POSSUM BRUSH QUARRY

SPECIES IMPACT STATEMENT

For:
PACIFIC BLUE METAL PTY LTD
As Trustee for Possum Brush Quarry Unit Trust

September, 97
36043RP3

ERM Mitchell McCotter Pty Ltd. A.C.N. 002 773 248. A member of the Environmental Resources Management Group.

This report was prepared in accordance with the scope of services set out in the contract between ERM Mitchell McCotter Pty Ltd (ERMMM) and Pacific Blue Metal Quarries Pty Ltd. To the best of our knowledge, the proposal presented herein accurately reflects the Pacific Blue Metal's intentions when the report was presented. However, the passage of time, application of regulators conditions or impacts of future events could modify the outcomes described in this document. In preparing the report, ERMMM used data, surveys, analyses, designs, plans and other information provided by the individuals and organisations referenced herein. While checks were undertaken to ensure that such materials were the correct and current versions of the materials provided, except as otherwise stated, ERMMM did not independently verify the accuracy or completeness of these information sources.

Approved by:	ANTHONY JOHN FISH
Position:	Project Director
Signed:	
Date:	12/9/97

ERM Mitchell McCotter Quality System

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EXECUTIVE SUMMARY

Pacific Blue Metal Pty Ltd is seeking consent to extract and process material from additional land adjoining its existing quarry site, and to deepen extraction in the existing approved pit. The additional extraction will require the clearing of approximately 4.4 hectares of forested land. The company proposes to continue to operate and manage the expanded quarry in an environmentally responsible manner which satisfies the requirements of all relevant public authorities.

This SIS was undertaken because it was determined highly likely that the Brush-tailed Phascogale and the Squirrel Glider would occur on the study area and may be impacted upon by the proposal. In addition to this, a rare Australian plant (Rudder's Box) was identified on the study area during initial field work and the threatened Glossy Black Cockatoo was identified on the study area in 1985, outside of the area to be cleared. In order to appropriately determine the impacts of the proposal and design applicable mitigation measures, an SIS was deemed necessary and a fauna trapping program was undertaken. During this program the Brush-tailed Phascogale and two species of threatened bat were identified in the study area.

This SIS has been undertaken in accordance with Sections 109 and 110 of the Threatened Species Conservation Act 1995 (TSC Act), which describe the form and content of an SIS. The Director General's Requirements for the proposal, pursuant to Section 111 of the TSC Act have also been addressed in this report.

Potential impacts of the development upon flora and fauna may be caused by habitat loss and modification, water quality and turbidity, dust, noise, traffic mortality and interference with fauna movements. Mitigation measures have been incorporated into the proposal and are discussed in this SIS.

Habitat loss and modification will be addressed through the enhancement of the remaining habitat by fencing off bushland areas, controlling feral animals including introduced bees which compete with native animals for tree hollows, the provision of nest boxes, progressive rehabilitation and an ecologically sound timed clearing regime.

Traffic mortality and interference with fauna movements will be mitigated through habitat enhancement, the erection of wildlife warning signs and the implementation of on-site speed limits.

Water quality and turbidity impacts will be addressed through physical sediment and erosion control measures which are currently in place for the existing quarry operations. Complementary measures such as the segregation of clean and dirty waters will further minimise the potential for sediment laden runoff to enter downstream watercourses.

Dust impacts will be addressed through the dampening of access roads and working areas during dry periods, the use of industrial exhaust extraction and control systems, avoiding dust generating activities during times of high winds, appropriate management of trucks leaving the site and progressive revegetation.

Noise impacts associated with the proposed quarry expansion were not considered to be particularly significant as the majority of noise-generating activities are undertaken during daylight hours and the majority of fauna considered likely/known to utilise the site are nocturnal, however quarry management will ensure that crushing and blasting hours are restricted to daylight hours.

The mitigation measures are necessary to reduce the direct impacts to threatened flora and fauna of the study area and the cumulative impact upon flora and fauna in the region. These measures will be included in an implementation program as part of the Environmental Management and Site Rehabilitation Plan (EMSRP) for the quarry.

The implementation program will be prepared after consultation with the National Parks and Wildlife Service and the review of similar programs.

In addition, a monitoring program is proposed to ensure that mitigation measures are adequate and that there are no additional impacts occurring which were not identified in this SIS.

Provided that the impacts identified in this SIS are mitigated with those measures suggested in this SIS, it is highly unlikely that the proposed expansion of Possum Brush Quarry will have a significant impact on any threatened species.

Chapter 1

INTRODUCTION

1.1 BACKGROUND

The Commonwealth and NSW State Governments recently launched the largest peacetime civil construction project in Australia's history since the building of the Snowy Mountains hydro-electric scheme with the announcement that $2.2 billion would be made available for major upgrading of the Pacific Highway.

The upgrading will involve the rebuilding of the 700 km Pacific Highway in New South Wales and will include:

- the construction of a four lane freeway along a new 22km section of highway between Bulahdelah and Coolongolook, costing $193 million; and
- the extension of the four lane freeway to Possum Brush.

Consequently, major supplies of road construction material will be required to undertake such roadworks.

The Roads and Traffic Authority (RTA) has particular specifications for road material to be used on major upgrading of roads such as the Pacific Highway. The material currently being extracted from Block A of the quarry is not meeting these requirements. Consequently, Pacific Blue Metal Pty Ltd is seeking to extract material from an additional 7 hectare area within Block B of the quarry which involves 4.4 hectares of uncleared land, and to deepen extraction in the approval section of Block A. This material will meet the RTA's specifications and contribute to satisfying the demand for hard rock material that will occur over the next ten years.

The study area, the component of the subject site where natural surface is proposed to be disturbed and Blocks A and B are shown in *Figure 1.1*

The quarry has been operating since 1986, in accordance with existing development consent. This operation has involved the annual extraction of up to 200,000 tonnes of hard rock and has included blasting, processing and transportation of material to markets extending from Raymond Terrace in the south to Johns River in the north.

The northern half of the study area has been used to graze beef cattle since before 1986, and continues to be used for this purpose to date.

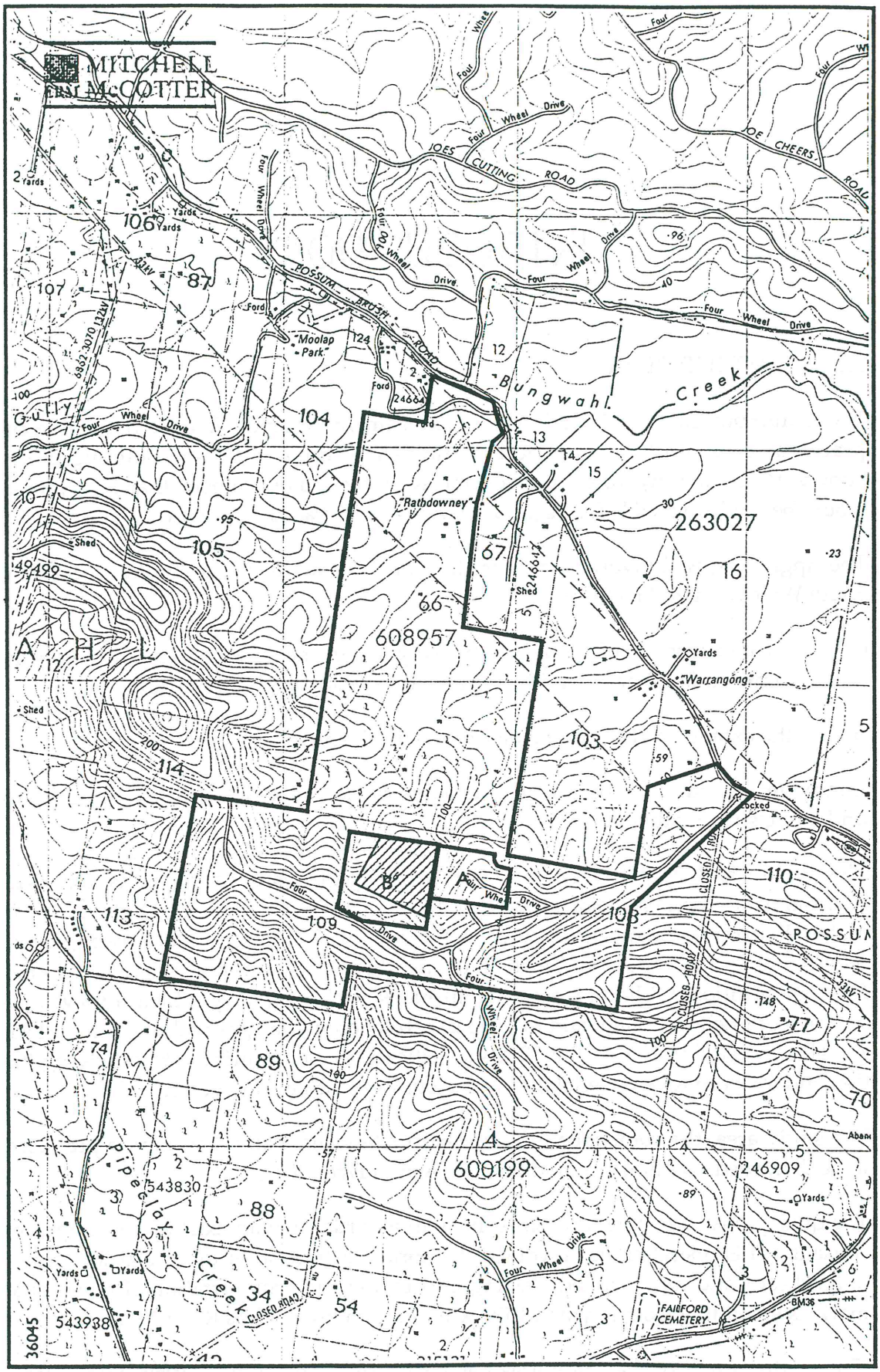


Figure 1.1 LOCALITY PLAN

A visual inspection of the study area has revealed that fire fuel loading was reasonably high. In addition, very few trees containing blackened trunks. were identified in the bushland of the study area. Consequently, the frequency of fire in bushland areas of the study area is low.

Griffith (1985) documents that the bushland on site was heavily logged in the early 1940s, and logged again in 1977.

This Species Impact Statement has been prepared on behalf of Pacific Blue Metal Pty Ltd to accompany a development application to Greater Taree City Council to extend extraction operations into an area of around 7 hectares within Block B (of which only 4.4 hectares requires clearing), to allow deeper extraction in Block A down to 40 metres AHD, to allow secondary rock breaking on the resultant new quarry pit floor when required, to process the resultant product through the existing processing plant and to transport the product from the site.

In order to maintain consistency with Geological reports and to avoid confusion over terminology, in the remainder of this EIS the three separate sections of the quarry which were defined as Areas A, B and C respectively in the 1986 Development Application are referred to as Block A, Block B and Block C.

1.2 THE PROPOSAL

The proposed extension of Possum Brush Quarry does not involve the intensification of quarry activities at the site. The current development consent for extraction from the existing extent of Block A, processing and delivery of product will remain unchanged. The proposal involves increasing the total extraction area available for development.

The objective of the proposed extension to the quarry is to immediately produce large quantities of the Unit B rock, a rock that has properties suitable for meeting current high quality aggregate specifications. The demand for this specification rock has increased considerably as large quantities are now required for major road projects, including the Pacific Highway upgrading. Processed Unit B rock can satisfy this specification, is the major rock type in Block B and is immediately accessible. Lowering the final floor level of the quarry will provide long term access to large quantities of Unit B rock.

The proposed development includes:

- extraction of Unit B material from the north-east section of Block B, processing of that material in the existing processing plant, and transport

from the site, all in accordance with a new development consent. This material will be a primary source of aggregate products;

- extraction from Block A below the existing approved floor level, processing of that material in the existing processing plant, and transport from the site, all in accordance with a new development consent. This extension will supply major quantities of Unit B material in the latter stages of development of the quarry;

- secondary rock breaking on the resultant new quarry pit floor when required; and

- producing, processing and transporting all product from the site at the same rates as permitted by the current development consent.

The order of site development will comprise:

- if required to supplement the existing functioning drainage system, the installation of drainage systems, geofabric filter fencing and other structures to ensure containment of run-off from disturbed catchment areas;

- stripping and clearing of vegetation and overburden from the initial undisturbed portion of Block B to be quarried; and

- the commencement of extraction operations.

The existing quarry operation and the area proposed to be cleared in Block B are shown in *Figure 1.2.*

1.3 REASON FOR THE SIS

The Threatened Species Conservation Act, 1995 (TSC Act) commenced on the 1st January 1996, and replaced the legislative scheme introduced by the Endangered Fauna (Interim Protection) Act, 1991. The TSC Act made substantial amendments to the National Parks and Wildlife Act, 1974 (NPW Act) and the Environmental Planning and Assessment Act, 1979 (EP&A Act). The new Section 5A of the EP&A Act, 1979 sets out eight factors to be considered in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats. If it is determined through the eight part test that the proposal would be likely to have a significant impact on threatened species a species impact statement is required.

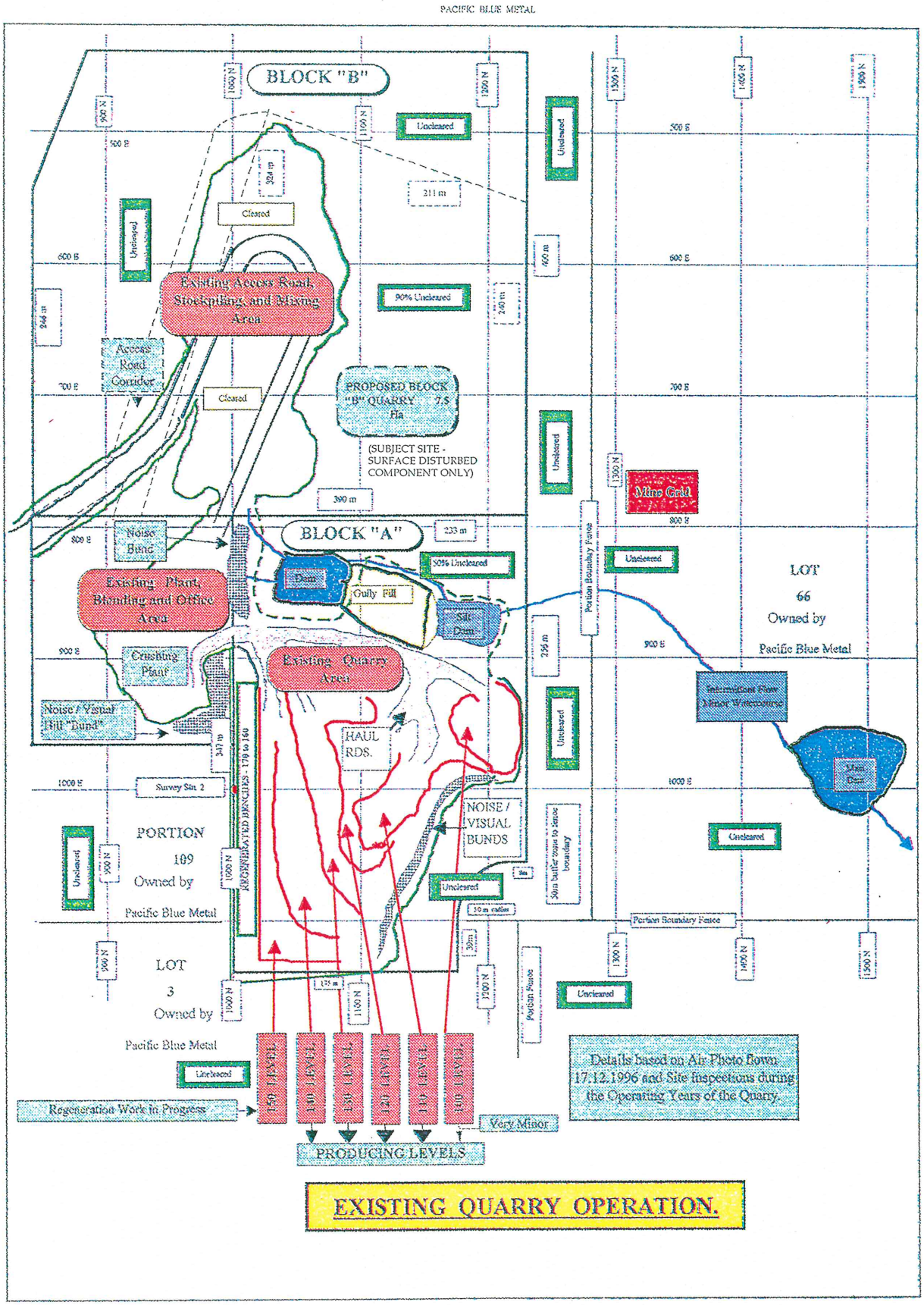


Figure 1.2 EXISTING QUARRY OPERATION (SOURCE: STEGGLES 1997)

An eight part test was commenced in early 1996. After undertaking initial investigations for the eight part test, it was evident that the Brush-tailed Phascogale and the Sugar Glider would be highly likely to occur on the subject site, and may experience habitat reduction up to 4.4 hectares because of the proposed quarry expansion. In addition to this, a Glossy Black Cockatoo was identified nearby the proposed extraction area by Debus in 1985 and a Rare Or Threatened Australian Plant (ROTAP) species, Rudder's Box, was identified on the eastern boundary of Block B. An additional four species of threatened fauna had been recorded within a ten kilometre radius of the quarry in similar habitat. It was therefore determined that the proposed quarry expansion may have a significant impact on a number of threatened species. Discussions were held with the National Parks and Wildlife Service, Northern Zone, to clarify this issue, and the requirement for a Species Impact Statement (SIS) for the proposal, based upon the above conclusion, was confirmed.

1.4 APPROVALS REQUIRED

The development is permissible with the consent of Greater Taree City Council. It is also a *designated development* as defined in Schedule 3 of the Environmental Planning and Assessment Regulation 1980. Consequently, an EIS must accompany the development application. The EIS must be advertised and placed on public exhibition, the Council must consider any submissions in its assessment, and objectors have a right of appeal on the merits of the proposal to the Land and Environment Court.

The EIS has been prepared in accordance with Clauses 50 and 51 of the Environmental Planning and Assessment Regulation 1980.

Additional environmental approvals will be needed under other legislation, including:

- the hardrock quarry would be scheduled premises under the Noise Control Act, 1975. Its operation must be licensed by the Environment Protection Authority;

- if any additional pollution control structures, including sedimentation dams beyond those currently licensed in respect to the current operation are not capable of being included within the current licences and approvals then additional licences and approvals will need to be obtained under the Clean Air Act and Clean Waters Act. The Environment Protection Authority must issue relevant licences and approvals before operations may commence;

- a permit would be required under the Rivers and Foreshores Improvement Act, 1948 for any excavations or constructions between the banks, or within 40 metres of the banks, of any defined water course; and
- an authority must be granted under the Soil Conservation Act before destroying or injuring trees growing on *protected land*. Protected land means land mapped with slopes generally in excess of 18° from the horizontal.

1.5 STRUCTURE OF THE REPORT

1.5.1 SIS Requirements

This SIS has been undertaken in accordance with Section 109 and 110 of the Threatened Species Conservation Act 1995 (TSC Act), which describe the form and content of an SIS. The Director General's requirements for the proposal, pursuant to Section 111 of the TSC Act have also been addressed in this report. A copy of the Director General's Requirements is given at Appendix H.

Table 1.1 details the contents of this SIS in accordance with Section 110 of the TSC Act and indicates the sections in this report in which they can be found. *Table 1.2* details the matters to be addressed in this SIS in accordance with the Director General's requirements and indicates the sections in this report in which they can be found. It should be noted that all persons involved with the preparation of this report are suitably qualified. A full copy of the curricula vitae of the team members can be found at *Appendix A*.

Table 1.1 Chapters In This Report Addressing Section 110 of the TSC Act.

Matter To Be Addressed	**Chapter In Which It May Be Found**
(1) A species impact statement must include a full description of the action proposed, including its nature, extent, location, timing and layout and, to the fullest extent practicable, the information referred to in this section.	*1 Refer to EIS for expansion of Possum Brush Quarry (ERM Mitchell McCotter 1997) for further information.*
(2) A species impact statement must include the following information as to threatened species and populations:	
(a) a general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is	4

Table 1.1 Chapters In This Report Addressing Section 110 of the TSC Act.

Matter To Be Addressed	Chapter In Which It May Be Found
likely to be affected by the action,	
(b) an assessment of which threatened species or populations known or likely to be present in the area are likely to be affected by the action,	4
(c) for each species or population likely to be affected, details of its local regional and Statewide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or threat abatement plan applying to it,	4
(d) an estimate of the local and regional abundance of those species or populations,	4
(e) a general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action,	4
(f) (i) *a full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and* (ii) *details of the distribution and condition of similar habitats in the region,*	(i) 2 (ii) 3
(h) a description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development,	7
(i) a full description and justification of the measures proposed to mitigate any adverse effects of the action on the species and populations, including a compilation (in a single section of the statement) of those measures,	4, 6
(j) a list of any other approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population.	1

Note: A number of Section 110 matters have not been included in the above table. This is because the Director General has advised that the following Section 110 matters need not be addressed in this SIS:

- *All reference to endangered populations and endangered ecological communities. The TSC Act does not currently list any relevant endangered populations or ecological communities;*
- *Reference to recovery plans and threat abatement plans in Section 110(2)(c). No recovery plans or threat abatement plans have been approved in accordance with the TSC Act.*
- *Reference to key threatening processes in Section 110(2)(c). The TSC Act does not currently list any key threatening processes;*

- *Section 110 (2)(e). This section is a replication of 110(2)(a);*
- *All reference to critical habitat. There is currently no declared critical habitat in NSW; and*
- *Section 110(2)(g). The matters raised in this section of the act have been clarified by the requirements below* (the Director General's requirements).

Table 1.2 Chapters In This Report Addressing The Director General's Requirements

Matters To Be Addressed	**Chapters In Which They May Be Found**
The Director General instructs that this SIS must meet all the matters specified in Sections 109 and 110 of the TSC Act with the exception of those matters limited on p 1.8. In addition, the Director General requires that the matters described below be addressed. All references used in this SIS have been cited throughout the report and listed in the Reference list.	
1. Description	
The SIS must include the information requested below:	
1.1 The type of action proposed must be detailed, including the timetable for the carrying out of the proposed development and the number of hectares affected. This must include details of the location of any auxiliary infrastructure and all components of the proposed development.	1 and *EIS for Expansion of Possum Brush Quarry (ERM Mitchell McCotter, 1997).*
1.2 A plan of the study area will be provided. This plan will show the location and type of vegetation communities present within the study area and the scale of the plan.	2
1.3 An aerial photograph of the locality (or reproduction of such a photograph) shall be provided, if possible. The aerial photograph should clearly show the study area and the scale of the photograph.	Appendix C
1.4 A topographic map of the locality at a scale of 1:25000 must be provided. This map will detail the location of the proposal, major land tenure units such as parks, reserves and State Forests and areas of high activity such as townships, regional centres and major roads.	Appendix B
1.5 The location of the subject species recorded during the SIS survey must be represented on a map of the study area. Where available, the information provided must include species name, date recorded, name of person who made the record, type of record, use of habitat and number of individuals recorded.	2
1.6 A description of suitable habitat characteristics for subject species in the study area must be provided. Where the habitat of each subject species within the study area can be	2

Table 1.2 Chapters In This Report Addressing The Director General's Requirements

Matters To Be Addressed	Chapters In Which They May Be Found
clearly delineated, this habitat must be represented on a map of the study area.	
1.7 A list of subject species must be provided. In determining these species, consideration shall be given to the habitat types present within the study area, recent records of threatened species in the locality and the known distribution of threatened species. A list of subject species has been provided by the Director General for consideration.	4
1.8 (i) *In describing the study area* (ii) *consideration must be given to previous land uses and the effect of these land uses on the study area. Relevant historical events may include sand mining, fire history, clearing, logging, recreational use and agricultural activities.*	(i) 1 (ii) 5
1.9 (i) *A description of fauna habitat components such as the frequency of tree hollows, density of understorey vegetation and the presence of rock outcrops must be given. The condition of the habitat within the study area shall be discussed, including the prevalence of introduced species.* (ii) *A description of the habitat requirements of threatened species likely to occur in the study area must be provided.*	(i) 2 (ii) 4
1.10. Fauna habitat for subject species must be described with particular reference to which areas are used in the study area and for what purposes these areas are required.	4
1.11 A fauna and flora survey is to be conducted in the study area. Targeted surveys must be conducted for all subject species. Species of taxonomic uncertainty must be confirmed by a recognised authority such as the Australian Museum.	Documented in Chapter 2 and Appendices C and D.
1.12 A full description of the methodologies used in the fauna and flora surveys and habitat assessment must be provided, including survey techniques employed, number and location of traps, size of survey sites, dates of surveys, the time spent on surveys and prevailing weather conditions. Where appropriate this information must be provided in a map format. Where possible, surveys should be undertaken during seasons and climatic conditions during which the subject species are most likely to be detected.	2
1.13 Any areas which may act as corridors between the study area and adjacent areas of likely habitat for subject species shall be identified and described.	2
1.14 A full list of the protected fauna and native plants (as defined by the NP&W Act, 1974) found during the course of surveys must be included. Such information is indicative of the habitat quality of the site.	Appendix F
1.15 The effect of the season and prevailing weather conditions shall be considered with respect to the results of the survey	2
2. Assessment of Likely Impacts	
The assessment matters listed below must be addressed:	
2.1 For all subject species, the SIS shall state the following:	

Table 1.2 Chapters In This Report Addressing The Director General's Requirements

Matters To Be Addressed	Chapters In Which They May Be Found
•) *the location, nature and extent of habitat removal or modification which may result from the proposed action;*	4,5
•) *the potential impact of the removal of modification of habitat; and*	4,5
•) *the likely contribution of the proposed action to the threatening processes acting on populations of those species in the locality.*	5
2.2 *A discussion of other populations of threatened species in the locality must be provided. The long term security of the other habitats must be examined. The relative significance of the subject site for subject species in the local context must be provided.*	3
2.3 *If movement corridors for subject species are present within the subject site, the impact of the proposal on these areas must be discussed.*	2
3. *Amelioration*	
The following issues must be addressed:	
3.1 *While no recovery plans or threat abatement plans have been approved in accordance with the TSC Act as yet, draft recovery plans have been prepared for the species listed in Appendix 2. Where a draft recovery plan is relevant to any subject species, consideration must be given to the information contained in these plans and whether any draft recovery plan recommendation is applicable to the proposal.*	4
3.2 (i) *In discussing alternatives to the proposal, and* (ii) *the measures proposed to mitigate the effect of the proposal, consideration must be given to developing long term management strategies to protect areas within the study area which are of particular importance for the subject species. This may include proposals to restore or improve habitat. The strategy should identify long term objectives for the subject site.*	(i) 1 (ii) 6
3.3 *Any proposed on-going monitoring of the effectiveness of the proposed mitigation measures shall be provided. Details of the methodology of such monitoring must be provided. Details of how the results may modify the proposal must be included.*	6
4. *Additional Information*	
4.1 *In providing a list of other approvals the following shall be included:*	
❑ *any consent required under Part 4 of the EP&A Act 1979 including the name of the consent authority and when it is proposed to make the development application; or*	1
❑ *any approvals required under Part 5 of the Environmental Planning and Assessment Act 1979 including the name of the consent authority(ies), the basis for the approval and when these approvals are proposed to be obtained.*	

1.5.2 *Definitions*

The definitions given below are relevant to this SIS. They are in accordance with the definitions given in the Director General's Requirements.

- **development** has the same meaning as in the EP&A Act 1979;
- **subject site** means the area which is proposed for the development;
- **study area** is the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The ecological impacts of the development are restricted essentially to the subject site; however, in order to ensure all possible impacts were considered, in preparing this SIS the Study Area was regarded as the whole of the continuous land owned by Pacific Blue Metal Pty Ltd (approximately 270 hectares) as shown in *Figure 1.1*;
- **locality** means the area within a 10 km radius of the study area;
- **subject species** means those threatened species which are considered known or likely to occur in the study area;
- **Director-General** means the Director-General of National Parks & Wildlife; and
- **NPWS** refers to the NSW National Parks & Wildlife Service.

Chapter 2

FLORA AND FAUNA SURVEY OF THE SUBJECT SITE AND STUDY AREA

2.1 FLORA SURVEY AND VEGETATION ASSESSMENT

Ecological investigations of the subject site and study area were undertaken over five days and four nights between 9 and 13 September 1996. The bat survey was undertaken during the preceding week. The studies combined investigations for flora and fauna species, with particular emphasis placed on searches for threatened species. A SEPP 44 survey targeting the Koala was also undertaken in February 1996. The results of that survey are contained in *Appendix D*.

2.1.1 *Methodology*

Investigations involved a review of relevant literature, topographic maps and interpretation of 1:25,000 coloured aerial photographs. A National Parks and Wildlife Service data search for threatened flora was obtained for the Camden Haven and Bulahdelah 1:100,000 map sheets. A field survey of the study area was undertaken on 29 February 1996.

The primary objectives of the flora survey were:

- to map and describe the vegetation communities using the classification system of Specht (1981) as a basis;
- to compile a list of the flora occurring on the subject site and study area, identifying any threatened, regionally or locally significant species; and
- to assess the likely impacts of the proposed development and formulate recommendations for minimising its impacts on the flora of the study area.

Vegetation analysis involved a general description of the plant communities using qualitative field observations and interpretation from aerial photographs. The random meander technique was used to identify communities and habitats and involved walking in a random manner through the study area, visiting the full range of potential habitats and recording observed plant species. Plant communities

identified have been classified using the structural characteristics of Specht (1981) as a basis and are illustrated in *Figure 2.1.*

Vegetation communities over the majority of the study area have been described previously by Griffith in the EIS for the original proposal, hence the intention of the field survey was to assess the potential of each vegetation community and fauna habitat to support native flora and fauna populations.

2.1.2 *Results:*

Based on structural characteristics and floristic composition, five main plant communities have been identified on the study area. These communities are:

- Dry Open Forest;
- Depauperate Rainforest;
- Acacia Woodland;
- Grassland; and
- Quarry pit.

i. Dry Open Forest

Canopy Layer: Dominated by Grey Ironbark (*Eucalyptus paniculata*), White Mahogany (*E. acmenioides*), and Grey Gum (*E. propinqua*).

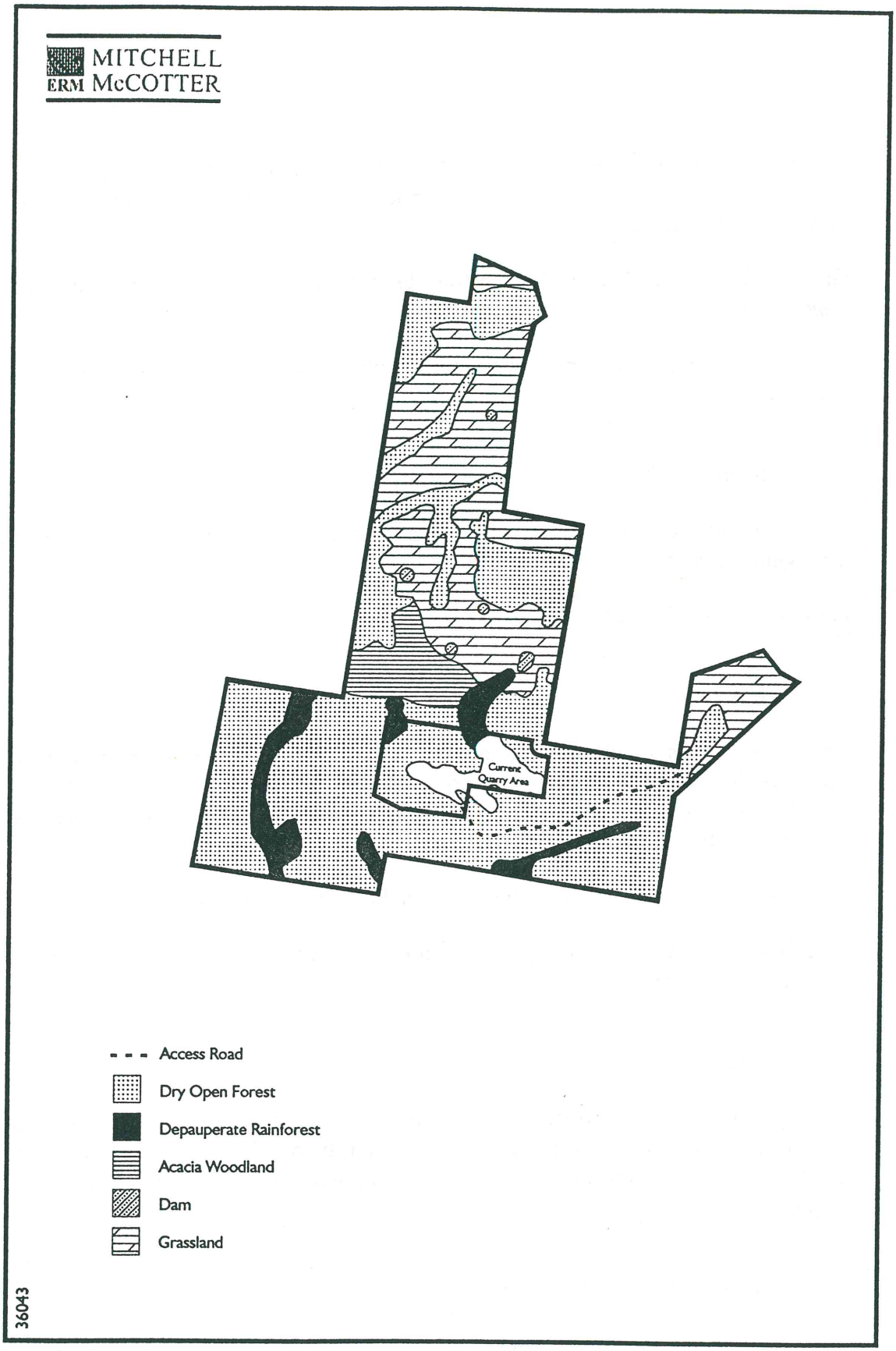
Shrub Layer: Wattle (*Acacia irrorata*), Dogwood (*Jacksonia scoparia*), and Lantana (*Lantana camara*).

Ground Cover: Dominated by Blady Grass (*Imperata cylindrica*), Mat Rush (*Lomandra longifolia*), *Poa sp.* and Kangaroo Grass (*Themeda australis*).

Distribution: This community is generally found on the more exposed hillsides.

ii. Depauperate Rainforest

Canopy Layer: Dominated by Tallowwood (*Eucalyptus microcorys*), Brushbox (*Lophostemon confertus*), Turpentine (*Syncarpia glommulifera*), and Grey Gum (*Eucalyptus propinqua*).



Note: map is conceptual only

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Figure 2.1 VEGETATION COMMUNITIES

Shrub Layer: Dominated by Forest Oak (*Allocasuarina torulosa*). Mesic species such as Brown Myrtle (*Choricarpia leptopetala*) and Brush Kurrajong (*Commersonia fraseri*) occur less frequently.

Ground Cover: This is variable over the site. Heavy infestations of Lantana (*Lantana camara*) occur.

Distribution: This community is predominantly found in sheltered gullies on the study area.

iii. Acacia Woodland

Upper Strata: This community is almost entirely dominated by *Acacia irrorata.* Emergent *Eucalypts* occur occasionally.

Ground Cover: Various grasses.

iv. Grassland

Description: This community is mostly a disclimax community resulting from previous clearing of the forest. It is dominated by grasses, a number of them being exotic pasture grasses. It varies from low to medium height and is sparse due primarily to disturbance by cattle.

Dominant Grass Species: This is highly varied over the study area.

Distribution: This community is distributed over the majority of the northern portion of the study area.

v. Quarry Pit

Description: This community is the area which is part of current quarry operations. The only plant species noted in this community are Lantana *(Lantana camara),* Blackberry *(Rubus ulmifolius)* and a number of climbers and *Eucalypt* seedlings on the slopes.

2.1.3 *Limitations to Flora Survey*

The detection and identification of some flora species was limited due to seasonality and a consequent lack of suitable flowering or fruiting material for some species.

2.2 FAUNA HABITAT ASSESSMENT

2.2.1 *Methodology*

The vegetation communities described above reflect differences in community structure and plant species composition. The majority of animals choose habitat based primarily on structural differences of vegetation communities, rather than detecting specific plant species differences. This, of course, excludes the Koala, which chooses habitat based mainly upon the presence of particular plant species. Structural characteristics include the height of the dominant layer, the number of distinctive layers and the density of vegetation. Many specialised faunal groups may depend upon availability of water and the presence of particular tree or shrub species and specific micro-climatic characteristics to survive. Any activity that changes the structure or cover of vegetation will, in turn, change the faunal habitat characteristics and may result in modifications to the composition of fauna within an area.

2.2.2 *Results*

Four fauna habitats have been identified on the study area, as listed below and shown in *Figure* 2.2.

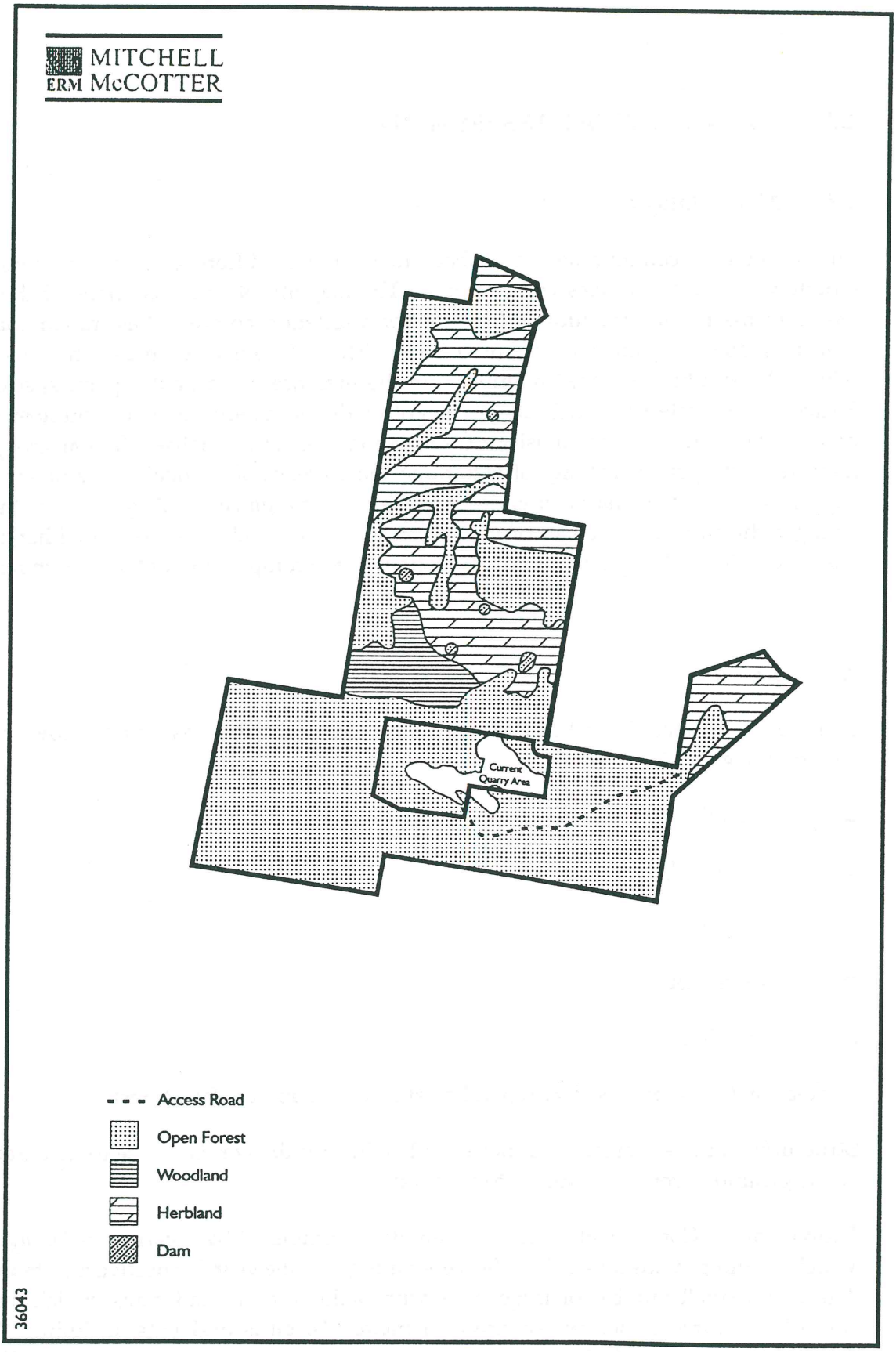
- Open Forest;
- Woodland;
- Herbland; and
- Quarry pit.

i. Open Forest

Vegetation Communities: Dry Open Forest and Depauperate Rainforest.

Structure: An open forest to 30 metres in height. Shrub layer is sparse to moderate, while ground cover is also sparse to moderate.

Fauna Habitat Components: This community is dominated by a variety of *Eucalypts* which would provide a mosaic of flowers throughout the year for nectivorous fauna. There is a small number of large trees with hollows, and dead stags, which may provide a source of shelter for arboreal mammals, birds and bats, including the subject species identified as occurring/likely to occur on the subject site. The presence of Koala feed tree species within this habitat indicates a food source for the



Note: map is conceptual only

N

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Figure 2.2 FAUNA HABITATS

Koala, although no scats or other evidence of the Koala were found during fieldwork. Ground hollows provide a good source of shelter for small mammals and reptiles. A dense layer of ferns and grasses combined with a number of stumps and logs provides good shelter for ground dwelling mammals and reptiles. Thick shrubbery in some areas provides good habitat for small birds. The presence of *Allocasuarinas* provides a good food source for the Glossy Black Cockatoo. Litter layer and ground cover provide shelter for amphibians and reptiles.

Vegetation Condition: The majority of this habitat contains some evidence of human modification through vehicular tracks, timber getting, clearing and rubbish dumping, although large expanses in the western portion of the study area are in a relatively natural condition. Lantana is the most prevalent weed and occurs frequently throughout the majority of this habitat. A number of other exotic weeds are present in low numbers. A fox was observed in this community and a number of black rats were also captured in this community. These factors indicate that the degree of naturalness of this habitat is moderate.

ii. Woodland

Vegetation Communities: Acacia woodland.

Structure: An open woodland to 6 metres in height. This community consists entirely of regrowth, no greater than 6 years of age.

Fauna Habitat Components: An abundance of flowers provides a resource for nectivorous fauna, while gliders may feed on the sap of the Acacias.

Vegetation Condition: The vegetation is generally in a healthy condition, although the community is grazed by cattle.

iii. Herbland

Vegetation Communities: Grassland.

Structure: Open pastureland containing sparsely scattered individual trees.

Fauna Habitat Elements: The abundance of grasses and herbs in this community provides a suitable foraging resource for grazing animals. The denser areas provide suitable shelter for small birds and mammals. The abundance of seeding grass species provides a suitable food source for birds.

Vegetation Condition: This habitat is a result of forest clearing for agricultural purposes, making it a disclimax community.

iv. Quarry Pit

Vegetation Communities: Quarry Pit

Structure: An active quarry which is void of any large areas of vegetation.

Fauna Habitat Elements: The open pit provides a foraging resource for insectivorous birds and bats. The dams provide a sub-optimum resource for reptiles and amphibians.

Vegetation Condition: This habitat is a result of forest clearing for quarrying and associated purposes.

2.2.3 *Movement Corridors*

The forest vegetation of the study area is relatively continuous for approximately 140 ha. It is an island of habitat however, and there are no forested corridors leading to larger expanses of forest outside of the study area. Hence, there is unlikely to be any sustainable movement corridor leading from the forested part of study area. The GTCC SOE Report has not identified any known wildlife or habitat corridors to run through the study area.

