# APPENDIX B ECOLOGICAL CONSTRAINTS MASTER PLAN (ECMP)

# ECOLOGICAL CONSTRAINTS MASTER PLAN (ECMP)

FOR THE

# HUNTER ECONOMIC ZONE (HEZ)

DRAFT REPORT

Version 1 –
for NSW & Commonwealth Government
Comment

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HSO Ecology
Harper Somers O'Sullivan Pty Ltd
P.O. Box 428 Hamilton NSW 2303
<p. 02 4961 6500> <f. 02 4961 6794>
<w. www.hso.com.au> <e. ecology@hso.com.au>

*The ECMP concept for the HEZ is the Winner of the NSW Excellence in Surveying and Mapping Award 2003 and has also received commendation from the Animal Research Review Panel*

# FOREWORD

The Ecological Constraints Master Plan (ECMP) is intended to be a comprehensive ecological database and a primary guiding document for the development of the Hunter Economic Zone (HEZ) industrial estate. The information contained within the ECMP report and the associated electronic datasets will be used to enable the streamlining of the development application process for potential users and construction within the HEZ.

The intended purpose of this initial draft (February 2004) of the ECMP report is to enable strategic decisions to be made at a local, state, and commonwealth government level which take into consideration the economic, social, and environmental benefits of the HEZ estate.

By providing a comprehensive and objective overview of the ecological attributes of the HEZ study area, the information contained within this report can be utilised by government authorities to make a strategic assessment of what areas need to be conserved and managed within the HEZ Study Area, such that a development / conservation framework can be developed for the HEZ estate.

Once a development / conservation framework has been determined by this consultative process, and any further conditions of approval have been received (eg. as part of the Department of the Environment and Heritage assessment approvals process), a finalised version of the ECMP report will be produced, and development of the HEZ estate can begin in earnest.

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# 1 INTRODUCTION

*This chapter provides the necessary background information and rationale that led to the development of the Ecological Constraints Master Plan (ECMP) for the Hunter Economic Zone (HEZ).*

## 1.1 Background & Overview

The Hunter Economic Zone (HEZ) is set to become New South Wales' largest continuous industrial estate. The HEZ Study Area is comprised of approximately 877ha of industrially zoned land, and approximately 2300ha of conservation zoned land, including portions of Werakata National Park. The site is located to the south of the township of Kurri Kurri in the Cessnock LGA.

The HEZ area is subject to its own Local Environment Plan (being the 'Hunter Employment Zone' LEP), which was approved in 2002 by the NSW Minister of Planning. This approval followed over five years of site investigation and planning, and was considered to offer excellent economic and environmental outcomes for the lower Hunter Valley and the state of New South Wales.

The configuration of the zoning precincts created by the HEZ LEP was based on information gathered prior to the rezoning process, including broadscale ecological information. Since the rezoning, more intensive surveys of the site, combined with additional NSW Scientific Committee determinations, have resulted in 28 threatened species and two endangered ecological communities being recorded within the HEZ study area. Following on from the reservation of over 70% of the study area, the ECMP process detailed herewith aims to ensure that this reservation has provided an adequate conservation outcome for all of the identified threatened species and endangered ecological communities.

Ideally, it is sought that the ECMP will enable an all-encompassing assessment of the site to be undertaken against relevant state and national threatened species legislation, and enable a definitive conservation outcome and an all-encompassing sign-off to be obtained. Such an outcome would enable development of the site to proceed with certainty, and in a manner such that predetermined and agreed ecological outcomes are achieved. Provided that any proposed development can be shown to be consistent with the objectives and conservation criteria set within the ECMP, it is sought that such development will not trigger impacts of significance under any of the relevant threatened species legislation and thereby enable the streamlining of the development application process.

