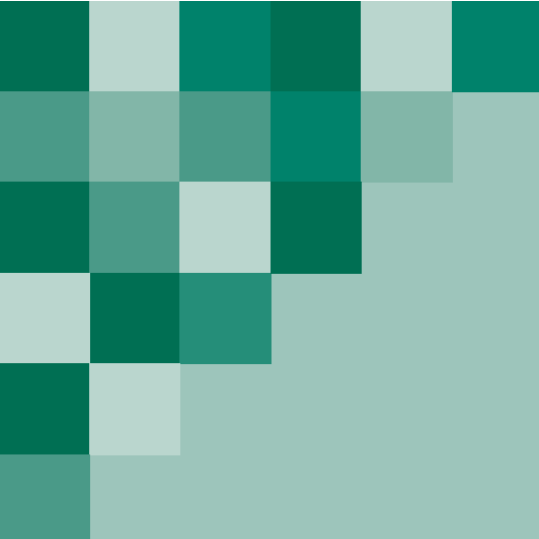




Environmental

Services

FINAL REPORT **Threatened Biodiversity Survey &** **Assessment**

Rezoning Investigations

Nebraska Estate

St Georges Basin

Shoalhaven City Council

November 2009

Our Reference: E1060461

FINAL REPORT

THREATENED BIODIVERSITY SURVEY & ASSESSMENT

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Rezoning Investigations

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Shoalhaven

Prepared November 2009

for

Shoalhaven City Council

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Acronyms

DECCW	Department of Environment, Climate Change and Water
DP	Deposited Plan
EPBC Act	Environment Protection and Biodiversity Conservation Act, 1999
FM Act	Fisheries Management Act, 1994
GIS	Geographic Information System
GPS	Global Positioning System
JBREP	Jervis Bay Regional Environmental Plan, 1996
PFC	Projected Foliage Cover
ROTAP	Rare or Threatened Australian Plants
SEPP	State Environmental Planning Policy
SLEP	Shoalhaven Local Environmental Plan, 1985
TSC Act	Threatened Species Conservation Act, 1995

EXECUTIVE SUMMARY

This report has described the biological environment of land comprising Nebraska Estate, St. Georges Basin, with particular focus on threatened biodiversity values. The overall aim of the study was to identify species, communities and habitats of high conservation value, in order to inform the rezoning process currently being undertaken by Shoalhaven City Council.

The existing environment was examined in detail from a literature review and from data gathered during fieldwork between December 2006 and May 2008. Flora and fauna surveys resulted in the detection of 155 flora species and 94 fauna species in the study area.

Three vegetation communities were recorded in the study area: Currambene Lowlands Forest, Coastal Sand Swamp Forest, and Coastal Sand Forest. One endangered ecological community listed on the *TSC Act*, *Swamp sclerophyll forest on coastal floodplains in the North Coast, Sydney Basin and South East Corner bioregions*, was identified in the parts of the study area comprising the vegetation mapped as Coastal Sand Swamp Forest.

Eight threatened fauna species were recorded in the study area during the survey period: the East Coast Freetail Bat *Mormopterus norfolkensis*, Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Gang-gang Cockatoo *Callocephalon fimbriatum*; Glossy Black-cockatoo *Calyptorhynchus lathami*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Grey-headed Flying-fox *Pteropus poliocephalus*, Powerful Owl *Ninox strenua* and Yellow-bellied Glider *Petaurus australis*.

All of these threatened fauna species are listed as Vulnerable on Schedule 2 of the *NSW Threatened Species Conservation Act 1995*. The Grey-headed Flying-fox is also listed as Vulnerable on the Schedules of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

Two threatened flora species were recorded in the study area: the Biconvex Paperbark *Melaleuca biconvexa* and Leafless Tongue Orchid *Cryptostylis hunteriana*. These threatened flora species are listed as Vulnerable under both the *NSW Threatened Species Conservation Act 1995* and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

One migratory species listed on the schedules of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* was recorded within the study area, the Black-faced Monarch *Monarcha melanopsis*.

One non-threatened flora species of particular conservation significance was recorded in the study area. The recently described orchid *Speculantha ventricosa* is currently only known to occur within the vicinity of St. Georges Basin, at Nebraska Estate and near Sussex Inlet.

The study area does not contain any potential Koala habitat pursuant to *NSW State Environmental Planning Policy No 44 – Koala Habitat Protection*.

The riparian vegetation of the study area was found to be of high conservation value, containing both the *Swamp sclerophyll forest* endangered ecological community and large numbers of the threatened plant *Melaleuca biconvexa*. Other areas of high conservation value include habitat for the orchids *Cryptostylis hunteriana* and *Specularantha ventricosa* in the north east of the estate.

Most of the study area is defined as part of an east-west 'disturbed habitat and vegetation' corridor under Clause 15 of the Jervis Bay Regional Environment Plan and provides important connectivity for species and habitats in the study area. Other ecological constraints to development of the study area include foraging resources for threatened species such as the Glossy Black-cockatoo and Yellow-bellied Glider, and a number of hollow-bearing trees.

While substantial parts of the study area contain high level ecological constraints and should not be developed further, it is considered possible to allow limited development in the remaining areas provided other significant biodiversity values are not substantially impacted.

Recommendations to further protect significant biodiversity values of Nebraska Estate are made in this report.

1. INTRODUCTION

1.1 Background

This report has been prepared by Bushfire and Environmental Services (BES) at the request of Shoalhaven City Council, to investigate the flora, fauna and habitat values associated with Nebraska Estate, St. Georges Basin, and to identify areas of conservation significance which should be protected. The outcomes of this report will inform the rezoning investigations currently being undertaken by Council.

The study area comprises a total of approximately 33 ha located north of the St. Georges Basin water body, between the townships of St. Georges Basin and Basin View, as shown in Figure 1 (Appendix A). The study area comprises 96 allotments from the Nebraska Estate subdivision which was registered in 1919. Lot sizes range from approximately 0.2 ha to 1.2 ha. Approximately 16 of these lots contain dwellings and/or other structures, although only five of the dwellings or structures in the study area are authorised. Shoalhaven City Council owns seven lots in the study area with a combined area of approximately 2.66 ha.

This report is the outcome of flora and fauna survey work and desktop analyses undertaken by BES between December 2006 and May 2008.

1.2 The Study Area and Locality

The study area for the purposes of this report is the part of Nebraska Estate shown in Figure 1 (Appendix A).

The study area is located at St. Georges Basin, approximately 30 km south of Nowra and 0.5 km north of the St. Georges Basin water body. The study area contains approximately 33 ha of disturbed bushland containing several forest communities. The Estate is generally bounded to the:

- North by largely undeveloped rural properties;
- East by partially developed rural land and smaller developed properties on Park Road;
- South by developed residential properties and The Wool Road; and
- West by developed residential properties of St. Georges Basin and the Grange Road.
Largely undeveloped rural land lies to the west of the Grange Road.

The study area is currently zoned Rural 1(d)(General Rural) and Rural 1(g)(Flood Liable) under the provisions of the SLEP. The erection of dwelling houses on individual allotments of less than 40 ha is generally not permissible.

Land situated within 50 m of the Grange Road is identified as a Scenic Preservation Area pursuant to clause 41 of SLEP. Land within the study area north of Pelican Road is identified as 'Land of Ecological Sensitivity' pursuant to clause 21 of the SLEP. Land within the study area north of Fisherman Road is identified as "disturbed habitat and vegetation" (corridor) under the provisions of clause 15 of the Jervis Bay Regional Environmental Plan 1996 (JBREP). The entire study area is also covered by the Coastal Zone under State Environmental Planning Policy Number 71: Coastal Protection.

The term "locality" for the purposes of this report describes the land within an area of 10 km x 10 km centred on the study area.

1.3 Aim and Objectives

The aim of this study was to investigate the ecological attributes of the study area and assess their conservation values to inform the rezoning process currently being undertaken by Council.

The objectives of this study were to:

1. identify and describe the vegetation communities present in the study area and their conservation significance;
2. identify and describe the presence and condition of fauna habitats within the study area;
3. identify and map the threatened fauna species and other significant fauna species which are found to occur in the study area;
4. identify and map the threatened flora species and other significant flora species in the study area;
5. identify and map vegetation and habitat significant for the survival of threatened species and communities;
6. determine whether the study area provides potential or core Koala habitat pursuant to *NSW State Environmental Planning Policy No. 44 – Koala Habitat Protection*;
7. identify ecological constraints to development;
8. provide recommendations to protect any significant biodiversity values;
9. indicate whether residential development of individual lots is feasible in respect of threatened biodiversity constraints;
10. advise Council on how the Estate's flora and fauna connectivity value can be maintained whilst maximising residential development constraints; and
11. to obtain comment on the potential rezoning of the study area by way of written correspondence from the Department of Environment and Climate Change, Department

of Primary Industries (Fisheries), Department of Water and Energy and the Department of the Environment, Water, Heritage and the Arts.

1.4 Consultation

Consultation was undertaken in writing with Department of Environment and Climate Change, Department of Primary Industries (Fisheries), Department of Water and Energy and the Commonwealth Department of the Environment, Water, Heritage and the Arts.

Only the NSW Department of Planning provided a written response and a copy is provided in Appendix B. The two issues raised in this response related to threatened biodiversity investigations being in accordance with the JBSS and recommending consultation with the DECC (now DECCW).

Council sought DECCW's comment on the Final Draft Threatened Biodiversity Survey and Assessment Report on 22 February 2009. DECCW's response dated 25 August 2009 is provided in Appendix C. In summary, DECCW considers the methods and techniques used in the study adequate to achieve the aims of identifying areas of high conservation value, and that the report will generally provide a sound basis on which to make informed biodiversity decisions on the areas suitable for additional development of the land. DECCW concurs with the main conclusion of the report, which is that development of all existing lots is not appropriate, but limited further development could proceed while maintaining key biodiversity values.

Based on its interpretation of the report, DECCW provided a map outlining areas which should not be developed further. Council subsequently sought clarification from DECCW in relation to the buffers. DECCW's response dated 11 November 2009 is included in Appendix C. The areas considered unsuitable for development by DECCW are indicated in Figure 7.

2. METHODOLOGY

2.1 Review of Existing Data

A review of relevant information was undertaken at various times during the project, which involved:

- a) reviewing available literature including relevant flora and fauna studies, legislation, environmental planning instruments, topographic maps, and aerial photographs of the study area;
- b) searching the Atlas of NSW Wildlife for threatened flora and threatened fauna species recorded in the locality; and
- c) searching the Commonwealth Environment Protection & Biodiversity Conservation Act Protected Matters Search Tool for matters of national environmental significance recorded in the locality.

2.2 Flora Survey Methods

Detailed botanical surveys were conducted by BES in the study area from December 2006 to September 2007. An additional survey for *Specularantha ventricosa* was undertaken during May 2008.

Community Identification and Floristic Audit

The Random Meander technique documented by Cropper (1993) was used across the study area in general, to document the flora species present, including those of conservation significance, and the location and extent of vegetation patterns and distribution. The study area was initially partitioned on the basis of broad vegetation structural groups. These structural groups were then sampled to assess floristic and structural detail. Sampling intensity was based on the size of the structural groups and the variation in landform position.

Six 20m x 20m quadrats were surveyed as representative sites within vegetation structural groups within the study area. For each quadrat the following information was recorded:

- Location using a hand held GPS unit;
- Full list of vascular plant species;
- Modified cover-abundance score (1-5);
- Dominant species for each stratum present; and
- Landform description including soil type, landscape position, slope and aspect.

A general description of the vegetation was then prepared based on structural characteristics and dominant species in accordance with Walker and Hopkins (1990) and Specht (1970). These

techniques were used to classify and name the vegetation communities. The boundaries of vegetation communities were marked onto a plan of the study area using a combination of GPS field data and aerial photography.

The vegetation communities recorded in the study area were compared with the Final Determinations of the NSW Scientific Committee to ascertain whether the communities were components of listed threatened ecological communities.

Targeted Orchid Surveys

Specific searches for Bauer's Midge Orchid *Genoplesium baueri*, the Leafless Tongue Orchid *Cryptostylis hunteriana*, the Tessellated Spider Orchid *Caladenia tessellata*, the Jervis Bay Leek Orchid *Prasophyllum affine* and *Specularantha ventricosa* were conducted by a team of experienced surveyors systematically walking along parallel transects approximately 5-10m apart, targeting areas of suitable or potential habitat (Figure 2, Appendix A). A more intensive search was undertaken if any individuals of target species were found, to determine relatively accurate numbers and distribution. These targeted surveys were undertaken between November 2006 and October 2007. Specific dates and survey efforts are detailed in Table 1. Surveys for *Specularantha ventricosa* were repeated during May 2008 to increase the understanding of the species' abundance and distribution in the study area, as at that time, the species was not known from beyond the study area.

A variation to the above methodology was required for the Eastern Underground Orchid *Rhizanthella slateri* because the species is almost completely subterranean and appears to prefer locations around the base of tree species such as Scribbly Gum *Eucalyptus sclerophylla*. Transects through potential habitat approximately 100m apart were followed, and the leaf-litter around the bases of trees within 5m either side of the transect were carefully raked back to a distance of up to 2m from the base of the tree while searching for evidence of flowers and stems. Surveys for this species were undertaken in October 2007.

All individuals or clusters of target orchid species located during the survey period were marked with coloured flagging tape and the location was recorded using Garmin Gecko 301 Global Positioning System.

Other targeted flora surveys

Targeted searches for the Biconvex Paperbark *Melaleuca biconvexa*, Tangled Bedstraw *Galium australe* and Magenta Lilly Pilly *Syzygium paniculatum* were conducted using a combination of random meander and systematic searches along defined transects through areas of suitable habitat. The most suitable habitat for these species within the study area was considered primarily to occur close to drainage lines and searches focused on these areas, although other habitat was also searched at lower intensities. The extent of the *Melaleuca biconvexa*

distribution and isolated individuals beyond this distribution were mapped via a hand-held Garmin Gecko 301 GPS. Specific dates and survey efforts are detailed in Table 1.

Limitations

The community identification and floristic survey was designed primarily to determine vegetation community classification, extent and distribution. Due to the relatively small size of the survey area, stratification was based on previous vegetation mapping boundaries for the selection of random walks and quadrat survey locations. Multivariate data analysis was not undertaken due to the relatively small number of quadrats. Selection of sites for random walks and quadrats was subjectively made based on placing survey points within relatively homogeneous units.

The limitations of these methods include potential bias in site selection, not detecting full variation in vegetation patterns and distribution, and subjective classification of the vegetation communities. However, these limitations are considered acceptable given the size of the survey area and the purpose of the survey in identifying ecological constraints in regard to rural residential planning and management.

Nomenclature

Most of the plant species names in this report are the current names published in the Flora of NSW (Harden 1990-1993). The taxonomic names have been supplemented with common names obtained from various sources. The scientific and conservation significance of individual plant species was established with reference to Briggs and Leigh (1996) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* in the national context, and to the *NSW Threatened Species Conservation Act 1995* in the state context.

Flora Survey Effort

The flora survey effort employed a total of 247.75 person-hours, as documented in Table 1.

Table 1: Flora survey effort employed over the study area

DATE	METHOD	EFFORT	TARGET SPECIES
29 November 2006	Parallel transect searches	9 person-hours	<i>P. affine</i>
14 December 2006	Parallel transect searches	36 person-hours	<i>C. hunteriana</i>
18 January 2007	Riparian habitat searches	20 person-hours	<i>M. biconvexa</i> , <i>G. australe</i> , <i>S. paniculatum</i>
31 January 2007	Vegetation plots and random meander	6.75 person-hours	All species
22 February 2007	Riparian habitat searches	2 person-hours	<i>M. biconvexa</i> , <i>G. australe</i> , <i>S. paniculatum</i>
23 February 2007	Riparian habitat searches	6 person-hours	<i>M. biconvexa</i> , <i>G. australe</i> , <i>S. paniculatum</i>

DATE	METHOD	EFFORT	TARGET SPECIES
14 March 2007	Vegetation plots and random meander	7.5 person-hours	All species
15 March 2007	Parallel transect searches	32 person-hours	<i>G. baueri</i>
1 May 2007	Parallel transect searches	34 person-hours	<i>S. ventricosa</i>
08 October 2007	Parallel transect searches with raking of leaf litter for <i>R. slateri</i>	24 person-hours	<i>R. slateri</i> & <i>C. tessellata</i>
14 May 2008	Parallel transect searches	19.5 person-hours	<i>S. ventricosa</i>
15 May 2008	Parallel transect searches	16.5 person-hours	<i>S. ventricosa</i>
16 May 2008	Parallel transect searches	13.5 person-hours	<i>S. ventricosa</i>
20 May 2008	Parallel transect searches	8 person-hours	<i>S. ventricosa</i>
21 May 2008	Parallel transect searches	13 person-hours	<i>S. ventricosa</i>
TOTAL FLORA SURVEY EFFORT		247.75 person-hours	

2.3 Fauna Survey Methods

Field investigations for fauna were conducted in the study area between November 2006 and December 2007 in the locations shown in Figure 3 (Appendix A).

Habitat analysis

A description of the fauna habitats in the study area was prepared because the type of habitat in an area influences which animals occur there, as well as diversity and abundance. This habitat assessment also has an important role in predicting threatened fauna likely to occur in an area and defining areas for targeted surveys. The information collected usually includes the type of vegetation present, the presence/absence of rock outcrops, tree hollows, dams, ponds, streams, foraging substrates and other features likely to attract threatened fauna. The study area was traversed along a number of transects to identify habitat components, which were recorded and described. The locations of key habitat features were recorded with a Personal Digital Assistant XDA O2 linked to a bluetooth EMTAC S3 BTGPS Global Positioning System or Garmin Gecko 301 Global Positioning System.

Diurnal habitat surveys

Diurnal searches were conducted throughout the study area, for habitats or resources of relevance for those threatened fauna species known from the general region, or species, which might be anticipated to occur given the vegetation communities and habitats present. Searches targeted trees containing medium to large sized hollows, feed-trees of the Glossy Black-cockatoo and Yellow-bellied Glider, roost sites of large forest owls, nests of raptors, mammal diggings, scratchings and scats, and ponds were searched for tadpoles. The locations of fauna

species of conservation significance, or evidence of such species, were recorded with a Personal Digital Assistant XDA O2 linked to a bluetooth EMTAC S3 BTGPS Global Positioning System or Garmin Gecko 301 Global Positioning System.

Stagwatching surveys and nesting assessments for hollow-dependant fauna

A range of modified stagwatching surveys were used to assess breeding or sheltering use of tree hollows by threatened fauna during the survey period. Species specifically targeted by these techniques included the Yellow-bellied Glider, Squirrel Glider, microchiropteran bats, Gang-gang Cockatoo, Glossy Black-cockatoo, Powerful Owl and Masked Owl. For species which use hollows only for breeding, such as the Gang-gang Cockatoo, Glossy Black-cockatoo and Powerful Owl, targeted surveys were undertaken only within the known nesting periods. Gliders, hollow-roosting microchiropterans and the Masked Owl may use tree hollows at any time of the year, so were targeted during all nocturnal stagwatching surveys, at various times of the year.

Trees were initially assessed for suitability and prioritised for stag watching using characteristics such as tree species and height, the size and type of hollows, evidence of usage and surrounding habitats. Nocturnal observation sessions (for owls, gliders and bats) generally commenced at sunset on each survey night and continued for another one to one and a half hours. During this period hollows were observed with the aid of binoculars and spotlights where necessary.

Diurnal nesting assessments for the Gang-gang Cockatoo and Glossy Black-cockatoo were undertaken using a combination of listening for calls and stagwatching of potential nest trees. These surveys were commenced one to two hours prior to dusk during the relevant breeding periods. During these periods, groups of hollow-bearing trees were monitored while listening for the loud characteristic vocalisations that are typical of these species as they return to the nest in the late afternoon. Generally, multiple observers simultaneously monitored different groups of trees throughout the study area to ensure adequate coverage of all suitable habitat in the study area. The surveys became more focused on particular areas if the behaviour of the cockatoos indicated a possible nest or roost site. This work was supplemented by opportunistic monitoring at various times of the day, when surveys for other species were being conducted.

Call playback surveys for nocturnal mammals and birds

The calls of the Koala, Squirrel Glider, Yellow-bellied Glider, Sooty Owl, Powerful Owl, Masked Owl and Barking Owl were broadcast through a 15W Toa megaphone within areas of appropriate habitat in the study area. Calls were generally broadcast intermittently for a period of up to five minutes each, followed by a listening period of 15 minutes. Post-playback listening periods generally extended into subsequent spotlighting surveys for a further half to one hour. Pre-playback listening surveys were generally undertaken during stagwatching surveys which involved a listening period of between one and two hours after sunset.

