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A FLORA AND FAUNA SURVEY OF LOT 4 DP 615261 AND LOT 1 DP374315, OCEAN DRIVE, LAKE CATHIE

Prepared for King and Campbell Pty Ltd,

Surveyors, Engineers and Planners,

Port Macquarie

May 2002

CONTENTS

GLOSSARY

Abundance: means a quantification of the population of the species or community.

Affected species: mean subject species likely to be affected by the proposal.

Conservation status: is regarded as the degree of representation of a species or community in formal conservation reserves.

Critical habitat: The area declared to be critical habitat under Part 3 of the TSC Act.

Development: in relation to land, means: the erection of a building on that land, the carrying out of work in, on, over or under that land, the use of that land or of a building or work on that land, and the subdivision of that land.

Ecological community: An assemblage of species occupying a particular area.

Endangered ecological community: An ecological community specified in Part 1 of Schedule 1 of the *Threatened Species Conservation Act* 1995.

Endangered population: A population specified under Part 1 of Schedule 1 of the *Threatened Species Conservation Act* 1995.

Endangered species: A species listed under Schedule 1 of the *Threatened Species Conservation Act* 1995.

EPA Act: *Environmental Planning and Assessment Act*, 1979

Habitat: An area or areas occupied, or periodically or occasionally occupied by a species, population or ecological community and includes any abiotic component.

Locality: The area within a 5 km radius of the study area**.**

NPW Act: *National Parks and Wildlife Act* 1974.

NPWS: National Parks and Wildlife Service.

Region: has the same meaning as it does under the *Threatened Species Conservation Act 1995***;** *a bioregion defined in a national system of bioregionalisation.*

GLOSSARY

Recovery and threat abatement plan: A plan to promote the recovery of threatened species, population or an ecological community with the aim of returning the species, population, or ecological community to a position of viability in nature. The purpose of the threat abatement plan is to manage key threatening processes with a view to their abatement, amelioration or elimination.

ROTAP: Rare or threatened Australian plant.

SEPP: State Environmental and Planning Policy.

Significant species: means species not listed under the *Threatened Species Conservation Act 1995* but considered to be of regional or local significance.

Study area: is the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly.

Subject site: The area which is proposed for development or activity.

Subject species: Those threatened species which are considered known or likely to occur in the study area.

Threatened species: A species specified in Part 1 or 4 of Schedule 1 or in Schedule 2 of the *Threatened Species Conservation Act* 1995

Threatening process: means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. This definition is not limited to key threatening processes.

TSC Act: *Threatened Species Conservation A*ct 1995

Vulnerable species: A species listed under Schedule 2 of the *Threatened Species Conservation Act* 1995

SUMMARY

- This flora and fauna study was prepared on behalf of King and Campbell Pty Ltd for the rezoning of Lot 4 DP 615261 and Lot 1 DP 374315 Lake Cathie, NSW.
- A flora and fauna survey was undertaken at the site from 25 to 28 February 2002. This included a floristic analysis and a systematic fauna trapping survey over three nights.
- A total of eight vegetation associations in five communities was recorded and mapped. These associations were: **littoral rainforest** dominated by brushbox, beach acronychia, tuckeroo and watergum; regrowth littoral rainforest dominated by blackwood and brown kurrajong; **open forest** dominated by grey ironbark and brushbox; **woodland** dominated by coast banksia; **swamp sclerophyll forest** dominated by pink-tipped bottlebrush, broad-leaved paperbark and swamp she-oak and by watergum and blackwood; and **grassland**, dominated by kangaroo grass and paspalum.
- One threatened plant species, the rough-shelled bush-nut was recorded at the site. However, this planted specimen is not known in the wild south of the Clarence River.
- One vulnerable bat, the common blossom bat, was trapped at the site while foraging on coast banksias. Another two vulnerable species, the grey-headed flying fox and little bent-wing bat were recorded flying over the site. Other vulnerable species which have suitable habitat components at the site include the rose-crowned fruit-dove and greater broad-nosed bat.
- Littoral rainforest is the most significant environmental feature of the site. This extends along the entire eastern frontage and has been gazetted under State Environmental and Planning Policy No. 26 as Littoral Rainforest No. 116.

SUMMARY

- This report recommends land management proposals which will enhance and maintain the littoral rainforest into the long term. These include reafforesting part of the littoral rainforest buffer and substantial reafforestation along an east-west corridor on the southern boundary of Lot 1, fencing along the western perimeter of the revegetated littoral rainforest buffer, upgrading the existing beach access by the provision of an elevated boardwalk and drainage works, the construction of stormwater settling ponds to enhance water quality and the introduction of native plantings throughout the site.
- In terms of the statutory assessment of a proposed residential development of the site, this study concluded that no viable populations of threatened species were likely to be placed at risk of extinction by the proposal;
- That the viability of endangered populations will not be significantly compromised by the proposal;
- That no regionally significant area of known habitat will be removed as a result of the proposed development;
- That no known habitat for threatened species will become isolated as a result of the proposed development;
- That no Critical Habitat will be affected as a result of the proposed development;
- That the proposed development is not a key threatening process and threatening processes are not likely to increase as a result of property development; and
- That threatened fauna which may seasonally or opportunistically occur at the site are not at the extreme of their known geographical range.

1.0 INTRODUCTION

This flora and fauna survey, prepared for King and Campbell Pty Ltd, forms part of a rezoning application for land identified as Lot 1, DP 374315 and Lot 4 DP 615261, Ocean road, Lake Cathie (the "site") (Fig. 1).

Part of the site and Crown lands to its east are mapped as Littoral Rainforest No. 116 under the State Environmental and Planning Policy (SEPP) No. 26 (Littoral Rainforests). The aim of the Littoral Rainforest Policy is *"to provide a mechanism for the consideration of applications for development …… with a view to the preservation of those areas in their natural state"*. The Policy applies to vegetated land mapped along the frontages of Lots 1 and 4 (the littoral rainforest core) and to land within 100 m from the outer edge of the subject line (the littoral rainforest buffer zone) (Fig. 1).

A systematic flora and fauna survey was undertaken at the site in February 2002 in order to identify and make recommendations to protect its natural values. This survey concentrated on the littoral rainforest, although vegetation assessments and standardised fauna survey methods were applied over the whole of the site.

2.0 PREVIOUS STUDIES

There are a number of previous studies or report which relate to the site. These include:

- ERM Mitchell McCotter Pty Ltd 1994 *Bonny Hills/Lake Cathie ecological study*. A report to Hastings Council. This ecological assessment included a flora survey and an assessment of the attributes of

the site for fauna. No systematic fauna survey was undertaken, but predictions of occurrence were provided;

- ERM Mitchell McCotter Pty Ltd 1994 *Regeneration strategy.* A report prepared for King and Campbell Pty Ltd. This report was commissioned by King and Campbell Pty Ltd to provide a regeneration strategy for land previously cleared on Lot 4 DP 615261, Lake Cathie; and
- ERM Mitchell McCotter Pty Ltd 1995 *Lake Cathie, SEPP 26 buffer assessment.* A report to Hastings Council. This report addressed potential land use impacts in the area within 100 m of the littoral rainforest and suggested a suitable buffer. ERM Mitchell McCotter relied on a single visit on 5 December 1995, a literature search and correspondence between a number of experts in specific disciplines.

3.0 FIELD SURVEYS

A flora and fauna survey was undertaken at the site from 25 to 28 February 2002, which included three nights of fauna trapping (25, 26 and 27 February 2002).

Survey methods varied in order to maximise results (Table 1, Fig. 2). This included setting harp-nets in gullies or flyways for megachiropteran and microchiropteran bats, using Elliott traps, hair-tube traps and cage traps in the littoral rainforest, undertaking spotlight surveys in areas of blossoming banksias and open grassland and establishing two lines of pit-fall traps over a variety of ecotones in the littoral rainforest.

Table 1: Survey methods (Fig. 2)

Standardised survey method	2002 survey
Bat acoustical sampling	25-27 February (three nights)
Bat harp-net	25-27 February (three nights)
Bat mist-net	25 February (one night)
Bird play-back calls	25-27 February (three nights)
Bird transects	25-27 February (day and night)
Cage traps	25-27 February (three nights)
Elliott traps	25-27 February (150 trap-nights)
Frog call detection	25-27 February (three nights)
Hair-tube traps	25-27 February (150 trap-nights)
Litter searches	opportunistic
Pitfall traps	25-27 February (30 trap-nights)
Scat analysis	opportunistic
Spot lighting	25-27 February (three nights)

3.1 Weather

The weather experienced during the survey is illustrated in Table 2:

Table 2: Weather recorded during survey period

Date	Day	Evening
25 February	Drizzle (1.5 mm), clearing by 1300 hrs, north-east winds to 8 knots	Drizzle, 6.5 mm rain recorded to 900 hrs
26 February	Drizzle, overcast, 25^{0}C at 1530 hrs, easterly breezes, 28^{0}C at 1700 hrs	23 ^{0}C 9.20, 0.5 mm overnight rain. Min overnight temperature 18.5^{0}C
27 February	Warm clear, slight easterly breeze	Full moon. Min overnight temperature 20.6 ^{0}C
28 February	Overcast 25^{0}C at 900 hrs, clearing 27 ^{0}C 1300 hrs	No overnight rain. Overnight temperature 21.7 ^{0}C

3.2 Vegetation

3.2.1 Air photo interpretation and field surveys

Vegetation mapping was initially undertaken prior to the commencement of fauna sampling. Vegetation was mapped over a coloured aerial photograph at a scale of approximately 1:5000 (Hastings Council) and vegetation patterns were ground truthed for accuracy (Fig. 1).

3.2.2 Vegetation classification, structure and floristics

The vegetation classification system adopted for this survey is based on Beadle and Costin (1953) and Walker and Hopkins (1990). This system describes the components of the association in the following order:

- the first species is usually the most abundant in the tallest stratum;
- a second species is chosen when it is always present in the tallest stratum. In the absence of a tallest stratum species the most abundant species in the next most conspicuous stratum is chosen. For those associations where several species dominate, these are listed in order of abundance;
- a third species is chosen from any stratum, usually a ground cover or shrub layer. It is used as an indicator species;
- the forest type refers to the distances between the crowns of adjacent trees (Table 3); and
- the height of the tallest stratum is defined by the terms 'low', 'mid-high', or 'tall' (Table 4).

3.2.3 Vegetation transects

Vegetation associations were surveyed and mapped between 25 and 28 February 2002 by walking in meandering transects throughout the site. Areas of vegetation were repeatedly inspected during both the vegetation and the fauna survey. The littoral rainforest was surveyed by transects that extended from the southern boundary of Lot 1 to near the northern boundary of Lot 4. Opportunistic observations and collections of plant specimens were undertaken beyond these transects during the fauna survey. The grassland areas at the site were accessed by vehicle and small forested patches were inspected on foot.