In this way, the information contained within this report and the associated electronic data will be used to assist in the fulfilment of the relevant requirements of the *Environmental Planning and Assessment Act 1979* (EPA Act), *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The data will also be able to be utilized in relation to any assessments and agreements relating to implementation of the *Rural Fires Act 1997* (RF Act), the *Water Management Act 2000* (WM Act) and the *Native Vegetation Conservation Act 1997* (NVC Act) within the site.

The formulation of the ECMP and the approach outlined herewith has involved consultation with the NSW Department of Environment and Conservation (formerly NSW National Parks & Wildlife Service), Department of Environment and Heritage (formerly Environment Australia), and Cessnock City Council. The approach has also been endorsed by the NSW Premiers Department.

## 1.2 Rationale & Objectives

There are two main goals of the ECMP. These can be succinctly stated as:

- To provide a detailed level of baseline ecological data that can be used to enable the streamlining of the development application process for potential development within the HEZ; and to
- Provide detailed ecological data from which superior strategic planning, development sequencing, and conservation decisions for the development of the HEZ can be made.

The ecological information contained within this report can be utilised to assist in the fulfilment of Cessnock City Council's objectives of the Zone No. 4(h) – Hunter Employment Zone (as detailed within the Cessnock Local Environmental Plan (LEP) 1989), particularly points (b), (e) and (f) – see below.

The LEP states that the objectives of the 4(h) zone are:

a) to encourage sustainable major industrial development or major employment-generating development that is conveniently accessible to urban centres and that has good road and rail access links, and

b) to encourage ecologically sustainable development by prohibiting development that contributes to the degradation of the Wallis and Fishery Creeks water catchments, and

c) to permit other development that is complementary, ancillary or related to existing development within the zone, and

d) to prohibit development that exposes residences and the natural environment to unacceptable levels of pollution or hazard risk, and

e) to minimise the clearing of native vegetation, and

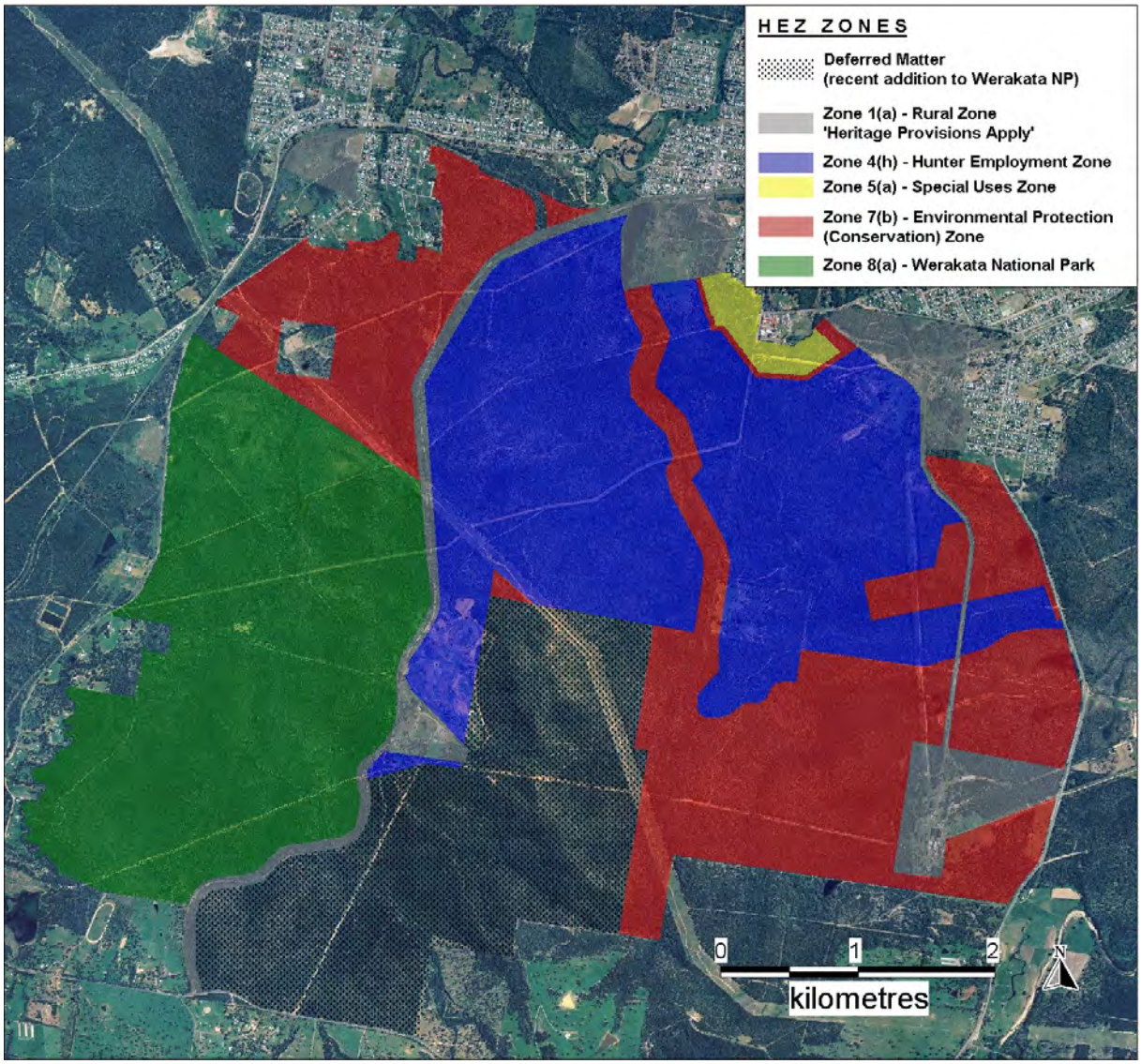
f) to facilitate the movement and survival of native fauna and flora by conserving native vegetation corridors.