Nocturnal spotlighting surveys

Spotlighting surveys using a Narva Colt 55 W hand-held spotlight with Faunatech battery pack were undertaken along tracks and transects through habitats likely to support threatened nocturnal fauna species at various times throughout the survey period. Binoculars were used to aid in the identification of species where necessary. Species targeted with this technique included the Koala, Yellow-bellied Glider, Squirrel Glider, Eastern Pygmy-possum, large forest owls and ground dwelling mammals such as the Spotted-tailed Quoll, Southern Brown Bandicoot, Long-nosed Potoroo and Giant Burrowing Frog. Spotlighting was undertaken while actively listening for vocalisations of nocturnal threatened fauna species. In general, each spotlighting session commenced at least 30 minutes after sunset and was undertaken for 0.5 to 1.5 hours.

Microchiropteran echolocation call recording surveys

Echolocation recording surveys were used to target microchiropteran bats in the study area over three nights in March 2007. Two AnaBat II bat detectors linked to ZCAIM digital data recorders were used in various habitats along walking transects and at stationary overnight positions to record microchiropteran echolocation calls. Walking AnaBat transects were undertaken in all broad habitat types along roads and open areas from approximately sunset for a further one hour.

Four overnight (stationary) echolocation recording survey sites sampled all broad habitat types in the study area over two nights. During overnight recordings, the detector was placed in a wooden frame which was attached to a tree at a height of approximately 2m above the ground to reduce interference from insects on the ground. Within each broad habitat type, overnight Anabat surveys targeted resources such as creeks or obvious flyways. Recorded data was analysed by Mr. Mick Welsh. Only those species identified to a 'confident' or 'probable' level were included in this report.

Microchiropteran trapping surveys

Two harp traps were used to target microchiropteran bats in the study area over three nights in March 2007. Harp traps were positioned across tracks or creeks to sample areas of higher bat activity. Shade cloth was erected to the sides of traps where necessary to direct bats into the trap. Generally, traps were employed for two nights at each site, yielding a total of 18 trap nights. Captured bats were retrieved early in the morning and identified, then placed into cloth bags and released that night.

Terrestrial mammal trapping and hair funnel surveys

Trapping surveys for terrestrial mammals were undertaken over four nights between 13 and 16 March 2007. A range of trapping techniques were employed to target threatened mammals including the Eastern Chestnut Mouse, Eastern Pygmy-possum, White-footed Dunnart,

Southern Brown Bandicoot, Long-nosed Potoroo and Spotted-tail Quoll. Trap sites were stratified by broad vegetation type and placed in areas of suitable habitat for target species.

A total of 50 type-A Elliott traps and 50 small cage (or bandicoot) traps were set over four consecutive nights, yielding a trapping effort of 200 trap-nights each. Traps were laid on the ground at 10-20 m intervals and were baited with a mixture of peanut butter, honey and rolled oats to target small to medium-sized mammals, including the Eastern Pygmy-possum.

Ten large cage traps were set within appropriate habitat in the study area for four consecutive nights, yielding a trapping effort of 40 trap-nights. Traps were baited with chicken pieces to attract carnivores, primarily the Spotted-tailed Quoll and the Heath Monitor.

A total of twelve pitfall traps were set to sample the range of habitat types in the study area for four consecutive nights, yielding a trapping effort of 48 trap-nights. Each trap site contained two pits approximately 15m apart, connected by approximately 20m of drift netting. Buckets approximately 50cm deep and 30cm wide were used for pit traps. Each bucket contained holes in the bottom to facilitate draining and floating material (usually bark) in case of heavy rainfall. Other material such as leaves provided shelter from sunlight and predators. Builder's damp course (30cm high) was used for drift fencing.

All traps were checked each morning soon after sunrise. Captured animals were identified and then released at the trap site.

Forty Faunatech hair funnels were set on the ground or on trunks of flowering or hollow trees in all habitat types across the study area for eleven consecutive nights from 12 to 23 April 2007, yielding a total hair funnel effort of 440 trap-nights. Hair funnels were baited with a mixture of peanut butter, honey and rolled oats. Any hair-funnel wafers with obvious hairs attached were sent to Ms. Barbara Triggs of Mallacoota, Victoria for analysis.

Targeted Amphibian Surveys

A range of techniques were used to survey for the Giant Burrowing Frog during the survey period. Spotlighting was undertaken for frogs in areas of potential breeding or foraging habitat, and in selected ponds along ephemeral creeks for tadpoles of this species during general spotlighting surveys and during targeted spotlighting following heavy rainfall. Diurnal searches for tadpoles were also undertaken at various times throughout the survey period. Call playback surveys were undertaken in various potential habitats, consisting of up to five minutes of call playback and between 15 and 30 minutes of listening for a response. Call playback for this species was undertaken with other call playback surveys and separately during targeted surveys following heavy rainfall.

Opportunistic nocturnal searches for this species were also made by vehicle, driving slowly along tracks within the study area, particularly after any rainfall. Opportunistic listening for calls of this species was undertaken throughout the survey period, particularly after any rainfall and in association with riparian areas.

Pitfall trapping, undertaken primarily for small mammals as described above, was also used to target the Giant Burrowing Frog in the study area. Some rainfall occurred prior to and during the pitfall trapping survey period, so conditions were not inappropriate for this species to be sampled by this method.

Diurnal Bird Surveys

Targeted surveys for diurnal bird species of conservation significance were undertaken in various habitats at various times during the survey period. Each survey combined a number of target species and habitats, including riparian areas for the Eastern Bristlebird, Australasian Bittern, Black Bittern, Latham's Snipe, Black-faced Monarch, Rufous Fantail, Satin Flycatcher and roosting sites of large forest owls; winter-flowering trees for the Regent Honeyeater and Swift Parrot; open grassy areas for the Turquoise Parrot; and general forest areas for evidence of nesting or other habitat use by the Square-tailed Kite, Osprey and White-bellied Sea-eagle.

Diurnal bird surveys utilised visual (aided by binoculars) and aural methods of detection, while actively searching or monitoring targeted habitats. Opportunistic surveys for diurnal birds were also undertaken at other time of the survey period during other flora and fauna surveys.

Limitations

The results of fauna surveys can be optimised by conducting repeat investigations over a long period to compensate for the effect of unfavourable weather, seasonal changes and climatic variation. In general, the longer the survey or the higher the number of repeat surveys, the more species will be detected and more detail will be gained in relation to the abundance, distribution and habitat use of the fauna. Wherever possible, surveys were conducted using a range of methods best suited for detecting target species, at optimum times during appropriate conditions.

However, surveys are subject to constraints that determine the amount of time allocated, the methods used and the timing of the work. Thus, the results should be viewed in the light of these limitations. The fauna detected in current survey work are a comprehensive guide to the native fauna present, but are not necessarily a definitive list of the species occurring in the study area. Nevertheless, given the habitats present, the techniques used in this investigation are considered adequate to gather the data necessary to identify species and habitats of high conservation value within the study area.

Nomenclature

The nomenclature in this report is based on the Mammals of Australia (Strahan 1995), and Australian Bats (Churchill 1998), The Taxonomy and Species of Birds of Australia and its Territories (Christidis & Boles 1994) and Reptiles and Amphibians of Australia (Cogger 1996).

Survey Conditions

Survey conditions throughout the study period are detailed in Table 2.

Table 2: Fauna survey conditions during the survey period

DATE	SURVEY TYPE	TEMPERATURE	WIND	CLOUD	MOON	RAIN
5 December 2006	Diurnal	14°C	None	0/8	N/A	None
7 December 2006	Diurnal	15°C	None	Light	N/A	None
8 December 2006	Diurnal	16°C	None	0/8	N/A	None
18 January 2007	Diurnal	27°C – 31°C	Light	4/8	N/A	None
31 January 2007	Diurnal	25°C – 28°C	None	3/8	N/A	None
13 February 2007	Nocturnal	19°C	None	6/8	1/4	Light
22 February 2007	Diurnal	24°C – 18°C	Light	2/8	N/A	None
23 February 2007	Diurnal	26°C – 21°C	Light	4/8	N/A	None
13-16 March 2007	Trapping	31°C – 13°C	Light	8/8	N/A	None
22 March 2007	Trapping	28°C – 14°C	Light	0/8	N/A	None
23 March 2007	Diurnal	20°C	Light	0/8	N/A	None
12 April 2007	Diurnal	19°C	Light	2/8	N/A	None
12-23 April 2007	Hair funnels	N/A	N/A	N/A	N/A	None
23 April 2007	Diurnal	17°C	Light	4/8	N/A	None
1 May 2007	Diurnal & nocturnal	20°C – 14°C	Light	4/8	4/4	None
26 July 2007	Diurnal	17°C	Light	N/A	N/A	None
31 July 2007	Nocturnal	13°C – 11°C	None	0/8	4/4	None
27 September 2007	Diurnal	21°C	Light	4/8	N/A	None
29 October 2007	Diurnal	22°C	Light	1/8	N/A	None

Survey Effort

The fauna survey effort employed a total of 108 person-hours, 200 Elliott (type A) trap nights, 200 small cage trap nights, 40 large cage trap nights, 440 hair funnel trap-nights, 6 harp trap nights and 42 hours of Anabat echolocation call recording as documented in Table 3.

Table 3: Fauna survey effort employed over the study area.

DATE	METHOD	EFFORT	TARGET SPECIES
5 December 2006	Nesting assessment	2 person hours	Gang-gang Cockatoo
7 December 2006	Nesting assessment	2 person hours	Gang-gang Cockatoo
8 December 2006	Nesting assessment	2 person hours	Gang-gang Cockatoo
18 January 2007	Habitat assessment	20 person hours	All species
31 January 2007	Habitat search	6 person hours	Diurnal birds, amphibians
13 February 2007	Call playback	1.5 person hours	Giant Burrowing Frog
	Spotlighting	1.5 person hours	Giant Burrowing Frog
22 February 2007	Habitat assessment	18 person hours	All species
23 February 2007	Habitat search	8 person hours	Diurnal birds, amphibians
13-16 March 2007	Elliott trapping	200 trap-nights	Eastern Pygmy-possum, White-footed Dunnart
	Small cage trapping	200 trap-nights	Long-nosed Potoroo, Southern Brown Bandicoot
	Large cage trapping	40 trap-nights	Spotted-tailed Quoll
	Pitfall trapping	48 trap-nights	Eastern Pygmy-possum, White-footed Dunnart, Giant Burrowing Frog
14-16 March 2007	Harp trapping	6 trap-nights	Microchiropterans (bats)
	Echolocation call recording	42 hours	Microchiropterans (bats)
15 March 2007	Stagwatching	10 person hours	Nocturnal birds and mammals
	Call playback	1 person hour	Yellow-bellied glider, Squirrel Glider, Koala, Masked Owl, Barking Owl, Giant Burrowing Frog
	Spotlighting	1 person hour	Nocturnal birds, mammals & frogs
22 March 2007	Habitat searches	2 person hours	Diurnal birds
23 March 2007	Habitat searches	2 person hours	Diurnal birds & amphibians
12-23 April 2007	Hair funnels	440 trap nights	Eastern Pygmy-possum, White-footed Dunnart, Long-nosed Potoroo, Southern Brown Bandicoot, Spotted-tailed Quoll
12 April 2007	Habitat search	6 person hours	Diurnal birds & amphibians
23 April 2007	Habitat search	4 person hours	Diurnal birds

DATE	METHOD	EFFORT	TARGET SPECIES
1 May 2007	Nesting Assessment	5 person hours	Glossy Black-cockatoo
	Stagwatching	5 person hours	Nocturnal birds and mammals
	Call Playback	1 person hour	Yellow-bellied glider, Squirrel Glider, Masked Owl, Powerful Owl
	Spotlighting	1 person hour	Nocturnal birds, mammals & frogs
26 July 2007	Nesting assessment	2 person hours	Powerful Owl, Glossy Black-cockatoo
31 July 2007	Stagwatching	2 person hours	Nocturnal birds and mammals
	Call playback	1 person hour	Yellow-bellied glider, Squirrel Glider, Masked Owl
	Spotlighting	1.5 person hours	Nocturnal birds, mammals & frogs
27 September 2007	Habitat search	2 hours	Diurnal birds
29 October 2007	Habitat search	1.5 person hours	Diurnal birds
TOTAL FAUNA SURVEY EFFORT		108 person-hours, 934 trap nights, 42 hours Anabat recording	

3. THE EXISTING ENVIRONMENT

3.1 Topography, Geology, and Soils

The study area lies at an altitude between approximately 1-23 metres Australian Height Datum and comprises gently sloping land. The study area drains to St. Georges Basin to the south via an unnamed creek which is roughly aligned with the study area's south western boundary. Two secondary unnamed creeks enter the study area from the north and east. The catchment area of these creeks extends to Island Point Road to the north and the Prices Highway to the North West, comprising a mix of cleared and uncleared rural land.

The study area is underlain by Wandrawandian Siltstone, of the Permian Shoalhaven Sandstone Group, which weathers to form silty soils. The creek lines are characterised by finely textured subsoils with a high proportion of clay and silt (Morse McVey & Associates 1994).

3.2 Disturbances

A range of disturbances are immediately apparent throughout the study area, including those associated with unsealed roads, permanent and temporary dwellings and other structures such as fences and sheds. Unformed roads in the study area are fairly regularly used by pedestrians and vehicles. Some sections of these roads have been augmented by introduced road base. Dwellings in the study area are associated by a range of typical disturbances such as slashing and mowing of vegetation, landscaping introduced garden plants and weeds, introduced animals such as cats and dogs and activities such as firewood collection.

Most of vegetation of the study area has been substantially disturbed. Extensive logging and clearing occurred in the 1970's with most vegetation now comprising advanced regrowth. Many lots are at least partially cleared, and extensive underscrubbing is apparent in some areas. Despite these disturbances, the abundance of introduced plant and animal species in the study area is relatively low and vegetative regrowth comprises predominantly native species.

3.3 Flora

The vegetation within the study area has been mapped by a number of sources as described below:

Antcliff Ecological Services (1994) - identified three vegetation communities within the study area; Open Forest / Woodland (dominated by Red Bloodwood, Red Mahogany, Turpentine and Blackbutt) away from the drainage lines; Bangalay / Melaleuca community in association with the drainage lines; and Cleared or Partially Cleared where clearing has occurred in association with residential developments.

Andrews Neil (1994) - identified three vegetation communities within the study area; Woodland on low nutrient soils in the north through east and south-east of the study area beyond the drainage lines; Riparian Open Forest in association with the drainage lines, and Mid Open Forest on Higher Nutrient Soils to the west of the unnamed creek that traverses the southern boundary of the study area.

Kevin Mills & Associates (KMA) (1999) – identified Blackbutt – Bloodwood Forest (PIL –GUM) throughout the bulk of the study area with some Bangalay Forest in the lower parts of the unnamed creek that traverses the southern boundary of the study area.

Tindall *et al.* (2004) – Mapped the majority of the study area as Coastal Sand Swamp Forest with Currumbene Lowlands Forest on the western, northern and eastern margins.

Gellie (2005) – Mapped the majority of the study area as Northern Coastal Lowlands Swamp Forest, with the western, northern and eastern margins mapped as Jervis Bay Lowlands Dry Shrub Grass Forest, with Jervis Bay Swamp Forest in the extreme south-eastern margins of the study area.

Each of these reports described the vegetation within the study area reasonably well, however for the purposes of this analysis the vegetation within the study area will be described using the vegetation community descriptions and nomenclature of Tindall *et al.* (2004).

It was concluded that three vegetation communities occur within the study area; Currumbene Lowlands Forest, Coastal Sand Swamp Forest, and Coastal Sand Forest. The distribution of these communities within the study area is shown in Figure 4 (Appendix A).

3.3.1 Currumbene Lowlands Forest

This vegetation community is the most widespread community in the study area occurring throughout the study area away from the drainage lines, except in the extreme south-east of the study area. The community is quite variable floristically and structurally within the study area with the vegetation in the north-eastern parts of the study area and at further distance from the drainage lines supporting a greater proportion of sclerophyllous vegetation. In the north-eastern parts of the study area the community has also been heavily affected by historic logging. The community has also been affected by under-scrubbing in association with the dwellings in the study area and particularly in the western margins of the study area abutting Grange Road.

The canopy is generally dominated by Blackbutt *Eucalyptus pilularis*, and Red Bloodwood *Corymbia gummifera*, however in places, and particularly in the north-eastern parts of the study area, the canopy also includes and may be dominated by White Stringybark *Eucalyptus globoidea*, Thin-leaved Stringybark *Eucalyptus eugenioides* and Sydney Peppermint *Eucalyptus piperita*. Spotted Gum *Corymbia maculata*, Large-fruited Mahogany *Eucalyptus scias* subsp.

callimastha, and Turpentine *Syncarpia glomulifera* subsp. *glomulifera* are also present in the canopy and may be co-dominant in places. The canopy is generally to a height of approximately 20-30 m with projective foliage cover (PFC) of approximately 20-30% dependent on the level of disturbance. There is usually a sub-canopy to approximately 10-20 m of Black She-oak *Allocasuarina littoralis* and Turpentine, and sometimes Saw Banksia *Banksia serrata*, Hickory *Acacia implexa* and Cherry Ballart *Exocarpos cupressiformis* with PFC of approximately 20%.

The understorey is dominated by sclerophyllous species including Yellow Tea-tree *Leptospermum polygalifolium* subsp. *polygalifolium*, Handsome Flat-pea *Platylobium formosum*, Turpentine, Hairpin Banksia *Banksia spinulosa* var. *spinulosa*, Narrow-leaf Geebung *Persoonia linearis* and Black She-oak but also often include species such as Bearded Heath *Leucopogon juniperinus*, Broad Leaf Geebung *Persoonia levis*, Sunshine Wattle *Acacia terminalis*, *Gompholobium glabratum*, Halo Bush-pea *Pultenaea linophylla*, Stalked Conesticks *Petrophile pedunculata*, Spiny Bossiaea *Bossiaea obcordata*, Lance-leaf Beard-heath *Leucopogon lanceolatus*, Sydney Golden Wattle *Acacia longifolia*, Gorse Bitter Pea *Daviesia ulicifolia*, *Xanthorrhoea concava* and Native Holly *Podolobium ilicifolium* which may be common in places. The understorey is generally to a height of approximately 1-5 m with PFC of approximately 20%.

The groundcover includes a diverse range of native ferns, forbs, sedges, climbers and grasses the most common of which are Oat Spear Grass *Anisopogon avanacea*, Thatch Saw-sedge *Gahnia radula*, Two Colour Panic *Panicum simile*, Wiry Panic *Entolasia stricta*, Spiny-headed Mat-rush *Lomandra longifolia*, Common Bracken *Pteridium esculentum*, Blue Dampiera *Dampiera stricta*, Screw Fern *Lindsea linearis*, Paroo Lily *Dianella caerulea* var. *producta*, Rough Guinea Flower *Hibbertia aspera*, Variable Sword-sedge *Lepidosperma laterale*, Love Creeper *Glycine clandestina* and Blady Grass *Imperata cylindrica*, to a height of 1 m with PFC of approximately 10-20 %. Other common groundcovers include *Oxalis perennans*, Kangaroo Grass *Themeda australis*, Holly Lomatia *Lomatia ilicifolia* Germander Raspwort *Gonocarpus teucrioides*, Leafy Purple Flag *Patersonia glabrata*, Native Sarsaparilla *Smilax glycyphylla* and Twining Pea *Hardenbergia violacea*.

3.3.2 Coastal Sand Swamp Forest

This vegetation community occurs in close association with the major drainage lines within the study area. The canopy is almost exclusively dominated by Bangalay *Eucalyptus botryoides* to a height of approximately 20 m with PFC of approximately 15-20%, however a few individuals of Woollybutt *Eucalyptus longifolia* occur in the extreme southern margins of the study area where it abuts the Wool Road. There area also occasional individuals of Blackbutt, Large-fruited Mahogany, and Spotted Gum on the margins of the community in places. There is a sub-canopy to a height of 10 m with PFC of up to 40% dominated by Biconvex Paperbark *Melaleuca biconvexa*, but also including Green Wattle *Acacia irrorata*, Snow in Summer *Melaleuca linariifolia*, and occasionally Black Wattle *Callicoma serratifolia*.