The following features of the vegetation were noted:

- dominant trees, shrubs and ground covers in each strata (Table 3);
- major plant species in the association;
- tree heights and foliage cover; and
- any threatened species.

Table 3: Structural formation classes defined by growth form and crown separation (after Walker and Hopkins 1990)

Crown separation	Closed or dense	Mid-dense	Sparse	Very sparse	Isolated plants	Isolated clumps
Field criteria	Touching-overlapping	Touching-slight separation	Clearly separated	Well separated	Isolated	Isolated
Growth form						
Tree	Closed forest	Open forest	Woodland	Open woodland	Isolated trees	Isolated clumps of heath shrubs
Heath shrub	Closed heathland	Heathland	Open heath	Sparse heath	Isolated heath shrubs	Isolated clump of heath shrubs
Sedge	Closed sedgeland	Sedgeland	Open sedgeland	Sparse sedgeland	Isolated sedges	Isolated clump of sedges
Sod grass	Closed sod grassland	Sod grassland	Open sod grassland	Sparse sod grassland	Isolated sod grasses	Isolated clumps of sod grasses

Table 4: Height classes and names of various growth forms for non-rainforest associations (after Walker and Hopkins 1990)

Height m	Trees, vines	Shrubs, heath shrubs, chenopod shrubs, mallee (tree or shrub form)	Tussock and hummock grasses, forbs, rushes, sedges, ferns	Sod grasses, mosses, lichens, liverworts
20.01-35.01	*Extremely tall*	*NA*	*NA*	*NA*
12.01-20	*Tall*	*NA*	*NA*	*NA*
6.01-12	*Mid-high*	*Extremely tall*	*NA*	*NA*
3.01-6	*Low*	*Very tall*	*Extremely tall*	*NA*
1.01-3	*Dwarf*	*Tall*	*Tall*	*Extremely tall*
0.51-1	*NA*	*Low*	*Mid-high*	*Tall*
0.26-0.5	*NA*	*Low*	*Mid-high*	*Tall*
<0.25	*NA*	*Dwarf*	*Low*	*Low*

3.3 Fauna

3.3.1 Aims

Fauna surveys were designed to record all vertebrate fauna using the site and specialist techniques targeted threatened species known to occur in the study area. Targeted species and survey techniques are listed in Table 5.

3.3.2 Methods

3.3.2.1 Frogs

Spotlighting and listening for frog calls was conducted over three nights (25 – 27 February 2002) and opportunistically during the day.

3.2.2.2 Reptiles

Foot-based searching and pit-fall trapping was conducted over three days from 25 –27 February 2002. Searches were undertaken in different habitats. These were undertaken along tracks and around potential shelter sites.

3.2.2.3 Birds

Birds were identified visually and aurally during post-dawn and evening transects (Fig. 2). Transects of approximately 40 minutes duration were undertaken. These were on the evenings of 25 – 27 February and the mornings of 26 - 28 February 2002.

Birds were also recorded on an opportunistic basis. Play-back calls, broadcast through a loudspeaker/hailer were used to identify the presence of cryptic or nocturnal species. Calls of the grass owl, masked owl and powerful owl were broadcast shortly after dusk and at random times between 1800 hours (dusk) and 1900 hours on 26 and 27 February 2002 (Fig. 2).

Table 5: Threatened fauna species for which suitable habitats occur at the study site

Common name	Scientific name	Habitat and sampling method
Birds		
Black bittern	*Dupetor flavicollis*	Riparian wetlands. Observation and play-back call
Rose-crowned fruit-dove	*Ptilinopus regina*	Rainforest specialist. Observation and call
Masked owl	*Tyto novaehollandiae*	Open woodland and forest. Play-back call
Powerful owl	*Ninox strenua*	Open woodland and forest. Play-back call
Mammals		
Common blossom bat	*Syconycteris australis*	Coastal banksias woodland and rainforest. Mist and Harp-nets
Grey-headed flying fox	*Pteropus poliocephalus*	Coastal banksias woodland and rainforest. Observation, spotlight and call
Yellow-bellied sheath-tail-bat	*Saccolaimus flaviventris*	Open woodland and forest. Anabat
Greater broad-nosed bat	*Schoteanax rueppellii*	Open woodland and forest. Anabat
Little bent-wing bat	*Miniopterus australis*	Open woodland, forest and rainforest. Anabat

3.3.2.4 Mammals

A mammal survey was conducted using a spotlight, pit-fall traps, Elliott traps, hair-tube traps, harp-nets, a mist-net, ultrasonic detection devices (Anabat 11), the collections of scats and day-time observations.

Hair-tube traps

A total of 25 hair-tube traps was set in two transects at the site over three nights (150 trap-nights) (25 - 28 February 2002).

Elliott and cage traps

Twenty five Elliott type "A" traps (25 x 3 x 2 = 150 trap-nights) were set along the same two transects as the hair-tube traps in order to confirm the results of the hair-tube trap analysis and detect species that may have been under-sampled or not sampled with hair-tube traps. These were set from 25 to

28 February 2002. Five cage traps were set along the same two transect lines (5x3 = 15 cage-trap nights). Hair-tube, Elliott and cage traps were baited with a mixture of peanut butter and oats containing vanilla essence and sardines.

Pit-fall traps

Pit-fall traps utilised 5 x 20 litre plastic buckets in two transects joined by a 30 m x 0.3 m high drift fence that was positioned to direct fauna into the traps. Pit-fall traps were set on 25 February and retrieved on 28 February 2002 (10 x 5 = 50 trap-nights). Traps were inspected daily throughout this period and any animals captured were released in the proximity of the trap-line.

Spotlighting

Nocturnal sampling was undertaken, using a hand-held 55 watt halogen spotlight, along the trap-line transect and along tracks within and around the site (Fig. 2).

Day-time searching

Day-time searching for reptiles and skinks focused on the littoral rainforest. Observations of birds and macropods included the littoral rainforest and grasslands.

Bat survey

Sampling for megachiropteran and microchiropteran bats utilised harp-nets, a mist net and ultrasonic detection devices. Two Austbat harp-nets were set along flyways on 25 February and one was set on 26 February 2002 (3 trap-nights). Three Anabat II detection devices were set to detect bat activity over all vegetation associations over three nights: 25 to 28 February 2002 (3 x 3 = 9 acoustical detector nights).

Bat calls were recorded on a 45 minute tape using a detector, a timing device and a tape recorder. Calls were analysed by this consultant.

Spotlighting and audible calls

Flying-foxes were recorded by spotlighting potential food trees and by the identification of their characteristic social calls. Spotlighting for bats was also undertaken throughout the study area, especially among flowering coast banksias.

4.0 RESULTS

4.1 Vegetation associations and communities

Eight vegetation associations in five communities was recorded and mapped (Table 6).

Table 6: Vegetation associations (Fig. 1)

Littoral rainforest

Lophostemon confertus (brushbox), *Acronychia imperforata* (beach acronychia), *Cupaniopsis anarcardioides* (tuckeroo) simple notophyll littoral rainforest

Acacia melanoxylon (blackwood), *Commersonia bartramia* (brown kurrajong), *Chrysanthemoides monilifera* spp. *rotundata* (bitou bush) simple notophyll (regrowth) littoral rainforest

Open forest

Eucalyptus siderophloia (grey ironbark), brushbox, *Lantana camara* (lantana) tall open forest

Woodland

Banksia integrifolia var. *integrifolia* (coast banksia), *Paspalum dilatatum* (paspalum) mid-high open woodland

Swamp forest

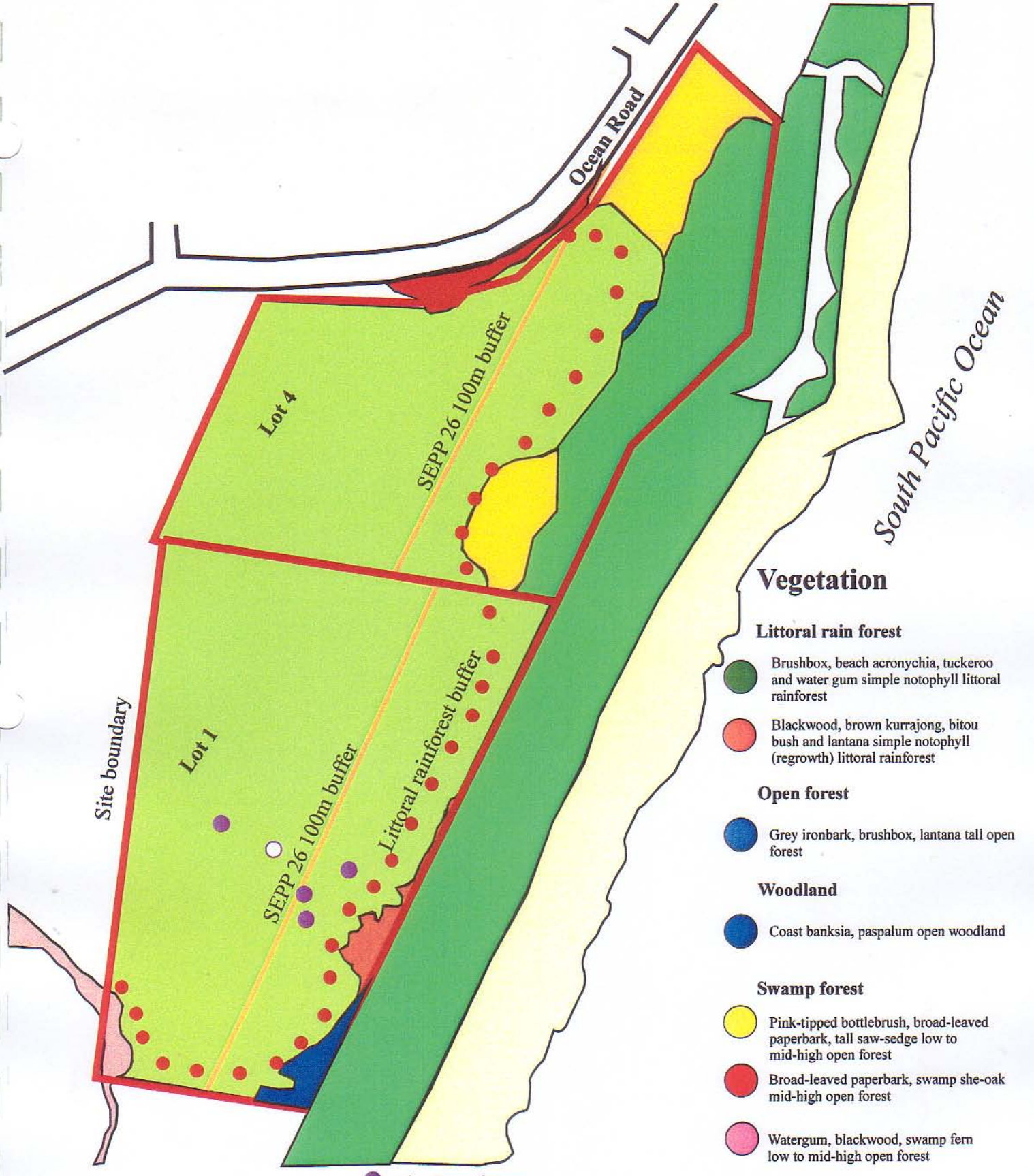
Callistemon saligna (pink-tipped bottlebrush), *Melaleuca quinquenervia* (broad-leaved paperbark), *Gahnia clarkei* (tall saw-sedge) low to mid-high open forest