2.3 FAUNA SURVEY

A detailed fauna survey was conducted on the study area from 3/9/96 to the 13/9/96. An additional bat survey was undertaken by Greg Richards from the 3/9/96 to the 7/9/96. The survey was designed to assess the fauna occurring in the study area, and in particular was designed to specifically target threatened species known or likely to occur in the study area. Survey sites were stratified according to the broad vegetation types identified in the preliminary investigations and their likelihood of disturbance. The location of sampling sites is shown in *Figure 2.3.*

The fauna investigations aimed to provide the following information:

- the significance of fauna habitats in the local area;
- threatened fauna species utilising the subject site and study area;
- potential constraints to development of the subject site imposed by the presence of fauna species identified; and

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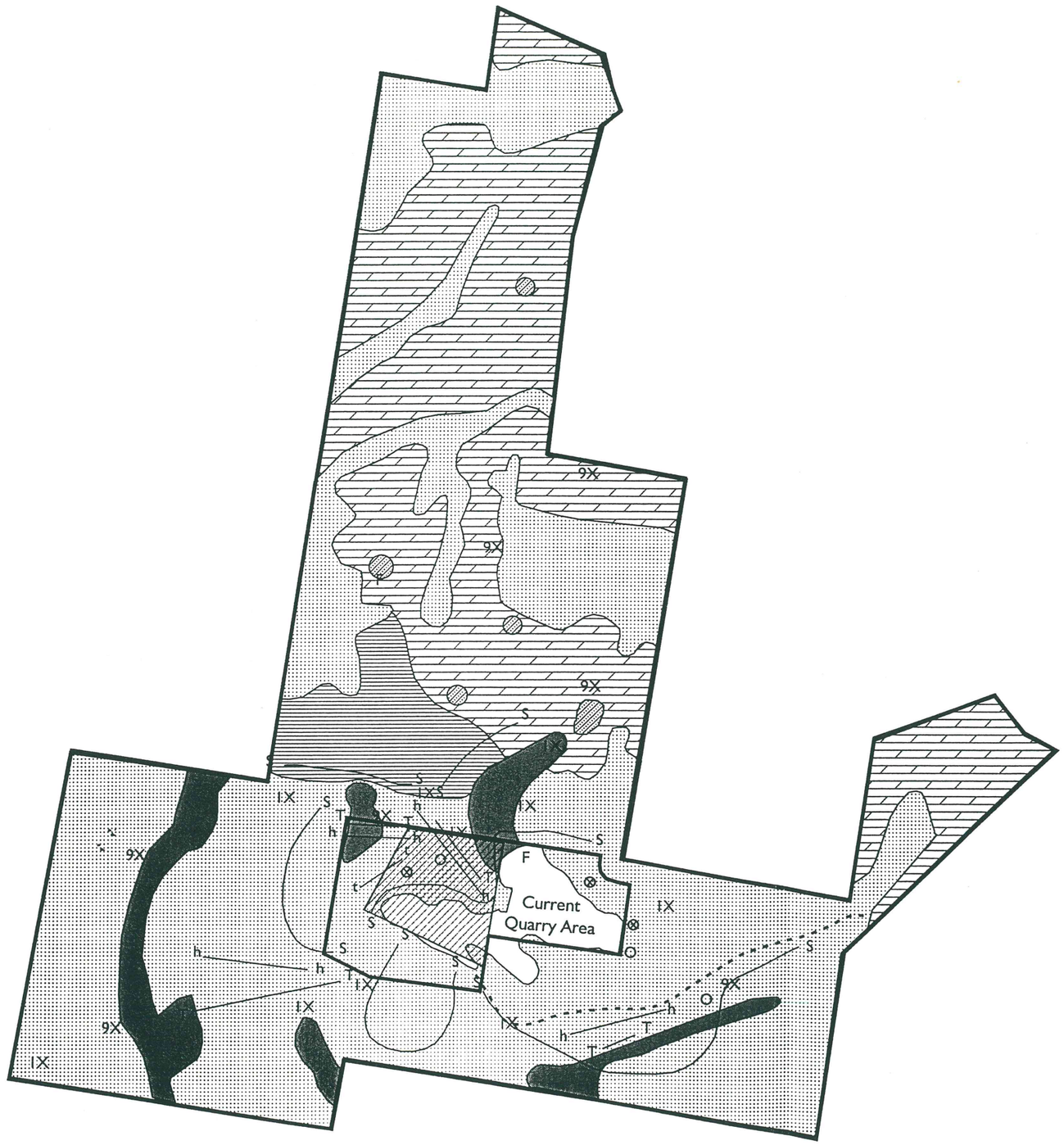


T-T Terrestrial & Arboreal Trapping Site

t-t Terrestrial Trapping Site Only

h-h Hair Tube Line

S-S Spotlight

O Owl Call Playback Site

F Frog Search Site

⊗ Stagwatching Site

1X Bat Sampling Points using Traps & Detectors

9X Bat Sampling Points using Detectors alone

- - - - - Access Road

Dry Open Forest

Depauperate Rainforest

Acacia Woodland

Dam

Grassland

Subject Site (Surface disturbed component only)

N

0 1km

metres

Note: map is conceptual only

Figure 2.3 FAUNA SURVEY SAMPLE SITES

- the effects of the proposed development on threatened fauna known or expected to occur on the subject site and study area.

2.3.1 *Methodology*

Investigations for the presence of fauna species involved a number of direct and indirect methods, including the following:

- trapping for terrestrial and arboreal mammals;
- stagwatching and spotlighting for terrestrial and arboreal mammals and birds;
- morning observations for diurnal birds;
- nocturnal playback calls for threatened owl species, followed by spotlighting;
- spotlighting and call identification for amphibians;
- use of hair tubes over a period of 12 nights for terrestrial and arboreal mammals; and
- searches for indirect evidence of fauna, such as scratch marks, scats, diggings and burrows.

In addition, species opportunistically sighted while undertaking other activities were recorded. The methods used to determine the fauna assemblage and target specific species are described below.

i. Birds

Diurnal Bird Survey

The diurnal census of birds involved foot traverses over the study area for approximately 1 hour between 0530 and 0930 hours each day, with a total of four hours being dedicated to diurnal bird census. Regular stops between five and ten minutes were made to listen to and observe all bird species present. All habitats were sampled, with sampling being undertaken along the trapping, hair tube and spotlighting lines. These are illustrated in *Figure* 2.3. During the period of the survey sunrise occurred at approximately 0500 hours.

Nocturnal Bird Survey

Stagwatching of mature and dead trees with suitable hollows was undertaken at dusk for a period of half an hour to identify any owl species which may depart the hollow.

Playbacks of pre-recorded owl vocalisations were made for approximately half an hour each night, based upon the procedures of Kavanagh and Peake (1993) and Debus (1995). Playbacks of the calls of all threatened owl species which may occur in the study area were made with a 16 watt portable loud hailer over the study area. Calls of each species were broadcast for a period of five minutes, coupled with short periods of quiet listening for any vocal response from the owls. Following playback calls, a period of 15 minutes quiet listening for vocal responses, and 15 minutes spotlighting the area was undertaken. Playback calls of arboreal marsupials, including the Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*), were also broadcast to attract owls to the area for identification.

Searches for characteristic whitewash caused by owls using a regular roost or nest were made, in combination with searches for regurgitation pellets. Both of these are indirect evidence of the presence of owl species.

The location of owl broadcasting sites and stagwatching sites is indicated in *Figure 2.3*.

ii. Mammals

Mammals were surveyed using a range of direct and indirect techniques. The direct survey technique used for each faunal group are outlined below. Indirect methods used included collection and analysis of scats, observation of diggings, tracks and burrows, and identification of vocalisations.

Small Terrestrial Mammals

Small terrestrial mammals were surveyed using two methods, ie. trapping and hair tubes.

Trapping was undertaken over four nights using Elliott Type A traps (8 x 10 x 33 cm) and Elliott Type B traps (15 x 16 x 45 cm) baited with a mixture of peanut butter, rolled oats and honey. The location of trapping lines is indicated in *Figure 2.3*. In total, 200 terrestrial Elliott A, 80 terrestrial Elliott B and 8 cage trap nights were undertaken for the project.

Traps were spaced approximately five to 10 metres apart and positioned next to logs and fallen branches, animal diggings, tree trunks and visible animal runways. Each trap was placed inside a plastic bag to maintain dry conditions in the event of rain, heavy dew or frost. Traps were checked as soon as possible after sunrise on each morning.

Hair tubes were used to census the presence of small terrestrial and scansorial mammals. Hair tubes allow the sampling of mammals to be undertaken through the collection of animal hairs without trapping specimens.

Hair tubes were placed on selected logs and stumps on the ground. Each hair tube was baited with a mixture of peanut butter, honey and rolled oats and left for a period of 15 consecutive nights. A total of 18 terrestrial hair tubes were set up in forested remnants, resulting in a total of 210 tube nights. The location of the four tube lines is indicated in *Figure* 2.3. Examination of hair tubes was undertaken by Barbara Triggs, an expert in the analysis of hair samples.

Medium and Large Terrestrial Mammals

Medium and large terrestrial mammals were surveyed with cage traps, hair tubes and spotlighting.

One cage trap was set for four nights in the Dry Open Forest within Block B of the quarry site. One other cage trap was set for four nights in the Dry Open Forest in the western portion of the study area along the Terrestrial Mammal trapping line. Both cage traps were baited with meat as well as a mixture of peanut butter, rolled oats and honey. The cage traps were checked each morning after sunrise.

18 hair tubes were set up for 15 nights in forested remnants as detailed previously. The location of the four hair tube lines is indicated in *Figure* 2.3.

Searches were made for indirect evidence to suggest the presence of medium and large terrestrial mammals, including searches for scats and examination of burrows, tracks and diggings. Spotlighting for large terrestrial mammals was also undertaken in conjunction with arboreal mammal and nocturnal bird spotlighting. A total of one and a half hours of spotlighting from a car using a 100 Watt spotlight was undertaken.

Arboreal Mammals

Arboreal mammals were surveyed using five direct techniques, namely trapping, spotlighting, use of hair tubes, stagwatching, playback of characteristic vocalisations, and a Koala habitat assessment in accordance with SEPP 44.

Arboreal trapping is a useful adjunct to other survey methods, particularly when surveying for cryptic species such as Squirrel Gliders, which are often difficult to observe and rarely vocalise (Menkhorst *et al.*, 1988).

Trapping for possums and gliders was undertaken using Elliott Type B traps mounted on platforms using a methodology adapted from Meggs *et al.* (1991). The location of arboreal mammal trapping sites is indicated in *Figure 2.3*. A total of 80 trapping nights was undertaken for arboreal mammals.

Traps were baited with a mixture of peanut butter, rolled oats and honey. A honey-water mixture was sprayed on the main trunks (boles) above and below traps to attract arboreal and scansorial mammals to the traps.

Tree mounted traps were generally inclined at an angle of approximately ten degrees above horizontal to facilitate drainage, and all traps were positioned as close as possible to the south-west side of the bole to allow shading from the morning sun. Traps were enclosed within plastic bags to maintain dry internal conditions in the event of rain.

Spotlighting searches were undertaken on foot across the study area and environs for a total of approximately 16 person hours. Two 55 Watt spotlights were used, and occasionally switched off for short intervals to allow quiet listening in darkness to detect any animal movements or vocalisations. Trees with hollows were targeted, especially immediately after dark because of the increased chance of animal activity around that time.

Playbacks of pre-recorded calls of the Yellow-bellied Glider, Squirrel Glider and Koala were made using a loud hailer. This was done in an attempt to elicit a vocal response from cryptic arboreal mammals. Stagwatching involves the quiet observation of potential nest trees at dusk to detect any animal movements. Stagwatching for approximately half an hour was undertaken at dusk for three nights. During the survey period sunset occurred at approximately 1800 hours.

Bats

Both michrochiropteran and megachiropteran bats were sampled in the study area. A trap/net array was used to sample microchiropterans, along with electronic detector systems. The megachiropterans were sampled using spotlighting transects. Details of the methodology used to sample bats is given in *Appendix G*.

iii. Reptiles and Amphibians

Reptiles

Diurnal searches for reptiles were undertaken across the study area while undertaking other activities, such as vegetation assessment. Searches were made beneath ground litter, such as scrap metal and sheets of iron, fallen timber, leaf litter, decorticated bark, stones and tufts of vegetation. It should be noted that temperatures in early September are typically too low for reptile activity. Thus locating reptiles during the survey period proved difficult.

Amphibians

Nocturnal searches for amphibians were conducted within the study area and environs. Searches involved spotlighting along drainage lines, waterlogged areas and dams, and quiet listening to identify calls and their location. Approximately three person hours of amphibian survey was undertaken. The location of nocturnal amphibian search sites is shown in *Figure 2.3.*

2.3.2 *Results*

i. Birds

A high number of diurnal birds were recorded on the study area. A full list of all birds sighted during the survey is provided in *Appendix F.*

ii. Mammals

A moderately high number of small terrestrial mammals were captured during the survey. A relatively high number of Sugar Gliders and Common Brushtail Possums were observed on the study area during the survey. Two Brush-tailed Phascogales were sighted together on a single tree in Block B. A number of bat species were also detected. A full list of mammals detected/captured during the survey is listed in *Appendix F.*

iii. Reptiles and Amphibians

The level of reptile and amphibian activity was found to be generally low due to climatic conditions. One reptile was sighted this being the Copper Tailed Skink (*Ctenotus taeniolatus*). Three frog species were identified. There are the Eastern

Dwarf Tree Frog (*Litoria fallax*), the Brown Froglet (*Crinia signifera*) and the Striped Marsh Frog (*Limnodynastes peronii*). The Brown Froglet and the Striped Marsh Frog were heard calling from dams on the study area. The Eastern Dwarf Tree Frog was heard throughout the survey (both day and night) in the forested areas, the grassland and from the dam on the study area.

2.3.3 *Weather Conditions*

Night temperatures measured around midnight were in the range of 12 - 17°C, and the minimum daily temperatures from radio reports were not below 10°C during the survey period.

2.3.4 *Limitations of Fauna Survey*

The fauna survey was undertaken during the period 3/9/96 to 13/9/96, and the bat survey during the period 3/9/96 to 7/9/96. The possible presence of threatened fauna was determined primarily on the likelihood of suitable habitat on the subject site and study area. The fauna survey was conducted to the fullest extent possible within the scope of the project, and was intended to focus on the detection of those species considered likely to utilise the habitat.

2.4 SIGNIFICANT FLORA AND FAUNA IDENTIFIED

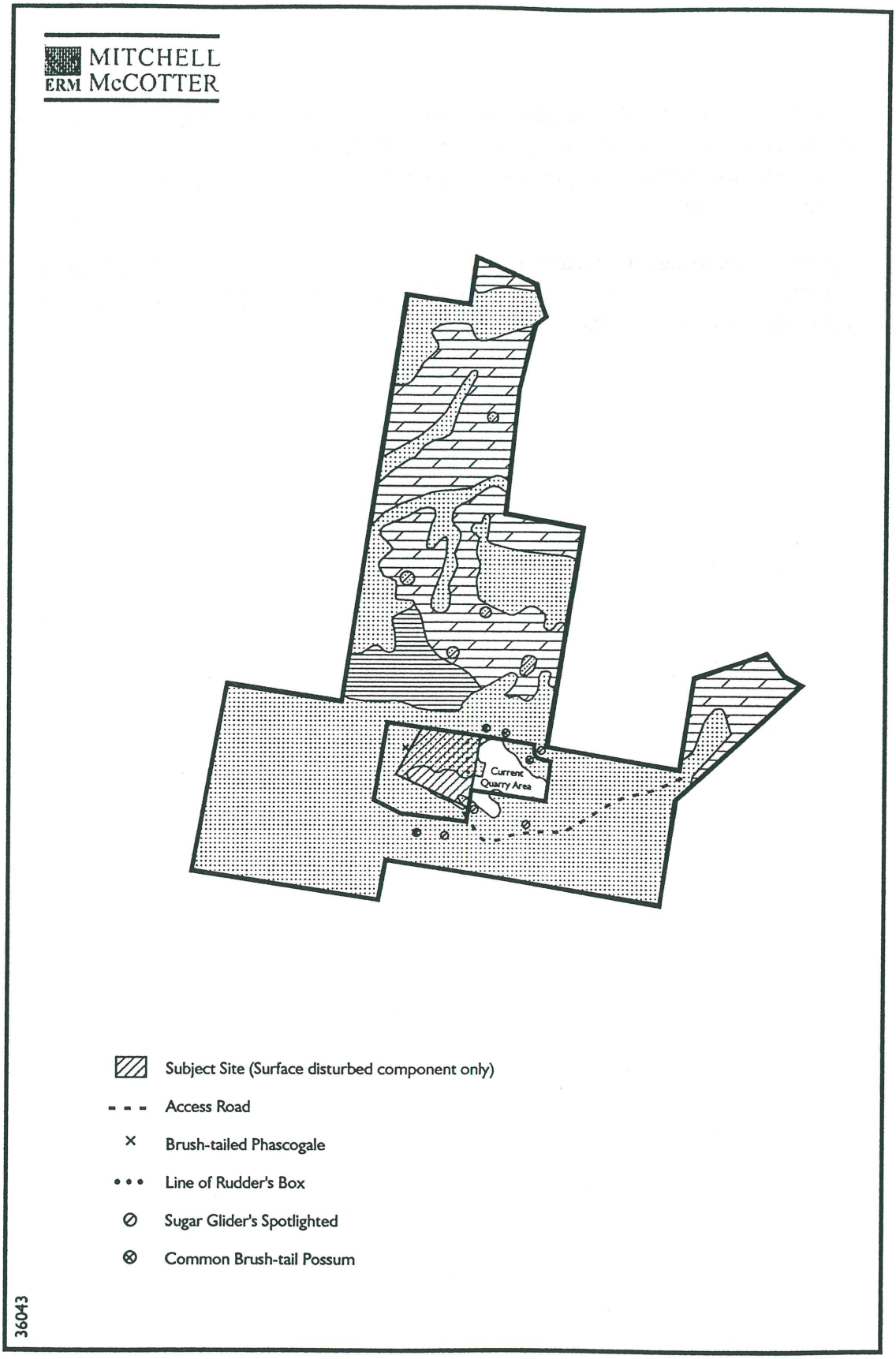
Brush-tailed Phascogale: Two Brush-tailed Phascogales were sighted in Block B using a spotlight, while undertaking the fauna survey. These individuals were sighted foraging on the same tree by Nicole Barkwill, one of the environmental scientists undertaking the fauna survey. Two other environmental scientists (Lisa Brown and Don Owner) were present to verify Nicole's sighting. The CVs of Nicole, Lisa and Don may be found at *Appendix A*.

Glossy Black Cockatoo: No Glossy Black Cockatoos, or evidence of Glossy Black Cockatoos were sighted during the fauna survey in September 1996. A number of Glossy Black Cockatoos were recorded foraging in the gully transects in the study area by Debus, S. in December 1984.

Rudder's Box: Three large individuals of this species were identified on the eastern boundary of Block B. These were identified by Lisa Brown, one of the environmental scientists undertaking the fauna survey. Two other environmental scientists (Nicole Barkwill and Don Owner) were present to verify Lisa's identification. Griffith, S. also identified this species in the study area during a field survey in December 1984.

Little Bent-wing Bat and Large Bent-wing Bat: These two species were both recorded in the Moist Open Forest during September 1996. These individuals were recorded by G. C Richards. *Appendix G* provides more detail on the methodology used to identify these individuals.

Figure 2.4 illustrates the location of the significant flora and fauna identified during the most recent field survey. *Appendix G* illustrates the location of the significant bat fauna identified during the study.



Note: map is conceptual only

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Figure 2.4 SIGNIFICANT FLORA & FAUNA LOCATIONS

Chapter 3

STUDY REGION AND LOCALITY

3.1 DESCRIPTION OF THE STUDY REGION

A detailed description of the study region has been provided in this chapter to allow the existence of threatened fauna and flora habitat on both a broad and detailed scale to be examined. Particular emphasis has been placed on the existence of vegetation communities in the region which provide similar habitat to that found on the subject site and study area.

3.1.1 Biogeographic Regions

i. Interim Biogeographic Regionalisation according to Thackway and Cresswell, 1995.

The Australian Nature Conservation Agency (ANCA) has developed a system of interim biogeographic regionalisation for Australia (IBRA). This system was developed for the purpose of establishing a national comprehensive system of parks and reserves. A biogeographic region can be defined as *"a complex land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout."* (Thackway and Cresswell, 1995). A biogeographic region describes the dominant landscape, scale of climate, lithology, geology, landforms and vegetation. IBRA has been derived by a combination of expert field ecological knowledge and interpretation of existing State and Territory regionalisations. In May 1996 the Director General of NPWS gave notice that pursuant to section 4 (1) of the TSC Act 1995, and section 4 (6A) of the EP&A Act 1979, the national system of biogeographic regionalisation, identified in Thackway and Cresswell (1995), is appropriate for the purposes of the provisions in which the term *'region'* is used.

Biogeographic regions provide a framework for summarising patterns, aggregating information and allocating resources and priorities in Nature Conservation. They are an 'ecologically meaningful' approach to defining a region, as they are based upon a conceptual model which seeks to describe and explain regional patterns of biological diversity and productivity. For the purposes of this report, the NSW North Coast Region (as defined by Thackway and Cresswell, (1995)), has been chosen as the biogeographic region used for determining the broader regional significance of the subject site and study area.

This region has been given the IBRA code NNC and the IBRA name NSW North Coast. The boundaries of this region are illustrated on the map "Boundaries of IBRA Regions", ANCA, 23 March 1995, Map Version 4.0 and are shown in *Figure 3.1.*

ii. The Biogeographic Region according to Specht et. al., 1995

An assessment of the conservation status of plant communities has been carried out by Specht *et al,* 1995. Vegetation lists for the whole of Australia have been examined on a grid basis with 921 major and minor plant communities objectively defined. Distribution of these communities and location of conservation reserves containing these communities are mapped including an appraisal of the conservation status of each plant community.

Floristic data has been analysed by CSIRO computer program TWINSPAN. Biogeographic regions within Australia have been determined from analysis of TWINSPAN floristic groups recorded in 1° latitude and 1° longitude cells across Australia. The region in which the subject site is contained is defined as Eastern 2 (E2) as shown in *Figure 3.2.* This region covers the coastal areas and part of the tablelands areas of NSW.

3.1.2 Smaller Regions

Because biogeographic regions are very large, covering the entire northern NSW Coast and beyond, the level of detail in describing habitats is broad. For this reason, two other regional areas have been defined to assess the representativeness and reservation of habitat on a more detailed scale. These regional areas are the southern area as defined by Benson and Hager (1994) and the local government areas of Greater Taree City Council and Great Lakes Shire Council as described below.

i. The Southern Zone according to Benson and Hager, 1994

The southern zone of the North Eastern NSW Forest Plant Communities as described by Hager and Benson (1994), has been used in this report as a smaller regional area. In the north, this area is defined by a line which runs down the Oxley Highway to Yarrowitch and passes through Werrikimbe National Park to Crescent Head. In the west, the region is defined by the New England Highway while the southern and eastern boundaries are defined by the Hunter River and Pacific Ocean respectively. An illustration of this area is given in Benson and Hager, 1994 and is shown in *Figure 3.3.*

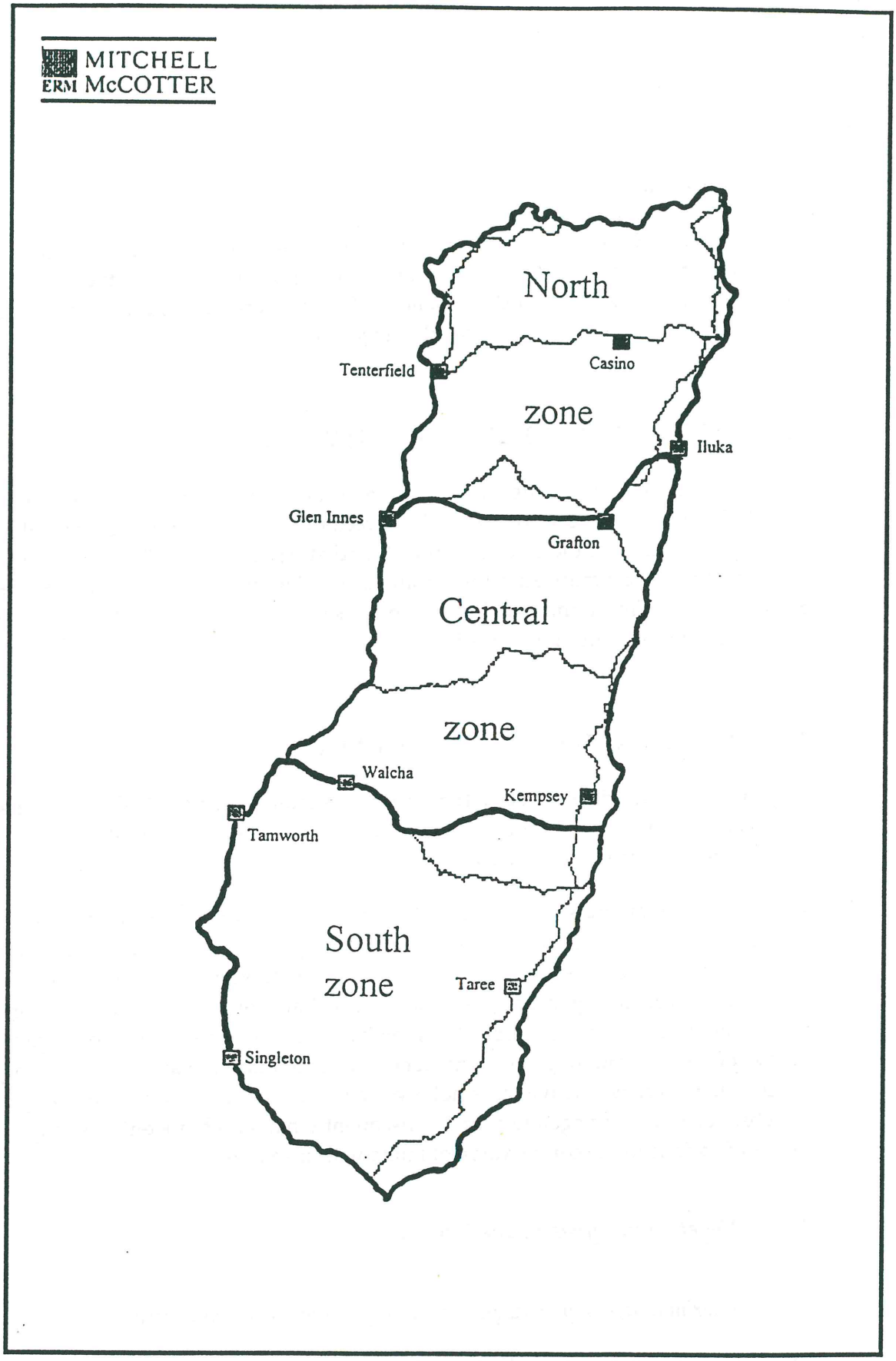


Figure 3.3 GEOGRAPHIC ZONES FOR NORTHERN NSW. SOUTH ZONE IS THE REGIONAL AREA IN WHICH THE STUDY AREA IS FOUND

ii. Immediate Region

The combined boundaries of the local government areas of Great Lakes and Greater Taree have been used to define the immediate region surrounding the subject site. Definition using these boundaries allows for ease and accuracy in collation of information . This region is illustrated in *Figure 3.4.*

3.2 DESCRIPTION OF THE LOCALITY

The locality is defined as the area within a 10 kilometre radius of the subject site. This definition is in accordance with the Director General's requirements for the SIS. A topographic map of the locality can be found at Appendix B. This map shows the location of areas of significance for threatened species, parks, reserves, forestry areas, SEPP 14 areas, Environmental Protection Zones, land tenure and the recording of threatened species within the locality.

3.3 REGIONAL HABITAT RESERVATION

Vegetation communities reflect differences in community structure and plant species composition. The vegetation communities and habitats on the study area and subject site are discussed in Chapter 2.

The majority of animals choose habitat based primarily on structural differences of vegetation communities, rather than detecting specific plant species differences. This, of course excludes the Koala, which chooses habitat based mainly upon the presence of particular plant species. Structural characteristics include the height of the dominant layer, the number of distinctive layers and the density of vegetation. Many specialised faunal groups may depend heavily upon the availability of specific habitat characteristics such as tree hollows, to survive. Any activity that changes the structure or cover of vegetation and consequently habitat characteristics may result in modifications to the composition of fauna within an area.

3.3.1 *Vegetation Types in the Region*

i. Interim Biogeographic Regions according to Thackway and Cresswell, 1995.

Thackway and Cresswell (1995) have determined the reservation status within each interim biogeographic region by calculating the relative area of each region conserved in protected areas. The NSW North Coast (NNC) biogeographic region covers 60,794 square kilometres. The Queensland component accounts for 2,604

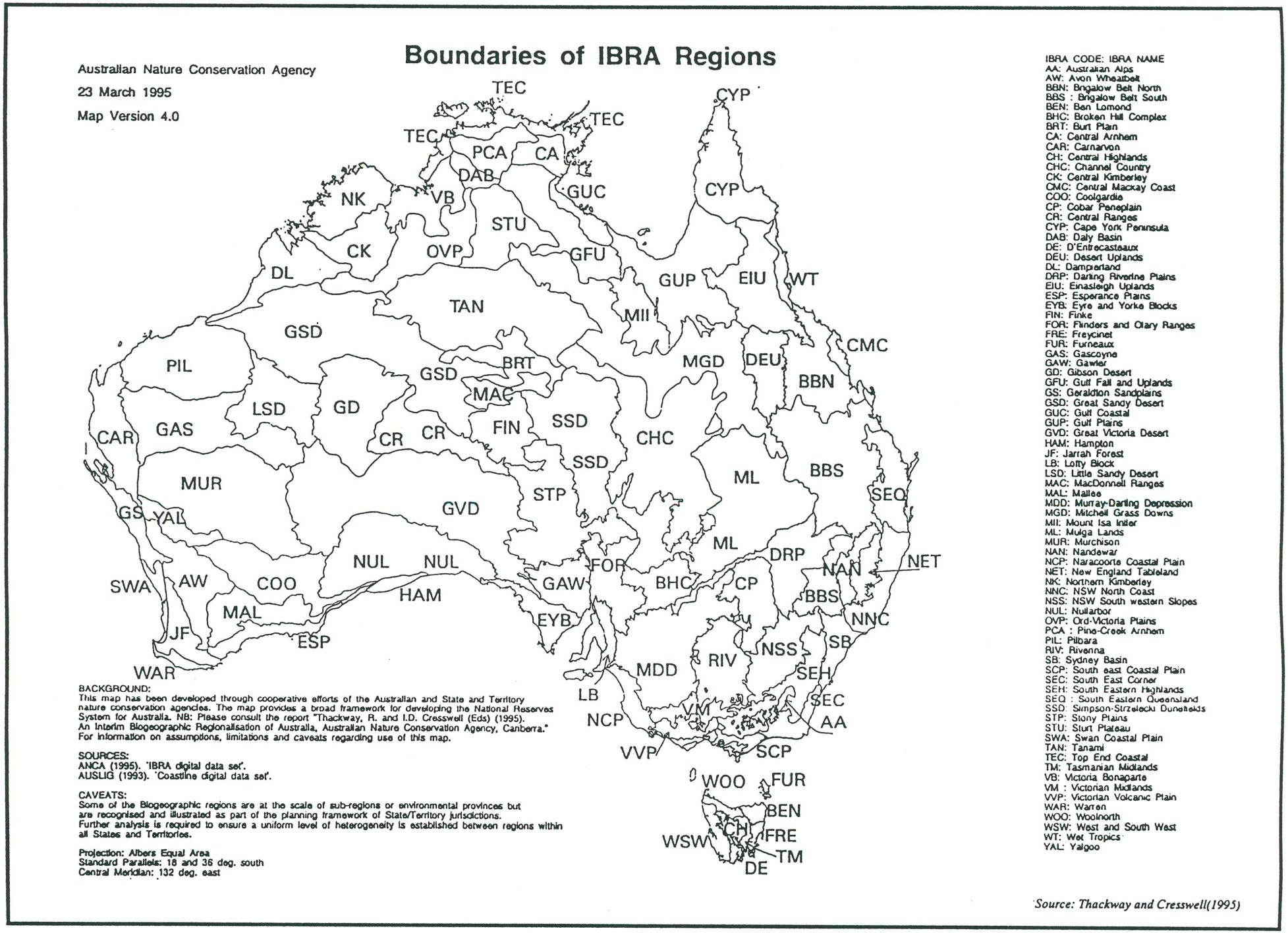


Figure 3.1 BIOGEOGRAPHIC REGIONS IBRA, NNC (NSW NORTH COAST) IS THE REGION IN WHICH THE STUDY AREA IS FOUND

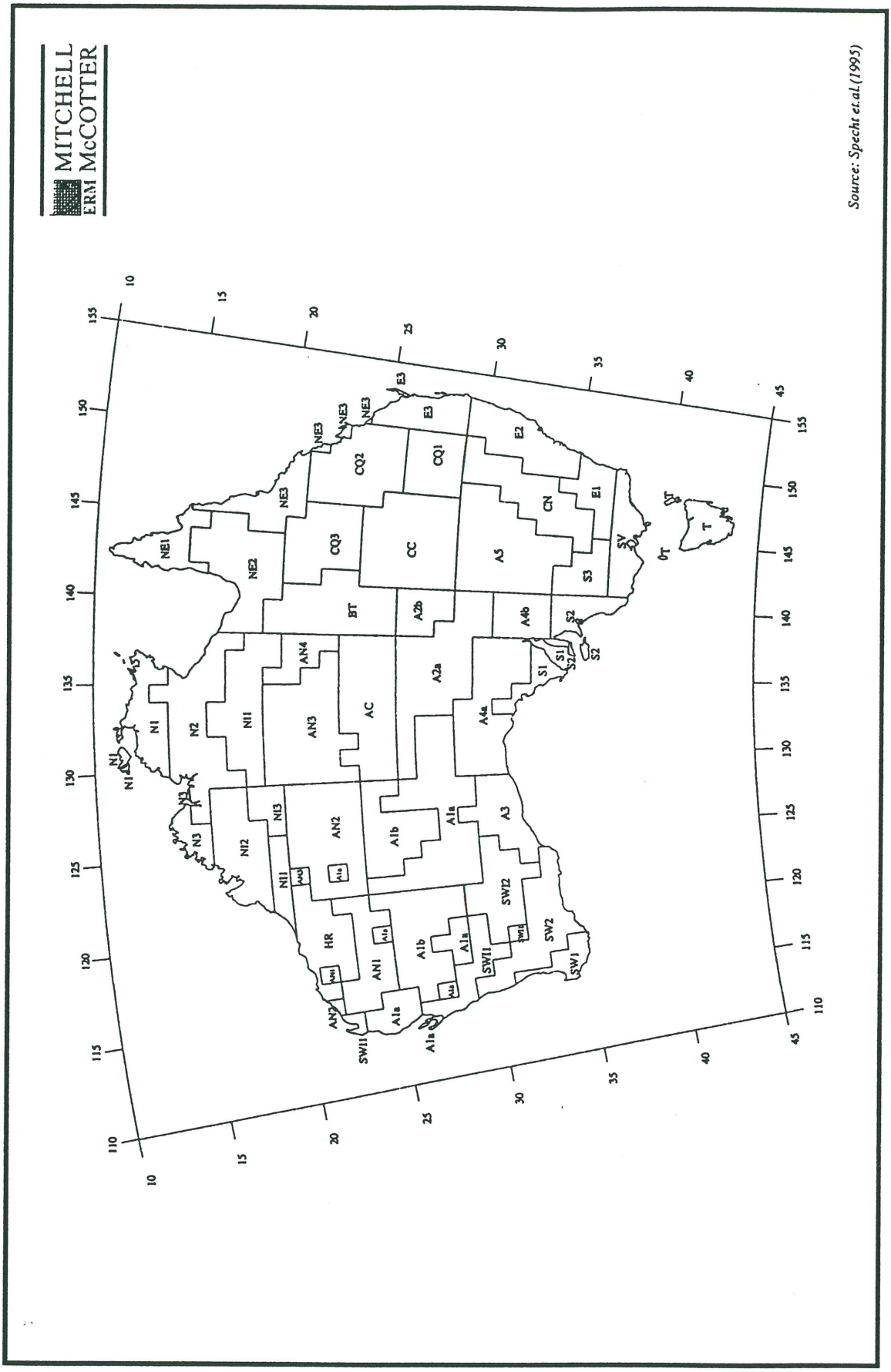
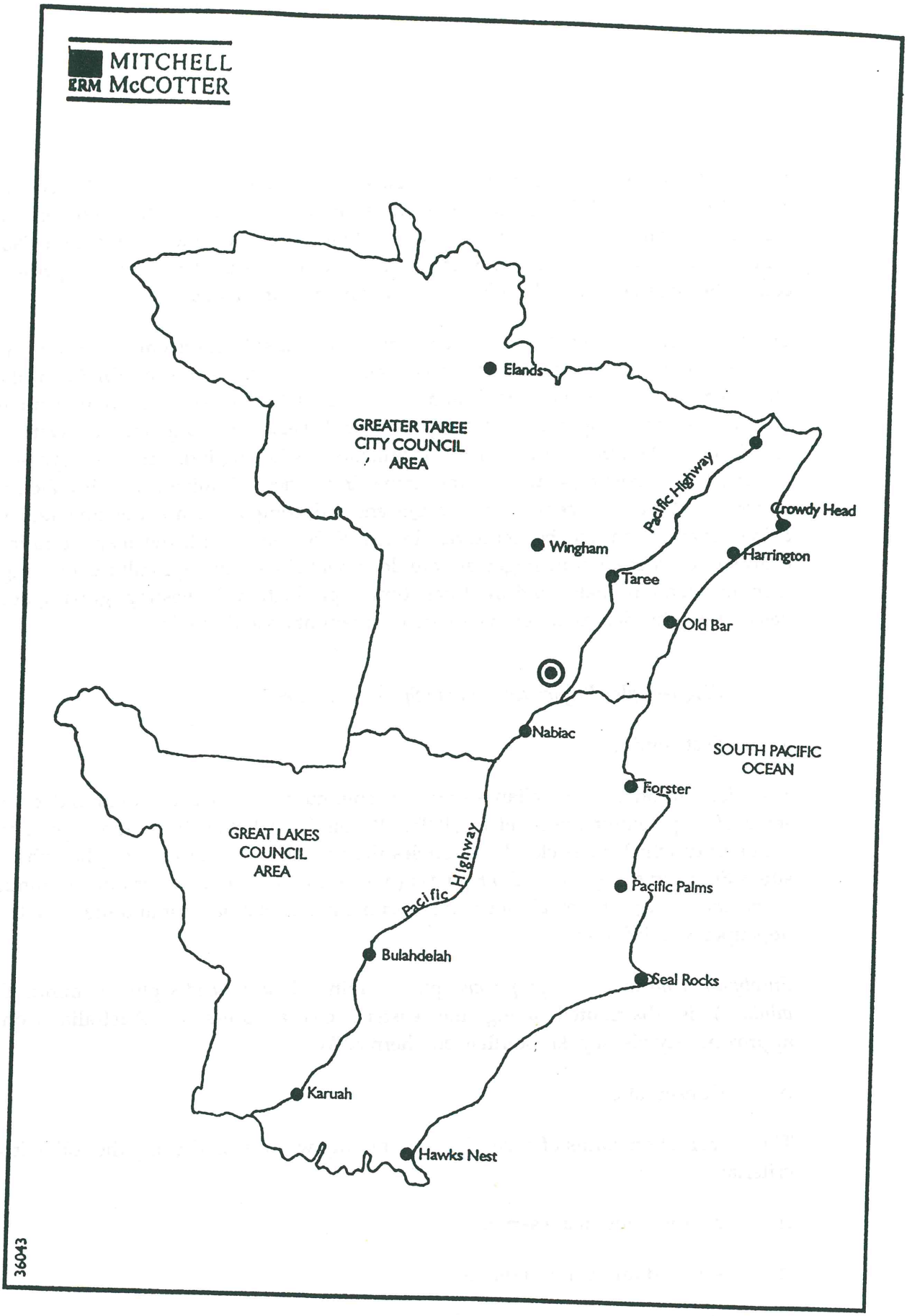


Figure 3.2 BIOGEOGRAPHIC REGIONS (FROM SPECHT et. al. 1995). E2 (EASTERN REGION 2) IS THE REGION IN WHICH THE STUDY AREA IS FOUND



Study Area *(not to scale)*

Figure 3.4 IMMEDIATE REGION

N

0 20km
metres

square kilometres of this area, while the NSW component amounts to 58,189 square kilometres. In the NNC region, reserved areas account for 5-10% of the total area. In considering this data, it should be noted that Thackway and Cresswell (1995) acknowledge that the current system of protected areas does not comprise a comprehensive sample of the variety of environments and landscapes.

Thackway and Cresswell (1995) document the dominant ecosystem condition and limiting factors and constraints to conservation management of each IBRA. In the NNC region, the dominant ecosystem condition of the Queensland component is documented as being 'modified ecosystems with very few indigenous ecosystems remaining'. The NSW component is documented as having indigenous ecosystems present but co-existing with pastoral/timber industries. Dominant limiting factors to conservation management in the Queensland component are documented as being urbanisation and horticulture. In the NSW component, the major limiting factors to conservation management are documented as being agriculture, clearing, cropping, feral animals, wildfire, forest timber production/harvesting, grazing and pastoral use, horticulture, mining, tourism, urbanisation and weeds.

ii. Biogeographic Region according to Specht et. al. 1995

a. Distribution

The distribution of Australian vegetation communities has been identified on a series of maps within Specht *et. al.* (1995). Within Specht et al (1995), the vegetation community which most closely resembles the Dry Open Forest type on the subject site is *Eucalyptus paniculata - E. propinqua* (plus or minus *E. acmenioides* plus or minus *E. pilularis*). Specht et al does not document any similar communities to the depauperate rainforest.

Eucalyptus paniculata - E. propinqua (plus or minus *E. acmenioides* plus or minus *E. pilularis*) is distributed along the eastern coastal areas of Australia from approximately Hervey Bay south to southern NSW.

b. Conservation

The conservation status of each plant community was assessed using the following criteria:

- conservation in a reserve;
- size and number of reserves;
- diversity of plant communities in the reserve; and

- representation in all biogeographic regions in which it occurs.

Conservation of *Eucalyptus paniculata - E. propinqua* (plus or minus *E. acmenioides* plus or minus *E. pilularis*) is poor (Specht *et al*, 1995), with this community being conserved in only 1 or 2 small reserves probably subject to human pressure. The range of biogeographic regions is not represented and ecological diversity is usually not present within these reserves. Within the E2 region the 2 reserves in which the *Eucalyptus paniculata - E. propinqua* (plus or minus *E. acmenioides* plus or minus *E. pilularis*) community is found have a total area of 17,740 hectares.

iii. The Southern Zone according to Benson and Hager, 1994.

Benson and Hager (1994) have undertaken an assessment of the conservation status of forest plant communities in north eastern NSW. *Table 3.1* outlines the conservation status of the associations found within the plant communities on the study area and subject site. The condition of these associations is not described by Benson and Hager, however since these reserves are managed for conservation purposes it could be reasonably expected that the majority would be diverse and natural.

Griffith (1993) describes the conservation status of coastal plant communities in Northern NSW. He indicates that *Eucalyptus pilularis* forests are widespread on bedrock substrates on the North Coast. Coastal reservations in which this community occurs includes Hat Head National Park, Limeburners Creek Nature Reserve, Crowdy Bay National Park, Booti Booti National Park and Myall Lakes National Park. This community occurs on both sandy substrates and bedrock substrates within these reserves.

Griffith (1993) also describes *Eucalyptus grandis* wet sclerophyll forests as widespread on the north coast in moist bedrock gullies association. Coastal reservations in which this community occurs includes Limeburners Creek Nature Reserve, Crowdy Bay National Park and Booti Booti National Park. This community occurs on both sandy substrates and bedrock substrates within these reserves.

Table 3.1 Conservation of Forest Plant Communities in Southern Region of North East NSW

Community	Species Present	Association - Benson and Hager	State Forest Type	Samples in NPWS Reserves	Samples in State Forest Reserves	Proportion conserved in Southern Zone	Conservation Status
Dry Open Forest	Dominant: *E. paniculata, E. acmenioides, E. propinqua.*	*E. acmenioides*	60	1	5	LT5	2
		E. acmenioides - E. propinqua		1			2
		E. propinqua	62	1	5	LT1	1
Depauperate Rainforest	Dominant: *Eucalyptus microcorys, E. propinqua, Lophostemon confertus and Syncarpia glomulifera.*	*Lophostemon confertus*	53	7	9	LT5	2
		L. confertus - Eucalyptus microcorys		1			2
		Syncarpia glomulifera	49	0	1	LT1	1
		Eucalyptus propinqua	62	1	5	LT1	1
		E. microcorys	45	3	0	LT25-GT25	4

Source: Benson and Hager (1994).

Notes: LT1, LT5, LT10, LT25 = Less than 1%, 5%, 10% or 25% conserved respectively; GT25 = >25% conserved.

Conservation Codes: 1 = Not/Poorly Conserved; 2 = inadequately conserved over all its range, 4= adequately conserved.

iv. Immediate Region

Within the immediate region a number of reserves exist within both State Forests and National Parks. The type, location, size and condition of these reserves are outlined below. In addition, a number of State Forests exist within the immediate region. The type, location and size of these forested areas, including the forest types present within these forests are also discussed below.

It is recognised that native vegetation units exist within freehold ownership. These areas are not discussed on a regional level due to the uncertainty associated with the medium to long term security of these units.

a. Greater Taree Local Government Area

State Forest Flora Reserves

Rowleys Rock Flora Reserve

Location: Bulga State Forest and Dingo State Forest.

Area: 146 ha.

Altitude: 600-1018m.

Climate: Temperate. Annual rainfall approx 1600mm. Occasional winter snowfalls.

Major Vegetation Types: Equal areas of rainforest and eucalypt forest. The rainforest is documented as being mostly Booyong subtropical type with a strong infusion of species more typical of warm temperate rainforest and small areas of depauperate rainforest. Eucalypt types vary from dry to tall wet sclerophyll forest, with more typical species including Blackbutt, Tallowwood, Sydney Blue Gum, New England Blackbutt and Silvertop Stringybark. This reserve contains similar habitat to that found on the study area.

Vegetation Condition: This reserve is mostly diverse and natural. Weed species are scarce and disturbance is minimal.

Rudders Box Flora Reserve

Location: Kiwarrak State Forest.

Area: 31ha.

Altitude: 100-200m.

Climate: Warm temperate; rainfall approx 1200mm per annum. Light winter frosts.