The understorey is generally dense to a height of 4 m with foliage projective cover of approximately 10-50%. The understorey is dominated by Tall Saw-sedge *Gahnia clarkei* which is abundant in clumps to approximately 2.5 m. Other understorey species include Yellow Tea-tree, Swamp Paperbark *Melaleuca ericifolia*, Sydney Golden Wattle, Blueberry Ash *Elaeocarpus reticulatus*, Sandpaper Fig *Ficus coronata*, Sweet Pittosporum *Pittosporum undulatum* and Cheese Tree *Glochidion ferdinandi*.

The groundcover includes a range of grasses, forbs, ferns and climbers such as Harsh Ground Fern *Hypolepis muelleri*, Common Maidenhair Fern *Adiantum aethiopicum*, Asian Pennywort *Centella asiatica*, False Bracken *Calochlaena dubia*, Native Violet *Viola hederacea*, the Pennywort *Hydrocotyle peduncularis*, Basket Grass *Oplismenus imbecillis*, Gristle Fern *Blechnum cartilagineum*, Common Bracken, Bordered Panic *Entolasia marginata*, Lilac Lily *Schelhammera undulata*, Pastel Flower *Pseuderanthemum variabile*, Rasp Fern *Doodia aspera*, Matgrass *Hemarthria uncinata* and Whiteroot *Pratia purpurascens* to a height of approximately 1 m. The density of the groundcover is influenced by the density of the understorey but is generally sparse with foliage projective cover averaging approximately 5-20%. Climbers include Morinda Jasmine *Morinda jasminoides*, Trailing Guinea-flower *Hibbertia scandens*, Broad-leaved Bramble *Rubus moluccanus* var. *trilobus*, Common Milk Vine *Marsdenia rostrata*, and Common Silkpod *Parsonsia straminea*.

3.3.3 Coastal Sand Forest

This community occurs in the south-eastern extremities of the study area to the south-east of the drainage line. The canopy is dominated by Bangalay but also includes a few individuals of Blackbutt, White Stringybark and Thin-leaved Stringybark to a height of 15-20 m and PFC of approximately 10 % as a result of clearing. There is a sparse sub-canopy to a height of approximately 8-14 m and PFC of approximately 10 % of Rough-barked Apple *Angophora floribunda* and to a lesser extent Turpentine, Saw Banksia and Snow in Summer.

The understorey is patchy but generally sparse as a result of relatively recent clearing and under-scrubbing and is dominated by Yellow Tea-tree, Snow in Summer, Sydney Golden Wattle, Lance-leaf Beard-heath *Leucopogon lanceolatus*, Slender Rice-flower *Pimelea linifolia*, and Prickly Tea-tree *Leptospermum juniperinus* to a height of 1-2 m and PFC of less than 5 %.

The groundcover has been modified by recent disturbances and includes a diverse range of native and exotic groundcovers to a height of approximately 1 m and PFC of approximately 20 %. The most common native species include Common Bracken, Spiny-headed Mat-rush, False Bracken, Two-colour Panic, Rough Guinea Flower, Wiry Panic, Blady Grass, Paroo Lily, Hairy Apple Berry *Billardiera scandens*, Tufted Hedgehog Grass *Echinopogon caespitosus*, Swamp Selaginella *Selaginella uliginosa*, Lilac Lily, *Hibbertia linearis*, Common Maidenhair Fern, Variable-leaved Goodenia *Goodenia hederacea*, Dusky Coral-pea *Kennedia rubicunda*, Broom Spurge *Amperea xiphoclada* var. *xiphoclada* and *Gonocarpus micranthus*.

3.3.4 Flora Species

A total of 156 flora species were identified during the flora surveys, and these are listed in Table 4. One hundred and fifty native species and six introduced species were identified.

Table 4: Plant species identified in the study area

(* denotes introduced species, bold denotes threatened species).

SCIENTIFIC NAME	COMMON NAME	COASTAL SAND SWAMP FOREST	CURRAMBENE LOWLANDS FOREST	COASTAL SAND FOREST
<i>Acacia binervata</i>	Two-veined Hickory		✓	
<i>Acacia implexa</i>	Hickory		✓	
<i>Acacia irrorata</i>	Green Wattle	✓	✓	✓
<i>Acacia longifolia</i>	Sydney Golden Wattle	✓	✓	✓
<i>Acacia myrtifolia</i>	Myrtles Wattle		✓	
<i>Acacia suaveolens</i>	Sweet-scented Wattle		✓	
<i>Acacia terminalis</i>	Sunshine Wattle		✓	✓
<i>Acacia ulicifolia</i>	Prickly Moses		✓	
<i>Adiantum aethiopicum</i>	Common Maidenhair Fern	✓		✓
<i>Allocasuarina littoralis</i>	Black She-oak	✓	✓	✓
<i>Amperea xiphoclada</i> var. <i>xiphoclada</i>	Broom Spurge		✓	✓
<i>Angophora floribunda</i>	Rough-barked Apple	✓		✓
<i>Anisopogon avenaceus</i>	Oat Spear Grass		✓	✓
<i>Aristida vagans</i>	Three-awned Spear-grass		✓	✓
<i>Austrodanthonia tenuior</i>	Wallaby Grass		✓	
<i>Banksia serrata</i>	Saw Banksia		✓	✓
<i>Banksia spinulosa</i> var. <i>spinulosa</i>	Hairpin Banksia		✓	✓
<i>Baumea nuda</i>	-	✓	✓	✓
<i>Baumea rubiginosa</i>	Soft Twig-rush	✓		
<i>Billardiera scandens</i>	Hairy Apple Berry		✓	✓
<i>Blechnum cartilagineum</i>	Gristle Fern	✓		
<i>Bossiaea obcordata</i>	Spiny Bossiaea		✓	
<i>Burchardia umbellata</i>	Milkmaids		✓	
<i>Callicoma serratifolia</i>	Callicoma	✓		
<i>Calochlaena dubia</i>	False Bracken Fern	✓	✓	✓

SCIENTIFIC NAME	COMMON NAME	COASTAL SAND SWAMP FOREST	CURRAMBENE LOWLANDS FOREST	COASTAL SAND FOREST
<i>Cassytha pubescens</i>	Common Devil's Twine		✓	✓
<i>Centella asiatica</i>	Asian Pennywort	✓		
<i>Corymbia gummifera</i>	Red Bloodwood		✓	✓
<i>Corymbia maculata</i>	Spotted Gum		✓	
<i>Cryptostylis erecta</i>	Hooded Orchid	✓	✓	✓
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid		✓	
<i>Cryptostylis subulata</i>	Large Tongue orchid		✓	
<i>Cyathochaeta diandra</i>	-			✓
<i>Cymbidium suave</i>	Snake Flower	✓		
<i>Dampiera stricta</i>	Blue Dampiera		✓	✓
<i>Daviesia ulicifolia</i>	Gorse Bitter Pea		✓	
<i>Desmodium varians</i>	Slender Tick-trefoil	✓		
<i>Dianella caerulea</i> var. <i>producta</i>	Paroo Lily	✓	✓	✓
<i>Dichelachne micrantha</i>	Plume-grass		✓	
<i>Dichondra repens</i>	Kidney Weed	✓		
<i>Digitaria</i> sp. <i>parviflora</i> ?	Small-flowered Finger Grass*			✓
<i>Dipodium variegatum</i>	-		✓	✓
<i>Dodonaea triquetra</i>	Common Hop Bush		✓	✓
<i>Doodia aspera</i>	Rasp Fern	✓		
<i>Echinopogon caespitosus</i>	Tufted Hedgehog Grass		✓	✓
<i>Elaeocarpus reticulatus</i>	Blueberry Ash	✓		
<i>Entolasia marginata</i>	Bordered Panic	✓	✓	✓
<i>Entolasia stricta</i>	Wiry Panic		✓	✓
<i>Epacris pulchella</i>	NSW Coral Heath		✓	
<i>Eragrostis</i> sp.	A lovegrass			✓
<i>Eucalyptus botryoides</i>	Bangalay	✓		✓
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark		✓	✓
<i>Eucalyptus globoidea</i>	White Stringybark		✓	✓
<i>Eucalyptus longifolia</i>	Woollybutt	✓		
<i>Eucalyptus pilularis</i>	Blackbutt	✓	✓	✓
<i>Eucalyptus piperita</i>	Sydney Peppermint		✓	✓

SCIENTIFIC NAME	COMMON NAME	COASTAL SAND SWAMP FOREST	CURRAMBENE LOWLANDS FOREST	COASTAL SAND FOREST
<i>Eucalyptus scias</i>	Large-fruited Red Mahogany		✓	
<i>Eustrephus latifolius</i>	Wombat Berry	✓		
<i>Exocarpos cupressiformis</i>	Native Cherry		✓	
<i>Ficus coronata</i>	Sandpaper Fig	✓		
<i>Gahnia clarkei</i>	Tall Saw-sedge	✓		✓
<i>Gahnia radula</i>	Thatch Saw-sedge	✓	✓	✓
<i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>	Cheese tree	✓	✓	
<i>Glycine clandestina</i>	Love Creeper	✓	✓	✓
<i>Gompholobium grandiflorum</i>	A wedge-pea		✓	
<i>Gompholobium latifolium</i>	Golden Glory-pea		✓	
<i>Gonocarpus micranthus</i>	-			✓
<i>Gonocarpus teucroides</i>	Germader Raspwort	✓	✓	✓
<i>Gonocarpus tetragynus</i>	Poverty Raspwort			✓
<i>Goodenia hederacea</i>	Variable-leaved Goodenia		✓	✓
<i>Goodenia ovata</i>	Hop Goodenia	✓		
<i>Goodenia paniculata</i>	Swamp Goodenia	✓		
<i>Imperata cylindrica</i>	Blady Grass		✓	✓
<i>Hakea salicifolia</i>	Willow-leaved Hakea			✓
<i>Hardenbergia violacea</i>	Twining Pea		✓	✓
<i>*Hedychium gardnerianum</i>	Ginger Lily	✓		
<i>Hemarthria uncinata</i>	Matgrass	✓		
<i>Hibbertia aspera</i>	Rough Guinea Flower		✓	✓
<i>Hibbertia diffusa</i>	Wedge Guinea-flower		✓	
<i>Hibbertia linearis</i>	-			✓
<i>Hibbertia scandens</i>	Golden Guinea Flower	✓	✓	✓
<i>Hydrocotyle penduncularis</i>	A pennywort	✓		✓
<i>Hypericum gramineum</i>	Small St John's Wort		✓	✓
<i>Hypolepis muelleri</i>	Harsh Ground Fern	✓		
<i>Imperata cylindrica</i>	Blady Grass	✓		✓
<i>Juncus continuus</i>	A rush		✓	

SCIENTIFIC NAME	COMMON NAME	COASTAL SAND SWAMP FOREST	CURRAMBENE LOWLANDS FOREST	COASTAL SAND FOREST
<i>Kennedia rubicunda</i>	Dusky Coral-pea			✓
<i>Kunzea ambigua</i>	White Kunzea		✓	✓
<i>Lagenophora gracilis</i>	Slender Lagenophora			✓
<i>Lepidosperma laterale</i>	Variable Sword-sedge		✓	✓
<i>Leptomeria acida</i>	Native Currant		✓	
<i>Leptospermum juniperinus</i>	Prickly Tea-tree			✓
<i>Leptospermum polygalifolium</i>	Yellow Tea-tree	✓	✓	✓
<i>Leptospermum trinervium</i>	Flaky-barked Tea-tree		✓	
<i>Leucopogon juniperinus</i>	Bearded Heath	✓	✓	✓
<i>Leucopogon lanceolatus</i>	Lance-leaf Beard-heath		✓	✓
* <i>Lilium formosanum</i>	Formosan Lily	✓		
<i>Lindsaea linearis</i>	Screw Fern		✓	✓
<i>Lindsaea microphylla</i>	Lacy Wedge Fern		✓	✓
<i>Lobelia alata</i>	A lobelia	✓		
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	✓	✓	✓
<i>Lomandra obliqua</i>	Twisted Mat-rush		✓	✓
<i>Lomatia ilicifolia</i>	Holly Lomatia		✓	
<i>Marsdenia rostrata</i>	Common Milk Vine	✓		
<i>Marsdenia suaveolens</i>	Sweet-scented Doubah		✓	
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	✓		✓
<i>Melaleuca ericifolia</i>	Swamp Paperbark	✓		
<i>Melaleuca linariifolia</i>	Snow-in-summer	✓	✓	✓
<i>Microlaena stipoides</i>	Weeping Meadow Grass	✓	✓	
<i>Morinda jasminoides</i>	Jasmine Morinda	✓		
<i>Olax stricta</i>	-		✓	
<i>Omalanthus populifolius</i>	Bleeding Heart	✓		
<i>Opercularia aspera</i>	Common Stinkweed		✓	✓
<i>Oplismenus imbecillis</i>	Basket Grass	✓		
<i>Oxalis perennans</i>	Oxalis	✓	✓	✓
<i>Pandorea pandorana</i>	Wonga-wonga Vine	✓		
<i>Panicum simile</i>	Two Colour Panic		✓	✓

SCIENTIFIC NAME	COMMON NAME	COASTAL SAND SWAMP FOREST	CURRAMBENE LOWLANDS FOREST	COASTAL SAND FOREST
<i>Parsonia straminea</i>	Common Silkpod	✓	✓	
* <i>Passiflora edulis</i>	Black Passionfruit	✓		
<i>Patersonia glabrata</i>	Leafy Purple Flag		✓	✓
<i>Persoonia levis</i>	Broad-leaved Geebung		✓	✓
<i>Persoonia linearis</i>	Narrow-leaf Geebung		✓	✓
<i>Petrophile pedunculata</i>	Stalked Conesticks		✓	✓
<i>Pimelea linifolia</i>	Slender Rice-flower		✓	✓
<i>Pittosporum undulatum</i>	Sweet Pittosporum	✓	✓	
<i>Platylobium formosum</i>	Handsome Flat-pea		✓	✓
<i>Poa</i> sp.	Tussock Grass		✓	
<i>Podolobium ilicifolium</i>	Native Holly		✓	✓
<i>Pratia purpurascens</i>	Whiteroot	✓		✓
<i>Pseuderanthemum variabile</i>	Pastel Flower	✓		
<i>Pteridium esculentum</i>	Common Bracken	✓	✓	✓
<i>Ptilothrix deusta</i>	-			
<i>Pultenaea daphnoides</i>	Large-leaf Bush-pea		✓	
<i>Pultenaea linophylla</i>	Halo Bush-pea		✓	
<i>Pultenaea retusa</i>	-		✓	✓
* <i>Rubus ulmifolius</i>	Blackberry	✓		
<i>Rubus moluccanus</i> var. <i>trilobus</i>	Broad-leaved Bramble	✓		
<i>Schelhammera undulata</i>	Lilac Lily	✓	✓	✓
<i>Schoenus melanostachys</i>	A bog-rush		✓	
<i>Selaginella uliginosa</i>	Swamp Selaginella	✓		✓
<i>Senecio minimus</i> var. <i>minimus</i>		✓		
* <i>Senna pendula</i>	Senna	✓		
<i>Smilax glycyphylla</i>	Native Sarsaparilla		✓	✓
<i>Specularantha ventricosa</i>	Orchid		✓	
<i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i>	Turpentine		✓	✓
<i>Syzygium australe</i>	Brush Cherry	✓		

SCIENTIFIC NAME	COMMON NAME	COASTAL SAND SWAMP FOREST	CURRAMBENE LOWLANDS FOREST	COASTAL SAND FOREST
<i>*Taraxacum officinale</i>	Dandelion			✓
<i>Tetradlea thymifolia</i>	Black-eyed Susan		✓	✓
<i>Themeda australis</i>	Kangaroo Grass		✓	✓
<i>Thysanotus tuberosus</i>	Fringe Lily		✓	✓
<i>Tricoryne elatior</i>	Yellow Rush-lily			✓
<i>Vernonia cinerea</i>	Veronia		✓	
<i>Veronica pliebea</i>	Veronica	✓		
<i>Villarsia exaltata</i>	Yellow Marsh-flower	✓		
<i>Viola hederacea</i>	Native Violet	✓	✓	
<i>Xanthorrhoea concava</i>	A grass tree		✓	✓

3.4. Fauna

3.4.1 Fauna Habitats

The fauna habitats present in the study area are fairly typical of disturbed forests. Much of the vegetation has been cleared in the past and this is reflected by the relatively low number of large trees and presence of other old growth habitat components such as tree hollows. More recent disturbances have substantially reduced or removed habitats associated with understorey and groundcover vegetation.

Despite these disturbances, the study area still contains forest habitats that support a relatively diverse fauna including several threatened fauna species. These habitats include dense riparian vegetation and ephemeral ponds, trees with hollows, stands of Black She-oak, winter-flowering and high nectar-producing trees and shrubs and a range of other foraging resources such as seeds, invertebrates, eucalypt sap and open grassy areas.

An important resource of the study area is hollow-bearing trees, which provide potential refuge and breeding sites for a range of hollow-dependent species. Hollow-dependent threatened species of the study area include the East Coast Freetail Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat, Yellow-bellied Glider, Glossy Black-cockatoo, Gang-gang Cockatoo and Powerful Owl, although none of these species were recorded using tree hollows in the study area. Hollows are likely to be important for sustaining populations of some non-hollow-dependent species that sometimes utilise hollows, including the Brown Antechinus, Common

Brushtail Possum and the Common Ringtail Possum, which is an important prey species for the threatened Powerful Owl.

One hundred and seven trees (61 live and 46 dead) containing medium to large visible hollows were recorded in the study area. A low number of these hollows could be regarded as high quality resources due to the extensive disturbances in the study area. Larger trees containing higher quality hollow resources are apparent in less disturbed vegetation to the north of the study area.

The seed cones of Black She-oak trees provide an almost exclusive food source for the Glossy Black-cockatoo, and occur through much of the study area. Twenty five Black She-oaks were found to be used by Glossy Black-cockatoos for foraging. Canopy and sub-canopy seed sources for the Gang-gang Cockatoo and other birds occur throughout the study area.

Nectar and pollen sources for birds and mammals, including the threatened Yellow-bellied Glider and Grey-headed Flying-fox, which are both known to forage in the study area, are present in the form of eucalypts and larger banksias and melaleucas within forest and woodland areas. Species including Spotted Gum generally flower over winter, which sustains nectar and pollen sources throughout the year. Other tree species such as Red Bloodwood, which occur in the north of the study area, provide important summer nectar resources for possums, gliders and Grey-headed Flying-foxes, and provide a food source for prey species of microchiropteran bats and the threatened Square-tailed Kite. Red Bloodwood provides the main sap resource for gliders in the study area, including the threatened Yellow-bellied Glider. Three Red Bloodwood trees in or adjacent to the study were found to be incised by the Yellow-bellied Glider to procure sap.

The density of understorey and groundcover vegetation varies throughout the study area according to differing land management practices on individual lots, but overall, provides sheltering and foraging habitat for a range of small terrestrial mammals, birds, reptiles and amphibians. Dense and sheltered microhabitats along creeklines are particularly important for a range of more cover dependant bird species.

Aquatic habitats within the study area are generally limited to three ephemeral creeks, containing some ponds and swampy areas. Along with several small dams, these riparian areas provide limited habitats for amphibians, birds, and some reptiles and mammals.

3.4.2 Fauna Species

Targeted fauna surveys and opportunistic observations during the survey period, together with the results of previous surveys, resulted in the detection of 94 faunal species in or adjacent to the study area. A total of 27 mammals, 58 birds, four reptiles and five amphibians were recorded and these are listed in Table 5.

Eight threatened fauna species were recoded during the survey period, consisting of four threatened bats, one threatened glider and three threatened birds. One Commonwealth listed migratory bird species was also recorded. Few introduced species were recorded.