Broad-leaved paperbark, *Casuarina glauca* (swamp she-oak) mid-high open forest

Tristaniopsis laurina (watergum), blackwood, *Blechnum indicum* (swamp fern) low to mid-high open forest

Grassland

Themeda australis (kangaroo grass), paspalum +/- *Pennisetum clandestinum* (kikuyu) low closed sod grassland



Peter Parker

Project: LES, Ocean Drive, Lake Cathie

Client: King and Campbell

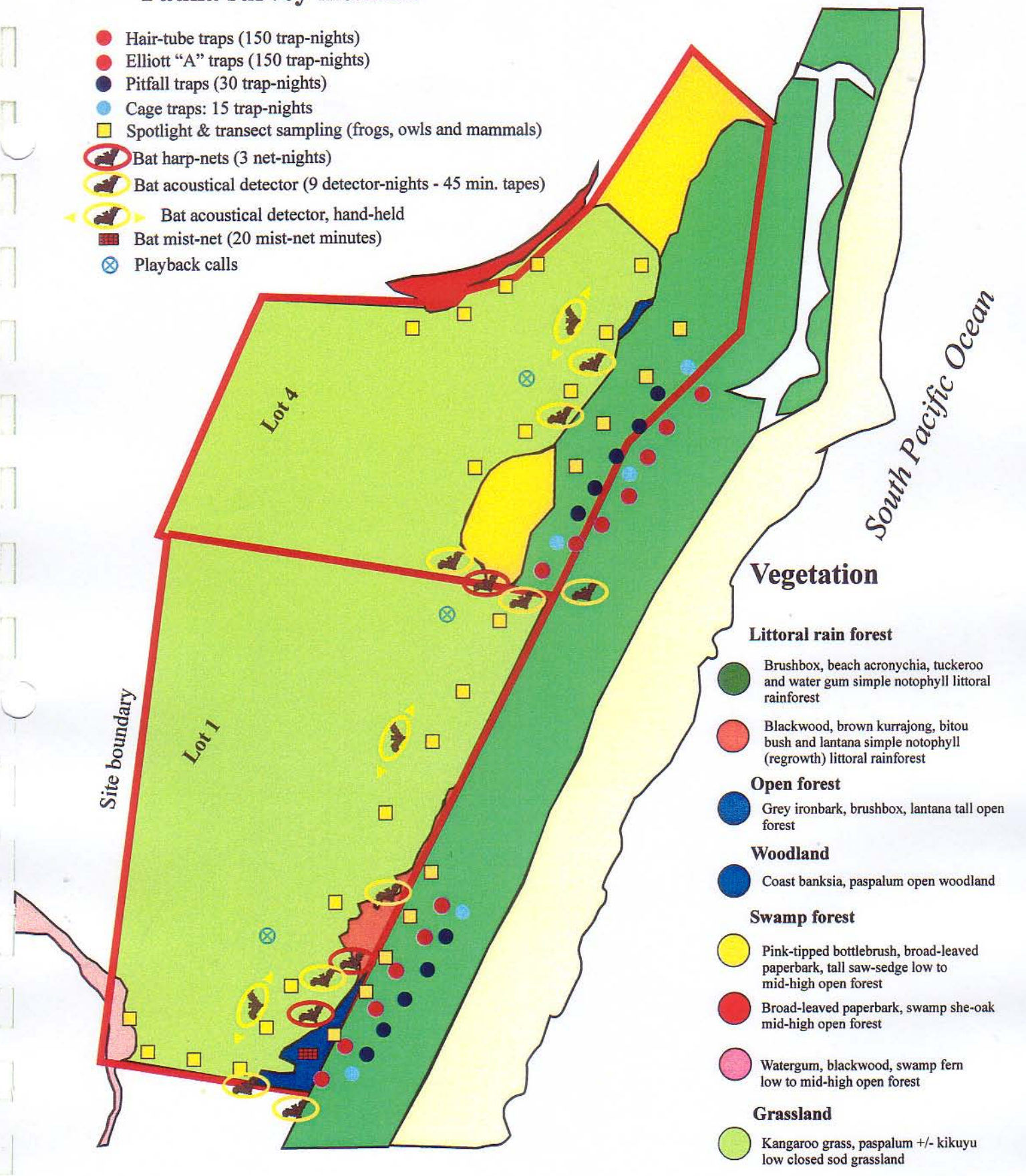
Fig. 1: Vegetation

North

Source: Field Survey Peter Parker

Date: March 2002

Scale metres: 0 — 100



Peter Parker

Project: LES, Ocean Drive, Lake Cathie

Client: King and Campbell

North

Fig. 2: Survey methods

Source: Field Survey Peter Parker

Date: March 2002

Scale metres: 0 — 100

4.1.1 Littoral rainforest

Lophostemon confertus (brushbox), *Acronychia imperforata* (beach acronychia), *Cupaniopsis anarcardioides* (tuckeroo) simple notophyll littoral rainforest

This was the most significant vegetation association recorded at the site in terms of its statutory protection, biodiversity and location in relation to adjoining vegetated areas.

Upper storey:

Brushbox, beach acronychia, tuckeroo, saw-tooth banksia, water-gum and broad-leaved paperbark

Mid storey:

Tuckeroo, beach acronychia, water-gum and broad-leaved lilly pilly

Understorey and ground cover:

Tall sawsedge, duboisia, mat rush, basket grass and austral sarsparilla

Acacia melanoxylon (blackwood), *Commersonia bartramia* (brown kurrajong), *Chrysanthemoides monilifera* spp. *rotundata* (bitou bush) simple notophyll (regrowth) littoral rainforest

A small area of regenerating littoral rainforest was recorded within the statutory buffer zone on Lot 1. This comprised mainly of pioneer species and exotics.

Upper storey:

Blackwood and brown kurrajong

Mid storey:

Lantana and bitou bush

Understorey and ground cover:

Winter senna and bitou bush

4.1.2 Open forest

Eucalyptus siderophloia (grey ironbark), brushbox, *Lantana camara* (lantana) tall open forest

Several tall eucalypts and brushbox combined to form the only tall open forest at the site. This vegetation was likely to be widespread an occupy most of the site prior to European settlement.

Upper storey:

Grey ironbark and brushbox

Mid storey:

Blackwood and red ash

Understorey and ground cover:

Hardenbergia, devil's twine and blackwood

4.1.3 Woodland

Banksia integrifolia var. *integrifolia* (coast banksia), *Paspalum dilatatum* (paspalum) mid-high open woodland

Banksia woodland was confined as scattered trees and clumps of trees in the south-eastern corner of Lot 1. Ecologically, coast banksia is a significant feed tree for the common blossom bat (see Law 1994).

Upper storey:

Coast banksia

Mid storey:

Coast banksia

Understorey and ground cover:

Pasture grasses

4.1.4 Swampforest

Callistemon saligna (pink-tipped bottlebrush), *Melaleuca quinquenervia* (broad-leaved paperbark), *Gahnia clarkei* (tall saw-sedge) low to mid-high open forest

Swampforest dominated by pink-tipped bottlebrush was recorded in the regeneration area in Lot 4. This areas was planted by the land owner Graham Cunning to compensate for habitat removal. It is now well advanced and contributes to the buffer of the littoral rainforest.

Upper storey:

Pink-tipped bottlebrush and broad-leaved paperbark

Mid storey:

Pink-tipped bottlebrush, tall saw-sedge ± water-gum

Ground cover:

Ferns and sedges

Broad-leaved paperbark, *Casuarina glauca* (swamp she-oak) mid-high open forest

A small area of swampforest was recorded fronting Ocean Road. This was mainly located within the road reserve with regenerating swamp species occurring within Lot 4. Surprisingly, native fish (*Gobiomorphus* sp.) were recorded in a drainage way along the roadside edge of this association.

Upper storey:

Broad-leaved paperbark and swamp she-oak

Mid storey:

Broad-leaved paperbark

Understorey and ground cover:

Sedges

Tristaniopsis laurina (watergum), blackwood, *Blechnum indicum* (swamp fern) low to mid-high open forest

Water-gum was located throughout the littoral rainforest and in patches this species dominated. However, this association was recorded in the south-west corner of Lot 1 along the creek system. It was impacted by cattle grazing and weed infestation.

Upper storey:

Watergum and blackwood

Low understorey:

White's passionflower and lantana

Understorey and ground cover:

Slender knotweed and pasture grasses

4.1.5 Grassland

Themeda australis (kangaroo grass), *Paspalum dilatatum* (paspalum) +/- *Pennisetum clandestinum* (kikuyu) low closed sod grassland

Kangaroo grass dominated the upper slopes of the site whereas paspalum and kikuyu dominated the flats and areas around the old homestead. This

association is of little ecological association when compared to other parts of the site but is grazed by the grey kangaroo and utilised by grass birds (e.g., Richard's pipit).

4.2 Fauna

4.2.1 Reptiles

The eastern grass skink, *Lampropholis delicata* was conspicuous and common in the littoral rainforest. Other species recorded included the three-toed skink, *Saiphos equalis*, the eastern water dragon, *Physignathus lesueurii,* the lace monitor, *Varanus varius* and the eastern brown snake, *Pseudonaja textiles.* A number of other species are expected to occur at the site due to the variety of habitats available (see Appendix 2).

4.2.2 Frogs

Five frog species were recorded at the site during the fauna survey. These were the eastern dwarf frog, *Litoria fallax*, the common eastern froglet, *Crinia signifera*, the brown-striped frog, *Limnodynastes peronii,* the red-backed toadlet, *Pseudophryne coriacea* and the dusky toadlet, *Uperlois fusca.*

Two of the above frog species were recorded in pit-fall traps. These were the common eastern froglet and the brown-striped frog.

Other frog species expected to occur at the site include the rocket frog, *Litoria nasuta* and the Peron's tree frog, *L. peronii*.

4.2.3 Birds

The site supported a variety of forest birds and open country species. Moreover, the survey was undertaken during the coast banksia flowering period which proved ideal for assessing the value of this habitat type for nectarivorous avifauna (Appendix 2).

