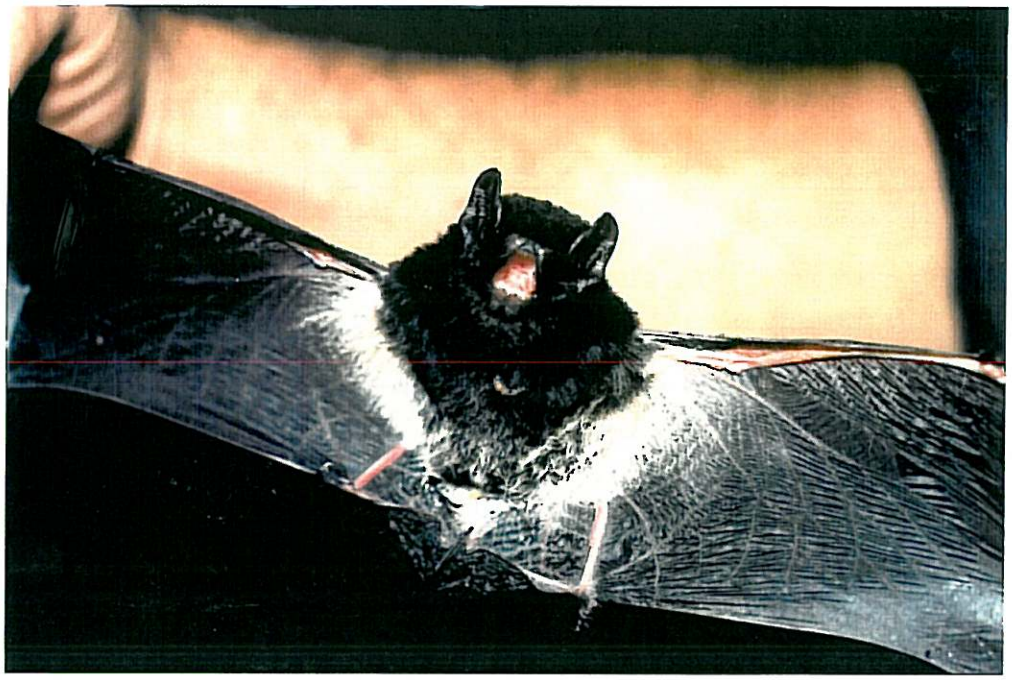
FAUNA AND FLORA OF

'BUNDANON',

SHOALHAVEN CITY

May 1996

A STUDY PREPARED FOR THE BUNDANON TRUST



Large Pied Bat *Chalinolobus dwyeri*

The detection of this bat at Bundanon was a range extension for the species (photo G. Daly)

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APPENDICES

1.0 EXECUTIVE SUMMARY

Surveys of flora and fauna north of the Shoalhaven River on the properties and Crown Leases of Bundanon, Eearie Park and Riversdale revealed the presence of several vegetation communities which equated to fauna habitat types. The habitat is varied and in excellent condition. The survey provides an inventory of fauna and flora for the Bundanon Trust. Comments are given on the conservation value of each habitat with respect to threatened animals and rare plants.

Investigations revealed the presence of many animal species which are significant because of their conservation status at a National and State level. Six species of animal were detected that are listed as threatened at a State level, one of which is also listed as threatened Nationally. Many other animal species detected are considered to be regionally significant because they are rare, habitat specialists and or are close to their known limit of distribution. No threatened species of plant were found although at least three species located are listed by Briggs and Leigh (in prep.) as rare and several others are considered regionally significant.

Daly and Murphy (1996) identified the escarpments of the Shoalhaven River and the Cambewarra Range as important habitat corridors for several Nationally and State endangered species of fauna. The properties of 'Bundanon' form a significant portion of the habitat corridor of the Shoalhaven River escarpment.

Because of the National and State significance of the fauna in the study area the lands should be given the highest possible protection and development limited to areas of cleared land.

The Trust should also look at the possibility of reintroducing some species of animal that were previously found in the area. In particular the Koala and Scrub Turkey should be considered for such a program.

2.0 BACKGROUND

2.1 General

The current survey was conducted for the Bundanon Trust with the aim of compiling an inventory of fauna and flora of 'Bundanon' (a Wildlife Refuge) to facilitate conservation of the natural heritage of the Trust properties, provide information for inclusion in Trust publications and to assist in the development of an environmental plan for 'Bundanon'. The project was supervised by Mr G. Daly who also conducted the majority of the fieldwork on fauna. The flora was surveyed by Mr G. Leonard and the bat survey conducted by Mr G. Hoye.

The brief for the study was to examine the flora and terrestrial vertebrate fauna of the area and to make recommendations for the management with respect to conserving regional biodiversity. In this context species currently listed on the *Threatened Species Conservation Act 1995* (TSC Act) are given detailed consideration.

The study area was located in the northern Shoalhaven ten kilometres of Nowra, New South Wales (34°52' S 150° 35' E) (Figure 1). The size of the study area, including Crown Leases was 1075 ha of which Bundanon, Eearie Park and Riversdale constitute 812 ha.

The topography of the study area varies between level, steep and cliffed (see McDonald *et al.* 1990), extending from 0 to 235 m AHD at the highest point on the plateau. The floodplain is generally cleared of native vegetation from the riverbanks to the lower escarpment benches. A narrow band of riverine vegetation has been retained along the riverbanks and ornamental plantings occur near dwellings and roadsides. Vegetation on the escarpment is generally intact, although there is evidence of selective logging and previous bushfire events. Some clearing for road construction, powerline easements and quarrying has taken place on the plateau.

2.2 Geology

The 1:100 000 sheet for the Kiama (Hazelton 1992) does not extend as far west as the study area, although it is likely that up to four soil landscape groups occur in the study area, all of which are described by Hazelton 1992:

The Nowra Group is associated with moderately to gently undulating rises and low hills on Nowra Sandstone. Soils derived from the Nowra Group are described as "...medium to coarse-grained quartz sandstones which contain rounded pebbles scattered throughout the

beds..." (Hazelton 1992). Vegetation on this soil type has been extensively cleared for agriculture and residential development, but would have mainly consisted of tall open-forest.

The Pulpit Rock Group is associated with rugged sandstone cliffs and talus slopes. Soils are similar to those of the Nowra Group, which generally support low open-woodland. The Shoalhaven Group consists of alluvial soils which occur along the Shoalhaven floodplain. Vegetation is generally completely cleared, "...except for scattered...(trees) on terraces and various reeds in swamps" (Hazelton 1992).

The Greenwell Point Group is associated with gently undulating rises on Wandrawandian siltstone. Small areas of this landscape group occur along the Shoalhaven River, although there are more extensive occurrences near the coast, between Culburra and Callala. The vegetation on this soil type has been extensively cleared, but would have generally supported tall open-forest (Hazelton 1992).

2.3 Previous Surveys

Other fauna/flora surveys that had been conducted in the immediate area include:

i) Daly (1995 a,b,c) at Bugong and Bangalee Reserve.
ii) Mills (1985) a flora and fauna survey of Bundanon.
iii) Robinson (1987) mammal surveys conducted by Robinson during the 1970-80s.
iv) Wong (1993) an examination of populations of Brush-tailed Rock-wallabies.
v) unpublished bird records from Bangalee Reserve held by Ms D. Wright
vi) Databases held by the National Parks and Wildlife Service were accessed and personal communications held with service staff (L. Russ)

Many of the above surveys have been directed at specific groups of fauna but the current investigation covers all non marine vertebrate species and:

* documents the area's terrestrial vertebrate fauna and flora
* relates the distribution of species to habitat
* comments on select species which are listed Nationally as endangered
* comments on select species which are listed on Schedule 1 and 2 of the *Threatened Species Conservation Act 1995* (TSC Act) and or Brigg and Leigh (in prep.)
* comments on select species which are of local and regional significance
* identifies and comments on habitat corridors
* gives recommendations for land use and management

The TSC Act was introduced 1st January 1996. Schedule 1 of this Act lists endangered species and Schedule 2 vulnerable species. The term 'threatened' covers both Schedules. The term 'Bundanon' includes all surveyed land whereas Bundanon only involves Eearie Park, Bundanon and associated Crown leased land.

3.0 METHODS

Fauna

Field surveys were conducted during February, March, April and May 1996. The following methods were employed to detect animals:

* direct observation
* identification based on species specific calls
* location of inactive animals by lifting habitat
* Elliott trapping of small mammals
* playing pre-recorded animal calls
* nocturnal observations using 50 watt 12 volt torches
* identification based on tadpole morphology
* identification based on analysis of scats
* identification based on species specific incisions by possums on *Eucalyptus* trees
* hand netting creeks
* harp trapping small bats
* identification of bats based on analysis of recorded ultrasonic calls
* hair tubes set to detect the Long-nosed Potoroo

Nomenclature in this report is based on the following texts:

*	mammals	Parnaby (1992) and Strahan (1995)
*	birds	Christiades and Boles (1994)
*	reptiles	Cogger (1992) and Ehmann (1992)
*	amphibians	Cogger (1992) and Tyler (1992)

3.11 Direct Observation

Most species were detected by direct observation. Birds and frogs were usually identified by a combination of methods which involved hearing calls and then seeing them. Observations on birds were aided by the use of binoculars. Most reptiles were found under refuge sites or when the animals were foraging or basking.

3.12 Elliott Trapping

Small Elliott traps were set along transects to detect small mammals (Figure 2). Traps were spaced at approximately ten metre intervals and baited with a mixture of peanut butter and oats. Traps were checked daily, animals if present were identified and released.

3.13 Play-back of Tapes

This involved playing prerecorded sounds of owls through a hailer. If the target species were within earshot of the broadcast they may respond by calling. The method relies on the fact that most species of animal are territorial and use calls as a method of defending their territory from members of the same species. Three species of owls, the Sooty *Tyto tenebricosa*, Masked *T. novaehollandiae* and Powerful *Ninox strenua* were surveyed in this manner. Trees in the area were spotlight for owls after the cessation of the play-back.

3.14 Spotlighting

This technique involved the use of 50 watt 12 volt spotlights. Trees adjacent to trails and roads were searched for owls, possums, frogs and fruit bats.