Major Vegetation Types: Flooded Gum is present along gullies with a rainforest understorey. A Narrow-leaved White Mahogany, Red Mahogany, Grey Ironbark, Grey Gum forest type occurs on the slopes, while a Grey Gum, Grey Ironbark, White Mahogany forest type occurs on the ridges. An ecologically significant feature of this reserve is the presence of Rudder's Box scattered in a range of sizes through all of the forest types in this reserve. State Forests (1989) state that Rudder's Box is of limited general distribution, with its major centre of occurrence in and around Kiwarrak State Forest. This reserve contains similar habitat to that found on the study area.

Vegetation Condition: This reserve is diverse and natural. Weed species are scarce and disturbance is minimal.

NPWS Reserves/National Parks

Crowdy Bay National Park

Location: Stretching from Crowdy Bay to Dunbogan.

Area: approximately 8,022 hectares.

In 1992 Griffith undertook a survey and study of the vegetation of Crowdy Bay National Park. Methods included air photo interpretation and the sampling of vegetation in transects along gradients. The majority of the park falls within Greater Taree City Council Local Government Area, while only a small portion in the north falls within Hastings Shire Council Local Government Area. Griffith (1992) documents 10 formations, 3 complexes and 13 subformations for the park which covers 54 vegetation communities. There is currently no written data on the total of each vegetation community in Crowdy Bay National Park, however a general idea may be gained from the vegetation map in Griffith's report. The following communities (which are actually documented as sub-formations where a community represents an alliance) are present.

- littoral rainforest dominated by *Cupaniopsis anacardioides* and *Lophostemon confertus;*
- mangrove forest and woodland dominated by *Avicennia marina;*
- wet sclerophyll forest dominated by *Eucalyptus grandis* and *E. pilularis;*
- dry sclerophyll forest and woodland dominated by *E. pilularis, E, gummifera, E. planchoniana; E. microcorys, E. signata, E. seeana, E. intermedia, E. resinifera,*

Angophora costata, A. floribunda, Allocasuarina littoralis, Banksia integrifolia, B. serrata and *Leptospermum laevigatum;*

- swamp sclerophyll forest and woodland dominated by *Eucalyptus robusta, E. resinifera, Melaleuca quinquenervia, M. sieberi, Angophora costata* and *Casuarina glauca;*
- dry sclerophyll mallee forest and woodland dominated by *Eucalyptus pilularis, E. signata, E. planchoniana, E. pilularis* and *E. resinifera;*
- swamp sclerophyll mallee forest and woodland dominated by *E. robusta;*
- rain-shrubland dominated by *Cupaniopsis anacardioides;*
- dry sclerophyll shrubland dominated by *Banksia aemula, B. integrifolia, Allocasuarina littoralis, Acacia sophorae* and *Leptospermum laevigatum;*
- swamp/wet sclerophyll shrubland dominated by *Banksia ericifolia, Leptospermum juniperinum* and *Melaleuca sieberi;*
- dry sclerophyll mallee shrubland dominated by *Eucalyptus pilularis;*
- dry heathland dominated by *Banksia aemula* and *Allocasuarina littoralis;*
- graminoid clay heathland dominated by *Banksia oblongifolia, Allocasuarina littoralis, Hakea teretifolia, Aristida warburgii* and *Ptilanthelium deustum;*
- wet heathland dominated by *Banksia oblongifolia, Leptospermum liversidgei, L. juniperinum, Lepyrodia interrupta, Sprengelia sprengelioides* and *Xanthorrhoea fulva;*
- chenopod shrubland dominated by *Sarcocornia quinquefaria* and *Sporobolus virginicus;*
- tussock grassland dominated by *Spinifex sericeus;*
- sod grassland dominated by *Themeda australis;*
- sedgeland dominated by *Baumea juncea, B. rubiginosa, Leptocarpus tenax, Restio pallens, Schoenus brevifolius, Lepironia articulata, Gahnia sieberana, Gleichenia dicarpa* and *Cladium procerum;*
- Rushland dominated by *Juncus krausii,*
- Fernland dominated by *Blechnum indicum;*

- saltmarsh complex; and
- headland.

This park contains a limited amount of similar habitat to that found on the study area.

Vegetation Condition: Most of the area is in a relatively undisturbed condition, however large portions are currently regenerating from sand mining and abound with weed species, particularly Bitou Bush. Some forested areas also exhibit signs of frequent 'hot' fires.

Coocumbac Island Nature Reserve

Location: Manning River at Taree.

Area: approximately 6 hectares.

This reserve is one of only two remnants of sub-tropical floodplain rainforest along 400 kilometres north from the Hunter River. The vegetation in the reserve is of the 'large fig - giant stinging tree' association. It is fringed by Grey and River Mangrove and Swamp She-oak. None of the vegetation communities in this reserve are similar to the vegetation communities on the study area.

Vegetation Condition: Much of the rainforest on the island is in good condition with only minor infestations of exotic weeds. There is a cleared portion of the island that is heavily infested with weeds, which if left uncontrolled would enter the rainforest section of the reserve. The NPWS has undertaken a program of weed control within the area (GTCC, 1995)

Khappinghat Creek Nature Reserve

Location: North of Diamond Beach and directly south of Saltwater, extending along Khappinghat Creek.

Area: 367 hectares (J Murray, SFNSW, pers comm).

The GTCC State of the Environment report documents this reserve to be a 'fine example of bar estuary and coastal sclerophyll complex'. The area includes examples of *Eucalyptus pilularis* open forest, *E. pilularis* 'mixed hardwood' open forest, *Melaleuca quinquenervia* open forest and woodland, *Eucalyptus robusta* open forest and woodland, *Casuarina glauca* open forest, open to closed scrub, wet and dry heath and sedgeland and grassland. The area is documented as being dominated by a coastal wetland complex. The area would provide a limited amount of similar habitat to the forest on the study area.

Vegetation Condition: Part of this area is currently being mined for rutile and will be added to the reserve once mining is complete. Some weeds occur within the reserve. There has also been some bark stripping of paperbarks within the reserve, otherwise the reserve is relatively natural and diverse.

Weelah Nature Reserve

Location: Bulga Plateau west of Laurieton.

Area: 37 hectares.

This reserve is surrounded on three sides by Bulga State Forest. The reserve consists almost entirely of sub-tropical rainforest, and was donated to NPWS specifically for the preservation of the rainforest. Floyd (1976) documented the area as containing great diversity of total species present. Floyd (1976) discusses the existence of a small area of wet sclerophyll forest in this reserve, hence it is likely to provide some amount of similar habitat to the Depauperate Rainforest on the study area.

Vegetation Condition: The condition of the reserve is not entirely pristine, as Floyd (1976) documented the rainforest as having been burnt in parts, causing the mortality of a number of plants.

b. Great Lakes Local Government Area

State Forests Flora Reserves

Sugar Creek Flora Reserve

Location: Wallingat State Forest.

Area: 85ha.

Altitude: 15-30m.

Climate: Subtropical. Rainfall about 1400mm.

Major Vegetation Types: Flooded Gum and Sydney Blue Gum are most typical. There are also smaller areas of White Mahogany, Red Mahogany, Grey Ironbark, Grey Gum, Blackbutt, Depauperate Rainforest and Coachwood Crabapple Rainforest types. This reserve contains similar habitat to that found on the study area.

Vegetation Condition: This reserve is diverse and natural. Weed species are scarce and disturbance is minimal (Kent pers comm, SFNSW).

O'Sullivan's Gap Flora Reserve

Location: Bulahdelah/Wang Wauk State Forests.

Area: 320ha.

Altitude: 45-260m.

Climate: Warm temperate. Rainfall about 1300mm.

Major Vegetation Types: The gullies contain Flooded Gum with some areas of rainforest. Rainforest species are common in the understorey. Tallowwood, Sydney Blue Gum, Narrow-leaved White Mahogany, Grey Gum and Grey Ironbark occur at higher topographic levels. This reserve contains similar habitat to that found on the study area.

Vegetation Condition: This reserve is diverse and natural. The Pacific Highway cuts through this reserve and a picnic area is also located in this reserve. Weeds have infiltrated these areas, otherwise weed species are scarce and disturbance is minimal (Kent pers comm, SFNSW).

Brysons Flora Reserve

Location: Myall River State Forest.

Area: 18ha.

Altitude: 210-370m.

Climate: Warm temperate with heavy winter frosts. Rainfall about 1400mm.

Major Vegetation Types: White Mahogany Forest Type is most typical, with smaller areas of Tallowwood-Sydney Blue Gum and Brushbox types. This reserve contains similar habitat to that found on the study area.

Vegetation Condition: This reserve is diverse and natural. Weed species are scarce and disturbance is minimal (Kent pers comm, SFNSW).

National Parks and Wildlife Reserves/National Parks

Myall Lakes National Park

Location: North of Hawks Nest, south of Seal Rocks and west of Bulahdelah.

Area: 31, 562 hectares.

An assessment of the north eastern portion of this National Park was undertaken by Myerscough and Carolin in the early 1980s. This north eastern portion is known as the Eurunderee area and is approximately 12,500 hectares in size. It lies between the lake systems and the ocean from Mungo Brush to Smiths Lake and Seal Rocks. National Parks and Wildlife Service (NPWS) has advised that this is the most comprehensive survey of the park and documents the vegetation of slightly less than half the park. The following vegetation communities and their distribution have been documented by Myerscough and Carolin as occurring in the Eurunderee area. These are documented according to the dominant species in each stratum. A comprehensive list of vascular plants in each vegetation community is available in Myerscough and Carolin (1986):

- wet sclerophyll forest dominated by Rough-barked Apple, Spotted Gum, Tallowwood, Grey Ironbark and Turpentine of approximately 1,900 ha;
- dry sclerophyll forest dominated by Blackbutt and Smooth-barked Apple of approximately 5,200 ha;
- intermediate dry forest dominated by Blackbutt, Smooth-barked Apple and Red Bloodwood of approximately 230 ha;
- dry heath forest dominated by Blackbutt, Smooth-barked Apple, Red Bloodwood and Broad-leaved Paperbark of approximately 600 ha;
- wet heath forest dominated by Smooth-barked Apple, Swamp Mahogany and Broad-leaved Paperbark of approximately 200 ha;
- swamp forest dominated by Broad-leaved Paperbark and Swamp Mahogany of approximately 1,100 ha;
- fringe forest dominated by Swamp Oak and Broad-leaved Paperbark of approximately 350 ha;
- headland thicket dominated by Tuckeroo, Coastal Banksia, Scentless Rosewood and Lilly Pilly of approximately 150 ha;

- vine thicket dominated by Rhodomyrtus, Lilly Pilly, Native Guava, Tuckeroo and Coastal Banksia of approximately 60 ha;
- beach-dune thicket dominated by Saw Banksia, Coastal Banksia, Coastal Tea Tree, Tuckeroo and Sweet Pittosporum of approximately 350 ha;
- dry heath dominated by Banksia species of approximately 200 ha;
- wet heath dominated by *Banksia oblongifolia* of approximately 500 ha;
- sand grasslands dominated by a wide range of salt-tolerant grass species of approximately 40 ha;
- foredune complex dominated by various salt-tolerant herbs of approximately 670 ha;
- swamp dominated by Broad-leaved Paperbark and Swamp Banksia of approximately 820 ha; and
- Lepironia swamp dominated by *Lepironia articulata* of approximately 60 ha.

This park contains a relatively limited amount of similar habitat to that on the study area, although plant species composition is mostly different.

Vegetation Condition: Myerscough and Carolin (1986) document the majority of the vegetation in the park to be in a relatively natural condition. However, there are a number of large areas within the park which are regenerating after sand mining and 'hot' fires.

Booti Booti National Park

Location: South of Forster.

Area: 1,488 hectares.

An assessment of Booti Booti National Park (at the time of the assessment it was a State Recreation Area) was undertaken by Lisbet De Castro Lopo in the early 1980s as an in-house document, conducted on behalf of the Booti Booti State Recreation Area Trust and the Department of Lands (De Castro Lopo, 1980). Since De Castro Lopo's survey was undertaken, an additional 420 hectares was gained by NPWS to the north of the original area. This has been documented in draft from as an addendum to De Castro Lopo's report. De Castro Lopo's documentation of the vegetation communities in Booti Booti National Park has been based primarily on structural characteristics with lesser regard given to dominant species. As a full species list has been provided by De Castro Lopo for each community, we have been

able to alter the organisation of the vegetation communities so that they are based on dominant species, giving less regard to structure, so enabling a comparison to be made to vegetation communities on the study area. Ground truthing was conducted where necessary.

After Myall Lakes National Park, Booti Booti is the largest NPWS estate in the region, now totalling approximately 1,488 hectares. The following vegetation communities and their distribution have been documented as occurring in Booti Booti National Park. These are documented according to the dominant species in each stratum. A more comprehensive list of vascular plants in each vegetation community is available in De Castro Lopo (1980).

- Blackbutt/Smooth-barked Apple Forest dominated by Blackbutt and Smooth-barked Apple of approximately 300 ha;
- Rainforest dominated by a large variety of typical warm temperate rainforest species of approximately 109 ha;
- Blackbutt/Grey Ironbark Forest dominated by Blackbutt and Grey Ironbark of approximately 35 ha;
- Dune Community dominated by Coastal Tea Tree and a variety of halophytic herbs of approximately 255 ha;
- Mixed Lowland Forest dominated by Broad-leaved Paperbark, Cabbage Tree Palm and Swamp Mahogany of approximately 79 ha;
- Paperbark Swamp Forest dominated by Broad-leaved Paperbark of approximately 110 ha;
- Saltmarsh and Mangrove dominated by Glassworts, Twig Rush, Grey Mangrove, Broad-leaved Paperbark and Swamp Oak of approximately 60 ha;
- Wet Heath dominated by sclerophyllous species in the families Restionaceae, Proteacea, Fabaceae, Myrtaceaea and Epacridaceae of approximately 150 ha;
- Swamp Oak/Paperbark/Cabbage Tree Palm/Swamp Mahogany Swamp Forest dominated by Swamp Oak, Broad-leaved Paperbark, Cabbage Tree Palm and Swamp Mahogany of approximately 50 ha;
- Forest Red Gum Forest dominated by Forest Red Gum of approximately 60 ha;
- Blackbutt/Tallowwood/Forest Oak Forest dominated by Blackbutt, Tallowwood and Forest Oak of approximately 110 ha;

- Littoral Rainforest dominated by a large variety of mesophyllic species of approximately 80 ha;
- Grass and Shrubland dominated by *Allocasuarina* species and Coastal Banksia of approximately 60 ha;
- Blackbutt/Forest Red Gum/Banksia Forest dominated by Blackbutt, Forest Red Gum and Saw Banksia of approximately 15 ha;
- Heath and Grassland dominated by Swamp oak and a variety of coastal herb species of approximately 5 ha; and
- Mixed Shrubland dominated by a variety of shrubs including Giant Honeymyrtle, Lantana and a variety of rainforest species of approximately 10 ha.

This park contains some amount of similar habitat to that on the study area, although plant species composition is mostly different.

Vegetation Condition: This park is generally in good condition and relatively natural. Parts of the park have been sandmined in the past and revegetation in parts of these areas is not in balance. There are also areas of high modification in heavy tourist areas such as Elizabeth Beach, Tiona Park, Cape Hawke, Green Point, Camp Elim, other picnic and boating areas and road areas. The most commonly occurring weed species is Lantana , with Bitou Bush/Boneseed also occurring.

Wallis Island Nature Reserve

Location: Within Wallis Lake, near Forster.

Area: Approximately 680 hectares.

The Wallis Island Plan of Management was utilised to determine the vegetation communities on Wallis Island. No vegetation assessment has been conducted for the south eastern corner of Wallis Island which was formerly the extent of Wallis Island Nature Reserve. Wallis Island Nature Reserve now extends north to the southern border of the air strip. The Plan of Management contained no species list for the vegetation communities identified on the island, hence aerial photo interpretation and ground truthing were undertaken. The following vegetation communities were identified:

- Blackbutt/Smooth-barked Apple Forest dominated by Blackbutt and Smooth-barked Apple of approximately 430 ha;

- Dry Heath dominated by Coastal Tea Tree and Saw Banksia of approximately 100 ha;

- Wet Heath dominated by sclerophyllous species in the families Restionaceae, Proteaceae, Fabaceae, Myrtaceaea and Epacridaceae of approximately 130 ha; and

- Sedgeland dominated by Lepironia, Twig Rush and Grey Mangrove.

This park contains some amount of habitat similar to that on the study area, although plant species composition is largely different.

Vegetation Condition: Some areas of this reserve are currently regenerating from fire. Weed species are prevalent in some areas. The area is used frequently for recreation purposes on the fringe, hence moderate human modification is evident. The core of the reserve is mostly diverse and natural.

c. Other Reserves

There are a number of other smaller nature reserves within Great Lakes Local Government Area, including Yahoo Island (47 ha), Regatta Island (102ha), Bandicoot Island (30ha), Baldy Island (61ha), John Gould (26 ha), Stormpetrel (8), Boondelbah (9), Seal Rocks (0.3 ha), Little Broughton Island(36 ha) and Coolongolook (198 ha). There is currently no data available on vegetation communities within these nature reserves (Turner pers comm, NPWS), however the general type of vegetation within these reserves can be estimated from their location. The majority of these reserves are located within or adjacent to Wallis Lake or its tributaries, hence vegetation would be expected to be predominantly riparian or swampy and largely different to that found on the study area, providing only limited areas of similar habitat.

3.3.2 *Vegetation Types Within Forestry Management Areas*

Table 3.2 shows the areas of particular forest types (vegetation communities) within the State Forests of the Taree Forestry Management Area (Taree FMA). The breakdown of forest types for each State Forest shows that the Dry Open Forest type in the study area is relatively abundant within the Taree FMA.

Table 3.2 Area Of Vegetation Communities Within The Taree Forestry Management Area

FOREST TYPE	STATE FOREST					
	Wallamba	Coolongolook	Mitchells Island	Kiwarrak	Yarratt	Total
Subtropical Rainforest (3)					27	27
Subtropical/Depauperate Rainforest (6/23)	4					4
Subtropical/Depauperate Rainforest (6/26)				106		106
Depauperate Rainforest (23)	1					1
Depauperate Rainforest - Viney Scrub (26)					25	25
Paperbark (31)				222	46	268
Dry Blackbutt (36)					2	2
Moist Blackbutt (37). Also includes 37a and 37b.			62	412	182	656
Blackbutt/Grey Gum /Grey Ironbark/White Mahogany (37/62)				1258		1258
Tallowwood/Sydney Blue Gum (47). Also includes 47f	30	14		780	25	849
Tallowwood/Sydney Blue Gum/Brushbox (47/53)				982		982
Flooded Gum (48)				119	133	252
Narrow-leaved White Mahogany/Red Mahogany/ Grey Ironbark/ Grey Gum (60). Also includes 60f	72	103		2360	329	2864
Grey Gum/ Grey Ironbark/ White Mahogany (62). Also includes 62a and 62b	281	226		5958	2071	8536
Spotted Gum/ Grey Ironbark/ Grey Gum (74)	246	184		629	474	1533
Forest Red Gum (92)				11		11
Scribbly Gum (117)					19	19

Table 3.2 Area Of Vegetation Communities Within The Taree Forestry Management Area

	STATE FOREST					
Improved Pasture and Crop land (216)				23		23
Forestry Hardwood Plantations (218b)				293		293
Cleared/Partially Cleared (220)					4	4
Scrub (224)					11	11
Rock (234)				2		2
TOTALS	634	527	62	13155	3346	17726

Notes: *1. Forest Type is presented in brackets after the type description.*

2. Referenced from Taree District State Forests of NSW.

3. Areas in hectares.

3.4 LOCAL HABITAT RESERVATION AND SPECIES POPULATIONS

Within the locality there are a number of areas which may form significant habitat for threatened species. These areas include: wetlands (under SEPP 14); areas zoned by Greater Taree City Council and Great Lakes Council as environmental protection areas; crown land, much of which is contained in its natural state, and Kiwarrak State Forest. The location of each of these areas is shown on the topographic locality map in *Appendix C.*

3.4.1 *Conservation Areas in the Locality*

i. SEPP 14 Wetlands

These areas are significant because of their ecological function, with the need for a policy arising out of the exploitation and degradation that occurred within coastal wetlands in the past. The aim of SEPP 14 - Coastal Wetlands is to ensure that coastal wetlands are preserved and protected in the interests of the State. The security of SEPP 14 wetlands for conservation purposes is not absolutely ensured as some developments are permitted within or nearby these wetlands provided development consent is obtained.

ii. Environmental Protection Zones

The environmental protection zones marked on Appendix D aim to protect and conserve features which are environmentally sensitive or delicate or of particular environmental interest. The general objectives of theses zones are to protect conservation values in the zoned areas. These zones are not necessarily secure from destruction or modification, however they have been recognised as areas of significance requiring extraordinary protection. The classification and objectives of these zones have been defined for both the Greater Taree City Council and the Great Lakes Council areas:

a. Greater Taree City Council

The Greater Taree City Council Local Environmental Plan (1995) indicates that the following conservation zonings exist within the locality:

- 7 (a) Environmental Protection Habitat. The objectives of this zone are to protect and conserve features which are environmentally sensitive or delicate or of particular environmental interest; and to regulate development to avoid inappropriate uses which would destroy or damage a habitat ecosystem, particularly that of wetlands, significant vegetation or wildlife.

b. Great Lakes Council

The current Local Environmental Plan (LEP) covering the Great Lakes Portion of the locality is the Manning LEP No 1 (which covered the former Manning Shire). This LEP which was gazetted in 1983 does not include conservation zones for land within the locality that forms part of the Great Lakes Shire Council area. A consolidated shire wide LEP is currently in draft form and is close to gazettal. This Great Lakes Draft Local Environmental Plan 1996 consolidates the three LEP's that currently cover the Shire and proposes some rezoning. In particular this draft LEP proposes rezoning some of the land within the locality to the conservation or environmental protection zonings listed below:

- 7 (a) Wetlands. The objectives of this zone are to restrict the type and scale of development considered incompatible with the special ecological or scientific values of coastal wetlands; and to allow development where it is unlikely to have a significant detrimental effect on the growth of native plant communities and the survival of native wildlife populations and the provision and quality of habitats for both indigenous and migratory species.

iii. Kiwarrak State Forest

This forest is found to the north of the subject site as illustrated in Appendix C. This forest consists of large areas of:

- Blackbutt associations with co-dominants including Tallowwood, Red Mahogany, Red Bloodwood, Turpentine, White Mahogany, Flooded Gum, White Stringybark and Grey Gum;
- moist hardwood dominated by Tallowwood, Sydney Blue Gum, Flooded Gum and Brushbox;
- dry hardwood dominated by Grey Gum, Grey Ironbark, White Mahogany, Forest Red Gum and Scribbly Gum;
- Spotted Gum forest types dominated by Spotted Gum;
- maritime forest types dominated by Swamp Mahogany and Broad-leaved Paperbark; and
- small areas of rainforest dominated by Sassafras, Corkwood, Giant Stinger and Myrtle.

Although Kiwarrak State Forest is commercially harvested, its designation as a State Forest ensures that a continual forest habitat will remain in the locality in the long term.

iv. Crown Land

There are large areas of crown land within the locality. These areas are found mainly within the Great Lakes Shire and consist of forest, woodland and wetland areas. The location of these areas is shown on the topographic map in Appendix C.

3.4.2 *Populations of Threatened Species in the Locality*

a. Brush-tailed Phascogale

Anecdotal sightings of this species have been made approximately 7 km east of the study area at Cloverhill Farm (Ecotone), and at Homestead Estate (Ecotone). Three unchecked sightings have also been made by NPWS at Kiwarrak State Forest approximately 6 km north of the subject site. Within the study area, this species was recorded in the Open Forest habitat. The existence of suitable habitat in the vicinity of the subject site, combined with the number of recordings of this species in the

region indicates that the Brush-tailed Phascogale is likely to be moderately common in the locality. Refer to Appendix B for location details.

b. Glossy Black Cockatoo

An anecdotal recording of this species has been made approximately 7 km east of the study area (Terry Evans - Senior Environmental Scientist at Great Taree City Council). This species was also recorded within the study area by Debus (1985). Due to numerous sightings in the region, the Glossy Black Cockatoo is regarded as being moderately common within the region. A recording of this species within the locality and the existence of suitable habitat types within the vicinity of the subject site indicate that this species may be locally common. Refer to Appendix C for location details.

c. Powerful Owl

A recording of the Powerful Owl has been made approximately 7 km east of the study area (ERM Mitchell McCotter). This species has been recorded a number of times throughout the region. Given the large home range of the Powerful Owl, it is possible that the recordings made within the region are of the same individual or family group. The Powerful Owl has only been recorded once in the locality. Refer to Appendix C for location details.

d. Masked Owl

Probable sightings of this species have been made at Cloverhill Farm (Ecotone), at Homestead Estate (Ecotone) and approximately 7 km east of the study area (ERM Mitchell McCotter). Given the large home range of the Masked Owl, it is possible that the recordings made within the region are of the same individual or family group. Refer to Appendix C for location details.

e. Koala

Six unconfirmed sightings of the Koala have been made by NSW State Forests within Kiwarrak State Forest north of the study area. Within the study area the Open Forest would provide the most suitable habitat for the Koala. The Koala has been recorded frequently throughout the region. Regionally, this species may be considered relatively common in forested areas. Refer to *Appendix C* for location details.

f. Squirrel Glider

Two unconfirmed sightings of the Squirrel Glider have been made at Homestead Estate (Ecotone). Within the study area the Open Forest would provide suitable habitat for the species. Recordings of the Squirrel Glider within the locality and the

existence of suitable habitat types within the vicinity of the study area indicate that this species may be locally common. Refer to *Appendix C* for location details.

g. Tiger Quoll

Three unconfirmed Tiger Quoll sightings have been made by NSW State Forests in Kiwarrak State Forest north of the study area. NSW State Forests has also made an unconfirmed sighting of this species approximately 2 km east of the study area. Within the study area, the Tiger Quoll may utilise all of the habitats to some degree. This species has been recorded at scattered locations throughout the region and may be considered moderately common within the region. Recordings of this species within the locality and the existence of suitable habitat on the study area indicate that this species may be locally common.

3.4.3 *Relative Significance of the Study Area for Subject Species in the Locality*

Given that the forested area in the study area is currently 20 year old regrowth (approximately), and has only a moderate degree of naturalness (weed species and vehicular tracks are prevalent), it is likely to provide only sub-optimum habitat for many threatened species. **Larger more pristine areas of habitat exist within the locality (eg State Forests) and are likely to provide more significant habitat for threatened species. Hence, in a regional context the study area is likely to be relatively insignificant.** Despite this, threatened species are known to occur in the study area and mitigation measures should be implemented.

Chapter 4

FLORA AND FAUNA OF CONSERVATION SIGNIFICANCE

4.1 SPECIES PROFILES

4.1.1 Methodology

Two threatened species as listed on the Schedules to the TSC Act were positively recorded on the study area. These are the Brush-tailed Phascogale which was recorded within Block B just outside the area proposed to be cleared (ERM Mitchell McCotter) in September 1996 and the Glossy Black Cockatoo (Debus, S) in 1985. Debus (1985) indicates that the Glossy Black Cockatoo was observed within the gully on the southern side of the ridge, outside of the area proposed to be cleared. One ROTAP species has also been recorded on the boundary of the subject site. Another 28 threatened species have been identified as having a moderate or high possibility of occurrence. These have been determined via a literature search for information on their ecology and known habitat preferences. As well as this, a search of the NPWS Atlas of Wildlife for flora and fauna was undertaken to determine which flora and fauna species of conservation significance occur within the immediate region.

Part 1.7 of The Director General's requirements for the SIS lists a number of 'subject species' which must be considered for the purpose of the SIS. This list is not definitive however and a number of species present on this list are unlikely to be located on the study area due to their known distribution and habitat preferences. *Table 4.1* lists these species, their likelihood of occurrence in the study area, and reasons for the given likelihood of occurrence.

Table 4.1 List of Subject Species Provided by NPWS

Species	Likelihood of Occurrence	Reason
Wallum Froglet	Low	No suitable habitat on site.
Regent Honeyeater	Moderate.	Suitable habitat on site, but infrequently recorded in the region.
Black Bittern	Low.	No suitable habitat on site.
Black-necked Stork	Low.	No suitable habitat on site.
Osprey	Low.	Suitable nesting habitat on site, but no nest was observed.
Glossy Black Cockatoo	Recorded on site.	Recorded in study area in 1985.
Masked Owl	High.	Suitable habitat on site and recorded occasionally in the region.
Painted Honeyeater	Low.	Not recorded in the region within the last 20 years.
Brush-tailed Phascogale	Recorded on site.	Recorded on site.
Common Planigale	Moderate	Recorded sparsely throughout the region and some suitable habitat on site.
Yellow-bellied Glider	Moderate.	Recorded sparsely throughout the region. Suitable but not optimum habitat on site.
Tiger Quoll	Moderate.	Numerous recordings in the region, however only a limited amount of habitat on site.
Eastern Little Mastiff Bat	Moderate	Recorded at only one location in the region. Suitable habitat on site.
Squirrel Glider	Moderate - High.	Recorded sparsely throughout the region. Recorded in the locality. Suitable habitat on site.
Koala	Moderate	Recorded frequently throughout the region and the locality and suitable habitat on site, however no evidence was found of this species on site.
Golden-tipped Bat	Low	Recorded infrequently throughout the region and limited suitable habitat in the study area.
Great Pipistrelle	Moderate.	Recorded infrequently throughout the region. Suitable habitat on site.
Little Bent-wing Bat	Recorded on site.	Recorded on site.
Large Bent-wing Bat	Recorded on site.	Recorded on site.
Large-footed Mouse-eared Bat	Low	Only one recording within the region. Study area does not contain suitable habitat.
Greater Broad-nosed Bat	Moderate-High	A number of recordings within the region. Suitable habitat on site.
Stephen's Banded Snake	Moderate	This species has been recorded

		within the region. No recordings within the locality, but suitable habitat on site.
Eucalyptus glaucina	Moderate	Not recorded during the flora survey, but may have been overlooked as suitable habitat exists on site.
Eucalyptus rudderi	Recorded on site.	Recorded on site.
Grevillea granulifera	Moderate.	Not recorded during the flora survey, but may have been overlooked as suitable habitat exists on site.

Only those species which have been given a moderate or high likelihood of occurrence on the study area have been considered in the species profiles. In addition to these, a number of species not listed by The Director General will be included in the species profiles based upon their known habitat preferences and occurrence in the region. These include:

- Swift Parrot;
- Turquoise Parrot;
- Square-tailed Kite;
- Powerful Owl
- Parma Wallaby;
- Pale-headed Snake;
- *Tetratheca juncea;*
- *Hibbertia hexandra;*
- *Thesium australe and*
- *Grevillea obtusiflora.*

4.1.2 Endangered Species

Endangered species are those species listed on Schedule 1 of the TSC ACT 1995. No endangered species are known to occur in the study area, however three have been identified as possibly occurring in the study area. A species is eligible for listing as an endangered species if, in the opinion of the Scientific Committee:

"(a) it is likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival or evolutionary development cease to operate, or

(b) its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced that it is in immediate danger of extinction, or

(c) it might already be extinct but is not presumed extinct."

4.1.3 *Vulnerable Species*

Vulnerable species are those species that are listed on Schedule 2 of the TSC Act, 1995. Of the 29 species examined in this study, 26 are listed as 'Vulnerable". A species is eligible for listing as a vulnerable species if, in the opinion of the Scientific Committee:

"the species is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate".

4.1.4 *Endangered Populations and Ecological Communities*

The TSC Act does not currently list any endangered populations or ecological communities, therefore they cannot be addressed in this report.

4.1.5 *Key Threatening Processes*

The TSC Act does not currently list any key threatening processes, however the threatening processes generally affecting each threatened species are discussed in the species profiles.

4.1.6 *Critical Habitat*

There is currently no declared critical habitat in NSW, therefore it could not be referred to in this report.

4.2 THREATENED SPECIES PROFILES

This chapter details the requirements and characteristics of each of the 24 species known/likely to occur within the study area. The impacts of the proposed development and recommended mitigation measures are also briefly discussed in this chapter and examined in detail in Chapter 5.

The regional distribution records of the NPWS Atlas of Wildlife were obtained to highlight those species previously recorded in the region. Past reports which have been prepared in the locality were also accessed to gain information on the presence of threatened species in the locality.

4.3 BIRDS

4.3.1 Swift Parrot (*Lathamus discolor*)

i. Statewide Abundance and Conservation Status

This species occurs in the eastern half of NSW, through to southern Queensland, although it is known to breed only in Tasmania. It occurs in NSW between January and May when it migrates from Tasmania. Listed on Schedule 2 (Vulnerable) of the TSC Act, 1995.

ii. Immediate Regional Abundance

This species has been recorded only in Crowdy Bay National Park, hence its regional distribution is likely to be rare.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

This species inhabits most types of timbered country which contains flowering tree species, particularly eucalypts.

v. Home Range

Their movement patterns appear to depend upon the availability of nectar and blossoms, as they follow the blossoming of various species (Frith et al, 1977).

vi. Feeding Requirements

They feed voraciously on pollen and nectar, particularly of Eucalypt species. They also feed on insects and their larvae, as well as seeds, fruits, berries and vegetable matter (Frith et al, 1977).

vii. Roosting, Breeding and Shelter Requirements

This species rests in the perches of tall trees in family groups. They breed in late September to early January in Tasmania only. They nest in a hollow limb or hole high in a tree, usually a Eucalypt. Egg incubation usually lasts about 20 days. They return to the mainland between January and May.

viii. Habitat Distribution in the Study Area

The Open Forest habitat would be utilised by this species for foraging. The Herbland may also be used for foraging.

ix. Threatening Processes

The main threat to this species is habitat modification and destruction, particularly the loss of mature hollow bearing trees through agricultural and forestry operations.

x. Impact From Proposal

If this species utilises the study area, it is likely to be only moderately affected by a loss of foraging habitat.

xi. Ameliorative Measures

The impact of the proposal will be ameliorated through the progressive revegetation of the disturbed areas using locally endemic tree species. Because the development is unlikely to have a significant impact upon this species, no intensive amelioration measures are required.

4.3.2 *Turquoise Parrot (Neophema pulchella)*

i. Statewide Abundance and Conservation Status

This species occurs in the eastern half of NSW, through to southern Queensland. Listed on Schedule 2 (Vulnerable) of the TSC Act, 1995.

ii. Immediate Regional Abundance

This species has been recorded in Myall Lakes National Park and Myall River State Forest, hence its regional distribution is likely to be rare.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

This species inhabits open forest and timbered grasslands on mountain slopes, ridges and along watercourses (Frith, 1977).

v. Home Range

This species is partly nomadic, with movement patterns appear depending upon the availability of foraging resources (Frith et al, 1977).

vi. Feeding Requirements

They feed voraciously on pollen and nectar, particularly of Eucalypt species. They also feed on insects and their larvae, as well as seeds, fruits, berries and vegetable matter (Frith et al, 1977).

vii. Roosting, Breeding and Shelter Requirements

This species spends most of its day on the ground searching for seeds and vegetable matter in small flocks in the shade of a tree. They breed between August and December and nest in a hollow tree, log or post. Egg incubation usually lasts about 18 days.

viii. Habitat Distribution in the Study Area

The Open Forest habitat would be the optimum habitat on site utilised by this species, however it may intermittently use the Herbland habitat.

ix. Threatening Processes

The main threat to this species is habitat modification and destruction, particularly the loss of mature hollow bearing trees through clearing for agriculture and forestry.

x. Impact From Proposal

If this species utilises the subject site, it may be affected by a loss of roosting and foraging habitat.

xi. Ameliorative Measures

The impact of the proposal will be ameliorated through the progressive revegetation of the disturbed areas using locally endemic tree species. Enhancement of the remaining bushland in the study area, to increase its carrying capacity, should also be undertaken to ameliorate the proposal's impacts.

4.3.3 Glossy Black Cockatoo *(Calyptorhyncus lathami)*

i. Statewide Abundance and Conservation Status

This species inhabits eucalypt forests and woodlands throughout the NSW east coast, but population numbers are variable throughout its range (Symbiosis, 1993). Northern New South Wales is the stronghold of the Glossy Black Cockatoo (Mitchell McCotter, 1993a), which has been recorded in all catchments on the north coast. This species is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. The Glossy Black Cockatoo population has been severely reduced due to the destruction of specialised habitats and poor recovery potential (Lunney *et al*, 1992).

ii. Immediate Regional Abundance

This species has been recorded at scattered locations throughout the region, including Port Stephens, Kiwarrak State Forest, Bachelor State Forest, Lake Innes, Johns River State Forest, Camden Haven and Doyles River State Forest.

iii. Local Abundance

The Glossy Black Cockatoo has been recorded in the study area and in a number of places within the locality (refer to Appendix C).

iv. Habitat Requirements

The Glossy Black Cockatoo inhabits a range of forests, woodlands, riparian vegetation and partially cleared areas from sea level up to 1000 metres. This species' distribution is linked to its reliance on their primary food source, the seeds of *Allocasuarina torulosa, A. verticillata* and *A. littoralis* (Mitchell McCotter, 1993a). Clout (1989) has shown that food quality and quantity are important variables influencing the time that Glossy Black Cockatoos spend feeding in particular *A. littoralis* trees. Lower rainfall dry sclerophyll forest on flat ground such as in the lower Clarence valley and the northern tablelands are this species' optimum habitat (NPWS, in publication).

v. Home Range

Groups of this species (two to twenty individuals) are known to occupy an area permanently, though individuals and sub groups may move around in this area (Blakers *et al,* 1984). Where *Casuarina* stands are extensive the birds appear to be resident all year but are probably nomadic in areas where casuarina species are scarce (Frith, 1977).

vi. Feeding Requirements

This species feeds on the fruit (cones) of casuarina species, primarily *Allocasuarina torulosa* and *A. littoralis* within the region. Glossy Black Cockatoos have also been recorded feeding on Angophora fruit, Sunflower seeds and the grubs found in some *Casuarina* and *Acacia* species (Blakers *et al.*, 1984).

vii. Roosting, Breeding and Shelter Requirements

Although the Glossy Black Cockatoo lives in loose groups, pairs or family parties, they will roost by themselves, joining the group during the day for feeding or water (Blakers *et al,* 1984). A hollow limb or hole, often in a tall dead tree in a forest clearing, is typically used for roosting (Forshaw and Cooper, 1978). Blackbutt (*Eucalyptus pilularis*) is known to be used for nesting (Mount King, 1993). This species requires large cavities for nesting and breeding which occur from March to

August (Mount King, 1993), however, the main breeding season is from April to June (Simpson and Day, 1993).

viii. Habitat Distribution in the Study Area

The Open Forest habitat would be utilised by this species.

ix. Threatening Processes

Ongoing reduction in forest area and the reduction in the age class structure of trees on both state and private forests poses a threat to the population levels of the Glossy Black Cockatoo. Local populations may be threatened through the localised harvesting of *Allocasuarina* for roof shingles, firewood, etc (NPWS, in publication). Frequent fires and grazing in dry sclerophyll forests, which results in increased mortality and reduced recruitment of *Allocasuarina* spp. and other mid-storey woody plants may also threaten local populations (NPWS, in publication). Brouwer and Garnett (1990) concluded that the conservation of the Glossy Black Cockatoo is dependent upon 'preserving large intact areas of forest with *Allocasuarina* stands and on implementing appropriate fire management regimes to minimise the loss of these stands and potential nesting trees in wildfires.'

x. Impact From Proposal

Impacts from the proposed expansion of the quarry include a loss of foraging and roosting habitat for the Glossy Black Cockatoo. Because of the relatively low number of *Allocasuarina* species to be removed for the proposal, removal of *Allocasuarina* species within the study area is not expected to significantly impact upon the Glossy Black Cockatoo. If this species utilises the subject site for nesting, it may be impacted by a loss of roosting habitat.

xi. Ameliorative Measures

To reduce the impact of destruction of roosting habitat on individuals, clearing of hollow-bearing trees should occur outside the main breeding and nesting period of April to June. The provision of nest boxes with large deep hollows would provide compensatory habitat in the short term. Progressive rehabilitation of the area to be disturbed, using locally endemic plant species, will assist in mitigating the impacts of the proposal in the long term.

4.3.4 Square-tailed Kite (*Lophoictinia isura*)

i. Statewide Abundance and Conservation Status

On a statewide level, this species is widely but sparsely distributed over most of NSW, but is concentrated in coastal areas. This species is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. Reasons for listing include a reduction of population to a critical level, poor recovery potential and severe threatening processes.

ii. Immediate Regional Abundance

This species has been recorded at Lansdowne and near Bungwahl, indicating that it is uncommon within the region.

iii. Local Abundance

This species has been recorded nesting in Kiwarrak State Forest north of the study site.

iv. Habitat Requirements

Open forests and woodlands in coastal and subcoastal areas are the primary habitat of this species, in conjunction with inland wooded watercourses. The Square-tailed Kite has been recorded from near sea level to greater than 1000 metres in elevation (NPWS, in publication). The Square-tailed Kite is primarily recorded hunting over open eucalypt forests, woodlands and mallee environments that are rich in small birds. Adjacent heaths and other low shrubby habitats, and non-eucalypt forest in tropical regions are also utilised by this species to a lesser degree (Debus and Czechura, 1989). This species has occasionally been seen to hunt around houses and towns (Debus and Czechura, 1989).

This species appears to be a spring and summer migratory bird in south-eastern Australia (Debus, 1983), possibly wintering in the tropics. However, this species was recorded in Grafton throughout the entire year of 1980 by G. Clancy (Lindsay, 1982). This occurrence may reflect the mild winter climate of this area (NPWS, in publication).

v. Home Range

The home range of breeding pairs is large, consisting of many tens of square kilometres (Debus and Czechura, 1989).

vi. Feeding Requirements

This species is a specialised predator of small birds in the canopy of forests, with its diet consisting mainly of honeyeaters, particularly the nestlings (NPWS, in publication). It is also known to feed on young rabbits, small reptiles, large insects and carrion (Lindsey, 1992).

vii. Roosting / Shelter and Breeding Requirements

The nest is a substantial conglomerate of sticks in a cup-shape and is lined with green leaves. The nest is usually placed on a horizontal limb approximately 15 to 20 metres from the ground (Lindsey, 1992). The nest may be re-used for several successive seasons. Breeding occurs during the spring and summer months, when two to three blotched white eggs are laid in the nest. The recruitment rate of this species is apparently low (Jolly, 1989).

viii. Habitat Distribution in the Study Area

This species may utilise the subject site as part of its hunting grounds, although the species home range would encompass a larger area.

ix. Threatening Processes

The primary threat to this species is habitat destruction and modification. Within eastern Australia over half the area of eucalypt forest and woodland has currently been cleared for agriculture, while forestry and grazing in the remaining habitat areas may deplete this species' food supply even further (Debus and Czechura, 1989). Illegal egg-collecting and shooting are also a threat to this species due to its low recruitment rate (Jolly, 1989).

x. Impact From Proposal

The impact of the proposal upon this species is likely to be minimal as the area to be cleared is small when compared to this species' home range.

xi. Ameliorative Measures

Progressive rehabilitation of the disturbed areas, using locally endemic plant species is suitable for ameliorating the impact of the proposal on this species.

4.3.5 Powerful Owl *(Ninox strenua)*

i. Statewide Abundance and Conservation Status

The Powerful Owl is confined to coastal and near-coastal areas of New South Wales. It has been recorded from the Tweed, Brunswick, Richmond, Clarence, Bellinger, Macleay, Hastings, Manning and Hunter river valleys (NPWS, in publication). It is listed on Part 2 (Vulnerable) of Schedule 2 of the TSC Act, 1995.

ii. Immediate Regional Abundance

This species has been recorded frequently throughout the region, at scattered locations including Old Bar, Bachelor State Forest and Myall Lakes National Park, indicating that it is likely to be regionally common.

iii. Local Abundance

This species has been recorded east of the study area within the locality.

iv. Habitat Requirements

Powerful Owls inhabit both wet and dry sclerophyll forests, with the optimum habitat being tall, dense eucalypt forest on hills and mountains up to 1200 metres altitude (NPWS, in publication). It is characteristically found in densely forested gullies on coastal slopes (Lindsey, 1992). Dense rainforest areas are generally avoided. This species is also known to live in suitably wooded areas within urban settlements.

v. Home Range

The home range of a pair of birds has been estimated from 1000 ha to 3000 ha, although the density of birds is proportional to the density of their principal prey (Norton, 1990). Schodde and Mason (1980) found that territory holding pairs are rarely found within 4-5 kilometres of each other, and are often much further apart (10-20 kilometres or more).

vi. Feeding Requirements

This species feeds primarily on slow-moving arboreal mammals, especially the Greater Glider, the Common Ringtail Possum and immature Brush-tailed Possums. Insects, large birds and a variety of other mammals including flying foxes are also taken (Frith, 1976). It is possible that this species forages along the forest edge where it consumes European Hare, Rabbits and open country birds (NPWS, in publication). Each bird must catch as many as 80 to 100 possums and gliders a year with catches at two to three day intervals in order to survive. 'Allowing for breeding and the rearing of one or two young owls, each territory may have to produce about 250-300 possums a year (or their equivalent) for the owls to survive.' (Schodde & Mason, 1980).

vii. Roosting, Breeding and Shelter Requirements

Outside of breeding season mated males and females roost apart, though always within calling distance. During the day the birds roost on bare branches, often 20 metres in the air, where they can gain a clear view of the surrounding area. Favoured roosting trees include Blackwoods (*Acacia melanoxylon*), other wattles, rainforest trees, tall casuarinas and Native Cherries (*Exocarpos cupressiformis*), with more open eucalypts on hillsides used infrequently (Schodde and Mason, 1980). Powerful Owls nest during winter from May to October, with eggs often laid from the second week in May to the third week in June. Incubation is up to 38 days, with the first flight at seven to eight weeks. During this time the male feeds both the female and the young (Hollands, 1991). Each pair mates for life, often up to thirty years or more. The nest site is a hollow in a tree trunk or large branch (Fleay, 1968), situated 12-40 metres above the ground, often at the head of a gully, or on the face of a hill. This species utilises large holes, in the trunk of a large eucalypt, as nest sites (Fleay 1968), laying a clutch of two eggs in winter.

viii. Habitat Distribution in the Study Area

Powerful Owls may utilise all of the vegetation communities in the study area for hunting grounds and may roost in the stags or hollows on site.

ix. Threatening Processes

Clearing of habitat and forest harvesting methods leading to even-aged stands pose a major threat to this species. Even-aged stands lead to a decrease in hollow bearing trees, which limits the distribution not only of Powerful Owls but also their prey species.

x. Impact From Proposal

If this species roosts on the subject site, it may be affected by a loss of roosting habitat. It is unlikely to be impacted by a loss of foraging habitat as the area to be removed is small in comparison to this species' home range.

xi. Ameliorative Measures

Clearing outside of the breeding season would avoid direct mortality of this species, if it occurs in the study area. The provision of nest boxes with large deep hollows would provide compensatory habitat until the rehabilitated areas are mature enough to provide tree hollows. Progressive rehabilitation of the subject site will assist in mitigating the impacts of the development in the long term.