Table 5: Fauna species recorded in the study area

(* denotes introduced species, bold denotes threatened or listed migratory species)

CATEGORY	COMMON NAME	SCIENTIFIC NAME	DETECTION METHOD
Mammals	Brown Antechinus	<i>Antechinus stuartii</i>	Elliott Trapping
	Bush Rat	<i>Rattus fuscipes</i>	Elliott Trapping
	Chocolate Wattled Bat	<i>Chalinolobus morio</i>	Harp Trapping
	Common Brushtail Possum	<i>Trichosurus vulpecula</i>	Direct Observation
	Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>	Direct observation
	Domestic Dog *	<i>Canis familiaris</i> *	Direct observation
	Dusky Antechinus	<i>Antechinus swainsonii</i>	Hair-tube
	Eastern Broad-nosed Bat	<i>Scotorepens orion</i>	AnaBat (Probable)
	East Coast Freetail Bat	<i>Mormopterus norfolkensis</i>	AnaBat (confident)
	Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	AnaBat (Probable)
	Eastern Forest Bat	<i>Vespadelus pumilus</i>	AnaBat (Probable)
	Eastern Grey Kangaroo	<i>Macropus giganteus</i>	Direct observation
	Eastern Horseshoe Bat	<i>Rhinolophus megaphyllus</i>	AnaBat (confident)
	Gould's Long-eared Bat	<i>Nyctophilus gouldi</i>	Harp Trapping
	Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	AnaBat (confident)
	Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	AnaBat (Probable)
	Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	Direct observation
	House Mouse*	<i>Mus musculus</i> *	Elliott Trapping
	Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>	Harp Trapping
	Large Forest Bat	<i>Vespadelus darlingtoni</i>	Harp Trapping
	Little Forest Bat	<i>Vespadelus vulturnus</i>	Harp Trapping
	Long-eared Bat	<i>Nyctophilus sp.</i>	AnaBat (confident)
	Long-nosed Bandicoot	<i>Perameles nasuta</i>	Direct observation
	Southern Forest Bat	<i>Vespadelus regulus</i>	AnaBat (Possible)
	Sugar Glider	<i>Petaurus breviceps</i>	Direct observation
	Swamp Wallaby	<i>Wallabia bicolor</i>	Direct observation
	Yellow-bellied Glider	<i>Petaurus australis</i>	Direct observation

CATEGORY	COMMON NAME	SCIENTIFIC NAME	DETECTION METHOD
	White-striped Free-tailed Bat	<i>Tadarida australis</i>	AnaBat (confident)
Birds	Australian Magpie	<i>Gymnorhina tibicen</i>	Direct observation
	Australian Owllet-nightjar	<i>Aegotheles cristatus</i>	Call Recognition
	Australian Pelican	<i>Pelecanus conspicillatus</i>	Direct observation
	Australian Raven	<i>Corvus coronoides</i>	Direct observation
	Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	Direct observation
	Black-faced Monarch	<i>Monarcha melanopsis</i>	Direct observation
	Brown-headed honeyeater	<i>Melithreptus brevirostris</i>	Direct observation
	Brown Thornbill	<i>Acanthiza pusilla</i>	Direct observation
	Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>	Direct observation
	Chicken*	<i>Gallus gallus</i>	Direct observation
	Cicadabird	<i>Coracina tenuirostris</i>	Direct observation
	Common Bronzewing	<i>Phaps chalcoptera</i>	Direct observation
	Common Koel	<i>Eudynamys scolopacea</i>	Direct observation
	Common Myna*	<i>Acridotheres tristis</i>	Direct observation
	Crimson Rosella	<i>Platycercus elegans</i>	Direct observation
	Dollarbird	<i>Eurystomas orientalis</i>	Direct observation
	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	Direct observation
	Eastern Whipbird	<i>Psophodes olivaceus</i>	Direct observation
	Eastern Yellow Robin	<i>Eopsaltria australis</i>	Direct observation
	Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	Direct observation
	Galah	<i>Cacatua roseicapilla</i>	Direct observation
	Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Direct observation
	Glossy Black-cockatoo	<i>Calyptorhynchus lathami</i>	Direct observation
	Grey Butcherbird	<i>Cracticus torquatus</i>	Direct observation
	Grey Fantail	<i>Rhipidura fuliginosa</i>	Direct observation
	Grey Shrike-Thrush	<i>Colluricincla harmonica</i>	Direct observation
	Laughing Kookaburra	<i>Dacelo novaeguineae</i>	Direct observation
	Lewin's Honeyeater	<i>Meliphaga lewinii</i>	Direct observation
	Magpie-lark	<i>Grallina cyanoleuca</i>	Direct observation
	Masked Lapwing	<i>Vanellus miles</i>	Direct observation
	Musk Lorikeet	<i>Glossopsitta concinna</i>	Direct observation

CATEGORY	COMMON NAME	SCIENTIFIC NAME	DETECTION METHOD
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	Direct observation
	Noisy Friarbird	<i>Philemon corniculatus</i>	Direct observation
	Olive-backed Oriole	<i>Oriolus sagittatus</i>	Direct observation
	Pied Currawong	<i>Strepera graculina</i>	Direct observation
	Powerful Owl	<i>Ninox strenua</i>	Direct observation
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	Direct observation
	Red Wattlebird	<i>Anthochaera lunulata</i>	Direct observation
	Red-browed Finch	<i>Neochmia temporalis</i>	Direct observation
	Restless Flycatcher	<i>Myiagra inquieta</i>	Call Recognition
	Rufous Whistler	<i>Pachycephala rufiventris</i>	Call Recognition
	Sacred Kingfisher	<i>Todiramphus sanctus</i>	Direct observation
	Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	Direct observation
	Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>	Direct observation
	Shining Bronze-Cuckoo	<i>Chrysococcyx lucidus</i>	Call Recognition
	Silvereye	<i>Zosterops lateralis</i>	Direct observation
	Southern Boobook	<i>Ninox novaeseelandiae</i>	Direct observation
	Spotted Pardalote	<i>Pardalotus punctatus</i>	Direct observation
	Striated Thornbill	<i>Acanthiza lineata</i>	Direct observation
	Superb Fairy-wren	<i>Malurus cyaneus</i>	Direct observation
	Tawny Frogmouth	<i>Podargus strigoides</i>	Call Recognition
	Variegated Fairy-wren	<i>Malurus assimilis</i>	Direct observation
	White-browed Scrubwren	<i>Sericornis frontalis</i>	Direct observation
	White-throated Treecreeper	<i>Cormobates leucophaeus</i>	Direct observation
	Willie Wagtail	<i>Rhipidura leucophrys</i>	Direct observation
	Wood Duck	<i>Chenonetta jubata</i>	Direct observation
	Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	Direct observation
	Yellow-tailed Black-cockatoo	<i>Calyptorhynchus funereus</i>	Direct observation
Reptiles	Dark-flecked Garden Skink	<i>Lampropholis delicata</i>	Direct observation
	Eastern Small-eyed Snake	<i>Rhinoplocephalus nigrescens</i>	Direct observation
	Eastern Water Skink	<i>Eulamprus quoyii</i>	Direct observation
	Jacky Lizard	<i>Amphibolurus muricatus</i>	Direct observation

CATEGORY	COMMON NAME	SCIENTIFIC NAME	DETECTION METHOD
	Red-bellied Black Snake	<i>Pseudechis porphyriacus</i>	Direct observation
Amphibians	Bibron's Toadlet	<i>Pseudophryne bibronii</i>	Call Recognition
	Bleating Tree Frog	<i>Litoria dentata</i>	Call Recognition
	Brown-striped Frog	<i>Limnodynastes peronii</i>	Call Recognition
	Common Eastern Froglet	<i>Crinia signifera</i>	Call Recognition
	Peron's Tree Frog	<i>Litoria peronii</i>	Call Recognition
	Tyler's Toadlet	<i>Uperoleia tyleri</i>	Call Recognition
	Verreaux's Tree Frog	<i>Litoria verreauxii</i>	Call Recognition

4. CONSERVATION SIGNIFICANCE

The *NSW Threatened Species Conservation Act 1995 (TSC Act)* and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* provide for the listing of threatened flora and fauna species.

The *EPBC Act* also provides for the listing of migratory species. The *NSW Fisheries Management Act 1994 (FM Act)* provides for the listing of threatened fish species and marine vegetation.

The *TSC Act* classifies threatened flora and fauna species as Endangered (Schedule 1, Part 1), Vulnerable (Schedule 2), or Presumed Extinct (Schedule 1, Part 4). Records of these species may be obtained by searching the Atlas of NSW Wildlife.

The *EPBC Act* classifies threatened flora and fauna species as Extinct, Critically Endangered, Endangered or Vulnerable. An indication of the threatened and migratory species likely to be encountered in a locality may be obtained by using the *EPBC Act* Protected Matters Search Tool.

Both of these databases were searched on 6 August 2007 for records of threatened flora, threatened fauna and migratory species within an area of 10 km x 10 km centred on the study area.

The *FM Act* classifies threatened fish and marine vegetation as Endangered, Vulnerable, or Presumed Extinct. An indication of the species likely to be encountered in a locality may be obtained by reviewing the recommendations for threatened species listed on the schedules of the *FM Act*.

4.1 Threatened Flora

The outcomes of database searches for threatened flora are shown in Table 6 with the status of each species listed as endangered (E) or Vulnerable (V).

The potential for each of these species to occur in the study area and the importance of the habitats are discussed in Table 6 and a decision made regarding the need for further assessment in this report.

Table 6: Threatened flora species recorded or likely to occur in the locality.

THREATENED FLORA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITAT WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
<i>Caladenia tessellata</i> Tessellated Spider Orchid	E	V	This terrestrial orchid is associated with low open forests with a heathy or sometimes grassy understorey on clay-loam or sandy soils. On the coast, flowering is thought to occur between August and November depending on the conditions leading up to flowering (Briggs, J. pers. comm., 2004). In coastal areas it can occur in dense shrubbery and is usually detected only after fire. It is currently known from one population in Braidwood and three populations in Wyong. There are no confirmed recent records of the species in the Shoalhaven, although four plants in bud stage were tentatively identified as the species in the Huskisson area in spring 2003. Another unconfirmed record for the species exists in the Ulladulla area, from Bangalay forest on poorly-drained clay soils. Targeted surveys of potential habitat within the known flowering period for the species did not detect any individuals within the study area. Given also the lack of positive records in the locality, it is considered unlikely that the species would occur in the study area.
<i>Calochilus pulchellus</i> Pretty Beard Orchid	E		This terrestrial orchid was formally listed as endangered in May 2008, with all known occurrences of the species occurring within the Shoalhaven Local Government Area. Small numbers of individuals are known from Vincentia, Booderee National Park and Morton National Park where they grow in heath communities associated with sandstone. The species is not expected to occur in the study area, which is dominated by forest communities and does not appear to support suitable habitat.
<i>Cryptostylis hunteriana</i> Leafless Tongue Orchid	V	V	Present. This terrestrial orchid grows in swamp-heath, woodland and open forest on sandy soils in predominantly coastal districts. A number of populations are known from the Shoalhaven, including the Jervis Bay area, although only one record occurs within five km of the study area. Targeted surveys recorded a single individual in the north-east corner of the study area, which relates to the most suitable habitat in the study area. Given these results, the species is unlikely to occur in other parts of the study area, and the study area is unlikely to support a large population of the species.
<i>Galium australe</i> Tangled Bedstraw	E		In the Shoalhaven, this perennial herb is known locally from Lake Windemere in Booderee National Park, Conjola National Park and Swan Lake near Swan Haven. The species has been recorded in moist gullies of tall forest, <i>Eucalyptus tereticornis</i> forest, coastal Banksia shrubland, and <i>Allocasuarina nana</i> heathland. Targeted surveys of the most likely habitat within the study area during the flowering season did not locate any individuals. The species can be difficult to locate, but is probably unlikely to occur in the study area. Most potential habitat for this species is likely to be retained within riparian areas and associated buffers.
<i>Genoplesium baueri</i> Bauer's Midge Orchid	V		This small orchid occurs in forest and woodland and has been recorded locally at Nowra, Jerrawangala, Callala and Vincentia. Targeted surveys during the known flowering period, following confirmation of flowering at the nearest known population, did not record any individuals. The absence of individuals during this survey suggests that the study area is unlikely to support the species or contain important habitat for the species.

THREATENED FLORA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITAT WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
<i>Melaleuca biconvexa</i> Biconvex Paperbark	V	V	Present. This paperbark is generally restricted to creeks and poorly drained areas. This species was found to occur along all creeks in the study area and was often a dominant species in these habitats. The study area contains a substantial population of the species.
<i>Prasophyllum affine</i> Jervis Bay Leek Orchid	E	E	This orchid occurs on clayey soils overlain by sand in heathland and sedgeland at Vincentia and Currarong. The study area generally contains unsuitable habitat and the species was not recorded during targeted surveys. It is considered unlikely that the species occurs in the study area.
<i>Rhizanthella slateri</i> Eastern underground Orchid	V		This orchid occurs almost entirely underground, although flowering heads may protrude up to two cm above the ground. The species is very cryptic and difficult to detect, and is known from fewer than ten locations in New South Wales. The species has been recorded locally from Vincentia, in Scribbly Gum Woodland, but is known to occur elsewhere in other habitats. Although potential habitat may exist in the study area, the species is probably unlikely to occur there. Targeted surveys did not detect this species in the study area, and habitats within the study area are not expected to be important for the species.
<i>Syzigium paniculatum</i> Magenta Lilly Pilly	V	V	This shrub or small tree with flaky bark is usually found in subtropical and littoral rainforests on sandy soils or sheltered gullies, especially near watercourses. The study area provides marginal habitat for the species in more sheltered gullies, however it was not detected despite thorough survey coverage. It is considered unlikely that the species occurs within the study area. All potential habitat along creek lines is likely to be protected along with other ecological constraints.

Two threatened flora species, *Melaleuca biconvexa* and *Cryptostylis hunteriana* were recorded in the study area (Figure 5, Appendix A). The ecological constraints to the rezoning of the study area posed by these species are discussed in subsequent sections of this report.

4.2 Other Flora of Conservation Significance

The study area is known to contain one non-threatened plant species of particular significance. *Specularantha ventricosa* is a terrestrial orchid currently known only from two sites in the St. Georges Basin locality – the study area and Sussex Inlet. The species was discovered near the northern boundary of the study area in 2000 by Mr. David Jones, who subsequently described and named the species, although this information had not been published at the time of writing. Initial targeted surveys by BES in 2007 recorded approximately 130 individuals in Currumbene Lowlands Forest vegetation from the north eastern and central parts of the study area. A more intensive survey by BES in 2008 recorded 467 plants within the same area (Figure 5, Appendix A). Individuals were predominantly associated with forest edges which had been disturbed by slashing or mowing, particularly along Nebraska Road in the north east of the study area, however approximately 40 individuals were also found on the edge of a mown section of an

established residential property near the centre of the study area. Individuals also occurred in open patches within denser forested areas.

The species is likely to be more widely distributed, however the currently known distribution is highly restricted and all known occurrences are currently unprotected by land zoning or relevant legislation and in most cases directly threatened by inappropriate land use practices. The species is eligible for listing as a threatened species, and potentially eligible for listing as an endangered species under both the *TSC Act* and the *EPBC Act*.

While it is possible for the species' apparent conservation significance to be downgraded by future discoveries of substantial numbers beyond the study area, until this information is available, the species should be treated as a threatened species. At a minimum, this should involve the retention of all known individuals and appropriate habitat connectivity. Any future rezoning of Nebraska Estate should consider the potential direct and indirect impacts to this species and its habitat. Additional surveys for the species are recommended to better understand the species' distribution and abundance within and beyond the study area.

4.3 Threatened Fauna

The outcomes of database searches for threatened fauna and the review of recommendations for threatened species listed on the schedules of the *TSC* and *EPBC Act* are shown in Table 7 below with the status of each species listed as endangered (E) or Vulnerable (V).

The potential for each of these species to occur in the study area and the importance of the habitats within the study area to these species are discussed in Table 7.

Additional threatened species recorded in the study area or that may inhabit the study area have also been included by correlating species habitat requirements with the existing environment. Marine and aquatic species have been omitted as they would not occur in the study area.

Table 7: Threatened fauna species recorded or likely to occur in the locality.

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
Mammals			
East Coast Freetail Bat <i>Mormopterus norfolkensis</i>	V		Present. This bat roosts in tree hollows and forages for insects in forests. This species was detected by echolocation call recording within forest towards the north eastern and south eastern parts of the study area. Suitable foraging habitat is present throughout most of the study area, and the distribution of large trees with hollows generally reflects potential roosting and breeding habitat for this species. No roost sites were observed during stag watching or

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
			other surveys, although potential shelter and breeding sites are present.
Eastern Bent-wing Bat <i>Miniopterus schreibersii oceanensis</i>	V		Likely to be present – recorded in the area by Andrews.Neil (1994) and known from the locality. This bat predominately uses caves as roosting and breeding sites and forests for foraging. Caves are not present in the study area so breeding habitat is absent, although suitable foraging habitat occurs over much of the study area. This wide ranging species is expected to forage within the study area on a fairly regular basis.
Eastern Cave Bat <i>Vespadelus troughtoni</i>	V		This species generally roosts in caves and forages in forest and woodland. The study area provides foraging habitat but no roosting resources. It was not detected during the survey period. The species does not appear to occur regularly in the Shoalhaven and is not expected to occur in the study area.
Eastern False Pipistrelle <i>Falsistrellus tasmaniensis</i>	V		Present. This bat roosts in tree hollows and forages in forests. It was detected by echolocation call recording to a “probable” level of identification confidence from the western and southern parts of the study area. It is expected to forage within the study area on a regular basis as suitable foraging habitat is present. Hollow trees suitable for sheltering and breeding are also present, and may potentially be utilised by this species, although no evidence of roosting was recorded during the survey period.
Eastern Pygmy-possum <i>Cercartetus nanus</i>	V	-	This species forages for pollen and nectar from a wide variety of nectar-bearing plants, and also eats insects, seeds and fruit. It often nests in tree hollows but may use a range of other shelter sites. This species is known from the St. Georges Basin and Vincentia areas, where it is most often recorded in heath woodland with a range of nectar producing trees and shrubs. The study area contains areas of suitable habitat, mostly in the north eastern section, but the species was not recorded by the range of survey methods employed. These results and the disturbance regime of the study area suggest that the study area is unlikely to be important for the species.
Greater Broad-nosed Bat <i>Scoteanax rueppellii</i>	V	-	Present. This bat roosts in tree hollows and forages in forests. It was detected by echolocation call recording to a “probable” level of identification confidence from the western portion of the study area. It is expected to forage within the study area on a regular basis as suitable foraging habitat is present. Hollow trees suitable for sheltering and breeding are also present, and may potentially be utilised by this species, although no evidence of roosting was recorded during the survey period.
Grey-headed Flying-fox <i>Pteropus poliocephalus</i>	V	V	Present. The species roosts in permanent camps and forages for nectar in flowering trees and shrubs over vast areas. Permanent roosting habitat is not present, but the species was observed foraging in flowering trees (mostly Red Bloodwood) throughout the study area during the survey period and is likely to do so whenever suitable trees are flowering. Suitable foraging resources for this species occur throughout the study area.

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
Large-eared Pied Bat <i>Chalinolobus dwyeri</i>	V	V	This bat uses caves as roosting sites and forests for foraging. Caves are not present in the study area although suitable foraging habitat is present. The species is not regularly detected south of Nowra, although it could be expected to forage in the study area on occasions. The species was not detected during targeted surveys and the study area does not represent important habitat.
Large-footed Myotis <i>Myotis adversus</i>	V		This bat roosts in caves, dense vegetation and tree hollows near watercourses. It typically forages over rivers, streams and similar waterbodies. Some potential roosting and breeding habitat is present within large trees containing hollows, and potential foraging habitat occurs along sections of the creeks in the study area. This species was not detected during the survey period despite echolocation call recording and harp trapping in riparian vegetation. The species appears unlikely to occur regularly in the study area, which does not appear to provide important habitat for the species.
Koala <i>Phascolarctos cinereus</i>	V	-	The study area contains some suitable feed trees for the Koala, but it was not detected during surveys. No recent records for the species exist in the general area and no populations are considered likely to occur nearby. Disturbances and the presence of introduced predators (dogs) further reduce the likelihood of the species occurring within the study area.
Long-nosed Potoroo <i>Potorous tridactylus</i>	V	V	This species often occurs in thick contiguous undergrowth where the soil is light and sandy. Parts of the study area contain potential habitat, although the species was not recorded during targeted surveys including cage trapping and hair funnels. The species has been recorded near Tomerong, but is not known from the immediate area. Given the lack of detection during the survey period and range of disturbances in and around the study area, the species is considered unlikely to occur in the study area.
Southern Brown Bandicoot <i>Isoodon obesulus</i>	E	E	This species requires thick contiguous undergrowth where the soil is light and sandy. Parts of the study area contain potential habitat, although the species was not recorded during targeted surveys including cage trapping and hair funnels. A record of the species occurs in Booderee National Park, although the species is now considered locally extinct in the Park. Given the lack of detection during the survey and lack of records in the locality, the species is considered unlikely to occur in the study area.
Spotted-tailed Quoll <i>Dasyurus maculatus</i>	V	E	This species occurs in a wide range of habitats and dens in fallen logs, tree hollows and rock crevices. It forages on a range of mammals, birds and insects over a large home range. The species is rarely recorded in the locality and the study area contains only marginal habitat. Better quality habitat occurs in some adjacent areas, but this is very fragmented. The species is unlikely to occur in the study area on a regular basis, and the study area does not contain important resources for the species.

