Lot 171 in DP 1081810
Highview Drive, Dolphin Point

Proposed Residential Subdivision

Part 3A Concept Plan
Response to Submissions

Appendix A – Part 1
BES 2007 Methods

April 2008
2. METHODS

2.1 Review of Existing Data

A review of relevant information was undertaken prior to the commencement of field studies, which involved:

a) reviewing available literature including relevant flora and fauna studies, legislation, environmental planning instruments, topographic maps, aerial photographs and draft plans pertaining to the proposal;

b) searching the Atlas of NSW Wildlife for threatened flora and threatened fauna species recorded in the locality; and

c) utilising the Commonwealth Environment Protection & Biodiversity Conservation Act Protected Matters Search Tool to search for matters of national environmental significance recorded in the locality.

The data gathered during the field studies and from the review of literature was analysed and interpreted in accordance with the provisions of legislation and planning controls pertaining to flora and fauna.

2.2 Flora Survey Methods

A detailed botanical survey was conducted in the study area by BES on 12 and 26 October, 15, and 16 November, 14, 15, 21, 23 and 28 December 2005, 5 January and 20 December 2006 in the locations shown in Figure 3 (Appendix A).

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 communities.

A vegetation survey sheet was completed for each vegetation community. The vegetation was surveyed at all levels present: the canopy (trees), middle canopy (trees), understorey (shrubs), and groundcover plants (plants less then one metre in height). An abundance score was assigned to each species recorded. Dominant species and the projected foliage cover of each stratum were recorded at eight locations that typified the vegetation communities present in the study area. A general description of the vegetation was then prepared based on structural characteristics and dominant canopy species in accordance with Walker and Hopkins (1990) and Specht (1970). These techniques were used to classify and name the vegetation communities in the study area.
The boundaries of vegetation communities were marked onto a plan of the study area using a combination of GPS field data, aerial photography, landscape position, geology, soils and existing vegetation maps.

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 Searches
Targeted searches for the Thick-lip Spider Orchid *Caladenia tessellata* were conducted using the Random Meander method targeting areas of potential or suitable habitat in the study area on 12 October 2005. The timing of the survey was determined via consultation with Mr. John Briggs of the Department of Environment and Conservation and Mr. Alan Stephenson, an orchid specialist. There were no known sites in the locality that could be used to confirm flowering prior to the surveys. The recorded site at Ulladulla was searched in September and October 2005 but the species was not found. Other searches of this recorded site at Ulladulla in September 2000 and September 2001 in the company of Dr. Stephen Clark of the Department of Environment and Conservation also failed to find any evidence of the species.

Targeted searches for the Leafless Tongue Orchid were conducted using a combination of grid transects and the Random Meander method targeting areas of potential or suitable habitat in the study area on 14, 15, 21, 23 and 28 December 2005 and 20 December 2006, and targeting areas of suitable habitat in Barunuj State Conservation Area on 23 December 2005 and 20 December 2006. Flowering individuals were located at the known site on Wheelbarrow Road in Meroo National Park, about 1 km south of Burrill Lake, prior to the surveys being undertaken in the study area. Individuals were also in full flower at other known sites in North Nowra, Vincentia and Bendalong at the time of the survey. All *C. hunteriana* located during the surveys were marked with a numbered aluminium tag and the location recorded using a Personal Digital Assistant XDA O2 linked to a bluetooth EMTAC S3 BTGPS GPS.

Specific searches for the threatened orchid *Genoplesium baueri* were conducted on 15 March 2006 by systematically walking along designated grid transects approximately 5m apart targeting areas of potential or suitable habitat. *Genoplesium baueri* was targeted in appropriate vegetation throughout the study area. The species was observed in flower at the nearest known site at Vincentia prior to the survey of the study area.

Limitations
The floristic audit undertaken detected as many species as possible and provides a comprehensive but not definitive species list. More species would probably be detected during a longer survey over various seasons.
Nevertheless, the techniques used in this investigation are considered adequate to gather the data necessary for the assessment of the effects of the proposal on flora species.

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 in the study area employed a total of 92.75 person-hours as documented in Table 1. An additional 12 person-hours of targeted searches for the Leafless Tongue Orchid was undertaken on 23 December 2005 and 2 person-hours on 20 December 2006 in Barnunj State Conservation Area.

Table 1: Flora survey effort employed over the study area.

<table>
<thead>
<tr>
<th>DATE</th>
<th>METHOD</th>
<th>EFFORT</th>
<th>TARGET SPECIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 October 2006</td>
<td>Random Meander and Vegetation survey sheets</td>
<td>3.75 person-hours</td>
<td>All flora species</td>
</tr>
<tr>
<td></td>
<td>Random Meander</td>
<td>3.5 person-hours</td>
<td>Caladenia tessellata</td>
</tr>
<tr>
<td>26 October 2005</td>
<td>Random Meander and Vegetation survey sheets</td>
<td>5 person-hours</td>
<td>All flora species</td>
</tr>
<tr>
<td></td>
<td>Random Meander</td>
<td>3.5 person-hours</td>
<td>Caladenia tessellata</td>
</tr>
<tr>
<td>15 November 2005</td>
<td>Vegetation community boundaries</td>
<td>1 person hour</td>
<td>N/A</td>
</tr>
<tr>
<td>16 November 2005</td>
<td>Vegetation community boundaries</td>
<td>4 person hours</td>
<td>N/A</td>
</tr>
<tr>
<td>14 December 2005</td>
<td>Random Meander and Grid transects</td>
<td>13 person hours</td>
<td>Cryptostylis hunteriana</td>
</tr>
<tr>
<td>15 December 2005</td>
<td>Random Meander and Grid transects</td>
<td>29 person hours</td>
<td>Cryptostylis hunteriana</td>
</tr>
<tr>
<td>21 December 2005</td>
<td>Random Meander and Grid transects</td>
<td>18 person hours</td>
<td>Cryptostylis hunteriana</td>
</tr>
<tr>
<td>23 December 2005</td>
<td>Random Meander and Grid transects</td>
<td>4.5 person hours</td>
<td>Cryptostylis hunteriana</td>
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<tr>
<td>28 December 2005</td>
<td>Random Meander</td>
<td>2 person hours</td>
<td>Cryptostylis hunteriana</td>
</tr>
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<td>5 January 2006</td>
<td>Vegetation community boundaries</td>
<td>2.5 person hours</td>
<td>N/A</td>
</tr>
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<td>15 March 2006</td>
<td>Random Meander and Grid transects</td>
<td>18 person hours</td>
<td>Genoplesium baueri</td>
</tr>
<tr>
<td>20 December 2006</td>
<td>Checking known orchid locations</td>
<td>2 person hours</td>
<td>Cryptostylis hunteriana</td>
</tr>
<tr>
<td>TOTAL FLORA SURVEY EFFORT</td>
<td></td>
<td>92.75 person-hours</td>
<td></td>
</tr>
</tbody>
</table>
2.3 Fauna Survey Methods

Field investigations for fauna were conducted in the study area by BES on 12 October, 4 November, and 1 and 21 December 2005, and 9, 10, 11, 12 and 30 January, 15, 16, 17, 22 and 23 February, 29 March, 11, 12, 13, 14, 19, 20, 21, 22, 23, 24 and 25 April, and 10 June 2006, in the locations shown in Figure 3 (Appendix A).

Opportunistic Diurnal Surveys

Opportunistic fauna surveys involved observations of animal activity, habitat surveys and searches for indirect evidence of fauna.

Diurnal mammal searches were conducted in areas of potential habitat across the study area, with emphasis on searches for scats, tracks, burrows, diggings and scratchings. Specific bird, reptile and amphibian searches were conducted across the study area involving both visual and aural detection of species.

Specific searches were conducted 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. All Black She-oak trees in the study area were inspected for the presence of crushed cones and the locations of identified feed trees recorded with a Garmin Geoko 301 GPS. All trees with visible hollows were identified, tagged and numbered, and their locations were recorded with a Garmin Geoko 301 GPS. Opportunistic records of all fauna species observed were maintained throughout the survey period, and an inventory was compiled of all species recorded during the current investigations.

Trapping Surveys

Non-specific trapping surveys for terrestrial mammals were undertaken within all vegetation types contained within the study area on two occasions, followed by a targeted trapping survey for the White-footed Dunnart. The non-specific surveys for small mammals were conducted over six nights from 10 – 12 January and 15 – 17 February 2006. A total of 35 small cage traps and 35 Type A Elliott traps were set along five transects. Traps were spaced at 25 m intervals and were baited with a mixture of peanut butter, honey and rolled oats. Each trap was covered with plastic to protect captured animals from rain. Trapping transects were located with GPS and marked with numbered flagging tape.

The traps were left in place for 3 consecutive nights during each trapping session, yielding a total trapping effort of 210 small cage trap-nights and 210 Elliott trap-nights, and checked each morning soon after sunrise. Captured animals were identified quickly and with minimal handling, prior to release.

