In view of 2, 3, 4, 5 and 6 above, the Scientific Committee is of the opinion that the Eastern Pygmy-possum *Cercartetus nanus* is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate, and is therefore eligible for listing as a vulnerable species.

Eastern Bristlebird

***Dasyornis brachypterus* (Latham, 1801)**

Other common name Brown Bristlebird

Conservation status

The Eastern Bristlebird is listed as an **Endangered Species** on Schedule 1 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act). This species is listed as an **Endangered Species** on of the Commonwealth *Endangered Species Protection Act, 1992*.

Description

(summarised from Pizzey & Doyle 1980; Bramwell 1990; Baker 1998; J Baker unpubl. data)

Length
200-220mm
Tail
90-130mm
Bill
17-21mm
Tarsus
26-30mm
Weight
35-51g

Eastern Bristlebirds are well camouflaged semi-flightless, terrestrial birds. They are a dull brownish colour above with lighter grey-brown below. The wings are very small and the legs are long and strong. The sexes are similar in appearance.

Individuals are shy and cryptic, although, they may occasionally be glimpsed scampering in the open or making low laboured flights of up to 20 metres.

When alarmed, a bird may move to a lookout perch a metre or more above the ground then disappear into thick vegetation. Eastern bristlebirds have numerous calls, the most characteristic being *pretty birdie* which is often answered by a strident *prist* in a duet which may be repeated at five second intervals.

Distribution

The Eastern Bristlebird is a rare species that is restricted to coastal eastern Australia, ranging from the Conondale Ranges in south-eastern Queensland, south along the NSW coast, to north-eastern Victoria (Chaffer 1954; Blakers *et al.* 1984).

Eastern Bristlebird - male

Within NSW, populations of Eastern Bristlebirds are isolated, fragmented and small. Disjunct populations occur in the north-east, the Illawarra region and the south-east of the state (Baker 1997).

Recorded occurrences in conservation reserves

New England NP, Nightcap NP, Border Ranges NP, Nadgee NR, Barren Grounds NR, Budderoo NP, Morton NP, NSW Jervis Bay NP (NPWS 1999).

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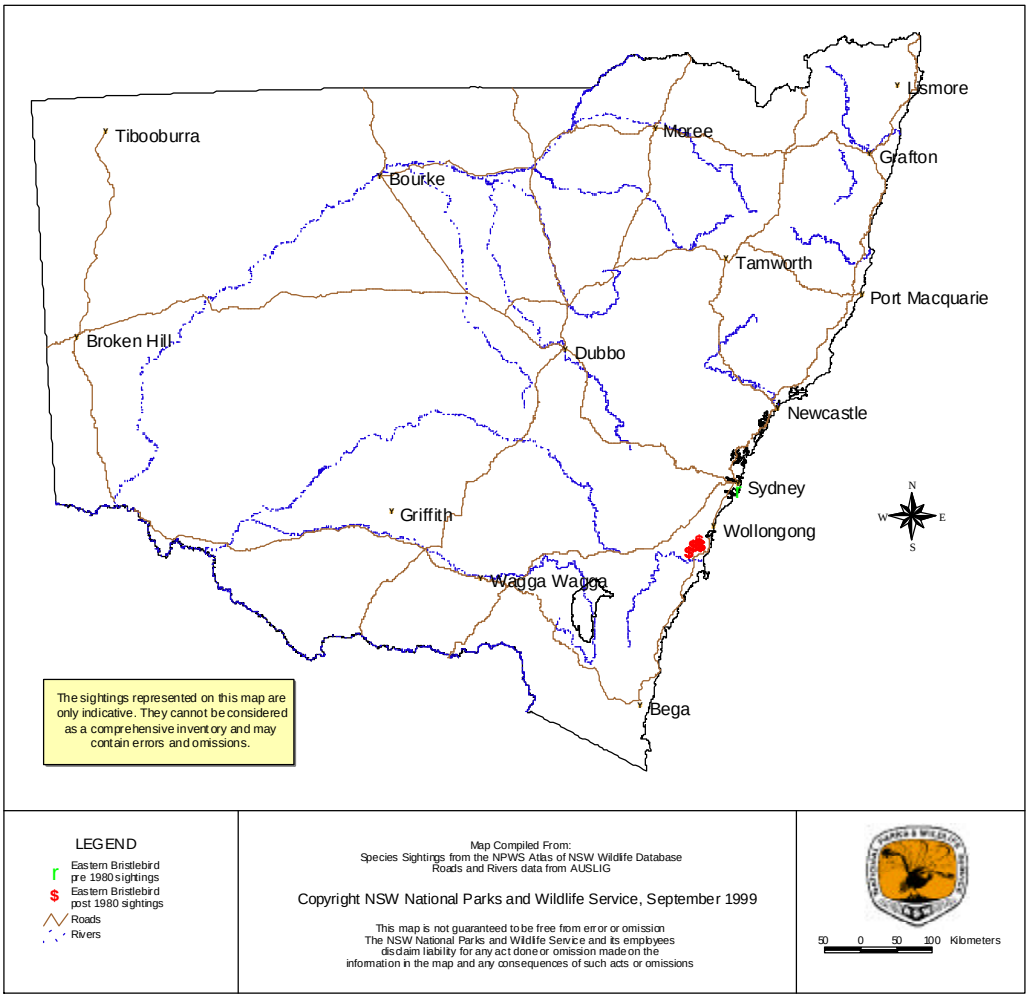