4.3.6 Masked Owl (*Tyto novaehollandiae*)

i. Statewide Abundance and Conservation Status

The Masked Owl is sparsely distributed in coastal regions along the entire New South Wales coastline (Blakers *et al.* 1984). In northern New South Wales, it has been recorded from the Tweed, Richmond, Clarence, Hastings, Manning and Hunter valleys. It is listed on Part 2 (Vulnerable) of Schedule 2 of the TSC Act, 1995.

ii. Immediate Regional Abundance

This species has been recorded frequently throughout the region at scattered locations, including Wallingat State Forest, Kiwarrak State Forest, Booti Booti National Park, Mount Seaview, Doyles River State Forest and Bellangry State Forest, indicating that this species is abundant within the region.

iii. Local Abundance

The Masked Owl has been recorded at numerous places within the locality.

iv. Habitat Requirements

The Masked Owl occurs from sea level to 1100 metres, although no more than 300 kilometres from the coast (Lindsey, 1992). It is typically recorded in dry sclerophyll forest and woodland (Hyem, 1979), but they feed in open or partly cleared country. Debus (1990) describes this species habitat in Werrikimbe National Park as a cleared

valley surrounded on hillsides and ridges by eucalypt and tall open forest with a ground cover of tussocky grasses.

v. Home Range

The home range of the Masked Owl in the south east region covers around 500 to 1,000 hectares (Blakers *et al*, 1984).

vi. Feeding Requirements

The female is larger than the male and it is thought that each sex takes a different range of prey animals (Lindsey, 1992). However, in general this species feeds on mainly terrestrial mammals up to the size of a rabbit. Rats feature prominently in their diet (Hyem, 1979). In Tasmania this species is known to prey on native and introduced rodents, Bandicoots, Sugar Gliders, Ring-tailed Possums, Rabbits, bats and birds including raptors and domestic poultry (Blakers *et al*, 1984).

vii. Roosting, Breeding and Shelter Requirements

This species is shy and secretive, roosting by day in tree hollows and thick foliage. It primarily roosts and breeds in wet sclerophyll forested gullies, favouring large roomy hollows for nesting, with depths varying from 0.4 to five metres (Hyem, 1979). Large old trees with hollows are required for breeding, with the same tree cavity often used for several years in a row. The Masked Owl mates for life and maintains permanent territories. Like other *Tyto* Owls, the Masked Owl is an opportunist and may breed at any time of the year, with most eggs laid from March to July (Hollands, 1991). Two to four (usually three) eggs are laid and they hatch at about 42 days (Hollands, 1991). During this time the female is fed at the nest by the male.

viii. Habitat Distribution in the Study Area

The Masked Owl may utilise the Open Forest and Herbland habitats.

ix. Threatening Processes

Schodde and Mason (1980) attribute the decline of this species to the decline of native mammals since European settlement. Agricultural production and commercial forests resulting in an imbalance of the age class of trees also represent a significant threat to this species.

x. Impact From Proposal

The proposal will primarily result in a loss of foraging and roosting habitat for the Masked Owl, if it utilises the subject site. The habitat to be removed for quarry expansion may provide suitable roosting habitat for this species due to the presence of mature trees with hollows. If this species does occur in the study area, the amount of habitat to be removed is likely to constitute only a very small part of a larger home range for this species, therefore any clearing that occurs will not remove a significant amount of foraging habitat.

xi. Ameliorative Measures

Appropriately timed clearing would avoid direct mortality of this species. The provision of nest boxes with large deep hollows would provide compensatory habitat until the rehabilitated areas are mature enough to provide tree hollows. Progressive rehabilitation of the subject site will assist in mitigating the impacts of the development in the long term.

4.3.7 Regent Honeyeater (Xanthomyza phrygia)

i. Statewide Abundance and Conservation Status

This species is found on the east coast of NSW, from Victoria through to southern Queensland. This species is listed on Schedule 1 to the TSC Act, 1995. The population and distribution of this species have been reduced to a critical level (Lunney *et* al, 1992), with the population in 1995 estimated to between 500 and 1500 individuals (EcoPro, 1995). As well as this, because it is the only member of its genus and its morphology does not vary across its range, on the grounds of phylogenetic distinctness alone, it warrants conservation action (Menkhorst, 1993).

ii. Immediate Regional Abundance

This species has been recorded only in Wallingat State Forest, indicating that it uncommon within the region.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

This species is found from sea level to 400 metres. Flocks of Regent Honeyeaters follow the flowering trees of eucalypts and banksias (Frith, 1977). These highly nomadic birds occupy temperate eucalypt woodland and open forest including forest edges, woodland, farmland and urban areas of mature eucalypts.

v. Home Range

The species is nomadic and congregates in groups of 50 to 500 individuals. The exact home range of this species is unknown.

vi. Feeding Requirements

This species feeds on a combination of cultivated fruits such as figs, plums and grapes in addition to nectar and insects (Frith, 1977). Lerp and other sugary secretions rich in carbohydrates may also be eaten.

vii. Roosting, Breeding and Shelter Requirements

The female of this species builds a cup shaped nest in either a fork of a shrub or tree, or suspended in pendulous foliage, often in a eucalypt (Simpson and Day, 1993). Nests are usually constructed of small twigs and strips of bark held together by spiders webs lined with mammal hair, soft plant material and the occasional feather. Nesting activities occur from May to March, with a clear peak from September to November.

viii. Habitat Distribution in the Study Area

If this species occurs on the study area, it would utilise the Open Forest, Herbland and Woodland habitats for foraging.

ix. Threatening Processes

This species is threatened by a loss and fragmentation of its habitat through activities which require clearing, particularly agriculture (Garnett, 1992).

x. Impact from Proposal

If this species utilises the study area, the proposal will primarily result in a loss of foraging and roosting habitat. The community affected by the proposal is the Open Forest which may be used intermittently by this nomadic species. The Open Forest would constitute only a small, and possibly insignificant, portion of this species' range, therefore any clearing that occurs will not remove a significant amount of habitat.

xi. Ameliorative Measures

The impact of the proposal will be ameliorated through the re-planting of the disturbed areas with locally endemic plant species.

4.4 MAMMALS (NON-FLYING)

4.4.1 Common Planigale (*Planigale maculata*)

i. Statewide Abundance and Conservation Status

The nominate subspecies *Planigale maculata* occurs in eastern NSW from the Queensland border south to approximately Sydney. A high proportion of this species' habitat corresponds with the low-lying flat to undulating, near coastal land that is intensively settled. In northern New South Wales, it has been recorded from the Tweed, Brunswick, Richmond, Clarence and Hastings Valleys (NPWS, in publication). This species is listed on Schedule 2 (Vulnerable) of the TSC Act 1995.

ii. Immediate Regional Abundance

This species has been recorded in Manning River District National Forest north of the study area, and around Blackhead Lagoon, indicating that it is uncommon within the region.

iii. Local Abundance

This species has not been recorded in the locality, indicating that it is locally uncommon.

iv. Habitat Requirements

In New South Wales, this species has been recorded from sea level up to 400 metres elevation, from rainforest, sclerophyll forests, heathland, grassland, marshland and rocky areas. Andrews and Settle (1982) concluded that habitat selection by this species 'appears primarily dependent upon surface cover'.

v. Home Range

The home range of this species is not known, however, other planigales have varying home ranges of between 500 and 2000 square metres (Cronin, 1991).

vi. Feeding Requirements

Its diet is primarily composed of a variety of insects, although small vertebrates are also consumed (Cronin, 1991).

vii. Roosting, Breeding and Sheltering Requirements

This primarily nocturnal species shelters in a shallow, saucer-shaped nest lined with grass and shredded bark in crevices, hollow logs, beneath bark or under rocks. On cold days they have been seen basking in the sun and they are known to be torpid for short periods when food is scarce (Cronin, 1991). Breeding extends from October to January, with 5-15 young born approximately 20 days after mating. The newborn attaches firmly to the females teats, remaining attached for about 21 days but not leaving the pouch for a further 24 days. At roughly 70 days the young are weaned and leave the nest (Cronin, 1991).

viii. Habitat Distribution in the Study Area

This species may utilise the Open Forest habitat and Herbland, for foraging and breeding purposes.

ix. Threatening Processes

The main threat to this species is habitat loss and it is particularly susceptible to removal of low ground cover and drainage of swampy land. Predation by feral cats (Archer 1976) and cane toads (Covacevich and Archer 1975) is also a significant threat.

x. Impact From Proposal

This species may experience a loss of habitat and if disturbed, may fall victim to road mortality in transition.

xi. Ameliorative Measures

The progressive rehabilitation of the disturbed areas will ensure that the impacts of the proposal on this species are ameliorated to the greatest possible extent. As well as this an internal speed limit should be enforced on the internal road to minimise road mortality.

4.4.2 Tiger Quoll (*Dasyurus maculatus*)

i. Statewide Abundance and Conservation Status

This species occurs on the east coast and tablelands of New South Wales, covering both sides of the Great Divide. In northern New South Wales, it is found in the Richmond, Clarence, Bellinger, Macleay, Hastings, Camden Haven, Manning and Hunter Valleys (NPWS, in publication). The highest numbers of recordings have been made on the New South Wales far north coast, particularly within large, non-fragmented forest areas (Osborne, 1982; Pulsford, 1982). This species is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. Reasons for listing include a severely reduced population and distribution and severe threatening processes.

ii. Immediate Regional Abundance

This species has been recorded at numerous scattered locations throughout the region including Manning River District National Forest, Myall Lakes National Park, Bulahdelah State Forest and Wang Wauk State Forest, indicating that it is moderately common within the region.

iii. Local Abundance

This species has been recorded at numerous locations in the locality, including Kiwarrak State Forest, and an area east of the subject site.

iv. Habitat Requirements

This species is generally found in areas that have an annual rainfall in excess of 1000 mm. Wet and dry sclerophyll forests and rainforests with a variety of understoreys are preferred habitat for this species (Mount King, 1993). The Tiger Quoll will utilise cleared areas adjacent to forests for feeding and is known to occur in habitats modified by humans (Mount King, 1993).

v. Home Range

Tiger Quolls have a home range in the order of 500 hectares (Serena and Soderquist, 1989; cited in Goldingay, 1994).

vi. Feeding Requirements

This species is nocturnal and an opportunistic hunter of a variety of prey including birds, their young, rats, other small terrestrial and arboreal mammals, gliding possums, small macropods, reptiles and arthropods. The Tiger Quoll will scavenge the carcasses of domestic stock (Edgar, 1983).

vii. Roosting / Breeding and Sheltering Requirements

This species lives in rock caves and hollow logs or trees, sheltering in these areas during the day, with basking sites often found nearby (Edgar, 1983). Family groups share a den, with both males and females aggressively defending it (NPWS, in publication). The breeding season extends from April to July. Gestation period lasts for 21 days and the average litter size is five (Edgar and Belcher, 1995). The young are attached to the teat for approximately seven weeks, during which time the male will bring food to the suckling mother. After this time the young will remain in the den until they are 14 weeks old, when they will begin to venture out of the den, becoming independent at five months (Cronin, 1991). Maturity is reached at the age of one year.

viii. Habitat Distribution in the Study Area

The Tiger Quoll may utilise all of the habitats available in the study area to some degree, for both foraging and breeding purposes.

ix. Threatening Processes

The main threat to this species is habitat destruction and modification (NPWS, in publication). A marked reduction has occurred in the distribution of this species associated with land clearing (Edgar, 1983). Edgar (1983) noted 'if the last forest areas in which it is found are opened up by logging, it may become so thinly distributed that it will be unable to survive.' Another threat is direct competition with and predation by the fox, feral dog and cat (NPWS, in publication).

x. Impact From Proposal

Clearing may reduce the amount of habitat available for this species, although it is likely to constitute only a small area of a larger home range.

xi. Ameliorative Measures

Progressive rehabilitation will ensure that the impact of the proposal on this species is ameliorated to the greatest possible extent. A speed limit for quarry transport on internal roads would help mitigate any possible collisions with this species.

4.4.3 Brush-tailed Phascogale *(Phascogale tapoatafa)*

i. Statewide Abundance and Conservation Status

The Brush-tailed Phascogale occurs in the north-eastern and south-eastern portions of New South Wales, but is absent from the region between 33-35°S. In northern New South Wales, this species has been recorded in the Brunswick, Richmond, Clarence, Bellinger, Macleay, Hastings, Camden Haven, Manning and Hunter valleys (NPWS, in publication). It is listed on Schedule 2 (Vulnerable) of the TSC Act 1995. Reasons for listing are a severely reduced population and distribution and severe threatening processes. This species is also an ecological specialist (Lunney *et* al, 1992). It is considered potentially vulnerable with a 10-50% decrease in population levels.

ii. Immediate Regional Abundance

This species has been recorded at numerous scattered locations throughout the region including Bulahdelah State Forest, Kiwarrak State Forest, Coopernook and North Arm Cove, indicating that it is moderately common within the region.

iii. Local Abundance

This species has been recorded a number of times in the locality (Ecotone) indicating that it may be locally common. It has also been recorded on the subject site.

iv. Habitat Requirements

The Brush-tailed Phascogale occupies a variety of habitats with reliable annual rainfall between 500-2000 mm. It has been recorded from a range of dry sclerophyll forest types, with a sparse ground cover of herbaceous plants, grass, scleromorphic shrubs or leaf litter from sea level to 1500 metres elevation (Cuttle, 1983), although its preferred habitat is 'open dry sclerophyll forest with little ground cover, on ridges up to 600 metres altitude' (Cuttle, 1983). This species has also been found in cool temperate rainforest and wet sclerophyll forest (Dickman and McKechnie, 1985; Harden, 1976). Little is known of the precise habitat requirements of this species in New South Wales. In Victoria, it occupies forest dominated by *Eucalyptus* spp. belonging to the Box and Stringybark groups. The ground cover is comprised of sparse low herbaceous plants and leaf litter.

v. Home Range

Little is known of the ecology of this species, however, one study recorded females having exclusive but adjoining home ranges of about four to five hectares during the lactation period from August to November (Cuttle, 1983). Traill and Coates (1993) found the home ranges of this species to be in the vicinity of 37.05 hectares for females and 86.53 hectares for males.

vi. Feeding Requirements

The diet consists of small invertebrates, mostly arthropods (especially centipedes and spiders) (Cuttle, 1983), and it is an occasional predator of small vertebrates and even poultry (Soderquist, 1995).

vii. Roosting, Breeding and Shelter Requirements

Mating occurs during the winter months. Females give birth to eight or more young after a gestation period of around 30 days. Lactation occurs from August to November when food is most abundant. Females raise only one litter per year. All males die shortly after mating due to stress related diseases, although most females survive to breed a second year (Cuttle, 1983). Brush-tailed Phascogales spend the day in a nest lined with leaves or shredded bark inside a tree hollow, sometimes

shared with others (Cuttle, 1983). An individual may use more than 20 nests in a single year, including hollow tree limbs, rotted stumps and globular birds nests (Soderquist, 1995).

viii. Habitat Distribution in the Study Area

The Open Forest habitat would provide suitable resources for this species in the study area.

ix. Threatening Processes

Habitat clearing and disturbance by fire, grazing or logging are considered to be the major threats to this species (Austeco, 1994). In addition, low population densities and annual male die-offs make this species vulnerable to localised extinction (Soderquist, 1995).

x. Impact From Proposal

The Brush-tailed Phascogale will be affected by a loss of habitat, reducing the resources available for roosting, nesting and foraging. The area to be cleared is likely to constitute only part of a greater home range. Traffic on the internal road may present a barrier to movement of displaced individuals, which may result in an increase in road mortality. The road is already existing however.

xi. Ameliorative Measures

The progressive rehabilitation of the disturbed areas using locally endemic plant species will ensure that the impact of the proposal on this species is ameliorated in the long term. In the short term, nest boxes should be provided for this species, as well as excluding cattle from the bushland in the study area and a number of other site-specific measures. A speed limit should be adhered to on the internal quarry road to reduce fauna mortality associated with traffic. Tree removal should not occur between May and December when hollows are being used for nests.

4.4.4 Koala (*Phascolarctos cinereus*)

i. Statewide Abundance and Conservation Status

In New South Wales, Koalas occur mainly on the central and north coast ranges and adjacent slopes, extending from the Queensland border to Sydney. Their

distribution is sparse and scattered west of the Great Dividing Range and on the south coast. Koala densities are highest 'on the north coast with concentrations around Port Stephens, from Bulahdelah to Taree, Port Macquarie and Coffs Harbour and between Lismore and Tweed Heads' (Reed *et al*, 1990). The Koala is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. Reasons for listing include a severely reduced population and distribution, poor recovery potential and severe threatening processes.

ii. Immediate Regional Abundance

This species is recorded frequently throughout the entire region, with over 2000 current recordings at Port Stephens, indicating that it is common within the region.

iii. Local Abundance

This species has been recorded a number of times in the locality, particularly in Kiwarrak State Forest, indicating that it may be common in forest surrounding the study area.

iv. Habitat Requirements

This species occurs in eucalypt forest and woodlands and is most abundant in coastal woodlands and in forest growing on high nutrient soils from sea level to 1200 metres elevation. With the exception of the north coast, Koalas are recorded mainly near rivers, particularly in the inland part of their range. This species is rare or absent in wet forest comprising mainly rainforest species and mallee vegetation. Koalas are essentially limited to areas where there are suitable food trees. While this species shows great preference for certain species within New South Wales, Koalas have been recorded in 51 of the 211 *Eucalyptus* species listed for the state (Reed *et al*, 1990). Koalas show a strong preference for large trees and for specific trees within communities (Hindell and Lee, 1987; 1988).

v. Home Range

Koalas are essentially solitary, sedentary animals living in the same restricted area over successive years. The home ranges of several individuals overlap and adult males have larger home ranges, and move more frequently (particularly during the breeding season) than females. Home range size is influenced by the density of large trees (ie. they are smaller in areas with high densities of large trees), and by the population density (smaller in areas with high population densities) (Mitchell, 1990). Home range sizes of 1.7 and 1.2 hectares have been recorded for male and female

Koalas respectively on French Island Victoria, and 3.1 and 2.1 hectares in Brisbane Ranges National Park near Melbourne (Mitchell, 1990; Hindell and Lee, 1988). In coastal northern New South Wales, populations have been estimated to range from one animal every 45 hectares to one every 4.5 hectares (average one every 20-25 hectares) (Austeco, 1994). Most male young disperse at two to three years of age and females remain in their natal area (Martin, 1983). If no suitable territory is found by the young Koalas they become nomadic.

vi. Feeding Requirements

Koalas feed predominantly on the foliage of certain species of eucalypts. Likely food trees in the region include primary browse trees such as Forest Red Gum, Swamp Mahogany, Grey Gum, Tallowwood and Sydney Blue Gum. Occasional browse trees such as Blackbutt, Broad-leaved Paperbark, Needlebark Stringybark and Red Mahogany are also common in the region. There are marked changes in diet throughout the year and at different sites (Martin and Lee, 1984; Reed *et al*, 1990).

vii. Roosting, Breeding and Shelter Requirements

Koalas sleep during the day in a fork of a tree, usually those trees they fed on the previous night or will feed on the following night. Breeding is seasonal with mating taking place during October to February and most births occurring between November and late March. Females produce one young per year. The young remains in the pouch for 6-7 months and is weaned by about 12 months of age (ie in spring and summer when eucalypts have nutrient rich new leaf growth). Females become sexually mature at three years of age and males at four years old. Koalas appear to be polygamous with the ranges of dominant males overlapping the ranges of several females (Lee and Martin, 1988; Mitchell, 1990).

viii. Habitat Distribution in the Study Area

The Open Forest habitat would provide the most suitable habitat for this species on site.

ix. Threatening Processes

Losses in Koala populations are due to overbrowsing, starvation, disease and drought-induced mortality as a result of loss of optimum habitat and fragmentation of the remainder (Reed and Lunney, 1990). A survey of Koalas in the lower Clarence Valley (Reed and Lunney, 1990) showed very few Koalas on the low nutrient soils or steep slopes which characterise the National Parks and Nature Reserves; twelve of

the twenty colonies overlapped with State Forests, but all colonies overlapped rural land. The distribution of the Koala is closely linked to the tree species which grow on high nutrient soils, such as those of the river valleys. These areas in general have been extensively cleared for agriculture (Reed and Lunney, 1990). The greatest threat to the survival of the Koala is destruction of habitat (Pahl *et al*, 1990; Hume, 1990) and survival of the Koala is dependent on the efforts of private landholders to provide patches of suitable habitat connected via a corridor of trees to adjacent populations of Koalas.

Other threats include a susceptibility to road kills, attacks by feral dogs and the lowering of reproduction rates due to the bacterium *Chlamydia psittaci* (Lunney *et al*, 1990).

x. Impact From Proposal

The primary impact of the proposed quarry will be a loss of potential habitat for the Koala. The most likely impact upon local Koala populations would occur in the form of reduction of home range and/or reduction of movement corridors. An increase in road kills may also occur with quarry vehicles regularly using the internal road. Koalas may also be impacted through noise from the quarry. The road however is already existing.

xi. Ameliorative Measures

The revegetation of the disturbed areas should incorporate local Koala feed tree species. As well as this, a speed limit should be enforced on the internal road to reduce mortality associated with traffic.

4.4.5 Squirrel Glider (*Petaurus norfolcensis*)

i. Statewide Abundance and Conservation Status

The Squirrel Glider is found throughout New South Wales on either side of the Great Dividing Range. Its distribution extends inland to Pilliga and Coonabarabran, and along the coast from Queensland to south of Sydney. In northern New South Wales, it has been recorded from the Tweed, Richmond, Clarence, Macleay, Hastings and Hunter valley (NPWS, in publication). It is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. Reasons for listing include severe reduction in population, reduced distribution, poor recovery potential and severe threatening processes.

ii. Immediate Regional Abundance

This species has been recorded in sparsely scattered locations throughout the region including north of Nerong State Forest and Booti Booti National Park, indicating that this species is moderately common within the region.

iii. Local Abundance

This species has been recorded around Blackhead Lagoon (Long pers comm). It has also been recorded around the junction of Blackhead and Tuncurry Roads and at Failford.

iv. Habitat Requirements

The Squirrel Glider is usually recorded from woodland and dry sclerophyll forest, although it is occasionally recorded in wet sclerophyll forest (Clancy 1986, Osborne 1982). Menkhorst *et al* (1988) found that Squirrel Gliders are usually associated with vegetation communities dominated by mature, hollow-bearing eucalypts and often mature acacias.

v. Home Range

Home ranges for the Squirrel Glider are approximately 20-30 hectares (Cronin, 1991).

vi. Feeding Requirements

Acacia gum, eucalypt sap and insects form the primary components of the Squirrel Gliders' diet (Suckling, 1995).

vii. Roosting, Breeding and Shelter Requirements

This nocturnal species shelters in leaf-lined nests in tree hollows in family groups (Suckling, 1983). This species is sexually mature at approximately 12 months, with mating occurring from May to December. Usually two offspring are produced and attach to one of four teats in the females forward-opening pouch. The young leave the pouch at about 70 days, but remain in the nest for a further 30 days. Weaning occurs at approximately 120 days (Cronin, 1991).

viii. Habitat Distribution in the Study Area

The Open Forest habitat would provide suitable resources for the Squirrel Glider on site. These communities provide some mature hollow-bearing trees for shelter and mature Acacia trees for feeding. The woodland habitat may be utilised for feeding.

ix. Threatening Processes

The clearance of open woodland areas for agricultural purposes has had a significant impact on the Squirrel Glider (Suckling, 1983), as have forest operations which have reduced the abundance of tree hollows.

x. Impact From Proposal

Traffic on the internal road may increase road kills of this species on site if they are displaced by clearing. The proposal may also decrease the amount of available habitat for this species, if it occurs on site. Outright mortality may occur if this species utilises the hollows on the subject site.

xi. Ameliorative Measures

Removal of hollow bearing trees should not occur during the peak mating and nesting period for the Squirrel Glider, which is between May and December. The trees either side of quarry roads should be retained as close to the road verge as possible to facilitate gliding of this species. Enhancing habitat in the remaining bushland should also be undertaken to ameliorate impacts.

4.4.6 Yellow-bellied Glider (*Petaurus australis*)

i. Statewide Abundance and Conservation Status

This species is restricted to eastern Australia and occurs along the entire eastern edge of New South Wales, although its occurrence within this area is extremely patchy. In northern New South Wales, this species has been recorded from the Richmond, Clarence, Bellinger, Macleay, Hastings, Camden Haven, Manning, and Hunter valleys (NPWS, in Publication). It is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. Reasons for listing are a severely reduced population and distribution, poor recovery potential and severe threatening processes.

ii. Immediate Regional Abundance

This species has been recorded at numerous locations throughout the region including Wang Wauk State Forest, Kiwarrak State Forest and Nerong State Forest. The majority of recordings have been made in State Forests, indicating that this species is most likely to be regionally rare.

iii. Local Abundance

This species has been recorded in the locality in Kiwarrak State Forest.

iv. Habitat Requirements

Yellow-bellied Gliders favour tall, mature forest with a range of *Eucalyptus* species, especially smooth barked species such as *E. viminalus, E. fastigata, E. ovata* and *E. cypellocarpa* which shed their bark annually and hence provide not only sap but insects which shelter in the loose bark (Kavanagh, 1988). The highest densities of gliders have been found in 'mature forests with sufficient diversity of favoured eucalypt species to provide a year round supply of food' (Kavanagh, 1987). On the New South Wales north coast dry sclerophyll forests were determined as being preferred habitats for the Yellow-bellied Glider by Mackowski (1986), with common species being Grey Gum, Blackbutt and Spotted Gum. However, Russells (1995) states that mature wet eucalypt forest is the preferred habitat of the species. This species is very agile, running beneath branches and gliding for up to 120 metres.

v. Home Range

This species lives in small family groups, with home ranges estimated to range between 32 and 65 hectares (Goldingay and Kavanagh, 1991; Mackowski, 1986). There is little overlap in the home-ranges of adjacent groups.

vi. Feeding Requirements

The Yellow-bellied Glider has a diverse diet consisting of nectar, pollen, *Eucalyptus* sap, manna (a sugary exudate produced at the site of insect damage by some *Eucalyptus* and *Angophora* species), invertebrates (including beetle larvae, cockroaches, spiders and isopods) and insect exudates (Henry and Craig, 1984; Craig, 1985; Goldingay, 1986). The components of its diet are all seasonal in availability, therefore a critical factor influencing potential habitat appears to be the presence of specific tree species and assemblages (Goldingay, 1986; Kavanagh, 1986; 1987). These assemblages must be within close proximity, and able to provide a

year-round food supply. When foraging they travel for up to two kilometres and can occasionally be seen feeding in small groups from the same tree.

vii. Roosting, Breeding and Shelter Requirements

This species is mainly nocturnal, sheltering in nests in tree hollows lined with leaves during the day (NPWS, in publication). Dominant males may live with up to five females and their young. This species becomes sexually mature at 18-24 months. Mating occurs from November to May, with a single young being born. It attaches to one of two teats in the female's forward-opening pouch. It remains in the pouch for about 100 days and then the nest for another 60 days (Russell, 1983). The young become independent at 180-240 days but remain with the parents until they are sexually mature. Mortality of sub-adult males is probably high due to harassment by the dominant male of the group (Russell, 1983).

viii. Habitat Distribution in the Study Area

This species may be found within the Open Forest habitat in the study area, utilising it for nesting and foraging.

ix. Threatening Processes

Clearing of habitat and forest harvesting methods leading to even-aged stands pose a threat to this species. Even-aged stands lead to a decrease in hollow bearing trees necessary for dens.

x. Impact From Proposal

Expansion of the quarry may impact upon the Yellow-bellied Glider through the removal of feeding and nesting habitat. While the Yellow-bellied Glider may be affected by loss of foraging and roosting resources, the home range incorporates a much larger area. Felling of nesting trees may affect individuals or family groups.

xi. Ameliorative Measures

The provision of nest boxes within a habitat enhancement program would provide compensatory nesting habitat in the short term. The trees either side of quarry roads should be retained as close to the road verge as possible to facilitate gliding of this species. Progressive rehabilitation should be undertaken, utilising locally endemic species.

4.4.7 Parma Wallaby (*Macropus parma*)

i. Statewide Abundance and Conservation Status

The Parma Wallaby is restricted to coastal areas, from the Nightcap Ranges in the north, south to the Bega District. In north-eastern NSW it has been recorded in the Brunswick, Richmond, Clarence, Macleay, Hastings, Manning and Hunter River Valleys during the last 20 years. This species is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. Austeco (1994) documents it as being once considered extinct in Australia, but now apparently stable with a 10 to 50 per cent decline in population levels.

ii. Immediate Regional Abundance

This species has been recorded in Manning River District National forest, the northern end of Myall Lakes National Park and also infrequently in Myall River State Forest, indicating that it is relatively uncommon within the region.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

The parma wallaby is found in wet and dry sclerophyll forests and occasional in rainforests, however, its optimum habitat appears to be wet sclerophyll forest with a thick shrubby understorey, coupled with grassy understorey forest patches (Maynes, 1977). This species appears to favour communities with blady grass and tussock grass, and fewer herbs and other grasses (Read and Fox, 1991). Johnson (1977) found them grazing pasture and sheltering in rainforest.

iv. Home Range

The Parma Wallaby is a mainly solitary species, occasionally grazing in small groups with 2-3 others. It has a home range of about 22 hectares (NPWS, in publication).

v. Feeding and Shelter Requirements

This species follows well-worn paths through the forest to open grassy feeding areas. Their diet is composed of various grasses and herbs (Cronin, 1991). The parma wallaby shelters in the dense shrubs during the day, emerging at dusk or shortly before (Maynes, 1995) into more open areas to feed (Strahan, 1991).

vi. Roosting, Breeding and Shelter Requirements

Breeding occurs throughout the year with the majority of births from February to June. 33-36 days after mating a single young is born and attaches to a teat in the mother's pouch. It remains in the pouch for approximately 30 weeks and then continues to suckle at foot until 10 months old. 45-105 days after birth the mother usually mates again, but the embryo remains dormant until the pouch is vacated (Cronin, 1991). Females become sexually mature at 1-1.5 years old, males at approximately 22 months of age.

viii. Habitat Distribution in the Study Area

All vegetation communities present in the study area may by utilised by the Parma Wallaby for foraging and breeding purposes. The Open Forest (particularly the Depauperate Rainforest) would be most critical to this species' survival.

ix. Threatening Processes

Threats to this species include clearing and modification of its habitat. Destruction of the understorey through logging, burning or grazing also increases predation by foxes and dogs.

x. Impact From Proposal

The Parma Wallaby may be affected by a loss of foraging and shelter resources, however this species is relatively mobile and would be able to move on to other areas incorporated in the species home range. It may experience traffic mortality if it is displaced by development of Block B.

xi. Ameliorative Measures

A speed limit should be adhered to on the internal quarry road to reduce Parma Wallaby mortality associated with traffic. Habitat enhancement of remaining bushland and progressive rehabilitation of disturbed areas should also be undertaken.

4.5 BATS

4.5.1 Greater Broad-nosed Bat *(Scoteanax rueppellii)*

i. Statewide Abundance and Conservation Status:

This species is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. Reasons for listing include a reduced population and severe threatening processes (Lunney *et al*, 1992). This species is restricted to eastern New South Wales, with isolated occurrences in eastern Queensland. It is found over a wide range of elevations.

ii. Immediate Regional Abundance

This species has been recorded at Kew, in Manning River District National Forest and in Booti Booti National Park, indicating that it is most likely to be regionally rare.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

This species is found in a range of vegetation types from dry sclerophyll forest to rainforest (Richards, 1983a). Preferred habitat is moist river and creek systems of the ranges, but it also occurs in lower numbers on the coast (Shortland Wetlands Centre, 1993). The Greater Broad-nosed Bat does not occur at altitudes above 500 m (Hoye and Richards, 1995).

v. Home Range

The distances travelled during the nightly foraging activities are unknown for this species.

vi. Feeding Requirements

Tree-lined creeks and the junction of woodland and cleared areas are favoured hunting grounds for this species (Richards, 1983a). This species has a varied insectivorous and carnivorous diet. It has the unusual habit or preying on other bat

species in the same bat trap and probably includes vertebrate prey as part of its normal diet (NPWS, in publication).

vii. Roosting Requirements

This species is dependent on tree hollows for roost sites, but details of hollow requirements are not known (Richards, 1983a). The reproductive biology of this species is unknown, however, a single young is born in January (Cronin, 1991).

viii. Habitat Distribution in the Study Area

This species may utilise the entire range of fauna habitats in the study area, using the forest types for roosting and foraging and the open areas for foraging only.

ix. Threatening Processes

The main threats to this species include the use of pesticides, loss of tree hollows and habitat modification and destruction (NPWS, in publication). Modification of the age structure of forests that interfere with the continual succession of mature hollow bearing trees is a significant threat to this species.

x. Impact From Proposal

Individuals of this species may be affected by the proposed activities through the removal of habitat trees for quarrying activities. Bats may be killed outright or suffer a decline as a result of habitat loss. It is unlikely that any significant loss of foraging habitat would occur. In addition, local populations may be affected if roosts occur in the proposed extraction area.

xi. Ameliorative Measures

Progressive replanting with native tree species will ensure that the impact of the proposal on this species is ameliorated to the greatest practical extent in the long term. The provision of roost boxes would provide compensatory habitat until the rehabilitated areas are mature. Clearing should not be undertaken in winter months when bats are in winter hibernation.

4.5.2 Large Bent-wing Bat (*Miniopterus schreibersii*)

i. Statewide Abundance and Conservation Status

This species is widespread throughout coastal areas of New South Wales, generally east of the western slopes of the Great Divide. It is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. The reasons for listing include the population of this species is reduced, but suspected to be stable. This species is an ecological specialist which tends to concentrate in specific areas (roosting) and has severe threatening processes (Lunney *et al*, 1992).

ii. Immediate Regional Abundance

This species has been recorded in Bulahdelah State Forest, Wang Wauk State Forest and Crowdy Bay National Park, indicating that it is moderately uncommon within the region.

iii. Local Abundance

This species has been recorded during the bat survey undertaken for this Species Impact Statement. It has not been recorded otherwise, therefore indicating that this species is locally uncommon.

iv. Habitat Requirements

This species occurs in a broad range of habitat types and altitudinal ranges (Dwyer, 1983a). It is a fast flying bat, but lacks manoeuvrability and forages above the forest canopy or in uncluttered environments.

v. Home Range

Dwyer (1968) studied the movements of the species in northern New South Wales. Regional movements of up to several hundred kilometres occur in response to seasonal reproductive behaviour and winter hibernation. Movement patterns differ between males and females, adults and sub-adults, and warmer coastal inhabitants and cooler northern escarpment populations. Distances travelled in one night for foraging purposes are unknown.

vi. Feeding Requirements

This species forages for insects above the canopy (Dwyer, 1995).

vii. Roosting, Breeding and Sheltering Requirements

This species roosts in caves which have high humidity and relatively large entrances which lack sharp turns. These caves contain small domes in the ceiling, enabling trapped air to be warmed by the body heat of bats, which can increase the air temperature by as much as 10°C (Dwyer, 1983a). Females form maternity colonies during spring and summer, bearing single young throughout December. Nearly all adult females in a population aggregate in the one maternity colony and suitable caves are critical for the survival of this species (NPWS, in publication). Individuals become reproductively mature at age two and can live in excess of 17 years (Dwyer, 1983a).

viii. Habitat Distribution in the Study Area

This species is cave-roosting and would not be expected to roost during the day in the study area. This species may use the open forest habitat for foraging purposes.

ix. Threatening Processes

The primary threats to this species include the use of pesticides and the destruction or modification of caves used as roosts. Habitat modification and destruction, especially in areas surrounding maternity caves is also a critical threat. Disturbance of hibernating colonies during the winter months can cause starvation due to loss of energy reserves, therefore recreational caving and tourism pose potential threats to this species (NPWS, in publication).

x. Impact From Proposal

As no roosts for this species would be expected on site and it is known to forage in open areas, it is unlikely that this species will be significantly affected by the proposed activities.

xi. Ameliorative Measures

Replanting with endemic plant species which currently exist on site will ensure that the impacts of the proposal on this species are ameliorated to the greatest practical extent in the long term.

4.5.3 Little Bent-wing Bat (*Miniopterus australis*)

i. Statewide Abundance and Conservation Status

This species is found on the north-eastern coastal areas of New South Wales, extending from the Queensland border southwards to the Manning Valley. It is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. Reasons for previous listing on NPW Act include: this species is an ecological specialist, its population and distribution are suspected to be reduced and threatening processes are severe (Lunney *et al*, 1992).

ii. Immediate Regional Abundance

This species has been recorded at numerous scattered locations throughout the region including Booti Booti and Myall Lakes National Parks, Wang Wauk State Forest and Myall River State Forest, indicating that it is moderately common within the region.

iii. Local Abundance

The Little Bent-wing Bat has been recorded during the bat survey undertaken for this Species Impact Statement. This species has been recorded near the village of Hallidays Point (Bell, pers comm), and also near Failford.

iv. Habitat Requirements

This species is found in a range of well-timbered habitats, with dense vegetation. Such vegetation includes Wet Sclerophyll Forest, Rainforest or Dense Coastal Banksia Scrub (NPWS, in publication). This species also occurs in Dry Sclerophyll Forests (Cronin, 1991).

v. Home Range

Most overall movements between roost sites are less than 32 km, with 60 km being the maximum distance recorded. The maximum distance moved between roost sites in any single night is 28 km (NPWS, in publication). Currently there is no data available on foraging distances travelled during one night.

vi. Feeding Requirements

This species appears to forage between the understorey and canopy of well-timbered habitats in search for insects (Dwyer, 1983b).

vii. Roosting, Breeding and Shelter Requirements

This species roosts during much of the year in small scattered roosts in caves, mines, tunnels, culverts and suitable buildings during the day (Cronin, 1991). In spring, females move to suitable nursery caves where a single young is born in December (Dwyer, 1983b). These maternity sites are normally situated in limestone cave systems, which provide sufficient temperature and humidity to raise the young. This species is known from the Yessabah Caves west of Kempsey to the north of the study area. At this site the Little Bent-wing Bat forms a maternity colony with the Large Bent-wing Bat, possibly relying on their larger numbers to artificially increase the ambient roost temperature (NPWS, in publication). The bats begin to assemble in the maternity cave from August and September, decrease in numbers during February-March and the cave is totally disbanded before early April.

viii. Habitat Distribution in the Study Area

This species is cave-roosting and would not be expected to roost during the day in the study area due to its lack of suitable roosting sites. This species could use the majority of the area for foraging purposes.

ix. Threatening Processes

The primary threats to this species include modification and clearing of foraging habitat, pesticide use, destruction of caves and disturbance of cave roosts, especially maternity colonies and winter roosts (NPWS, in publication).

x. Impact From Proposal

As no roosts for this species would be expected on site and it is known to forage in open areas, it is unlikely that this species will be significantly affected by the proposed activities.

xi. Ameliorative Measures

Replanting with endemic plant species which currently exist on site will ensure that the impacts of the proposal on this species are ameliorated to the greatest possible extent in the long term.

4.5.4 Eastern Little Mastiff Bat (*Mormopterus norfolkensis*)

i. Statewide Abundance and Conservation Status:

The only definite records for this species are from the Clarence Valley, near Brisbane; near Sydney and a recent record just north of Kempsey. Therefore, it is expected to be found throughout mid-coastal New South Wales extending into south-eastern Queensland (NPWS, in publication). This species is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. The population and distribution of the Eastern Little Mastiff Bat is suspected to be reduced and this species has moderate threatening processes. This species is also an ecological specialist (Lunney *et al*, 1992) which tends to concentrate in specific sites (caves for roosting).

ii. Immediate Regional Distribution and Conservation Status

This species has been recorded just south of Bulahdelah indicating that it is most likely to be regionally rare.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

Its habitat requirements are largely unknown, however, it appears to favour dry eucalypt forest but has also been recorded from rainforest fringing rivers (G.A. Hoye, pers.comm.). This species has commonly been confused with other *Mormopterus* species, with very few specimens found in museum collections from its entire geographic range (NPWS, in publication).

v. Home Range

The home range of this species is not known.

vi. Feeding Requirements

This species has limited manoeuvrability and forages above the forest canopy and in clearings for insects taken in flight. It also forages on the ground for terrestrial insects (Cronin, 1991; Allison, 1983a).

vii. Roosting, Breeding and Sheltering Requirements

Although it has previously been recorded roosting in tree hollows in eucalypts, its roost preferences are largely unknown (G. Hoye, pers.comm.). Small colonies have been found roosting in tree hollows and under loose bark, as well as rock crevices, river banks and buildings (Allison, 1983a; Mount King, 1992). Individuals have been recorded in the roof of huts (Allison and Hoye, 1995). The breeding requirements for this species are largely unknown, however, it is likely that births occur during November or December, with weaning over a month later, as with many other *Mormopterus* species.

viii. Habitat Distribution in the Study Area

This species is likely to utilise all of the habitats on the study area. The forested habitat would be utilised for roosting and foraging requirements.

ix. Threatening Processes

Similar to most tree roosting, insectivorous bats, threats include pesticides and habitat destruction and modification, specifically the loss of trees with hollows.

x. Impact From Proposal

The vegetation to be removed for quarry operations may contain suitable tree hollows for this species to roost in. Therefore, the proposal may result in a loss of roost sites for this species. Due to the relatively small area to be cleared, the manoeuvrability of this species and the abundance of foraging and roosting habitat remaining on the study area, the proposal is unlikely to impact upon foraging habitat for this species.

xi. Ameliorative Measures

Replanting with native tree species will ensure that the impact of the proposal on this species is ameliorated. The provision of nest boxes would provide

compensatory habitat in the short term. Clearing should not be undertaken in winter months when bats are in hibernation.

4.5.5 Great Pippistrelle (*Falsistrellus tasmaniensis*)

i. Statewide Distribution and Conservation Status

This species has been recorded throughout NSW from the highlands to the coast. In north-eastern NSW the Great Pipistrelle is widespread and localised, probably restricted to higher elevation temperate forests. This species is listed on Part 2 (Vulnerable) of the TSC Act 1995. Reasons for listing include a suspected reduction in population and distribution and severe threatening processes. This species is also an ecological specialist (Lunney *et al*, 1992).

ii. Immediate Regional Abundance

This species has previously been recorded in Doyles River State Forest, Ballengarra and Kippara State Forest.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

Very little is known of this species biology and it is poorly represented in museum research collections. It has primarily been recorded in open, tall wet sclerophyll forests. In NSW it is suspected that some populations migrate in winter from the highlands to coastal areas (Parnaby, 1983).

v. Home Range

Radio tracking studies in Victoria have revealed nightly movements of approximately 13 kilometres between roost trees (NPWS, in publication).

vi. Feeding Requirements

Analysis of stomach contents of specimens from NSW revealed that this species eats moths and occasionally beetles and ants. However, this information was obtained from only a small number of animals (eight) (Parnaby, 1983).

vii. Roosting, Breeding and Shelter Requirements

This species primarily roosts in tree hollows, although they are also found in caves in the Jenolan area and occasionally elsewhere in abandoned buildings (Parnaby 1983). The breeding requirements of this species are poorly known. In Victoria, Great Pipistrelles give birth to a single young, however the month of birth is unknown (Parnaby, 1983).

viii. Habitat Distribution in the Study Area

This species may occur on site in the suitably wooded areas. Preferred habitat for this species occurs in the ranges to the west.

ix. Threatening Processes

One of the most serious threats to this species' survival is loss of roosting trees due to intensive forestry operations resulting in a loss of mature hollow-bearing trees (Parnaby, 1983). Changes to the structure of forests and woodlands that disrupt the continual succession of mature hollow-bearing trees are also a threat. Pesticide use may also threaten the survival of this species (NPWS, in publication).

x. Impact From Proposal

The vegetation to be removed by quarry operations may contain suitable tree hollows for the species to roost in. Therefore, the proposal may result in a loss of roost sites for the species. A loss of foraging habitat will also occur.

xi. Ameliorative Measures

The impact of this species through a loss of roosting habitat will be reduced through progressive rehabilitation of the site during and beyond the life of the quarry. This rehabilitation should incorporate a high number of plant species taken from local seed stock. Clearing of vegetation should not occur from June to August, when this species is thought to migrate from mountainous areas to the coastal strip. The provision of nest boxes would provide compensatory habitat in the short term.