## 1.3 Description of the Study Area

The HEZ study area is located within the lower Hunter Valley of New South Wales in the Cessnock Local Government Area. The study area is defined as all of the lands covered by the Cessnock Local Environmental Plan (LEP) 1989 (Amendment No. 60) - Hunter Employment Zone. It includes approximately 3200 hectares of areas zoned for industrial purposes, special uses, heritage and environmental conservation. The HEZ LEP study area is shown below in Figure 1-1.

The 'Hunter Employment Zone' was renamed the 'Hunter Economic Zone' by the proponents of the estate in 2003. However all Cessnock City Council terminology contained within the DCP, LEP, and EMS's still refers to the site as the 'Hunter Employment Zone'. It is anticipated that these inconsistencies will be rectified in the near future.

**Figure 1-1 The Hunter Economic Zone Study Area**



## 1.4 Relationship to Other Environmental Planning Instruments

The Ecological Constraints Master Plan (ECMP) has been structured to take into account a number of the relevant environmental planning instruments including Cessnock City Council's Development Control Plan (DCP) No. 56 "Flora and Fauna Survey Guidelines Lower Hunter Central Coast Region 2002" and the Habitat Management Strategy (HMS) for the HEZ (Ecotone 2002).

As part of provisions detailed in the Development Control Plan (DCP) for the Hunter Economic Zone, the HMS was prepared to address habitat protection, maintenance of flora and fauna habitat, including habitat for threatened species, rehabilitation, and removal and/or replanting of trees and vegetation within the HEZ. Ongoing development within the HEZ should be in-line with the objectives and schedules of the HMS.

Information provided and contained within the ECMP provides a substantial baseline ecological database that can be used to streamline the development application process, such as through the conduct of Eight-Part Tests (Section 5A of the *Environmental Planning & Assessment Act 1979*), and in the fulfilment of the majority of the requirements of the HMS and the objectives for the 4(h) – Hunter Employment Zone, as specified within the Cessnock LEP 1989.