NPWS records of the Eastern Bristlebird in NSW

Habitat

The Eastern Bristlebird is a cover-dependent and fire-sensitive species. It inhabits a wide range of vegetation communities including rainforest, eucalypt forest, woodland, mallee, shrubland, swamp, heathland and sedgeland where there is low dense cover (Baker in press).

At Barren Grounds, there was zero to low density of Eastern Bristlebirds during the first few years post-fire, with densities plateauing at two birds per 10 ha, 7-14 years post-fire (Baker 1997). In old fire-age habitat at Barren Grounds-Budderoo, Jervis Bay and Nadgee, Eastern Bristlebirds breed and occur at relatively high densities. Fire has been implicated in the local extinction of numerous Eastern Bristlebird populations. The two largest, known populations occur in habitat at Barren Grounds-Budderoo and Jervis Bay, which is characterised by a 30 year history of relatively small-area burns and long periods between fires over much of the available habitat. (Baker in press).

Ecology

Eastern Bristlebirds are generally detected singly or in pairs, rarely as a group of three or four and never in a flock. Individuals have a home range of more than 10 ha and are presumed to be sedentary (Baker 1998).

When feeding, Eastern Bristlebirds peck at the ground and vegetation but do not use their feet to scratch the ground (Baker 1998). Diet studies show that ants are a regular food item and that other insects, including beetles and weevils, are also taken (Baker 1998). Barker and Vestjens (1990) reported a single stomach sample containing insects of the order Hemiptera (bugs).

Low fecundity appears to be a feature of the species. Ten documented records, dating from Ramsay (1882) to Adams and Coontz (1989), suggest that Eastern Bristlebirds generally lay a clutch of two eggs between August and February and raise only one fledgling. Breeding failure appears to be symptomatic of the genus. Nest and chick desertion were reported after human interference with Eastern Bristlebirds (Chaffer 1954) and presumably, they are also sensitive to other disturbances such as intrusion by potential predators. Eastern Bristlebird nests are elliptical domes (Chaffer 1954) constructed in low dense vegetation, usually in tufted plants (Baker in press).

Threats

- Loss of habitat, including indirect loss due to unsuitable fire regimes, has been recognized as the main process which reduced the occurrence of the Eastern Bristlebird in the last few centuries (Chaffer 1954; Garnett 1992)
- Fragmentation and isolation are characteristic of Eastern Bristlebird populations and may be adversely affecting the species. Small isolated populations are prone to local extinction and they may be suffering because of their lack of genetic variability (Elphinstone & Baker in prep.)
- Predation by native and introduced predators is a potential threat but its extent is unknown (Baker 1998)
- Road-kills of Eastern Bristlebirds occurs in the Jervis Bay area but the extent of this threat to populations is unknown
- Grazing by livestock and the consequent trampling of habitat is a threat to the northern populations (Holmes 1989). Off-road vehicles (four-wheel-drives and motor bikes) have damaged some habitat (Baker 1998)
- Dieback disease due to the pathogenic fungus *Phytophthora* spp. is not recorded as a threat to Eastern Bristlebird habitat, although potentially it could become a threat (Baker 1998)

Management

- Areas of known Eastern Bristlebird habitat and adjacent potential habitat should be managed to enhance the growth of dense low vegetation and to exclude fire (Baker in press)
- Wildlife road-signing has been erected at Jervis Bay to raise awareness of drivers and assist in reducing road-kills
- Reintroduction has been proposed to enable the establishment of populations outside the core populations at Jervis Bay and Barren Grounds

Recovery plans

A recovery plan is in preparation for the Eastern Bristlebird.

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Threatened Species Information

Tangled Bedstraw

Galium australe

Conservation Status

Tangled Bedstraw is **presumed extinct** under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

Description

Tangled Bedstraw is a straggling perennial with a weak sparsely to densely haired stem. It has small branches 20-60 cm long and leaves and stipules in whorls of 4. Inflorescence contains 1-7 white flowers approximately 2 mm long. Fruit in this species is approximately 1.5 mm long often with numerous transparent hooked hairs (Harden 1992).

Distribution

Tangled Bedstraw occurs on the south coast of NSW, and in Victoria, Tasmania, Queensland and South Australia (Harden 1992).

Habitat

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* (Swamp Mahogany) and *Syncarpia glomulifera* (Turpentine)..

Ecology

Flowering is considered to flower in summer.

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