4.6 REPTILES

4.6.1 Stephen's Banded Snake (*Hoplocephalus stephensi*)

i. Statewide Distribution and Conservation Status

This species occurs on the coastal side of the Great Dividing Range from approximately the Gosford area northwards to the Queensland border. Within north-eastern New South Wales it has been recorded from the Tweed, Richmond, Clarence, Bellinger, Macleay, Camden Haven and Hunter River valleys (NPWS, in publication). This species is listed on Part 2 (Vulnerable) of the TSC Act, 1995. It has been identified by Ehmann (1992) as rare to sparse.

ii. Immediate Regional Abundance

This species has been recorded at Bombah Point, Myall Lakes National Park, Smiths Lake and Manning River District National Forest, indicating that it is moderately rare within the region.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

Stephen's Banded Snake is found in a variety of habitats including dry rainforest, sub-tropical rainforest, wet sclerophyll forest, dry sclerophyll forest and rock outcrops, especially granite. It has been recorded from near sea level up to 950 metres in elevation. This species lives and shelters primarily in trees and is particularly dependent on tree scar crevices. An important feature of its habitat appears to be the close proximity to a variety of forest formations (NPWS, in publication).

v. Home Range

The exact home range of this species is unknown, however in rainforests of the Border Ranges this species was recorded at densities of 0.7 per hectare or one animal per 1.4 hectares (Austeco, 1994). Studies in other regions have not been undertaken.

vi. Feeding Requirements

Stephen's Banded Snake feeds on lizards (primarily geckos and skinks), frogs, small mammals (including bats which cohabit its shelter), and possibly birds (Ehmann, 1992).

vii. Roosting, Breeding and Shelter Requirements

This species shelters during the day between decorticating bark and tree trunks, scar crevices, hollow trunks, limbs and rock crevices or under slabs (Ehmann, 1992). This species is primarily nocturnal, but may occasionally be seen basking in sheltered sites during mild weather (NPWS, in publication). Mating of this species occurs from late spring to early summer. Three to eight, with an average of six, live young are born in late summer to early autumn (Shine 1983). The female only reproduces every second year (Ehmann, 1992).

viii. Habitat Distribution in the Study Area

This species may utilise the forested habitats for foraging and breeding purposes.

ix. Threatening Processes

The principal threat to this species is habitat removal and modification. Loss of large trees from sclerophyll forests poses a threat to this species and results from forest harvesting, timber stand improvement and increased fire frequencies for fuel reduction or grazing management (NPWS, in publication).

x. Impact From Proposal

Stephen's Banded Snake could be impacted by the proposal through a loss of habitat. This species may be impacted by road mortality if it is displaced by quarry expansion.

xi. Ameliorative Measures

The impact on this species through loss of habitat will be reduced by progressive rehabilitation of the site during and beyond the life of the quarry. This rehabilitation should incorporate a high number of plant species taken from local seed stock. A speed limit on the internal roads and an awareness program to alert drivers of fauna in the area may limit possible road mortality. Habitat enhancement in remaining

bushland would also assist in mitigating the impacts of the proposal. Clearing should be undertaken outside of winter months when snakes are in winter torpor.

4.6.2 Pale-headed Snake (*Hoplocephalus bitorquatus*)

i. Statewide Distribution and Conservation Status

This species occurs on both sides of the Great Dividing Range from Sydney in the south to the Queensland border. This species is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995.

ii. Immediate Regional Abundance

This species has been recorded at Myall River State Forest.

iii. Local Abundance

This species has not been recorded in the locality.

iv. Habitat Requirements

This species favours wet and dry sclerophyll forest and woodland, preferring those with *Callitrus* sp. Occasionally, rainforests are utilised. In the western, drier portion of this species' range, it is primarily dependent on riparian vegetation (Ehmann, 1992).

v. Home Range

The home range of this species is unknown.

vi. Feeding Requirements

The Pale-headed Snake feeds upon small reptiles (Sutherland, 1994).

vii. Roosting, Breeding and Sheltering Requirements

This nocturnal, mainly arboreal species is frequently found beneath loose bark on trees, or in hollow trunks and limbs of dead trees. It is also found close to watercourses (NPWS, in publication; Gow, 1989). Mating takes place during spring,

with between two and 17 (average of five) live young born from February to March (Ehmann, 1992). It is thought females probably only reproduce every second year.

viii. Habitat Distribution in the Study Area

Vegetation communities on site do not contain *Callitris* sp. which are preferred by the Pale-headed Snake. However, dead trees, occasional hollows and decorticating bark at the base of some trees in the Open Forest habitat are suitable for this species.

ix. Threatening Processes

The primary threat to this species is habitat loss and fragmentation. Forest harvesting and higher fire frequencies leading to a reduction in the potential life span of trees pose a threat to this species due to a loss of sheltering requirements. Predation by foxes and cats may also be threatening this species.

x. Impact From Proposal

The Pale-headed Snake could be impacted by the proposal through traffic on the internal road it if is displaced which could also result in higher road mortality of this species.

xi. Ameliorative Measures

A speed limit on the internal roads may limit possible road mortality. Progressive rehabilitation should be undertaken to mitigate impacts in the long term. Habitat enhancement in the remaining bushland would also assist in mitigating impacts. Clearing should be undertaken outside winter months when snakes are in winter torpor.

4.7 FLORA

4.7.1 Rudder's Box (Eucalyptus rudderi)

Description: A medium-sized to tall forest tree with light grey, box-type bark persistent on the trunks and branches. Adult leaves are narrow lanceolate and concolourous in the coastal forms and broad lanceolate and discolourous in forms north-west of Wyong. The leaf is 130 by 30 millimetres in size. Flowers are white and flowering occurs from February to March. Fruit is hemispherical to barrel-

shaped with three or four valves to rim level or slightly enclosed (Brooker and Kleinig, 1983).

i. Conservation Status

This species is not listed as 'threatened' on the schedules to the TSC Act, however it is listed by Briggs and Leigh (1994 in prep.) as a Rotap species. The risk code for this species is *3RC-* (Briggs and Leigh, 1996). A *3RC-* coding means that this species has a distribution ranging over 100 kilometres but tends to occur in small populations. Rudders Box is considered rare in Australia but not currently considered endangered or vulnerable, which means that at least one reasonable population of this species is known to occur within a secure habitat. This species is reserved within Rudders Box Flora Reserve located in Kiwarrak State Forest, approximately 15-20 kilometres south of the study area.

ii. Distribution at a Local, Regional and Statewide Level

Local Distribution: This species was recorded on the subject site during the flora survey for this report.

Immediate Regional Distribution: Recorded in Kiwarrak State Forest and at a location north of Taree (ROTAP data search).

Statewide Distribution: This species is confined to the Taree/Karuah District (Harden, 1991). The Taree Forestry Management Plan recognises this species as having an uncommon, but widely scattered distribution in the Manning and Hunter valleys.

iii. Habitat Requirements

Occurs in wet sclerophyll or dry sclerophyll forest on sloping soil of medium fertility (Harden, 1991).

iv. Habitat Distribution in the Study Area

This species was found in the Dry Open Forest. *Figure 2.4* illustrates the location of the individual trees of this species.

v. Threatening Processes

Specht (1981) describes the ever-increasing pressures of urbanisation, tourism, recreation, farming, forestry etc as risking the integrity of many species of Australian plants. Threatening processes of individual Australian plant species can be generally described as anything which has altered, or is in the process of altering, the ecology in which the species have evolved and adapted.

vi. Impact From Proposal

The proposal will result in the removal of Rudder's Box trees recorded on the subject site.

vii. Ameliorative Measures

The impact of the proposal on this species will be ameliorated through re-planting of this species on site.

4.7.2 *Eucalyptus glaucina*

Description: A small medium-sized woodland tree with a short bole and a dense, branching habit. Bark decorticates over the whole trunk in large plates to leave a smooth or mottled surface of white or grey. Leaves are lanceolate (seventeen by three centimetres) and concolourous. Flowers are white with flowering period from September to November. Fruits are hemispherical up to one by one centimetre with three to five exserted valves (Brooker and Kleinig, 1983).

i. Conservation Status

This species is listed under Schedule 2 (vulnerable) of the TSC Act 1995. The risk code for this species is *3VCa* (Briggs and Leigh, 1996). A *3VCa* coding indicates that this species has a broad range but tends to occur in small populations. The Slaty Red Gum is considered vulnerable and, although not presently endangered, is in risk of disappearing from the wild over a period of 20 to 50 years. Its disappearance could occur through continued depletion or changes in landuse and clearing of populations. It has adequate populations reserved with over 1,000 individuals in Selection Flat Flora Reserve which is located in Myrtle State Forest in the Casino Forestry Management Area

ii. Distribution at a Local, Regional and Statewide Level

Local Distribution: This species has not been recorded in the locality.

Immediate Regional Distribution: This species has been recorded as occurring on Coocumbac Island (NPWS data search). However, the Taree Forestry Management Plan has no records of this species as occurring in the area, and State Forests Northern Research Centre (Coffs Harbour) has no records of this species occurring in the Taree Region (Chapman, pers comm).

Statewide Distribution: This species has a scattered distribution on the low coastal ranges and tablelands of the Mid North Coast of New South Wales, occurring around the Gresford and Gloucester area. It also occurs around Casino in Northern New South Wales (Brooker and Kleinig, 1983).

iii. Habitat Requirements

Found in grassy woodland on deep, moderately fertile and well-watered soils (Harden, 1991).

iv. Habitat Distribution in the Study Area

If this species occurs on the study area, it may be found in the vegetated habitats.

v. Threatening Processes

Specht (1981) describes the ever-increasing pressures of urbanisation, tourism, recreation, farming, forestry etc as risking the integrity of many species of Australian plants. Threatening processes of individual Australian plant species can be generally described as anything which has altered, or is in the process of altering, the ecology in which the species have evolved and adapted.

vi. Impact from Proposal

If this species occurs on the subject site, it may experience a small amount of habitat loss.

vii. Ameliorative Measures

The impact of the proposal on this species will be ameliorated through replanting of this species on site. Guided walkways will be constructed in the remaining bushland to minimise human disturbance.

4.7.3 Grevillea obtusiflora

Description: A shrub to one metre in height with untoothed, stiff, hairy leaves, 20 to 30 millimetres long and 3 to 5 millimetres wide. It has green and red flowers (Beadle, 1972).

i. Conservation Status

This species is listed on Schedule 1 (endangered) of the TSC Act 1995. The risk code for this species is 2E (Briggs and Leigh 1996). A 2E coding indicates that this species is endangered and has a distribution of less than 100 km. It is adequately reserved in the Northern Tablelands of New South Wales and has over 1,000 individuals reserved within the Blue Mountains and Oxley Wild Rivers National Parks.

ii. Distribution at a Local, Regional and Statewide Level

Local Distribution: This species has not been recorded in the locality.

Immediate Regional Distribution: Recorded at Glenthorne, Burrell Creek Mount George (ROTAP data search), and Kundibakh Creek.

Statewide Distribution: This species has a scattered distribution on the Central and Northern Tablelands and coast of New South Wales.

iii. Habitat Requirements

Found in dry sclerophyll forest or woodland on acidic substrates (Harden, 1991).

iv. Habitat Distribution in the Study Area

If this species occurs on the subject area it is likely to occur in the Open Forest and Woodland habitats.

v. Threatening Processes

Specht (1981) describes the ever-increasing pressures of urbanisation, tourism, recreation, farming, forestry etc as risking the integrity of many species of Australian plants. Threatening processes of individual Australian plant species can be generally described as anything which has altered, or is in the process of altering, the ecology in which the species have evolved and adapted.

vi. Impact from Proposal

If this species occurs on the study site, it may experience a small amount of habitat loss.

vii. Ameliorative Measures

The impact of the proposal on this species will be ameliorated through replanting of disturbed areas with locally endemic species.

4.7.4 *Grevillea granulifera*

Description: Two distinct forms of this species occur. Specimens either have strongly erect branches or slender weeping branches, a floral rachis of 10 - 13 mm long with an average 12 - 14 flowers or 2 - 5 mm long with an average of 6 - 10 flowers and a densely silky leaf or moderately dense, slightly loose, subsilky undersurface (Olde and Marriott, 1994).

i. Conservation Status

A conservation rating of 3K Ca (Briggs and Leigh, 1996) has been applied to *Grevillea granulifera*. This coding indicates that the range of this species exceeds 100 km however it is a poorly known taxon. This species is listed on the TSC Act as vulnerable.

ii. Distribution at a Local, Regional and Statewide Level

Local Distribution: This species has not been recorded in the locality.

Immediate Regional Distribution: This species has not been recorded in the region.

Statewide Distribution: This species is distributed in NSW from Mt George (near Wingham) to Polblue Creek, Barrington Tops State Forest, extending west to Woolombi Falls (Olde and Marriott, 1994).

iii. Habitat Requirements

This species inhabits ridge tops and hillsides in open forest. Most collections have been from poor, stony serpentine soil and decomposed granitic sand (Olde and Masrroitt, 1994).

iv. Habitat Distribution in the Study Area

This species is likely to occur on the ridge tops and slopes of the open forest types.

v. Threatening Processes

Specht (1981) describes the ever-increasing pressures of urbanisation, tourism, recreation, farming, forestry etc as risking the integrity of many species of Australian plants. Threatening processes of individual Australian plant species can be generally described as anything which has altered, or is in the process of altering, the ecology in which the species have evolved and adapted.

vi. Impact from Proposal

If this species occurs on the subject site, it will experience habitat loss, resulting in an overall reduction in area available for the growth of the species.

vii. Ameliorative Measures

The impact of the proposal will be ameliorated through habitat retention and replanting of the site with locally endemic plant species.

4.7.5 *Tetratheca juncea*

Description: A prostate shrub with angular flattened stems up to one metre long, usually with 2 to 3 wings. Alternate leaves are usually reduced to narrow triangular scales up to 20x5 millimetres long. Flowers are solitary or paired with four petals up to 11 millimetres long. Flowers are a deep lilac pink and flowering occurs from July to December (Harden, 1992 and Beadle, 1972).

i. Conservation Status

This species is listed on Schedule 2 (Vulnerable) of the TSC Act, 1995. The risk code for this particular species is *3VCa* (Briggs and Leigh, 1996). A *3VCa* coding indicates that this species has a distribution ranging over 100 kilometres but tends to occur in small populations. This species is considered vulnerable in Australia, ie not presently endangered but at risk of disappearing from the wild over a longer period. It is considered inadequately reserved, having 1,000 or more individuals known to occur within conservation reserves.

ii. Distribution at a Local, Regional and Statewide Level

Local Distribution: This species has not been recorded within the locality.

Regional Distribution: This species has been recorded around Nabiac, Karuah and in Bulahdelah State Forest.

Statewide Distribution: This species is found from Nabiac to Lake Macquarie. It is also recorded from Port Jackson to Botany Bay (Harden, 1992).

iii. Habitat Requirements

This species is found in sandy and occasionally swampy heath as well as in dry sclerophyll forest (Harden, 1992). In dry sclerophyll forest it is most commonly associated with Smooth-barked Apple and Bloodwood. The understorey typically comprises a range of xeromorphic shrubs and native grasses.

iv. Habitat Distribution in the Study Area

If this species occurs on the study area it would be most likely to occur in the Dry Open Forest.

v. Threatening Processes

Specht (1981) describes the ever-increasing pressures of urbanisation, tourism, recreation, farming, forestry etc as risking the integrity of many species of Australian plants. Threatening processes of individual Australian plant species can be generally described as anything which has altered, or is in the process of altering, the ecology in which the species have evolved and adapted.

vi. Impact From Proposal

If this species occurs on the subject site, it may experience a small amount of habitat loss.

vii. Ameliorative Measures

The impact of the proposal on this species will be ameliorated through replanting of the disturbed areas with locally endemic plant species.

4.7.6 *Hibbertia hexandra*

Description: This is a tall shrub or small tree, with branches stellate to hairy. Its leaves are mostly oblanceolate to elliptic, rarely spathulate, 20 - 60 mm long, 5 - 15 mm wide, apex rounded and often emarginate, base tapering, margins entire and +/- flat, upper surface tuberculate to glabrous, lower surface whitish with stelate hairs; petiole 5 - 20 mm long. Flowers are axillary, peduncle 7 - 10 mm long. Sepals are 7 - 8 mm long, stellate - hairy. Petals are 7 mm long, stamens 6, surrounding carpels. This species flowers mainly spring to early summer (Harden, 1992).

i. Conservation Status

This species is listed under schedule 1 (endangered) of the TSC Act 1995. The risk code for this species is 3RC- (Briggs and Leigh, 1996). A 3RC- coding means that this species has a distribution ranging over 100 km but tends to occur in small populations. *Hibbertia hexandra* is considered rare in Australia but not currently considered endangered or vulnerable, which means that at least one reasonable population of this species is known to occur within a secure habitat.

ii. Distribution at a Local, Regional and Statewide Level

Local Distribution: This species has not been recorded in the locality.

Immediate Regional Abundance: This species has not been recorded in the region.

Statewide Distribution: Occurs from the ranges of Mt. Warning. This species has also been collected near Wauchope (Harden, 1992).

iii. Habitat Requirements

The main habitat of this species is heath, open forest and rainforest.

iv. Habitat Distribution in the Study Area

If this species occurs on the subject site, it is likely to occur in the Open Forest habitat.

v. Threatening Processes

Specht (1981) describes the ever-increasing pressures of urbanisation, tourism, recreation, farming, forestry etc as risking the integrity of many species of Australian plants. Threatening processes of individual Australian plant species can be generally described as anything which has altered, or is in the process of altering, the ecology in which the species have evolved and adapted.

vi. Impact from Proposal

If this species occurs on the subject site, it may experience a small amount of habitat loss.

vii. Ameliorative Measures

The impact of the proposal on this species will be ameliorated through replanting of the disturbed areas with locally endemic plant species.

4.7.7 Thesium australe

Description: This is an erect perennial herb to 40 cm high, pale green to yellow-green, glabrous; stems are 1 - several, little branched, wiry, sytriate. Leaves are linear, usually 1 - 4 cm long, 0.5 - 1.5 mm wide, apex acute, midrib decurrent, sessile; lowest leaves are scale like. Flowers are solitary, axillary, green-yellow; peduncle is 1 - 3 mm long, subtended by leaf with 2 opposite bracteoles; pedicel is very short. Receptacle is cup like to globose, 1 mm long. Tepals are oblong, 1 - 1.5 mm long, finely heeled, green with white margins. Style is 1 mm long. Fruit is +/- globose, 2 - 2.5 mm diameter, reticulate - striate, +/- glaucescent, crowned with persistent tepals. It flowers from spring to summer (Harden, 1992).

i. Conservation Status

This species is listed under Schedule 2 (vulnerable) of the TSC Act 1995. The risk code for this species is 3VCc+ (Briggs and Leigh, 1996). A conservation rating of 3VCc+ indicates that this species has a range greater than 100 km, is not presently

endangered and is adequately reserved. However, less than 1000 plants are known to occur within a conservation reserve.

ii. Distribution on a Local, Regional and Statewide Level

Local Distribution: This species has not been recorded in the locality.

Immediate Regional Distribution: This species has not been recorded in the region.

Statewide Distribution: This species is found on the north coast, central coast, northern tablelands, southern tablelands and the north western slopes.

iii. Habitat Requirements

This species prefers grassland or woodland, often in damp sites.

iv. Habitat Distribution in the Study Area

If this species occurs on site it is likely to occur in the Herbland and Woodland habitats.

v. Threatening Processes

Specht (1981) describes the ever-increasing pressures of urbanisation, tourism, recreation, farming, forestry etc as risking the integrity of many species of Australian plants. Threatening processes of individual Australian plant species can be generally described as anything which has altered, or is in the process of altering, the ecology in which the species have evolved and adapted.

vi. Impact from Proposal

If this species occurs on the subject site, it may experience a small amount of habitat loss.

vii. Ameliorative Measures

The impact of the proposal on this species will be ameliorated through replanting of the disturbed areas with locally endemic plant species.

Chapter 5

IMPACTS OF PROPOSED DEVELOPMENT

The proposed development may have a variety of impacts upon threatened fauna and flora of the study area. These impacts are discussed below as they would occur if there were to be no mitigation measures implemented. They have been documented prior to the formulation of mitigation measures so that mitigation measures may be designed to reduce site-specific impacts. In documenting the impacts, consideration has been given to the cumulative/indirect impact and the likely contribution of the proposal to the threatening processes acting on populations of the subject species in the locality.

5.1 HABITAT LOSS / MODIFICATION

i. Immediate Impact

It is proposed to clear approximately 4.4 hectares of land on the subject site in no less than 3 campaigns over many years. It is possible that if clearing of trees is undertaken on the subject site from June through to November, some threatened species which rely upon hollows for nesting may be killed outright or perish as an indirect result of the disturbance. The species most likely to be affected by direct mortality on the subject site is the Brush-tailed Phascogale, as it is known to utilise the subject site. If clearing is undertaken during winter or spring, it is possible that direct mortality of the Brush-tailed Phascogale would occur.

ii. Cumulative / Indirect Impact and the Likely Contribution of the Proposal to the Threatening Processes Acting on Populations of the Subject Species in the Locality

The development of the subject site adds to the incremental loss of fauna and flora habitat being experienced along the NSW coastline. Habitat modification is a threatening process generally affecting all of the subject species examined in this report. The development may place additional pressures on those species which rely upon the subject site as part of their home range and they may have to search elsewhere for the resources that are lost as a result of the development. If these resources are not immediately available they may perish from a lack of suitable feeding resources or may not breed due to a lack of genetic resources. The Brush-tailed Phascogale is known to occur in other areas throughout the locality, therefore it is unlikely that the loss of the species on the subject site will lead to local

extinction, however if adequate measures are not taken to mitigate the impacts of the proposal, it is possible that this species will be extinct within the study area, due to a lack of genetic resources to maintain a viable population. Because the Brush-tailed Phascogale is a threatened species, measures should be taken to preserve the existence of this species in the study area.

It is inevitable that for quarrying activities to occur as proposed, the Rudder's Box on the boundary of the subject site will be destroyed. With the introduction of appropriate mitigation measures however, it will be possible to avoid the extinction of this species in the study area.

5.2 TRAFFIC MORTALITY AND INTERFERENCE WITH FAUNA MOVEMENTS

i. Immediate Impacts

It is not proposed to increase the amount of traffic leaving the quarry site as a result of extraction extending into Block B. In addition, the habitat to be removed for quarrying does not dissect any known movement corridors, or reduce a portion of habitat to a width that will not facilitate faunal movement within the study area. Because of the habitat removal which will occur as a result of extraction in Block B, it is possible that fauna will be displaced and that there will be an increased number of transient fauna which will be crossing the access road and possibly Possum Brush Road. These species may fall subject to traffic mortality.

The species most at risk of collision with vehicles include:

- larger animals such as macropods, bandicoots, Koalas and reptiles;
- ground birds including Bowerbirds and Lyrebirds;
- locally nomadic fauna or animals with large home ranges such as Quolls;
- arboreal mammals including possums and gliders which move from one area to another along the ground; and
- reptiles and amphibians which either bask on the sealed road surface or cross the road in search of foraging habitat.

ii. Cumulative / Indirect Impact and the Likely Contribution of the Proposal to the Threatening Processes Acting on Populations of the Subject Species in the Locality

If fauna are killed or injured due to collisions with vehicles during clearing operations, a decrease in the total gene pool of the locality may be experienced. This decrease may result in a lack of genetic diversity and a decrease in the ability of the species to cope with environmental change.

5.3 NOISE

i. Immediate Impact

There is little relevant information pertaining to the effects of noise on Australian wildlife, with the majority of published data referring to American or domestic fauna. This information is widely scattered throughout scientific literature and is frequently inconclusive and even contradictory (Shaw, 1978).

Few, if any of the suggested effects of noise benefit animals or increase the chances of species' survival (Shaw, 1978). Lee and Griffith (1978) report that the main effects of noise on American wildlife are behavioural changes leading to modifications in mating, loss of food supply for predators, changes in inter-specific relationships (predator/prey) and competition for shelter. The main reasons these impacts occur are due to impacts on hearing, communication, non auditory physiological effects and behavioural changes.

Busnel (1978) notes that a large number of fauna species are adapted to human presence and associated noise. The sighting of the Brush-tailed Phascogale, during the fauna survey, in habitat adjacent to the area currently being quarried supports this theory. Laboratory experiments with captive animals in restricted areas reveal that noise can produce a variety of physiological damage by acting on the auditory and central nervous system, inducing stress symptoms. Further to this, Busnel (1978) indicates that very little is known of the effects of noise on these same species which are living free in nature, and many species are well adapted to human activities and noise. Some species of fauna such as rats, mice, crows, pigeons, starlings and seagulls will in fact take advantage of human activities by living, apparently without damage, with extremely loud human noise (Busnel, 1978). However, in relation to fauna which are already rare or threatened, it is considered that noise and vibration may further affect their survival (Shaw, 1978).

Most evidence suggests that unusual noise is more likely to cause stress for an animal when combined with a visual stimulus. There is evidence that some fauna become adapted to the presence of humans and their associated noise after an initial

reaction of panic, fear and avoidance of the noise source (Busnel, 1978). The majority of vertebrates may eventually ignore the noise if other sensory organs, such as optical and chemical sensors, are not stimulated (Busnel, 1978). If the animal becomes accustomed to the noise, particularly when it is combined with familiarity of the visual stimulus, all indications are that most species of fauna will be unaffected and carry out their usual routine. Reactions to noise vary widely according to the biological state of a species (Busnel, 1978). In the USA, hares, which generally take flight when alarmed by an unusual noise, have been found to be generally unaffected during the birthing season by heavy machinery working in lucerne fields (Busnel, 1978). This provides evidence that, in the study of wildlife reaction to noise, the different biological aspects of each species must be taken into consideration, hence it is impossible to make general statements which will apply to all species (Busnel, 1978).

The Environment Protection Authority (EPA) does not set out criteria or guidelines for assessment of the effects of noise on wildlife, although the evidence above suggests that wildlife are generally able to tolerate noise levels significantly higher than the existing background noise levels encountered in natural areas. In consideration of the above information, it can be generalised that fauna may experience only limited effects of noise below 50 dB(A), with some reaction between 50 dB(A) and 70 dB(A), and strong reactions above 70 dB(A).

As the proposal is an extension of a current operation rather than a proposed development which will introduce new or increased noise sources, and noise levels are not expected to increase significantly, noise would be unlikely to have a significant impact upon the majority of the subject species.

ii. Cumulative / Indirect Impact and the Likely Contribution of the Proposal to the Threatening Processes Acting on Populations of the Subject Species in the Locality

If any fauna experience adverse reactions as a result of extraction operations, they would be likely to move northwards and north west into Kiwarrak State Forest, across cleared pasture land. Movement of fauna to the south could occur, but would place both the transient fauna and resident fauna in this area under stress as habitat is extremely fragmented. As well as this, they would be moving in the direction of the Pacific Highway and mortality associated with fast moving traffic may occur. Predation by domestic and feral animals is also a possibility as animals move from the noise source. This impact may contribute to the general threatening processes of habitat modification and loss affecting the subject species.

As with the immediate impact, because the expansion of the quarry will not increase noise levels on the subject site, it is unlikely that significant noise-related impacts will occur as a result of the proposed quarry expansion.

5.4 DUST

i. Immediate Impacts

Dust Generation and Air Quality are not expected to significantly change from the current levels as extraction and processing operations would remain the same. Short term episodes of increased dust generation may be encountered, especially in dry periods when winds blow above five metres a second. Typically these episodes would occur when winds originate from the south-west. Sensible management practices such as cessation of stockpile reshaping or dry crushing during periods of high winds after long dry periods should be implemented to limit episodic impacts.

ii. Cumulative / Indirect Impact and the Likely Contribution of the Proposal to the Threatening Processes Acting on Populations of the Subject Species in the Locality.

Without appropriate mitigation measures, dust has the potential to decrease the habitat value of bushland, by coating leaves and interfering with the process of photosynthesis in plants. This may cause dieback and make the bushland unsuitable for fauna so that they are forced to seek habitat elsewhere, thereby increasing the pressure on other habitat resources in the locality. These potential problems will be satisfactorily addressed by the proposed amelioration measures.

5.5 WATER QUALITY AND TURBIDITY

i. Immediate Impacts

A network of gullies within the study area provides a surface drainage system to Bungwahl Creek. Two dams exist on site, the first being a sediment control dam and the second being a storage dam for stock water. Water storage dams for stock have also been developed on adjoining land. There are unlikely to be any immediate impacts on threatened fauna, as no natural water bodies containing threatened fauna habitat exist in the study area.

ii. Cumulative / Indirect Impact and the Likely Contribution of the Proposal to the Threatening Processes Acting on Populations of the Subject Species in the Locality.

The main potential effects of the proposed development upon surface waters may be to change water quality in downstream watercourses and/or to vary the volume of water discharged from the study area.

There are no process wastewaters generated by the quarry and the only potential change to downstream water quality would be generated by sediments leaving the study area. Without adequate planning these sediments have the potential to increase turbidity in downstream waters, thereby increasing sedimentation, and making downstream waters unsuitable for flora and fauna.

The study area is located in the upper headwaters of Bungwahl Creek which receives run off waters from the catchment and discharges into the Wallamba River at a point two kilometres downstream of Failford (approximately 11 kilometres from the study area).

The only potential effect on regional groundwaters would be a loss of groundwater input from rainwater infiltration. Quarry operations would not prevent such infiltration occurring although there may be a decrease in the infiltration rate due to increased runoff from working areas of the quarry. There will be no significant effects on regional groundwaters as a result of quarry operations.

Chapter 6

MITIGATION MEASURES

6.1 INTRODUCTION

Chapter 5 identifies a number of impacts upon threatened fauna and flora of the study area resulting from the proposed development. All of these impacts are able to be mitigated so that the impact of the proposal upon threatened fauna and flora may be minimised or considered negligible. All of the mitigation measures discussed below target the direct impacts to threatened fauna and flora of the study area, and the cumulative impact to flora and fauna within the region.

These mitigation measures will be included in the Environmental Management and Site Rehabilitation Plan (EMSRP) for the quarry. The EMSRP will include implementation programs for the mitigation measures that will be prepared after consultation with NPWS and review of similar programs.

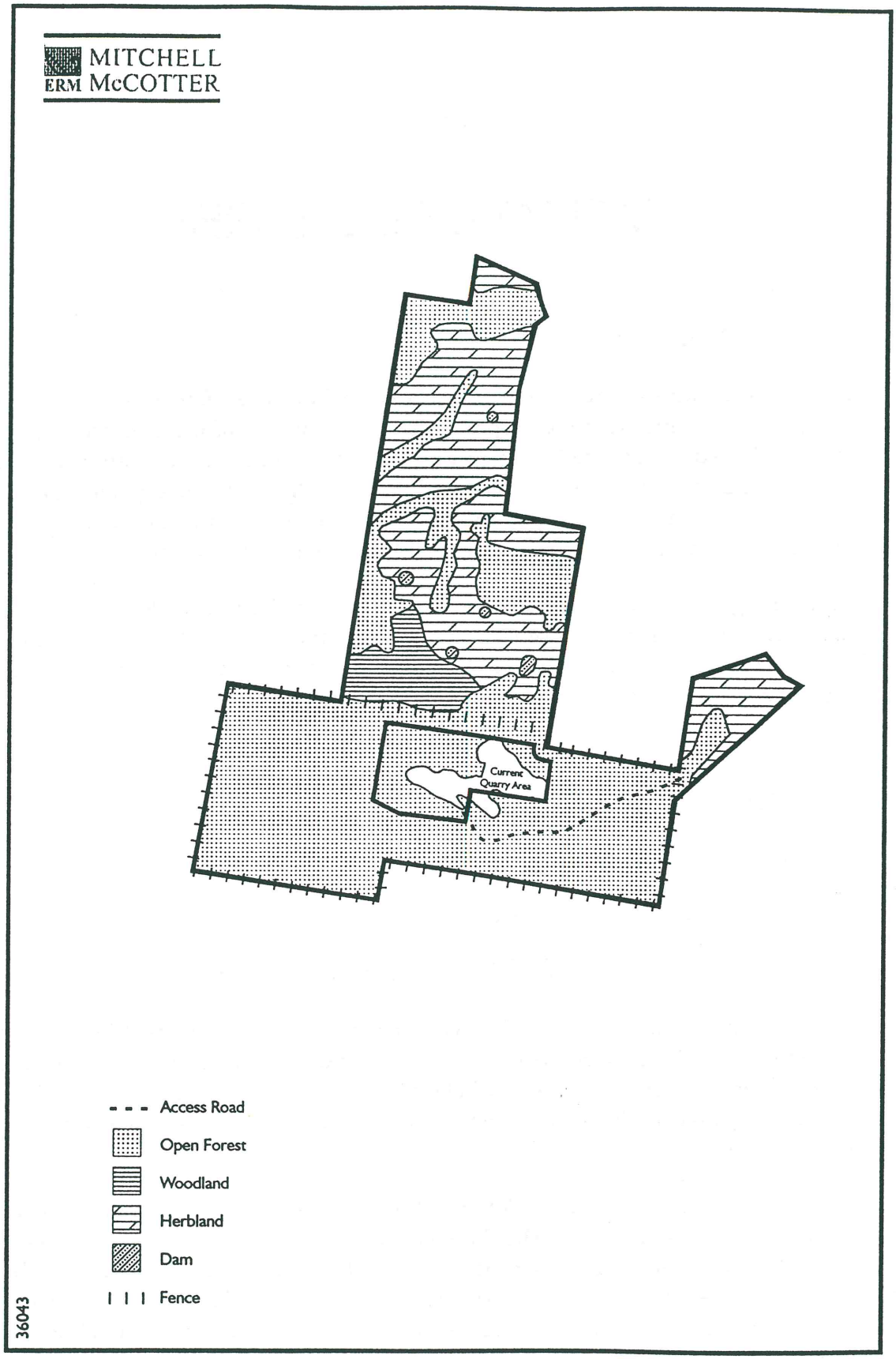
6.2 HABITAT ENHANCEMENT

This measure addresses the impacts of:

- habitat loss/modification; and
- traffic mortality and interference with fauna movements.

The study area is known habitat for two threatened species, and one ROTAP species. Therefore, in order to compensate for the 4.4 hectares (approximately) of habitat lost for the expansion of the quarry, it will be necessary to enhance the remaining habitat in the study area so that its carrying capacity is increased. This should incorporate the following:

a. *Fencing Off of Bushland.* A fence should be constructed around the bushland on the subject site. This fence should be constructed around the area shown in *Figure 6.1.* The fence should be designed to keep cattle out of the bushland in order to promote a more natural understorey. The area of bushland inside the fence should be managed as a habitat area throughout the life of the quarry and cattle should therefore be excluded.



Note: map is conceptual only

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meters

Figure 6.1 AREA TO BE FENCED TO EXCLUDE LIVESTOCK

b. *Control of Foxes, Cats and Dogs.* Appropriate baiting programs should be undertaken in the area to control cats, dogs and foxes in order to ensure that the Brush-tailed Phascogale is given the greatest possible chance of survival in the study area. Such a baiting program should only be undertaken if deemed appropriate by the relevant authorities. Advice on the most appropriate baiting program for foxes, cats and dogs should be sought from the local Department of Agriculture prior to commencing any program, and should be undertaken in close consultation with the Department of Agriculture.

c. *Provision of Nest Boxes.* Cuttle (1983) documents the home range of the Brush-tailed Phascogale to be approximately four to five hectares for females. Given that the bushland remaining in the study area will be in the vicinity of 135 hectares, one nesting box should be placed within every 5 hectares so that a total of 27 nesting boxes are placed within the study area. A suitably qualified ecologist or zoologist should be employed to undertake this task. Each nesting box should be constructed of exterior grade plywood or undressed pine planks so that they are weather resistant. The inside diameter should be 250 mm, the hole depth 300 mm and the entrance diameter 60 mm. The entrance hole should be made near the top of the box. The boxes will need to be placed vertically, no less than 4 metres above the ground, and should be securely attached to the side of a hardwood tree species. It should be ensured that the tree to which the nesting box is attached does not contain hollows in which Brush-tailed Phascogales may already be nesting. Construction and placement of nesting boxes in the study area should be undertaken prior to the clearing of any vegetation in Block B so that individuals displaced by the clearing activities have an immediate alternative source of shelter. Nest boxes should also be installed for other threatened hollow-dependant fauna identified in this report as highly likely to utilise the study area.

d. *Extermination of Feral Bees.* In order to maximise the potential for use of tree hollows by native fauna, a program should be undertaken, prior to clearing, to identify trees with hollows in the remaining bushland. This should be undertaken by a qualified zoologist/ecologist. Once these trees have been identified and marked, they should be inspected by quarry management to determine if feral bees have hived in the hollows. If any hives are identified, they will be appropriately exterminated. Advice on this should be sought from NPWS before commencing, and it is considered appropriate that NPWS should work co-operatively with quarry management to undertake this.

6.3 REVEGETATION

This measure addresses the impacts of:

- habitat loss / modification

a. Germination and re-planting of Rudder's Box. A qualified horticulturalist should be used to germinate no less than 50 Rudder's Box seedlings. The seeds should be taken from local seed stock and after germination, planted by a qualified horticulturalist on the site in areas currently being rehabilitated in Block A, as well as the areas to be rehabilitated in the future in Block B. Maintenance of this species on site after each seedling has been planted will need to be intense to ensure a high survival rate. A suitably qualified horticulturalist should undertake a three monthly inspection of the rehabilitated areas to ensure that rehabilitation is successful, and that the mortality rate of the Rudder's Box seedlings is minimised. The results of the inspection should be incorporated in an annual monitoring report to be prepared for Greater Taree City Council after the first year of quarry operations. Copies of the report should also be made available to the NPWS if requested.

b. Progressive Rehabilitation. A comprehensive rehabilitation plan should be incorporated into the environmental management and site rehabilitation plan. The plan should detail a program of progressive rehabilitation for Block B incorporating the following species:

- Ground Cover: Blady Grass (*Imperata cylindrica*) and Kangaroo Grass (*Themeda australis*);
- Herb Layer: Mat Rush (*Lomandra longifolia*);
- Shrub Layer: Dagger Wattle (*Acacia falcata*), Dogwood (*Helichrysum diosmifolium*), Native Indigo (*Indigofera australis*), Broom Pea (*Jacksonia scoparia*), Forest Oak (*Casuarina torulosa*);
- Tree Layer: Hickory (*Acacia binervata*), Blackwood (A. melanoxylon), Fern Wattle (*A. irrorata*), White Mahogany (*Eucalyptus acmenioides*), Grey Ironbark (*E. placita*), Rudder's Box (*E. rudderi*), Tallowwood (*E. microcorys*), Grey Gum (*E. propinqua*); and
- Vines: Glycine (*Glycine clandestina*), Coral Pea (*Kennedia rubicunda*), Sarsparilla (*Hardenbergia violaceae*).

6.4 TIMED CLEARING

This measure addresses the impacts of:

- habitat loss / modification.

Clearing of more than 1 hectare of the subject site in any one year should not be undertaken during winter or spring. Therefore, if clearing of more than one hectare occurs, it should only be undertaken during the months of December to May. This will avoid the direct mortality associated with the destruction of winter roosts and spring nests.

6.5 SPEED LIMITS AND WILDLIFE WARNING SIGNS

This measure addresses the impacts of:

- traffic mortality and interference with fauna movements.

A speed limit of 40 km per hour should be implemented on the internal access road to allow fauna to move safely within the study area. In addition, wildlife crossing signs should be placed at appropriate intervals along the internal access road to further mitigate the impact of traffic mortality.

6.6 SEDIMENT AND EROSION CONTROL

This measure addresses the impact of:

- water quality and turbidity.

There are no process wastewaters generated by the quarry and the only potential change to downstream water quality would be generated by sediments leaving the site. Without adequate planning these sediments have the potential to increase turbidity in downstream waters, thereby increasing sedimentation.

Sediment and erosion control measures proposed for the quarry will be effective in controlling sediment movement. All runoff from the proposed quarry extraction will continue to flow through the existing quarry and the existing licensed and approved management system. Complementary measures such as segregation of clean and dirty waters and preferential reuse of dirty water will further minimise the potential for sediment laden runoff entering downstream watercourses. The quarry will have no significant effect on water quality in downstream watercourses.

6.7 DUST SUPPRESSION

This measure addresses the impact of:

- dust.

Emissions of dust from the quarry will be controlled by:

a. the use of a water cart to dampen the haulage and access roads and working areas during dry periods;

b. ensuring hydraulic rock drills are fitted with industrial exhaust extraction and control systems;

c. avoiding, where possible, drilling or blasting or using dust extraction facilities during high winds;

d. prompt revegetation of exposed areas, bunds and topsoil stockpiles; and

e. ensuring all trucks leaving the quarry have their tailgates locked and loads properly secured.

6.8 RESTRICTIONS ON BLASTING HOURS AND HOURS OF OPERATION

This measure addresses the impacts of:

- noise.

The majority of threatened fauna examined in this report are nocturnal, including the Brush-tailed Phascogale. Crushing and blasting hours should be restricted to daylight, so that they do not interfere with the activities of nocturnal fauna.

6.9 LONG TERM MONITORING AND MANAGEMENT

This measure addresses the impacts of:

- habitat loss / modification;
- traffic mortality and interference with fauna movements;
- dust; and

- water quality and turbidity.

On-going monitoring and management should be conducted within the study area to determine whether the mitigation measures proposed in this chapter are adequate. Measures should include:

a. inspection of rehabilitated areas annually by a suitably qualified person to investigate and document the success of the rehabilitation program. If rehabilitation is found to be unsuccessful, a contingency plan will need to be formulated by a suitably qualified person and implemented immediately on site;

b. inspection of nest boxes during winter to ensure that they are being used by fauna, and are not being used by introduced species. This needs to be undertaken by a suitably qualified person. If feral species are utilising the nest boxes, they should be eradicated immediately; and

c. inspection of fencing surrounding the bushland should be undertaken at quarterly intervals by quarry staff. If any breaks in the fence are discovered, they should be mended immediately.

Chapter 7

CONCLUSION

7.1 ALTERNATIVES TO THE PROPOSAL

The availability of suitable aggregate from existing quarries in the market region to supply future Pacific Highway upgrading projects is limited. The demand for high quality material will exceed supply at least in the short to medium term. Quality assured products are essential for high quality construction of the Pacific Highway and if they are not available locally, they must be imported using costly road transportation.

Only a limited number of other quarries in the region are able to produce high quality premium grade aggregates to meet current RTA specifications. Collectively they will be unable to supply the quantities of demand expected to be required by the Pacific Highway upgrading and local market demands.

An alternative to the proposal would be to continue the extraction sequence in accordance with the existing development consent. This approach would not allow the quarry to supply high quality material required for Pacific Highway upgrading in the short term.

7.2 PROJECT JUSTIFICATION

7.2.1 Biophysical Considerations

The extension to existing quarry operations will not create an adverse impact upon downstream waterways or cause a decrease in air quality that will adversely affect the surrounding environment.

Appropriate mitigation measures will be introduced to ensure that the operations will not cause significant adverse impacts on threatened flora and fauna species in the study area. Rehabilitation of the quarry will be undertaken progressively to restore native vegetation to the area and the quarry site will function as a sustainable ecosystem which reflects the natural ecology of the area.

7.2.2 *Economic Considerations*

The upgrading of the Pacific Highway is the largest post war civil construction project to be undertaken in Australia. The upgrading and reconstruction of sections of the highway between Bulahdelah and Johns River contribute a significant proportion of the work to be undertaken. **The extension of the existing operations at Possum Brush quarry will secure a substantial reserve of high quality material that will enable the long term supply to Pacific Highway construction projects in the Region.** The quarry owners have already been approached to supply material to impending construction works. The highway upgrading will provide significant economic benefits and opportunities in the local, state and national economies.

The quarry will provide direct ongoing employment for nine persons, and will assist employment in the housing, tourism and construction industries by providing essential materials at affordable costs.

7.2.3 *Social Considerations*

The operation of the quarry will have impacts upon surrounding residents. Careful management and control of these impacts, including noise, vibration and dust will allow the quarry to operate with acceptable levels of impact. As indicated in Section 7.1 of this report, the operation of the quarry extension can operate within the specified noise and blasting criteria and no specific mitigation measures are required to reduce noise or overpressure levels.

Current quarry management has shown its willingness to resolve the concerns of neighbours and has the experience to implement responsible quarry management so that the interests of neighbours and the public are protected.

The proposed development is justified because it will allow supply of essential materials to a civil works project that is of major state and regional importance and will contribute to an increase in safety for future Pacific Highway motorists.

7.2.4 *Principles of Ecologically Sustainable Development*

The national strategy for ecologically sustainable development (ESD) details the Federal Government Policy which seeks to achieve economic development in an environmentally sustainable manner. The four principles of ESD are listed in Schedule 2 of the Environmental Planning and Assessment Regulation (1994) as follows:

- the precautionary principle, namely that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not

be used as a reason for postponing measures to prevent environmental degradation;

- inter-generational equity, namely that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- conservation of biological diversity and ecological integrity; and
- improved valuation and pricing of environmental resources.