Characteristic woodland species that occupied the site throughout the survey period included, in order of abundance, flocks of the rainbow lorikeet, *Trichoglossus haematodus*, and the scaly-breasted lorikeet, *Trichoglossus chlorolepiotus*, the brush (little) wattlebird, *Anthochaera chrysoptera*, the noisy friarbird, *Philemon corniculatus*, the grey fantail, *Rhipidura fuliginosa*, and the willie-wagtail, *Rhipidura leucophrys*.

Less conspicuous species within the littoral rainforest, included the eastern yellow robin, *Eopsaltria australis*, Lewin's honeyeater, *Meliphaga lewinii*, the eastern whipbird, *Psophodes olivaceus,* the grey shrike-thrush, *Colluricincla harmonica* and the spangled drongo, *Dicrurus bracteatus.*

Species that characterised the grasslands or more open country included the Australian magpie, *Gymnorhina tibicen*, the masked lapwing, *Vanellus miles,* the Australian magpie lark, *Grallina cyanoleuca,* the bar-shouldered dove, the willie wagtail, the grey butcherbird, *Cracticus torquatus*, the pied butcherbird, *Cracticus nigrogularis*, the torresian crow, *Corvus orru* and Richard's pipit, *Anthus novaeseelandiae.*

No vulnerable birds species were recorded despite the use of play-back calls.

4.2.4 Mammals

Hair-tube and Elliott trap surveys provided a broad picture of habitat usage by small to medium sized mammals. The northern brown bandicoot, *Isoodon macrourus,* the introduced black rat, *Rattus rattus*, and the brown antechinus, *Antechinus stuartii*, provided hair samples in traps set in the littoral rainforest. The usage of the site by the northern brown bandicoot was also apparent from the numerous diggings and a day-time observation.

Of the macropods, the eastern grey kangaroo, *Macropus giganteus,* was the most conspicuous with up to 19 individuals counted at the site on 27 February 2002. However, the swamp wallaby, *Wallabia bicolor,* was also observed.

The bush rat, *Rattus fuscipes,* was the most abundant species captured in Elliott traps although the brown antechinus was also recorded (Tables 7 and 8).

Table 7: Elliott trap results (south transect)

Date (2002)	***Rattus fuscipes*** No of individuals & trap number	***Antechinus stewartii***
26 February	**3**: 1;2;23	
27 February	**3**: 3;21;24	**1**: 19
28 February	**3**;21	**2:** 19;23

Table 8: Elliott trap results (north transect)

Date (2002)	***Rattus fuscipes***	***Antechinus stewartii***
26 February	**4**: 4;7;20;25	**4**: 13;14;18;21
27 February	**5**: 2;6;7;11;25	**6**: 12;14;18;21;22;24;
28 February	**3**: 2;10;25	**4**: 11;19;23;24

Dogs were observed accompanying their owners walking through the site to the beach on all survey-days.

The most significant mammal recorded was the vulnerable common blossom bat, *Syconycteris australis*. This species was captured in a mist-net set among

the coast banksias for 20 minutes on 25 February 2002. The coast banksia woodland is located adjacent to the littoral rainforest in the south of Lot 1 (Fig. 1). Another vulnerable bat species, the grey-headed flying fox, *Pteropus poliocephalus,* was recorded flying over the site on a number of occasions.

Two other species were captured at the site using harp-nets. These were the eastern forest bat, *Vespadelus pumilus* and the little forest bat, *Vespadelus vulturnus.*

A total of four microchiropteran bat species were detected using echo-locating devices. These were the vulnerable little bent-wing bat, *Miniopteris australis,* the eastern horse-shoe bat, *Rhinolophus megaphyllus,* the eastern broad-nosed bat, *Scotorepens orion* and most likely the lesser long-eared bat, *Nyctophilus geoffroyi,* although this species call is indistinguishable from Gould's long eared bat, *Nyctophilus gouldi* (Reinhold *et al.*, 2001).

Other species recorded in similar habitats to those occurring at the site include the greater broad-nosed bat, *Scoteanax rueppellii,* and the white-striped mastiff bat, *Nyctinomus australis* (see Appendix 2).

4.2.5.1 Koala habitat

An assessment of potential koala habitat was undertaken pursuant to the requirements of State Environmental and Planning Policy No. 44 (SEPP 44) (Koala Habitat Protection). No koala food trees were recorded. Thus, potential koala habitat does not occur at the site.

5.0 DISCUSSION

5.1 Plants of conservation significance

The rough-shelled bush nut, *Macadamia tetraphylla*, was the only threatened plant recorded which is listed under the *Threatened Species Conservation Act 1995* (TSC Act). However, the rough-shelled bush nut was planted as an orchard tree in the vicinity of ruins located approximately 150 m west of the littoral rainforest and is only known in the wild north of the Clarence River (Harden 2002). In this context, this species has little ecological value.

5.2 Vegetation of conservation significance

Littoral rainforest 116 occurs as a Crown Land frontage to Lot 1 and is located partly within Lot 4. This rainforest is of State significance being gazetted under SEPP 26. It is one of the largest littoral rainforest remnants in the local area, is relatively weed free and not impacted by cattle grazing or other significant anthropocentric effects.

Reafforestation and the management of plantings within the littoral rainforest buffer zone at Lot 4 in the north of the site (Fig. 1) is well advanced with established plantings providing a complete canopy cover in parts of the planting area.

Littoral rainforest 116 stands out from many other remnants along the NSW coastline in both its size, species diversity, small mammal assemblages and the virtual absence of rubbish dumping. However, in relation to rubbish dumping, this remnant has benefited from litter removed from the site by the land owner over a number of years (Graham Cunning pers. com.).

5.3 Edge effects and buffer design

5.3.1 Introduction

When rainforest is fragmented due to the clearing of vegetation, the remnant forest is often subjected to edge effects that can have negative impacts on the remaining plants and animals in the remnant. Edge effects can be placed in two categories; those stemming from changes in the microclimate near the edges of the remnant and those that result from human activity in the cleared areas surrounding the remnant (the matrix). Buffers are often advocated as a management tool to reduce or nullify edge effects and thus ameliorate these negative impacts. For buffers to be effective, their design should be specific to the ecology and physical environment of the site and should address potential effects from proposed land uses in the surrounding matrix. Designing appropriate buffers requires not only the determination of an appropriate width for the buffer but also the determination of what features (e.g. plantings or fencing) should be incorporated into the buffer. This section of the report assesses potential edge effects that may stem from the proposed residential development of the site and discusses the design of an appropriate buffer to protect littoral rainforest 116.

5.3.2 History and condition of the rainforest edge

ERM Mitchell McCotter (1995) have analyzed past aerial photography to reconstruct the history of vegetation clearance on the site. This analysis revealed that nearly all of the present rainforest edge in the southern half of the site (Lot 1 DP 374315) had been cleared before 1976 while the edge in the

northern half of the site (Lot 4 DP 615216) was cleared in stages between 1976 and 1986. Thus the existing edge has been exposed for a substantial period of time (between 16 and more than 26 years).

Microclimatic edge effects are greatest immediately following the creation of an edge as the vegetation and fauna respond to a new microclimate that is usually drier, warmer and windier. In tropical and subtropical rainforests however, the vegetation along a newly created edge quickly responds with increased growth of lianas and lateral branches in existing trees and increased germination and growth of seedlings and saplings (see e.g. Longman & Jenik 1974, Lovejoy *et al.* 1986, Williams-Linera 1990 and Camargo & Kapos 1995). This has the effect of "sealing" the edge and allowing the microclimate close to the edge to quickly return to a condition similar to that existing prior to the edge creation.

An inspection of the western edge of littoral rainforest 116 revealed that it conformed to the above model and that a microclimate typical of the interior of the rainforest existed right up to the boundary of the rainforest. The edge appears stable and the vegetation along the boundary is in good condition with weed invasion being limited to the first few metres.

5.3.3 Wind and salt spray

The prevailing wind direction at the site is from the south-east, with north-east winds also common during late spring and early summer. Strong westerly winds blow periodically during winter and early spring. The littoral rainforest on the site seems to be resilient to the drying effect of these westerly winds probably because the vegetation relies on the high water table

for moisture. The current western edge of the littoral rainforest is on the lee side of the salt laden south-east and north-east winds and as a result the vegetation on this edge is not obviously affected by salt spray.

The construction of buildings taller than the existing rainforest canopy and close to the western edge of the rainforest could cause some turbulence which would lead to an increase in salt deposition along this edge. Since tall buildings are not proposed for the site, there should be no significant increase in salt deposition.

5.3.4 Hydrology and runoff

Housing developments adjacent to rainforest have the potential to affect infiltration rates and the incidence of surface run-off. It is most important that any proposed development not lead to a change in the level of the watertable under the littoral rainforest. A significant increase in the level of the watertable would lead to a change towards swamp forest while a significant decrease in the level of the watertable would lead to the development of a drier forest type on the site.

It is also important to ensure that untreated surface run-off from the developed area of the site does not flow into the rainforest. Such run-off can cause erosion and sedimentation and increase the level of nutrients in the forest thus facilitating the growth of weeds, in addition to directly carrying the seed of weed species into the forest. At present, erosion and the associated spread of weed species resulting from stormwater runoff is only evident along an informal path through the littoral rainforest that is used by the public to access the beach.

Therefore, any residential development on the site should incorporate a stormwater management system that maintains the level of the watertable under the rainforest and prevents surface flows into the rainforest both during and after construction. Such a system would typically utilise drains, swales and retention ponds. An elevated walkway and rip-rap filters or similar structures should be constructed along the existing pathway through the littoral rainforest in order to prevent further erosion and the introduction of weeds in this area.

5.3.5 Noise and light

Residential developments adjacent to rainforests can result in increased noise and night-time light levels that may negatively impact some rainforest fauna. No species that are known to be particularly sensitive to moderate increases in noise or light were identified during the fauna survey. In addition, noise effects on this site would be reduced because the prevailing winds blow from the forest towards the proposed development site and because there already exists a relatively high level of background noise from the surf.

It would however, be prudent to plant a buffer of trees at least 10 metres wide along the existing edge and to direct street lights in the buffer zone away from the forest in order to reduce light penetration into the forest.

5.3.6 Domestic and feral animals

Feral animals such as foxes, dogs and cats can prey on ground-dwelling and ground-utilising fauna in small rainforest remnants, putting populations at risk. No feral animals were detected during the fauna survey of the site but it is probable that such animals are present in the vicinity, given the large

amount of forest cover to the west of the site. Residential development on the site should reduce the incidence of feral animal incursion into the rainforest as these animals are much less likely to traverse a residential area as opposed to the existing grassland.