3.15 Tadpole Morphology

Most species of frog are active in summer and some call for a limited time after rain. Locating some species is difficult because they are rare and call for a brief period. This problem can be partially overcome by the identification of species by the morphology of tadpoles.

3.16 Scat Analysis

Carnivorous mammals and owls expel undigested remains of their prey. Mammal faeces often contain the undigested hair and bones of their prey and occasionally grooming hairs. Hence analysis of the hair within carnivorous mammal scats can indicate the predator and prey species.

3.17 Identification of Possums by Incisions

Sap feeding Yellow-bellied Gliders *Petaurus australis* make distinctive V shaped incisions on the trunks of gums such as the Grey Gum *Eucalyptus punctata* (Goldingay 1990, 1991). The Sugar Glider *Petaurus breviceps* incises Red Bloodwood *Corymbia gummifera* and makes distinctive linear incisions, a reliable sign for their presence (pers. obs.).

3.18 Electronic Detection of Bats

Glenn Hoye surveyed small insectivorous bats by harp trapping and taping their calls (using Anabat 11 detectors) which were later matched with prerecorded calls. Bat surveys were

conducted from the 21-22 February 1996 during still, warm weather. Seven sites were used for harp trapping and electronic detection (Figure 2).

3.19 Hair-tube Surveys

Two lines of 10 hair-tubes, made from 100 mm PVC pipe, were set on the ground and baited with a mixture of peanut butter, rolled oats and honey for 10 days adjacent to dense vegetation to target Long-nosed Potoroos. The inside of the tubes were covered with strips of double sided tape which remove hairs from mammals when they enter the tube to investigate the smell of the bait. Analysis of hair can reveal the identity of the mammal to species level.

Flora

3.21 Identification, Naming of Species & Families & Classification of Communities

Plant identifications were made according to nomenclature in Harden (1990, 1991, 1992 & 1993). Recent name changes outlined in issues of Cunninghamia or Telopea are used where applicable. Stands of vegetation are described with reference to Specht (1981) and Mills (1985).

3.22 Conservation Significance of Plant Species

The scientific and conservation significance of individual species and vegetation types was established with reference to Briggs & Leigh (in prep.) in the national context. The regional significance of plant species, plant communities and habitats was considered with reference to Mills (1985) and Mills & Associates (1992)

3.23 Field Survey Strategy

General surveys (York *et al.* 1991) were conducted between 7-9/2/96 and 11-12/3/95 in order to locate most of the plant species occurring in the study area. Searches were made for species of conservation significance to confirm occurrences previously recorded by Mills (1985) and to locate additional occurrences. Of particular interest were plant species of conservation significance not described at the time of the study carried out by Mills (1985). A list of plant species recorded in the area of potential disturbance is included as Appendix B and the extent of plant communities are indicated in Figure 3. In both the species list and the vegetation plan, four broad structural groups are indicated.

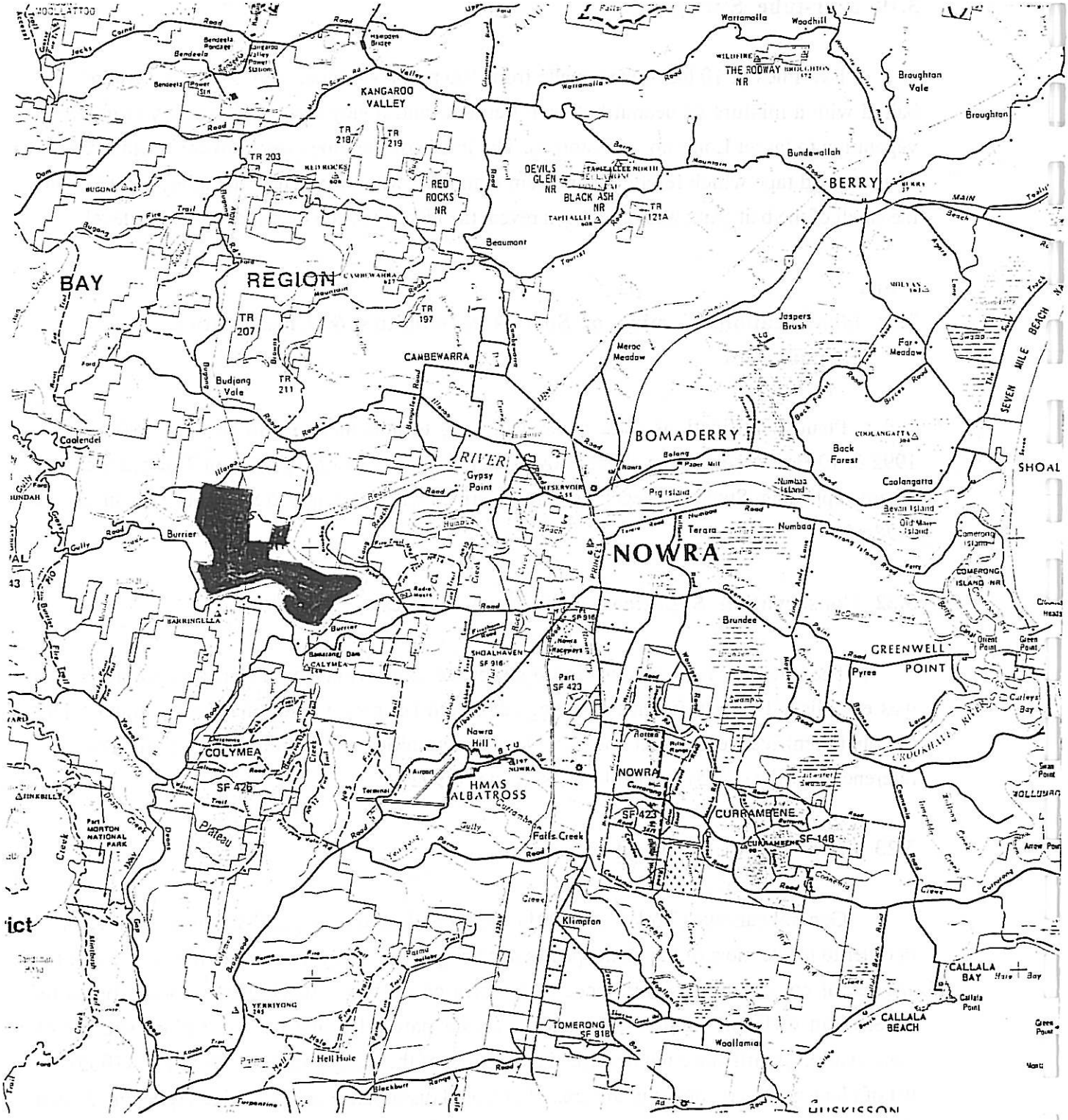

Figure 1. Location of study site (shaded area). Base map courtesy State Forests

4.0 RESULTS

Fauna

The area surveyed possesses a rich and varied assemblage of fauna and flora (Appendix A and B). Significant fauna detected, or previously recorded on Bundanon include eleven species listed on Schedules 1 and 2 of the TSC Act (Table 1). This includes five mammal (two bats), four bird, one reptile and one species of frog. Two species, the Brush-tailed Rock-wallaby *Petrogale penicillata* and the Broad-headed Snake *Hoplocephalus bungaroides* are also listed Nationally as endangered (Endangered Species Protection Act 1992).

The habitat is suitable for at least an additional nine species which are listed as rare and vulnerable at a State level (Table 3). Several of these species have been detected close to the study site and based on habitat preference are expected to occur, at times, on 'Bundanon'.

During this survey 126 species of vertebrates were detected comprising 21 mammal, 80 bird, 15 reptile, 8 frog and 2 fish species. Seven species listed as 'threatened' on the TSC Act were found, namely the Yellow-bellied Glider *Petaurus australis,* Large-footed Myotis *Myotis adversus*, Large Pied Bat *Chalinolobus dwyeri*, Glossy-black Cockatoo *Calyptorhynchus lathami*, Powerful Owl *Ninox strenua*, Broad-headed Snake *Hoplocephalus bungaroides* and Eastern Owl Frog *Heleioporus australiacus.* A breakdown of fauna in each study area is given in Appendix A. Twenty six vertebrate species which occur on or near the study area are of regional significance as they are rare, have specialised habitat requirements or have suffered a severe population decline in recent years. Sixteen vertebrate species are presumed to have been extirpated (become locally extinct) from the 'Bundanon' area.

Table 1. Significant Species of Fauna Detected in the Area

Species	Location	Habitat
Tiger Quoll	Cambewarra Range	Various forest types
White-footed Dunnart #	Bugong/Bundanon Crown Leases	Spotted Gum forest
Yellow-bellied Glider *	Bugong/Bundanon	Grey gum/spotted gum forest
Long-nosed Potoroo	Cambewarra and possibly Bundanon	Coastal and escarpment forests
Brush-tailed Rock-wallaby #	Bugong and Bundanon	Rocky escarpment
Large Pied Bat*	Bundanon	Tall open forests
Eastern Little Mastiff-bat	Bugong and probably Bundanon	Dry and moist escarpment forests
Common Bent-winged Bat	Bugong and probably Bundanon	Tall open forests
Greater Broad-nosed Bat	Bangalee, Bugong and probably Bundanon	Tall open forests
Large-footed Myotis *	Bugong and probably Bundanon	Shoalhaven River
Black Bittern #	Bundanon	Shoalhaven River
Masked Owl	Bangalee Reserve	Grey gum/spotted gum forest
Sooty Owl #	Cambewarra, Bugong, Bangalee and Bundanon	Rainforest/Closed Eucalypt
Powerful Owl # *	Bangalee, Bugong and Bundanon	Eucalypt forest
Square-tailed Kite	Bangalee	Grey gum/spotted gum forest
Glossy Black-cockatoo *	Bugong and Bundanon	Eucalypt forest and she-oaks
Broad-headed Snake *	Bugong and Bundanon	Rocky escarpment
Eastern Owl Frog *	Bugong and Bundanon	Heath and woodland
Stuttering Frog #	Bugong	Riparian forest

* indicates threatened species detected during the survey

indicated threatened species previously recorded as occurring in the general area

4.1 Habitat Assessment

The habitat types on site include:

i) Open-forest; *Corymbia maculata*

ii) Open-forest/ tall open-forest *Eucalyptus "botrysaligna"* ms.

iii) Closed forest

iv) Woodland *Corymbia gummifera*

v) Shrubland/ heathland

vi) Grassland/ horticultural/ riverine

These are described in greater detail in Section 5.