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
Squirrel Glider <i>Petaurus norfolcensis</i>	V	-	The species dens in tree hollows and forages in forests and woodlands where it's preferred foraging resources are found. The species appears to be sparsely and patchily distributed on the south coast, and can be difficult to locate. It has apparently been recorded from the Vincentia area, as well as Callala Bay and Culburra. The study area contains potential denning and foraging habitat, but the species was not detected during the survey period. Given the lack of records in the locality and previous disturbances to the study area and surrounds, the species is considered unlikely to occur there. The study area is unlikely to be important for this species.
White-footed Dunnart <i>Sminthopsis leucopus</i>	V	-	This species inhabits a range of environments including grassland, heath and forest, and in NSW may prefer vegetation with a more open understorey. The species is known from a number of records in the Jervis Bay area. The species was not detected during the survey period and is not known from the locality. Potentially suitable habitat occurs in the northern parts of the study area, however the lack of evidence of the species suggests that the study area does not provide important habitat and the species is unlikely to occur there.
Yellow-bellied Glider <i>Petaurus australis</i>	V	-	Present. The species dens in tree hollows and forages in open forests where it's preferred feed trees are found. The species was observed in the study area, much of which contains suitable foraging resources and scattered denning resources. The species is known to use at least the northern portion of the study area for foraging and three Red Bloodwood sap-feeding trees were observed. No evidence of den tree use was recorded during the survey period. Individuals utilising the study area also use adjacent habitats of higher quality to the north and west.
Yellow-bellied Sheathtail Bat <i>Saccolaimus flaviventris</i>	V	-	This species generally roosts in tree hollows and buildings and forages for insects in a wide variety of habitats from forests to treeless areas. The study area provides potential roosting and foraging habitat. This species was not detected during the survey period and is rarely recorded in the Shoalhaven. The species may occasionally occur in the study area, although it is not expected to occur regularly, nor is the study area likely to comprise important habitat for the species.
Birds			
Painted Snipe <i>Rostratula benghalensis</i>	E	E	This species occurs in swamp or marsh type vegetation where it nests on the ground amongst taller grasses or reeds. It forages at night on invertebrates and some vegetation. It is most common in the Murray-Darling Basin and no records of the species are known from the Shoalhaven. The study area contains no suitable habitat and the species is not expected to occur there.
Barking Owl <i>Ninox connivens</i>	V	-	This species relies on hollow trees for nesting and a range of mammals and birds for foraging. Records of this species in the locality are scarce and do not appear to represent resident individuals or indicate permanent territories. Suitable foraging, roosting and nesting habitat is present in the study area, but the species was not recorded during the survey period. Given the ephemeral

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
			occurrence of the species in the locality, it is not expected to utilise habitats in the study area on a regular basis.
Black Bittern <i>Ixobrychus flavicollis</i>	V	-	This species is usually found in wetlands, soaks and along vegetated rainforest streams. The species was not recorded during the survey period, although some marginal habitat does exist along the creeklines of the study area. The species could conceivably utilise these habitats for sheltering and foraging on occasions, but is unlikely to use the area for nesting. All potential habitat for the Black Bittern is also affected by other environmental constraints and is very likely to be entirely retained for environmental protection purposes.
Eastern Bristlebird <i>Dasyornis brachypterus</i>	E	E	The Eastern Bristlebird is a cover-dependent species predominantly of dense heath or similar low-level vegetation. The species is known to utilise dense riparian vegetation, but was not recorded during the survey period. Habitats in and around the study area are largely unsuitable for the species and it is not expected to occur there.
Gang-gang Cockatoo <i>Callocephalon fimbriatum</i>	V	-	Present. Gang-gang cockatoos are hollow-dependent inhabitants of forest and woodlands of south-eastern Australia. The species feeds on the seeds of eucalypts, acacias and a range of other species. The species was recorded foraging in the study area and a nest tree was located just to the north of the study area. Much of the study area contains suitable foraging habitat, and the species is expected to forage in the area on a regular basis. Potential nesting resources also occur in larger hollow-bearing trees in the study area, however these are of lower quality relative to the larger hollow-bearing trees within less disturbed areas of forest in the locality, including forest adjoining the north of the study area.
Glossy Black-cockatoo <i>Calyptorhynchus lathami</i>	V	-	Present. This species occurs in forests and woodlands where She-oak feeding resources are prevalent and suitable tree hollows exist for breeding. Twenty five feed-trees were recorded, mostly within the northern half of the study area. The species is expected to forage regularly in the study area, although based on the extent of foraging activity, the study area does not contain particularly important foraging habitat for the species. The species was not recorded breeding in the study area, and while this is possible (as some potentially suitable tree hollows are present), it is considered unlikely given the larger trees within less disturbed areas of forest beyond the study area, such as land adjoining the north of the study area.
Ground Parrot <i>Pezoporus wallicus</i>	V	-	This cover-dependent species is usually associated with low heathland and sedgeland vegetation. No suitable habitat occurs in the study area and the species is not expected to occur there.

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
Masked Owl <i>Tyto novaehollandiae</i>	V	-	This species breeds and may roost in tree hollows and forages mostly on small terrestrial mammals. Suitable foraging habitat occurs in more open vegetation in the study area, and some potentially suitable roosting and breeding habitat is present in larger trees with hollows. The species was not recorded during the survey period and the study area does not provide high quality or particularly important habitats for this species. The Masked Owl is known from the locality and could occur in the study area on occasions, but is unlikely to breed or occur there regularly given the lower quality of habitat in the study area relative to much of the surrounding area.
Olive Whistler <i>Pachycephala olivacea</i>	V	-	This species is usually associated with moist tall forests at higher elevations but may move to lower elevations during the winter months. Breeding generally occurs during spring and summer at higher altitudes within habitats providing both a thick understorey and moderate canopy. The species has been infrequently recorded in coastal areas in the Shoalhaven and was not recorded during the survey period. Riparian forest habitats could potentially be utilised by the species on occasions, although the study area does not contain important habitats for the species and it is not expected to occur regularly.
Orange-bellied Parrot <i>Neophema chrysogaster</i>	E	E	This non-breeding winter migrant to the region forages mainly on seeds and fruits of sedges, saltmarsh plants and shrubs close to the coast, but may occur in other near-coastal habitats including highly modified areas. The study area does not provide suitable habitat for this species and it is unlikely to occur there.
Osprey <i>Pandion haliaetus</i>	V	-	This species builds nests on cliff tops or in large dead trees close to water and hunts for fish in open water such as rivers, lakes and the ocean. It has been recorded at Jervis Bay. No suitable habitat occurs in the study area and the species is not expected to occur there.
Powerful Owl <i>Ninox strenua</i>	V	-	Present. Preferred habitat for this species is forest containing large tree hollows for breeding and a prey base of primarily arboreal mammals. The species was observed roosting in the central gully of the study area, although roosting resources are generally marginal and limited to a few riparian areas. The entire study area provides suitable foraging habitat, although this is not of particularly high quality given the relatively low density of mammalian prey species observed. The Powerful Owl is expected to forage in the study area on occasions as part of a larger home range. Breeding within the study area is unlikely given the marginal nature of the few potential nesting areas and the superior habitat in surrounding areas.
Regent Honeyeater <i>Xanthomyza phrygia</i>	E	E	This migrant to the region forages in winter-flowering trees such as Spotted Gum, Woollybutt, and Swamp Mahogany. Some lower quality foraging resources are present within the study area and it is possible that the species could utilise these resources on occasions, although much higher quality foraging habitat occurs elsewhere in the locality. The species is not expected to breed in the locality and the study area does not constitute important habitat for

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
			this species. The species is not regularly recorded in the locality and was not detected during the survey period.
Sooty Owl <i>Tyto tenebricosa</i>	V	-	This species is typically associated with closed forest and tall wet open forest, but is known to also occur in a wider range of habitats. The species has been recorded in the locality, although apparently not occupying any permanent territories. Suitable foraging habitat occurs within the study area, although potentially important roosting and breeding resources are not present. The species was not recorded during the survey period and is not expected to occur in the study area regularly.
Square-tailed Kite <i>Lophoictinia isura</i>	V	-	This summer migrant to the Shoalhaven hunts for passerines in coastal open forests and breeds in mature trees often near waterways. The Square-tailed Kite was not recorded during the survey period, but is regularly observed within the locality during the warmer months. The species is expected to forage in the study area on occasions as part of a much larger home range, and most of the study area provides suitable foraging habitat. The species is unlikely to nest in the study area and no evidence of nesting was found during the study.
Striated Fieldwren <i>Calamanthus fuliginosus</i>	V	-	This species occurs in coastal heaths, swamp margins, tussocky grasslands and other dense, low vegetation. Habitat in the study area is largely unsuitable. The species is not known from the locality and was not recorded during the survey period. It is unlikely that the species occurs in the study area.
Swift Parrot <i>Lathamus discolor</i>	E	E	This non-breeding migrant to the region forages for nectar in flowering trees such as Spotted Gum, Swamp Mahogany and Red Bloodwood. The species was not recorded during the survey period and no records exist in the locality, however some suitable foraging resources are present within the study area and it is possible that the species will utilise such resources on occasions. However, the limited foraging resources in the study area would not be of importance to the species, and are of relatively low quality.
Turquoise Parrot <i>Neophema pulchella</i>	V	-	This species favours open woodland habitats and generally feeds on seeds from grasses, herbs and shrubs. It nests in hollow trees or logs, which may be close to the ground. There are few records in the locality, and the species was not recorded during the survey period. The study area provides marginal foraging habitat and unlikely breeding habitat for the species. The species is unlikely to occur regularly in the study area, which does not appear to be of importance to the species.
Amphibians			
Giant Burrowing Frog <i>Heleioporus australiacus</i>	V	V	This species may be found in a range of habitats from forest to heath, usually in sandy soils and breeds in creeks and ephemeral ponds often underlain with sandstone, or within burrows. The species appears intolerant of clearing and poor water quality. The species is known from Booderee National Park and Vincentia, but has not been recorded in the vicinity of the study area. The ephemeral creeks of the study area offer some marginal habitat, but the

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	TSC Act	EPBC Act	
			species was not recorded during the survey period. The study area does not appear to provide typical or important habitat for the species, which seems unlikely to occur there.
Green and Golden Bell Frog <i>Litoria aurea</i>	E	V	This species prefers unshaded water bodies containing emergent vegetation. No recent records of this species occur in the locality. The creeks in the study area do not provide suitable habitat, and one small ornamental dam provides only marginal habitat. The species was not detected during the survey period and is considered unlikely to occur in the study area.
Reptiles			
Broad-headed Snake <i>Hoplocephalus bungaroides</i>	E	V	This nocturnal species occurs on the edges of sandstone cliffs where it shelters in crevices and under rocks during the cooler months, and utilises tree hollows for shelter during the hot summer months. There is no suitable or potential habitat in the study area and the species is not expected to occur there.
Rosenberg's Goanna <i>Varanus rosenbergi</i>	V	-	This species occurs in heaths, woodlands and forests and incubates its eggs in termite mounds. It shelters in burrows, hollow logs and rock crevices. The study area provides largely unsuitable habitat given the lack of termite mounds. The species is not known from the locality, was not detected during the survey period and is not expected to occur in the study area.
Insects			
Giant Dragonfly <i>Petalura gigantea</i>	E	-	This dragonfly occurs in permanent swamps and bogs and is detectable from about November to early February. Adults forage on flying insects among vegetation adjacent to swamps. The species is known from the Vincentia area. No typical habitat occurs in the study area, and the species was not detected during the survey period. The species is considered unlikely to occur in the study area.

A total of eight threatened fauna species were recorded in the study area during the survey period: the East Coast Freetail Bat *Mormopterus norfolkensis*, Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Gang-gang Cockatoo *Callocephalon fimbriatum*; Glossy Black-cockatoo *Calyptorhynchus lathami*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Grey-headed Flying-fox *Pteropus poliocephalus*, Powerful Owl *Ninox strenua*, and Yellow-bellied Glider *Petaurus australis*. The locations of these species are shown in Figure 5 (Appendix A).

The ecological constraints to the rezoning of the study area posed by these species are discussed in subsequent sections of this report.

4.4 Migratory Species

The outcome of the *EPBC Act* database search for migratory species is shown in Table 8 below. The potential for each of these species to occur in the study area and the importance of habitats in the study area is discussed in Table 8.

Species encountered in marine environments have been omitted, as these habitats do not occur in the study area.

Table 8: Migratory species recorded or likely to occur in the locality.

SPECIES	POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
Black-faced Monarch <i>Monarcha melanopsis</i>	Present. This migratory species is known to breed in damp forest types and forage in rainforest and eucalypt forest. Several individuals were heard calling from the gully near the northern boundary of study area. Primary habitat (including potential breeding habitat) for this species occurs throughout the dense, forested creek lines of the study area. Foraging habitat may extend into adjacent drier forest. Breeding by this species was not confirmed in the study area, although it is possible, given the suitability of habitat.
Latham's Snipe <i>Gallinago hardwickii</i>	This migratory species is found in a range of vegetated wetlands and does not breed in Australia. The marginal habitats of the study area suggest this species would be unlikely to occur there regularly. It was not detected during the survey period.
Orange-bellied Parrot <i>Neophema chrysogaster</i>	This migratory species breeds in the south-west of Tasmania and migrates in autumn to spend the winter on the coast of south-eastern South Australia and southern Victoria. Typical winter habitat is saltmarsh and strandline/foredune vegetation communities within 3 km of the coast. Habitats in the study area are generally unsuitable for this species and it is not expected to occur there.
Painted Snipe <i>Rostratula benghalensis</i>	This migratory species is usually found in vegetated, shallow, temporary or infrequently filled wetlands. The study area contains largely unsuitable habitat for this species. Given its rarity in the region and lack of records in the Shoalhaven, it is considered unlikely to occur in the study area.
Regent Honeyeater <i>Xanthomyza phrygia</i>	This migrant to the region forages in winter-flowering trees such as Spotted Gum, Woollybutt, and Swamp Mahogany. Some suitable, although not high quality, foraging resources are present within the study area, and it is possible that the species will utilise these resources on occasions. The species is not expected to breed in the locality and the study area does not constitute particularly important habitat. The species was not detected during the survey period and is unlikely to occur in the study area regularly.
Rufous Fantail <i>Rhipidura rufifrons</i>	This species is known to utilise dense understorey in damp forests or beside rivers. The study area contains potential habitat for the species, in association with riparian vegetation. The species could potentially occur in the study area, although was not recorded during the survey period. The study area does not constitute particularly important habitat for this species.
Satin Flycatcher <i>Myiagra cyanoleuca</i>	This migratory species inhabits lowland eucalypt forests. It is known to nest in dense gully vegetation. Potential habitat is present within denser vegetation in the study area, particularly riparian areas, which are expected to be largely retained with any future development. The species could occur in the study area on occasions, but was not

SPECIES	POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS WITHIN THE STUDY AREA
	recorded during the survey period. The habitats present do not represent particularly important areas for the species.
Swift Parrot <i>Lathamus discolor</i>	This non-breeding migrant to the region forages for nectar in flowering trees such as Spotted Gum, Swamp Mahogany and Red Bloodwood. The species was not recorded during the survey period and no records exist in the locality, however some suitable foraging resources are present within the study area and it is possible that the species will utilise such resources on occasions. However, the limited foraging resources in the study area would not be of importance to the species, and are of relatively low quality.
White-bellied Sea-eagle <i>Haliaeetus leucogaster</i>	This migratory species inhabits primarily coastal environments but may occur inland in association with rivers, lagoons and floodplains, where it forages for fish and nests in tall trees. Marginal nesting resources are present in the study area, and no evidence of nesting was observed during the survey period. No foraging resources for the species occur in the study area. The study area does not contain important habitat for this species.
White-throated Needletail <i>Hirundapus caudacutus</i>	This migratory species is often seen gliding ahead of storm fronts and forages for insects on the wing. It roosts on the side of cliffs or tree trunks. There are no important resources likely to be used by the species in the study area. The study area does not contain important habitat for the species.

The Black-faced Monarch was recorded in the study area (Figure 5, Appendix A) and may utilise habitats within the study area on a seasonal and regular basis. The ecological constraints to the rezoning of the study area posed by this species are discussed in subsequent sections of this report.

4.5 Endangered Populations

The *TSC Act* provides for the listing of endangered populations on Schedule 1, Part 2. There are no endangered populations listed on the schedules of the *TSC Act* found in the City of Shoalhaven. No further consideration or assessment is given to endangered populations in this report.

4.6 Endangered Ecological Communities

The *TSC Act* and *EPBC Act* provide for the listing of endangered ecological communities. The Coastal Sand Swamp Forest within the study area is considered to comprise the Swamp Sclerophyll Forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (hereafter referred to as Swamp Sclerophyll Forest), listed on the *TSC Act* (Figure 5, Appendix A).

Whilst parts of the Coastal Sand Forest of Tindall *et. al.* (2004) comprise the Bangalay Sand Forest in the Sydney Basin and South East Corner Bioregions (hereafter referred to as Bangalay Sand Forest) (NSW Scientific Committee 2005) which is listed on the *TSC Act*, the

Coastal Sand Forest within the study area is not considered to be the Bangalay Sand Forest community as:

- it does not include any individuals of *Banksia integrifolia* subsp. *integrifolia* which the final determination (NSW Scientific Committee 2005) lists as one of the most common tree species;
- the shrub stratum is not dominated by either *Monotoca elliptica*, *Leptospermum laevigatum*, *Breynia oblongifolia* or *Pittosporum undulatum* and in fact does not include these species;
- the shrub stratum is dominated by Yellow Tea-tree, Snow in Summer, Sydney Golden Wattle, Lance-leaf Beard-heath, Slender Rice-flower, and Prickly Tea-tree, which are not characteristic species of the community; and
- it includes canopy species not characteristic of the community such as White Stringybark and Thin-leaved Stringybark.

The Bangalay Sand Forest appears to be restricted to habitats that have a greater exposure to salt-laden winds, where species such as *Monotoca elliptica* and *Leptospermum laevigatum* generally occur, or in more sheltered hind dune habitats where, in the absence of fire, mesic species such as *Breynia oblongifolia* and *Pittosporum undulatum* are common. The Coastal Sand Forest within the study area, whilst protected from coastal influences somewhat by distance from the open sea and the vegetation between the study area and St Georges Basin, also appears to have been more exposed to and likely more frequently affected by fire. As such, whilst the community does not currently comprise the Bangalay Sand Forest, it is possible that in the long term absence of fire, the community may increasingly resemble the community.

No other vegetation communities within the study area have characteristics associated with threatened ecological communities listed on either the *TSC Act* or *EPBC Act*.

4.7 Koala Habitat

The study area does not contain any species which are listed as koala feed trees on Schedule 2 of *NSW State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP No. 44)*. Therefore, the study area does not contain potential koala habitat as defined by *SEPP No. 44*.

There is also no evidence of koalas occurring within the locality recently and they were not detected during targeted surveys utilising call playback, spotlighting and diurnal searches for individuals and characteristic scratchings on trees. Koalas would appear unlikely to occur within the study area.

4.8 Habitat Corridor and Connectivity Values

The study area has a number of values relating to habitat corridors and connectivity to adjoining vegetated areas.

Habitat within the study area north of Fisherman Road lies within the 'disturbed habitat and vegetation' (corridor) identified by Clause 15 of the Jervis Bay Regional Environment Plan (JBREP). This corridor links habitats in Jervis Bay National Park at Vincentia with habitats in Corramy State Conservation Area at Basin View and vast areas of other vegetated lands to the west of the Princes Highway. The northern portion of the study area has excellent connectivity to higher quality habitats to the north and north east, and good connectivity to similarly high quality habitats to the west, separated only by Grange Road. While more heavily disturbed than much of the surrounding habitats identified as a 'corridor' under Clause 15, the portion of the study area north of Fisherman Road would facilitate movement of fauna species and exchange of genetic material in a wider context.

Habitat connectivity to the south west and south east exists initially as scattered trees within a largely developed rural or residential setting, although substantial blocks of vegetated land exist nearby. This type of landscape offers foraging habitat and 'stepping-stone' connectivity for more mobile bird and bat species.

Habitat connectivity to the south of the study area, via relatively narrow riparian habitats, is also considered particularly important due to the adjoining large areas of good quality riparian habitats associated with St. Georges Basin. While dissected by the Wool Road, the disruption to habitats is relatively narrow and currently allows for good connectivity. The study area also has important and relatively undisturbed riparian habitat connectivity to the north. Riparian habitats to the east have been heavily disturbed on the adjacent rural property, although a partially vegetated corridor is present. Riparian connectivity to the west has been diminished by land clearing within the study area and by Grange Road, but riparian habitats are relatively intact to the west of Grange Road.