The manner in which these four principles apply to Pacific Blue Metals' Possum Brush Quarry operation are as follows:

i. The Precautionary Principle

The proposal will be consistent with the *precautionary principle* to the extent that all potential threats to the quality of the environment, such as sedimentation, erosion, entry of pollutants to the catchment, loss of habitat of endangered flora and endangered fauna and noise pollution, have been identified and mitigation measures are proposed that will prevent significant adverse impacts.

ii. Inter-generational Equity

The proposal will be consistent with the principle of *inter-generational* equity as it will assist future generations to be supported by provision of a high standard Pacific Highway, whose value will extend well into the future; and the quarry site will ultimately be rehabilitated to form part of a viable ecosystem.

iii. Conservation of Biological Diversity and Ecological Integrity

The proposal will be consistent with the principle of *conservation of biological diversity and ecological integrity*. Measures are proposed to rehabilitate and revegetate the subject site during and after quarrying. Impacts on threatened fauna will be ameliorated by providing, among other measures, compensatory habitat, nesting boxes and fauna exclusion fencing. Impacts on plants of conservation significance that would be affected by the proposed operations, particularly *Eucalyptus rudderi* would be ameliorated by planting of seedlings.

Other measures have been recommended in Section 8.2 to reduce the impacts of the operation on adjoining natural areas. Those measures include fencing, dust suppression and preventing spill or flyrock entering vegetated areas.

iv. Improved Valuation and Pricing of Environmental Resources

Environmental resources can be defined to include natural resources such as flora, fauna, rivers, sand and gravel and the human built environment such as roads and railways. As stated by James (1995) the *valuation and pricing* [of extractive materials] *is related to the customer's perception of the value of the product and their willingness to pay. In general, extractive materials are considered to be low value, low cost materials so there is little opportunity for improved valuation and pricing of the environmental resources.*

While this is a valid perception, the final cost of the extractive materials includes the total cost of extraction and delivery. Extraction and delivery includes costs associated with:

- environmental assessment;
- rehabilitation;
- environmental management and monitoring; and
- road use contribution.

Due to increasingly tight legislative and environmental controls by State and Local governments, it is reasonable to expect that quarry products, including those from Possum Brush will increase in value, although improved productivity may balance long term value increases. The hard rock resource in this site will be utilised to assist achievement of a project of national importance (the Pacific Highway upgrading), thereby putting that resource to an optimum use for the benefit of the community.

The value of the natural resources of the site is being recognised by the protection, mitigation and environmental rehabilitation measures proposed for the extended quarry site.

7.3 CONCLUSION

The area of bushland to be cleared for the proposed development is small in size when compared to the vegetated areas of the remainder of the study area and the extensive areas of adjoining and nearby bushland. The study area contains known habitat for two threatened species of fauna; the Brush-tailed Phascogale and Glossy Black Cockatoo; and it is therefore possible that the proposal, if unmitigated, may impact upon these species.

Chapter 5 discusses the impacts associated with the proposed development. Chapter 6 discusses the mitigation measures recommended to ameliorate the expected impacts. These measures have been designed in consultation with NPWS, Northern Zone, using the latest scientific information specific to those species that are most likely to be significantly affected by the proposal. Provided those mitigation measures are implemented it is considered that the proposed development would be unlikely to have a significant impact on threatened species.

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Matthew Bell, Ecotone

Michael Harrison, Travis McEwen Group

Brett Newbold, Travis McEwen Group

APPENDICES

Appendix A

CURRICULA VITAE OF THE STUDY TEAM

NAME:	**CHRISTOPHER JOHN POWER**
ACADEMIC QUALIFICATIONS:	Graduate Diploma In Planning University of Technology Sydney Certified Town and Country Planner, NSW Local Government Act (1919) Engineering Surveying Certificate.
PROFESSIONAL QUALIFICATIONS AND AFFILIATIONS:	Member Royal Australian Planning Institute
CAREER AND SPECIALISED COMPETENCE:	Urban, rural and regional planning Multi-Disciplinary Environmental Studies Local government strategic planning and management Environmental assessment and development control Urban and rural planning policy Expert testimony
AWARDS:	Royal Australian Planning Institute Award for Excellence in Planning - Hastings Section 94 Study, 1993

PROFESSIONAL EXPERIENCE:

October 1992 to Present **ERM MITCHELL McCOTTER**

Manager of NSW North Coast Office, Taree. Responsible for supervision and preparation of urban and rural planning studies and multi-disciplinary environmental and management studies.

A representative range of projects undertaken or supervised is as follows:

Planning And Environmental Studies

Local Environmental Study Blueys Beach (Great Lakes Council).
Environmental study to examine potential for rezoning for residential purposes of sensitive coastal land.

Taree/Wingham Urban Strategy Review (Greater Taree City Council).
Review of Council's long term urban expansion strategy and recommended short term urban release programme.

North Tuncurry Vegetation Study (Great Lakes Council)
Assessment of flora and fauna habitat values and conservation significance, including wildlife corridors and rare plant associations.

Crookwell Development control Plan (Crookwell Council)
Preparation of DCP for Crookwell Town Centre and urban area. Issues included heritage, townscape, pedestrian and vehicle access, development standards, catchment water quality, residential expansion and Industrial development.

Environmental Responsibilities Advice (Nambucca Council)
Advice on the extent and nature of the Council's environmental obligations, risks and liabilities, forming Stage I of a proposed Environmental Management System for the Council.

Fauna Impact Statement, Dunbogan (Hurd Haulage Pty Ltd.)
An FIS examining the impact of a sand extraction operation in a sensitive coastal environment adjoining Crowdy Bay National Park.

Bonnie Hills Flora and Fauna Investigations (Hastings Council)
Investigations and management recommendations for an environmental study for urban expansion adjoining a littoral rainforest.

Rural Residential Rezoning Proposal, Wingham (Bungay Pty Ltd).
Report on issues relating to proposal for rural residential rezoning, including siltation of Manning River, agricultural viability, flooding and water supply.

Regional Flora Survey and Ecological Assessment for Dunbogan Canal Subdivision (Planning Workshop).
Supplementary investigations following submission of EIS to assess ecological impacts and Regional Flora implications of proposed Canal Subdivision.

Concept Plan, Beach Street Harrington (Harrington Bowling Club Ltd).
Concept plan for expansion of Bowling Club onto adjoining riverfront reserve.

Bushfire Hazard Assessment, Blueys Beach (Private landowner)
Assessment of bushfire hazard and management recommendations on proposed coastal urban development site.

Agricultural Classification of Land, Lansdowne (G Armstrong).
Investigation and report on boundary between class 3 and class 4 agricultural land to facilitate application for rural subdivision.

Johns River Development Principles Plan (Private Client)
Rural Residential development principles and design. Issues included potable and non potable water supply, surface and groundwater management, Koala and fauna habitat, access and subdivision design.

Acoustic Assessment and Application for Amendment of Development Consent, Chatham (Caltex Oil Australia Pty Ltd).
A report and assessment of acoustic impact of fuel depot on adjoining land and application for amendment of development consent.

Odour Investigations, Taree Sewage Treatment Works (Greater Taree City Council)
Investigation of sources of odour and recommended management strategies relating to treatment works located in a developing urban area.

Highway Bypass Resumption, Taree (Private Landowner).
Assessment of planning implications of proposed resumption for Highway Bypass through rural land, to assist in assessment of valuation and participation in court proceedings.

Rezoning Application, Hogan Street Harrington (GK Armstrong)
Application for residential rezoning of flood prone land adjoining SEPP 14 Wetlands.

Mingaletta Koala Management Plan (Hurd Haulage Pty Limited)
Preparation of a Koala Management Plan pursuant to State Environmental Planning Policy No. 44 for proposed hardrock quarry.

Feasibility Assessment, Mingaletta Quarry (C and J Berne)
Assessment of Planning and Environmental issues and previous judicial consideration of proposed hard rock quarry.

Lismore RRR Study (Lismore City Council)
Review of subdivision and residential development policies for NSW provincial city.

Forster Shopping Village Traffic Study (Coles Myer Properties Limited)
Traffic study for expansion of commercial activities adjoining a regional commercial centre.

Old Bar Open Space Study (Greater Taree City Council)
An assessment of existing and future open space requirements for the Old Bar coastal village area.

Hawks Nest Environmental Study (Great Lakes Council)
Assessment of ecological, flooding, drainage, groundwater, geomorphology and coastal processes for proposed urban expansion area in a coastal environment.

Wauchope Traffic Study (Hastings Council)
Traffic assessment and management plan for Wauchope Urban Area and CBD.

Minnamurra Tea Tree Plantation (Cassegrains)
Statement of Environmental Effects for establishment of a large Tea Tree plantation on low lying land in the Maria River catchment. Major issues included Acid Sulphate Soils, flooding, drainage, use of chemicals and impacts on neighbours.

Richmond River Rural Residential Development Strategy (Richmond River Shire Council)
Preparation of a strategy for Rural Residential Development within Richmond River Shire, in accordance with Rural Settlement Guidelines for the New South Wales North Coast.

Taree City Bike Plan (Greater Taree City Council)
Development of a Bicycle Plan and Implementation Program for the Greater Taree City LGA.

Yamba Traffic Study (Maclean Council)
Traffic Study of Yamba Urban Area and its environs, identification of existing and future road hierarchy, identification of management works and costs and background report for Section 94 Roadworks Plan.

Environmental Impact Assessment And Management

Manning River Dredging EIS (Peakhurst Properties Pty Ltd).
A proposal to dredge sand from the Manning River at Harrington to provide fill material for a proposed canal subdivision.

Assessment of Waste Management Facility Development Application (Hastings Council)
Assessment of Development Application, Environmental Impact Statement and Fauna Impact Statement together with public and private submissions for a proposed Regional Waste Facility to service the Hastings Local Government Area.

Mingaletta Quarry Environmental Impact Statement (Hurd Haulage Pty Ltd)
Environmental Impact Statement for extraction and processing of 9.2 million tonnes of greywacke over 25 years, together with associated railway siding.

Objection to EIS Proposals for Pacific Highway Deviation, Coffs Harbour (O'Donnell and Hanlon)
Preparation of submission to Roads and Traffic Authority (RTA) objecting to impacts of highway upgrading proposal on approved residential development.

Manning River Stabilisation Advice (Greater Taree City Council)
Advice on policies and methods of stabilising eroding river banks on the Manning River.

Sweet Pea Rehabilitation and Landscape Plan (private client)
Rehabilitation and Management Plan for sand extraction operation in a visually sensitive area.

Beechwood Timbers Sawmill EIS (Beechwood Timbers Pty Ltd).
EIS for expansion and modification of existing sawmill adjoining rural residential development.

Grants Head Quarry EIS (Hurd Haulage Pty Ltd).
EIS for extraction of conglomerate from coastal quarry near Port Macquarie.

Harrington Back Channel Management Plan snd EIS (Greater Taree City Council)
Development and Management Proposals and subsequent EIS for dredging of part of the back channel on the Manning River at Harrington.

Wingham Abattoir Pollution Reduction Program (Wingham Beef Exports)
Pollution Reduction Program for beef abattoir adjoining an urban area on the New South Wales mid north coast. Project involved identification and quantification of pollutants and wastes and assessment of impacts on the environment, together with a program and schedule of works to reduce pollution to acceptable levels.

Dunbogan Sand Extraction EIS (Hurd Haulage Pty Ltd).
EIS for extraction of sand from an environmentally sensitive hind dune area adjoining State Environmental Planning Policy 14 Wetlands and Crowdy Bay National Park.

Dunbogan Quarry Environmental Management Plan (Hurd Haulage Pty Limited)
An implementation plan to ensure responsible ongoing environmental management and monitoring of sand extraction operation.

Clause 64 Assessment, Billinudgel to Chinderah Pacific Highway Deviation EIS (RTA)
Assessment of EIS and public submissions and preparation of report for determination of EIS by Chief Executive of the RTA.

Melinga Quarry Statement of Environmental Effects (K and R Newby)
Environmental assessment and development application for quarry expansion pursuant to State Environmental Planning Policy No. 37.

Mingaletta Quarry Environmental Management Plan (Hurd Haulage Pty Ltd)
A detailed plan outlining procedural, monitoring and reporting requirements to ensure compliance with conditions of consent, environmental statutes and current Best Practise for proposed Hard Rock Quarry.

Kew Quarry Statement of Environmental Effects (Hurd Haulage Pty Limited)
Environmental assessment and development application for quarry expansion pursuant to State Environmental Planning Policy No. 37

Irrigation Site Investigations (Hastings Co-op Limited)
Site investigation of a rural property to determine minimum area and wet weather storage requirements for irrigation of waste water from Hastings Dairy Co-op factory.

Socio Economic Studies

Development feasibility, Local Commercial Centre Hallidays Point (Mr J Dixon).
A report assessing development feasibility and making recommendations on nature and extent of commercial development for a local shopping centre. The report included an economic assessment of commercial development as compared to residential development on the site.

Section 94 Contributions Study and Plan (Hastings Council)
Background report and section 94 contributions plan for car parking, water and sewerage, community facilities, open space and bushfire resources. This project won a Royal Australian Planning Institute Award for Excellence in Planning (1993).

Objections to Regional Shopping Centre Development (Webb Brothers)
Objection to rezoning and Development Applications for major shopping centre development proposal. Issues included social and economic impacts, parking, traffic, urban design and planning.

Taree Highway Service Centre Study (Greater Taree City Council)
Assessment of economic, social, ecological, archaeological, planning and traffic implications of proposed service centre adjoining the Taree Traffic Relief Route, Pacific Highway.

East Perth Concrete Plants Planning Study (MRWA and East Perth Redevelopment Authority)
A study which assessed the impacts of the Perth City Northern Bypass on existing concrete plants in East Perth and evaluated options for provision of concrete plants to service the Perth central business district.

Richmond River Section 94 Plan (Richmond River Shire Council)
Developer Contributions Plan for large local government area on the North Coast of New South Wales.

Lakes Way/Pacific Highway Connection Economic Assessment (Great Lakes Council)
Cost benefit analysis and socio-economic evaluation of a proposed road linking the southern end of the Lakes Way with the new Pacific Highway deviation.

June 1981 to October 1992 **GREATER TAREE CITY COUNCIL**

Director City Planning and Building Services, May 1991 to October 1992. Responsible to the Council for all environmental planning and building functions. Management of Division comprising 25 staff, including seven professional planners and seven building surveyors.

Chief Town Planner, December 1981 to May 1991. Responsible to Council for management of all environmental planning functions.

Town Planner, June 1981 to December 1981. Primarily responsible for strategic planning.

A representative range of projects undertaken or supervised is as follows:

Urban And Environmental Planning:

Draft Greater Taree City Wide Local Environmental Plan and Development Control Plan (1992): modern, consolidated local environmental plan and development control plan for the Greater Taree local government area.

Taree/Wingham Urban Growth Plan (1990): long term urban expansion, infrastructure and servicing proposals for the Taree, Wingham and nearby urban areas.

Wingham Urban Area Environmental Study and Local Environmental Plan (1987).

Diamond Beach Environmental Study and Local Environmental Plan (1984).

Hallidays Point/Redhead Environmental Study and Local Environmental Plan (1983).

Various local environmental plans and development control plans for urban expansion/release areas, rural residential release areas and industrial areas, City of Greater Taree.

Management of Consultant Studies:

Taree City Centre Study (1991). Purdon Associates Pty Ltd, Transport Environment Consultants, Gardner Brown Planning Consultants, Suters Architects Snell.

Greater Taree Aboriginal Heritage Study (1991). National Heritage Studies Pty Ltd.

Greater Taree Heritage Study (1990). Suters Architects Snell.

Greater Taree Waste Management Strategy, Bucketts Way Depot Environmental Report and Quarry EIS (1988). Mitchell McCotter & Associates Pty Ltd.

Wingham Urban Conservation Area Study (1986). Latona, Masterman and Associates.

Greater Taree Rural Land Environmental Study (1984). Davenport, Campbell and Partners Pty Ltd.

Harrington Environmental Study (1983). Gutteridge Haskins and Davey.

Environmental Assessment:

Expansion of Old Bar Commercial Centre (1991).

Aluminium Can Manufacturing Plant for Containers Packaging Pty Ltd, Taree (1990).

Expansion of K-Mart Shopping Centre, Taree (1990).

Asphaltic Concrete Plants for Pioneer Asphalt Pty Ltd and Bitupave Ltd, Kolodong (1990).

Excavation of Material and subdivision within a Designated Wetland at Harrington (1990).

Filling and Development within SEPP 14 Wetlands, Old Bar (1987).

Hard Rock Quarry, Wyan Holdings Pty Ltd, Possum Brush (1985).

Canal Subdivision and Dredging of the Manning River at Harrington.

Sand and Gravel Extraction from Manning River at Tinonee (1982), Taree (1983), Charity Creek (1987) and Wingham (1989)

Hard Rock Quarry, Jandra Blue Metals Pty Ltd, Possum Brush (1982).

Various major residential, industrial, rural-residential and rural subdivisions, City of Greater Taree.

Policy and Management Studies:

Initiation of Local Approvals Review Program Processes for Greater Taree City Council (1992).

Organisation Development and Management Planning, Greater Taree City Council (1991-1992).

Provision Standards for Support Services, Housing for Aged and Disabled Persons (Greater Taree City Council 1991).

Old Bar Coastline Management Plan (1990).

Greater Taree Interim Flood Plain Management Policy (1987).

Greater Taree Industrial Development Code (1985).

Greater Taree Landscape Code (1985).

Greater Taree Group Housing Development Code (1984-1992).

Greater Taree Vehicle Parking & Access Policy (1984-1992).

Greater Taree Rural Lands Development Policy (1984).

Expert Testimony:

Preparation and presentation of evidence in the NSW Land and Environment Court in relation to various designated and non-designated development appeals and valuation hearings.

November 1973 to June 1981 **CAMPBELLTOWN CITY COUNCIL**

Three years Deputy Chief Town Planner, one year Acting Deputy Chief Town Planner, three and a half years as member of Strategic Planning Project Team. Strategic planning, development control and planning management in large, metropolitan growth centre during major expansion/development phase.

August 1972 to November 1973 **LIVERPOOL CITY COUNCIL**

Engineering Assistant Subdivision, road and drainage design, local government engineering.

February 1972 to August 1972 — **REEVES SMITH CONSTRUCTIONS, CIVIL ENGINEERING CONTRACTORS, SYDNEY**

Estimator/Surveyor. Estimating, tendering, setting out and supervision of civil construction works.

September 1970 to February 1972 — **MILLER AND STEWART CONSULTING SURVEYORS, COFFS HARBOUR**

Engineering Surveyor - Responsible for subdivision planning, survey, engineering design and construction supervision.

January 1966 to September 1970 — **WALLIS & MOORE (FORMERLY CHALMERS AND FINNEY) CONSULTING SURVEYORS AND ENGINEERS, SYDNEY**

Trainee Survey Technician/Engineering Surveyor. Cadastral, engineering and mining surveying, with emphasis on subdivision planning, survey and engineering design.

NAME: **LISA DIANE BROWN**

ACADEMIC QUALIFICATIONS: Bachelor of Applied Science (Environmental Assessment and Management)

University of Newcastle, NSW, 1994

PROFESSIONAL AFFILIATION: Scientific Member of Royal Zoological Society of New South Wales

Member New South Wales Bird Atlassers

PROFESSIONAL EXPERIENCE:

July 1995 - Present **ERM MITCHELL McCOTTER**

Environmental Scientist with ERM Mitchell McCotter's north coast office at Taree. Responsible for undertaking ecological surveys, assessment of conservation value, assisting in the preparation of environmental impact statements, recommending mitigation measures and formulating management plans and other environmental studies. Also the Regional Quality Manager, responsible for coordinating the Quality Assurance System (AS/ISO 9001) in the Taree office.

Ecological Studies

Hawks Nest Local Environmental Study (Great Lakes Council):
Participation in the conservation assessment of an area north of Hawks Nest, to determine the impacts that urban development will have on the natural environment of the area.

Ballina Ecological Study (CSR Readymix):
An investigation to determine the flora and fauna issues in establishing a sand quarry at South Ballina. Areas of conservation significance and likelihood of rare or threatened flora and endangered fauna occurring on-site was determined.

Sandbar Investigations (Paspaley Pearls):
This ecological study was an investigative study to determine the flora and fauna issues involved with expanding a caravan park and golf course in native bushland at Sandbar (Pacific Palms). Areas of conservation significance and likelihood of rare or threatened flora and fauna occurring on-site was determined.

Mingaletta Application to Clear on Protected Land (Hurd Haulage Pty Limited):
Project management of the preparation of a report to gain approval to remove vegetation on Protected Land. The applicability of SEPP 46 to the land was also examined and commented upon.

Lake Cathie State Environmental Planning Policy 26 Littoral Rainforest Buffer Assessment (Hastings Council):
An investigation into rainforest ecology in order to determine an appropriate buffer width between a littoral rainforest and a proposed tourist/residential subdivision.

An LES for two sites at Harrington (GTCC):
Project management of an LES for two sites at Harrington proposed for residential development. Issues examined included ecology, traffic, archaeology, demographics, community facilities and bushfire.

Demon Nature Reserve Vegetation Survey (NPWS):
Project management of a vegetation survey and scientific report for a nature reserve near Tenterfield. Components of the project included statistical analysis of field data and research into the fire ecology of significant plant species.

Regional Representation of Vegetation Communities (*Degotardi Smith and Partners*):
Project management of an assessment of the representation of vegetation communities within a defined region in the Great Lakes Local Government Area. The purpose of this study was to determine whether vegetation communities at Pacific Palms are well represented within the region.

Review of Environmental Factors for the Pacific Highway Upgrade (RTA):
Co-ordination of the ecological component of an REF for the Pacific Highway upgrade between Karuah and Bulahdelah. Issues included removal of habitat trees and involved liaison with a number of government authorities.

Lake Munmorah Ecology (DPWS):
An investigation into the ecological issues associated with clearing two parcels of land for a proposed school. This report served as advice to the client on the suitability of the purchase of the land.

Bulahdelah By-pass Ecology (Thiess Construction):
This project involved the monitoring of habitat trees, prior to clearance for a new section of the highway, in accordance with a NPWS protocol. The object was to determine whether the trees were being used as habitat for threatened fauna.

Fauna and Species Impact Statements / Seven and Eight Part Tests

Kew Quarry Fauna Impact Statement (Hurd Haulage Pty Limited)

Possum Brush Quarry Species Impact Statement (Pacific Blue Metal)

Hastings Waste Transfer Facility Eight Point Check (Hastings Council)

Tallwoods Residential Development Species Impact Statement (Tallwoods P/L)

Minnamurra Tea Tree Plantation Eight Part Test (Gerard Cassegrain and Co P/L)

Failford Road Eight Part Test (Tipton & Gehrig P/L)

Barrington Wilderness Eight Part Test (Private Client)

Camden Haven High School Eight Part Test (PWS)

Rocks Ferry Eight Part Test (Hastings Council)

South Forster Tourist Development (Degotardi Smith and Partners)

Sweet Pea Road Sand Quarry (Lakes Independent Concrete)

Plans Of Management

Grants Head Quarry Environmental Management Plan (Hurd Haulage Pty Limited):
Participation in the rehabilitation strategy for a gravel quarry at Grants Head, south of Port Macquarie, in accordance with conditions of development consent, as set out by Hastings Council.

Sweet Pea Road Sand Quarry Rehabilitation/Revegetation Plan (Lakes Independent Concrete):
Project management of a rehabilitation/revegetation plan for a sand quarry at Forster. This plan was undertaken in accordance with, and covering the conditions of, approval specified in the development consent by Great Lakes Council.

Dunbogan Sand Quarry Environmental Management Plan (Hurd Haulage Pty Limited):
Participation in the flora, fauna, rehabilitation and monitoring components of an Environmental Management Plan for a sand quarry at Dunbogan. The plan covers the conditions of approval specified in the development consent by Hastings Council.

Mingaletta Environmental Site and Rehabilitation Plan (Hurd Haulage Pty Limited):
Involvement in the flora, fauna, archaeology, fire and public safety components of the plan. This included the construction of practical mitigation measures designed to comply with the EIS, FIS and Council's conditions of consent.

Reviews

Pacific Palms Draft Environmental Study Review (Degotardi Smith and Partners)
This involved a review of the ecological investigations for the Pacific Palms Draft Local Environmental Study. This was undertaken in order to determine whether development precincts had been appropriately set. Where discrepancies were found to exist, alternate development precincts were suggested.

Hastings Waste Facility Review of Submissions (Hastings Council)
This involved a review of the private and public submissions to Council on the Environmental Impact Statement and associated appendices for Hastings Waste Facility Development Application. Issues arising from the submissions were summarised and actions needing to be undertaken by Council in response to these issues were identified.

Mingaletta Quarry Appeal (Hurd Haulage P/L):
This involved a response to a critical review of an FIS carried out by ERM Mitchell McCotter for a hard rock quarry on the NSW Mid North Coast.

SEPP 44 - Koala Habitat Protection

Johns River SEPP 44 - Koala Habitat Protection Study (Private Client)

Campbell's Quarry SEPP 44 (Hurd Haulage Pty Ltd)

Tallwoods SEPP 44 - Koala Habitat Protection Study (Tallwoods Pty Limited)

Minnamurra SEPP 44 - Koala Habitat Protection Study (Gerard Cassegrain & Co P/L)

Failford SEPP 44 - Koala Habitat Protection Study (Private Client)

Barrington Wilderness SEPP 44 (Private Client)

Camden Haven High School Eight Part Test (PWS)

Planning Reports

Coopernook Rural Residential DA (Private Client):
The formulation of a Statement of Environmental Effects to accompany a development application for a proposed rural residential development on the mid north coast.

Moorland Dairy SEPP 1 Objection (Private Client):
This involved the formulation of a Statement of Environmental Effects for an objection to the provisions of the Greater Taree City LEP, for a proposed subdivision.

Taree Service Centre Demographic Study (Mobil Oil Australia Ltd):
This was a project which involved research into and documentation of the demographic characteristics of Taree and surrounding townships.

FEBRUARY 1995 - JULY 1995 ECOPRO PTY LIMITED

Environmental Scientist with EcoPro Pty Limited Environmental Consultants on the mid north coast of New South Wales.

Ecological Studies

Fire Prescription Management for Sensitive Plants in Wollemi NP. (NPWS):
Identifying fire sensitive plants, including rare or endangered species, in the northern end of Wollemi National Park and recommending appropriate fire prescriptions for these species. These species will then be used as indicator species for the overall vegetation communities in which they are found.

Wingen Maid Nature Reserve Resource Inventory (NPWS):
Undertaking flora and fauna surveys in the Nature Reserve to be used as base data for a Review of Environmental Factors (REF) for fire prescription burning.

Ecological Assessment Of Subdivision (Hurd Haulage Pty Limited):
Assessment of a proposed subdivision near Kew for the likely occurrence of rare or threatened Schedule 12 fauna species.

Bushfire Assessment, Pacific Palms (Great Lakes Council):
An assessment of bushfire hazard in the Pacific Palms area including the recommendation of management strategies to reduce bushfire risk.

Pacific Palms Critical Habitat Assessment (Great Lakes Council):
Assessment of critical fauna habitat for Schedule 12 species in the Pacific Palms area, in order to recommend environmentally sensitive measures for future urban development.

Statement Of Environmental Effects

Kew Quarry Statement of Environmental Effects (SEE) (Hurd Haulage Pty Limited):
Involvement in habitat assessment and fauna trapping as well as the design of mitigation measures for a SEE for expansion of a gravel quarry at Kew.

Fauna Impact Statements / Seven Point Checks

Mingaletta Quarry Fauna Impact Statement (FIS) (Hurd Haulage Pty Limited):
Assessment of the possible impacts of a hard rock quarry, north of Port Macquarie, on the fauna in the area and recommending mitigation measures.

Peppermint Crescent Seven-point Fauna Check (Hastings Council):
Involvement in a seven-point fauna check for a proposed residential subdivision at Peppermint Crescent, Wauchope.

SEPP 44 - Koala Habitat Protection

Peppermint Crescent SEPP 44 - Koala Habitat Protection Study (Hastings Council):
Investigation and assessment of potential koala habitat, in accordance with SEPP 44, for a proposed residential subdivision at Peppermint Crescent, Wauchope.

Pacific Palms SEPP 44 - Koala Habitat Protection Study (Great Lakes Council):
Investigation and assessment of potential and core koala habitat, in accordance with SEPP 44, for development planning in the Pacific Palms area.

Mingaletta Quarry SEPP 44 - Koala Habitat Protection Study (Hurd Haulage Pty Limited):
Investigation of core koala habitat, in accordance with SEPP 44, for a proposed hard rock quarry at Mingaletta, south of Kempsey.

Tea Gardens SEPP 44 - Koala Habitat Protection Study (Developments Pty Limited):
Investigation and assessment of core koala habitat, in accordance with SEPP 44, for a proposed residential subdivision in the Tea Gardens area.

Currabubula Quarry SEPP 44 - Koala Habitat Protection Study (Private Client):
Investigation of core koala habitat, in accordance with SEPP 44, for a proposed gravel quarry at Currabubula, south west of Tamworth.

Plans Of Management

Dunbogan Sand Quarry Koala Plan of Management (Hurd Haulage Pty Limited): Involvement in the formulation of a Koala Plan of Management for a sand quarry at Dunbogan in accordance with SEPP 44 - Koala Habitat Protection. This involved an assessment of impacts and the design of mitigation measures.

1994 - STATE FORESTS (*compulsory unit of tertiary studies*)

An investigation into the causes of Sydney Blue Gum dieback in NSW State Forests.

PUBLICATIONS

Arms, C.A and Brown, L.B (1994).

An investigation into the cause of Canopy Dieback in Sydney Blue Gum stands in NSW State Forests. NSW 'State Forests' Research Division.

Hunter, JT, Brown, LB, Barkwill, NB and Beresford-Smith, N (1997, in prep)

Vegetation Survey of Demon Nature Reserve.

NAME:	NICKY BARKWILL
ACADEMIC QUALIFICATIONS:	Bachelor of Applied Science (Honours) Southern Cross University, NSW, 1995
PROFESSIONAL AFFILIATIONS:	Member of New South Wales Bird Atlassers
	Member Royal Australian Ornithologists Union (RAOU)

PROFESSIONAL EXPERIENCE:

July 1996 to Present **ERM MITCHELL McCOTTER PTY. LTD.**

Environmental Scientist with ERM Mitchell McCotter's north coast office at Taree. Responsible for undertaking ecological surveys, soil surveys and assessments, assessment of conservation value, assisting in the preparation of environmental impact statements, recommending mitigation measures and formulating management plans and other environmental studies.

Environmental Impact Statements and Assessments

Possum Brush Quarry Environmental Impact Statement (Pacific Blue Metal Quarries, in progress)

Assessment of soils, contamination potential, review of environmental performance, examination of vegetation communities and determination of their conservation significance.

Minnamurra Tea Tree Plantation Development Application Advice (G. C. Cassegrain and Co. Pty Ltd, in progress)

Investigations into hydrology and soil characteristics of a property proposed for a tea tree plantation. Tasks included providing input into the preparation of a water monitoring program, development of a soil capability assessment program and assessment of hydrological effects of the proposal.

Minnamurra Tea Tree Plantation Statement of Environmental Effects and Dam Site Investigations (Gerard Cassegrain & Company; in progress)

Work involved bushfire hazard assessment, an archaeological assessment, acid sulfate soil investigations and input into the preparation of an acid sulfate soils management strategy. Work was undertaken for a proposed tea tree plantation.

Species Impact Statements

Possum Brush Quarry Species Impact Statement (Pacific Blue Metal Quarries, in progress):

This study is an assessment of possible impacts on threatened flora and fauna utilising the proposed quarry site. The report includes the recommendation of management strategies to mitigate the impacts of the proposal. The report is being undertaken in accordance with sections 109 and 110 of the TSC Act 1995 and the Director Generals requirements for the proposal pursuant to section 111 of the TSC Act 1995.

Tallwoods Species Impact Statement (Tallwoods Pty Limited):

This study was an assessment of possible impacts on threatened flora and fauna utilising a proposed residential site. The report included management strategies to mitigate the impacts of the proposal. The report was undertaken in accordance with sections 109 and 110 of the TSC Act 1995 and the Director Generals requirements for the proposal pursuant to section 111 of the TSC Act 1995.

Ecological Investigations

Minnamurra Tea Tree Plantation Ecology (Gerard Cassegrain and Co. Pty Ltd).

This is an assessment of the impacts of the works associated with the establishment and operation of a tea tree plantation on threatened flora and fauna. The report includes management strategies to mitigate the impacts of the proposal. The assessment is being undertaken in accordance with eight criteria listed for consideration under Part 5A of the EP&A Act.

Failford Road Eight Part Test (Tipton and Gehrig Pty Ltd)

Undertaking of an eight part test to determine the impacts of a rural residential development on threatened species. Also involved a full flora and fauna survey and the formulation of measures to mitigate the impacts of the proposal.

Rocks Ferry Boat Ramp Eight Part Test (Hastings Council, in progress).

Undertaking of an eight part test to determine the impacts of upgrading an existing boat ramp and car park on threatened species. The assessment was undertaken in accordance with eight criteria listed for consideration under Part 5A of the EP&A Act.

Brimbin Local Environment Study - Stage 2 (Greater Taree City Council, in progress).

This study incorporated an assessment of the potential ecological impacts associated with proposed development. The study included an eight part test undertaken in accordance with eight criteria listed for consideration under Part 5A of the EP&A Act, and the assessment of conservation values. Soils and contaminated land investigations and an archaeological assessment were also part of this study.

Demon Nature Reserve Vegetation Survey (NPWS Glen Innes District, in progress)

Technical involvement in a vegetation survey and report for a nature reserve near Tenterfield. Components of the project included statistical analysis of field data and research into the fire ecology of significant plant species.

SEPP 44: Koala Habitat Protection

Tallwoods SEPP 44 - Koala Habitat Protection Study (Tallwoods Pty Ltd)

An assessment of core Koala habitat.

Minnamurra SEPP 44 (Gerard Cassegrain and Co. Pty Ltd)

An assessment of potential Koala habitat.

Failford Road SEPP 44 (Tipton and Gehrig Pty Ltd)

An assessment of core Koala habitat.

Plans of Management

Acid Sulfate Soils Land Management Plan (Hastings Council, in progress):

Participation in the study to develop a management plan for the Partridge Creek Catchment to help ameliorate the impacts of acid sulfate soils. Tasks included reviewing existing catchment data, the undertaking of extensive field studies, soil and water assessment, developing a range of management options and providing recommendations on field trials and pilot studies.

Soil Investigations

Hawks Nest Local Environment Study - Stage 2 (Great Lakes Shire Council, in progress)

Work involved the preparation of soil investigation guidelines for the Hawks Nest North area. Acid sulfate soil assessment and management guidelines were developed, as well as soil analysis and measures required to accommodate urban development.

Wallis Lake Oyster Leases Acid Sulfate Soil Investigations (Moran, Dent, Kenny and Island Oysters, in progress).

Work involved project management and methodology design of the sampling and analysis of potential acid sulfate soils proposed for dredging at four oyster leases within Wallis Lake.

Harrington Waters Estate Local Environment Study (Greater Taree City Council, in progress).

Work undertaken included an assessment of the likelihood of acid sulfate soil occurrence. From this assessment, broad management strategies have been developed. Contamination potential and bushfire risk were also determined.

Failford Road Soil Investigations (Private Client)

Work involved project management and investigation of a potential effluent disposal site. All work was undertaken in accordance with *AS 1547 - 1994, Determination of Appropriate Effluent Disposal Systems for Domestic Premises.*

Moorland SEPP 1 (Private Client)

Work involved soils investigations to determine the appropriate type of disposal system for effluent disposal from domestic premises in accordance with *AS 1547 - 1994.*

Glacken Street Local Environment Study (GTCC).

Work undertaken included an assessment of the likelihood of acid sulfate soil occurrence. From this assessment, broad management strategies have been developed. Contamination potential and bushfire risk were also determined.

DA - Bangalow Road, Coopernook (Private Client)

Work involved soils investigations to determine the appropriate type of system for effluent disposal from domestic premises as part of a development application and in accordance with *AS 1547 - 1994.*

Minnamurra Soils - Determination of Appropriate Effluent Disposal System (Gerard Cassegrain and Company, in progress).

Work involved soil investigations to determine the appropriate type of effluent disposal system from domestic premises as part of a development application and in accordance with *AS 1547 - 1994 -Determination of Appropriate Effluent Disposal Systems for Domestic Premises.*

February to November 1995 **SOUTHERN CROSS UNIVERSITY**

Part-time Biology/Ecology Tutor

Duties included teaching 1st year Bachelor of Applied Science students biological and ecological concepts, scientific nomenclature, demonstrating introductory quantitative analysis and scientific experimentation.

PUBLICATIONS

Barkwill, N.L (1994)
The variability of acid sulfate materials within the Tuckean Swamp. Integrated Project, University of New England, Northern Rivers.

Barkwill, NL (1995a)
Acid sulfate soils: An historical review. Honours Project, Southern Cross University.

Barkwill, NL (1995b)
A comparison of scanning electron microscopy and thin sections for the examination of pyrite micromorphology in acid sulfate soils. Honours Project, Southern Cross University.

Barkwill, NL (1995c)
An examination of pyrite micromorphology in sandy acid sulfate soils. Honours Thesis, Southern Cross University.

Hunter, JT, Brown, LD, Barkwill, NL and Beresford-Smith, N (in prep)
Vegetation Survey of Demon Nature Reserve.

CURRICULUM VITAE: D. OWNER

Full Name: Donald Gordon Stephen Owner
Date of Birth: 11th June, 1972
Address: 3 Ruth Street, Wingham, 2429.
Telephone: (065) 535346
Marital Status: Single

Education: *Bachelor of Applied Science - Conservation Technology* (Southern Cross University, N.S.W., 1992 - 1995). The following units have been studied:

Units Studied	Grade
Biology	Credit
Chemistry	Pass
Resource Assessment Techniques I	Credit
Geology	Pass
Ecology	Distinction
Hydrology & Climatology	Credit
Quantitative Analysis	Pass
Aquatic Ecosystems	Pass
Techniques in Plant Conservation	Credit
Computing in Applied Science	Credit
Soil Processes	Credit
Water Resource Mgt. & Tech.	Pass
Land Degradation & Rehab.	Credit
Waste Technology	Pass
Natural Resource Economics	Credit
Land Use Planning	Pass
Protected Area Management	Credit
Coastal Resources Management	Distinction
Remote Sensing & GIS	Credit
Project Planning & Mgt	Credit
Techniques in Wildlife Conservation	Credit
Resource Assessment Techniques II	Distinction
Integrated Project	Distinction

Year 12 Certificate (from Hawker College, A.C.T., 1991), Tertiary Entrance Rank 75.26 (Top 24.74%).

T-Courses	Course Length	Scaled Scores	Weighting	Weighted Scaled Scores
English	Major	153.91	1.0	153.91
Mathematics 2	Major	150.46		
Life Sciences	Major	156.99	1.0	156.99
Phys. Sc. & Tech.	Minor	162.73	0.6	97.64
History	Major	178.59	1.0	178.59
Aggregate Score				587

Subject	Unit Studied	Grade
English	Understanding Poetry	B
	Short Forms of Literature	C
	The Short Story	A
	The American Experience	B
Mathematics	Algebra 2	A
	Algebra 3	A
	Introductory Calculus	A
Life Science	Plant Production	B
	Animal Production	B
	Ecology	A
Physical Science & Tech.	Matter & Molecules	A
	Electricity & Electrochemistry	B
	Heat Energy & Fuels	A
History	Hinduism & Buddhism	B
	Indigenous Peoples	A
	Secular Ideologies	A

School Certificate (from Macksville High School, 1987). The following subjects were satisfactorily studied:

Subject	Grade
English	Grade 3
Mathematics - Advanced	Grade B
Science	
History	
Technical Drawing	
Technics 1	

Other Qualifications: Current NSW Drivers Licence, Class 1A (manual).
Applied Biology Certificate (TAFE Animal Handling)

Employment:

May - August 1996	Factory Process Worker - SUBO Fitting and Turning
Mar - Jun 1995	Laboratory Assistant (general) - Southern Cross University
Nov - Dec 1992	Cotton Chipper (weed control) - Goondawindi
Sept 1990	Driveway Attendant - Macksville Caltex Service Station
Sept - Dec 1990	Carpenter Apprentice - Adrian Burke
Jan - May 1990	Automotive Mechanical Engineer Apprentice - Nambucca Toyota

Equipment Previously Utilised:

Tractor (4WD & 2WD), slasher, planter, disc plough
Chainsaw
Cash register, (EFTPOS)

Equipment Previously Utilised (cont....)

Downward Displacement Autoclave
Centrifuge
Mechanical rock/soil crusher
Freeze Drier
Soil augers (bucket, standard)
D-section corer
Spectrophotometer
A wide variety of laboratory and field equipment
Pneumatic equipment (nail guns, drills, wrenchs)
Elliott, Cage, Turtle and Harp traps
Mist nets

Skills:

Basic plant propagation skills
Basic tissue culture skills
Advanced report writing skills
Intermediate oral skills
Strategic questioning skills
Laboratory maintenance and operation
Plant herbarium maintenance/construction
Field surveying skills (flora, fauna and soil survey)
Land suitability assessment
Satellite image, aerial photograph and map interpretation
Intermediate level cartographic skills
Basic GIS skills
Intermediate database/spreadsheet skills
Word processing skills
Laboratory procedures
Terrestrial vertebrate trapping and identification
Advanced research skills
Basic Mechanical Maintenance

Interests: Fauna and flora observation, mechanics, golf, squash, motor racing.

Referees:

David Rohweder	PHD Student (SCU) (066) 203000
Max Egan	Laboratory Manager (SCU) (066) 203635
Craig Taylor	Technical Officer (SCU) (066) 203661
Robert de Leon	Gen. Manager (Subo Turning) (02) 6094320

CURRICULUM VITAE - G.C. RICHARDS

FULL NAME : Gregory Charles Richards

ADDRESS : Greg Richards & Associates Pty Limited
(ACN 074 890 823)
Wildlife Research and Ecological Assessment
Consultants, PO Box 3305 BMDC, Belconnen,
ACT 2617

DATE OF BIRTH : 20 November 1949

PAST POSITION : Experimental Scientist Grade 3
Resource Ecology Assessment Program
CSIRO Division of Wildlife & Ecology

EDUCATION HISTORY:

1996	PhD thesis prepared, to be submitted Oct 1996
1994	upgraded to PhD studies at University of NSW
1991	commenced MSc studies (CSU)
1990	granted MSc qual. (CSU)
1973	commenced BSc studies externally at Charles Sturt University
1968	awarded NSW Higher School Certificate (Canberra)

EMPLOYMENT EXPERIENCE :

1968-96	CSIRO Division of Wildlife & Ecology	27 years
1967-68	Australian National University	1 year

RESEARCH EXPERIENCE :

- Involved in bat research for nearly three decades, internationally recognised as expert in the taxonomy and ecology of Australia's bat fauna.
- Invited by Zoological Society of London to present review of fruit bat ecology.
- PhD thesis entitled *Ecological determinants of forest bat distribution and community structure in south-eastern Australian forests.*
- Skilled in data management and use of higher statistics for ecological analysis.

- Skilled in classical methods and analysis for identifying taxa, revising genera and describing new species.
- Developed a computerised video imagery system for use in taxonomic research and for estimating size of large bat colonies.
- Examiner for two post-graduate theses on flying-fox ecology.

CONSULTING EXPERIENCE :

- Compiler of the national Action Plan for Bat Conservation (ANCA).
- Contributor to the development of exclusion methods for flying-foxes in orchards (Greenspan Technology).
- Bat survey in Murwillumbah Management Area (State Forests of NSW)
- Bat survey in Wingham Management Area (State Forests of NSW)
- Bat survey in Kempsey-Wauchope Management Area (State Forests of NSW)
- Bat survey in Gloucester-Chichester Management Area (State Forests of NSW)
- Bat survey in Walcha-Nundle Management Area (State Forests of NSW)
- Review of bat fauna impact statement for Queanbeyan-Badja Management Area for State Forests of NSW
- Review of bat fauna impact statement for Tenterfield Management Area (State Forests of NSW)
- Review of bat fauna impact statement for Glenn Innes Management Area (State Forests of NSW)
- Review of bat fauna impact statement for Coffs Harbour Management Area (State Forests of NSW)
- Prediction of bat fauna in pre-1780 forests of southeast NSW (NSW NPWS).
- Assessment of bat fauna at Shoalwater Bay Military Training Area, central Queensland (for Department of Defence).
- Contributor to the Commonwealth Commission of Inquiry into tenure and status of the Shoalwater Bay Military Training Area.
- Bat fauna survey of East McIlwraith lowlands in Cape York (Geo Peko).
- Bat surveys of Torres Strait islands in relation to disease quarantine (Queensland Department of Primary Industries).
- Assessment of rabies status of migratory bats in Torres Strait (Australian Animal Health Laboratory).
- Assessment of conservation status of an endangered and undescribed flying-fox in Torres Strait (Australian Nature Conservation Agency).
- Contributor to the IUCN Old World Fruit Bat Action Plan.
- Contributor to landuse management plan for Cape York (Environmental Resources Information Network, ANCA).
- Contributor to conservation planning for bats in Wet Tropics World Heritage Area (Natural Resource Assessments).
- Review of threatened bat species (ACT Parks & Conservation Unit).
- Assessment of impacts on the bat fauna of the Very Fast Train project (VFT Consortium).
- Contributor to the assessment of impacts of mining and exploration on Ghost bats (Conservation Commission of the NT).