Targeted trapping for the White-footed Dunnart was conducted over four nights from 11 – 14 April 2006 within all known vegetation types in the study area. A total of 50 Type A Elliott traps were set along nine transects yielding 200 Elliott trap-nights, and 16 pitfall traps were set along
eight transects yielding 64 pitfall trap-nights. For Elliott traps, there were eight transects comprising five traps each and one transect with ten traps. All pitfall trapping transects comprised two traps each.

Elliott traps were spaced at 20m intervals and were baited with a mixture of peanut butter, honey and rolled oats. They were covered with plastic to protect captured animals from rain and lined with cotton wool to provide insulation for trapped animals. Pitfall traps comprised two pits separated by a distance of 30m, with drift fence extending between the pits and for a distance of 20m beyond each pit.

Trapping transects and pitfall sites were marked with numbered flagging tape and the locations recorded using a Personal Digital Assistant XDA O2 linked to a bluetooth EMTAC S3 BTGPS GPS.

Hair Funnel Surveys
Twenty-five (25) Faunatech Hair Funnels were positioned along 5 transects (5 per transect) in all vegetation types across the study area on two occasions. Hair funnels were placed alternately on tree-trunks about 2 m above the ground and on the ground along each transect. All hair funnels were baited with a mixture of peanut butter honey and rolled oats and left in position over six nights between 9 - 12 January and 14 – 17 February 2006, yielding 60 arboreal hair funnel-nights and 90 terrestrial hair funnel-nights. Hair samples from hair funnels were sent to Ms. Barbara Triggs for analysis.

Nocturnal Spotlighting and Call Playback Surveys
Spotlighting was undertaken along a number of traverses throughout the study area. A Narva Colt 100 W hand-held spotlight with Faunatech battery pack was used in attempts to illuminate mammals, birds and amphibians.

Call playback techniques were used to survey for nocturnal mammals and birds on 23 February and 10 June 2006. The calls of the Powerful Owl, Sooty Owl, Masked Owl, Barking Owl, Yellow-bellied Glider, Squirrel Glider and Giant Burrowing Frog were broadcast through a Toa megaphone in two locations within the study area. Calls were broadcast for a period of five (5) minutes followed by a listening period of fifteen (15) minutes and spotlighting for a further twenty minutes.

Nocturnal ANABAT Survey
ANABAT echolocation recording was used to target microchiropteran bats in the study area on 9 January, 22 February, 29 March, and 19, 20, 21, 22, 23, 24 and 25 April 2006. One hand-held ANABAT II bat detector linked to a Sony Walkman cassette recorder was employed in January, February for walking traverses of the study area from one half hour before dusk to one hour after dusk when microchiropteran bat activity is considered to be high. March and April bat surveys involved the use of one ANABAT II bat detector linked to a ZCAIM module and attached
to a tree-trunk at locations adjacent to clusters of hollow-bearing trees in the study area. The detector was left in-situ to record echolocation calls from one half hour before dusk until sunrise the next morning. Tapes and digital files of echolocation calls were sent to Mr. Adam Fawcett, Regional Ecologist of Forests NSW for analysis.

**Diurnal Nesting Assessments**

Diurnal nesting assessments for the Gang-gang Cockatoo were undertaken on 1 December 2005 across the entire study area. Four observers were positioned in strategic locations for one and one half hours before dusk to listen for the characteristic vocalisations made by Gang-gang Cockatoos as they return to the nest. Diurnal nesting assessments for the Glossy-black Cockatoo were undertaken on 19, 20, 21, 22, 23, 24 and 25 April 2006 across the entire study area. A single observer was positioned in strategic locations for one hour before dusk to listen for the characteristic vocalisations made by Glossy-black Cockatoos as they return to the nest.

**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. 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.

**Limitations**

The results of fauna surveys can be optimised by conducting investigations over a long period to compensate for the effect of unfavourable weather, seasonal changes and climatic variation. In general, the longer the survey the more species will be detected. Results can also be improved by using a wide range of techniques, since some species are more likely to be detected by a particular method. Such techniques include scat analysis, small-cage trapping, pitfall trapping, hair tubing and harp trapping. 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 guide to the native fauna present, but are by no means a definitive list of the species occurring in the study area. Nevertheless, the techniques used in this investigation are considered adequate to gather the data necessary for the assessment of the effects of the proposal on fauna species.

**Nomenclature**

The nomenclature in this report is based on the Mammals of Australia (Strahan 1995), 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.

<table>
<thead>
<tr>
<th>DATE</th>
<th>TEMPERATURE</th>
<th>WIND</th>
<th>CLOUD</th>
<th>MOON</th>
<th>HUMIDITY</th>
<th>RAIN</th>
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<tr>
<td>12 October 2005</td>
<td>18°C – 19°C</td>
<td>N</td>
<td>4/8</td>
<td>NA</td>
<td>60</td>
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<tr>
<td>4 November 2005</td>
<td>18.8°C – 19.2°C</td>
<td>SSW</td>
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<td>NA</td>
<td>80</td>
<td>2.8mm</td>
</tr>
<tr>
<td>1 December 2005</td>
<td>22°C – 25°C</td>
<td>None</td>
<td>6/8</td>
<td>NA</td>
<td>81</td>
<td>0.6mm</td>
</tr>
<tr>
<td>21 December 2005</td>
<td>13.9°C – 31.4°C</td>
<td>SSW</td>
<td>0/8</td>
<td>NA</td>
<td>71</td>
<td>None</td>
</tr>
<tr>
<td>9 January 2006</td>
<td>17.6°C – 25°C</td>
<td>S</td>
<td>2/8</td>
<td>NA</td>
<td>76</td>
<td>None</td>
</tr>
<tr>
<td>10 January 2006</td>
<td>19.1°C – 26.1°C</td>
<td>NE</td>
<td>0/8</td>
<td>NA</td>
<td>81</td>
<td>None</td>
</tr>
<tr>
<td>11 January 2006</td>
<td>19.1°C – 25°C</td>
<td>SSW</td>
<td>0/8</td>
<td>NA</td>
<td>63</td>
<td>None</td>
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<tr>
<td>12 January 2006</td>
<td>23°C – 25.5°C</td>
<td>SSE</td>
<td>8/8</td>
<td>NA</td>
<td>89</td>
<td>12mm</td>
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<td>20°C – 22°C</td>
<td>SE</td>
<td>8/8</td>
<td>NA</td>
<td>62</td>
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<td>15 February 2006</td>
<td>17.9°C – 25.6°C</td>
<td>NNE</td>
<td>6/8</td>
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<td>16 February 2006</td>
<td>21.3°C – 28.1°C</td>
<td>N</td>
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<td>17 February 2006</td>
<td>18.9°C – 26.5°C</td>
<td>ENE</td>
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<td>22 February 2006</td>
<td>26°C</td>
<td>SE</td>
<td>7/8</td>
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<td>23 February 2006</td>
<td>20°C – 25.9°C</td>
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<td>29 March 2006</td>
<td>16.6°C – 22.6°C</td>
<td>NE</td>
<td>2/8</td>
<td>NA</td>
<td>72</td>
<td>0.5mm</td>
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<tr>
<td>11 April 2006</td>
<td>12.5°C – 29.2°C</td>
<td>NE</td>
<td>1/8</td>
<td>NA</td>
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<tr>
<td>12 April 2006</td>
<td>16.4°C – 29.2°C</td>
<td>SSE</td>
<td>3/8</td>
<td>NA</td>
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<td>16.7°C – 23.1°C</td>
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<td>NA</td>
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<td>14 April 2006</td>
<td>15.4°C – 23.9°C</td>
<td>NE</td>
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<tr>
<td>20 April 2006</td>
<td>17°C – 23°C</td>
<td>W</td>
<td>0/8</td>
<td>Quarter</td>
<td>NA</td>
<td>None</td>
</tr>
<tr>
<td>21 April 2006</td>
<td>9°C – 19°C</td>
<td>S gusty</td>
<td>4/8</td>
<td>Quarter</td>
<td>NA</td>
<td>None</td>
</tr>
<tr>
<td>22 April 2006</td>
<td>11°C – 18°C</td>
<td>S light</td>
<td>2/8</td>
<td>None</td>
<td>NA</td>
<td>None</td>
</tr>
<tr>
<td>23 April 2006</td>
<td>11°C – 19°C</td>
<td>S light</td>
<td>4/8</td>
<td>None</td>
<td>NA</td>
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<td>NA</td>
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<td>10 June 2006</td>
<td>9°C – 11°C</td>
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<td>0/8</td>
<td>Full</td>
<td>NA</td>
<td>None</td>
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</table>
Survey Effort
The fauna survey effort employed a total of 68 person hours, 106 ANABAT detector-hours, 60 arboreal hair funnel-nights, 90 terrestrial hair funnel-nights, 410 Elliot trap-nights, 210 small cage trap-nights and 64 pitfall trap-nights as documented in Table 3.