4.2 Non Flying Mammals

Twenty one mammal species were detected of which two were exotic. Scat analyses revealed the presence of six species of animal, the Fox, Dog, Echidna, Long-nosed Bandicoot, Swamp Wallaby and Common Ring-tail Possum.

The Tiger Quoll was not found during the survey but animals have been detected four kilometres to the north of Bundanon along the Cambewarra escarpment.

The White-footed Dunnart was trapped at Bugong (Daly and Murphy 1996). This is the first state Museum based specimen from north of the Shoalhaven River and represents a range extension (King 1980) of the NSW population. Other species detected during small mammal trapping are the Bush Rat *Rattus fuscipes* and the Brown Antechinus *Antechinus stuartii* (Table 2). No hairs were found in the hair-tubes.

Table 2. Small Mammals Detected during Elliott Trapping

Trap Line	Location	No. of Trap Nights	Habitat	Number of Captures
1	Crown Land Bundanon	100	Woodland	2 Brown Antechinus
2	Crown Land Bundanon	75	Heath/woodland beside creek	11 Brown Antechinus 4 Bush Rat 1 Eastern Water skink

The continued existence of the Brush-tailed Rock-wallaby *Petrogale penicillata* was confirmed by NPWS staff. The decline of Rock-wallaby populations in NSW has prompted the NPWS to instigate a baiting program for feral carnivores in the Bugong area.

The Yellow-bellied Glider was detected by the identification of species specific incisions on Grey Gums and calls. Grey Gums are found in the study area along the Shoalhaven River escarpment from Bomaderry Creek westward to the Hampton Bridge area (Kangaroo Valley).

4.3 Bats

Eleven species of bat were detected (Appendix A) of which two are threatened. These are the Large-footed Fishing Bat *Myotis adversus* and the Large-eared Pied Bat *Chalinolobus dwyeri.* Several other threatened species have been detected adjacent to Bundanon and are expected to occur on site (Daly and Murphy 1996). They are the Greater Broad Nosed Bat *Scoteanax rueppellii,* Common Bent-wing Bat *Miniopterus schreibersii* and the Eastern little Mastiff Bat *Mormopterus norfolkensis.*

The area has a significant bat fauna primarily because of the presence of habitat such as caves and tree hollows. The Shoalhaven River escarpment has caves and fissures which provide bat roosts. A maternity site of the Eastern Horseshoe Bat was located adjacent to Bangalee Reserve. This cave had several hundred bats and the presence of guano indicated that the site had been used for many years. This is significant because maternity roosts are rarely found. The closest known maternity roosts are Royal National Park in the north and Depot Beach in the south (R. Coles pers. comm.).

Recent work conducted by H. Parnaby for State Fisheries detected a large number of Fishing Bats at Bomaderry Creek (Parnaby 1996). The Shoalhaven River escarpment is continuous with that at Bomaderry and the area probably has a Fishing Bat maternity roost.

4.4 Birds

Eighty species of bird were detected during this survey of which five were exotic. The area has a rich avifauna and is significant because of the presence of five species which are dependant on old growth forest for nesting (Scotts 1981). A nest of the Glossy Black Cockatoo was found in an old *Eucalyptus* tree (S. Evison pers. comm.) and a Powerful Owl was called up at Bundanon after broadcasting the species call through a loud hailer. Calls of

either a Barn Owl or Masked Owl were heard at Riversdale. Unfortunately the animal was not seen and hence positive identification was not possible.

4.5 Reptiles

Fifteen species of reptile were detected during the survey including one tortoise, two dragons, one gecko, eleven skinks, one goanna and eight front fanged snakes. The most significant reptile found was a Broad-headed Snake *Hoplocephalus bungaroides*. The Broad-headed Snake is specific in its habitat requirements and is associated with loose rock on west facing sandstone ridge tops. Currently there has been little disturbance to this habitat type in the study area although the escarpment immediately east of Riversdale has been vandalised by rock collectors.

The impact of the illegal removal of bush rock on the Broad-headed Snake is unknown but is expected to be significant as loose rock are utilised by this species of snake and its prey, the Lesueur's Gecko *Oedura lesueurii* (pers. obs.).

4.6 Frogs

A total of eight species of frog were found during the survey which include four tree frogs and four ground dwelling species (Appendix A). Frogs were identified by direct observations, identification of calls and the morphology of tadpoles. The Eastern Owl Frog *Heleioporus australiacus* was detected by the presence of tadpoles at two sites.

4.7 Fish

No specific surveys were conducted for fish, although two species were observed in creeks at Riversdale, the Mountain Galaxias *Galaxias brevipennis* and Coxes Gudgeon *Gobiomorphus coxii*. The seventeen species of fish listed in Appendix A are taken from Daly and Murphy (1996).

4.8 Flora

Four regionally significant species of plant were located. They were *Leptospermum sejunctum, Acacia subtilinervis, Triplarina nowraensis* and *Dodonaea rhombiflora*. Nine plant species were found that were regionally significant (Table 3) and one regionally significant plant community.

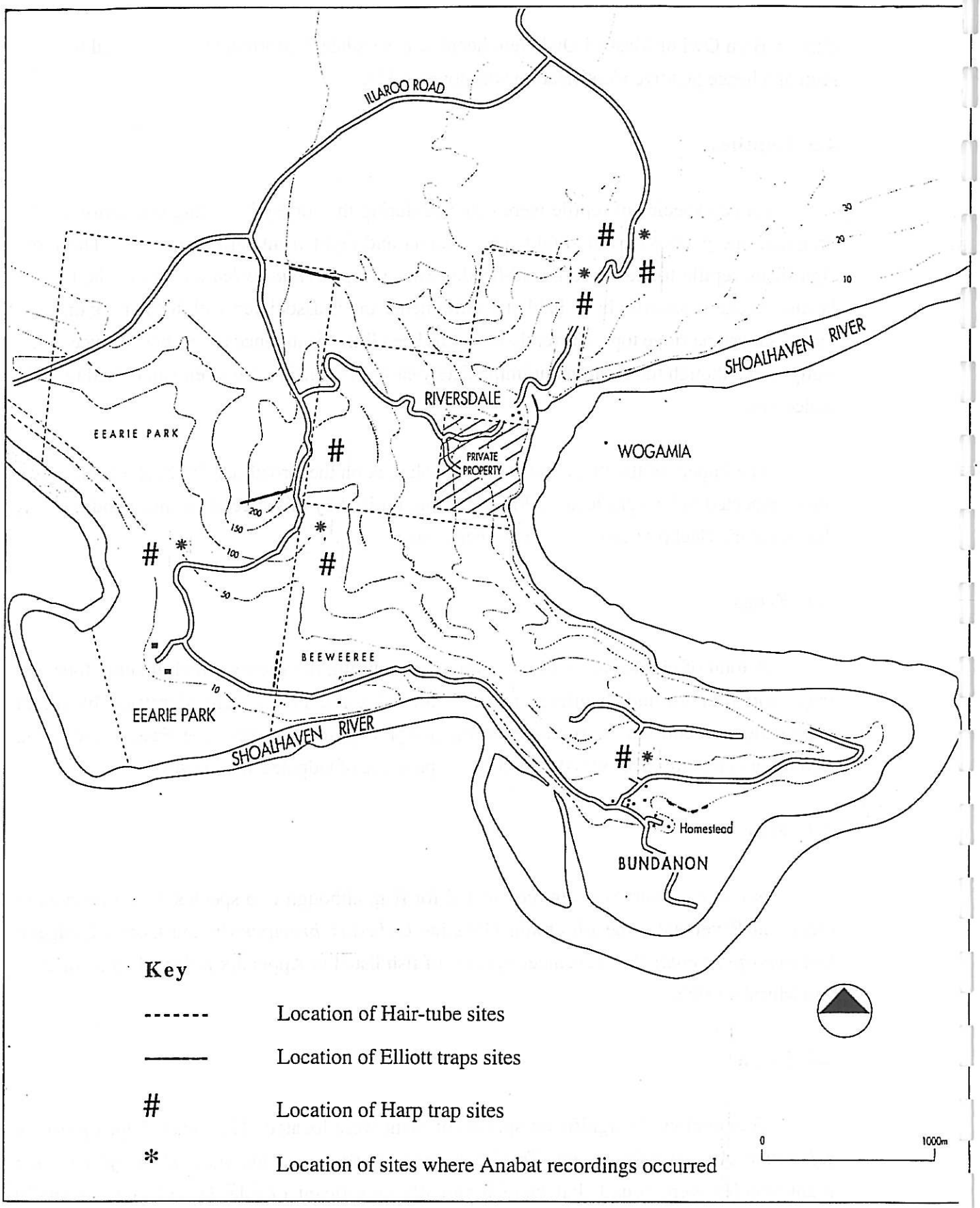

Figure 2. Location of Hair-tubes, Harp and Elliott trap and echolocation call detection sites

5.0 VEGETATION COMMUNITIES

5.1 General

The most extensive native vegetation types are the tall open-forest communities occurring on the escarpment slopes and the open-woodland communities on the plateau. Floristics and structure appears to be influenced by factors such as soil type, aspect and topography. Rainforest (closed forest) stands are generally limited to creeklines and sheltered slopes on the lower escarpment slopes, although components of the rainforest communities may also occur as understorey in tall open-forest stands or at the base of cliffs. Shrubland/ heathland naturally occurs on some sections of the plateau, probably as a response to soil type and depth, but also occurs as a managed vegetation type beneath power-lines. Most of the flood-plain vegetation has been replaced by improved pastures, although narrow bands of native vegetation occur along some sections of creekline as well as along the banks of the Shoalhaven River. The most extensive ornamental plantings in the study area occur around the Bundanon Homestead.

5.2 Closed forest

Structure

Closed forest to 25m, but often not exceeding 15m. Understorey may consist of ferns and sedges or may be absent. Lianas are not common, although some fine old specimens occur in deeper gullies.