Domestic dogs and cats can also prey on or disturb ground-dwelling and ground-utilising rainforest fauna. Domestic dogs accompanying their owners were observed using the existing access through the rainforest to the beach. As residential development around the site expands, the incidence of domestic dogs and cats in the vicinity will increase and the proposed residential development on the site will further add to this. Incursion of domestic dogs and cats into the rainforest is much more likely where backyards directly abut either the rainforest or a revegetated buffer.

Design features in the buffer can greatly decrease the likelihood of domestic animal incursion into the rainforest. These features should include the following.

- Protective fencing should be incorporated along the western edge of a planted buffer to the littoral rainforest. Fencing should be approximately 1200 mm in height so as not to restrict the movement of macropods from the rainforest but to restrict access by dogs and cats.
- Abutting the protective fencing on its western side should be a low, thick hedge about 1.5m wide and consisting of plant species with spines or thorns.
- A cleared public area including such features as a road and grassed areas should separate houses from the hedge and fencing. It is important to maintain grassed areas in the buffer between the houses and the fence so as to provide a food source for the macropods which utilise the rainforest and its margins for cover.

- The current access-way through the rainforest should also be fenced with a 1200 mm fence. The design of this fence should incorporate gaps at ground level to allow for the transit of small native fauna such as bandicoots, so as to not impede their movement within the rainforest.

5.3.7 Human intrusion

Probably the greatest threat to littoral rainforests located between the beach and residential developments is the unregulated clearing of the forest by residents whose houses abut the forest. This usually takes two forms. First, residents will clear paths through the forest adjacent to their property to provide direct access to the beach. Such clearing is particularly destructive of rainforest remnants as it opens the canopy, resulting in increased light levels and also provides a path for the overland flow of water which together result in a significant invasion of weeds into the core of the rainforest. Currently the canopy of littoral rainforest 116 adjacent to the site is intact with few discernable breaks or gaps except for the existing access path and this is a major reason for the very limited presence of weeds at the moment.

The second form of clearing involves residents extending their yards that directly abut the forest. The clearing can either involve total clearance of the canopy and understorey vegetation or simply the removal of understorey vegetation to produce a par- like environment. Once one resident starts to clear the forest adjacent to their house in order to extend their yard, other residents tend to follow suite. This can lead to the loss of a significant area of forest and the break-down of the closed edge of the forest, changing the microclimate near the edge and facilitating the invasion of the forest by weeds.

These forms of clearing can be prevented by incorporating physical barriers such as the fence and thorny/spiky hedge already described, and a hardened and moderately well used public space between the residential lots and the buffer plantings. A road/bicycle path is ideal for this purpose. Such a road should be designed to have a low speed limit and relatively low usage levels by cars so as to minimise the risk of native fauna being hit.

5.3.8 Dumping of rubbish

The dumping of large items of rubbish can physically damage plants around the edge of rainforest remnants and contribute to the breaking down of the edge structure. However, a greater danger comes from the dumping of garden waste into rainforest, as such waste often contains the seeds and propagules of weed species. Such dumping of garden waste is again most common where residential lots directly abut the rainforest or vegetated buffer, allowing residents to dump their garden wastes unseen. At present, the littoral rainforest is free of rubbish.

The design features described above to limit human access into the rainforest will also help prevent the dumping of garden waste and other rubbish. Another essential design feature is to ensure that the houses adjacent to the buffer face towards the buffer road. This will increase public surveillance of the buffer and combined with signs warning against the dumping of rubbish or garden wastes will deter both residents and visitors from dumping.

5.3.9 Fire

While fires seldom burn through rainforests because of the moist microclimate and lack of fire promoting plant species, they can cause significant plant mortality and damage around the edges of remnants and facilitate weed invasion. Repeated fires can thus cause significant incremental damage to the rainforest. At present, the vegetation in the grassland adjoining the rainforest is low and thus there is little chance of fire damaging the rainforest. However, in the absence of residential development on the site, it is not certain that in the future this grass will be kept low. If the grass was allowed to grow taller in the future there would be a fire risk to the rainforest edge. Thus the proposed residential development will reduce the likelihood of fire damaging the rainforest and the road and mown grass swale described above will act as a fire break between the residential estate and buffer plantings.

5.3.10 Summary of recommendations

A buffer between the proposed residential development and the littoral rainforest should be developed and include the following elements moving from east to west:

1. A vegetated strip at least 10m wide consisting of dense plantings of locally-sourced rainforest or swamp forest species as appropriate. While we consider a 10m strip, in combination with the other design features below, wide enough to protect the littoral rainforest from potential edge effects from the proposed development, we believe the strip should be widened in places to up to 40m in order to improve the shape of the littoral rainforest by decreasing the edge-to-area ratio

and to serve as compensation for a reduction in the 100m buffer specified in SEPP 26 – Littoral Rainforests.

2. A 1.2m high fence to restrict access by humans and domestic animals into the rainforest while allowing macropods to move in and out of the rainforest.

3. A hedge of thorny or spiny shrub shrubs to further dissuade access by humans and domestic animals.

4. A roadway to provide a well-defined public space between residences and the rainforest and the revegetated strip and thus prevent encroachment of residents yards into public space and discourage dumping of garden wastes. The road should be designed to have a low speed limit and relatively low usage levels by cars so as to minimise the risk of native fauna being hit.

5. A grassed swale which is regularly mown to allow infiltration of stormwater and provide a food resource for macropods.

In addition, the following measures should be undertaken in order to minimise potential impacts on the littoral rainforest and to enhance the ecology of the site and the neighbouring areas.

1. Signs should be erected along the proposed buffer road warning against the dumping of rubbish and garden wastes.

2. Houses adjoining the buffer should face towards the buffer to increase surveillance and thus reduce the possibility of illegal dumping.

3. Street lights in the buffer zone should be directed away from the forest in order to reduce light penetration.

4. A vegetated east-west corridor should be developed to link the littoral rainforest with riparian habitat in the south-west corner of the site. This can be achieved by plantings along the southern boundary of Lot 1. Plantings should incorporate the coast banksia woodland in the

south-east corner and emphasise coast banksias in the planting scheme. Properly constructed and managed, this corridor will provide feeding resources for the common blossom bat, assist in fauna passage for the more cryptic animal species and provide for greater biodiversity.

5. An elevated and fenced walkway should be constructed along the existing access track through the littoral rainforest. The fence should allow for the passage of small ground-dwelling native fauna. Rip-rap filters or similar structures should also be constructed in this area to improve drainage and minimise erosion.

6. The proposed development should incorporate a stormwater management system that maintains the level of the watertable under the rainforest and prevents surface flows into the rainforest both during and after construction.

5.4 Threatened species

One vulnerable plant, the rough-shelled bush nut and three vulnerable vertebrate species, the common blossom bat, the grey-headed flying fox and the little bent-wing bat were recorded during the fauna survey. The common blossom bat forages on coast banksia and roosts in littoral rainforest (see Law 1993; 1994). The littoral rainforest is likely to be an important local roosting site and the coast banksia woodland a recognised feeding site. Coast banksia is limited to a small woodland in the south-east corner of Lot 1. It is recommended that extensive replanting of this species be undertaken to enhance common blossom bat feeding opportunities.

The grey-headed flying fox is widely distributed and may feed within the littoral rainforest and on paddock figs while the little bent-wing bat is a wide-ranging cave-roosting insectivorous species. The planting and management proposals recommended in this report are unlikely to significantly enhance the habitat of either of these two species.

6.0 STATUTORY CONSIDERATIONS

The TSC Act commenced on 1 January 1996. This Act, *inter alia*, amended s4, s110, s111 and s112 of the *Environmental Planning and Assessment Act*, 1979 with regard to the protection of the plants and animals.

Section 5A is used to determine whether a proposed development is likely to significantly affect threatened species, populations or ecological communities or their habitats. Section 5A requires the following factors to be taken into account:

a). in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

In assessing the likelihood that a *viable local population* of a species will be placed at risk of extinction from this proposal the following factors have been considered:

- the proposals likely impact upon the key habitat components essential to the species' lifecycle; and
- the size of the local population in comparison with that which is proposed to be removed/modified.

A local population is considered to be the population contained within interconnected suitable habitat within a 5 km radius of the study site.

Flora

One threatened plant species was recorded at the site. This was the rough-shelled bush-nut which does not occur naturally south of the Clarence River. Further, records of threatened species in the immediate locality were reviewed and it was concluded that it is unlikely that the proposal to rezone and provide for residential development on the grassland would *disrupt … a viable local population of* any threatened plant *species.*

Similarly, it is unlikely that *the life cycle of* any *species* would *be disrupted such that a viable local population of the species … to be placed at risk of extinction.*

Fauna either recorded at the site or those species which have essential habitat components at the site

Little bent-wing bat

The little bent-wing bat is an insectivorous cave roosting species that forages widely. The site of the proposal is wholly within cleared grassland. Thus, the proposal is unlikely *to cause a viable local population of the species is likely to be placed at risk of extinction.*

Common blossom bat

The common blossom bat was recorded at the site during the fauna survey. This species forages on coast banksia blossoms and, to a lessor extent, broad-leaved paperbark flowers and roosts in nearby littoral rainforest. Both of these habitats occur at the site. However, there is no intention to remove any habitat of significance to this species nor will the proposal *cause a viable local population of the species …. to be placed at risk of extinction.*

The grey-headed flying fox

The grey-headed flying fox was recorded flying over the site. However, it is likely that this species would forage opportunistically on figs and flowering paperbarks. The impact of the proposal on the grey-headed flying fox is likely to be negligible. Thus, the proposal is unlikely *to cause a viable local population of the species … to be placed at risk of extinction.*

Possible seasonal visitors or vagrants

Other vulnerable species which have suitable habitat components at the site, include the rose-crowned fruit-dove and the greater broad-nosed bat.

The proposal is unlikely *to cause a viable local population of* any of these *species … to be placed at risk of extinction.*

b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

No endangered populations, listed under Part 2 of Schedule 1 of the TSC Act occur within the vicinity of the site. Thus, the proposed activity will not disrupt the life cycle of any species constituting an endangered population and will not significantly compromise the viability of any endangered population.

The endangered animal populations listed under the TSC ACT include the little penguin at Manly point, the brush-tailed rock-wallaby at Warrumbungles, the long-nosed bandicoot at North Head, the squirrel glider on Barrenjoey Peninsula, north of Bushrangers Hill, the koala in the Pittwater Local Government Area and at Hawks Nest, the Riverina population of the glossy black cockatoo, and the beetle, *Menippus fugitives*, in the Sutherland Shire.