INTERNATIONAL EXPERIENCE :

- *USA and Costa Rica* - conference and survey methodology for fauna management.
- *Cambodia* - adviser re major bat conservation problem in National Museum.
- *UK, Germany, Netherlands* - granted an award for taxonomic research in museums.
- *India* - adviser to the UN Sustainable Development Program re bat fauna surveys in proposed reserves.
- *Thailand* -adviser to World Wide Fund for Nature in re survey methodology for endangered cave bats (collaborative).
- *Sarawak(Borneo)* - collaborative research included bat fauna surveys for the Malaysian National Parks & Wildlife Authority, the assessment of the conservation status of endangered endemic cave bats for the Sarawak Museum, and the provision of curatorial advice re bat specimen collections of the Sarawak Museum.

PROFESSIONAL ORGANISATIONS :

- Founder and President of the Australasian Bat Society
- Member of the Ecological Society of Australia
- Member of the Australian Wildlife Management Society
- Member of the Royal Zoological Society of NSW
- Application being reviewed as a Fellow of the Zoological Society of London

PUBLICATION AND EDITORIAL EXPERIENCE :

- Publications list exceeds 100 entries.
- Consultant for bats section in the Readers Digest *Encyclopaedia of Australian Wildlife.*
- Consultant for *The Mammals of Australia*, Second edition, published 1995.
- Member of editorial committee for the journal *Macroderma.*
- Section Editor, *The Australian Museum Complete Book of Australian Mammals*, published 1983.
- Referee for research papers and scientific articles in : *Biological Conservation, Biotropica, Australian Mammalogy, Australian Wildlife Research, Australian Journal of Ecology, Australian Journal of Zoology, Australian Zoologist, Biological Journal of the Linnean Society, Australian Geographic, Macroderma.*
- Editor, *Australian Bat Research News.*

Appendix B

TOPOGRAPHIC MAP OF THE LOCALITY

Study Area

Area A

Area B

T A L A W A H L

MOUNT TALAWAHL

Talawahi △ 433

BULL HILL

CALVARY HILL

Crockery Gully

Bungwohl Creek

Joe Cheers Road

Joes Cutting Road

Pipeclay Creek

Nabiac Creek

Candoormakh Creek

Wooster Road

Closed Road

Pacific Highway

Failford Park Motor Cross Track

Failford Cemetery

Possum Brush

"Moolap Park"

"Rathdowney"

"Kelvedene"

"Warrangong"

"Glenirby"

"Bettemaree"

"Eloura"

"Ridgelands"

"Grahwhey"

"Wee Brae"

"Mountain View"

"Athlone"

"Bundarra"

"Sunny Hill"

"Gwandalen"

"Glenayr"

Sawmill

Caravan Park

Substation

Pump

Ruins

Abandoned

Shed

Hut

Yards

Ford

Locked

Four Wheel Drive

Reserve

Creek

Pt 136

Pt 139

Pt 37

Pt 301741

Pt 30

Pt 36

Pt 35

Pt 27

Pt 76

Pt 69

BM 35

BM 36

RM 36

T20

N150

N145

N119

N120

580375

587845

619192

559443

568931

572204

543938

543830

600199

626769

589074

565974

619802

608957

263027

246031

246909

259557

250230

245828

215131

622173

600894

600890

595240

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Appendix C

AERIAL PHOTOGRAPH OF THE SUBJECT SITE

KEY

Outline of Study Area

Area A & B

Appendix D

SEPP 44 ASSESSMENT

APPENDIX D

SEPP 44 ASSESSMENT

INTRODUCTION

This report has been prepared to supplement the Species Impact Statement for the expansion of Possum Brush Quarry. The purpose of this supplementary report is to address SEPP 44 where it is required to be considered under Section 90 of the EP&A Act 1979.

MANAGEMENT CONTEXT - SEPP 44

State Environmental Planning Policy No. 44 - Koala Habitat Protection (SEPP 44) aims to:

> *encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline.*

The aim of the policy will be achieved by ensuring that for any DA to which the policy applies, consent is not issued without an investigation for the presence of core Koala habitat. The presence of potential Koala habitat is the trigger for an investigation of core Koala habitat.

Potential Koala habitat is defined as:

> *areas of native vegetation where trees of the types listed in Schedule 2 of the Policy constitute at least 15 per cent of the total number of trees in the upper or lower strata of the tree component.*

Tree species, as listed in Schedule 2 of the Policy, are given in *Table 1*.

Table 1 *SCHEDULE 2 TREE SPECIES*

Scientific Name	Common Name
Eucalyptus tereticornis	Forest Red Gum
Eucalyptus microcorys	Tallowwood
Eucalyptus punctata	Grey Gum
Eucalyptus viminalis	Ribbon or Manna Gum
Eucalyptus camaldulensis	River Red Gum
Eucalyptus haemastoma	Broad-leaved Scribbly Gum
Eucalyptus signata	Scribbly Gum
Eucalyptus albens	White Box
Eucalyptus populnea	Bimble Box or Poplar Box
Eucalyptus robusta	Swamp Mahogany

If the study area contains potential Koala habitat then further investigations are necessary to determine if this area contains core Koala habitat.
Core Koala habitat is defined as

> *an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of, and historical records, of a population.*

POTENTIAL KOALA HABITAT ASSESSMENT

Methodology

A field survey was undertaken to sample the study area on 29 February 1996. This survey was undertaken in order to gain a full quantitative understanding of the percentage of tree species in the upper and lower strata of the tree component for each of the vegetation communities containing Schedule 2 trees. A series of vegetation survey plots were marked out and individual trees counted to give an estimation of percentage of tree species present over the subject site and study area. The placement of plots over the study area is shown in *Figure D1*.

Survey Design

Six plots of 0.1 hectare (50 metres by 20 metres) in size, were used to sample the trees and give a percentage estimation of tree species over the study area. A plot size of 0.1 hectare (1,000 square metres) can be used as a standard for most purposes and is used by State Forests of NSW and CSIRO Division of Wildlife and Ecology for sampling overstorey species. A plot this size ensures that floristic diversity of the tree stratum is included (York *et al*, 1991).

York *et al* (1991) states that plot shape may be varied to suit the sampling area. Plots of 50m x 20m are commonly used by the State Forests of NSW, and plots of this

shape fit into and appropriately sample the size and shape of the differing vegetation communities in the study area.

Sampling of the vegetation communities for this SEPP 44 assessment included the following:

a) Four plots sampled the Dry Open Forest. Given the total area of this community on the study area, three plots were considered adequate to sample this community;

b) Two plots sampled the Depauperate Rainforest. This community is the least dominant community on the study area, therefore two plots were considered adequate.

c) The Herbland and Acacia Woodland were not sampled, as any trees located in the Herbland community were too sparsely scattered to be adequately sampled by plots used in this survey. Trees in the Acacia Woodland consisted only of Acacia regrowth.

Vegetation Structure

The definition of potential Koala habitat in SEPP 44 refers to the upper and lower strata of the tree component. The upper component in this study has been classified as the forest canopy layer and associated emergents. Actual height varies between 15 and 30 metres. The lower tree stratum has been classified as the tall understorey and the subcanopy varying between 6 and 16 metres. Trees between 10 and 15 metres have been classified as lower strata. This stratification of upper and lower strata is based on York *et al* (1991).

Analysis of Results

During the field survey, the number and type of tree species were recorded for both the upper and lower strata for each plot. From this the percentage of each species per plot was determined. The percentage of species listed in Schedule 2 of SEPP 44 was also drawn from these results. Plots which contained greater than 15 percent of Schedule 2 species in either the upper or lower strata were considered to be potential Koala habitat.

Results

Plot No.	Species Type And Number In Lower Stratum	Species Type And Number In Upper Stratum
Plot 1: Depauperate Rainforest	*Acacia binervata* (11) *Alphitonia excelsa* (3) *Diospyros australis* (5) *Eucalyptus microcorys* (3) *Commersonia fraseri* (6)	*Diospyros australis* (4) *Livistona australis* (2) *Eucalyptus microcorys* (5) *Eucalyptus propinqua* (7) *Alphitonia excelsa* (4) *Rhodamnia rubescens* (4) *Ficus coronata* (4)
Plot 2: Dry Sclerophyll Forest	*Acacia binervata* (10) *Jacksonia scoparia* (8) *Diospyros australis* (2) *Leucopogan juniperinus* (6) *Eucalyptus propinqua* (3) *Casuarina torulosa* (5)	*Allocasuarina torulosa* (6) *Corymbia gummifera* (8) *Syncarpia glommulifera* (3) *Eucalyptus acmenioides* (8) *Eucalyptus placita* (3)
Plot 3: Dry Sclerophyll Forest	*Allocasuarina torulosa* (21) *Acacia irrorata* (10)	*Allocasuarina torulosa* (12) *Eucalyptus placita* (3)
Plot 4: Dry Sclerophyll Forest	*Acacia binervata* (13) *Jacksonia scoparia* (2) *Diospyros australis* (1) *Eucalyptus propinqua* (3) *Allocasuarina torulosa* (8) *Maytenus silvestris* (2)	*Glochidion ferdinandii* (3) *Corymbia gummifera* (3) *Syncarpia glommulifera* (3) *Eucalyptus acmenioides* (17) *Eucalyptus placita* (3)
Plot 5: Depauperate Rainforest	*Acacia binervata* (12) *Eucalyptus microcorys* (1) *Eucalyptus propinqua* (10) *Livistona australis* (7) *Rhodamnia rubescens* (6) *Trochocarpa laurina* (1)	*Acronychia oblongifolia* (5) *Corymbia gummifera* (16) *Livistona australis* (10) *Guoia semiglauca* (7) *Eucalyptus acmenioides* (10)
Plot 6: Dry Sclerophyll Forest	*Eucalyptus placita* (6) *Allocasuarina torulosa* (21) *Glochidion ferdinandii* (4) *Eucalyptus microcorys* (2)	*Eucalyptus placita* (12) *Eucalyptus microcorys* (1) *Corymbia gummifera* (7) *Eucalyptus acmenioides* (5) *Allocasuarina torulosa* (6)

Percentages of Schedule 2 tree species for each plot shown in Table 2.

PLOT NUMBER	TOTAL NUMBER AND PERCENTAGE OF SCHEDULE 2 TREES IN LOWER STRATUM		TOTAL NUMBER AND PERCENTAGE OF SCHEDULE 2 TREES IN UPPER STRATUM		POTENTIAL HABITAT
	Total	%	Total	%	
Plot 1: (Depauperate Rainforest)	28 (3)	10.7	30 (3)	10.0	No
Plot 2: (Dry Sclerophyll Forest)	34 (0)	0.0	28 (0)	0.0	No
Plot 3: (Dry Sclerophyll Forest)	31 (1)	3.2	15 (0)	0.0	No
Plot 4: (Dry Sclerophyll Forest)	29 (0)	0.0	29 (0)	0.0	No
Plot 5: (Depauperate Rainforest)	37 (1)	2.7	48 (0)	0.0	No
Plot 6: (Dry Sclerophyll Forest)	33 (2)	6.1	31 (1)	3.2	No

Note: Within the total column the first number is the total number of trees within the plot while the number in brackets is the total number of schedule 2 trees in the plot.

Conclusion

No plots contained greater than 15 percent of Schedule 2 tree species in the upper strata or lower strata.

Results clearly indicate that the study area does not form potential Koala habitat, as outlined by Clause 7 and Schedule 2 of SEPP 44. Because the study area is not potential koala habitat, no further provisions of the policy apply to the DA.

A koala scat search conducted randomly under trees within the study area was undertaken in conjunction with the potential Koala habitat assessment. This brief search did not reveal any Koala scats, however a number of smooth barked trees were found to have scratches on them, and it appeared that a number of rough barked trees had also been used by arboreal animals. Site workers on the quarry indicated that they have not seen Koalas within the study area.

This potential Koala habitat assessment has been based on tree species listed under Schedule 2 of SEPP 44. The schedule 2 tree species recorded on site was Tallowwood (*Eucalyptus microcorys*). On the Mid North Coast of New South Wales, known Koala feed trees not listed on Schedule 2 of the policy which occur in the study area are Grey Gum (*Eucalyptus propinqua*), Grey Ironbark (*Corymbia paniculata*), Brush Box (*Lophostemon confertus*) and Pink Bloodwood, (*Eucalyptus intermedia*).

Even though the study area is not potential Koala habitat under SEPP 44, it does contain favoured Koala food trees as listed above. In addition Greater Taree City Council State of the Environment Report 1995 details that *'the present status of the Koala within the Greater Taree City Council area is of concern, as much of the population appears to be centred on the developing areas'*. For these reasons, it is not sufficient to

disregard the study area as being valuable in some way for the Koala as a species. Therefore, the Koala has also been addressed in the Species Impact Statement.

Appendix E

FLORA SPECIES OF THE STUDY AREA

APPENDIX E

FLORA OF THE STUDY AREA

Dry Open Forest	Depauperate Rainforest	Acacia Woodland	Herbland
Upper strata	*Upper strata*	*Upper Srata*	*Upper Srata*
Callistemon salignus	*Acronychia oblongifolia*	*Eucalyptus paniculata*	*Eucalyptus paniculata*
Casuarina torulosa	*Alectryon subcinereus*	*Eucalyptus microcorys*	*Eucalyptus microcorys*
Choricarpia leptopetala	*Alphitonia excelsia*	*Acacia irrorata*	*Acacia irrorata*
Commersonia fraseri	*Argyrodendron*		
Dendrocnide excelsa	*actinophyllum*	*Herb Layer*	*Herb Layer*
Diospyros australis	*Arytera divaricata*	*Themeda australis*	*Themeda australis*
Diplogottis australis	*Bachhousia sciadophora*	*Aristida ramosa*	*Aristida ramosa*
Drypetes australasica	*Choricarpia leptopetala*	*Cympobogan refractus*	*Cympobogan refractus*
Elaeocarpus reticulatus	*Commersonia fraseri*	*Cynodon dactylon*	*Cynodon dactylon*
Elattostachys nervosa	*Cryptocareya microneura*	*Digitaria parviflora*	*Digitaria parviflora*
Endiandra muelleri	*C. rigida*	*Entolasia stricta*	*Entolasia stricta*
Eucalyptus microcorys	*Dendrocnide excelsa*	*Eragrostis brownii*	*Eragrostis brownii*
Euodia micrococca	*Diospyros australis*	*Panicum simile*	*Panicum simile*
Eucalyptus placita	*Diploglottis australis*	*Lomandra longifolia*	*Lomandra longifolia*
Eucalyptus propinqua	*Drypetes australasica*	*Dianella caerulea*	*Dianella caerulea*
Eucalyptus acmenioides	*Elaeocarpus reticulatus*		
Glochidion ferdinandi	*Elattostachys nervosa*		
Gmelina leichhardtii	*Endiandra muelleri*		
Hibiscus heterophyllus	*Eucalyptus microcorys*		
Syncarpia glomulifera	*Euodia micrococca*		
Tristania conferta	*Ficus coronata*		
	Glochidion ferdinandi		
Shrub Layer	*Gmelina leichhardtii*		
Abutilon oxycarpum	*Guioa semiglauca*		
Acacia binervata	*Hibiscus heterophyllus*		
A. irrorata	spp.*heterophyllus*		
A. maidenii	*Jagera pseudorhus*		
Astrotricha latifolia	*Livistonia australis*		
Breynia oblongifolia	*Mallotus philippensis*		
Callistemon salignus	*Melia azedarach*		
Casuarina torulosa	*var. australasica*		
Choricarpia leptopetala	*Planchonella australis*		
Cinnamomum	*Rhodamnia rubescens*		
camphora	*Streblus brunonianus*		
Commersonia fraseri	*Trochocarpa laurina*		
Diospyros australis			
Elaeocarpus reticulatus	*Shrub layer*		
Euodia micrococca	*Acacia binervata*		
Eupomatia laurina	*Acronychia oblongifolia*		
Glochidion ferdinandi	*Alectryon subcinereus*		
Hibiscus heterophyllus	*Alphitonia excelsa*		
Indigofera australis	*Canthium coprosmoides*		
Jacksonia scoparia	*Capparis arborea*		
Lantana camara	*Choricarpia leptopetala*		
Lespedeza juncea	*Citriobatus pauciflorus*		
Leucopogon juniperinus	*Claoxylon australe*		
Maclura	*Clerodendrum*		
cochinchinensis	*tomentosum*		
Maytenus silvestris	*Coelebogyne ilicifolia*		
Olearia nernsteii	*Commersonia fraseri*		
Persoonia linearis	*Cordyline stricta*		
Polyscias sambucifolia	*Croton verreauxii*		
Pomaderris sp.	*Cryptocarya miconeura*		
Rapanea variabilis	*C. rigida*		

Dry Open Forest	Depauperate Rainforest	Acacia Woodland	Herbland
Sida rhombifolia	*Diospyros australis*		
spp. *rhombifolia*	*Elaeocarpus reticulatus*		
Solanum mauritianum	*Euodia micrococca*		
Trema aspera	*Eupoimatia laurina*		
	Ficus coronata		
Herb Layer	*Glochidion ferdinandi*		
Adiantum aethiopicum	*Guioa semiglauca*		
Anagallis arvensis	*Hibiscus heterophyllus*		
Apium tenuifolium	spp. *heterophyllus*		
Axonopus affinis	*Lantana camara*		
Bidens pilosa	*Livistonia australis*		
Blechnum	*Maclura cochinchinensis*		
cartilagineum	*Mallotus philippensis*		
Brunoniella pumilio	*Maytenus silvestris*		
Cenchrus caliculatus	*Notelaea longifolia*		
Centaurium spicatum	*Omalanthus populifolius*		
Cheilanthes sieberi	*Pittosporum revolutum*		
Chenopodium	*P. undulatum*		
carinatum	*Rapanea variabilis*		
Cirsium vulgare	*Rhodamnia rubescens*		
Conyza bonariensis	*Solanum mauritianum*		
C. parva	*Streblus brunonianus*		
Cymbopogon refractus	*Trochocarpa laurina*		
Cynodon dactylon			
Cyperus sphaeroideus	*Herb layer*		
Dawsonia sp.	*Adiantum aethiopicum*		
Doodia aspera	*A. hispidulum*		
Gahnia aspera	*Alpina caerulea*		
Gymnostachys anceps	*Carex appressa*		
Hybanthus	*Commelina cyanea*		
enneaspermus	*Cyperus polystachyos*		
spp. *stellarioides*	*C. tetraphyllus*		
Hypericum gramineum	*Dawsonia* sp.		
Hypochoeris radicata	*Doodia aspera*		
Imperata cylindrica	*Gahnia aspera*		
var major	*Gymnostachys anceps*		
Juncus polyanthemos	*Hydrocotyle tripartita*		
Kreysigia multiflora	*Kreysigia multiflora*		
Kunstleria blackii	*Kunstleria blackii*		
Lepidosperma laterale	*Lomandra longifolia*		
Lomandra longifolia	spp. *longifolia*		
spp. *longifolia*	*Oplismenus aemulus*		
Mentha satureioides	*var. lasiorhachis*		
Microlaena stipoides	*Pellaea falcata*		
Oplismenus aemulus	*P. paradoxa*		
var. lasiorhachis	*Plectranthus parviflorus*		
Oxalis corniculata	*Rumex brownii*		
Panicum simile			
Paspalum dilatatum	*Epiphytes*		
Pellaea falcata			
P. paradoxa	*Davallia pyxidata*		
Phytolacca octandra	*Platycerium bifurcatum*		
Plantago debilis			
P. lanceolata	*Lianes, vines or*		
Plectranthus parviflorus	*scramblers*		
Poa sp.			
Poranthera microphylla	*Cayratia clematidea*		
Pratia purpurascens	*Celastrus subspicatus*		
Pseuderanthemum	*Cissus antarctica*		
variabile	*C. hypoglauca*		
Pteridium esculentum	*Dioscorea transversa*		

Dry Open Forest	Depauperate Rainforest	Acacia Woodland	Herbland
Senecio lautus spp. *lanceolatus* *Setaria geniculata* *var. pauciseta* *Sigesbeckia orientalis* *Solanum nigrum* *Sonchus oleraceus* *Sporobolus africanus* *S. diander* *Themeda australis* *Trifolium repens* *Verbena bonariensis* *Vernonia cinerea* *var. cinerea* *Veronica calycina* *Viola hederacea* *Wahlenbergia* sp. *Zornia dyctiocarpa* ***Epiphytes*** *Cymbidium sauve* *Davallia pyxidata* *Platycerium bifurcatum* ***Lianes, vines or scramblers.*** *Cissus opaca* *Clematis glycinoides* *Dioscorea transversa* *Flagellaria indica* *Geitonoplesium* *cymosum* *Kennedia rubicunda* *Pandorea pandorarna* spp. *pandorana* *Passiflora subpeltata* *Rubus parvifolius* *R. vulgaris* *Smilax australis* *Stephania japonica* *var. discolor*	*Flagellaria indica* *Geitonoplesium cymosum* *Marsdenia flavescens* *Pandorea pandorana* spp. *pandorana* *Passiflora subpeltata* *Ripogonum album* *R., fawcettianum* *Rubus hillii* *R. rosifolius* *Sarcopetalum harveyanum* *Smilax australis* *Stephania japonica* *var. discolor* *Tetrastigma nitens* *Wilkea huegeliana*		

Appendix F

FAUNA SPECIES OF THE STUDY AREA

APPENDIX F

FAUNA OF THE STUDY AREA

Key
OF = Open Forest
W= Woodland
H = Herbland

AC = audible call
O = observed
S = scat evidence

Table 1 Fauna Species Observed

Common Name	Scientific Name	Method of Observation	Habitat In Which It Was Observed
Birds			
Australian Brush-turkey	*Alectura lathami*	O	H
Australian King Parrot	*Alisterus scapularis*	O	OF
Pheasant Coucal	*Centropus phasianinus*	O	OF
Grey Shrike Thrush	*Colluricincla harmonica*	AC	OF
Black faced Cuckoo Shrike	*Coracina novaehollandiae*	O, AC	OF
White-throated Treecreeper	*Cormobates leucophaea*	O	OF
Australian Raven	*Corvus coronoides*	O	OF
King Quail	*Coturnix chinensis*	AC	OF
Pied Butcherbird	*Cracticus nigrogularis*	O	OF
Grey Butcherbird	*Cracticus torquatus*	AC	OF
Kookaburra	*Dacelo novaeguineae*	AC, O	H
Black-shouldered Kite	*Elanus notatus*	O	OF
Eastern Yellow Robin	*Eopsaltria australis*	O	OF
Common Koel	*Eudynamys scolopacea*		
Brown Falcon	*Falco berigora*	O	H
Crested Pigeon	*Geophaps lophotes*	O	OF
Magpie Lark	*Grallina cyanoleuca*	O	OF
Magpie	*Gymnorhina tibicen*	O	H, W
Welcome Swallow	*Hirundo neoxena*	O	H
White -winged Triller	*Lalage tricolor*	O	OF
Wonga Pigeon	*Leucosarcia melanoleuca*	AC	OF
Yellow faced Honeyeater	*Lichenostomus chrysops*	O	W

Superb Blue Fairy Wren	*Malurus splendens*	O	OF
Noisy Miner	*Manorina melanocephala*		OF
Bell Miner	*Manorina melanophrys*	AC	OF
Lewin's Honeyeater	*Meliphaga lewinii*	O, AC	OF
Jacky Winter	*Microeca leucophaea*	O	H
Scarlet Honeyeater	*Myzomela sanguinolenta*	O	OF
Red-browed Firetail	*Neochmia temporalis*	O	OF
Rufous Whistler	*Pachycephala rufiventris*	AC	OF
Golden Whistler	*Pachycephalas pectoralis*	AC	OF
Straited pardalote	*Pardalotus straitus*		
House Sparrow	*Passer domesticus*	O	OF
Common Bronzewing	*Phaps chalcoptera*		OF
Noisy Friarbird	*Philemon corniculatus*	O, AC	OF
Eastern Rosella	*Platycercus eximius*		OF, W, H
Tawny Frogmouth	*Podargus strigoides*	O	OF
Eastern Whipbird	*Psophodes olivaceus*	AC	OF
Satin Bowerbird	*Ptilinorhynchus viloaceus*	O & AC	OF
Grey Fantail	*Rhipidura fuliginosa*	O	OF, W
Grey Fantail	*Rhipidura fuliginosa*	O	OF
Willie Wagtail	*Rhipidura leucophrys*	AC	OF
Yellow-throated Scrubwren	*Sericornis citreogularis*	O	OF
White-browed Scrubwren	*Sericornis frontalis*	O	OF
Pied Currawong	*Strepera graculina*	AC	OF
Rainbow Lorikeet	*Trichoglossus haematodus*	O	OF
Masked Lapwing	*Vanellus miles*	AC	OF
Silvereye	*Zosterops lateralis*	O	OF

Mammals

Cow		O	H
Rabbit	*Oryctolagus cuniculus*	O & S	H
Sugar Glider	*Petaurus breviceps*	O,AC	OF
Common Brushtail Possum	*Trichosurus vulpecula*	O	OF

Bandicoot species	*Isoodon sp.*	O of diggings	OF
Fox	*Vulpes vulpes*	S	H
Amphibians			
Common Toadlet	*Crinia signifera*	AC	WV
Striped Marsh Frog	*Limnodynastes peronii*	AC	WV
Dwarf Tree Frog	*Litoria fallax*	O, AC	WV
Reptiles			
Copper-tailed Skink	*Ctenotus taeniolatus*	O	OF

Table 2 Fauna Species Captured

Common Name	Scientific Name	Numbers Captured	Communities In Which They Were Captured
Brown Antechinus	*Antechinus stuartii*	4	Moist Open Forest and Dry Open Forest
House Mouse	*Mus musculus*	2	Dry Open Forest
Bush Rat	*Rattus fuscipes*	15	Dry Open Forest
Black Rat	*Rattus rattus*	3	Dry Open Forest

Appendix G

BAT SURVEY

BAT SURVEY

of

POSSUM BRUSH QUARRY SITE

by

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for

ERM Mitchell McCotter, Taree, NSW
September 1996

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Figure 3 : Three dimensional plot showing habitat relationships based on species richness, with inventory sites at dams excluded. 19

INTRODUCTION

Literature review

A major bat survey was conducted in the Wingham Management Area of State Forests of NSW in late 1991 by the consultant (Richards 1992). As this area is only 40 km or so to the north-east of the Possum Brush quarry site, habitats were, as expected, similar in both areas. In the WMA, over 60 sampling sites were stratified across habitats denoted as dry sclerophyll forest, moist sclerophyll forest, New England sclerophyll forest, rainforest and water points such as earth dams. There were 19 species recorded in the 1991 survey.

Data from Richards (1992) contributed to an analysis of the habitat utilisation patterns of microchiropteran bats over a larger region which also included the forests Kempsey-Wauchope and Gloucester Chichester Management Areas, and also surveyed by the consultant. This research formed the basis of PhD studies at the University of New South Wales (Richards, unpublished), results of which were presented at the Australian Bat Research conference, Lismore, 1993. A copy of the abstract of this paper is attached as Appendix 1.

Small, short term bat surveys have been conducted elsewhere in the general region, and include (alphabetically) Barrington Tops National Park (Adam 1987), Boorganna Nature Reserve (Rose 1976), Doyles River State Forest (Hines 1991), Hastings River Catchment (Tidemann, unpublished), Mt Seaview NR (Adam 1987), Woko NP and Camels Hump NR (Griffith 1989), Werrikimbe NP (Adam 1987), Wingham Management Area (FC-NSW 1990).

There are very few studies providing guidance to the likely impact of forest modification upon bat faunas that are appropriate to this project, apart from the PhD studies of the consultant mentioned above. Lunney *et al* (1985, 1988), Tidemann and Flavel (1987), and Taylor and Savva (1988) provide information on roosting ecology of several species that were recorded in this study. Richards and Tidemann (1988) Crome and Richards (1988), and Richards (1990, 1991) provide both hard data and reviews of the likely impacts of forest logging and clearance at a state or national scale.

Taxonomic notes

There have been several instances where past taxonomic revisions of Australian bat groups have been ignored. Of most significance is the revision of Kitchener *et al* (1995) of the genus *Myotis*. Of importance for this report is that *M.adversus* is now known only from a small population restricted to north-east New South Wales, and the species distributed elsewhere in the state is now recognised as *M.macropus*. Unfortunately, Schedule 2 of the NSW Threatened Species Conservation Act 1995 No 101, which lists Vulnerable species, does not list *M.macropus*.

The NSW Threatened Species Conservation Act 1995 also lists as *Eptesicus* species that have been recognised as being within the genus *Vespadelus* for a considerable time, resulting from the taxonomic revision by Kitchener *et al* (1986) and the chromosome studies of Volleth and Tidemann (1989).

This report applies currently accepted taxonomy and nomenclature.

METHODS

Pre-survey data search

A list of species expected in the area was extracted from the consultant's national database of 59,000 distribution records, and those listed in Schedules 1 and 2 of the Threatened Species Act 1995 formed a primary target list, in case they required unique methodology in the field due to their ecological specialisations. Species such as *Myotis macropus*, which has an affinity for foraging over water, and *Kerivoula papuensis* which prefers to forage in dense vine tangles (M.Schulz, pers. comm.) are examples of species on the target list that was generated. The latter species requires a specialised design of harp trap to ensure successful capture if present.

Habitat sampling

Three vegetation types were identified in the area by S. Griffiths (see separate report) with a further one (or two, depending upon interpretation) being included by ERM Mitchell McCotter. For the purposes of the bat survey, dams in the area were identified as bat foraging habitat and the shrubland and grassland in the northern portion of the property was combined as a single habitat. The latter decision accommodated the trapping methodology, and it was considered that bats using the grassland would also forage over the shrubland due to the small scale of the mosaic. Furthermore, this habitat was used for cattle grazing and is not expected to be adapted for other uses. Habitats were denoted as follows :

- Moist open forest
- Dry open forest
- Dry rainforest (considered "depauperate") by Griffiths
- Shrubland/Grassland
- Water points

Bat survey methodology - sampling strategy

The bat fauna in each habitat was surveyed on replicated sampling points, as shown in Table 1. A total of 16 sites were established to give a minimum of 3 replicates for each of the four vegetation types, and included the two water points in the area which were used to provide data for the species inventory. The approximate locations of each sampling point are shown in Plate 1. Replication in the stratified sampling regime and survey effort expended at each site is shown in Table 1.

Plate 1

Aerial photograph of study area and environs, showing location of sampling points. Numerals indicate sites with traps and detectors, alpha characters indicate sites where detectors were used alone.

Table 1 : Replication of sampling points and overall field survey effort across the five bat habitats identified in the Possum Brush quarry area.

Habitat type	Total sites	Total trap nights	Total detector nights
Dry open forest	3	6	6
Moist open forest	5	6	10
Dry rainforest	3	5	5
Shrubland/Grassland	3	2	4
Water points	2	1	4
Totals	16	20	29

Bat survey methodology - Microchiroptera

A trap/net array was used to capture bats at each sampling site, focussing primarily on microchiropteran species. The trap/net array consisted of a harp trap at the centre of two 12.3 m (40 ft) mist nets, which were attached to the side of the trap and set at an angle to the trap to form a shallow Vee. The array effectively acts as a funnel with a mouth approximately 25 m wide to capture bats that have the ability to detect mist nets, and gives a standardised catching area to allow valid between-habitat comparisons. Examples of the net/trap array are shown in Plates 2 and 3.

Many bat surveys rely upon flyways in forest as trap sites, but traps are rendered ineffective in open habitats such as, in this case, shrubland or open forest. The mist nets also allow the capture of small megachiropterans. The net/trap array was first devised by the consultant to accommodate the 27 habitats assessed in the Shoalwater Bay Military Training Area in Queensland (which is approximately 60 x 100 km in size), all of which varied in the density of their vegetation. Other areas where this method has been used in surveys include Cape York (East McIlwraith Lowlands) and north coastal NSW (Wingham, Kempsey-Wauchope, Gloucester-Chichester and Walcha-Nundle forestry management areas).

At the Possum Brush site mist nets were initially used but problems with large animals (probably cattle) being caught and ruining the nets compelled their replacement with an alternative. Plastic "bird net", used to exclude birds from fruiting trees, was purchased and substituted for mist nets during the majority of the

Plate 2

Photograph of site 9 showing a harp trap with side wings of plastic bird netting. The netting is not visible but its direction can be ascertained by the yellow cord (arrowed) from which it is suspended. The black plastic hanging behind the blue catching bag prevents bats flying underneath. This trap/net array increases the catching area for bats, and is the consultant's standardised method used to accommodate the varying density of vegetation between different habitats.

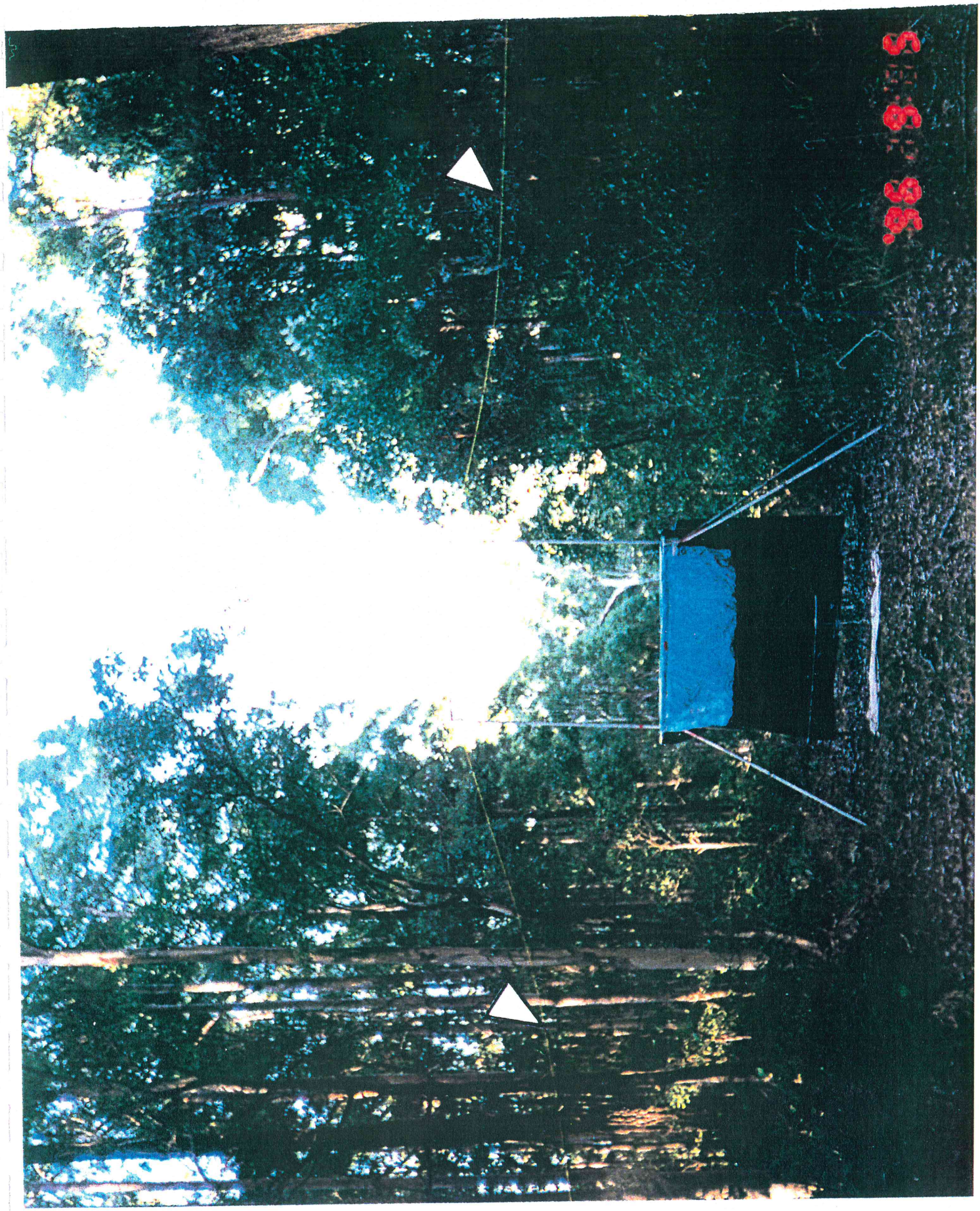


Plate 3

Photograph of site 1 in Area B, showing harp trap with side wings of mist nets (arrowed), which have been furled during the daytime to prevent the capture of birds whilst the site is unattended. At dusk the nets are unfurled and reach the top of the aluminium pole attached to the left side of the trap (arrowed).

study. Because the plastic netting was suspended vertically and did not have benches and pockets, no birds were caught during the daytime. Its effectiveness was measured at one site that was operated with a trap alone on a track which was then fitted with 15 m of net each side for the following night. Captures were nil and eight bats respectively each night.

No small megachiropterans (specifically *Syconycteris australis*) were caught when the mist nets were in operation. Suitable foraging habitat such as heath was not observed in the study area, so the substitution of the plastic netting was considered valid and not likely to affect results.

Trapping sites were operated for, in most cases, a minimum of two consecutive nights. Captured bats were marked with an "X" on the underside of one wing with a waterproof xylene free marker pen to identify retrapped individuals. During morning trap rounds each bat was identified, and weighed and measured where necessary. They were then released by being placed under the loose bark of the nearest suitable tree to avoid bird predation.

Each site was monitored with an electronic detector system. ANABAT II detectors were linked with a call-activated switching device, enabling automatic operation from dusk to dawn, with calls being recorded onto cassette tape. Some sites were monitored with an Ultra Sound Advice S25 detector linked directly to a cassette recorder and were only in operation for four hours or so each night when the consultant was present. Sites monitored manually were either the sediment dams used to build the local species inventory, or sites in the three forest habitats that were not trapped as well (see Table 1).

Climatic conditions

Past studies have shown that the nocturnal activity of microchiropteran bats in Australia is affected by temperature, where cool temperatures cause a reduction in prey availability (Richards 1989). Night temperatures measured around midnight were in the range of 12 - 17°C, and daily minima from radio reports were not below 10°C during the survey period.

There may also be some species whose activity is reduced during periods of bright moonlight. The survey was conducted when the moon phase was in the last quarter so that the survey results would not be affected by the consequent absence of lunar phobic species.

Rain, which can affect the activity of some species, particularly those with short wavelength echolocation calls, was not recorded during the survey.

Bat survey methodology - Megachiroptera

In past surveys flying-foxes, if present, were recorded during spotlight transects that were located so as to observe flowering or fruiting trees, along a route marked during the day. Their presence is usually first established by hearing territorial calls at night, or by observing individuals in flight against the dusk sky.

As there were no indications of flying-foxes using the study area, road transects to evaluate food availability (eucalypt blossom) were conducted instead, in an attempt to explain their absence. These transects included :

1. ridge track driven for 1.1 km;
2. quarry access road driven 0.8 km from ridge track intersection north-eastwards to start of bitumen.
3. Pacific Highway between the Talawahl Creek bridge and the Koorainghat Creek bridge, a distance of approximately 7 km.

Data analysis

Because a standardised net/trap array is used, then the absence data in presence/absence analyses becomes more reliable. In past surveys it has been difficult to compare the abundance of bat species due to the two different methods of gathering data: direct captures versus detector passes. The major problem has been in the interpretation of high numbers of passes that may not necessarily come from high numbers of individuals. How does one compare 50 passes of species "x" (which may be 50 bats once or one bat 50 times, etc) with 50 captures of species "y"? Are the two species of equal abundance.

A new method to resolve this problem has been developed by the consultant, using an extensive dataset (Richards 1996) which assesses the two techniques now used in bat surveys. This research showed that bats could be separated into three groups:

- those species that are only ever caught and are rarely detected (such as Long-eared bats in the genus *Nyctophilus*);
- those that are only ever detected and are rarely caught (such as molossids in the genera *Nyctinomus* or *Mormopterus*);
- those that have a roughly equal chance of being caught as being detected.

Data collected from three fauna surveys in different regions in eastern Australia were used to develop this new analysis technique: Murwillumbah and Wingham areas in New South Wales, and the Shoalwater Bay Military Training Area in central Queensland. These surveys had been conducted by using mist nets, harp traps, and electronic detection in tandem, and constitute a total of 22 weeks of field work between 1991 and 1995. In each of these surveys, the sampling points that were censused were stratified according to habitats based upon vegetation communities, but also included other foraging habitats for bats, such as rivers and lakes.

Over 200 sampling points were surveyed : 61 at Wingham, 75 at Murwillumbah, and 65 at Shoalwater Bay, and a dataset of 1073 captures and 1533 passes was produced. There were six species that were detected and never captured (primarily emballonurids and molossids), and two species (both *Nyctophilus*) that were only captured and never detected. However, when the proportions of captures to detections was examined, many other species fell into groups that had a low probability of being recorded by either method. Conversely, species such as *C.morio* have an almost equal probability of being recorded by either method (45 captures and 51 passes, a ratio of 47:53).

RESULTS

Database search

A search of the extensive distribution database revealed that 23 species have been recorded in the general area, the coastal boundaries of which were from Bulahdelah northwards to Port Macquarie, and inland as far as the Wingham forestry management area (which includes Doyles River, Bulga, Dingo Tops and Knorrit State Forests). Table 2 lists the species recorded for the region, grouped into sub-regions as indicated.

Species recorded during the field survey

Table 2 also shows the species that are listed as Vulnerable in Schedule 2 of the NSW Threatened Species Conservation Act 1995 No 101. This table was used to generate a "target" list of ecological specialists (*sensu* Richards and Hall 1996) that may have required specialised techniques in the field that would ensure that, if they were present, they would then be recorded. Species in this category, and the methods applied to especially search for them during this survey, are as follows :

Syconycteris australis	mist nets in suitable habitat (especially near flowering shrubs such as *Banksia* spp)
Kerivoula papuensis	modified harp trap placed into vine tangles growing in wet gullies
Myotis macropus	mist nets, traps and detectors at smooth-flowing or still water such as dams
Saccolaimus flaviventris	electronic detection systems operating for the entire night to counter for rarity, or the large home range or foraging circuits that have been noted elsewhere by the consultant
Mormopterus norfolkensis	as for *S.flaviventris*
Nyctinomus australis	as for *S.flaviventris*

Therefore, with the large number of sampling points, the conduct of the survey during perfect climatic conditions, and the application of techniques that would ensure that all species would have an optimal chance of being recorded if they were present in the area, the list of species recorded during the survey shown in Table 3 can be considered as a valid representation of the bat fauna of the Possum Brush quarry site.

Table 2 : List of bat species expected in the general proximity of the study area, separated into subregions, as extracted from a database of approximately 59,000 distribution records. Species listed as Vulnerable in Schedule 2 of the NSW Threatened Species Conservation Act 1995 No 101 are shown in bold.

	Wingham Management Area SFs	Taree area	Forster area	Port Macq. area	Bulahdelah area
Pteropodidae					
Pteropus poliocephalus	-	x	x	-	-
Syconycteris australis	-	x	x	-	-
Rhinolophidae					
Rhinolophus megaphyllus	x	-	-	-	x
Emballonuridae					
Saccolaimus flaviventris	x	-	-	-	-
Molossidae					
Mormopterus norfolkensis	x	-	x	-	-
Nyctinomus australis	x	x	-	x	-
Vespertilionidae					
Chalinolobus dwyeri	x	-	-	-	-
Chalinolobus gouldii	x	x	x	-	-
Chalinolobus morio	x	-	-	x	-
Falsistrellus tasmaniensis	x	x	-	-	-
Kerivoula papuensis	-	-	-	-	x
Miniopterus australis	x	-	x	-	x
Miniopterus schreibersii	x	x	-	-	x
Myotis macropus	x	x	-	x	-
Nyctophilus geoffroyi	x	-	x	-	-
Nyctophilus gouldi	x	-	x	-	x
Scoteanax rueppellii	x	-	x	-	-
Scotorepens greyii	x	-	-	-	-
Scotorepens orion	x	x	-	-	-
Vespadelus darlingtoni	x	-	x	-	-
Vespadelus pumilus	x	-	-	-	-
Vespadelus regulus	x	-	-	-	-
Vespadelus vulturnus	x	x	x	-	x
Regional species count	20	9	10	3	5
% of regional total (n=23 spp.)	87	39	43	13	22
Number of Schedule 2 species	7	3	4	0	3

Table 3 : List of bat species recorded during the field survey of the Possum Brush quarry site. Species listed as Vulnerable in Schedule 2 of the NSW Threatened Species Conservation Act 1995 No 101 are shown in bold. Common names follow the revision of Richards *et al* (1993).

Gould's Wattle Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Little Bentwing-bat	***Miniopterus australis***
Common Bentwing-bat	***Miniopterus schreibersii***
White-striped Freetail-bat	*Nyctinomus australis*
Lesser Long-eared Bat	*Nyctophilus geoffroyi*
Gould's Long-eared bat	*Nyctophilus gouldi*
Eastern Horseshoe-bat	*Rhinolophus megaphyllus*
Large Forest bat	*Vespadelus darlingtoni*
Southern Forest Bat	*Vespadelus regulus*
Little Forest Bat	*Vespadelus vulturnus*

Habitat utilisation

Table 4 shows the habitats utilised by bats in the Possum Brush quarry study area. It can be seen that the depauperate Dry Rainforest and the Shrubland/Grassland habitats had the lowest species counts, whereas the Dry and Moist Open Forests and sediment dams had the highest.