Riparian vegetation contains the Swamp Sclerophyll Forest endangered ecological community and large numbers of the threatened species *Melaleuca biconvexa*, which are expected to occur in all adjoining drainage lines associated with the study area. Riparian vegetation also contains particular habitats for a range of fauna, including the migratory Black-faced Monarch and potential roosting sites for the threatened Powerful Owl.

5. ECOLOGICAL CONSTRAINTS

5.1 Threatened Flora

Melaleuca biconvexa

A substantial population of the Biconvex Paperbark *Melaleuca biconvexa* occurs in the study area, in a nearly continuous distribution along the main and secondary drainage lines. The population within the study area is expected to contain over 1000 individuals. The species is known to extend at least some way beyond the study area in association with all drainage lines, including along the vast majority of the south-western boundary. Several individual *M. biconvexa* plants or clusters of plants were found to occur away from the main distribution. These separate individuals towards the west and south of the study area are likely to represent the distribution of *M. biconvexa* prior to clearing. However, one separate cluster of several individuals in the west of the study area seems to be the result of deliberate planting or germination in marginal habitat. The study area is considered to contain important habitat for *M. biconvexa*, and currently has good connectivity to adjacent habitats known to contain the species.

The species' association with creeks and swampy areas makes them potentially vulnerable to changes in hydrological regimes, water quality and run-on impacts. A 50m buffer has been applied to the main distribution of the species, in which further disturbances should be prevented or minimised. Within this buffer, the distribution of the species could be extended by appropriate rehabilitation of riparian areas that have been cleared, such as in the west and south of the study area.

Cryptostylis hunteriana

A single Leafless Tongue Orchid *Cryptostylis hunteriana* was found close to the north eastern corner of the study area during the survey period. The study area is not expected to contain a particularly large or important population of the species given the distribution of suitable habitat in the area and results of targeted surveys. The preferred habitat for the species appears limited to the north-eastern portion of the study area, with larger and less disturbed examples of this habitat occurring beyond the study area to the north east.

While the main extent of the local *Cryptostylis hunteriana* population may possibly occur beyond the study area, the single individual found during the survey period is currently the only evidence of this species in the immediate area and one of only two records in the locality. This record and surrounding habitat should be retained and protected, at least until it can be demonstrated that the individual and associated habitat in the study area are not important components of the local population. A 50m buffer has been applied to this individual, to allow retention of preferred habitat in the study area, which is likely to contain other undetected

individuals of the species. This buffer also ensures connectivity is maintained with suitable habitat beyond and to the northeast of the study area. It is possible that other individuals of this species could occur in the north east of the study area beyond the 50m buffer applied to the single *C. hunteriana* individual, but no further habitat protection measures are proposed, given that habitat quality for this species appears to diminish with increasing distance from the north eastern corner of the study area. The north eastern portion of the study area is also covered by multiple constraints for other species and/or habitats.

The study area is not expected to contain important habitat for other threatened flora species.

5.2 Other Flora of Conservation Significance

The survey has recorded one non-threatened flora species of particular conservation significance, *Speculantha ventricosa*, which is a recently described species currently known only from the study area. A total of 467 individuals of this species were recorded during the survey period, mostly near the north-eastern corner of the study area, but some on the edges of Pelican Road and one cluster further south, close to Fishermans Road. The majority of individuals were found to be associated with vegetative clearing along forest edges or more open areas within denser forest.

While the species is not formally recognised as 'threatened' and thus has no legal status or protection as a threatened species, it appears eligible for listing as a threatened species under state and commonwealth legislation as the entire known population is small, unprotected by land tenure or zoning and under threat from land management practices.

The species is likely to occur more widely, at least in adjoining areas, but until the status of the species can be clarified by an increased understanding of its taxonomy, distribution and abundance, it is recommended that the species (and associated habitat) is treated with the same status as that of a threatened species. All known individuals and associated habitat should be retained.

A 50m buffer has been applied to all known individuals (Figure 6, Appendix A) to retain some suitable habitat for undetected individuals and pollinators (which are largely unknown at this time). Approximately 95% of the known population in the study area occur within a 250m x 250m area in the north-eastern corner. The 50m buffers around individuals in this main occurrence link all of these individuals to adjoining suitable habitat to the north and east of the study area. The two clusters to the south and west of the main occurrence are more closely associated with riparian habitats (which are likely to be retained intact), but the importance of the riparian vegetation for habitat connectivity and pollinators is not clearly understood. However, the orchid buffers together with the riparian vegetation constraint buffers (which also comprise non-riparian habitats) are probably adequate to ensure habitat connectivity between all occurrences of *Speculantha ventricosa* in the study area.

5.3 Threatened Fauna

5.3.1 Mammals

Yellow-bellied Glider

Yellow-bellied Gliders are known to use at least large parts of the study area for foraging, as evidenced by observations of one individual and two sap-feeding trees in the study area and several anecdotal records. Characteristic incisions on sap-feeding trees were also observed beyond the study area to the north and the south west. The species is known to use the eastern half of the study area from the northern boundary to at least 100m south of Pelican Road. Given the distribution of surrounding records and suitable habitat, the species is very likely to utilise the habitats in the western parts of the study area, particularly those to the west of Waterpark Road.

No use of hollow-bearing trees in the study area for denning was recorded during the survey period, although this is possible given the suitability of a number of larger hollow-bearing trees and the confirmed use of the area by the species. However, den tree use is more likely to occur within higher quality habitat beyond the study area, to the north, north-east or west.

The study area forms part of a home range of Yellow-bellied Gliders, although the core of this habitat (as defined by the number of records and likely denning and breeding sites) appears to lie to the north of the study area. This conclusion is supported by a number of sources: observations during the survey period of individuals moving into the study area from the north and lack of denning or dusk calling evidence from within the study area; the results of two broader Yellow-bellied Glider studies that had survey sites in and around the study area (SCC 2003; Garrock 2006); and the results of two previous flora and fauna surveys of the study area (Andrews.Neil 1994; Burcher 1994).

Available data suggest that habitat in the far south of the study area, and connectivity to other habitat to the south, may not be important for the Yellow-bellied Glider. The species does not appear to have been recorded in the southern portions of the study area or in forested areas to the south of the Wool Road during this or other relevant surveys (BES 2008; SCC 2003; Garrock 2006; Andrews.Neil 1994; Burcher 1994). These results reinforce the concept that the northern parts of the study area are of most importance to the Yellow-bellied Glider.

In order to protect key habitat for the Yellow-bellied Glider, a 20m buffer has been applied to both sap-feeding trees and all trees containing medium and/or large hollows, which may provide denning resources. Connectivity to these resources should be maintained by an adequate retention of canopy trees. In particular, habitat within the northern parts of the study area (essentially that defined under Clause 15 of the JBREP), should be managed to protect and enhance habitat for the Yellow-bellied Glider.

Microchiropterns

Eastern False Pipistrelle, East Coast Freetail Bat, Greater Broad-nosed Bat

These three species were detected in the study area via echolocation call recording analysis and all are fairly regularly recorded in the Shoalhaven area. Each species generally forages for insects in forested environments over a very large home range and also roost in tree hollows. Each species could be expected to forage over most of the site, and many of the larger hollow-bearing trees may provide suitable roosting resources, however no evidence of any communal roosting sites was found during the survey period. The study area is likely to provide foraging habitat and possibly occasional roosting habitat, although the resources in the study area are of lower quality than much of the adjacent forest and the study area is not expected to provide resources of any great importance to these species.

Eastern Bentwing Bat, Large-footed Myotis

These species were not recorded during the survey period, although have been recorded in the general area on a number of occasions. The Eastern Bentwing Bat was recorded just to the north of the study area during a previous survey by Andrews.Neil (1994). This species could forage over the study area on occasions, but generally roosts in caves. The Large-footed Myotis largely occurs in and near riparian habitats and may roost in nearby tree hollows. Some sections of the creeks in the study area provide suitable, although ephemeral foraging resources for this species. The study area may provide occasional, but not particularly important resources for either of these species.

An indicative buffer of 20m has been applied to hollow-bearing trees in the study area in recognition of their potential use by hollow-dependant microchiropterans and other threatened fauna and importance to biodiversity in general. It is desirable to retain a proportion of the vegetation in the study area as a foraging resource for these species, and it is likely that this will be achieved through specific habitat retention for other threatened biodiversity.

Grey-headed Flying-fox

The Grey-headed Flying-fox was recorded foraging within the study area on a number of occasions during the warmer months, and it is known to forage widely throughout the locality. No important roosting sites were recorded or are expected to occur within the study area. The study area contains a range of eucalypt foraging resources for this species. It is desirable to maintain at least some of these foraging resources, particularly in the form of larger undisturbed areas containing large, mature trees, but even the retention of a number of isolated larger trees may still provide important resources for the species.

5.3.2 Birds

Gang-gang Cockatoo

The Gang-gang Cockatoo was observed foraging in the study area on several occasions and a pair was observed nesting in a hollow-bearing tree near the gully approximately 30m to the

north of the study area. Nesting by this species was also observed by Andrews.Neil (1994) in an unspecified location “within the wildlife corridor”, assumed to be north of the study area. Both of the above records indicate that the species is inclined to select higher quality breeding sites beyond the study area. All habitats, and particularly hollow-bearing trees, are of much higher quality to the north of the study area. An indicative 50m buffer has been applied to the nesting tree, which encroaches a small distance into the study area. While breeding in the study area appears unlikely, retention of most hollow-bearing trees is recommended, and a 20m buffer has been applied to all trees with medium to large hollows, some of which constitute potential breeding resources for this species. While foraging resources in the study area are not particularly important for this species, retention of some vegetation containing foraging resources is desirable. This is likely to be achieved by the retention of habitat for other threatened biodiversity.

Glossy Black-cockatoo

The Glossy Black-cockatoo was observed in the study area on several occasions and evidence of foraging was found at 25 Black She-oaks trees, mostly in the north of the study area. Feed trees are specifically selected by the species for their particular qualities and reused over time. All feed trees should be retained, and a 20m buffer has been applied to these resources to ensure an adequate level of protection.

Like the Gang-gang Cockatoo, the Glossy Black-cockatoo is considered unlikely to breed in the study area given the superior breeding resources available in surrounding areas and disturbances to the study area. The 20m buffer applied to all trees with medium to large hollows will retain the potential, but unlikely, breeding resources for this species.

Powerful Owl

The Powerful Owl was observed roosting by day in the northern gully of the study area, although generally habitat is marginal or unsuitable for roosting in the study area. The species is likely to forage in the study area as part of a much larger home range, and has been heard calling from the general area. Nesting by this species in the study area is unlikely given the marginal resources resulting from previous disturbances. The known roosting area and potential roosting areas should be protected by retaining and buffering riparian vegetation. Recommended retention and buffering of Swamp sclerophyll forest is adequate to achieve this and will also protect some habitat for the Common Ringtail Possum, a key prey species often inhabiting dense riparian vegetation. The 20m buffer applied to hollow-bearing trees will also retain resources for other prey species. The retention of additional vegetation as prey habitat in configurations that compliment the retained riparian areas and tree hollows is also desirable.

Square-tailed Kite

The Square-tailed Kite was not recorded during the survey period, but is observed regularly in the area during the warmer months of the year and is expected to forage in the study area on

occasions as part of a much larger foraging range. Suitable foraging habitat occurs over most of the study area. Breeding is unlikely due to the previous disturbances in the study area and higher quality habitat elsewhere in the locality.

The retention of some foraging habitat is desirable, and is likely to be achieved through retention of habitat for other threatened biodiversity.

5.4 Migratory Species

One migratory species, the Black-faced Monarch, was recorded in the dense riparian vegetation near the northern boundary of the study area. Potentially suitable breeding habitat exists within dense riparian vegetation throughout the study area, although it is not the high quality rainforest vegetation typically preferred by the species. The species is likely to at least shelter and forage in the study area on occasions, and primary riparian habitat should be retained and buffered to include adjacent foraging habitat. Adequate habitat retention would be achieved and connectivity maintained by the recommended protection and buffering of Swamp sclerophyll forest and *Melaleuca biconvexa*.

5.5 Endangered Ecological Communities

The distribution of the *Swamp sclerophyll forest* endangered ecological community is associated with all drainage lines in the study area and approximates the distribution of *Melaleuca biconvexa*. The entire distribution of this community should be regarded as having high conservation value. The *Swamp sclerophyll forest* in the study area is connected to adjacent occurrences of this community along the extension of drainage lines to the north, south, east and west of the study area. The community provides important habitat for a range of species and performs important ecosystem functions such as creek bank protection.

The continuous distribution of the *Swamp sclerophyll forest* in the study area should be retained and protected by a 50m buffer. As with *Melaleuca biconvexa*, opportunities to regenerate previously cleared sections of this community exist within the 50m buffer zone in the west and south of the study area.

5.6 Habitat Corridor and Connectivity

Generally, two types of habitats or areas within the study area are important for connecting the study area with the surrounding landscape and maintaining movement passages for fauna and other genetic material:

- Riparian vegetation, which provides connectivity for limited habitats on all sides of the study area; and
- The portion of the study area north of Fisherman Road, identified as 'disturbed habitat and vegetation' (corridor) under Clause 15 of the JBREP.

Riparian habitats in the study area are of high conservation value and offer good connectivity to adjoining areas of similar habitat. All creeks in the study area support a continuous distribution of the endangered ecological community *Swamp sclerophyll forest*, and a near continuous distribution of the threatened *Melaleuca biconvexa*. The retention of the *Swamp sclerophyll forest/Melaleuca biconvexa* distribution and adjoining vegetated buffer of 50m will maintain adequate connectivity along riparian areas. In the west and south of the study area, rehabilitation of riparian vegetation within the 50m buffer will greatly enhance the connectivity value at these boundaries, which are currently degraded through clearing.

The land to the north of Fisherman Road identified as part of the disturbed habitat and vegetation (corridor) in Clause 15 of the JBREP, occupies the majority of the study area. This land also contributes up to approximately 400m of the 800-1100m wide section of corridor identified under Clause 15, or 36-50% of the corridor's width in the section north of Fisherman Road. The defined corridor within the study area forms a substantial, but not necessarily integral part of the Clause 15 corridor. The portion of corridor in the study area is more disturbed and apart from riparian areas, is generally of lower habitat quality than adjacent areas of the corridor to the north, east and west.

However, the study area to the north of Fisherman Road would certainly contribute to and enhance the value of the Clause 15 corridor as a whole, while acting as a buffer between residential land to the south and higher quality habitats in the corridor north of Nebraska Road. Habitats in the study area are well connected to these higher quality habitats to the north via a relatively undisturbed interface in the vicinity of Nebraska Road, which contributes to the conservation value of the northern half of the study area. These values warrant the protection of substantial areas of habitat in the northern portion of the study area, particularly in the north east.

5.7 Synthesis of Ecological Constraints

The analysis above has identified a number of different types of ecological constraints to the rezoning of the study area as depicted in Figure 6 (Appendix A) including:

- a) specific resources or key habitat (e.g. feed-trees, roosting areas) known to be used by threatened fauna species;
- b) potential key resources (e.g. large trees with hollows) for threatened and non-threatened fauna;
- c) occurrences of threatened or otherwise significant flora;
- d) occurrences of an endangered ecological community;
- e) general foraging habitat and corridor areas; and
- f) various vegetated buffers to key habitats.

Ecological Constraint Buffers

The provision of fully vegetated or partially vegetated buffers around specific habitats or resources plays an important role in sustaining these resources in the longer term. The various buffer widths and management prescriptions applied to each buffer have been determined by a number of factors including the conservation significance of the resource, the likely impacts and/or threats to the resource, and the specific functions or objectives of the buffer, as set out below:

- An indicative 50m vegetated buffer has been applied to the nest tree of the Gang-gang Cockatoo (to the north of the study area) to minimise further disturbances close to this tree, so that the resource can continue to be used as a nest site in the future. This species is known to retain at least some fidelity to nesting sites over successive breeding seasons. Only the edge of this buffer affects the study area, at the intersection of the Nebraska Road easement and the creek. This, along with several other overlapping constraints, indicates that Nebraska Road should not be fully developed.
- An indicative 50m vegetated buffer has been applied to the diurnal roosting site of the Powerful Owl in the north of the study area to prevent further disturbances which may render the roost unusable. This buffer is encompassed by the 50m vegetated buffers to Swamp sclerophyll forest and *Melaleuca biconvexa*, which are expected to provide a buffer to other potential Powerful Owl roosting areas in the study area.
- A 20m managed buffer vegetated with canopy trees has been applied to Yellow-bellied Glider sap-feeding trees to ensure access for the gliders is maintained to these resources and that inappropriate development does not render the resource unusable. Retained trees within the buffer are also likely to function as additional (non-sap) foraging resources for the species, potential sap-tree resources and allow recruitment trees for connectivity and foraging. Connectivity for this species also needs to be maintained beyond these buffers, between areas of retained vegetation in the study area and with forest to the north of Nebraska Road. It is considered feasible to permit some development (such as asset protection zones and minor roads) within this buffer, as long as the development does not compromise the key objective of this buffer, which is to enable continued use of these resources by protecting the feed-trees themselves and ensuring adequate canopy trees and recruitment trees are retained to provide long-term connectivity with adjoining areas of habitat. Apart from asset protection zone establishment and maintenance using hand tools only, no development should occur within the drip-line of any feed-tree and no buildings should be constructed within 20m of any feed tree. Development should preferentially be located as far away from feed-trees as possible.
- An indicative 50m vegetated buffer has been applied to occurrences of *Swamp sclerophyll forest* and *Melaleuca biconvexa* because of the conservation significance of

the endangered ecological community, the restricted habitat of both constraints, and their association with drainage lines, which increases the potential for adverse impacts such as weed invasion and changes to hydrological and nutrient regimes. These buffers will provide for the potential of *Melaleuca biconvexa* and species associated with the *Swamp sclerophyll forest* to expand their current distribution, which in some areas has been reduced by clearing. Vegetated buffers also provide habitat for the pollinators of key species, enhance the ecological function and composition of the ecological community and the paperbark population, and minimise the potential for edge effects to degrade these core areas. Generally, no further development or related activities should be permissible within these buffers, which should be revegetated if possible where current disturbances exist. The continued use of existing un-maintained roads which pass through some riparian areas and buffers may be appropriate if no feasible alternatives exist. Bushfire asset protection zones may overlap with parts of the outer edge of these buffers if appropriately managed to function as part of the buffer.

- An indicative 50m buffer has been applied to occurrences of *Specularantha ventricosa*, due to the potentially very high conservation value of this species. Generally, no further development should occur within these buffers, which are likely to contain and protect additional individuals and maintain habitat for pollinators. Direct and indirect impacts to these buffers should be monitored and managed appropriately. An appropriately controlled disturbance regime may be beneficial to the species, as flowers were most numerous in areas which have been subject to particular disturbances. Maintaining connectivity between these buffers is also important for genetic exchange (pollinator movement) and protection of undetected individuals in the population, as suitable habitat may extend beyond the 50m buffers.
- An indicative 50m vegetated buffer has been applied to the single record of *Cryptostylis hunteriana* in the north-east of the study area, as it currently appears to be the only evidence of a population in the immediate vicinity and one of only two records in the locality. This buffer is likely to encompass other undetected individuals and links known habitat in the study area with suitable habitat beyond the study area to the north east.
- A 20m buffer vegetated with at least canopy trees has been applied to large trees with hollows, which represent an important fauna resource and potential habitat for a range of threatened fauna, to ensure the root zones of these trees are not damaged, to maintain some connectivity to and from these trees for the Yellow-bellied Glider, and to prevent development occurring at a proximity which is likely to compromise the future use of these resources. The outer protection areas of asset protection zones may be established and maintained within the outer 10m of this buffer if they do not substantially affect the objectives of the buffer.

- A 20m managed buffer has been applied to known Glossy Black-cockatoo feed-trees to ensure that the trees, including root zones, are not inadvertently damaged by future development, and to retain some additional Black She-oaks as potential foraging, recruitment and pollination resources. Asset protection zones may be established and maintained within this buffer if they do not substantially affect the objectives of the buffer. The construction of dwellings and other structures should not be permitted within this buffer. Roads and property access may be permitted within the outer 15m of this buffer. In all cases, other female Black She-oaks within these buffers should be retained wherever possible, at densities appropriate for the associated land uses. Beyond these buffers, Black She-oaks should be retained preferentially throughout the study area where possible.