# 2 METHODS

*This chapter provides an overview of the methods that were utilised for the development of the Ecological Constraints Master Plan (ECMP).*

## 2.1 Summary of Methods

The development of the ECMP comprised of the following aspects:

- **Collation of existing flora and fauna datasets and survey reports** – The results of the numerous flora and fauna investigations that have been undertaken within the Hunter Economic Zone (HEZ) to date, in particular threatened species records, have been incorporated into the ECMP.

  Important information sources utilised include Bell (2001, 2004), Ecotone (1999; 2000, 2002a; 2002b), Harper Somers O'Sullivan (2002), and NPWS Atlas of NSW Wildlife (2003), and University of Newcastle (2001).

- **Vegetation survey & mapping over the entire HEZ study area** – A detailed vegetation survey and mapping report was undertaken by Stephen Bell (Eastcoast Flora Survey) on behalf of Harper Somers O'Sullivan. This was undertaken to replace the broad-scale vegetation maps of the HEZ previously produced by Ecotone (1999; 2000) and House (2003) – LHCCREMS, as well as that previously produced by Bell (2001) within the Werakata National Park section of the study area.

- **Detailed 4(h) development zone surveys and habitat investigations –** Detailed ecological investigations, using high accuracy DGPS (Differential Global Positioning System), were undertaken within the 4(h) development zone and the central 7(b) conservation zone corridor along Chinamans Hollow Creek.

- **Additional targeted threatened species surveys** – In addition to those threatened species surveys previously conducted within the HEZ study area, further targeted surveys for a select number of species were conducted so that a more comprehensive overview of the occurrence of these species within the HEZ could be attained.

## 2.2 Pre-Existing Data Collation

A number of flora and fauna investigations have been undertaken within the Hunter Economic Zone (HEZ) to date. The results of these reports, in particular threatened species records, have been incorporated into the ECMP. These include:

- Bell, S.A.J. (2001) *The Vegetation of Werakata (Lower Hunter) National Park, Hunter Valley, New South Wales*. Prepared by Eastcoast Flora Survey for NSW NPWS. (Study undertaken throughout Werakata National Park, including the 'Kearsley section' contained within the study area).

- Bell, S.A.J. (2004) *Vegetation of the Hunter Economic Zone* (HEZ), *Cessnock LGA, New South Wales*. Final Report, January 2004. Prepared by Eastcoast Flora Survey for Harper Somers O'Sullivan. (Survey undertaken throughout the HEZ Study Area);

- Ecotone Ecological Consultants (1999) *Flora and Fauna Investigations and Planning Assessment for the Tomalpin Employment Zone within Cessnock City Local Government Area*. Report to Harper Somers Pty. Ltd. and Cessnock City Council. 26th February 1999;

- Ecotone Ecological Consultants (2000) *Additional Flora and Fauna Investigations within Tomalpin Employment Zone – Supplementary Report.* Report to Harper Somers Pty. Ltd. and Cessnock City Council. 6th March 2000;

- Ecotone Ecological Consultants (2002a) *Habitat Management Strategy for Development of the Hunter Employment Zone*. Prepared for Cessnock City Council. Second Draft September 2002;

- Ecotone Ecological Consultants (2002b) *Results from Supplementary Targeted Fauna Surveys Hunter Employment Zone*. Prepared for Cessnock City Council. 11 November 2002 (Targeted Surveys for Woodland Birds and Yellow-bellied Glider);

- Harper Somers (2002) *Flora and Fauna Assessment for Proposed Road and Rail Infrastructure within the Hunter Employment Zone (HEZ)*. Prepared for HEZ Pty Ltd. April 2002. (Report for previous alignment since withdrawn, although collated data and select text utilised herein);

- Harper Somers O'Sullivan (2002) *Species Impact Statement for Stage 1 Road Alignment within the Hunter Employment Zone (HEZ)*. Prepared for HEZ Pty Ltd. August 2002;

- HLA Envirosciences (2001) *Environmental Impact Statement: Re-processing of Emplaced Chitter at Hebburn No.2 Colliery*. Prepared for Enviro Mining Pty Ltd. July 2001.