<table>
<thead>
<tr>
<th>DATE</th>
<th>METHOD</th>
<th>EFFORT</th>
<th>TARGET SPECIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 October 2005</td>
<td>Diurnal habitat search</td>
<td>2.25 person-hours</td>
<td>All species</td>
</tr>
<tr>
<td>4 November 2005</td>
<td>Diurnal habitat search</td>
<td>18 person-hours</td>
<td>All species</td>
</tr>
<tr>
<td>1 December 2005</td>
<td>Nesting assessment</td>
<td>6 person-hours</td>
<td>Gang-gang Cockatoo</td>
</tr>
<tr>
<td>21 December 2005</td>
<td>Feed tree survey</td>
<td>18 person-hours</td>
<td>Glossy Black-cockatoo</td>
</tr>
<tr>
<td>9-12 January 2006</td>
<td>Hair funnel survey</td>
<td>30 arboreal hair funnel-nights</td>
<td>Arboreal and terrestrial mammals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45 terrestrial hair funnel-nights</td>
<td></td>
</tr>
<tr>
<td>9 January 2006</td>
<td>ANABAT survey</td>
<td>9 person-hours</td>
<td>Microchiropteran bats</td>
</tr>
<tr>
<td>10-12 January 2006</td>
<td>Small cage and Elliot</td>
<td>105 small cage trap-nights</td>
<td>Small terrestrial mammals</td>
</tr>
<tr>
<td></td>
<td>trapping</td>
<td>105 Elliot trap-nights</td>
<td></td>
</tr>
<tr>
<td>30 January 2006</td>
<td>Spotlighting</td>
<td>1.75 person-hours</td>
<td>Nocturnal mammals and birds</td>
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<td>14-17 February 2006</td>
<td>Hair funnel survey</td>
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<td>Arboreal and terrestrial mammals</td>
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<td>45 terrestrial hair funnel-nights</td>
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<td>105 Elliot trap-nights</td>
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</tr>
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<td>Powerful Owl, Sooty Owl, Masked Owl, Barking Owl,</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Yellow-bellied Glider, Squirrel Glider, Giant</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Burrowing Frog</td>
</tr>
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<td>ANABAT survey</td>
<td>14 detector-hours</td>
<td>Microchiropteran bats</td>
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<tr>
<td>11-14 April 2006</td>
<td>Pitfall and Elliott Trapping</td>
<td>200 Elliot trap-nights, 64</td>
<td>White-footed Dunnart</td>
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<tr>
<td></td>
<td></td>
<td>pitfall trap-nights</td>
<td></td>
</tr>
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<td>19 April 2006</td>
<td>ANABAT survey</td>
<td>14 detector-hours</td>
<td>Microchiropteran bats</td>
</tr>
<tr>
<td></td>
<td>Nesting assessment</td>
<td>1 person-hour</td>
<td>Glossy Black-cockatoo</td>
</tr>
<tr>
<td>DATE</td>
<td>METHOD</td>
<td>EFFORT</td>
<td>TARGET SPECIES</td>
</tr>
<tr>
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| TOTAL FAUNA SURVEY EFFORT | 68 PERSON HOURS, 106 ANABAT DETECTOR-HOURS, 60 ARBOREAL AND 90 TERRESTRIAL HAIR-FUNNEL NIGHTS, 410 ELLIOT TRAP-NIGHTS, 210 SMALL CAGE TRAP-NIGHTS, 64 PITFALL TRAP-NIGHTS |
Figure 4: Vegetation communities within the study area
Figure 5: Locations of trees with hollows
Figure 6: Species and communities of conservation significance

Lot 171 DP 1081810
Highview Drive, Dolphin Point

Cryptostylis hunteriana
Eastern Freetail Bat
Glossy Black-cockatoo feed tree
Rufous Fantail
White-footed Dunnart
Swamp sclerophyll forest endangered ecological community

Base air photo
© Land and Property Information NSW

© BES
Reference: 04283 May 2007
Figure 7: *Cryptostylis hunteriana* recorded by BES within 1km of the study area
Figure 8: Swamp sclerophyll forest within 10km of Lot 171 DP 1081810
Lot 171 in DP 1081810
Highview Drive, Dolphin Point

Proposed Residential Subdivision

Part 3A Concept Plan
Response to Submissions

Appendix A – Part 2
BES Supplementary Surveys

April 2008
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<td>December 2007 and January 2008</td>
<td>Targeted surveys in appropriate habitat.</td>
<td>Development Area and Barnunj SCA</td>
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Figure: Leafless Tongue Orchid records in Barnunj State Conservation Area & surrounding lands

- Barnunj State Conservation Area
- Leafless Tongue Orchid* (33 plants December 2005 and December 2006 surveys)

*Points may represent multiple individuals

Base art photo
© Land and Property Information NSW

Reference: E1070108 - January 2008
Lot 171 in DP 1081810
Highview Drive, Dolphin Point

Proposed Residential Subdivision

Part 3A Concept Plan
Response to Submissions

Appendix A – Part 3
Keystone 2008 Methods

April 2008
4 SURVEY METHODS

The survey for this report drew on past investigations in the study area and built upon it by expert habitat assessment and supplementary survey using Faunatech “Universal” hair funnels. The sampling strategy employed was intended to sample the areas that were most likely to support *Sminthopsis leucopus*.

Habitat assessment

Habitat assessment was conducted by foot traverse in the development area; by both vehicular and foot traverse in Barnunj State Conservation Area and the Crown Land to the south of Barnunj; and by vehicular traverse in Termeil State Forest and parts of Meroo National Park. Habitat parameters sought were those that defined *Sminthopsis leucopus* habitat in the Mumbulla population (Lunney et al. 1989): disturbed treeless ridges and midslopes with sparse ground cover.

In addition to a qualitative visual assessment of habitat, quadrats of 25 square metres were sampled in likely areas of habitat in the development area (3 quadrats) and Barnunj State Conservation Area (5 quadrats). Data recorded in the quadrats included a visual estimate of tree cover, a visual estimate of ground cover, position in the landscape and an estimate of availability of nest sites. Quantitative sampling was not conducted in the Crown Land, Termeil State Forest or Meroo National Park.

The areas sampled are shown in Figures 2, 3 and 4.

Trapping

Past trapping exercises in the development area (reported in Young 2007) relevant to survey of *Sminthopsis leucopus* included:

- 210 trap nights using Elliott traps during January and February of 2006;
- 90 trap nights using terrestrial hair funnels during January and February of 2006;
- 200 trap nights using Elliott traps during April of 2006; and
- 64 trap nights using pitfall traps during April of 2006.

In the spring of 2007, further investigation was carried out by BES in Barnunj State Conservation Area (David Coombes, BES pers comm). Elliott traps and pitfall traps were set in the unburnt sections of Barnunj State Conservation Area. The number of trap nights is unknown, but pitfalls were set at 9 sites and Elliott trapping was conducted at a further 7 sites.

The locations of survey in 2006 and 2007 are shown in Figure 2. Note that this survey avoided the most disturbed and recently burnt areas.

For the purposes of this study, an initial site assessment was carried out on 3rd December 2007 in order to locate likely habitat for subsequent targeted sampling. Given the patterns of habitat use exhibited by the Mumbulla population (Lunney and Ashby 1987), particular attention was paid to the areas in Barnunj State Conservation Area that had been burnt during the previous summer.

The *Sminthopsis leucopus* population in Mumbulla preferentially occupied the logged burnt ridge habitats and individuals were regularly found along the disturbed roadsides. Therefore, initial habitat assessment for this study consisted of roadside visual observations from a slow-moving vehicle, driving over all available roads in Barnunj State Conservation Area and in the adjacent Crown Land. The development area was only surveyed on foot.

Survey was conducted from the 12th December 2007 to 7th January 2008, using 100 Faunatech Universal hair funnels giving a total of 2,500 trap nights. Although the development area had already been thoroughly surveyed by BES, funnels were placed in
both the development area and Barnunj State Conservation Area so that direct comparisons could be made.

The most likely areas of open disturbed habitat were chosen for trapping. Barnunj State Conservation Area contained a much larger area of potential habitat, and so more traps were placed in Barnunj (80) than in the development area (20).

Reference points of the survey transects and grids were taken by hand-held GPS and are provided Appendix 1.

The locations of the trapping grids and transects are shown in Figure 2. Photographs illustrating the habitat characteristics of these sampling areas are shown in Appendix 2.

The traps were located in that part of the development area that had relatively open understorey, evidence of past fire, some bare ground, available sheltering sites (such as fallen timber) and positioned near tracks. The 20 traps were arranged in two parallel transects of 10 traps, 5 metres between trap stations and transects. This configuration was dictated by the linear nature of the available habitat being sampled.

The 80 traps in Barnunj State Conservation Area were arranged in two grids of 40 traps (5x8), located 5 metres apart, each grid occupying 700 square metres. These grids were placed in open areas that had been burnt in the fire of the previous summer, near disturbances such as roadside soil movements and tail-out drains and with patches of bare ground. There was little shelter (such as fallen timber or bark) available in the burnt areas.

The standard bait made up of peanut butter, rolled oats and honey was used as Sminthopsis leucopus has been successfully captured using such bait in Mumbulla (Lunney and Barker 1986) and on the development site (Young 2007). The hair wafers were checked and the bait refreshed on 23rd December 2007. Any wafers with hairs as of 23rd December 2007 were collected and replaced with fresh wafers. All wafers were collected on 7th January 2008.