To smooth the varied number of trap-nights and detector nights, the number of species recorded in each habitat was equated to a single night for each method (Table 4). These calculations again relegated the Dry Rainforest to being the poorest habitat, and equated the others to some extent. A nearest neighbour analysis was conducted to assess the relationships of actual and calculated species counts in each habitat, using a single linkage cluster analysis of Euclidean distance (Figure 1).

Rainforest and the Shrubland/Grassland grouped together on the basis of species counts, as did Dry and Moist Open Forest, whereas the inventory sites (the sediment dams) differed from all of the stratified sampling points. The relationships of these habitats are also shown in Figure 2 with dams included, and in Figure 3 with dams excluded.

Table 4 : Presence/absence data showing the habitats utilised by the 11 species of bats recorded in the Possum Brush quarry study area. Species listed as Vulnerable in Schedule 2 of the NSW Threatened Species Conservation Act 1995 No 101 are shown in bold.

	Dry open forest	Moist open forest	Depauperate rainforest	Shrubland/ grassland	Sediment dams
Chalinolobus gouldii	x	x	-	-	x
Chalinolobus morio	x	x	-	-	x
Miniopterus australis	x	x	-	-	x
Miniopterus schreibersii	-	x	-	-	x
Nyctinomus australis	x	-	-	x	x
Nyctophilus geoffroyi	x	x	-	x	-
Nyctophilus gouldi	-	x	-	-	-
Rhinolophus megaphyllus	-	x	x	-	-
Vespadelus darlingtoni	-	x	-	-	-
Vespadelus regulus	x	x	-	-	x
Vespadelus vulturnus	x	x	x	x	x
Number of species recorded	7	10	2	3	7
Number of species per trap-night	1.2	1.7	0.4	1.5	7.0
Number of species per detector night	1.2	1.0	0.4	0.8	1.8

Figure 1 : Cluster analysis of the relationship of habitats according to their species composition in the Possum Brush quarry site study area.

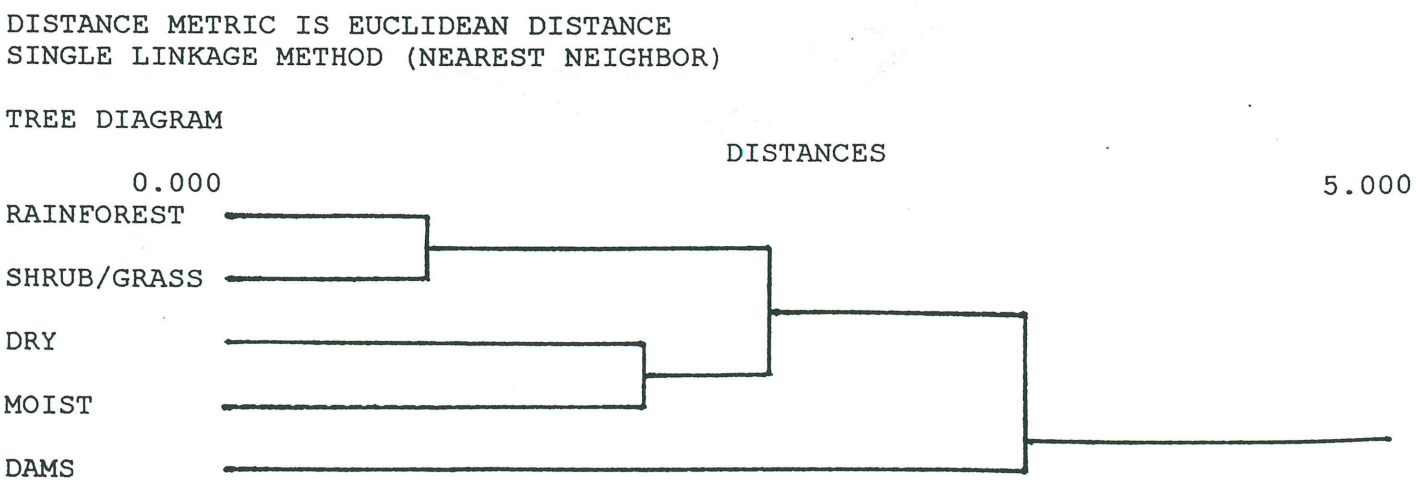


Figure 2 : Habitat relationships with dams included

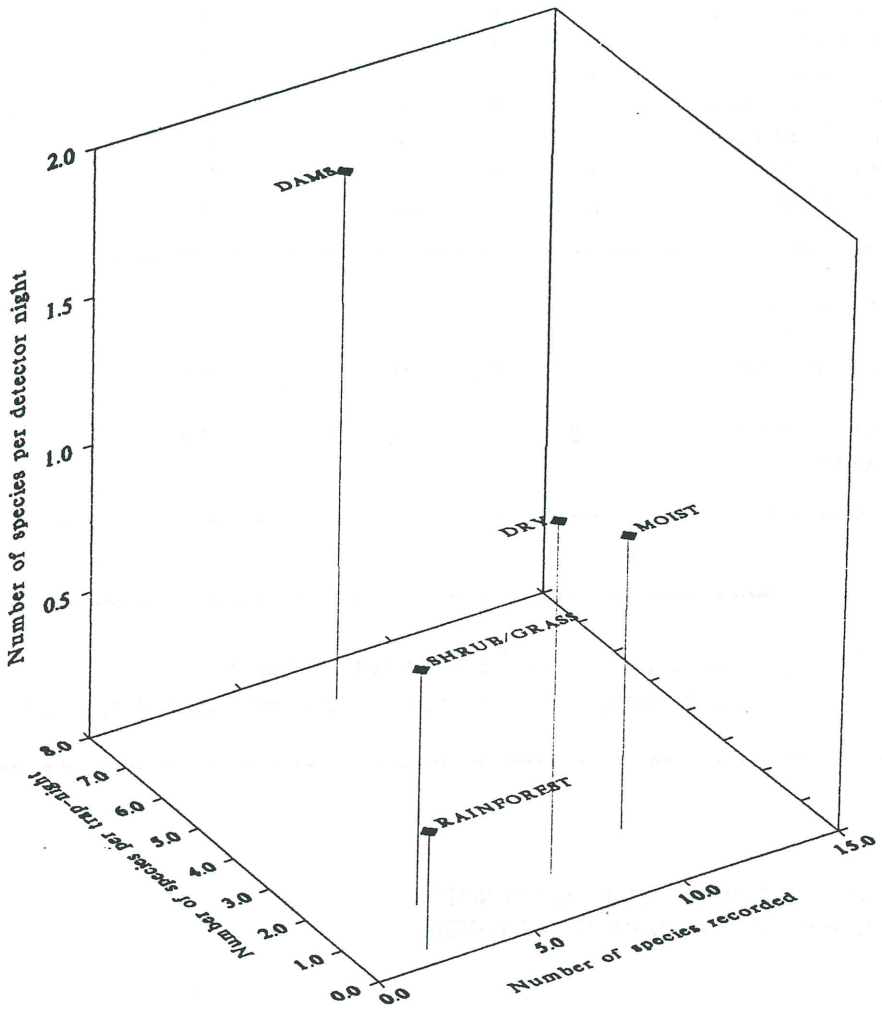
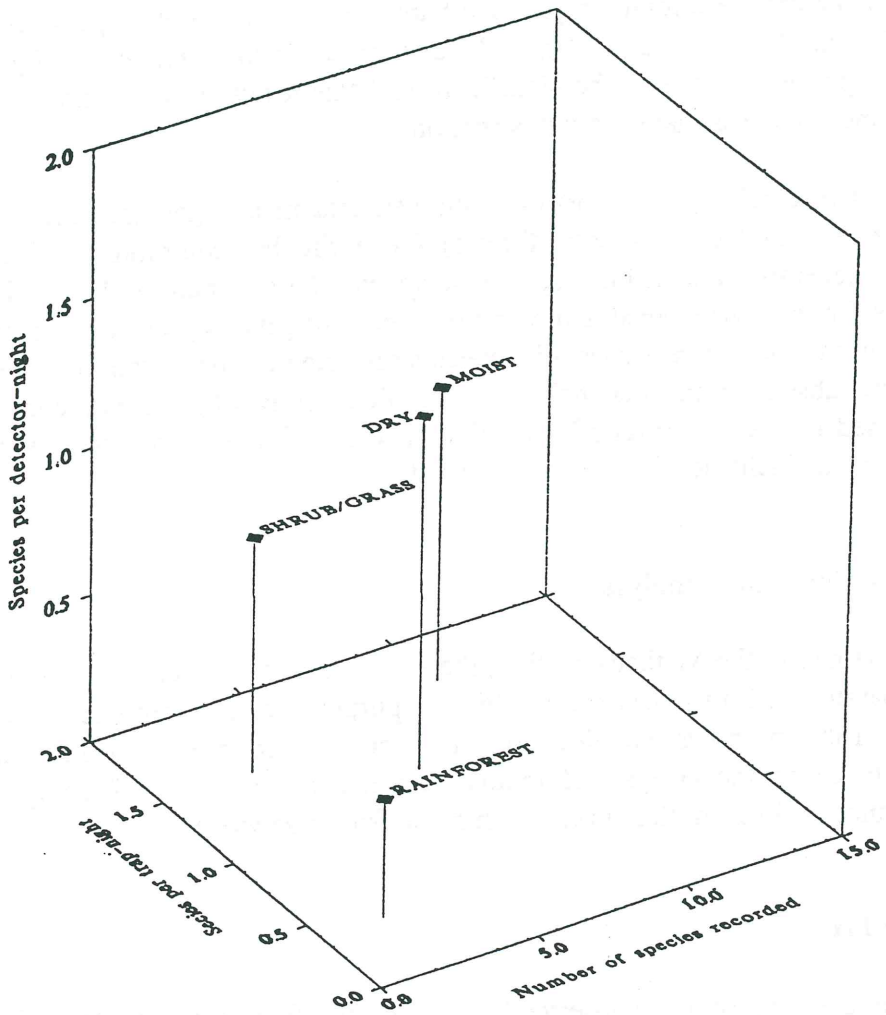


Figure 3 : Habitat relationships with dams excluded



Developmental area

Area B, which is being considered for the extension of the quarry, was assessed by one sampling point set within Dry Open Forest (denoted as site 2 in Plate 1). Only three species were recorded (*C.morio, N.geoffroyi* and *V.vulturnus*), none of which are listed in the NSW Threatened Species Conservation Act 1995, nor were they found only at this site and nowhere else. This site was operated for three nights.

Species distribution analyses

Several species were found in just one habitat (Table 4). These species, *Miniopterus schreibersii, Nyctophilus gouldi,* and *Vespadelus darlingtoni*, were only recorded at Moist Open Forest sites. The significance of this result is ascertained in the relative abundance analyses that follow this section.

Previous research by the consultant showed that in this general region (Wingham, Gloucester and Kempsey state forests) the entire bat community is composed of habitat generalist and habitat specialist species (see Appendix 1). It is generalist species that are widespread and common, and will generally occupy disturbed forest, urban areas, etc, whereas specialist species are often of conservation concern because they are absent from such habitats. At Possum Brush, the bat community was composed primarily (91%) of generalist species, with *M.schreibersii* being the only specialist, as identified from the previous studies.

Species abundance analyses

As explained in the Methods section, the entire east coast microchiropteran fauna can be separated into two data groups for the purposes of assessing relative abundance ranks. Table 5 shows the allocation of Possum Brush species to these data groups, Table 6 shows the analysis of relative abundance, and Table 7 compares relative abundance ranks from this survey with those from elsewhere.

Flying-foxes

Assuming an approximate observable width of 30-50 metres along the 1.9 km of food tree transect in the study area, no flowering eucalypt trees were observed, although flying-foxes were apparently present at the nearest known camp at Wingham Brush. The supplementary transect along the Pacific Highway between the Talawahl Creek bridge and the Koorainghat Creek bridge, a distance of approximately 7 km, had approximately 30 flowering eucalypts. The absence of food trees in the Possum Brush quarry area explained the lack of records of flying-foxes.

Table 5 : Allocation of Possum Brush study area species to the data groups of Richards (unpublished). A total of 2606 records from 201 sampling sites in three east coast study areas formed the basis of this analysis of the degree of "catchability" and/or "detectability" of 32 species overall.

"Primarily detectable" group	"Primarily capturable" group	In both categories
M.schreibersii	*N.geoffroyi*	*C.gouldii*
N.australis	*N.gouldi*	*C.morio*
		M.australis
		R.megaphyllus
		V.darlingtoni
		V.regulus
		V.vulturnus

Table 6 : Species recorded during Possum Brush quarry site survey listed by relative abundance rank.

	Number of captures	Rank using captures	Number of passes	Rank using passes	Mean rank
V.vulturnus	26	1	58	1	1.0
N.gouldi	9	2	0	-	2.0
N.geoffroyi	8	2	0	-	2.0
C.morio	10	2	25	2	2.0
V.regulus	7	2	18	3	2.5
V.darlingtoni	5	3	6	5	4.0
M.australis	1	4	11	4	4.0
R.megaphyllus	1	4	10	4	4.0
M.schreibersii	1	4	10	4	4.0
C.gouldii	0	-	10	4	4.0
N.australis	0	-	7	5	5.0

Table 7 : Relative abundance rank of species recorded during Possum Brush quarry site survey compared with relative abundance in the nearby Wingham state forests and at three areas on the east coast of Australia.

	Possum Brush	Wingham state forests	East coast
Species relatively more or similarly abundant elsewhere than at Possum Brush			
V.vulturnus	1	1	4
N.gouldi	2	2	3
C.morio	2	3	5
V.darlingtoni	4	2	4
M.australis	4	8	3
R.megaphyllus	4	6	2
M.schreibersii	4	4	5
C.gouldii	4	5	7
N.australis	5	7	4
Species relatively more abundant at Possum Brush than elsewhere			
N.geoffroyi	2	7	7
V.regulus	2.5	4	6

INTERPRETATIONS AND DISCUSSION

The general impression that the survey area offers poor habitat for bats, an assessment based on the consultant's experience conducting bat surveys elsewhere in NSW coastal forests (see Appendix 3), is supported by the results outlined above. This statement is supported by the points that follow.

1. A search of the consultant's distribution database, the largest available in Australia, revealed that 23 species had been recorded in the general area, yet after intensive survey using up to date techniques and state of the art detecting technology, only 11 species (or 48 %) were recorded.

2. The consultants unpublished multiple regression analyses of habitat utilisation (see Appendix 2) show that many species in temperate coastal forests of New South Wales are dependent upon a high density of natural understorey. The absence of some species may be explained by this factor, particularly since much of the area is infested with lantana.

3. The absence of some species known locally elsewhere is explained by the lack of ecological specialists. The following outline attempts to explain the absence of the 12 species not recorded :

   Pteropus poliocephalus : The absence of suitable food trees, as shown by transect data, was assumed to explain the lack of observation of this species.

   Syconycteris australis : The absence of appropriate habitat such as flowering shrubs (for example *Banksia, Melaleuca* and *Callistemon* spp) is the most likely explanation.

   Kerivoula papuensis : The absence of appropriate foraging habitat, being primarily vine tangles growing in wet gullies, but this species also has a preference for roosting in the suspended moss nests of scrubwrens (M.Schulz unpublished) which were not seen during the survey. A suitably modified trap was used at several sites in moist open forest which, although did not have prime habitat for this species, was the most likely place for this species to occur.

   Myotis macropus : The absence of appropriate habitat is the most likely explanation, but the larger sediment dam (site D) was expected to be the most likely site to record this species if was present.

   Saccolaimus flaviventris and *Mormopterus norfolkensis* : Although electronic detection systems operated for entire nights, these species were not recorded. Absence remains unexplained but may relate to the rarity of these species and a lack of suitable habitat, as both seem to have a preference for foraging above very wet and dense forests. *S.flaviventris* is relatively more abundant in the tropics (Richards, unpublished).

Chalinolobus dwyeri : This species is marginally distributed in this part of NSW, and is far more abundant in the north of its range, with relative abundance ranks declining from 3 to 7 to 9 from Shoalwater Bay to the Murwillumbah area to the Wingham Management Area.

Falsistrellus tasmaniensis and *Scoteanax rueppellii* : Although not scientifically published as yet, there is some evidence to suggest that these two species may separate on an altitudinal basis, where *F.tasmaniensis* is found at higher and cooler altitudes, and *S.rueppellii* is found primarily in warmer coastal areas. These factors may explain the absence of *F.tasmaniensis* from Possum Brush, but suggests that *S.rueppellii* should be present. In the Wingham forestry management area, *S.rueppellii* was found only in "moist forest" habitat (Richards 1992), which has a higher density of canopy trees and understorey than does the "moist open forest" habitat at the Possum Brush site.

Scotorepens orion and *Vespadelus pumilus* : The absence of these species may also be explained by differences in habitat, where the densest habitat at the Possum Brush site may not be as dense as required by these species. The latter appears to have a preference for rainforest elsewhere in NSW.

Scotorepens greyii is predominantly distributed in central Australia and may be at its margins on the east coast. It is more abundant at northern latitudes. It was recorded in New England hardwood forest in the Wingham Management Area (Richards 1992) which is very tall forest with a better understorey than in the Possum Brush survey area, which may explain its absence.

4. The presence of two Vulnerable species listed on Schedule 2 of the NSW Threatened Species Conservation Act 1995 No 101, viz. *Miniopterus australis* and *Miniopterus schreibersii*, needs to be addressed. There is no colony site known in the survey area, the nearest known site being a cave near Bulahdelah. Although there is no direct evidence to support this statement, there is a possibility that these observations were of transient individuals, or individuals that were maximising a poor habitat through lack of competition. The consultant has evidence that these two species may, at certain times of the year, occupy marginal habitat. Evidence from the consultant's Shoalwater Bay study (see Schodde *et al* 1992) indicates that at least *M.schreibersii* is more flexible in its roosting ecology than previously assumed. In this area, this species used a transient roost (culvert pipes) when apparently on long foraging excursions at a distance from the cave roost. Although this may not be the case for the Possum Brush individuals, it shows that there are aspects of species ecology that are still to be learnt. It should also be noted that both species have a greater relative abundance elsewhere, particularly in the subtropical coastal region of NSW (Richards, unpublished).

5. The inventory sites at sediment dams appeared to have the highest number of species when the data was ordinated to a trap-night or detector-night basis to level the survey effort at each (Figure 2). If one assumes that the species numbers recorded foraging at night in any particular habitat would reflect habitat quality, then the forested habitats in the survey area are the poorest of those that have been identified. With the dam sites excluded, the Dry Rainforest and Shrubland/ Grassland still show a poor fauna when compared with the Dry Open and Moist Open forest habitats (Figure 3).

6. Ten species were recorded in the Moist Open forest, and attention should be given to ensuring that this habitat receive the least attention as possible when future development is considered. Nine of the 11 species recorded for the area were recorded in this habitat, including the two *Miniopterus* species that are listed as Vulnerable in Schedule 2 of the NSW Threatened Species Conservation Act 1995 No 101. However, when decisions regarding these species are to be considered, then the points outlined above relating to local, regional and national abundance should be taken into account.

7. It should be noted that Area B, which is being considered for the extension of the quarry into Dry Open Forest had a very depauperate bat fauna. Only three species, considered as habitat generalists (see Appendix 2) were recorded, these being *C.morio, N.geoffroyi* and *V.vulturnus*. None of these are listed in the NSW Threatened Species Conservation Act 1995, nor were they found only at this site and nowhere else.

Satisfaction of requirements of Director General of NSW National Parks and Wildlife Service

As far as the consultant is aware, the requirements of the Director-General, as outlined in her letter dated 24 July 1996, have been addressed for bats during the field survey phase, and in the preparation of this report.

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Appendix 1 : Copy of abstract of results of PhD studies by the conultant, presented at the Australian Bat Research Conference held at Lismore, 1993.

(overleaf)

Richards, G.C. (1996) An assessment of two techniques for observing microchiropteran bats in fauna surveys. *Aust. Bat Soc. Newsl.* 6 : 13-16.

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Appendix 1 : Copy of abstract of results of PhD studies by the conultant, presented at the Australian Bat Research Conference held at Lismore, 1993.

(overleaf)

Relationships of Forest Bats with Habitat Structure and Foliage Nutrients in South-eastern Australia

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Keywords: microchiroptera, community structure, habitat use, foliage nutrients.

In three separate study areas in central coastal NSW, 93 census points were established to provide replicated sampling of habitat use by microchiropteran bats. Floristic and structural data were available for each site, and insects were light-trapped in each of the identifiable habitats. A total of 22 species were recorded during the two-year study. A Principal Components Analysis (PCA) of 13 habitat utilisation variables showed that only three variables (related to the number of habitats utilised and bat abundance in each) explained 99% of the variance in the data set. Cluster analysis of habitat utilisation variables elucidated three major species groups in the community, arbitrarily termed abundant generalists, restricted generalists, and habitat specialists.

Site structural and foliage nutrient data was averaged for each species to reduce the data to a generalised habitat that each species utilised. A PCA established that most of the variance (60%) was explained by a foliage potassium index and by the number of canopy trees in the generalised habitat. The addition of the third PC, a foliage nitrogen index, increased the proportion of variance explained to 77%. An x-y plot of the foliage potassium index and tree abundance for each species was a highly correlated (r=0.920) linear relationship. Each species was ranked along a gradient from low to high foliage potassium/tree abundance, a pattern that was also followed when the nitrogen index was added as a third dimension to the relationship. Half of the species appeared to occupy separated niches, the other half formed a group on the middle of the gradient, this assemblage being termed the "central cluster".

The majority of central cluster species had been previously classified as generalists, and were re-analysed after separation of the non-cluster (outlier) species, which had been previously classified as specialists. A PCA of the cluster species showed that foliage potassium was still a major factor in explaining a significant proportion of the sample variance, but the basal area of the understorey in each habitat had replaced tree abundance as the second PC. An x-y plot of foliage potassium and understorey density also showed a linear relationship, indicating that central cluster species are arranged in niches that relate to the density of the shrubs. However, it was unclear whether this fine-tuning of habitat selection by the cluster species could in fact be effected without inter-specific competition. Since there was a high degree of overlap in flight morphology characteristics, it was doubtful that any differences in foraging modes would have an effect.

A single-linkage cluster analysis defined 8 flight niches that reflected the foraging style used by the 22 species. The cluster analysis dendrogram also produced seven species-pairs, indicating similar flight and foraging patterns, but each pair could be separated by differing echolocation call characteristics. Wavelengths of calls (which indicate the size of insects that are detected with the greatest precision) were analysed to establish whether estimated prey size limits were a factor that ecologically separated the community, in particular the central cluster. Surprisingly, there was a concentration of species with call lengths that correlated with the major size range of insects in the light-trap samples, and these species had been previously classified as generalists. This large group of bats appear to break classical rules in ecology by co-existing without competition. This leads to the hypothesis (Currently under test) that generalist bats have evolved to utilise the most common and richest habitat niche in eucalypt forests, and within that niche have evolved to utilise the prey size that is most abundant. Since the majority of generalist species are endemic, and most specialists have extralimital distributions, it is possible that the present-day structure of the forest bat communities is a result of past broad scale palaeobotanical changes to habitat and the formation of land bridges during Ice Ages.

LISMORE BAT CONFERENCE, 1992

Appendix 2 : Details of sampling sites, locations of which are shown in Plate 1. The values in the right-hand columns are the date in September 1996 that the site was sampled. Alphabetic site labels indicate that electronic detectors were only used for sampling.

Site	Description	Trap nights	Detector nights
1	Dry open forest in area B, north of dump	3, 4	3, 4
2	Sediment dam near workings	3	3, 4
3	Moist forest, along track turning off main ridge track	3, 4	3, 4
4	Dry open forest, top of ridge, on track	3, 4	3, 4
5	Depauperate dry rainforest, central patch on ridge slope near southern boundary of study area	4, 5	4, 5
6	Moist open forest, along track going south off start of main ridge track	4, 5	4, 5
7	Shrubland/Grassland, along track through grove of *Acacia* in cattle paddock of property	5, 6	5, 6
8	Moist open forest off track that swings north-west from garbage dump	5, 6	5, 6
9	Dry open forest along track past explosives dump	5, 6	5, 6
10	Depauperate dry rainforest, small patch south of main sediment dam in cattle paddock	6	6
A	Depauperate dry rainforest, central patch on ridge slope near southern boundary of study area	4, 5	4, 5
B	Moist open forest on south side of quarry access road not far from start of bitumen	-	5, 6
C	Moist open forest on north side of ridge near western boundary of forested portion of study area	-	5, 6
D	Main sediment dam in shrubland/grassland	-	5, 6
E	Ecotone of Shrubland/Grassland and Dry open forest along overflow watercourse from main sediment dam, detector directed into grassland	-	6
F	Open grassland near watercourse in centre of cattle paddock	-	6

Appendix 3 :

CURRICULUM VITAE - G.C. RICHARDS

FULL NAME : Gregory Charles Richards

ADDRESS : Greg Richards & Associates Pty Limited
(ACN 074 890 823)
Wildlife Research and Ecological Assessment Consultants, PO Box 3305 BMDC, Belconnen, ACT 2617

DATE OF BIRTH : 20 November 1949

PAST POSITION : Experimental Scientist Grade 3
Resource Ecology Assessment Program
CSIRO Division of Wildlife & Ecology

EDUCATION HISTORY:

1996	PhD thesis prepared, to be submitted Oct 1996
1994	upgraded to PhD studies at University of NSW
1991	commenced MSc studies (CSU)
1990	granted MSc qual. (CSU)
1973	commenced BSc studies externally at Charles Sturt University
1968	awarded NSW Higher School Certificate (Canberra)

EMPLOYMENT EXPERIENCE :

1968-96	CSIRO Division of Wildlife & Ecology	27 years
1967-68	Australian National University	1 year

RESEARCH EXPERIENCE :

- Involved in bat research for nearly three decades, internationally recognised as expert in the taxonomy and ecology of Australia's bat fauna.
- Invited by Zoological Society of London to present review of fruit bat ecology.
- PhD thesis entitled *Ecological determinants of forest bat distribution and community structure in south-eastern Australian forests.*
- Skilled in data management and use of higher statistics for ecological analysis.

- Skilled in classical methods and analysis for identifying taxa, revising genera and describing new species.
- Developed a computerised video imagery system for use in taxonomic research and for estimating size of large bat colonies.
- Examiner for two post-graduate theses on flying-fox ecology.

CONSULTING EXPERIENCE :

- Compiler of the national Action Plan for Bat Conservation (ANCA).
- Contributor to the development of exclusion methods for flying-foxes in orchards (Greenspan Technology).
- Bat survey in Murwillumbah Management Area (State Forests of NSW)
- Bat survey in Wingham Management Area (State Forests of NSW)
- Bat survey in Kempsey-Wauchope Management Area (State Forests of NSW)
- Bat survey in Gloucester-Chichester Management Area (State Forests of NSW)
- Bat survey in Walcha-Nundle Management Area (State Forests of NSW)
- Review of bat fauna impact statement for Queanbeyan-Badja Management Area for State Forests of NSW
- Review of bat fauna impact statement for Tenterfield Management Area (State Forests of NSW)
- Review of bat fauna impact statement for Glenn Innes Management Area (State Forests of NSW)
- Review of bat fauna impact statement for Coffs Harbour Management Area (State Forests of NSW)
- Prediction of bat fauna in pre-1780 forests of southeast NSW (NSW NPWS).
- Assessment of bat fauna at Shoalwater Bay Military Training Area, central Queensland (for Department of Defence).
- Contributor to the Commonwealth Commission of Inquiry into tenure and status of the Shoalwater Bay Military Training Area.
- Bat fauna survey of East McIlwraith lowlands in Cape York (Geo Peko).
- Bat surveys of Torres Strait islands in relation to disease quarantine (Queensland Department of Primary Industries).
- Assessment of rabies status of migratory bats in Torres Strait (Australian Animal Health Laboratory).
- Assessment of conservation status of an endangered and undescribed flying-fox in Torres Strait (Australian Nature Conservation Agency).
- Contributor to the IUCN Old World Fruit Bat Action Plan.
- Contributor to landuse management plan for Cape York (Environmental Resources Information Network, ANCA).
- Contributor to conservation planning for bats in Wet Tropics World Heritage Area (Natural Resource Assessments).
- Review of threatened bat species (ACT Parks & Conservation Unit).
- Assessment of impacts on the bat fauna of the Very Fast Train project (VFT Consortium).
- Contributor to the assessment of impacts of mining and exploration on Ghost bats (Conservation Commission of the NT).

INTERNATIONAL EXPERIENCE :

- *USA and Costa Rica* - conference and survey methodology for fauna management.
- *Cambodia* - adviser re major bat conservation problem in National Museum.
- *UK, Germany, Netherlands* - granted an award for taxonomic research in museums.
- *India* - adviser to the UN Sustainable Development Program re bat fauna surveys in proposed reserves.
- *Thailand* -adviser to World Wide Fund for Nature in re survey methodology for endangered cave bats (collaborative).
- *Sarawak(Borneo)* - collaborative research included bat fauna surveys for the Malaysian National Parks & Wildlife Authority, the assessment of the conservation status of endangered endemic cave bats for the Sarawak Museum, and the provision of curatorial advice re bat specimen collections of the Sarawak Museum.

PROFESSIONAL ORGANISATIONS :

- Founder and President of the Australasian Bat Society
- Member of the Ecological Society of Australia
- Member of the Australian Wildlife Management Society
- Member of the Royal Zoological Society of NSW
- Application being reviewed as a Fellow of the Zoological Society of London

PUBLICATION AND EDITORIAL EXPERIENCE :

- Publications list exceeds 100 entries.
- Consultant for bats section in the Readers Digest *Encyclopaedia of Australian Wildlife.*
- Consultant for *The Mammals of Australia*, Second edition, published 1995.
- Member of editorial committee for the journal *Macroderma.*
- Section Editor, *The Australian Museum Complete Book of Australian Mammals*, published 1983.
- Referee for research papers and scientific articles in : *Biological Conservation, Biotropica, Australian Mammalogy, Australian Wildlife Research, Australian Journal of Ecology, Australian Journal of Zoology, Australian Zoologist, Biological Journal of the Linnean Society, Australian Geographic, Macroderma.*
- Editor, *Australian Bat Research News.*

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Appendix H

DIRECTOR GENERALS REQUIREMENTS FOR SIS

12 July, 1996

ERM Mitchell McCotter Quality System			
Date received	1.8.96		
Referred to	L Brown	Ref. No.	36093

☐ refer to verification record
☑ verification not required
Signature: _____ Date: 1-8-96
Project Manager

NSW NATIONAL PARKS AND WILDLIFE SERVICE

Mr Chris Power
Regional Manager
ERM Mitchell McCotter
4/224 Victoria Street
TAREE NSW 2430

Our reference:
Your reference:

24 JUL 1996

Dear Mr Power

RE: DIRECTOR-GENERAL'S REQUIREMENTS FOR A SPECIES IMPACT STATEMENT FOR THE PROPOSED PACIFIC BLUE METAL QUARRIES, POSSUM BRUSH ROAD, POSSUM BRUSH.

Thank you for your letter dated 8 July 1996 requesting the Director-General's requirements for a Species Impact Statement (SIS) for the development cited above.

Sections 109 and 110 of the *Threatened Species Conservation Act 1995* (TSC Act) describe the form and content of a SIS. Pursuant to Section 111 of the TSC Act, I have limited and modified these matters and provided additional matters to be addressed, as described below:

Definitions

The definitions given below are relevant to these requirements:

- *activity* has the same meaning as in the *Environmental Planning and Assessment Act 1979.*
- *development* has the same meaning as in the *Environmental Planning and Assessment Act 1979.*
- *Director-General* means the Director-General of National Parks and Wildlife.
- *locality* means the area within a 10 km radius of the study area.
- *study area* is the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly.
- *subject site* means the area which is proposed for development/activity.
- *subject species* means those threatened species which are considered known or likely to occur in the study area.
- *NPWS* means the NSW National Parks and Wildife Service.

All other definitions are the same as those contained in the TSC Act.

Matters which have been limited or modified

I consider that the following Section 110 matters need not be addressed by your SIS.

- All reference to endangered populations and endangered ecological communities. The TSC Act does not currently list any endangered populations or ecological communities.

Northern Zone
GIO House
24 Moonee Street
Coffs Harbour NSW
Australia
PO Box 914
Coffs Harbour 2450
Fax: (066) 516 187
Tel: (066) 515 946

Head Office
43 Bridge Street
Hurstville NSW
Australia
PO Box 1967
Hurstville 2220
Fax: (02) 585 6555
Tel: (02) 585 6444

- Reference to recovery plans and threat abatement plans in Section 110(2)(c). No recovery plans or threat abatement plans have been approved in accordance with the TSC Act.
- Reference to key threatening processes in Section 110(2)(c). The TSC Act does not currently list any key threatening processes.
- Section 110(2)(e). This section is a replication of 110(2)(a).
- All reference to critical habitat. There is currently no declared critical habitat in NSW.
- Section 110(2)(g). The matters raised in this section of the act have been clarified by the requirements below.

Matters to be Addressed

The SIS must meet all the matters specified in Sections 109 and 110 of the TSC Act with the exception of those matters limited above. In addition to these sections (refer Appendix 1), I require the matters described below to be addressed. Previous surveys and assessments may be used to assist in addressing these requirements. All references used throughout the SIS must be cited and listed in a bibliography.

1. Description

The SIS must include the information requested below:

Study area.

1.1 The type of action proposed must be detailed, including the timetable for the carrying out of the proposed development and the number of hectares affected. This must include details of the location of any auxiliary infrastructure and all components of the proposed development.

1.2 A plan of the study area will be provided. This plan will show the location and type of vegetation communities present within the study area and the scale of the plan.

1.3 An aerial photograph (preferably colour) of the locality (or reproduction of such a photograph) must be provided. This aerial photograph should clearly show the study area and the scale of the photograph.

1.4 A topographic map of the locality at a scale of 1:25 000 must be provided. This map will detail the location of the proposal, major land tenure units such as parks, reserves, and State Forests, and areas of high activity such as townships, regional centres and major roads.

Threatened species habitat.

1.5 The location of the subject species recorded during the SIS survey must be represented on a map of the study area. Where available, the information provided must include species name, date recorded, name of person who made the record, type of record (eg. scat identification, trapped, sighted), use of habitat (eg. nesting, roosting, foraging), and number of individuals recorded.

1.6 A description of suitable habitat characteristics for subject species in the study area must be provided. Where the habitat of each subject species within the study area can be clearly delineated, this habitat must be represented on a map of the study area.

1.7 A list of subject species must be provided. In determining these species, consideration shall be given to the habitat types present within the study area, records of threatened species in the locality and the known distribution of threatened species. The subject species must include, but need not be limited to, the following species:

Amphibia:

Crinia tinnula	Wallum Froglet

Birds:

Xanthomyza phrygia	Regent Honeyeater
Dupetor flavicollis	Black Bittern
Xenorhynchus asiaticus	Black-necked Stork
Pandion haliaetus	Osprey
Calyptorhynchus lathami	Glossy Black Cockatoo
Tyto novaehollandiae	Masked Owl
Grantiella picta	Painted Honeyeater

Mammals:

Phascogale tapoatafa	Brush-tailed Phascogale
Planigale maculata	Common Planigale
Petaurus australis	Yellow-bellied Glider
Dasyurus maculatus	Tiger Quoll
Mormopterus norfolcensis	Eastern Little Mastiff Bat
Petaurus norfolcensis	Squirrel Glider
Phascolarctos cinereus	Koala
Kerivuola papuensis	Golden-tipped Bat
Falsistrellus tasmaniensis	Great Pipistrelle
Miniopterus australis	Little Bent-wing Bat
Miniopteris schreibersii	Common Bent-wing Bat
Myotis adversus	Large-footed Mouse-eared Bat
Scoteanax rueppellii	Greater Broad-nosed Bat

Reptiles:

Hoplocephalus stephensi	Stephen's Banded Snake

Flora:

Eucalyptus glaucina
Eucalyptus rudderi (ROTAP)
Grevillea granulifera

Databases such as the NPWS Atlas of NSW Wildlife may be used to assist in compiling the list. For information from the NPWS Atlas of NSW Wildlife, please contact the Data Licensing Officer at NPWS Head Office on 02 5856684.

1.8 In describing the study area, consideration must be given to the previous land uses and the effect of these land uses on the study area. Relevant historical events may include sand mining, fire history, clearing, logging, recreational use and agricultural activities.

1.9 A description of fauna habitat components such as the frequency of tree hollows, density of understorey vegetation and presence of rock outcrops must be given. The condition of the habitat within the study area must be discussed, including the prevalence of introduced species. A description of the habitat requirements of threatened species likely to occur in the study area must be provided.

1.10 Fauna habitat for subject species must be described with particular reference to which areas are used in the study area, and for what purposes these areas are required (e.g. roosting, feeding, nesting or breeding, etc.).

Survey methods.

1.11 A fauna and flora survey is to be conducted in the study area. Targeted surveys must be conducted for all subject species. Species of taxonomic uncertainty must be confirmed by a recognised authority such as the Australian Museum.

1.12 A full description of the methodologies used in the fauna and flora surveys and habitat assessment must be provided, including survey techniques employed, number and location of traps, size of survey sites, dates of surveys, the time spent on surveys and prevailing weather conditions. Where appropriate this information must be provided in a map format. Where possible, surveys should be undertaken during seasons and climatic conditions during which the subject species are most likely to be detected.

1.13 Any areas which may act as corridors between the study area and adjacent areas of likely habitat for subject species must be identified and described.

1.14 A full list of the protected fauna and native plants (as defined by the *National Parks and Wildlife Act 1974*) found during the course of surveys must be included. Such information is indicative of the habitat quality of the site.

1.15 The effect of the season, prevailing weather conditions, and survey techniques employed must be considered with respect to the results of the survey.

2. Assessment of likely impacts

The assessment matters listed below must be addressed:

2.1 For all subject species, the SIS shall state the following:

- the location, nature and extent of habitat removal or modification which may result from the proposed action;
- the potential impact of the removal or modification of habitat; and
- the likely contribution of the proposed action to threatening processes acting on populations of those species in the locality.

2.2 A discussion of other populations of threatened species in the locality must be provided. The long term security of the other habitats must be examined. The relative significance of the subject site for subject species in the local context must be provided.

2.3 If movement corridors for subject species are present within the subject site, the impact of the proposal on these areas must be discussed.

2.4 Consideration must be given to possible indirect effects of the action on the area surrounding the subject site, for example altered hydrological regimes, soil erosion or pollution.

3. Amelioration

The following issues must be addressed:

3.1 While no recovery plans or threat abatement plans have been approved in accordance with the TSC Act as yet, draft recovery plans have been prepared for the species listed in Appendix 2. Where a draft recovery plan is relevant to any subject species, consideration must be given to the information contained in these plans and whether any draft recovery plan recommendation is applicable to the proposal.

3.2 In discussing alternatives to the proposal, and the measures proposed to mitigate the effect of the proposal, consideration must be given to developing long term management strategies to protect areas within the study area which are of particular importance for the subject species. This may include proposals to restore or improve habitat. The strategy should identify the long term objectives for the subject site.

3.3 Any proposed on-going monitoring of the effectiveness of the proposed mitigation measures must be provided. Details of the methodology of such monitoring must be provided. Details of how the results may modify the proposal must be included.

3.4 Details of any habitat restoration programs proposed for the study area must be provided, including the expected timeframe for habitat restoration, any proposals or opportunities to improve habitat, and the likely impact on flora and fauna, particularly during the time between the impact on the habitat and any habitat restoration.

4. Additional Information

4.1 A list of other approvals required must be provided, including:

- any consent required under Part IV of the *Environmental Planning and Assessment Act 1979* including the name of the consent authority and when it is proposed to make the development application; or
- any approvals required under Part V of the *Environmental Planning and Assessment Act 1979* including the name of the determining authority(ies), the basis for the approval and when these approvals are proposed to be obtained.

Should you require any further information on these requirements please contact Alan Feely, Manager, Northern Zone NPWS on 066 515946.

Yours sincerely

ROBYN KRUK
Director-General

Appendix 1: Sections 109 and 110 of the Threatened species Conservation Act 1995 as of 1/1/96.

Division 2 Species impact statements

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109 Form of species impact statements

(1) A species impact statement must be in writing.

(2) A species impact statement must be signed by the principal author of the statement and by:

(a) the applicant for the licence, or

(b) if the species impact statement is prepared for the purpose of the Environmental Planning and Assessment Act 1979, the applicant for the development consent or the proponent of the activity proposed to be carried out (as the case requires).

110 Content of Species Impact statements

(1) A species impact statement must include a full description of the action proposed, including it's nature, extent, location, timing and layout and, to the fullest extent reasonably practicable, the information referred to in this section.

(2) A species impact statement must include the following information as to threatened species and populations:

(a) a general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action,

(b) an assessment of which threatened species or populations known or likely to be present in the area are likely to be affected by the action,

(c) for each species or population likely to be affected, details of its local, regional and Statewide conservation status, the key threatening processes generally affecting it, its habitat requirements, and any recovery plan or threat abatement plan applying to it,

(d) an estimate of the local and regional abundance of those species or populations,

(e) a general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action,

(f) a full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region,

(g) a full assessment of the likely effect of the action on those species and populations, including, if possible, the quantitative effect of local populations in the cumulative effect in the region,

(2) contd.

(h) a full description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic, and social considerations and the principles of ecologically sustainable development,

(i) a full description and justification of the measures proposed to mitigate any adverse effect of the action on the species and populations, including a compilation (in a single section of the statement) of those measures,

(j) a list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population.

(3) A species impact statement must include the following information as to ecological communities:

(a) a general description of the ecological community present in the area that is the subject of the action and in any area that is likely to be affected by the action,

(b) for each ecological community present, details of its local, regional and Statewide conservation status, the key threatening processes generally affecting it, its habitat requirements, and any recovery plan or any threat abatement plan applying to it,

(c) a full description of the type, location, size and condition of the habitat of the ecological community and details of the distribution and condition of similar habitats in the region,

(d) a full assessment of the likely effect of the action on the ecological community, including, if possible, the quantitative effect of local populations in the cumulative effect in the region,

(e) a description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic, and social considerations and the principles of ecologically sustainable development,

(f) a full description and justification of the measures proposed to mitigate any adverse effect of the action on the ecological community, including a compilation (in a single section of the statement) of those measures,

(g) a list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the ecological community,

(4) A species impact statement must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement.

(5) The requirements of subsections (2) and (3) in relation to information concerning the State-wide conservation status of any species or population, or any ecological community, are taken to be satisfied by the information in that regard supplied to the principal author of the species impact statement by the National Parks and Wildlife Service, which information that Service is by this subsection authorised and required to provide.

Appendix 2: **Draft Recovery Plans available as of 1/1/96.**

Recovery Plans for Threatened Species occurring in New South Wales

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A recovery plan delineates, justifies and schedules the research and management actions necessary to support recovery of the threatened species, population or ecological community.

The following recovery plans have been prepared in conjunction with the Australian Nature Conservation Agency (ANCA) and cover the range of the species in NSW.

Under the NSW *Threatened Species Conservation Act 1995,* these plans are considered as drafts and will go through the process as outlined in the Act.

SPECIES	COMMON NAME	AUTHOR	DATE
Plants			
Acronychia littoralis	Scented Acronychia	J Hunter et al	1991
Acrophyllum australe		M Henderson	1994
Allocasuarina defungens		A Benwell	1992
Allocasuarina portuensis		S Nash, M Matthes	1994
Apatophyllum constablei		W Jones, J Volmer	1994
Asterolasia elegans		J Scott	1994
Cynanchum elegans	White Cynanchum	S Nash, M Matthes	1993
Diospyros mabacea	Red -fruited Ebony	A S Murray	1995
Diploglottis campbellii	Small-leaved Tamarind	J Hunter et al	1992
Elaeocarpus williamsianus	Hairy Quandong	J Hunter et al	
Epacris hamiltonii		J Cohn	
Fontainea oraria	Coastal Fontainea	J Hunter et al	
Gentiana wingecarribiensis		J Cohn	
Grevillea beadleana		J Benson	1991
Grevillea caleyi		J Scott et al	1995
Grevillea iaspicula	Wee Jasper Grevillea		
Grevillea kennedyana		A Duncan	1992
Haloragodendron lucasii		S Nash, M Matthes	1994
Kunzea rupestris		J Cohn	1993
Olearia flocktoniae		S Griffiths	1992
Phaius australis	Swamp Orchid	A Benwell	1994
Phaius tancarvilliae	Swamp Orchid	A Benwell	1994
Phebalium lachnaeoides		J Cohn	
Pimelea spicata	Pink Pimelea	S Nash, M Matthes	1993
Pterostylis gibbosa	Ellawora Greenhood Orchid	QEM Pty Ltd	1994
Rutidosis leptorrhynchoides	Button Wrinklewort	F Zich et al	1995
Swainsona plagiotropis			
Thesium australe	Austral Toadflax	S Griffiths	1992
Velleia perfoliata		K Maryott-Brown	1994
Zieria involucrata		K Maryott-Brown	1994
Zieria prostrata		S Griffith	1992