- University of Newcastle (2001) *Vertebrate Fauna Survey of Lower Hunter National Park*. Prepared for NSW NPWS by Dept. of Biological Sciences and TUNRA Pty. Ltd. June 2001. (Study undertaken throughout Lower Hunter (Werakata) National Park, including the 'Kearsley section' contained within the study area).

Table 2-1 summarises the survey methods / effort undertaken as part of each of the above mentioned studies.

Several other important data sources were utilised for the ECMP, including:

- Atlas of NSW Wildlife (NSW National Parks & Wildlife Service). Accessed November 2003;

- Harper Somers O'Sullivan (2003) *Species Impact Statement for the Link Road to the Hunter Economic Zone (HEZ)*. November 2003;

- Hunter Bird Observers Club (HBOC) records; and

- Saunders. D. (2002) *Assessment of Swift Parrot Sites near Cessnock, Lower Hunter Valley Region, NSW – including the Hunter Employment Zone*. Prepared by Debbie Saunders, National Swift Parrot Recovery Team for NSW National Parks and Wildlife Service.

**Table 2-1 Combined Survey Effort of Previous and Current Flora and Fauna Investigations within the Study Area.**

| | Ecotone (1999) | Ecotone (2000) | University of Newcastle (2001) | HLA Envirosciences (2001) | Ecotone (2002b) | Harper Somers (2002) | Harper Somers O'Sullivan (2002) | Bell (2004) | Harper Somers O'Sullivan (*current surveys*) | Combined Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Season** | Summer (December-February) | Summer (February) | Autumn (April-June) | Methods not available at time of printing | Spring – Summer (September – November) | Dec. 2001, March-April 2002 | June-August 2002 | March – November 2003 | February 2003 – current 2004 | Autumn, Winter, Spring, Summer |
| **Flora Survey Work** | Delineation of vegetation community boundaries | 16 two hundred metre long flora/habitat transects, and 16 20m X 20m quadrats | No flora surveys undertaken | Yes | - | Define edge of KSSW, traverse proposed road and rail route noting vegetation and significant species | Define edge of KSSW, traverse proposed road noting vegetation and significant species | Re-define the distribution and classification of vegetation assemblages throughout the entire HEZ in line with methodology outlined in DCP No. 56, including 31 floristic plots. | Accurately map distribution of individual threatened flora species within development zone, and general distribution within conservation zones. | Delineation of vegetation community boundaries noting vegetation and significant species |
| **Diurnal Bird Survey** | General observation and call identification | - | General observation and call identification | Yes | CRA survey methodology targeting threatened woodland birds across the HEZ | General observation and call identification | Targeted Diurnal Bird Census | | General observation and call identification during all aspects of ECMP fieldwork, incidental records of threatened species accurately mapped. | General and targeted surveys |
| **Effort** | Undertaken during each site visit | - | 30 person hours | ? | 18 sites surveyed on two occasions (12 hours combined) | Undertaken during each site visit | Undertaken during each site visit | | Undertaken during each site visit | Unspecified, but extensive (est. >1000 hours) targeted and incidental observations |
| **Nocturnal Bird Survey** | Call playback and spotlighting | - | Call playback & spotlighting | Yes | Powerful Owl call playback | Call playback and spotlighting | - | | - | Call playback and spotlighting |
| **Effort** | 9 hours in total among different fauna groups | - | 15 person hours and four broadcast locations | ? | 30 sites over 3 nights | 4 hours spotlighting in total among different fauna groups, playback from three different locations | - | | | 40+ hours of spotlighting and playback. Various locations. |