Wafers with hair on the sticky surface were sent to specialist Barbara Triggs for analysis and identification to species using the methods of Brunner and Coman (1974) and an extensive reference collection that included hair of this species from the Mumbulla study (Lunney et al. 1990). Sminthopsis leucopus hair can be distinguished from the closely-related Sminthopsis murina Common Dunnart by a 5 micron difference in the width of the guard hairs (Barbara Triggs pers comm).
Acknowledgements

Thanks go to Joe Carlin, Rob Suesse and Bill Boyd for their assistance in the field; Barbara Triggs for hair analysis; David Coombes and staff from BES for access to their data; and Dominic Fanning and Emma Dean from Environmental Insites for use of their extra hair funnels.

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Licensing

When conducting flora and fauna surveys, consultants are required to possess licences to ensure that works are completed in an appropriate manner.

Staff and sub-consultants of Keystone Ecological are licensed under the NSW National Parks and Wildlife Act (1974) by the NSW NPWS. This allows Keystone Ecological to undertake scientific investigations, collect specimens of protected flora and fauna across NSW in service and non-service areas. This licence requires that all survey results are reported to the NSW NPWS for inclusion into the Atlas of NSW Wildlife.

Staff and sub-consultants of Keystone Ecological also hold an Animal Research Authority under the Animal Research Act (1995), as administered by NSW Agriculture. Surveys are approved and supervised by an Animal Care and Ethics Committee, applying the standards as detailed in the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (NHMRC 1997).
REFERENCES


Lot 171 in DP 1081810
Highview Drive, Dolphin Point

Proposed Residential Subdivision

Part 3A Concept Plan
Response to Submissions

Appendix B
Keystone 2008 Report

April 2008
White-footed Dunnart Survey

Dolphin Point

For: Malbec Properties

REF: ShCC 07-096
March 2008
White-footed Dunnart Survey

Dolphin Point

REF: ShCC 07-096
March 2008

Author:
Elizabeth Ashby

This document may be cited as:

Cover: Photo showing part of the ridge top in Barnunj State Conservation Area burnt in the fires of 2006-07. Although the fire was hot in parts (note the dead canopies) and occurred only 12 months prior to this photo, the area has experienced remarkable regrowth with parts of the heathland now supporting a very dense ground cover of shrubs, grasses, sedges and herbs.

Photo: R. Suesse, December 2007
Keystone Ecological was contracted by Malbec Properties to survey parts of Barnunj State Conservation Area and its environs in order to establish the significance of the capture of *Sminthopsis leucopus* White-footed Dunnart in an adjacent area proposed for subdivision and residential development.

Some of the early scientific literature related to this species indicated that it occurs in a broad range of habitats and prefers dense vegetation. However, this was shown to be a mistaken analysis after a breeding population was studied in a production forest on the south coast of New South Wales. This work demonstrated that *Sminthopsis leucopus* is a specialist of disturbed areas, deserting its breeding habitat once the regrowth reaches a critical density. A study of movements of the same population showed that these animals (particularly “explorer” males and juvenile females) regularly move large distances (in the order of kilometres), following the ridge lines in its coastal forest habitat. It is likely that records of this species in dense forest and heathland are just such dispersing individuals looking for newly-disturbed (and therefore suitable) habitat or roaming males looking for a mate.

Extensive trapping surveys of the proposed development area had been undertaken by others during 2006 and in Barnunj State Conservation Area in the spring of 2007. Given the ecology of this species, it was likely that those parts of Barnunj State Conservation Area that had been burnt in the summer of 2006-2007 provided potential breeding habitat for *Sminthopsis leucopus* in the spring of 2007. However, the survey of Barnunj State Conservation Area around these burnt areas did not capture any *Sminthopsis leucopus*.

Therefore, cost-effective survey (hair funnels) was initiated in December 2007 and January 2008 when juveniles (and possibly adults) would be dispersing if there was a breeding population in these recently disturbed sites. In addition to hair funnels, habitat assessment was undertaken across the development areas, the burnt parts of Barnunj State Conservation Area, the Crown Land to the south of Barnunj, part of Termeil State Forest and part of Meroo National Park.

No *Sminthopsis leucopus* were detected in the hair funnels. Terrestrial mammal species recorded using this method reflected the species captured during the previous trapping program.

Habitat assessment revealed that, although there were two captures of *Sminthopsis leucopus* in February 2006, the development area does not contain suitable habitat for this species. The vegetation is too dense at all levels and probably favours olfactory predators such as the *Antechinus*, a species that was commonly recorded in all habitats, in all survey periods using all survey techniques. The most likely explanation of the presence of the *Sminthopsis leucopus* trapped in the development area is that it was a single dispersing juvenile female looking for suitable habitat.

Barnunj State Conservation Area probably periodically provides suitable habitat for this species after catastrophic disturbance (such as fire) as it provides the other critical factors identified in studies of *Sminthopsis leucopus* habitat: disturbed treeless ridges with sparse ground cover. However, two countervailing habitat characteristics militate against it being high quality breeding habitat: it provides few sheltering sites (such as fallen timber) and the ground layers exhibited rapid regrowth after fire, being dense in many places within 12 months.

The absence of *Sminthopsis leucopus* in the hair funnel survey is most likely because this species is absent from those areas - the survey areas did not contain appropriate habitat and therefore is not likely to support a population of this species. The rapidly regenerating vegetation of Barnunj State Conservation Area is probably unsuitable habitat for this species in which to remain and breed, even though it may have supported this species at an earlier seral stage. The habitat of the development area is also generally unsuitable for this species as it supports relatively undisturbed and dense vegetation.
An alternative explanation for the lack of Sminthopsis leucopus hair in the funnels is that the sampling technique is inappropriate to detect this species. However, this is not considered a credible explanation as other dasyurids are regularly detected using this method and Sminthopsis leucopus is readily captured using the standard bait mixture. Further, dispersing juveniles are likely to be curious and investigate novel odours such as those of the baited funnels. It is considered therefore that hair funnels are an appropriate sampling method for this species, and certainly during the dispersal phase in summer.

Habitat assessment in the local area revealed that the coastal heathlands to the south of Barnunj State Conservation Area are far too dense to support this species and the disturbances observed do not provide suitable habitat within them. However, the coastal forests to the west of the Princes Highway probably do contain suitable habitat for this species periodically and may continue to do so with their ongoing management. This is particularly so for Termeil State Forest as it remains a production forest and will therefore undergo disturbances similar to those observed in the Mumbulla population that favoured Sminthopsis leucopus – logging, roading and burning.

It is likely that this species occurs naturally in very low numbers across its range in the coastal forests, woodlands and heaths of the south coast of New South Wales. It is rarely encountered during survey because of this natural rarity and the fact that it prefers habitats that are also rarely available: early to mid seral stage vegetation. It is reportedly difficult to catch, with pitfall traps providing the most success. However, individuals of the Mumbulla population readily entered standard Elliott traps when placed in the correct habitat – open and disturbed areas that are usually avoided by fauna surveyors. Therefore it is possible that this reputation for being trap shy is partly a function of its habitat (open disturbed areas) not being trapped.

It is most unlikely that the animals or animal recorded in the development area represents a resident population. The development area is sandwiched between Barnunj State Conservation Area and residential development, with estuarine environments beyond. The development area is therefore unlikely to provide a link or corridor for the movement of this species.

The presence of one or two individual Sminthopsis leucopus in a trapping program does not mean that the habitat within which it was trapped is an important place for the persistence of a local population; it is more likely that the individual found in the development was passing through while exploring for suitable habitat. The conservation of Sminthopsis leucopus will depend upon appropriate active management of appropriate habitat at the landscape scale. Reserving small patches of dense undisturbed bushland will not accommodate its peculiar movements or unusual choices of breeding habitat.
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1 INTRODUCTION AND BACKGROUND

Keystone Ecological has been contracted by Malbec Properties to provide a survey and assessment of Sminthopsis leucopus White-footed Dunnart at a proposed development site and its environs at Dolphin Point on the south coast of New South Wales.

The site is located at Lot 171 DP 1081810 Highview Drive and the proposed residential subdivision is a listed Major Project as defined under Part 3A of the Environmental Planning and Assessment Act (1979).

The proposed development has been the subject of much ecological investigation and impact assessment (see Young 2007). During one of these surveys, two captures were made of Sminthopsis leucopus in the development area.

In response to a request by the then Department of Environment and Conservation (now the Department of Environment and Climate Change), mechanisms to offset the impacts of the development proposal on threatened species were investigated by Bushfire Environmental Services (BES). In particular, Barnunj State Conservation Area was surveyed by BES for the presence of threatened species and their habitats in the spring of 2007.

No Sminthopsis leucopus were captured despite an extensive trapping program.

Keystone Ecological was subsequently contracted to carry out further survey in likely habitat using cost-effective techniques in order to assess the significance of the finding of Sminthopsis leucopus in the development area.