The endangered plant populations listed are: Tadgell's Bluebell in the local government areas of Auburn, Bankstown, Strathfield and Canterbury, *Hibbertia incana* in the local government area of Baulkham Hills, the Gosford Wattle, in the Hurstville and Kogarah Local Government Areas, *Dillwynia tenuifolia*, at Kemps Creek, *Darwinia fascicularis* subsp. *oligantha* population in the Baulkham Hills and Hornsby Local Government Areas, *Cryptandra longistaminea* in the vicinity of Ellandgrove Road, South Grafton, *P. prunifolia* in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas and the low growing form of *Ziera smithii* at Diggers Head.

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

In determining whether a significant area of known habitat is to be modified or removed in relation to the regional distribution of the habitat of a threatened species, population or ecological community, an assessment needs to consider the following characteristics of the site:

- its relative scale and remnant value;
- its habitat quality; and
- its setting in the landscape at the regional scale.

For the purpose of this assessment "a region" is considered to be a bioregion defined in the national system of bioregionisation (see part "f" of this assessment). An area will be considered to contain "known habitat" for a species if it is similar to the known habitat preferences of that species and lies within its known range.

No habitat of significance to threatened species will be removed from the site. In contrast, this proposal will provide some significant management initiatives, including planted rainforest buffers and corridors, the management of stormwater into the littoral rainforest and enhanced public access.

Thus, the proposal will not entail the removal of *a significant area of known habitat* for any threatened species.

d) whether an area of habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for threatened species, population or ecological community

'Interconnecting or proximate areas of habitat' are taken to be two or more areas of habitat where individuals could potentially move from one to the other. Areas are considered 'likely to become isolated' if it is predicted that the proposal creates a situation preventing future movement of individuals between these areas.

In this assessment, consideration is given to the local 'connectivity values' of the site; whether the site is contributing to the local movement patterns of any threatened species and whether the proposal would significantly disrupt these patterns.

The site includes a significant littoral rainforest which will be further buffered by plantings and linked to riparian habitats by an east-west corridor. No clearing of trees or shrubs is proposed and no habitat linkages will be disrupted or broken. Thus, it is unlikely that habitat at the site will *become isolated from currently interconnecting or proximate areas of habitat for threatened species, population or ecological community.*

e) whether critical habitat will be affected

The area under application does not contain any area which has been identified and declared as critical habitat under Part 3 of the TSC Act. Therefore, critical habitat will not be affected by the proposal.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Australian Nature Conservation Agency (ANCA) has developed a system of biogeographic regionalisation for Australia (IBRA). This system was developed for the purpose of establishing a national comprehensive system of

parks and reserves. A biogeographic region can be defined as "a complex land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout" (Thackway and Cresswell 1995). A biogeographic region describes the dominant landscape, scale of climate, lithology, geology, landforms and vegetation. IBRA has been derived through a combination of expert ecological knowledge and interpretation of existing State and Territory regionalisations. On 31 May 1996, the Director General, NPWS gave notice that pursuant to s.4(1) of the *TSC Act* and s.4(6A) of the *EPA Act* 1979, the national system of biogeographic regionalisation, identified by Thackway and Cresswell (1995), "is appropriate for the purposes of the provisions in which the term 'region' is used".

Biogeographic regions provide a framework for summarising patterns in nature conservation. They are an ecologically meaningful approach to defining a region, as they are based upon a conceptual model which seeks to describe and explain a regional pattern of biological diversity and productivity. The north coast region has the IBRA code NNC and the IBRA name *NSW North Coast* (Thackway and Cresswell 1995). In determining the reservation status within this biogeographic region, Thackway and Cresswell (1995) calculated that reserved areas accounted for approximately 5-10% of the total area of the NNC region (60,794 km^2) and that the existing reserves in the region fail to include samples of the most extensive ecosystems (or land systems) i.e. those that characterise entire sub-regions to a "moderate" degree.

The threatened species which have been recorded in the locality, or are likely to occur seasonally or opportunistically in the locality are wide-ranging and are represented in a number of conservation reserves in the NNC region.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process

A threatening process is defined under the TSC Act as a process that threatens, or may have the capability to threaten the survival or evolutionary development of species, populations or ecological communities.

Threatening processes listed as of September 2001 include the following:

- Anthropogenic climate change.
- Bushrock removal.
- Clearing of native vegetation. Clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long-term modification, of the structure, composition and ecological function of a stand or stands.
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition. High frequency fire is defined as two or more successive fires close enough together in time to interfere with or limit the ability of plants or animals to recruit new individuals into a population, or for plants to build up a seed-bank of sufficient size to maintain the population through the next fire.
- Loss or degradation (or both) of sites used for hill-topping by butterflies. Hill-topping in butterflies is a complex behaviour that often facilitate mating between sexes. Many butterfly species appear to congregate on hill-tops or ridges that are usually higher than the surrounding landscape. These sites may range in area from a few square metres to several hectares.
- Invasion of native plant communities by bitou bush, *Chrysanthemoides monilifera.* The ability of bitou bush to become the overwhelming dominant in invaded ecological communities threatens all plant communities within its distribution.
- Predation by the mosquito fish, *Gambusia holbrooki*.

- Predation by the European red fox, *Vulpes vulpes*.
- Predation by the feral cat, *Felix cattus.* Predation by the feral cat has been implicated in the extinction and decline of many species of birds on islands around Australia and in the early extinction of up to seven species of small mammals on the Australian mainland.
- Predation by the ship rat *Rattus rattus* on Lord Howe Island.

Anthropogenic climate change is unlikely to occur due to the small scale of the proposal.

Bushrock will not be removed from the site.

The vegetation at the site is dominated by littoral rainforest and grassland. There is no need to remove native vegetation should residential development be approved. Thus, the site of the proposed development is not within the definition of threatening processes.

Development of the site for residential housing is unlikely to contribute to an increase in fire frequency.

Loss or degradation of sites used for hill-topping by butterflies. The flora and fauna survey did not reveal the use of the site by hill-topping butterflies.

Bitou bush was recorded at the site. However, the proposal is unlikely to result in its spread.

The mosquito fish was not recorded at the site and is not expected to occur due to the lack of suitable aquatic habitats. Development of the site is unlikely to result in the spread of this species.

The fox was not recorded although it is known from the local area. The proposal is unlikely to alter the status-quo of this species.

The feral cat was not recorded at the site, although it is expected to occur due to the proximity of the site to urban areas.

The occurrence of the Lord Howe Island ship rat is not applicable to this site.

h) whether any threatened species, population or ecological community is at the limit of its known distribution

No threatened species, either recorded at the site or expected to occur as a vagrant, is near the southern extreme of its known range.

6.1 Conclusion

Based on available information:

- No viable populations of the species detailed under (a) are likely to be placed at risk of extinction by the proposal to develop the site for residential housing.
- The viability of endangered populations will not be significantly compromised by the proposal.
- No regionally significant area of known habitat will be removed as a result of the proposed development.
- No known habitat for threatened species will become isolated as a result of the proposed development.
- No Critical Habitat will be affected as a result of the proposed development.
- The proposed development is not a key threatening process under Schedule 3 of the TSC Act, and threatening processes listed under the TSC Act are not likely to increase as a result of this development.
- Threatened fauna that may seasonally or opportunistically occur at the site are not at the extreme of their known geographical range.

7.0 REFERENCES

Beadle, N.C.W. and A.B. Costin 1952 Ecological Classification and Nomenclature. *Proc. Linn. Soc. of NSW* 77: 61-82.

Briggs, J.D. and J.H. Leigh 1996 *Rare or threatened Australian plants.* CSIRO, Canberra.

Harden, G. J., 2002. *Flora of New South Wales, Volume 2.* NSW University Press.

Law, B.S. 1993 Roosting and foraging ecology of the Queensland blossom bat (*Syconycteris australis*) in north-eastern NSW: Flexibility in response to seasonal variation. *Wildl. Res.* 20: 419-431.

Law, B.S. 1994 *Banksia* nectar and pollen: Dietary items affecting the abundance of the common blossom bat, *Syconycteris australis*, in south-eastern Australia. *Aust. J. of Ecol.* 19: 425-434.

Law, B.S. and H.J. Spencer 1995 Common blossom bat, *Syconycteris australis*, (Peters, 1867). (In) Strahan, R. (ed) *Mammals of Australia* pp. 423-425. The Australian Museum and Reed Books, Sydney.

NPWS 1995 *Vertebrates of upper north-east NSW.* A report by the NSW National Parks and Wildlife Service to the Natural Resources Audit Council. Publ. National Parks and Wildlife Service.

Parnaby, H. 1992 An interim guide to the identification of insectivorous bats of south-eastern Australia. *Technical Reports of the Australian Museum* No.8. Pp. 1031-8062.

Pizzey, G. and F. Knight 1997 *Field guide to the birds of Australia.* Angus and Robertson, Sydney.

Reinhold L, Law, B. Ford, G. and M. Pennay 2001 *Key to bat calls of south-east Queensland and north-east NSW.* Publ. Queensland Department of Natural Resources and Mines.

Sheringham P., and J. Westaway 1995 *Significant vascular plants of upper north-east NSW.* A report by the NSW National Parks and Wildlife Service for the Natural Resources Audit Council. NPWS, NSW.

Walker, J. and M. S. Hopkins 1990 Vegetation in *Australian soil and land survey field handbook* ed by R. C. McDonald, R. F. Isbell, J. G. Speight, J. Walker and M. S. Hopkins. Inkata Press: Melbourne.