| **Herpetofauna Survey** | Diurnal-hand searches in suitable habitat for frogs and reptiles. Nocturnal–spotlighting and frog call playback | - | General searches | Yes | Opportunistic | Diurnal-hand searches in suitable habitat for frogs and reptiles. Nocturnal–spotlighting searches | Diurnal-hand searches in suitable habitat for frogs and reptiles | | General observation during all aspects of ECMP fieldwork. Specific nocturnal searches and habitat surveys for Green-thighed Frog during 2002/2003 & 2003/2004 summers | Diurnal-hand searches in suitable habitat for frogs and reptiles. Nocturnal–spotlighting and frog call playback |
| **Effort** | Diurnal unknown, 9 hours in total spent spotlighting various fauna groups | - | 22 person hours | ? | - | Diurnal unknown, 4 hours spotlighting in total including herpetofauna searches | Unspecified | | Diurnal unknown. Nocturnal 4 nights (Green-thighed Frog) | Diurnal extensive. > 50 hours nocturnal searches |
| **Bat Survey** | Harp Trapping and Anabat Surveys | - | Anabat II | Yes | - | Anabat II | - | | Anabat II | Harp Trapping and Anabat ll Surveys |
| **Effort** | 4 Harp trap nights and 4 overnight static Anabat surveys, and mobile detection in conjunction with other nocturnal surveys | - | 2 stationary overnight sessions | ? | - | 2 stationary overnight sessions | - | | 1 overnight and mobile session (around Hebburn Dam) | 4 Harp trap nights and 9 stationary / mobile overnight sessions |
| **Terrestrial Mammal Survey** | Elliott Type A, cage traps and Hair Tubes | - | Elliott Type A and Elliott Type B trapping and Hair Tubes | Yes | Opportunistic | Elliott Type A and Elliott Type B trapping | - | | General observation during all aspects of ECMP fieldwork. | Elliott Type A, Elliott Type B, cage traps and Hair Tubes |
| **Effort** | 276 Elliott Type A, 60 cage trap and 480 hair tube nights | - | 300 Elliott Type A and 24 Elliott Type B trap nights and 15 Hair Tube nights | ? | - | 60 Elliott Type A and 15 Elliott Type B trap nights | - | | | 639 Elliott Type A trap nights, 39 Elliott Type B trap nights, 60 cage trap nights and 495 Hair Tube nights |
| **Arboreal Mammal Survey** | Elliott Type A and Elliott Type B trapping and Hair Tubes | - | Spotlighting | Yes | Targeted Yellow-bellied Glider surveys | Spotlighting and Elliott Type B trapping | - | | General observation during all aspects of ECMP fieldwork. | Elliott Type A and Elliott Type B trapping, Hair Tubes and Spotlighting |
| **Effort** | 124 Elliott Type A, 40 Elliott Type B and 180 hair tube nights plus spotlighting | - | 15 person hours | ? | 30 sites over 3 nights | 45 Elliott Type B trap nights plus 4 hours spotlighting | - | | | 124 Elliott Type A, 85 Elliott Type B, 180 hair tube and 30+ hours spotlighting |
| **Koala Survey** | Searches for scratchmarks & scats, spotlighting | - | Searches for scratchmarks & scats, spotlighting | Yes | - | SEPP 44 assessment plus scratch and scat surveys | SEPP 44 assessment plus scratch and scat surveys | | General observation during all aspects of ECMP fieldwork. | Searches for scratch marks & scats, spotlighting and SEPP 44 assessment |
| **Effort** | Unspecified | - | Unspecified | ? | - | Unspecified | Unspecified | | | Unspecified, but considerable. |
| **Secondary indications and incidental observations** | Scat searches | Yes | Searches for scratches, scats, diggings, whitewash, nests, burrows, bones, feathers etc. | Yes | Opportunistic | Searches for scratches, scats, diggings, whitewash, nests, burrows, bones, feathers etc. | Searches for scratches, scats, diggings, whitewash, nests, burrows, bones, feathers etc. Samples sent to Barbara Triggs for formal identification. | | General observation during all aspects of ECMP fieldwork. | Searches for scratches, scats, diggings, whitewash, nests, burrows, bones, feathers |
| **Effort** | Unspecified | Unspecified | 16 person hours | ? | - | Unspecified | Unspecified | | | Unspecified, but extensive. |