The author of this report has considerable experience in this area of study, having published on the population dynamics of Sminthopsis leucopus in Mumbulla State Forest near Bega on the south coast of New South Wales (see Lunney and Ashby 1987), its diet (Lunney et al. 1986) and as a prey item for introduced predators (Lunney et al. 1990). This population was also the subject of studies regarding survey techniques (Lunney and Barker 1986), habitat preferences (Lunney et al. 1989) and movements (Lunney and Leary 1989). An unpublished study was also carried out on the taxonomy of Sminthopsis leucopus and the closely-related Sminthopsis murina, in the hope of revealing a reliable set of field characters to separate the two species (Lunney and Sanders, unpublished data).

This report draws heavily from that body of work.
2 THE STUDY AREA

The brief for this survey was to investigate the significance of the Sminthopsis leucopus records on the development site. Therefore, the habitat of the development site was investigated in relation to other habitat in its immediate vicinity. The location of the study area is shown in Figure 1.

The study area for this survey and habitat assessment comprises:

- the Dolphin Point development area;
- Barnunj State Conservation Area; and
- Crown Land lying to the south of Barnunj State Conservation Area on the eastern side of the Princes Highway.

A rapid assessment of the availability of suitable habitat was also carried out for vegetation further afield on the western side of the Princes Highway.

The **Dolphin Point development area** occupies approximately 16 hectares of coastal woodland. Four vegetation types have been identified on the property (Young 2007). The majority of the site supports Stringybark - Bangalay Dry Open Forest / Woodland with smaller patches of Scribbly Gum Bloodwood Woodland and Red Bloodwood Shrubland. The lower parts of the site support Bangalay Swamp Forest in the drainage lines.

This bushland is in relatively good condition and is generally undisturbed despite having residential development on its eastern and northern boundaries and cleared agricultural land to the west. The perimeters suffer from edge effects with rubbish dumping, mowing and other unauthorised uses such as vehicle parking and so on with a commensurate increase in the numbers and types of weeds. There are also a number of walking tracks crossing through the bushland that are regularly used by locals, presumably for recreational pursuits such as bike riding and dog walking. These tracks also provide an alternative access to the adjacent Barnunj State Conservation Area.

Overall, however, the vegetation exhibits little evidence of serious widespread disturbance other than the occasional fire. The fire history of the site is unknown.

The **Barnunj State Conservation Area** occupies 164 hectares and lies to the south of the development area. It supports coastal dune vegetation (particularly heathlands), low woodland on ridges and exposed slopes and taller forests in the gullies. The main access is via a road running along an east-west ridgeline but it also has a number of other tracks criss-crossing the ridges and dunes.

This area has experienced unregulated recreational activities for many years prior to its dedication as Barnunj State Conservation Area. The current management plan for this area (NSW NPWS 2005) recognises that the most significant disturbances have arisen from recreational activities that include unregulated vehicle access, horse riding, camping and firewood collection. The attendant impacts include the loss of vegetation, erosion of tracks, destabilizing of dunes, degradation of waterbodies and dieback of forested communities.

The central part of Barnunj State Conservation Area was burnt by two wildfires in the summer of 2006-2007. The area to the north of the central road burnt in December 2006 and the area to the south of the road burnt in the following month, January 2007. The mapped extent of those fires has been provided by NSW National Parks and Wildlife Service and is shown in Figure 2.

Despite evidence of it being a very hot fire (e.g. burnt tree canopies, complete removal of above-ground vegetation), the regeneration of the vegetation has been rapid, with dense low vegetation now covering most of the burnt areas.

The **Crown Land** to the south of Barnunj State Conservation Area occupies a similar suite of coastal habitats and suffers a similar set of unregulated disturbances.
3 ECOLOGICAL PROFILE OF SMINTHOPSIS LEUCOPUS

The White-footed Dunnart is listed as Vulnerable under Schedule 2 of the Threatened Species Conservation Act (1995). This species is not listed under the Schedules of the Environment Protection and Biodiversity Conservation Act (1999).

This species is a small dasyurid (marsupial carnivore), with a head and body length of approximately 10 centimetres and a body weight of approximately 19-26 grams (DECC 2008). It has notched ears, protruding eyes and a pointed muzzle. Its feet are covered in fine white hairs - thus the common name.

It has a remarkable distribution, known from coastal environments in Tasmania, Victoria, and southern New South Wales with a disjunct population in North Queensland rainforests (Van Dyck 1985). The Shoalhaven area is believed to be the northern limit for Sminthopsis leucopus in New South Wales (DECC 2008). Although Van Dyck (1985) explains the enormous disjuncture as due to the difficulty in capturing the species, the difficulty in identifying them in the hand, lack of survey and lack of taxonomic investigation, this distribution must be viewed with caution as the Queensland record is based on only two specimens.

Sminthopsis leucopus can be easily confused with the closely-related Sminthopsis murina Common Dunnart, there being no set of reliable distinguishing field characteristics assigned to the species (Lunney 1995). Although not a field character, it is reported that the guard hairs of Sminthopsis leucopus and Sminthopsis murina are consistently different by a width of 5 microns (Barbara Triggs pers comm).

Published taxonomic treatments to date have relied on microscopic characteristics of the teeth and patterns on the foot pads, but these are not consistent characters with different combinations of both striated and granular pads observed, for example, on the same animal and in the same populations (Daniel Lunney, unpublished data, Jonathan Sanders pers comm). Workers have largely depended on published distribution maps to determine which of these Dunnart species they have observed (pers ob). This is poor science and may further obscure other species within this complex (Lunney 1995).

Confusion surrounding this species is not confined to its taxonomy however: its ecology is also somewhat difficult to understand with many contradictions published in the literature.

For example, these animals are reportedly difficult to trap, with studies in Victoria and North Queensland indicating that they are only caught in pitfall traps (Lunney 1995). By contrast, another study near Melbourne caught this species in “Sherman” box aluminium traps (Lunney 1995), and a population of this species in Mumbulla State Forest on the south coast of New South Wales was also readily trapped in “Elliott” box aluminium traps (Lunney and Barker 1986).

One of the most elusive features of this species is a reliable description of habitat. The literature indicates that low numbers of Sminthopsis leucopus have been captured in a wide range of habitats from foredune heathland to Nothofagus forest (Lunney and Ashby 1987). Habitat preferences were further clouded by an attempt by Morton et al. (1980) to clarify the different habitats exploited by Sminthopsis leucopus and Sminthopsis murina by sampling and describing the vegetation of collection sites of museum specimens many years (in some cases decades) after their capture. As vegetation structure and plant species composition are dynamic features of habitat, this study perpetuated many spurious beliefs about habitat preferences of this species.

A comprehensive long-term study of the Mumbulla State Forest population has helped to explain many of these seemingly anomalous results. This population was studied from 1981 to 1983 in a forest that had been logged in 1979, burnt in 1980, and was drought-affected throughout the study. Sminthopsis leucopus bred in this disturbed habitat but did not persist when the vegetation regrew and became dense (Lunney and Ashby 1987).
This seemingly peculiar habitat preference was further investigated and it was found that this species selects treeless ridges and midslopes with less than 50% cover in the logged areas of burnt forest (Lunney et al. 1989). It was not found in gullies or where ferns were abundant in the ground cover. However, the reason for its choice of logged, burnt ridges was not related to food, as a study of their diet demonstrated (Lunney et al. 1986): the prey items consumed were available in similar numbers as those taken in all habitats in the forest.

The inhospitable environment of the logged, burnt ridges with little ground cover provided breeding habitat for this species, with pouch young present in August, September and October (Lunney and Ashby 1987).

A study of the movements of this species revealed that the breeding population (of approximately 99 individuals) in Mumbulla occupied a discrete area of approximately 500 hectares within the centre of the forest (Lunney and Leary 1989). Adult females occupied small home ranges that did not overlap with other females. Males, however, had larger and overlapping home ranges (Lunney and Leary 1989).

Mark recapture data revealed that the males were of two kinds: “resident” or “explorer” (Lunney and Leary 1989). Explorer males were measured as moving at least 1 kilometre straight line distance in a single night; although the actual route probably taken (following the ridges) makes the distance travelled much greater. A similar movement pattern - large scale movements along the ridges - was also recognised in juvenile females.

The ability to travel long distances enables this species to find suitable habitat and to use suddenly abundant and transient resources, such as disturbed forest, which may occur naturally only as disjunct and temporary patches (Lunney 1995). This feature of its biology alone accounts for the vast array of habitat and vegetation types within which it has been recorded. Many records are probably not of residents but of travelling individuals looking for suitable habitat.

The ecology of other species of Sminthopsis has revealed a similarity in all respects, namely high rates of mobility and transience (Haythornthwaite and Dickman 2006), an extended seasonal pattern of reproduction, relatively rapid development of the young and the probable existence of polyoestry (Friend et al. 1997). All of these attributes enable a high degree of reproductive flexibility and permit these species to opportunistically invade new habitats and ephemeral post-fire seral stages (Friend et al. 1997).