APPENDIX 1:

VEGETATION

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
FERNS							
ASPLENIACEAE							
Asplenium australasicum	bird's-nest fern	x					
BLECHNACEAE							
Blechnum cartilagineum	gristle fern	x					
Doodia aspersa	rasp fern	x					
DENNSTAEDTIACEAE							
Hypolepis muelleri	harsh ground fern	x					
Pteridium esculentum	bracken	x			x		x
DICKSONIACEAE							
Calochlaena dubia	common ground fern	x					
POLYPODIACEAE							
Microsorum diversifolium	kangaroo fern	x					
Platycerium bifurcatum	elk-horn fern	x					
Pyrrosia rupestris	rock felt-fern	x					
ANGIOSPERMS (Flowering plants)							
Monocotyledons							
(palms, palm-lilies and cycads)							
AGAVACEAE							
Cordyline stricta	narrow-leaf palm lily	x					
AMARYLLIDACEAE							
Crinum pedunculatum	swamp lily	x	x				
ARACEAE							
Alocasia brisbanensis	cunjevoi	x					
Gymnostachys anceps	settler's flax	x					
ARECACEAE							
Archontophoenix cunninghamiana	bangalow palm	x					
Livistona australis	cabbage palm	x					
ASPARAGACEAE							
**Protasparagus aethiopicus*	asparagus fern	x					
**Protasparagus africanus*	climbing asparagus fern	x					
BAMBUSOIDEAE							
**Bambusa* sp	bamboo				x		
COMMELINACEAE							
Commelina cyanea	scurvy weed	x					
CYPERACEAE							
Cyperus polystachos	bunchy flat sedge		x				x
Eleocharis sphacelata	spike rush				x		
Fimbristylis dichotoma	fringe rush				x		
Gahnia aspersa	red-fruited saw sedge	x					
Gahnia clarkei	tall sawsedge	x					
Isolepis nodosus	a sedge					x	
Lepidosperma laterale	sword sedge	x					
DIOSCOREACEAE							
Dioscorea transversa	native yam	x					

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
FLAGELLARIACEAE							
Flagellaria indica	whip vine	x					
JUNCACEAE							
Juncus usitatus	tussock rush				x		
MENISPERMACEAE							
Sarcopetalum harveyanum	pearl vine	x					
ORCHIDACEAE							
Calanthe triplicata	Christmas orchid	x					
Cymbidium madidum	northern cymbidum	x					
Dendrobium aemulum	ironbark orchid	x					
PHILYDRACEAE							
Philydrum lanuginosum	wooly frogmouth				x		
POACEAE							
**Axonopus affinis*	broad-leaved carpet grass						x
** Briza maxima*	quaking grass						x
Cynodon dactylon	couch						x
Imperata cylindrica var. *major*	blady grass				x		x
Oplismenus imbecillis	basket grass	x					
**Paspalum dilatatum*	paspalum						x
**Pennisetum clandestinum*	kikuyu						x
**Setaria palmifolia*	palm grass						x
**Setaria sphacelata*	canary seed grass						x
**Sorghum bicolor*	sorghum						x
Spinifex sericeus	hairy spinifex					x	
**Sporobolus indicus* var. *capensis*	Parramatta grass						x
Themeda australis	kangaroo grass						x
RIPOGONACEAE							
Ripogonum album	white supplejack	x					
SMILACACEAE							
Smilax australis	austral sarsparilla	x					
TYPHACEAE							
Typha orientalis	broad-leaved cumbungi				x		
XANTHORRHOEACEAE							
Lomandra hystrix	lomandra	x					
Lomandra longifolia	matrush	x				x	
Dicotyledons							
ANACARDIACEAE							
Euroschinus falcata var. *falcata*	ribbonwood	x					
APIACEAE							
Hydrocotyle bonariensis		x				x	
APOCYNACEAE							
Melodinus australis	southern melodinus	x					
Parsonsia straminea	common silkpod	x					
ASCLEPIADACEAE							
**Asclepias curvassica*	redhead cotton bush				x		
Hoya australis	native hoya	x					

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
**Gomphocarpus fruiticocus*	narrow-leaf cotton-bush				x		
Tylophora paniculata	thin-leaved tylophora	x					
ASTERACEAE							
**Ageratina adenophora*	crofton weed				x		
**Biddens pilosa*	cobbler's pegs				x		x
**Chrysanthemoides monilifera* spp. *rotundata*	bitou bush				x	x	x
** Hypochoeris radicata*	flatweed						x
CAESALPINIACEAE							
**Senna pendula*	winter senna	x					
**Senna floribunda*	smooth cassia	x					
CAPPARIDACEAE							
Capparis arborea	brush caper berry	x					
CELASTRACEAE							
Cassine australis var. *australis*	red olive plum	x					
CASUARINACEAE							
Casuarina glauca	swamp she-oak		x				
Casuarina equisitifolia var. incarna	horse-tail oak					x	
CELASTRACEAE							
Denhamia celastroides	denhamia	x					
DILLENIACEAE							
Hibbertia scandens	twining guinea flower	x					
Hibbertia vestita	hairy guinea flower				x		
EBENACEAE							
Diospyros australis	black plum	x					
Diospyros fasciculosa	grey ebony	x					
ELAEOCARPACEAE							
Elaeocarpus obovatus	hard quandong	x					
EPACRIDACEAE							
Leucopogon parviflorus	beach beard-heath					x	
Trochocarpa laurina	tree heath			x			
ESCALLONIACEAE							
Quintinia verdonii	grey possumwood	x					
EUPHORBIACEAE							
Alchornea ulicifolia	native holly	x					
Breynia oblongifolia	breynia	x					
Bridelia exaltata	brush ironbark	x					
Claoxyon australe	brittlewood	x					
Drypetes australasica	yellow tulip	x					
Glochidion ferdinandii var. ferdinandii	cheese tree	x			x		
Omalanthus populifolius	bleeding heart				x		
EUPOMATIACEAE							
Eupomatia laurina	bolwarra	x					
FABACEAE							
Subfamily FABOIDEAE							
Hardenbergia violacea	hardenbergia			x			

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
LAURACEAE							
Cassytha glabella forma glabella	devil's twine			x			
**Cinnamomum camphora*	camphor laurel	x					
Cinnamomum virens	red-barked sassafras	x					
Cryptocarya triplinervis var. *triplinervis*	three-veined cryptocarya	x					
Cryptocarya rigida	rose maple	x					
Endiandra discolor	rose walnut	x					
Endiandra sieberi	hard corkwood	x					
Litsea reticulata	bollygum	x					
Neolitsea australiensis	green bollygum	x					
LOBELIACEAE							
Pratia purpurascens	common white root	x					
LORANTHACEAE							
Amylotheca dictyopleba	brush mistletoe	x					
MALVACEAE							
**Hibiscus splendens*	pink hibiscus	x					
**Sida rhombifolia*	Paddy's lucerne	x					
MELIACEAE							
Synoum glandulosum	scentless rosewood	x					
MENISPERMACEAE							
Stephania japonica var. *discolour*	snake vine	x			x		
MIMOSOIDEAE							
Acacia sp.				x	x		
Acacia melanoxylon	blackwood	x			x		
Acacia sophorae	beach sally wattle				x	x	
MONIMIACEAE							
Wilkiea heugliana	veiny wilkiea	x					
MORACEAE							
Ficus rubiginosa	rusty fig						x
Ficus watkinsiana	strangler fig	x					
Maclura cochinchinensis	cockspur thorn	x					
MYRSINACEAE							
Rapanaea variabilis	muttonwood	x					
MYRTACEAE							
Acmena hemilampra	broad-leaved lilly pilly	x					
Acmena smithii	lilly pilly	x					
Callistemon saligna	pink-tipped bottlebrush	x	x				
Eucalyptus siderophloia	grey ironbark	x		x			
Lopohostemon confertus	brushbox	x		x			
Melaleuca quinquenervia	broad-leaved paperbark	x	x				
Rhodamnia rubescens	brush turpentine	x					
Rhodomyrtus psidioides	native guava	x					
Tristaniopsis laurina	water-gum	x	x				
MUSACEAE							
**Musa paradisiaca*	banana				x		

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
OLEACEAE							
Notelaea longifolia form glabra	large mock-olive	x					
PASSIFLORACEAE							
**Passiflora subpeltata*	White's passionflower		x		x		
PITTOSPORACEAE							
Citriobatus pauciflorus	orange thorn	x					
PLANTAGINACEAE							
**Plantago gaudichaudii*	narrow-leaf plantain				x		x
POLYGONACEAE							
Periscaria strigosa	slender knotweed		x		x		
PROTEACEAE							
Banksia integrifolia var. *integrifolia*	coast banksia	x			x	x	
Banksia serrata	saw-tooth banksia	x					
Macadamia tetraphylla 1(2VC-) 8S	rough-shelled bush nut				x		
Stenocarpus salignus	scrub beefwood	x					
RANUNCULACEAE							
Clematis glycinoides	forest clematis						
Ranunculus inundatus	river buttercup						
RHAMNACEAE							
Alphitonia excelsa	red ash			x			
ROSACEAE							
Rubus hillii	molucca bramble	x					
RUBIACEAE							
Canthium coprosmoides	coast canthium	x					
Morinda jasminoides	morinda	x					
Pomax umbellata	pomax				x		
Psychotria loniceroides	hairy psychotria	x					
RUTACEAE							
Acronychia imperforata	beach acronychia	x					
Acronychia wilcoxiana	silver aspen	x					
**Citrus limon*	bush lemmon				x		
Phebalium squamulosum	silver basswood	x					
SANTALACEAE							
Exocarpus latifolius 8S	broad-leaved ballart	x					
SAPINDACEAE							
Alectryon coriaceus	beach alectryon	x				x	
Arytera divaricata	coogera	x					
Guioa semiglauca	guioa	x					
Sarcopteryx stipata	steelwood	x					
Toechima dasyrrhache	blunt-leaved steelwood	x					
SAPOTACEAE							
Planchonella australis	black apple	x					
SOLANACEAE							
Duboisia myoporoides	duboisia	x					
**Solanum mauritianum*	wild tobacco				x		

Appendix 1: Vegetation

Scientific name	Common name	littoral rainforest	swampforest	open forest	banksias, regrowth, creek & farm dam	frontal dune complex	grassland
** introduced or naturalised*							
**Solanum seaforthianum*	climbing nightshade			x			
STERCULIACEAE							
Commersonia bartramia	brown kurrajong	x			x		
SYMPLOCACEAE							
Symplocos stawellii	white hazlewood	x					
ULMACEAE							
Aphananthe philippinensis	rough-leaved elm	x					
URTICACEAE							
Dendrocnide photinophylla	shining-leaved stinging tree	x					
VERBENACEAE							
Clerodendrum floribundum	smooth clerodendrum	x					
** Lantana camara*	lantana	x	x		x		
**Verbena bonariensis*	purpletop						x
VIOLACEAE							
Viola hederaceae	native violet	x					
VITIDACEAE							
Cissus antarctica	watervine	x					
Cissus hypoglauca	five-leaf water vine	x					
Cissus sterculifolia	long-leaf watervine	x					

APPENDIX 2:

FAUNA

Appendix 2: Fauna

Scientific name	Common name	recorded	expected
* : introduced species; # threatened species			
MAMMALS			
CANIDAE			
*Canis familaris**	dog	x	
*Vulpes vulpes**	fox		x
DASYURIDAE			
Antechinus stuartii	brown antechinus	x	
EMBALLONONEURIDAE			
Saccolaimus flaviventris#	yellow-bellied sheath-tail bat		x
FELIDAE			
*Felis catus**	feral cat		x
MACROPODIDAE			
Macropus giganteus	eastern grey kangaroo	x	
Wallabia bicolor	swamp wallaby	x	
MOLOSSIDAE			
Nyctinomus australis	white-striped mastiff bat		x
MURIDAE			
*Mus musculus**	house mouse		x
Rattus fuscipes	bush rat	x	
Rattus lutreolus	swamp rat		?
*Rattus rattus**	black rat	x	
PERAMELIDAE			
Isoodon macrourus	northern brown bandicoot	x	
PETAURIDAE			
Pseudocheirus peregrinus	common ringtail possum		?
PHALANGERIDAE			
Trichosurus vulpecula	common brushtail possum		x
PTEROPODIDAE			
Pteropus poliocephalus	grey-headed flying-fox	x	
Syconycteris australis #	Queensland blossom-bat	x	
RHINOLOPHIDAE			
Rhinolophus megaphyllus	eastern horse-shoe bat	x	
TACHYGLOSSIDAE			
Tachyglossus aculeatus	short-beaked echidna		x
VESPERTILIONIDAE			
Chalinolobus gouldii	Gould's wattled bat		x
Miniopteris australis#	little bent-wing bat	x	
Miniopteris schreibersii#	large bent-wing bat		?
Scoteanax rueppellii#	greater broad-nosed bat		x
Scotorepens orion	eastern broad-nosed bat	x	
Vespadelus pumilus	the eastern forest bat	x	
Vespadelus vulturnus	little forest bat	x	