Occurrence

This vegetation type is generally restricted to gullies formed by creek-lines flowing down the escarpment towards the Shoalhaven River. The most continuous examples occur in the two creeklines draining into the river near "Riversdale".

Floristics

The closed forest stands occurring in the study area are not as floristically rich as similar forest stands occurring further to the north, but they are nevertheless interesting in that a large number of plant species of conservation significance were recorded in these stands. The major part of the closed forest stands approximates Floyd's (1990) description of Dry Rainforest Suballiance No 30: *Backhousia myrtifolia-Acmena smithii*. There are, however, components of Warm Temperate Rainforest Suballiance 37 *Ceratopetalum/Schizomeria-Acmena-Doryphora* and also Subtropical Rainforest Suballiance 14 *Doryphora-Daphnandra micrantha-Dendrocnide-Ficus-Toona*.

Commonly occurring tree species are Ironwood *Backhousia myrtifolia*, Lilly Pilly *Acmena smithii*, Native Olive *Notelaea longifolia* and Smooth Cheesetree *Glochidion ferdinandi* var. *ferdinandi.* Occasional emergent mature specimens of Sydney Blue Gum *Eucalyptus saligna*, Coachwood *Ceratopetalum apetalum* and Water Gum *Tristaniopsis laurina* are also present. Scrub Stringybark *Rhodamnia rubescens*, Brush Daphne *Pittosporum undulatum* and Blueberry Ash *Elaeocarpus reticulatus* are common near the rainforest margins while Native Hydrangea *Abrophyllum ornans* and fern species are more common in deeper, more sheltered gullies.

5.3 Open-forest; *Corymbia maculata*

Structure

Trees to 30m, usually with straight trunks. Understorey ranges from smaller trees to 10m to sparse shrub or herb groundcover from 1 to 3m.

Occurrence

This vegetation type occurs on the upper slopes of the escarpment, and in some places extends onto the rocky plateau where this vegetation type may merge quite abruptly with open-woodland. Downslope this vegetation type generally merges gradually with tall open-forest *Eucalyptus saligna* or abruptly with cleared areas.

Floristics

Spotted Gum *Corymbia maculata* occurs in monotypic stands in some sections of the study area, although Turpentine *Syncarpia glomulifera* and eucalypt species are co-dominant in other sections. On the escarpment slopes common eucalypt species are Grey Ironbark *Eucalyptus paniculata* and White Stringy Bark *E. globoidea*, while on the plateau and upper slopes common species are Red Bloodwood *Corymbia gummifera* and Sydney Peppermint *E. piperita.* Common small trees include Black Oak *Allocasuarina littoralis*, Two-veined Hickory *Acacia binervata* and NSW Christmas Bush *Ceratopetalum gummiferum.* Shrub understorey species include Burrawang *Macrozamia communis*, Hop Bush *Dodonaea triquetra* and Geebung *Persoonia* spp. Where shrub cover is absent, grass species such as *Microlaena stipoides* and *Themeda australis* or ferns, especially *Calochlaena dubia* and *Pteridium esculentum* are common.

5.4 Open-forest/ tall open-forest *Eucalyptus "botrysaligna"* ms.

Structure

Trees generally to 30m, but exceeding 45m in sheltered areas. Trees have tall straight trunks and narrow canopies. Understorey may consist of dense stands of mesic species or small sclerophytic trees or a sparse shrub and grass cover.

Occurrence

This vegetation type sometimes occurs on the upper slopes of the escarpment but is more common on the lower escarpment slopes and foothills. Extensive clearing of this vegetation type has probably been carried out for logging and grazing, although some fine remnants have been retained on the grazed foothills.

Floristics

Sydney Bluegum hybrid *Eucalyptus "botrysaligna"* ms. (syn. *E. saligna/ E. botryoides* hybrid) generally occurs in monotypic stands, although Forest Redgum *E. tereticornis* is common on the slopes above the Bundanon Homestead. Commonly occurring tree species growing in association with Sydney Bluegum include Turpentine, Rough-barked Apple *Angophora floribunda*, Spotted Gum and Sydney Peppermint *E. piperita*. Common mesic tree species include Smooth Cheese Tree, Two-veined Hickory and Bastard Rosewood *Synoum glandulosum*. On drier slopes common understorey trees include Old Man Banksia *Banksia serrata*, Green Wattle *Acacia irrorata* subsp *irrorata* and Geebung *Persoonia linearis*. In a boggy section near the "Amphitheatre" is a dense stand of Snow in Summer *Melaleuca linariifolia*.

5.5 Woodland *Corymbia gummifera*

Structure

Trees from 10 to 20 m. generally with low-branching, broad canopies. Trees may be spaced 5m apart, or may widely dispersed, in which case the trees are often in mallee form. Shrub understorey varies according to location, ranging from 1m to 2.5 m in height and is generally sparse. In moist areas a dense groundcover occurs, is usually dense and consists of herbs, grasses and sedges.

Occurrence

This vegetation type occurs on the plateaus. At the eastern end of the study area the trees are tall and generally straight, while at the western end the trees are generally shorter and more widely spaced.

Floristics

The dominant canopy species is often Red Bloodwood, particularly on the eastern plateau. Other eucalypt species associated with the taller woodland stands include Grey Gum and Blue-leaved Stringybark *E. agglomerata* . In the lower open-woodland stands Scribbly Gum *Eucalyptus sclerophylla,* Yertchuck *E. consideniana* and two Stringybarks *E. capitellata* and *E. imitans* are associated species. Common shrub species are Old Man Banksia and Hair-pin Banksia *B. spinulosa* var. *spinulosa*, Tea-tree *Leptospermum* spp and Mountain Devil *Lambertia formosa.*

5.6 Shrubland/ Heathland

Structure

Shrubs from 2.5 m to less than 1m. Stands are often dense, in which case understorey is sparse to absent. Where the canopy is more open, understorey consists of herbs and sedges.

Occurrence

An artificial shrubland occurs within the powerline easements, while several stands also occur to the west of Bundanon, possibly as regrowth on abandoned farm-land. The most extensive heathland stands occur at the north-western end of the study area.

Floristics

Common shrub species include Tick Bush *Kunzea ambigua*, Paper-bark Tea-tree *Leptospermum trinervium* and Prickly-tea-tree *L. juniperinum.* In constantly moist areas Native Broom *Viminaria juncea* and Narrow-leaved Bottlebrush *Callistemon linearis* are common, in association with sedges such as *Lepyrodia scariosa* and *Caustis flexuosa.*

5.7 Grassland/ Horticultural/ Riverine

This vegetation type occupies most of the floodplain, riverbanks and gardens around dwellings. Improved pasture, consisting of introduced species such as Kikuyu *Pennisetum clandestinum* and Clover *Trifolium* spp covers a large proportion of the area. Along the riverbank stands of River Oak *Casuarina cunninghamiana* have been retained, presumably for bank stabilisation as well as for aesthetics. Near the residences at Bundanon, Riversdale and Eearie Park are some fine ornamental specimens of introduced trees and shrubs. Examples are Cotton Wood *Populus deltoides,* Lombardy Poplar *P. nigra* 'Italica', English Oak *Quercus robur*, Kurrajong *Brachychiton populneus* subsp *populneus*, Indian Coral *Erythrina x sykesii,* Silky Oak *Grevillea robusta*, Mugga *Eucalyptus sideroxylon,* Chinese Elm *Ulmus parvifolia,*

English Elm *U. procera,* Oriental Plane *Platanus orientalis* and English Ash *Fraxinus excelsior.* Near the foothills, particularly in moist areas, some sections of paddock have been over-run by stands of Lantana *Lantana camara.*

5.8 Assessment of Habitat

Bundanon is of National and State significance because it provides habitat which is suitable for the Broad-headed Snake and the Brush-tailed Rock-wallaby which are listed Nationally as endangered. The distribution of these species in the Shoalhaven is highly associated with west facing sandstone cliffs of the Shoalhaven escarpment (Daly and Murphy 1996).

Other species detected during the survey which are listed Schedule 2 of the TSC Act 1995 include the Yellow-bellied Glider, Large-footed Fishing Bat, Large Pied Bat, Powerful Owl and Eastern Owl Frog. Several of these species are associated with the sandstone escarpment and the Shoalhaven River.

Bundanon is part of a continuous block of bush of 'old growth forest' that stretches from Hampton Bridge (Kangaroo Valley) to the bridge at Nowra. Old growth forest is taken from Scotts (1991) as one which has a vertical diversity resulting from the presence of more than one age class of trees and possesses large live trees (> 1.0 m diameter at breast height) that are old (150 yrs) and have stags and logs present in significant numbers (> 4/ha for stags and 10/ha for logs).

The vegetation on the edge of the Shoalhaven escarpment has Grey Gum which is found in association with Spotted Gum, Red Bloodwood and Sydney Peppermint. These are nutrient rich eucalypt species which have been documented as being significant for wildlife (Davey 1984, Braithwaite *et al.* 1988). The habitat is suitable for the Koala and is 'potential' Koala habitat as defined under State Environmental Planning Policy No 44 (Department of Planning 1995). The fact that several old growth forest dependant species of animal exist in the area (ie Tiger Quoll, Yellow-bellied Glider, Sooty Owl Masked Owl, Powerful Owl and Stuttering Frog) demonstrates the areas significance.