Recognised threats to the survival of this species include (DECC 2008):

- Loss and fragmentation of habitat resulting from land clearing for residential and agricultural developments;
- Modification and disturbance of habitat in coastal forest and foredune complex vegetation by camping and other recreational activities;
- Predation by foxes, cats and dogs;
- Collection of firewood from areas of habitat, including standing dead timber and logs on the ground; and
- Fire regimes that result in continual absence of cover or thick regeneration may be deleterious.

A number of recovery strategies have been listed for this species, including feral predator control, rabbit control, application of mosaic hazard reduction burning, avoidance of overgrazing of habitat, application of forestry regimes that create suitable floristic and structural diversity and protection of habitat and retention of linkages at the landscape scale (DECC 2008).
4 SURVEY METHODS

The survey for this report drew on past investigations in the study area and built upon it by expert habitat assessment and supplementary survey using Faunatech “Universal” hair funnels. The sampling strategy employed was intended to sample the areas that were most likely to support Sminthopsis leucopus.

Habitat assessment

Habitat assessment was conducted by foot traverse in the development area; by both vehicular and foot traverse in Barnunj State Conservation Area and the Crown Land to the south of Barnunj; and by vehicular traverse in Termeil State Forest and parts of Meroo National Park. Habitat parameters sought were those that defined Sminthopsis leucopus habitat in the Mumbulla population (Lunney et al. 1989): disturbed treeless ridges and midslopes with sparse ground cover.

In addition to a qualitative visual assessment of habitat, quadrats of 25 square metres were sampled in likely areas of habitat in the development area (3 quadrats) and Barnunj State Conservation Area (5 quadrats). Data recorded in the quadrats included a visual estimate of tree cover, a visual estimate of ground cover, position in the landscape and an estimate of availability of nest sites. Quantitative sampling was not conducted in the Crown Land, Termeil State Forest or Meroo National Park.

The areas sampled are shown in Figures 2, 3 and 4.

Trapping

Past trapping exercises in the development area (reported in Young 2007) relevant to survey of Sminthopsis leucopus included:

- 210 trap nights using Elliott traps during January and February of 2006;
- 90 trap nights using terrestrial hair funnels during January and February of 2006;
- 200 trap nights using Elliott traps during April of 2006; and
- 64 trap nights using pitfall traps during April of 2006.

In the spring of 2007, further investigation was carried out by BES in Barnunj State Conservation Area (David Coombes, BES pers comm). Elliott traps and pitfall traps were set in the unburnt sections of Barnunj State Conservation Area. The number of trap nights is unknown, but pitfalls were set at 9 sites and Elliott trapping was conducted at a further 7 sites.

The locations of survey in 2006 and 2007 are shown in Figure 2. Note that this survey avoided the most disturbed and recently burnt areas.

For the purposes of this study, an initial site assessment was carried out on 3rd December 2007 in order to locate likely habitat for subsequent targeted sampling. Given the patterns of habitat use exhibited by the Mumbulla population (Lunney and Ashby 1987), particular attention was paid to the areas in Barnunj State Conservation Area that had been burnt during the previous summer.

The Sminthopsis leucopus population in Mumbulla preferentially occupied the logged burnt ridge habitats and individuals were regularly found along the disturbed roadsides. Therefore, initial habitat assessment for this study consisted of roadside visual observations from a slow-moving vehicle, driving over all available roads in Barnunj State Conservation Area and in the adjacent Crown Land. The development area was only surveyed on foot.

Survey was conducted from the 12th December 2007 to 7th January 2008, using 100 Faunatech Universal hair funnels giving a total of 2,500 trap nights. Although the development area had already been thoroughly surveyed by BES, funnels were placed in
both the development area and Barnunj State Conservation Area so that direct comparisons could be made.

The most likely areas of open disturbed habitat were chosen for trapping. Barnunj State Conservation Area contained a much larger area of potential habitat, and so more traps were placed in Barnunj (80) than in the development area (20).

Reference points of the survey transects and grids were taken by hand-held GPS and are provided Appendix 1.

The locations of the trapping grids and transects are shown in Figure 2. Photographs illustrating the habitat characteristics of these sampling areas are shown in Appendix 2.

The traps were located in that part of the development area that had relatively open understorey, evidence of past fire, some bare ground, available sheltering sites (such as fallen timber) and positioned near tracks. The 20 traps were arranged in two parallel transects of 10 traps, 5 metres between trap stations and transects. This configuration was dictated by the linear nature of the available habitat being sampled.

The 80 traps in Barnunj State Conservation Area were arranged in two grids of 40 traps (5x8), located 5 metres apart, each grid occupying 700 square metres. These grids were placed in open areas that had been burnt in the fire of the previous summer, near disturbances such as roadside soil movements and tail-out drains and with patches of bare ground. There was little shelter (such as fallen timber or bark) available in the burnt areas.

The standard bait made up of peanut butter, rolled oats and honey was used as Sminthopsis leucopus has been successfully captured using such bait in Mumbulla (Lunney and Barker 1986) and on the development site (Young 2007). The hair wafers were checked and the bait refreshed on 23rd December 2007. Any wafers with hairs as of 23rd December 2007 were collected and replaced with fresh wafers. All wafers were collected on 7th January 2008.

Wafers with hair on the sticky surface were sent to specialist Barbara Triggs for analysis and identification to species using the methods of Brunner and Coman (1974) and an extensive reference collection that included hair of this species from the Mumbulla study (Lunney et al. 1990). Sminthopsis leucopus hair can be distinguished from the closely-related Sminthopsis murina Common Dunnart by a 5 micron difference in the width of the guard hairs (Barbara Triggs pers comm).
5 RESULTS

5.1 Survey conditions

Survey for Sminthopsis leucopus occurred in the development area and / or Barnunj State Conservation Area from January 2006 to January 2008. According to the NSW Department of Primary Industries, the south coast district was drought-declared for 16 of those 25 months. Only 9 of those months experienced above average rainfall, the majority of this rain falling in the winter (Bureau of Meteorology).

Over the last 10 years, rainfall statistics from the Ulladulla weather station show that the area has experienced below average rainfall as well as a change in the pattern of rain from summer-dominant rains towards a Mediterranean climate of winter rainfall. This pattern has been particularly pronounced in the last three years, with the autumn-winter rains falling in significant storm events.

The influence of this shifting weather pattern on native species is yet to be determined, but it is likely that those species that rely on summer rains or a dry winter will have their life cycles affected.

The weather data from the Ulladulla weather station for the period of the hair funnel survey (12th December 2007 to 7th January 2008) are provided in Appendix 1. The rainfall for these two months was average or above average but it was preceded by a very dry spring in 2007.

5.2 Trapping

Young (2007) reported that Sminthopsis leucopus was trapped on two occasions in February 2006. A female was captured in two different trap lines on two different nights. The animal was not marked when released, so this may have been the same animal on both occasions. Both of these trap lines were located near one of the tracks that cross the development area.

Although there are no reliable field characters to distinguish Sminthopsis leucopus from the closely-related Sminthopsis murina, the characters generally relied upon were evident in the specimen(s) captured - white feet and striated interdigital footpads. These features are shown in photographs of the specimen at Figures 5 and 6.

Subsequent targeted survey in the development area in 2006 did not capture any Sminthopsis leucopus (Young 2007). The most common small mammals captured were Antechinus agilis, A. swainsonii and Rattus fuscipes.

The targeted pitfall trapping in Barnunj State Conservation Area in the spring of 2007 also yielded no Sminthopsis leucopus.

5.3 Hair funnels

The species recorded by this survey method are detailed in Appendix 1.

Hairs on wafers from the funnels in the development area were identified as Homo sapiens (presumably a contaminant from the field workers), Wallabia bicolor Swamp Wallaby, Trichosurus sp. Brushtail Possum, Antechinus agilis Agile Antechinus, Antechinus sp. and Canis familiaris Dog. These species were all recorded during the previous trapping program.

Hair on wafers from the funnels in Barnunj State Conservation Area were identified as Wallabia bicolor Swamp Wallaby, Trichosurus sp. Brushtail Possum, Antechinus agilis Agile Antechinus, Antechinus sp. and Felis catus Cat.

Therefore, both areas support a similar suite of common terrestrial species. No Rattus species were detected in the hair funnels, although they were detected by trapping.
5.4 Habitat assessment

None of the areas searched in the development area or Barnunj State Conservation Area contained the complete set of characteristics determined as defining breeding habitat for Sminthopsis leucopus (sensu Lunney et al. 1989) viz. disturbed, treeless ridge or midslope with sparse ground cover.

The entire development area supported a forest or woodland structure; it was not treeless. The ridge and midslope areas possessed a thick shrubby understorey with little bare ground in evidence – indeed it was difficult to find a suitable area to set the hair funnels. Most of the site was relatively undisturbed except for along the track edges and at the periphery where it adjoined cleared land. However, the disturbance along the track edges was generally minor (they are narrow foot tracks) and the perimeter quickly gave way to weed species and dense open grassland. The development area did, however, provide potential sheltering sites on the ground amongst fallen timber. The vegetation quadrats measured in the development area returned average readings of 37% tree cover (minimum 30%, maximum 45%, n=3) and 45% ground cover (minimum 35%, maximum 50%, n=3).