Ecological Constraint Categories

The categorisation of ecological constraints can assist with the identification of appropriate planning strategies to protect and sustain the integrity of ecological infrastructure in the long-term. This categorisation depends on a combination of factors including the conservation significance of the ecological constraint, its function in the ecological landscape, and the potential for impacts on the constraints arising from future uses in its vicinity.

These ecological constraints have been categorised into high, moderate-high and moderate levels in Figure 7 (Appendix A) according to their conservation values relating to the study area and its landscape context. A brief description of the ecological resources associated with each constraint category is given below.

A high level of constraint was applied to occurrences of the endangered ecological community Swamp Sclerophyll Forest and the threatened *Melaleuca biconvexa* because of the narrow habitat requirements and association with drainage lines, which make these occurrences vulnerable to a range of disturbances within the catchment area. A high level of constraint was also applied to individuals and buffers of the orchids *Cryptostylis hunteriana* and *Speculantha ventricosa* for several reasons. The life cycle of these terrestrial orchids is such that the full extent of populations are not readily apparent until multiple surveys have been undertaken and the buffers to orchids are likely to contain and provide habitat for undetected individuals and pollinators. Otherwise, these orchids have been given a high level of constraint because of the current lack of information regarding their distribution and abundance beyond the study area. The *Cryptostylis hunteriana* individual in the study area is one of only two known records from the locality. *Speculantha ventricosa* individuals and buffers have been given a high level of constraint because of the potentially high conservation value of the species. The constraint level of both orchid species has the potential to be downgraded if additional information from wider studies supports such a conclusion.

A moderate-high level of constraint was applied to buffers of endangered ecological communities and *Melaleuca biconvexa*, key foraging resources for vulnerable species (identified feed-trees of the Yellow-bellied Glider and Glossy Black-cockatoo) and their respective buffers, the off-site Gang-gang Cockatoo nesting tree, habitat corridor areas (Clause 15 JBREP areas) and potential breeding and sheltering resources for vulnerable species (large trees with hollows). Large trees with hollows were considered a moderate-high level constraint due to the number of hollow-dependent threatened fauna species which are known or likely to utilise the area (and thus potentially these trees) and the general biodiversity and habitat value these trees would sustain.

A moderate level of constraint was applied to the remaining native vegetation within the study area because it comprises foraging habitat for a number of vulnerable fauna species (particularly the Yellow-bellied Glider, but including the Grey-headed Flying-fox, Eastern False Pipistrelle, East Coast Freetail Bat, Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl and Square-tailed Kite) and provides canopy habitat corridors through the study area for a range of species including threatened species.

A low level of constraint was applied to areas that have been so heavily disturbed that they currently offer little in the way of flora or fauna habitat values. Several individual lots initially fitted this criterion, but they were also affected by higher level buffers or broader designated habitat corridors, which added to their conservation value. No parts of the study area were given a low level of constraint.

Areas More Suited for Limited Further Development

As indicated in Figure 7 (Attachment A), the most highly constrained parts of the study area relate to riparian vegetation along drainage lines and orchid habitat in the north eastern corner. Parts of the study area more suitable for limited further residential development include the central and north western portions covered by moderate and moderate-high level constraints (Figure 7). These areas should be considered for further development along with the issues discussed above and the recommendations in Section 7.

The buffer sizes and categories discussed above should be used as a guide to maintaining threatened biodiversity values, however compromises may be necessary to achieve a balance between biodiversity protection and development. In some instances, buffers of variable size may be appropriate, allowing for reduced buffer distances in some areas which could be compensated in other areas by larger buffers, rehabilitation of degraded buffers, and/or greater restrictions on clearing in other areas.

DECCW's recommendations for areas to be retained (no development) and where development could be considered are shown in Figure 7. DECCW indicated that the main area potentially suitable for development is in the north western portion of the site.

6. CONCLUSIONS

This report describes the biological environment of the Nebraska Estate, St. Georges Basin, and specifically investigates the presence and conservation significance of threatened biodiversity and makes recommendations for maintaining the Estate's key biodiversity values.

These biodiversity values included one endangered ecological community, eight 'vulnerable' threatened fauna and two 'vulnerable' threatened flora species, listed on the schedules of the *NSW Threatened Species Conservation Act 1995*. The two threatened flora species recorded in the study area are also listed as 'vulnerable' on the schedules of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. One migratory species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* and a newly described orchid species with the potential to be listed as a threatened species were also recorded during the survey period.

The study area does not contain any potential Koala habitat pursuant to *NSW State Environmental Planning Policy No 44 – Koala Habitat Protection*.

The main threatened biodiversity values, and therefore primary constraints to development, are associated with riparian vegetation and orchid habitat in the north east of the estate. Important fauna habitats include canopy and sub-canopy foraging resources for mobile and wide-ranging threatened species as well as numerous hollow-bearing trees. Habitat connectivity between the estate and adjoining habitats, along riparian corridors and at the northern boundary interface, are also key considerations for the maintenance of biodiversity.

Much of the study area also comprises part of the 'disturbed habitat and vegetation' (corridor) defined under Clause 15 of the JBREP. Development within this area should comply with the Clause 15 objectives to maximise the retention of native vegetation and maximise the rehabilitation of degraded areas. The existing subdivision pattern and the size and dimensions of the individual lots would greatly limit the extent to which these objectives could be achieved. However, as the study area occupies only part of the 'disturbed vegetation and habitat' (corridor) defined by the JBREP, limited and low-density development within this area should not substantially compromise these objectives or the functioning of the general area as a 'disturbed habitat corridor'.

Given the extent of ecological constraints present, the development of all lots in the Estate is not considered appropriate. However, it is considered possible to maintain the key biodiversity values of Nebraska Estate while allowing limited further residential development. This would involve the retention of substantial areas of habitat for conservation purposes, particularly the riparian corridors and the north eastern portion of the site which represent high level constraints,

and possibly the amalgamation or reconfiguration of lots to allow limited residential development to occur in areas of lower ecological constraints.

A number of other strategies have been recommended below to maintain the key biodiversity values of the study area and to inform the rezoning process. These strategies should mitigate the effects on threatened species or their habitats of rezoning parts of the study area for residential purposes, and minimise the impacts of rezoning on the flora and fauna values of the study area in general.

Achieving long-term habitat retention in close proximity to dwellings is difficult but achievable provided appropriate development controls are in place, coupled with education and enforcement strategies.

7. RECOMMENDATIONS

A number of recommendations to preserve the key biodiversity values of Nebraska Estate are outlined below.

General

1. Appropriate biodiversity conservation objectives and controls for various proposed zones within study area should be developed for any future development. Recommendations 5-12 set out below should be used as the basis for establishing these objectives and controls as they set the minimum habitat requirements for sustaining threatened species, populations and ecological communities or their habitats.
2. The majority of land in the northeast of the study area should be retained as habitat for threatened biodiversity along with a substantial amount of higher value habitat over the entire study area to comply with Clause 15 of the Jervis Bay Regional Environmental Plan ('disturbed habitat and vegetation'). Further guidelines for potential development in the Clause 15 area are given in recommendation 14.
3. Existing un-maintained roads which occur within areas of moderate to high level constraints may be upgraded to accommodate continued use if the upgrade and subsequent increase in traffic levels do not substantially affect the objectives of the relevant buffer/s and if no feasible alternative route exists.
4. Shoalhaven City Council should consider seeking biodiversity certification for any future local environmental plan over the study area.

Significant vegetation

5. Occurrences of the endangered ecological community *Swamp sclerophyll forest* and the primary occurrences of the vulnerable species *Melaleuca biconvexa* should be protected from any further disturbances ideally by a 50m buffer of undisturbed vegetation. Where existing roads dissect areas of *Swamp sclerophyll forest* or *Melaleuca biconvexa*, the buffer could be reduced and aligned with the edges of the roads to permit continued use of these roads where no feasible alternative route exists. Appropriately managed asset protection zones could overlap with the outer portions of these buffers where this does not substantially compromise the buffer objectives. Where possible, no other development or activities should be permissible within these buffers. Where possible, the buffers should be revegetated where current disturbances exist, particularly on the western and southern boundaries where rehabilitation of buffers would enhance connectivity to adjoining habitats.
6. The occurrence of the vulnerable orchid species *Cryptostylis hunteriana*, should be retained and protected by a 50m buffer, which would encompass primary habitat and probably undetected individuals. No further vegetation removal should be permitted within this buffer,

as there appears to be only one other record of the species in the locality and the importance of this population is currently unclear. Additional surveys in the northeast of the study area and adjoining suitable habitat would help clarify this situation.

7. All occurrences of the orchid *Specularantha ventricosa* should be retained and adjacent habitat protected from further disturbances by a 50m buffer. As the species is currently known only from two populations in the St. Georges Basin region, the population in the study area is potentially very significant. Management strategies, such as not disturbing known habitat during the period of flowering and above ground growth, should be implemented immediately to ensure that the survival of existing individuals is not compromised. Additional surveys of potential habitat in the study area and surrounding lands are recommended to better understand the distribution and conservation status of the species. Management strategies should be reviewed as additional information on the ecology or conservation status of this species becomes available.

Fauna and fauna habitat

8. The known nest tree of the Gang-gang Cockatoo, which lies approximately 30-40m north of Nebraska Road, should be protected from further disturbances by limiting or excluding development from adjacent areas of Nebraska Estate (as shown in Figure 7), including any substantial upgrading of Nebraska Road.
9. Larger trees with hollows, which act as potential nest, den and roost trees for the Yellow-bellied Glider, threatened cockatoos, large forest owls and microchiropteran bats, should be retained and buffered from further disturbance by 20m of intact vegetation where possible. The outer protection areas of asset protection zones may be established and maintained within the outer 10m of this buffer if they do not substantially affect the objectives of the buffer.
10. Sap-feeding trees incised by the Yellow-bellied Glider should be retained and protected from further disturbances. No dwellings, other structures or substantial disturbances should be permitted within 20m of any feed-tree. Generally through the eastern half of the study area, an adequate amount and distribution of mature canopy trees and younger recruitment trees should be retained to enable the continued use of sap-feeding trees by this species and to ensure long-term connectivity with adjacent areas of habitat. Asset protection zones and roads may be established and maintained within these buffers as long as the above buffer objectives are met and heavy machinery is not used within the drip-line of any feed-tree. Development should preferentially be located as far away from feed-trees as possible.
11. Over most of the study area, canopy trees should be retained at an appropriate density to allow for movement by the Yellow-bellied Glider to access the resources outlined above, to

provide additional foraging resources and to maintain connectivity to other habitat in the study area.

12. Black She-oak feed-trees used by the Glossy Black-cockatoo should be retained and protected from further disturbances by a 20m managed buffer. No dwellings or other structures should be permitted within this buffer. Where necessary, roads and property access may be permitted within the outer 15m of this buffer. Wherever possible, additional mature and immature female Black She-oaks should be retained within these buffers as additional foraging resources and recruitment trees, at densities appropriate for the associated land use. Asset protection zones may be established and maintained within these buffers as long as the above buffer objectives are met and heavy machinery is not used within 5m of any feed-tree. Development should preferentially be located as far away from feed-trees as possible.
13. Female (cone-bearing) Black She-oaks should be preferentially retained and also used within landscaping throughout the study area wherever possible, as additional foraging resources for the Glossy Black-cockatoo.

Development within Clause 15 JBREP ‘disturbed habitat and vegetation’

14. Any development within the ‘disturbed habitat and vegetation’ (corridor) north of Fisherman Road should be consistent with the two objectives of this clause, which are to maximise the retention of native vegetation and to maximise the rehabilitation of degraded areas. In addition, the following guidelines should be used to mitigate impacts to threatened fauna habitats in this area.

- a) Minimise disturbance along north and north-eastern boundaries of the study area to maintain connectivity with adjacent habitats also within the 'disturbed habitat and vegetation' corridor.
- b) Maximise the connectivity of all retained vegetation both within the study area and with land to the north and north-east of the study area. This is particularly important to enable the Yellow-bellied Glider to continue to access the study area from land to the north.
- c) Minimise disturbance in the north-eastern section of the estate, which contains relatively high densities of ecological constraints, including the main habitat in the study area for two terrestrial orchid species of conservation significance.
- d) Restrict the vegetative disturbance on developable lots to the minimum extent required to establish a dwelling, associated structures, access and asset protection zone.
- e) Maximise the retention of trees, particularly hollow-bearing trees, feed-trees of the Yellow-bellied Glider and Glossy Black-cockatoo, and other large trees wherever possible to maintain foraging resources for the Yellow-bellied Glider, Gang-gang Cockatoo, Powerful Owl and bats.
- f) Any rehabilitation of degraded areas should aim to re-establish or buffer habitat for threatened biodiversity, for example planting or preferencing feed-tree species for the Yellow-bellied Glider and Glossy Black-cockatoo, or enhancing riparian buffer vegetation.

Implementation

15. The above recommendations should be included in development controls for the subject land and underpinned by education and enforcement strategies.

8. GLOSSARY

AnaBat	A type of electronic bat detector used to convert the usually inaudible echolocation calls of insectivorous bats into audible electronic signals, which can then be recorded and analysed to assist with identifying bat species.
Arboreal	Living in trees.
Biodiversity	Biological diversity – the variety of all living organisms.
Bioregion	A relatively large area defined by broad geophysical features and environmental processes. A relatively large area shares roughly similar climatic, geological and ecological communities. The Shoalhaven forms part of the Sydney Basin Bioregion which stretches from Nelson Bay to almost Batemans Bay and almost out to Mudgee.
Call playback	A fauna survey technique whereby recorded vocalisations or calls of certain species are broadcast via a speaker in an attempt to elicit a response from the target species.
Choke point	A particularly narrow or constricted area within a wildlife or habitat corridor, or where a major road dissects a corridor.
Diurnal	Active by day.
Echolocation call	High frequency sound waves emitted by insectivorous bats in order to navigate and forage. Typically inaudible to the human ear, these calls can be recorded via specific equipment and analysed to identify the species of bat.
Elliott trap	A type of collapsible aluminium box-trap of approximately 30cm x 10cm x 8cm for the live capture of mammals.

Endangered ecological community	An ecological community in immediate danger of becoming extinct and listed as endangered in Part 3 of Schedule 1 of the TSC Act or the EPBC Act.
Endangered species	A plant or animal species in immediate danger of becoming extinct and listed as endangered in Part 1 of Schedule 1 of the TSC Act or the EPBC Act.
Ephemeral	Temporary or impermanent.
Feed-tree	Tree used for feeding by the Glossy Black-cockatoo or Yellow-bellied Glider.
Floristics	Description of plant species within an area or community.
Foraging	Feeding.
Hair funnel	Plastic funnel partially lined with a wafer containing dry adhesive to collect and retain hair of any mammals entering or investigating the funnel. A standard vegetarian bait is enclosed at one end of the funnel as an attractant. The collected hair samples can then be analysed to identify species.
Harp trap	Live trapping mechanism for insectivorous bats, consisting of vertical, parallel segments of fishing line stretched between a frame above a catch bag, into which bats become trapped.
Key threatening process	An identified process that threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community and listed in Schedule 3 of the TSC Act or the EPBC Act.
Locality	The area within 5km of the study area.
Microchiropteran	Small insectivorous bats, often termed 'microbats'.
Migratory	An animal species which moves between areas on a regular seasonal basis. Migratory species listed on the

EPBC Act are considered to be of national environmental significance.

Nocturnal

Active by night.

Pitfall trap

One or more containers sunk into the ground so that the container mouth is level with the surface, used to capture small terrestrial fauna species as they fall into the container (or 'pit'). Typically a low barrier of material extends from and/or connects two or more pits to divert fauna into the pit/s.

Quadrat

An area of 20m x 20m defined to intensively survey vegetation species and structure.

Riparian

Associated with edges of a creek or other water body.

Roost

Shelter site for birds or bats, typically in the canopy of a tree, tree hollow or cave.

Stag watch

Observation of trees with hollows to determine their use by fauna species, typically undertaken at dusk when nocturnal species are emerging from hollows.

Threatened species

Species considered to be at risk of becoming extinct and listed under the TSC Act or EPBC Act. The listing of threatened species incorporates various categories of risk including vulnerable and endangered species.

Transect

A survey line or path used to dissect or sample habitat for flora and fauna surveys.

Vagrant species

A non-resident species occurring only occasionally or sporadically.

Vulnerable species

A plant or animal species at risk of becoming endangered and listed as vulnerable on Schedule 2 of the TSC Act or the EPBC Act.