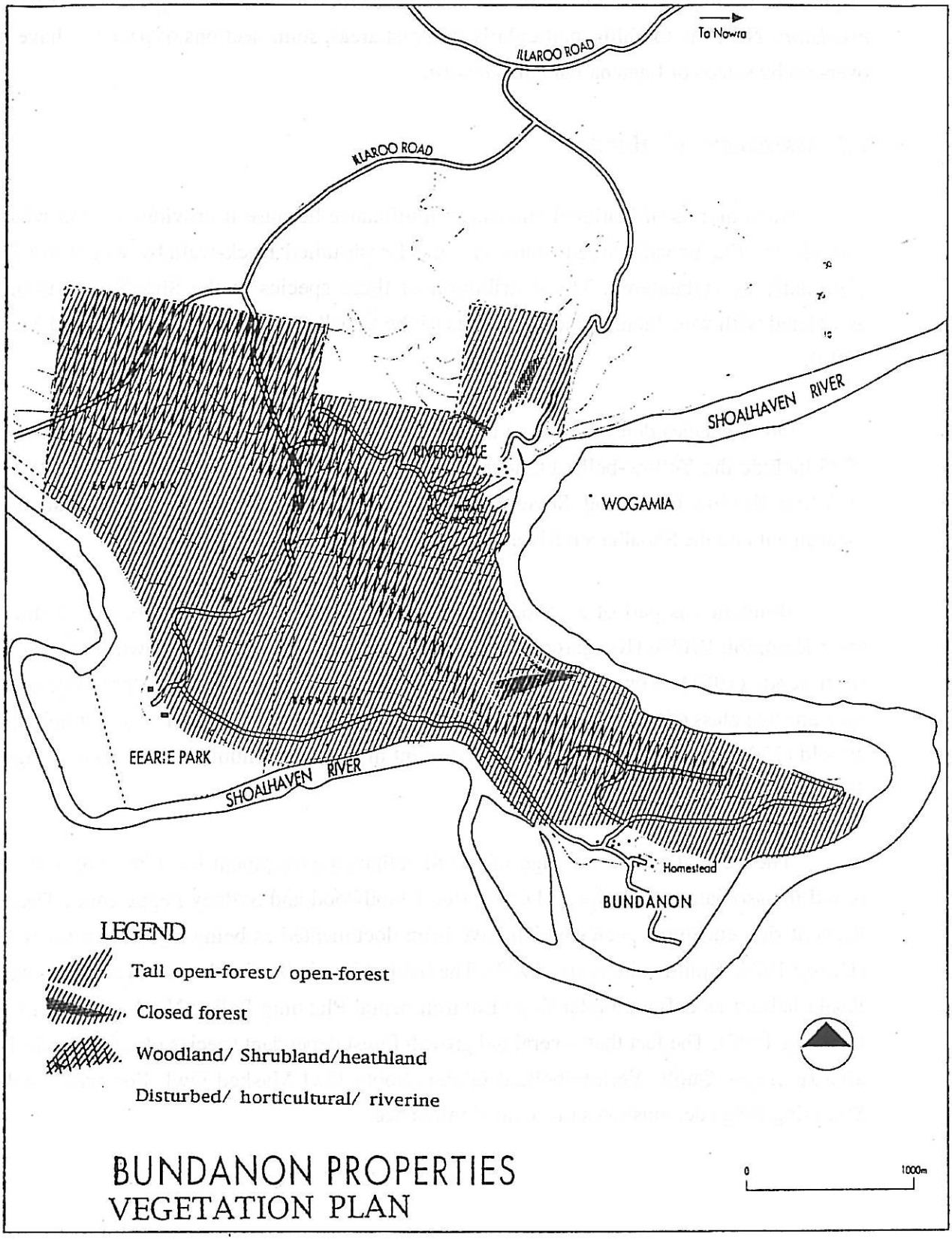

Figure 3. Vegetation Communities of 'Bundanon'

6.0 THREATENED AND SIGNIFICANT SPECIES:

Table 3 Threatened Species of Fauna Recently Detected in the General Area

Schedule 1 Species	
Broad-headed Snake	*Hoplocephalus bungaroides*
Schedule 2 Species	
Tiger Quoll	*Dasyurus maculata*
White-footed Dunnart	*Sminthopsis leucopus*
Yellow-bellied Glider	*Petaurus australis*
Brush-tailed Rock-wallaby	*Petrogale penicillata*
Large-footed Mouse-eared Bat	*Myotis adversus*
Great Pipistrelle	*Falsistrallus tasmaniensis*
Common Bent-wing Bat	*Miniopterus schreibersii*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Eastern Little Mastiff-bat	*Mormopterus norfolkensis*
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*
Large Pied Bat	*Chalinolobus dwyeri*
Black Bitten	*Ixobrychus flavicollis*
Square-tailed Kite	*Lophoictinia isura*
Glossy-black Cockatoo	*Calyptorhynchus lathami*
Sooty Owl	*Tyto tenebricosa*
Masked Owl	*Tyto novaehollandiae*
Powerful Owl	*Ninox strenua*
Giant Burrowing Frog	*Heleioporus australiacus*
Stuttering Frog	*Mixophyes balbus*

6.1 Description of Threatened Fauna

The following is a brief summation of general habitat requirements and local distribution of threatened species which have been detected on or close to 'Bundanon'. Many species occur in small scattered populations and hence for the conservation of regional biodiversity it is of utmost impotence to protect habitat.

Schedule 1 Endangered Species

Broad-headed Snake

The habitat requirements of the Broad-headed Snake overlap those of the Brush-tailed Rock-wallaby, that is north facing sandstone escarpments which have woodland-open forest on the top of the escarpment (pers. obs.). 'Broad-heads' are saxicoline being found under flat pieces of tight fitting sandstone that sit on the parent rock (pers. obs.). This 'rock on rock' habitat is one favoured by several species of reptiles in the region and in particular the Lesueur's Geckoes *Oedura lesueurii* (Schlesinger and Shine 1994, pers. obs.).

The Broad-headed Snake eats geckoes (Shine 1983, 1991). The only species of gecko in the Shoalhaven which occupies a similar habitat to the Broad-headed Snake is the Leseuer's Gecko. The Broad-headed Snake appears to specifically select rocks that have no soil or a scant amount organic debris under them (pers. obs.).

One Broad-headed Snake had previously been detected on site (S. Evison pers. comm.) and another animal was found during this survey. There is concern for this species because of its preference for flat rocks as shelter sites. The illegal collection of 'bush rock' occurs in the Shoalhaven City and the activity has a direct impact on Broad-headed Snakes.

I found bush rock piled up beside the road adjacent to the gate at Riversdale and lighter coloured patches on the sandstone escarpment which indicated that rock collectors had removed quantities of material for landscaping purposes. Although this land is outside the Trust property the activity compromises the fauna of 'Bundanon' as the Shoalhaven River escarpment is a habitat corridor for Broad-headed Snakes. Any major disturbance to habitat adjacent to the Shoalhaven River escarpment will reduce the long term viability of Broad-headed Snakes in this area.

Schedule 2 Vulnerable Species

Tiger Quoll

Tiger Quolls have large home ranges which vary between 614 and 1067 ha for females and 1287 and 1452 ha for males (Belcher 1995). The Tiger Quoll's habitat includes rainforest, tall eucalypt forest and *Acacia/Lantana* regrowth (GD pers. obs.). In New South Wales the Kiama/Nowra area possesses the highest density of Tiger Quolls south of Sydney (pers. obs).

This species is regularly observed along the Cambewarra Range. The most recent recorded sighting was during May 1996. This site is four kilometres north of Bundanon and because of the Quolls large home range and its habitat preference it is expected to occur on site.

White-footed Dunnart

Records for the White-footed Dunnart in the Illawarra/Shoalhaven are from heath at Bherwerre Peninsula (King 1980), sclerophyll forest at Currambene State Forest (Braithwaite *et al.* 1988) and wet sclerophyll/rainforest at Mount Keira Scout Camp (Robinson 1987). The Illawarra represents the northern limital distribution of this species (King 1980).

The Robinson (1987) record is in doubt because there is no Museum based specimen to confirm identification. During the survey of Crown Land at Bugong a specimen was trapped (Daly and Murphy 1996). The area where the Dunnart was caught is part of crown land which is currently leased by Bundanon. This represents the most northern museum based specimen in NSW. Dunnarts are also expected to occur in the heath/woodland areas adjacent to the transmission lines.

Yellow-bellied Glider

The identification of trees incised by Yellow-bellied Gliders is considered to be the most appropriate method for assessing the presence of this species in large areas of forest (Goldingay & Kavanagh 1991). The sap of eucalypts forms a central part of the diet of this species (Goldingay 1987, 1991). In order to obtain sap, gliders bite into the bark on the trunks of trees, typically but not always, making a 'V' shaped cut from which they can feed on the sap as it bleeds from the tree. No other animal marks eucalypts in this way. Therefore, the detection of trees which bear these marks can be used as a simple way to determine the presence of the Yellow-bellied Glider.

Previous studies indicated that Yellow-bellied Gliders in the Shoalhaven area show a preference for the Grey Gum *Eucalyptus punctata* for sap feeding (Goldingay 1991, Daly and Murphy 1996). Grey Gums that were incised by Yellow-bellied Gliders have been located throughout the study site especially in Grey Gum forests along the escarpment.

Brush-tailed Rock Wallaby

Robinson (1987) noted the existence of this species in the Shoalhaven and commented on the fragility of the populations of these wallabies in the City. Wong (1993) examined the Bugong area for evidence of the continued existence of Rock-wallabies and found small colonies. The major threats to this species is predation by Foxes, Dogs and feral Cats, competition with introduced herbivores (Rabbits and Goats), disease, fire, human disturbance, inbreeding and habitat modification and destruction (Wong 1993). Wong (1993) states that the areas that possess Rock-wallabies that are Crown Land should be included as part of Morton National Park.

Additional Rock Wallaby sites were located during the study at Bugong (Daly and Murphy 1996) and have recently been found on Bundanon crown leased land (L. Russ pers. comm.). The north facing escarpment at Bundanon and Riversdale are expected to be utilised by Rock Wallabies. A small population of Goats still exist at Eearie Park. These should be removed as they pose a direct threat to Rock Wallabies.

Large-footed Mouse-eared Bat

Strahan (1995) states that this species hunts fish and insects over placid water and roosts in caves, old mines, buildings and in dense rainforest foliage. Two specimens were detected along the Shoalhaven River at Bugong and Tallowa (Daly and Murphy 1996) and recently nineteen Fishing Bats were detected at Bomaderry Creek (Parnaby 1996).

These studies indicate the Shoalhaven River is significant for Fishing Bats and that maternity roosts occur along the river as the majority of animals captured by Parnaby (1996) were females, many of which were pregnant or had enlarged teats. During this survey Fishing Bats were detected by their calls along the river at Riversdale.