The recently burnt parts of Barnunj State Conservation Area possessed a number of characteristics that coincide with Sminthopsis leucopus habitat: it occurred at the top of the landscape, was generally treeless, contained areas of bare ground and had been disturbed by the fires of December 2006 and January 2007 as well as by vehicular tracks and associated erosion gullies and drains. However, there was little shelter in the form of fallen timber, shedding bark or the like. The vegetation quadrats measured in Barnunj State Conservation Area returned average readings of 0% tree cover and 20% ground cover (minimum 10%, maximum 35%, n=5). Note, however, that although no trees occurred in the vegetation sampling quadrats, some trees did occur along the edge of Grid 4 as it was located close to the woodland boundary.

The Crown Land to the south of Barnunj State Conservation Area contained no habitat suitable for Sminthopsis leucopus in the areas surveyed. While the aerial photography showed many open disturbed areas, these consisted of featureless tracks and vehicle turning circles adjoined by dense heathland with almost 100% cover. The open disturbed parts were bare soil or sand and contained no habitat whatsoever that was suitable for Sminthopsis leucopus.

The cursory vehicle traverse through Termeil State Forest revealed some likely habitat for Sminthopsis leucopus, particularly on the ridge along the southern part of the Lemon Tree Creek loop as indicated in Figure 7. Most of the forest along the loop road was moist with a relatively dense ferny and / or shrubby understorey. However, the forest on the southern ridge was of a dry type dominated by Stringybarks with an open understorey and patches of bare ground, reminiscent of the dry coastal forests of Mumbulla.

The cursory road traverse of parts of Meroo National Park also revealed dry open forests with shelter sites and disturbance, and so may also contain potential habitat for Sminthopsis leucopus.
6 DISCUSSION AND CONCLUSIONS

There are two possible explanations for the absence of Sminthopsis leucopus during survey – the species may not be there or they may not be detectable. They may be undetectable because the trapping was conducted in the wrong place, at the wrong time or the method itself was inappropriate.

Past experience with this species demonstrates that the traps were located in the best possible positions. Targeted trapping was undertaken for this species during surveys in 2006 and 2007. The survey of Barnunj State Conservation Area for this study was particularly targeted to this species, with trapping in habitat exhibiting the majority of the critical features identified in previous studies.

The timing of the trapping programs was correct in all cases. Summer trapping should encounter juveniles born in the spring that are dispersing from the nest sites, looking for appropriate habitat within which to establish territories. The pitfall trapping in the spring of 2007 should have encountered explorer males seeking mates, particularly as some of the trap sites were located near the recently disturbed areas.

It is unlikely that the trapping methodology was inappropriate. Other dasyurids are readily detected using hair funnels in this and other surveys, so there is probably nothing inherently obnoxious to small predators about the hair funnels. The bait type that was used has successfully lured Sminthopsis leucopus into traps in a number of instances including in the development area and in the comprehensive Mumbulla study. Moreover, one would expect that dispersing juveniles would be naïve to and curious about novel odours. Sminthopsis leucopus is a disturbance specialist and such habitat would be available naturally on a short term basis and in a very patchy spatial pattern. Therefore, the long range movement patterns observed in males and juvenile females of this species are an obvious adaptation to finding such transient and erratic habitat.

The presence of two records of Sminthopsis leucopus in the development area in February 2006 is probably a reflection of this exploratory behaviour in what was probably a juvenile female. It does not indicate that the development area supports an important population of this species. In fact, the absence of this species in all follow-up studies over two years of survey reinforces this assessment.

Habitat assessment for this study further confirmed that the development area does not support suitable habitat for Sminthopsis leucopus as its vegetation is relatively undisturbed and complex and dense at all structural levels.

It is likely that Sminthopsis leucopus occurs in the local area in low numbers, seeking out suitable disturbed open habitats after events such as fire. It is possible that Barnunj State Conservation Area may have provided such habitat in the spring following the fires of 2006-2007 as the burnt area exhibited many of the essential habitat features. However, the absence of nesting sites and the rapid regrowth may have forestalled or prevented the breeding of this species in those areas, thus accounting for their absence in subsequent survey.

Available suitable habitat is patchy and naturally rare across the landscape. This was confirmed by investigation of the Crown Land to the south of Barnunj State Conservation Area and a cursory inspection of nearby forests of the coastal range, namely Termiel State Forest and Meroo National Park. Only the drier forested ridges of Termiel State Forest seemed to provide a suitable suite of habitat features and, given that it is a production forest, disturbances such as logging, roading and burning will continue in a managed mosaic.

While no attempt was made to quantify this habitat, it would represent vastly larger areas than that in the development area. These coastal forested habitats also have greater opportunities for corridors linking suitable dry forested habitats. The development area, by contrast, is a small patch jutting out in a sea of residential development and leading to other
inappropriate estuarine habitats. Its value therefore to any individuals of this species that may occupy Barnunj State Conservation Area is minimal.

The most parsimonious conclusion from the extensive survey program in and around the development area and supported by habitat analysis is that this species is not present in the survey areas. It is concluded that the potential habitat in the development area is not important habitat. Given the ecology of this species, the presence of one or two animals in a single trapping session does not indicate the presence of a viable local population or habitat critical to the long-term survival of this species.
Acknowledgements

Thanks go to Joe Carlin, Rob Suess and Bill Boyd for their assistance in the field; Barbara Triggs for hair analysis; David Coombes and staff from BES for access to their data; and Dominic Fanning and Emma Dean from Environmental Insites for use of their extra hair funnels.

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REFERENCES


Young, D. (2007) Flora and Fauna Assessment – Proposed Residential Subdivision, Lot 171 DP 1081810 Highview Drive Dolphin Point. BES (Bushfire Environmental Services), St Georges Basin
FIGURES
Figure 1: Extract of topographic map showing approximate boundary of development site (red dashed line) and Barnunj State Conservation Area (black). Source: Department of Lands
Figure 2: Locations of survey for Sminthopsis leucopus in Barnunj State Conservation Area and on the development site. Capture locations of Sminthopsis leucopus in February 2006 indicated by green stars. This study: hair funnel sampling grids (blue squares) and transects (blue lines) December 2007-January 2008. Previous studies undertaken by BES: Elliott trap sites (red squares), pitfall trap sites (red circles) September 2007; trap sites including Elliott traps and pitfall traps (red lines) January, February and April 2006. Boundary of a wild fire of the 2006-07 summer shown in orange. The northern half burnt in the December, the southern half in the January with the approximate boundary shown by a dotted line. Source: NSW National Parks and Wildlife Service.
Figure 3: Aerial photograph showing areas searched for habitat (yellow) suitable for Sminthopsis leucopus in Barnunj State Conservation Area (black solid line), the development area (black dotted line) and Crown Land to the south. Of the areas searched to the east of the highway, the disturbed track edges in Barnunj State Conservation Area, particularly in recently burnt areas, are judged to have the most potential to provide habitat for Sminthopsis leucopus. Quadrats measured for ground cover shown as yellow circles.

Figure 4: Areas investigated in Termeil State Forest and Meroo National Park (ex-Woodburn State Forest) for suitability as potential Sminthopsis leucopus habitat. Location of development area shown as black star.
Figure 5: Close up of pes of *Sminthopsis leucopus* caught in February 2006 from the development site at Dolphin Point. Note the pattern of striated interdigital pads, regarded by many as a diagnostic feature of this species. Photo: Dr Milton Lewis.

Figure 6: *Sminthopsis leucopus* in Elliott trap in February 2006 showing the rounded ears, long snout and white feet typical of this species. Photo: Dr Milton Lewis.
Figure 7: Forest in Termeil State Forest along the ridge line circled in red supports habitat that is reminiscent of that used by Sminthopsis leucopus in Mumbulla State Forest being dry, open, disturbed and burnt.
**Sminthopsis leucopus White-footed Dunnart** records generally occur along the coast and low altitude ranges south from the Nowra area. However, it has also been captured in high altitude montane forests near Bombala (pers ob). There are 90 records of this species in New South Wales. Source: NSW NPWS Wildlife Atlas, February 2008

**Sminthopsis leucopus White-footed Dunnart** records in the northern part of its range show a cluster of records around Jervis Bay, with a large gap southwards until Murramarang National Park with records dating from the 1980s.

**Figure 8:** Distribution of records (pink circles) of *Sminthopsis leucopus* White-footed Dunnart in New South Wales (top) and in the northern part of its range near the subject site (bottom). Location of subject site indicated by black star. Source: NSW NPWS Wildlife Atlas (February 2008).
**Table 1.1:** Locational data of survey features. Latitude and longitude determined by hand-held GPS. Grid references are provided as both MGAs (current Map Grid of Australia GDA94) and AMGs (Australian Geodetic Datum 1966 AGD66) as the current topographic map of the area (Tabourie 8927-II-S) is produced in the 1966 datum. Translations: Geocentric Datum of Australia Technical Manual (Version 2.2)

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**Table 1.2:** Weather statistics recorded at Ulladulla weather station during the days of fauna survey in December 2007 and January 2008.  
Source: Bureau of Meteorology

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Table 1.3: Identification of hair on wafers. Trapping period 1 = 12 December 2007 to 23 December 2007; trapping period 2 = 23 December 2007 to 7 January 2008.