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APPENDIX A: FIGURES

Figure 1: Location of Nebraska Estate, St Georges Basin

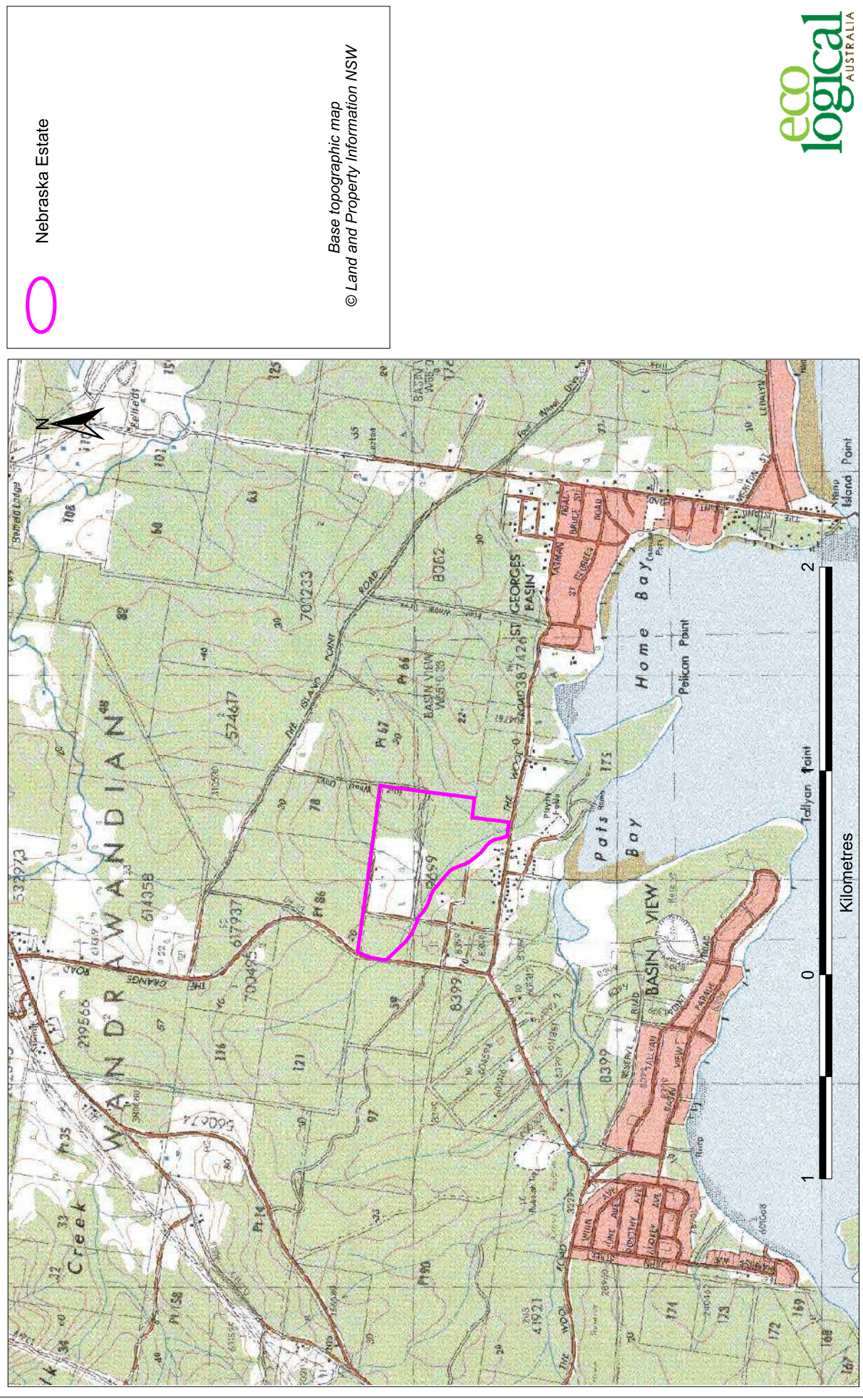


Figure 2: Locations of flora surveys

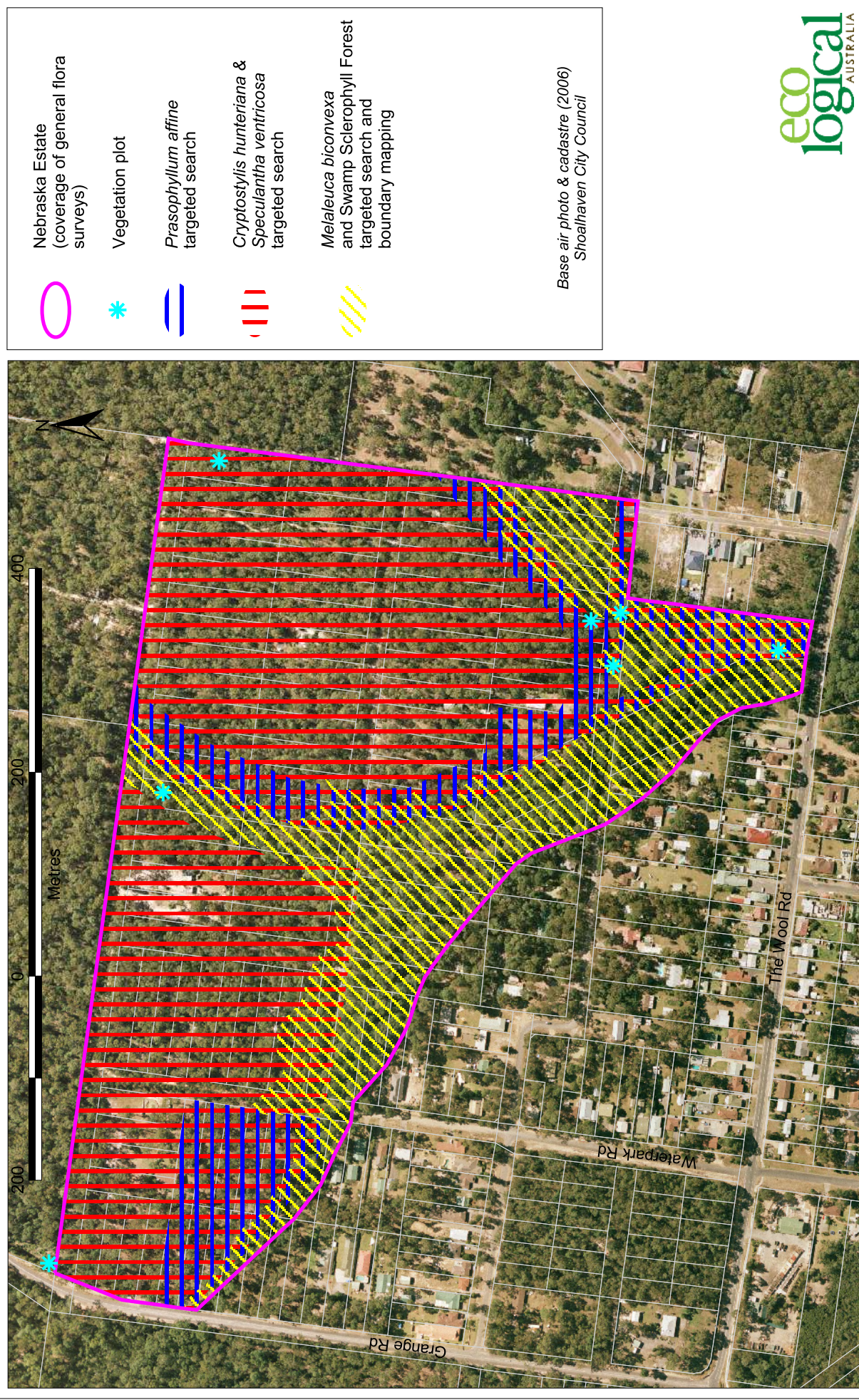


Figure 3: Locations of fauna surveys

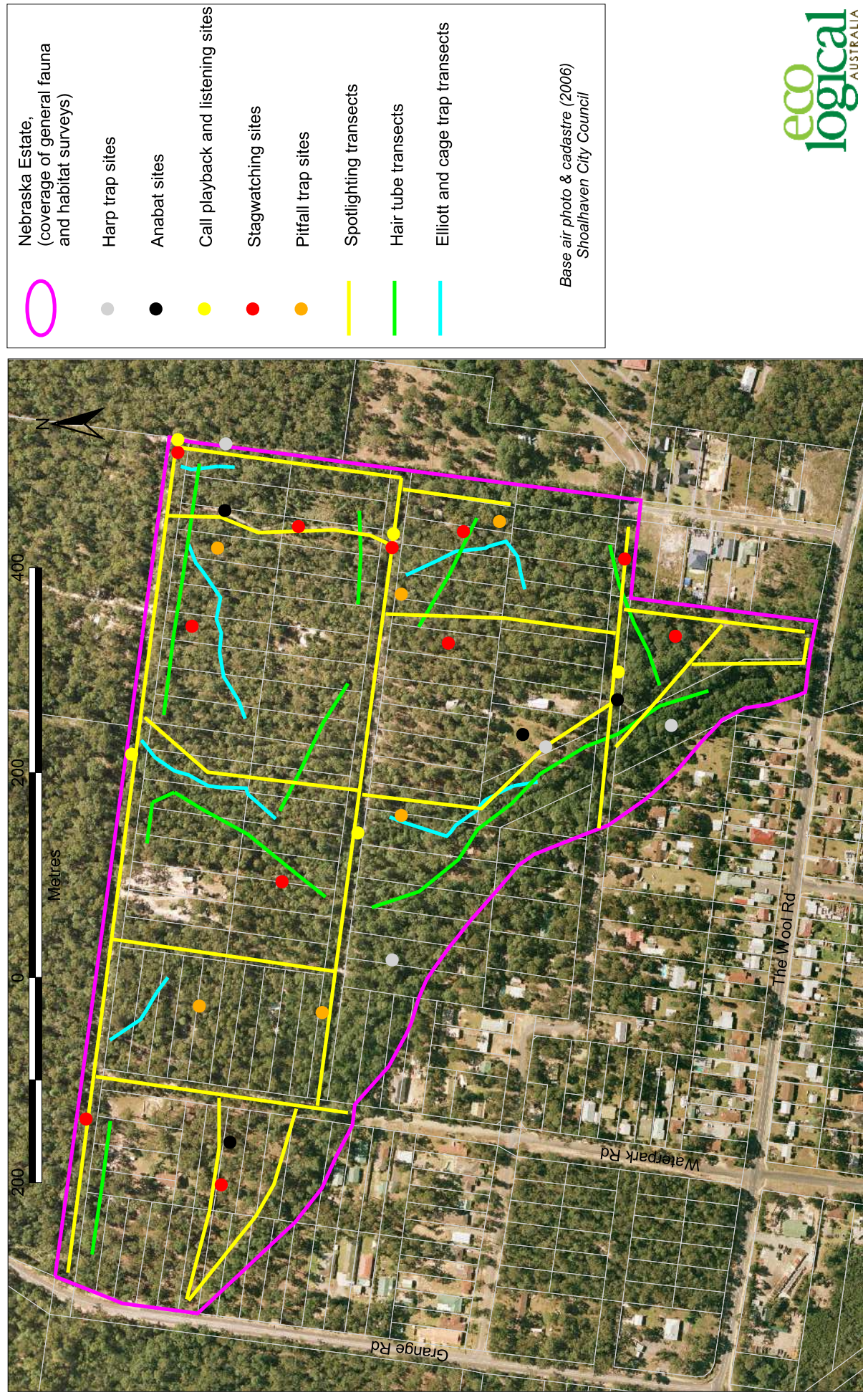
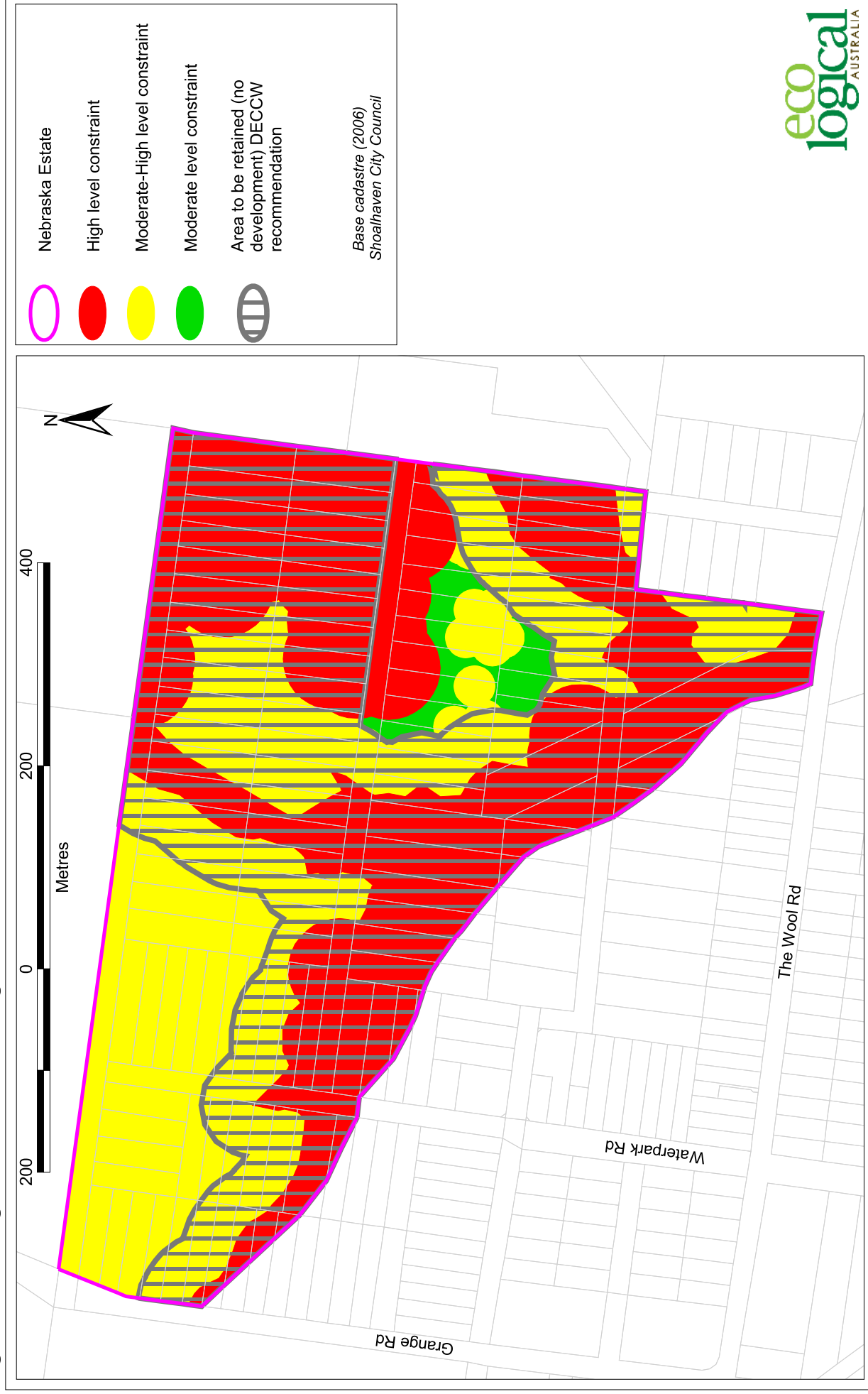


Figure 7: Ecological constraint categories



APPENDIX B:
INITIAL CORRESPONDENCE WITH
GOVERNMENT DEPARTMENTS

Your reference:

Our reference: 6461

16 August 2007

The Manager

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.....
.....

Dear Sir/madam,

**Re: Threatened Biodiversity Survey and Assessment
Nebraska Estate, St Georges Basin**

BES has been engaged by Shoalhaven City Council to undertake a Threatened Biodiversity Survey and Assessment of land at St Georges Basin known as Nebraska Estate. I have attached a letter of introduction from Council to this effect.

The study area is located midway between the townships of St Georges Basin and Basin View and is bounded the west by Grange Road and to the south by The Wool Road.

The purpose of the Threatened Biodiversity Survey and Assessment is to:

- a) Review vegetation within the study area and to make an assessment of the potential impacts of urban development on threatened species, populations and endangered ecological communities and their habitats under the *NSW Threatened Species Conservation Act 1995* and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*;
- b) Outline site-specific land management principles and practices, both essential and desirable, that will help achieve or protect biodiversity conservation values of the identified ecologically significant areas;
- c) Recommend any other impact mitigation strategies as may be necessary to permit urban development generally in accordance with Stages 1-4 as identified by the Commission of Inquiry; and
- d) Advise Shoalhaven City Council if development of the study area, including the provision of roads and service infrastructure, will trigger the need for a Species Impact Statement under the *NSW Threatened Species Conservation Act 1995*, and/or Ministerial approval

under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, and, if so, how development could be modified to avoid significant effects/impacts.

In accordance with the scope of works prepared by Shoalhaven City Council, the purpose of this correspondence is to initiate formal written consultation with the department regarding any comments the department may have on threatened biodiversity issues associated with Nebraska Estate and with any adjoining lands or waters, in the context of points a) to d) above.

BES also requests the provision of any relevant land capability information held by the department pertaining to Nebraska Estate that may assist with the completion of the project and, in particular, any records of threatened biodiversity.

I look forward to your response regarding this matter.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'DC', followed by a long horizontal line extending to the right.

David Coombes

Senior Ecologist

Environmental Services Division



NSW GOVERNMENT
Department of Planning
Office of the Director General

received 24.9.07

Mr David Coombes
Bushfire and Environmental Services
PO Box 106
ST GEORGES BASIN NSW 2540

DGC07/1452
You ref: 6461

Dear Mr Coombes,

I refer to your letter seeking our comments on threatened biodiversity issues associated with Nebraska Estate.

Land use planning strategies and documents relevant to Nebraska Estate include the Jervis Bay Settlement Strategy and the South Coast Regional Strategy. I have included a copy of the South Coast Regional Strategy for your information. The Jervis Bay Settlement Strategy can be obtained from the following link:

<http://www.shoalhaven.nsw.gov.au/council/pubdocs/PlanningDocs/JBSettlementStrategy.pdf>

Investigations should be in accordance with the Jervis Bay Settlement Strategy page 80 which outlines the matters to be considered for Nebraska Estate investigations and page 44 the specified biodiversity considerations.

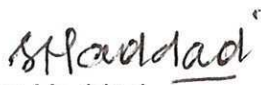
I strongly recommend consulting with the Department of Environment and Climate Change (DECC) regarding the threatened species and biodiversity issues. DECC is the State agency primarily responsible for managing the state's natural resources including biodiversity.

The relevant contact person is Mr Michael Hood, Manager, Planning and Aboriginal Heritage (South), postal address:

Department of Environment and Climate Change
PO Box 733
QUEANBEYAN, NSW 2620.
Phone - 62989706

Should you have any further enquiries about this matter, I have arranged for Ms Claudia Jordan, Senior Planner, Southern Region, to assist you. Ms Jordan can be contacted on telephone number (02) 4224 9464.

Yours sincerely


Sam Haddad
Director General

13.9.2007

APPENDIX C:
DECCW COMMENTS ON DRAFT THREATENED
BIODIVERSITY SURVEY AND ASSESSMENT OF
NEBRASKA ESTATE

Our reference : Fil08/1575
Your reference : Nebraska Estates

Mr Gordon Clark
Strategic Planning Manager
Shoalhaven City Council
PO Box 42
NOWRA NSW 2541

Dear Gordon

RE: Draft Flora and Fauna Study for Nebraska Estates by BES

I refer to your email requesting comments from the Department of Environment, Climate Change and Water (DECCW) on the *draft Flora and Fauna Study for Nebraska Estates by Ecological/BES*. Particularly, DECCW was requested to review the areas that are inappropriate for development based on the reports findings on biodiversity issues. The delay in replying is regretted.

DECCW has reviewed the draft reports and generally considers the report will provide a sound basis on which to make informed biodiversity decisions on the areas suitable for additional development on the land.

The following comments are provided on the technical aspects of the report:

- Given the habitats present, the techniques used in this investigation are considered adequate to gather the data necessary to identify species and habitats of high conservation value within the study area.
- The Intensity and distribution of surveys across the site and habitat types were appropriate for the target species. As recognised in the report further survey work could have been undertaken for orchid species for completeness. However, it is considered adequate for the stage of the planning process.

DECCW concurs with the reports main conclusion that *'given the extent of ecological constraints present, the development of all lots in the Estate is not considered appropriate. However, it is considered possible to maintain the key biodiversity values of Nebraska Estate while allowing limited further residential development. This would involve the retention of substantial areas of habitat for conservation purposes, particularly the riparian corridors and other areas of high level constraints, and possibly the amalgamation or reconfiguration of lots to allow limited residential development to occur in areas of lower ecological constraints'* P57.

The main implications for future conservation/development zoning of the site from the studies are considered to be:

- *The riparian vegetation of the study area was found to be of high conservation value, containing both the Swamp sclerophyll forest endangered ecological community and large numbers of the threatened plant Melaleuca biconvexa. P57*



- Other areas of high conservation value include habitat for the orchids *Cryptostylis hunteriana* and *Specularantha ventricosa* in the north east of the estate. P57
- The known nest tree of the Gang-gang Cockatoo, which lies approximately 30-40m north of Nebraska Road, should be protected from further disturbances by limiting or excluding development from adjacent areas of Nebraska Estate P60
- The northern portion of the study area is defined as part of an east-west 'disturbed habitat and vegetation' corridor under Clause 15 of the Jervis Bay Regional Environment Plan and provides important connectivity for species and habitats in the study area. P57 The existing subdivision pattern and the size and dimensions of the individual lots would greatly limit the extent to which these objectives could be achieved. However, as the study area occupies only part of the 'disturbed vegetation and habitat' (corridor) defined by the JBREP, limited and low-density development within this area should not substantially compromise these objectives or the functioning of the general area as a 'habitat corridor'. P57
- Other ecological constraints to development of the study area include foraging resources for threatened species such as the Glossy Black-cockatoo and Yellow-bellied Glider, and a number of hollow-bearing trees. Page vi
- On the corridor issues the conservation values of the northern portion of the study area are in part related to its good connectivity to adjoining habitats of high quality. These values warrant the protection of much, if not all, of the habitat in the northern portion of the study area Page 51

DECCWs interpretation of how the findings could be applied in a planning layer is shown in the attached map Appendix 1.

Other issues if development is to occur in the areas outside "High Level Constraint" Lands

- It is clear that if the detailed management recommendations on Pages 59-62 of the report are to be applied that the existing lot configuration would have to be amalgamated considerably. It is going to take a high level of compliance and commitment from Council if the biodiversity values are to be maintained on these lands in the future.
- In developing the amalgamated lot design the requirements for clearing and fuel reduction to meet RFS requirements should be factored in up front.
- The existing Volunteer Conservation Agreement (VCA) under NPW Act 1974 outcomes should not be compromised by the design.

Should you have any queries regarding the above Information, please contact Miles Boak, Conservation Planning Officer on 02 62297095.

Yours sincerely

MBoak 25 Aug 09.

MICHAEL HOOD
Manager Planning and Aboriginal Heritage, South Branch
Environment Protection and Regulation

Our reference : FIL08/1575, DOC09/53964
Your reference : Nebraska Estates

Mr Gordon Clark
Strategic Planning Manager
Shoalhaven City Council
PO Box 42
NOWRA NSW 2541

Dear Gordon

RE: Draft Flora and Fauna Study for Nebraska Estates by BES

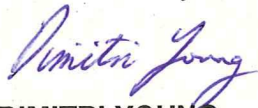
I refer to your email of 9 November 2009 requesting clarification from the Department of Environment, Climate Change and Water (DECCW) regarding buffers to biodiversity assets for Nebraska Estates.

DECCW concurs with the *draft Flora and Fauna Study for Nebraska Estates* prepared by Ecological/BES which has generally recommended a 50m buffer to the endangered ecological community (EEC), the threatened Biconvex Paperbark (*Melaleuca biconvex*) and the orchid *Speculantha ventricosa*. These buffer areas should be included in the lands excluded from development and managed for biodiversity conservation.

This would leave the north-western corner of the Estates available for development and would severely constrain the remainder of the site. Hence, the existing approved dwellings and one or two additional dwellings may be the only feasible development options in the eastern part of the Estates.

Should you have any queries regarding the above Information, please contact Miles Boak, Conservation Planning Officer on 02 62297095.

Yours sincerely



11 November 2009

DIMITRI YOUNG
A/Manager Landscape Aboriginal Heritage Protection
Environment Protection and Regulation