Great Pipistrelle

The Great Pipistrelle roosts in tree-holes (Strahan 1995) and forages in open areas (O'Neill and Taylor 1986). This species was found in open forest composed of Spotted and

Grey Gum at Bugong Crown Land (Daly and Murphy 1996). This vegetation type also occurs at Bundanon and it is expected that the Great Pipistrelle occurs on site.

Common Bent-wing Bat

This is a cave roosting species (Hall and Richards 1979, Hall, Young and Spate 1975). The sandstone escarpment beside the Shoalhaven River provides excellent habitat for this species and it was detected in four localities during the survey by Daly and Murphy (1996). The Common Bent-wing Bat is expected to occur at 'Bundanon'.

Great Broad-nosed Bat

Great Broad-nosed Bats forage in a variety of habitats which range from rainforests to tree lined creeks (Strahan 1983). In the survey by Daly and Murphy (1996) this species was detected in a variety of habitat types including tall eucalypt forest along the escarpment and creeklines in three localities at Bangalee Reserve and Bugong. It is expected to occur at 'Bundanon'.

Eastern Little Mastiff-bat

This species has been recently detected in the Shoalhaven City (Daly and Murphy 1996). The paucity of information on the eastern Little Mastiff-bat is reflected by Strahan's (1992) comments "Little can be said with certainty about the biology of this species." In the current survey this species was not detected but it is expected to occur on site.

Yellow-bellied Sheathtail-bat

This species is usually solitary by nature and feeds above the canopy (Strahan 1983), hence there are few records of this species in NSW. The Yellow-bellied Sheathtail-bat roosts in trees and has been found in the abandoned nests of the Sugar Glider, *Petaurus breviceps,* in hollow limbs (Hall and Richards 1979). It has a fast, direct flight pattern and hunts above the forest canopy (Parnaby 1992). Recent surveys have detected this species in the Shoalhaven City (Glass 1993, Murphy in prep.) and hence it may occur at 'Bundanon'.

Large Pied Bat

The Large Pied Bat roosts in a variety of locations including caves, old mines and tree holes (Strahan 1995). A specimen was detected in eucalypt forest to the west of Wedderburn

(NPWS database). The forest in this area is primarily composed of Spotted and Grey Gum (pers. obs), hence based on habitat I expected the species to occur at Bundanon. A single animal was caught in a harp trap beside the electricity easement at Bundanon and extends the species known range some forty kilometres to the south east of the previous record from Bungonia.

Black Bittern

This species has been recently observed at Bundanon (Carpenter 1995). The Black Bittern forages along the Shoalhaven River and roosts in dense thickets of River Oak. The presence of the Black Bittern at Bundanon indicates the importance of riparian vegetation along the Shoalhaven River.

Square-tailed Kite

The Square-tailed Kite *Lophoictinia isura* has been recorded in coastal and subcoastal forests and woodlands, and inland riverine woodlands (Debus & Czechura 1989: Debus 1990, 1991). The ecological requirements for the Square-tailed Kite are, in general terms, reasonable well known: it is dependant on eucalypt open forest and woodland, and on passerines (particularly honeyeaters) that nest in the foliage canopy (Debus *et al.* 1993). A pair of birds nested in Bangalee Reserve in October 1994 and were subsequently observed at various sites in Nowra over the summer of 1995 (Daly and Evison 1996). The home range of the Square-tailed Kite is considerable and covers approximately 70,000 ha (Garnett 1992). The pair detected during this survey covered an area of 30,000 ha over four months (Daly and Evison 1996) and probably hunted at 'Bundanon'.

Glossy Black Cockatoo

'Bundanon' has a large population of Black Oaks *Allocasuarina littoralis.* Casuarinas form the major component of Glossy Black Cockatoo's diet (Garnett 1992). The main habitat of the eastern subspecies of Glossy Black Cockatoo is eucalypt *Eucalyptus* woodlands and forest with casuarinas (Garnett 1992). Two pairs of Glossy Black Cockatoos were observed under the electricity easement on the road to Bundanon during this survey. Glossy Black Cockatoos nest in the area (S. Evison pers. comm.).

Sooty Owl

The Sooty Owl has been the subject of recent investigations (Kavanagh 1990, Kavanagh & Peake 1993). A survey of this species habitat requirements on the far south coast of NSW indicates that it prefers low altitudes (< 300 metres), sheltered south-east facing sites which possess rainforest with a dense understorey layer (Kavanagh & Peake 1993). Garnett (1992) suggests that habitat fragmentation and the loss of old-growth elements may affect this species.

A single animal was heard calling from the creek at Riversdale prior to this survey (S. Evison pers. comm.). The vegetation along the northern creek at Riversdale is quite suitable for this species.

Masked Owl

Debus (1993) states that the Masked Owl is an opportunistic generalist, widespread in coastal and subcoastal open forests and woodlands. Its diet is varied but prefers terrestrial vertebrates, Rabbits, Rats and occasionally Ringtail Possums and Sugar Gliders.

Although the Masked Owl is dependant on old hollow eucalypts for breeding its habitat preference appears to be forested areas next to farmland. The estimates of Masked Owls home range vary according to its geographic location. Estimates of home range vary from 400-500 hectares to at least 1 km across in one direction (Debus 1993).

A pair of Masked Owls were detected at Bangalee Reserve during August 1992 (GD pers. obs.). The frequent calling and the owls localised movements indicated that they nested in the Reserve and then left several months later. Calls heard at Riversdale may have been a Masked or Barn Owl.

Powerful Owl

The Powerful Owl inhabits both wet and dry eucalypt *Eucalyptus* forest (Garnett 1992). Nests are in tree hollows, usually within large eucalypts (Garnett 1992). The main prey of the species are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider, but it is an opportunistic forager, taking birds and a variety of other mammals including Flying-foxes (Kavanagh 1988,1990).

Powerful Owls have large home ranges. Estimates of home range varies from 400-1450 ha (Garnett 1992). Powerful Owls were detected in the creek at Riversdale (Carpenter 1995) and during the current survey at Bundanon. The collective properties of 'Bundanon' are probably utilised by two pairs of Powerful Owls. The species nested adjacent to Bangalee Reserve during August 1995 (S. Evison pers. comm.).

Giant Burrowing Frog

This species may exist as two geographically distinct populations (Daly in press). The northern population ranges from the Watagan Mountains to Narooma. The habitat preference of the northern population of the Giant Burrowing Frog is swampy heath, woodland and coastal forests which have an underlying substrate of sandstone. This habitat type is well represented along the Shoalhaven River escarpment. Tadpoles were collected at Bundanon from two separate sites during this survey (Daly in press).

Stuttering Frog

The habitat preference of the Stuttering Frog is described by Barker *et al.* (1995) as rainforests in the mountains. Ferrier *et al.* (1993) state that these species is found in rainforest, Antarctic Beech and wet sclerophyll forest of the coast and highlands. The Stuttering Frog occurs along the entire Great Divide from Victoria to the Gibraltar Range and the Clarence River (Ferrier *et al.* 1993).

Records of this species are scant as it is cryptic, living among the leaf litter on the rainforest floor. Males are mostly detected by their calls after heavy rain in late summer and the species appears to have had a marked population decline over the last decade (Daly in prep.).

Stuttering Frogs were detected at Bugong, some two kilometres to the north west of Bundanon. The two creeks at Riversdale and the one to the north west of Eearie Park have habitat suitable for Stuttering Frogs.

6.2 Fauna Which is Presumed to be Extirpated From the Area

The following animals appear to have become locally extinct in the area as a result of changes such as loss of habitat, hunting and predation by exotic carnivores. Several of the species listed below were previously common in the area.

Eastern Quoll *Dasyurus viverrinus*

Robinson (1987) recorded this species at Cambewarra Mt. in 1970. J Selby gave an accurate description of an animal shot during the 1960's near the headwaters of School Creek which matches the description of the Eastern Quoll. No Eastern Quolls have ben detected on mainland Australia for over twenty years.

Tuan *Phascogale tapoatafa*

There are no confirmed records of the Tuan in the Illawarra. The open sclerophyll forest on top of the Shoalhaven River escarpment which is bordered by wet sclerophyll forest/rainforest is suitable habitat for this species (Strahan 1995).

Eastern Bettong *Bettongia gaimardi*

This species occurred in open sclerophyll forest and grasslands in coastal south-eastern mainland Australia, but now only exists in Tasmania (Strahan 1995).

Red-necked Pademelon *Thylogale thetis*

Robinson (1987) detected this species on the edge of rainforests and "hanging swamps" where sedges grow amongst scattered eucalypts in Kangaroo Valley and Barren Grounds Nature Reserve. He also states that around 1900 it was common around Bugong (Robinson 1988). If Foxes were permanently removed small macropods could be reintroduced into the area.

Parma Wallaby *Macropus parma*

This species occurred in thick scrub that bordered rainforest. It is eaten by Foxes, as clearly demonstrated in 1988 when captive bred animals were released by the NPWS of NSW at Macquarie Pass in the Illawarra. Of the 48 odd animals released 12 were fitted with radio collars. All collared animals were eaten by Foxes within a four months of their release (Short *et al.* 1992).

White-footed Rabbit Rat *Conilurus albipes*

This species is extinct. It was found along the east coast and ranges from eastern South Australia to southern Queensland (Strahan 1995).

Koala *Phascolarctos nasuta*

The Koala had previously occurred along the Cambewarra escarpment and an animal was shot approximately four kilometres to the north of Bundanon about fifty years ago (B. Wilson pers. comm.). The Grey Gum and Forest Red Gum forests at Bundanon are suitable feed trees for Koalas and this species may still occur in the area.

Emu *Dromaius novaehollandiae*

Prior to European settlement the Emu occurred in most habitat types, except rainforest (Lindsay 1992). The species has not been recorded in the Illawarra which suggests that it was removed early on during European settlement of the area. Emus could be reintroduced to Bundanon.

Bush Stone-curlew *Burhinus grailarius*

Gibson (1989) states that this sedentary species prefers open country. It had previously been recorded in the Cambewarra area (Chafer 1989).

Black-necked Stork *Xenorhynchus asiaticus*

This species occurs in tropical wetlands and is rare south of Sydney (Lindsay 1992). This species had previously been recorded at Coomonderry Swamp in 1974 (NPWS wildlife database). The dams at Bundanon are suitable for this species.