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APPENDIX 2

SITE PHOTOGRAPHS
Appendix 2: Photographs

**Photo 1:** Habitat in and around Transects 1 and 2. Note the fallen timber and relatively open ground cover. This area had been burnt.

**Photo 2:** Hair funnel in Grid 3. Note the open heathy understorey with some patches of bare ground and the disturbed soil in the background. This trapping grid was located beside a tail-out drain associated with the central ridge line road.

**Photo 3:** Hair funnel in Grid 4. Note the leaf litter amongst the sparse cover of grasses and graminoids. This grid was closer to a woodland boundary and so supported trees that were absent in Grid 3.
Lot 171 in DP 1081810
Highview Drive, Dolphin Point

Proposed Residential Subdivision

Part 3A Concept Plan
Response to Submissions

Appendix C
DECC Correspondence

April 2008
Ms Heather Warton  
Director Coastal Assessments  
Department of Planning  
GPO Box 39  
SYDNEY NSW 2001  
Attention Ms Paulina Hon

Dear Ms Warton

RE: Major Project No. 05_0024, Proposed Residential Subdivision, Lot 171 Highview Drive, Dolphin Point

I refer to a 20 August 2007 meeting between officers of the Department of Environment and Climates Change (DECC), Department of Planning (DoP) and the developer, Malbec.

At this meeting, DECC agreed to clarify its position on principles for acceptable mitigation of impacts or offsets or compensation, in relation to the specific circumstances of this proposal.

The attached position forms DECC's recommendation to DoP and the developer on acceptable mitigation of biodiversity and conservation area impacts for this proposed development.

Note that this position falls into three categories of impact assessment and mitigation:
   A. Amelioration of likely impacts on Barnunj State Conservation Area (being measures to contribute to amelioration of likely off-site impacts attributable to this development);
   B. Mitigation of Impacts on Biodiversity on Lot 171 (being measures to retain and protect on-site habitat of White-footed Dunnart and Cryptostyris hunteriana populations that DECC considers significant and which therefore are unlikely to be able to be offset);
   C. Impact mitigation by Offsets (being measures to achieve a maintain-or-improve outcome for the Glossy Black Cockatoo and hollow-dependant microchiropteran bats, by securing off-site land management / tenure agreements consistent with PVP Developer and/or Biobanking methodologies).

DECC understands that the developer has asked DoP to place the Environmental Assessment (EA) of this development proposal on exhibition. If this occurs, then DoP should regard this letter as a submission on the exhibited document. DECC reiterates that it considers that the draft EAs presented to date did not demonstrate that this proposal will maintain or improve biodiversity values. (DECC may make a further submission before the closing date.)

The Department of Environment and Conservation NSW is now known as the Department of Environment and Climate Change NSW
Please contact Craig Jones or myself at the Queanbeyan office of the DECC on 02 6122 3100 if you require any further information.

Yours sincerely

DAVID WINFIELD
Head of Operations
South East Region
DECC POSITION

Provisional Subdivision of Lot 171 Highview Drive Dolphin Point

A. Amelioration of Impacts on Barnunj SCA

The high lot yields of both the Malbec subdivision proposal and the proposed subdivision by Elderslie immediately to the west will lead to unacceptable impacts on the adjoining Barnunj SCA from increased visitor and resident pressures.

DECC undertakes to prepare a plan to rationalise the vehicular and pedestrian track system in Barnunj SCA in order to deal with anticipated increases in visitation and impacts from increased numbers of adjoining residents. The plan is likely to address a number of matters including, access for pedestrians from both subdivisions, preferred routes for pedestrian and vehicle access, rehabilitation and revegetation of existing routes to be closed, and upgrading of Potholes Road, Point Nor-east Road and Potholes Car Park in the SCA. The plan shall also cost the works proposed.

DECC requests that the following ameliorative measures be incorporated into the proposal and/or approval for the subdivision of Lot 171 to protect the adjoining Barnunj SCA from anticipated subdivision impacts arising from increased visitor and resident pressures. These impact amelioration measures should not be construed as offsets (as per the Draft Guidelines for Threatened Species Assessment prepared by the Department of Primary Industries and DECC) to compensate for unavoidable impacts.

1. The proponent shall design pedestrian access along the southern edge of the southern perimeter road corridor of the proposal on Lot 171 for the purposes of providing pedestrian access along this perimeter that will eventually be linked with the pedestrian track system in Barnunj SCA.

2. The Department of Planning should consider requesting that the proponent incorporate into the proposal a commitment to make a financial contribution to the rationalisation and upgrade of the pedestrian access through Barnunj SCA. This commitment should be
added to the proponent’s Statement of Commitments. DECC estimates that the cost of these works will be between $29,000 and $43,000.

B. Mitigation of Impacts on Biodiversity on Lot 171

DECC considers that the populations of White-footed Dunnart and C. hunteriana recorded on Lot 171 are highly significant populations.

The nearest records of White-footed Dunnart are from Vincentia to the north and Kioloa to the south. The species’ northern limit of distribution appears to be at Vincentia, suggesting that the population at Dolphin Point is approaching this limit and may therefore be an important population for sustaining genetic variability.

There are few known records of C. hunteriana in the area. The C. hunteriana population on Lot 171 comprises about 36% of those individuals recorded by the proponent’s ecological consultant, BES, during surveys of Lot 171 and Barnunj SCA. These surveys were conducted in a good flowering year.

DECC also considers that the Red Bloodwood Shrubland and the mosaic of treeless areas in the Scribbly Gum-Bloodwood Woodland on Lot 171 are regionally significant vegetation communities. Only 29ha of Red Bloodwood Shrubland and mosaics of treeless heathland occur in Barnunj SCA and nearby Meroo National Park. Recent surveys undertaken by the Prasophyllum affine recovery team found less than 100ha of similar vegetation (habitat suitable for both P. affine and C. hunteriana) along the coast between Sydney and Cudmirrah.

DECC recommends that the following mitigation measures be incorporated into the proposal and/or approval for the subdivision of Lot 171 to protect regionally significant threatened species, ecological communities and vegetation communities on Lot 171. These impact mitigation measures should not be construed as offsets (as per the Draft Guidelines for Threatened Species Assessment prepared by the Department of Primary Industries and DECC) to compensate for unavoidable impacts.
1. The area to be excluded from development in the south-west of Lot 171 is to include the *C. hunteriana* population, the Red Bloodwood Shrubland, and a proportion of the Scribbly Gum – Bloodwood Woodland as per Map 1 (attached). This includes the area in which the White-footed Dunnart was recorded and an area of Glossy Black-cockatoo habitat. If the proponent demonstrates that a population of White-footed Dunnart occurs in Barnunj SCA, then the area to be excluded from development could be reduced to that indicated in Map 2 (attached) by not including all of the White-footed Dunnart habitats. The future tenure and management of the area excluded from development requires further consideration. One option would be for the proponent to gift the area to the National Parks Foundation (a registered charity). Gifts to the Foundation are likely to be tax deductible.

2. The subdivision layout shall be designed such that the road system separates residential lots from the area to be excluded from development and the adjoining Barnunj SCA.

3. The proponent shall fence the area to be excluded from development and the boundary with Barnunj SCA with a farm style fence that is reinforced with a steel cable to make it more difficult for vehicles to breach. This requirement is consistent with the condition of approval imposed by the Department of Planning for the development of the Stockland site at Vincentia.

4. The proponent shall design an elevated crossing of the watercourse in the west by Road Number One so that it avoids disturbances to existing native vegetation and the riparian corridor. This will allow fauna movement along the riparian area that links patches of Swamp Sclerophyll Forest Endangered Ecological Community within the Malbec subdivision with other floodplain Endangered Ecological Communities in the adjoining Elderslie subdivision proposal.
C. Impact Mitigation by Offsets

DECC is unaware of any other known habitat for *C. hunteriana* or White footed Dunnart within the Ulladulla area that would be available for securing as an offset. Hence, the recommended mitigation for impacts on these species has focussed on the retention of known populations and associated habitat within the development site.

It is important for the Department of Planning to note that the package of impact amelioration and mitigation described in sections A and B above does not achieve a maintain-or-improve outcome for all the biodiversity to be lost in the development footprint, particularly for Glossy Black-cockatoo and hollow-dependent microchiropteran bats. Most of the feed trees for the Glossy Black-cockatoo and the hollow-bearing trees providing roosting and breeding habitat for the microchiropteran bats occur within the remaining development area.

A maintain-or-improve outcome for the proposal can only be achieved by securing land management/tenure agreements off site at a ratio commensurate with that calculated by the PVP Developer and/or Biobanking methodologies to compensate for the loss of known Glossy Black-cockatoo and microchiropteran bat habitat, in addition to the impact amelioration and mitigation described in sections A and B above.

One option for the proponent may be to acquire vacant Crown Lands in the immediate area for the purposes of securing an appropriate an offset.