Appendix 2: Fauna

Scientific name	Common name	recorded	expected
* : introduced species; # threatened species			
BIRDS			
ACANTHIZIDAE			
Gerygone olivacea	white-throated gerygone	x	
Sericornis frontalis	white-browed scrubwren	x	
Sericornis magnirostris	large-billed scrubwren		x
ACCIPITRIDAE			
Accipiter cirrhocephalus	collared sparrowhawk		x
Accipiter fasciatus	brown goshawk		x
Accipiter novaehollandiae	grey goshawk		x
Aquila audax	wedge-tailed eagle		x
Aviceda subcristata	pacific baza		x
Circus approximans	swamp harrier	x	
Circus assimilis	spotted harrier		x
Elanus notatus	black-shouldered kite	x	
Haliaeetus leucogaster	white-bellied sea-eagle	x	
Hieraaetus morphnoides	little eagle		x
Milvus indus	brahminy kite	x	
Milvus sphenurus	whistling kite	x	
AEGOTHELIDAE			
Aegotheles cristatus	Australian owlet-nightjar		x
ALCEDINIDAE			
Alcedo azurea	azure kingfisher		x
Dacelo novaeguineae	laughing kookaburra	x	
Todiramphus macleayii	forest kingfisher		x
Todiramphus sanctus	sacred kingfisher		x
ANATIDAE			
Anas castanea	chestnut teal		x
Anas gibberifrons	grey teal		x
Anas platyrhynchos	mallard		x
Anas superciliosa	Pacific black duck	x	
Chenonetta jubata	maned duck	x	
ANHINGIDAE			
Anhinga melanogaster	darter	x	
APODIDAE			
Aerodramus spodiopygius	white-rumped swiftlet		x
Apus pacificus	fork-tailed swift	x	
Hirundapus caudacutus	white-throated needletail		x
ARDEIDAE			
Ardea ibis	cattle egret		x
Ardea intermedia	intermediate egret		x
Ardea novaehollandiae	white-faced heron	x	
ARTAMIDAE			
Artamus leucorhynchus	white-breasted woodswallow	x	
CAMPEPHAGIDAE			
Coracina novaehollindiae	black-faced cuckoo-shrike	x	
Coracina tenuirostris	cicadabird		x
Lalage leucomela	varied triller	x	

Appendix 2: Fauna

Scientific name	Common name	recorded	expected
* : introduced species; # threatened species			
CAPRIMULGIDAE			
Caprimulgus mystacalis	white-throated nightjar		x
CHARADRIIDAE			
Vanellus miles	masked lapwing	x	
COLUMBIDAE			
Chalcophaps indica	emerald ground-dove		x
Columba leucomela	white-headed pigeon		x
Columba livia *	feral pigeon		x
Geopelia humeralis	bar-shouldered dove		x
Geopelia placida	peaceful dove		x
Geophaps lophotes	crested pigeon	x	
Lopholaimus antarcticus	topknot pigeon		x
Macropygia amboinensis	brown cuckoo-dove		x
Ptilinopus regina#	rose-crowned fruit-dove		x
*Streptopelia chinensis**	spotted turtle-dove	x	
CORACIIDAE			
Eurystomus orientalis	dollarbird	x	
CORVIDAE			
Corvus orru	torresian crow	x	
CRACTICIDAE			
Cracticus nigrogularis	pied butcherbird	x	
Cracticus torquatus	grey butcherbird	x	
Gymnorhina tibicen	Australian magpie	x	
Strepera graculina	pied currawong	x	
CUCULIDAE			
Cacomantis flabelliformis	fan-tailed cuckoo		x
Centropus phasianinus	pheasant coucal		x
Chrysococcyx basalis	horsfield's bronze-cuckoo		x
Chrysococcyx lucidus	shining bronze-cuckoo		x
Chrysococcyx minutillus	little bronze-cuckoo		x
Eudynamys scolopacea	common koel		x
DICAEIDAE			
Dicaeum hirundinaceum	mistletoe bird		x
DICRURIDAE			
Dicrurus bracteatus	spangled drongo	x	
FALCONIDAE			
Falco berigora	brown falcon		x
Falco cenchroides	Australian kestrel		x
Falco longipennis	Australian hobby		x
GRALLINIDAE			
Grallina cyanoleuca	Australian magpie-lark	x	
HIRUNDINIDAE			
Hirundo ariel	fairy martin		x
Hirundo neoxena	welcome swallow	x	
Hirundo nigricans	tree martin		x

Appendix 2: Fauna

Scientific name	Common name	recorded	expected
* : introduced species; # threatened species			
MALURIDAE			
Malurus cyaneus	superb fairy-wren		x
Malurus lamberti	variegated fairy-wren	x	
Malurus melanocephalus	red-backed fairy-wren		x
MEGAPODIIDAE			
Alectura lathami	Australian brush-turkey		x
MELIPHAGIDAE			
Acanthorhynchus tenuirostris	eastern spinebill		x
Anthochaera chrysoptera	brush (little) wattlebird	x	
Lichmera indistincta	brown honeyeater		x
Manorina melanocephala	noisy miner	x	
Meliphaga lewinii	Lewin's honeyeater	x	
Melithreptus albogularis	white-throated honeyeater		x
Myzomela sanguinolenta	scarlet honeyeater		x
Philemon citreogularis	little friarbird	x	
Philemon corniculatus	noisy friarbird	x	
Phylidonyris nigra	white-cheeked honeyeater	x	
MEROPIDAE			
Merops ornatus	rainbow bee-eater		x
MOTACILLIDAE			
Anthus novaeseelandiae	Richard's pipit	x	
ORIOLIDAE			
Oriolus sagittatus	olive-backed oriole	x	
Sphecotheres viridis	figbird		x
ORTHONYCHIDAE			
Psophodes olivaceus	eastern whipbird	x	
PACHYCEPHALIDAE			
Colluricincla harmonica	grey shrike-thrush	x	
Colluricincla megarhyncha	little shrike-thrush		x
Eopsaltria australis	eastern yellow robin	x	
Monarcha melanopsis	black-faced monarch		x
Monarcha trivirgatus	spectacled monarch		x
Myiagra inquieta	restless flycatcher		x
Myiagra rubecula	leaden flycatcher		x
Pachycephala pectoralis	golden whistler	x	
Pachycephala rufiventris	rufous whistler		x
Petroica rosea	rose robin		x
Rhipidura fuliginosa	grey fantail		x
Rhipidura leucophrys	willie-wagtail	x	
Rhipidura rufifrons	rufous fantail		x
PARDALOTIDAE			
Pardalotus striatus	striated pardalote		x
PHALACROCORACIDAE			
Phalacrocorax sulcirostris	little black cormorant		x
Phalacrocorax varius	pied cormorant		x
Phalocrocorax melanoleucos	pied cormorant		x

Appendix 2: Fauna

Scientific name	Common name	recorded	expected
* : introduced species; # threatened species			
PHASIANIDAE			
Coturnix ypsilophora	brown quail	x	
PLATALEIDAE			
Threskiornis molucca	Australian white ibis		x
Threskiornis spinicollis	straw-necked ibis		x
PLOCEIDAE			
Neochmia temporalis	red-browed finch	x	
PODARGIDAE			
Podargus strigoides	tawny frogmouth		x
PSITTACIDAE			
Alisterus scapularis	Australian king parrot		x
Cacatua galerita	sulphur-crested cockatoo		x
Cacatua roseicapilla	galah		x
Calyptorhynchus funereus	yellow-tailed black cockatoo		x
Platycercus eximius	eastern rosella		x
Trichoglossus chlorolepiotus	scaly-breasted lorikeet	x	
Trichoglossus haematodus	rainbow lorikeet	x	
STRIGIDAE			
Ninox boobook	southern boobook		x
SYLVIIDAE			
Megalurus gramineus	little grassbird		x
Megalurus timoriensis	tawny grassbird		x
ZOSTEROPIDAE			
Zosterops lateralis	silvereye		x
REPTILES			
AGAMIDAE			
Physignathus lesueurii	eastern water dragon	x	
Pogona barbata	bearded dragon		x
BOIDAE			
Morelia spilota	carpet python		x
CHELIDAE			
Chelodina longicollis	long-necked tortoise	x	
COLUBRIDAE			
Boiga irregularis	brown tree snake		x
Dendrelaphis punctulata	green tree snake		x
ELAPIDAE			
Demansia psammophis	yellow-faced whip snake		x
Furina diadema	red-naped snake		x
Pseudechis porphyriacus	red-bellied blacksnake		x
Pseudonaja textilis	eastern brown snake	x	
SCINCIDAE			
Anomalopus verreauxii			x
Ctenotus robustus	striped skink		x
Eulamprus quoyii	eastern water skink		x

Appendix 2: Fauna

Scientific name	Common name	recorded	expected
* : introduced species; # threatened species			
Lampropholis delicata	eastern grass skink	x	
Lampropholis guichenoti	garden skink		x
Ophioscincus truncatus	yellow-bellied legless lizard		x
Saiphos equalis	three-toed skink	x	
Saproscincus challengeri	challenger skink		x
Tiliqua scincoides	eastern blue-toungued lizard		x
TYPHLOPIDAE			
Ramphotyphlops nigriscens	a blind snake		x
VARANIDAE			
Varanus varius	lace monitor	x	
AMPHIBIANS			
HYLIDAE			
Litoria fallax	eastern dwarf frog	x	
L. nasuta	rocket frog		x
L. peronii	Peron's tree frog		x
MYOBATRACHIDAE			
Adelotus brevis	tusked frog		x
Crinia signifera	common eastern froglet	x	
Limnodynastes ornatus	ornate burrowing frog		x
Limnodynastes peronii	brown-striped frog	x	
L. tasmaniensis	spotted grass frog		x
L. terraereginae	northern banjo frog		x
Pseudophryne coriacea	red-backed toadlet	x	
Uperlois fusca	dusky toadlet	x	