Pheasant Coucal *Centropus phasianinus*

Gibson (1989) states this species habitat preference as swamplands, damp heaths and associated woodland. Prior to severe bushfires in 1968 this species occurred in heathlands along the Mt. Keira/Wilton road (Gibson 1989). Based on the habitat preference of this species on the north coast of NSW, it is thought that it would have occurred on the edges of the escarpment rainforest. This species has recently been observed at Barren Grounds Nature Reserve, twenty four kilometres to the north (Gibson 1989).

Scrub Turkey *Alectura lathami*

This bird once occurred in the Illawarra (Pizzey 1980) rainforests ranging as far south as the Shoalhaven River. During a recent survey old nesting mounds were located at Bugong (Daly and Murphy 1996). This species could be reintroduced to Bundanon.

Wompoo Pigeon *Ptilinopus magnificus*

This species had its southern limit in the rainforests of the Illawarra (Pizzey 1980). Habitat destruction and shooting has caused it to become locally extinct. Gibson (1989) states that the species has not been recorded in the region since 1920.

Striated Fieldwren *Calamanthus fuliginosus*

Striated Fieldwrens utilise heath and associated woodlands. Morris *et al.* (1981) and Schodde and Tidemann (1993) regard the contemporary north-eastern limit of this species to be the upper Clyde River in Morton National Park however, it has been recorded further north in Morton National Park close to Tianjara Falls in 1995 (pers. obs.) and also in Botany Bay in 1979 (Morris *et al.* 1981).

In New South Wales the Striated Fieldwren occupies similar habitat to that used by the Ground Parrot and the Eastern Bristlebird (Tanton 1994). This is the case in Morton National Park where the Ground Parrot and Bristle Bird exist (pers. obs.). Bundanon has habitat, west of the transmission lines, that is suitable for Striated Fieldwrens.

Eastern Bristlebird *Dasyornis brachypterus*

Currently the Eastern Bristlebird is known form Morton National Park (pers. obs.), Red Rocks Nature Reserve (B. Gray pers. comm.), Budderoo National Park and Bherwerre Peninsula Jervis Bay (Barker 1995, unpublished report). The species is highly associated with heath and based on habitat preference and distribution Bristlebirds probably occurred close to the transmission wires on the plateau behind Bundanon.

Ground Parrot *Pezoporus wallicus*

Ground Parrots are also associated with heath and currently exist in Morton National Park, Budderoo National Park and Beecroft and Bherwerre peninsulas Jervis Bay. The species is a strong flier and probably also occurred in the heath on the plateau behind Bundanon.

6.3 Fauna of Regional Significance

The northern Shoalhaven possess the following species which we consider are of regional significance. This group has been selected based on criteria such as their sensitivity to modifications in habitat, are habitat specialists, are at the limit of their known distribution and /or are regionally rare. Some of the species were detected during the study.

Yellow-footed Antechinus *Antechinus flavipes*

A single record of this species was obtained from hair taken from a Fox scat. This is the only record of this species in the Illawarra. Possibly occurs at Bundanon.

Feather-tailed Glider *Acrobates pygmaeus*

An arboreal possum which feeds on nectar, insects and the exudates of Grey Gums that have been incised by Yellow-bellied Gliders (GD pers. obs.). Feather-tailed Gliders have been observed at Bundanon by staff after domestic Cats have brought animals into the house.

Pygmy Possum *Cercartetus nanus*

A small possum that is found in a variety of habitats ranging from heath or woodland which has a heath understorey and closed forest. This species was not detected during this survey but based on habitat preference and distribution it is expected to occur in the area.

Lewin's Rail *Rallus pectoralis*

A rare species that inhabits swamps and dams next to rainforest. One pair has been observed around dams at west Cambewarra.

Buff-banded Rail *Gallirallus phillippensis*

This species has been detected by Ms D. Wright in Bangalee Reserve and still occurs along Tapitallee Creek (S. Evison pers. comm.).

Peregrine Falcon *Falco peregrinus*

A breeding pair exists close to the study area and utilise a south facing sandstone shallow cave for nesting. This nest site has been in use for several years and is under threat by rock climbers using the site (Daly and Murphy 1996).

Barking Owl *Ninox connivens*

Few records of the Barking Owl exist for the Illawarra (Gibson 1989; NPWS database). This species has been found at Bugong, West Cambewarra (GD pers. obs. 1994)

and Moeyan Hill (GD pers. obs. 1993). A major problem associated with the detection of this species is that it calls infrequently and seasonally (GD pers. obs.).

White-winged Triller *Lalage sueurii*

This species is rare in the region and was detected once during the survey at Bendeela picnic area, adjacent to the study area. It had been recorded at Bangalee Reserve (D. Wright pers. comm.).

Origma *Origma solitaria*

This species is highly associated with sandstone escarpments in the Sydney Basin. It is widespread along the Shoalhaven River escarpment.

Heathwren *Sericornis pyrrhopygius*

A shy rare species found in heath and woodland which has heath as an understorey. Observed at Bomaderry Creek Bushland (GD pers. obs.).

Scaly Thrush *Zoothera lunulata*

An uncommon species which is associated with rainforests and closed eucalypt forest. Widespread in the study area but mostly detected in autumn and spring.

Crested Shrike-tit *Falcunculus frontalis*

Although Lindsay (1992) stated that this species establish permanent territories. Gibson (1989) found that the species is nomadic. Previously recorded at Bangalee and Cambewarra .

Rainbow Bee-eater *Merops ornatus*

A summer seasonal migrant which nests in the sandy banks of the Shoalhaven River in the Illaroo Farm area. Several birds were seen along the road to Bundanon.

Brown-headed Honeyeater *Melithreptus brevirostris*

This species is uncommon and declining in the region (Murphy 1995b). One animal was observed in heath/woodland close to the transmission lines above Bundanon.

Scarlet Honeyeater *Myzomela sanguinolenta*

A species which is scarce and nomadic (Gibson 1989) which has been detected at Cambewarra and Coolendel (D. Wright pers. comm.).

Yellow-throated Scrubwren *Sericornis citreogularis*

A species that inhabits rainforest and closed sclerophyll forest. It is widespread and was found in several of the study sites along creeks.

Monarch Flycatcher *Monarcha melanopsis*

The Monarch Flycatcher is a summer migrant which inhabits rainforests and wet sclerophyll forests (GD pers. obs.). It was widespread in the study area.

Beautiful Firetail *Stagonopleura bella*

This species is highly associated with heathland and adjacent woodlands. One animal has been detected at Bundanon (Carpenter 1995).

Logrunner *Orthonyx temminckii*

A sedentary species found in closed forest (rainforest and moist eucalypt forest) associated with the escarpment (GD pers. obs.). Detected at Cambewarra and may occur at 'Bundanon'.

Catbird *Ailuroedus crassirostis*

A sedentary species associated with closed forests along the escarpment which was not detected during this survey.

Striped Skink *Ctenotus robustus*

Although no specimens were detected during this study this species has been found in the Shoalhaven at Flat Rock Dam (P. German pers. comm.) and at Bomaderry (G. Merdith pers. comm.). It is expected that small populations exist in grassy areas on heavy soils (GD pers. obs.).

Maccoy's Skink *Nannoscincus maccoyii*

A fossorial skink found in wet sclerophyll, rainforests and coastal eucalypt forest (Murphy 1995b). The northern limit of this species distribution occurs in the Illawarra (Swan 1990). Found in rainforest at Bugong, Bangalee, Mount Scanzi and Cambewarra.

Diamond Python *Morelia spilota*

A high order consumer which has been seen at Bundanon by staff.

Australian Bass *Macquaria novemaculeata*

A large fish that occurs in the Shoalhaven River and its tributary creeks. This species migrates into brackish water when breeding (Allen 1989). Tallowa Dam may have impacted on

the population of Bass as the dam does not possess a fish ladder and restricts the movement of fish.

Australian Grayling *Prototroctes maraena*

This species has been previously reported for the Shoalhaven River (Bishop and Bell 1978) and has had a population decline and is considered rare (Merrick and Schmida 1984). The Shoalhaven River is close to the northern limital distribution of the Australian Grayling (Merrick and Schmida 1984).

Mountain Galaxia *Galaxias brevipennis*

A species is restricted to the upper portions of clear, cool streams which are bordered by forest (pers. obs). Detected during the survey in two small creeks at Riversdale.

6.4 Plant Species of Regional Significance

Four plant species of national conservation significance were recorded in the study area. None of the species are common and the study area, and occur in small populations in areas with specific habitats.

Leptospermum sejunctum

This species was only recorded at one site; on a cliff ledge to the north of Riversdale, at the extreme north-east end of the study area. One population extends as a narrow band more or less continuously for a distance of about 30m. This species is restricted to the Nowra district (Harden 1991) and currently has a conservation rating of 2K, which means that the species is poorly known, but appears to have a very restricted distribution (Briggs & Leigh in prep.). The population is an area that has been recently burned, and is less than 50m from the road and boundary of the study area, so may be subject to occasional disturbance.

Acacia subtilinervis

Only a few individuals of this species were recorded in heathland at the western end of the study area near a disused quarry. It could not be confirmed whether the presence of this species was an artefact of previous disturbance or a natural occurrence. This species has a conservation rating of 3RCa, which indicates that the species is rare, but not currently considered endangered or vulnerable and is known to occur in adequate numbers in conservation areas.

Triplarina nowraensis

This is a recently described species which was only recorded once, in heathland near a creekline at the western end of the study area. The species is probably restricted to an area from Jervis Bay towards Nowra, so the occurrence at the study area may be close to the western limit of distribution. The species will probably have a "vulnerable" conservation rating, once it has been fully studied.

Dodonaea rhombifolia

This species was previously recorded by Mills (1985) at the western end of the study area. The most recent conservation code for this species is 3RCa, which indicates that the species is

known to occur in adequate numbers in conservation areas, including Morton National Park (Briggs & Leigh in prep.).

Mills (1985) nominated several plant species of regional conservation significance that occur in the study area: These are listed in Table.

Table 3 Regionally Significant Plant Species

Species	Location	Significance
Abrophyllum ornans	closed forest, near creek-lines; north of Riversdale	near southern limit of distribution
Melicope micrococca	closed forest, near creek-lines; north of Riversdale	near southern limit of distribution
Toona ciliata	tall open-forest with mesic understorey; north of Bundanon	large specimens rare in region
Glochidion ferdinandi var *pubens*	closed forest, near creek-lines; north-west of Riversdale	near southern limit of distribution
Corymbia eximia	open woodland, north end of Eearie Park	near southern limit of distribution
Jacksonia scoparia	woodland on plateau, north of Bundanon	uncommon in region
Cyathea cooperi	closed forest, near creek-lines; north of Riversdale	uncommon in region
Myoporum floribundum	open-forest, lower slopes.	uncommon in region
Zieria cytisoides	cliff ledges, north of Eearie park	uncommon in region

6.5 Significant Plant Communities

The closed forest community occurring in the study area is considered to be adequately conserved at the state level (Floyd 1989). At a local level, however, the closed forest should be considered to be an important remnant of the rainforest stands that have been extensively cleared from the region (see Mills & Jakeman 1995). The tall-open forest fringing the rainforest patches provides a buffer, protecting the mesic species against desiccation from sun and wind.

The sclerophytic vegetation types occurring in the study area are well represented in conservation areas in the region. However the occurrence of several plant species of national

conservation significance in the study area, particularly in the shrubland/ heathland patches, should be considered. Moreover many plant species of regional conservation significance are restricted to specific habitats, such as the cliff-lines, steep slopes, exposed plateaus, poorly drained plateaus and gullies.

7.0 CONCLUSIONS

7.1 Wildlife Corridors

The southern end of the Illawarra is defined as areas north of the Shoalhaven River (Robinson 1977). At this point the Illawarra abuts the Shoalhaven River escarpment. 'Bundanon' lies within the Shoalhaven River escarpment. This area has been identified as a habitat corridor for a suite of endangered fauna, namely the Brush-tailed Rock-wallaby, Yellow-bellied Glider, Large-footed Fishing Bat, Sooty and Powerful Owl, Broad-headed Snake and Eastern Owl Frog (Daly and Murphy 1996).

The Shoalhaven River escarpment is important because it joins the Cambewarra escarpment which links populations of animals in a north-south (Illawarra) direction (Robinson 1977). Preservation of the area will allow endangered species such as the Brush-tailed Rock-wallaby, Powerful and Sooty Owl the possibility of recolonising areas to the north.

7.2 SEPP 44 Koala Habitat

The Koala has lost such a significant amount of its habitat in NSW that in 1995 a separate State Environmental Planning Policy (SEPP) was introduced to aid the conservation of the species. The aim of this policy is for Local Government to identify "Core Koala Habitat" and to encourage these areas to be included in environment protection zones (Department Of Planning Circular No. B35). The Shoalhaven is listed on Schedule 1 of SEPP 44 as a Local Government Area to which this act applies.

The Shoalhaven City has at present not produced a Plan of Management for Koalas. Our studies indicate that there is a need to produce such a plan as under SEPP 44 Bundanon is potential Koala habitat because tree species listed in Schedule 2 of that policy constitute 15% or more of the upper canopy. The suitability of the Shoalhaven River escarpment for Koalas was previously indicated by R. Goldingay (Mitchell McCotter 1992) but Bundanon is particularly significant because it has Forest Red Gum forest. The requirements of SEPP 44 should be considered in any land use planning in the area.

Currently there is a proposal to revegetate portions of Riversdale and ultimately Bundanon with endemic species of eucalypt that are known Koala feed tree species. Bundanon Trust should consider a proposal for the reintroduction of select species of fauna to Bundanon. The Koala is a particular case because the species did occur in the area and suitable habitat already exists at Bundanon.

Any reintroduction program would involve a coordinated effort between the NPWS and the Trust and involve monitoring. There would be several benefits of a Koala reintroduction program. They include scientific, public relations and conservation.

7.3 State and Local Significance of 'Bundanon'

Based on distribution the most significant animal that occurs at 'Bundanon' is the Broad-headed Snake. The Broad-headed Snake is only found within a 200 km radius of Sydney and the distribution of suitable habitat is patchy throughout the species' range (Cogger *et al.* 1993). The Broad-headed Snake's range coincides with the highest density of human population in Australia and wide-scale habitat degradation has broken the remaining population into small isolated units (Cogger *et al.* 1993). Fortunately the Shoalhaven is a stronghold of the species because agricultural and urban development has occurred primarily on the fertile coastal plain which is not suitable habitat for Broad-headed Snakes.

Within the Shoalhaven City the Broad-headed Snake is confined to Morton National Park and associated sandstone escarpments south to the Clyde River valley (pers. obs.). The species was not detected on Beecroft or Bherwerre Peninsulas (Coyne *et al* 1979; Daly 1995d, 1996). In the northern Shoalhaven the species has been found from Riversdale along the Shoalhaven River escarpment to Hampton bridge, Kangaroo Valley (but probably occurs east to Bomaderry Creek).

Conservation of the Broad-headed Snake's habitat should be given priority when the Trust considers potential sites for development. Protection of Broad-head habitat will also aid in the conservation of the other species previously noted as having a high association with the Shoalhaven River escarpment.

Other threatened species such as the Yellow-bellied Glider, Brush-tailed Rock-wallaby, Sooty Owl and Eastern Owl Frog have widespread but patchy distributions within NSW. The fact that the above species occur within a small geographic range along the Shoalhaven River is attributed to the diversity and quality of habitat. 'Bundanon' constitutes a significant portion of the Shoalhaven escarpment and its value in terms of the preservation of the above species at a local level should be recognised. The trapping of the Large Pied Bat is also noteworthy because this is the first specimen to be found in the Illawarra and represents the southern limit of the species. Clearly 'Bundanon' is significant at a local and state level because of the presence of the above threatened species and the position of the land in respect to habitat corridors.

7.4 Management Recommendations

'Bundanon' has a high biodiversity because it contains a range of habitat types and has old growth forests. This diversity in part relates to the Shoalhaven River forming a zoogeographic zone with subtropical rainforests close to their southern limit at the river (Mills and Jakeman 1995). The area has not had a great deal of disturbance and this has been a contributing factor to the area's high biodiversity. The natural areas of 'Bundanon' also have a high visual amenity.

The area's biodiversity is under threat from changes in land use. For example the developments that have occurred in and around the study area such as urbanisation, logging and roads have adversely impacted upon the distribution and abundance of some species of animals.

Urbanisation directly impacts fauna by removing habitat as well as killing animals during road construction. Indirect impacts on fauna associated with urban development include mortality associated with vehicular traffic, weeds, commensal species, increased risk of fire, pollution of waterways and domestic animals.

The Shoalhaven City has had a rapid growth over the last decade (Department of Planning 1993). The population increase has put pressure on the bushland and hence the fauna of 'Bundanon'. The following activities impact on wildlife: motor cycle/four wheel driving, horse riding, abseiling, dumping of rubbish, collection of firewood and bush rock. At a local government level the Shoalhaven City council should consider appropriate zoning adjacent to 'Bundanon' so that urban sprawl (rural residential) does not degrade the area's wildlife habitat and aesthetic value.

Bundanon is a Wildlife Refuge and yet resident farm workers possess domestic Cats and Dogs. This is unacceptable as it compromises the intent of the refuge declaration. The farm hand (S. Hale) indicated that their Cat captures small possums. 'Bundanon' should be a Cat and Dog free zone as the presence of these animals is in direct conflict with the area being a Wildlife Refuge.

The small population of feral Goats on the Shoalhaven River escarpment at Eearie Park should be eradicated. Goats directly compete with Brush-tailed Rock-wallabies for refuge sites such as caves and rocky overhangs. Many of the caves in Bugong had old goat pellets and lighter coloured Rock-wallaby scats. This indicated that Rock-wallabies were excluded by

Goats because lighter coloured scats are older than dark ones. The only fresh Goat pellets in the area are at Eearie Park and hence the population appears to be confined to this area.

The heathland west of the transmission lines on top of the escarpment is divided by several small roads. These roads are currently used by various persons for illegal activities such as the dumping of rubbish. The Trust should liaise with its neighbours (Nolan Estate), local government and fire and energy authorities to close these roads and erect signs warning off potential dumpers. The presence of these roads is in direct conflict with the overall objectives of 'Bundanon' as a natural place which conserves fauna and flora and gives inspiration for artistic endeavours. The presence of rubbish and garden refuse is unsightly and there is a potential for weeds to spread into bushland.

'Bundanon' should also cater for and encourage scientific studies. The current investigation revealed the presence of the Large Pied Bat which was previously unknown in the Shoalhaven. The habitat at 'Bundanon' is so diverse that there are probably several other species of plant and animal in the area that are not listed in Appendix A or B. There is a real need to do additional field surveys in the area. In particular more work is required on insectivorous bats and plants of conservation significance.

As a priority the Trust should have 'critical' habitat for threatened species and ecological communities mapped so that these areas can be considered by the Threatened Species Scientific Committee for inclusion under the TSC Act. The Trust should also investigate the possibility of funding or facilitating projects such as the monitoring of threatened species populations. For example: the breeding success of the Eastern Owl Frog, breeding site fidelity of Glossy Black Cockatoos (and possibly owls), accurate assessment of the populations of Yellow-bellied Glider, home range studies on the Rock Wallaby and Tiger Quoll. Research priority should be given to those species listed as endangered at a National Level and then those listed on Schedule 1 of the TSC Act.

It should be noted that the TSC Act requires recovery plans for all 'threatened' species currently listed in NSW to be prepared over the next decade. The Trust should liaise with federal (Australian Nature Conservation Agency) and state (NPWS) conservation agencies to participate in this process. Certainly recovery plans should address the habitat at 'Bundanon' as our investigations indicate that the area is regionally significance for several threatened species.

Revegetation/regeneration programs will concentrate on the removal of Lantana and the planting of endemic species which retard soil loss and provide habitat for wildlife. Plants used

in revegetation works should be grown from local seed and other propagules so that the genetic integrity of the vegetation is maintained.

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Study Team

Mr G. Hoye - bats

Mr G. Daly - mammals, birds, reptiles, amphibians and fish.

Mr G. Leonard - plants.

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