## 2.3 Vegetation Survey and Mapping

A detailed vegetation survey and mapping report was undertaken by Stephen Bell (Eastcoast Flora Survey) on behalf of Harper Somers O'Sullivan (Bell 2004). This was undertaken to replace the broad-scale vegetation maps of the HEZ previously produced by Ecotone (1999; 2000) and House (2003) - LHCCREMS, as well as that previously produced by Bell (2001) within the Werakata National Park section of the study area.

The survey involved aerial photograph interpretation and a detailed ground truthing program to produce a vegetation map of the study area, showing the distribution of vegetation communities and their variants, following the terminology of the Lower Hunter and Central Coast Regional Environmental Management Strategy and Cessnock City Council's DCP No. 56 – Flora and Fauna Survey Guidelines. The Bell (2004) report is included in its entirety in Appendix B.

## 2.4 Development Zone Surveys and Habitat Investigations

In order to obtain an overview of a broad range of ecological and environmental variables, detailed ecological investigations were conducted by HSO throughout the entire 4(h) development zone and the central 7(b) conservation zone corridor along Chinamans Hollow Creek, between February and October 2003. In order to achieve this, the entire area (932ha) was sub-divided into 467 individual grid squares of area 2.25ha each (150m x 150m). The location of each of the grid cells is shown in Figure 2-1.

Within each of these grid squares, information on a number of ecological attributes was collected using high accuracy DGPS (Differential Global Positioning System). These attributes included both qualitative and semi-quantitative data, ranging from individual species distributions, to specific habitat features for threatened species (as per Schedule 2 of the HMS) and disturbance and degradation regimes. The ecological / environmental attributes collected within each grid are shown in Table 2-2. The variables collected were based on scientifically recognised principles of habitat definition/quality, specifications of HMS, replicate survey methods of Ecotone Ecological Consultants (2000), and in consultation with the NPWS.

The data was collected by systematic random meander surveys within each particular grid (mainly determined by navigation to mature and hollow bearing trees and threatened flora occurrences), comprising a minimum survey effort of one (1) person hour per grid. 'Complex' grids containing large number of trees and/or threatened species were noted as taking up to 3 hours to detail.

The key features detailed as part of the development zone habitat surveys included:

- Keystone Mature Tree Species;
- Hollow-bearing Trees;
- 'Grid Pattern' Habitat Investigations; and
- Threatened Species Surveys.

### *2.4.1 Keystone Mature Tree Species*

The definition of 'Keystone Mature Tree Species' was derived from Schedule 2 of the Habitat Management Strategy. Within the schedule, a list (in an un-named table p.22) is provided of the tree species that have been identified as "providing important foraging resources for threatened fauna".

Schedule 2 also stipulates that a mature tree should be defined as a tree with a DBH (diameter at breast height) of greater than 50cm.

**Species**

On the basis of the requirements of the Habitat Management Strategy (HMS), the keystone tree species detailed included:

- *Angophora floribunda* (Rough-barked Apple);
- *Corymbia maculata* (Spotted Gum);
- *Corymbia gummifera* (Red Bloodwood);
- *Eucalyptus amplifolia* (Cabbage Gum);
- *Eucalyptus crebra* (Narrow-leaved Ironbark);
- *Eucalyptus fibrosa* (Broad-leaved Ironbark);
- *Eucalyptus moluccana* (Grey Box);
- *Eucalyptus paniculata* (Grey Ironbark);
- *Eucalyptus punctata* (Grey Gum); and
- *Eucalyptus tereticornis* (Forest Red Gum).

*Angophora floribunda* was added to the list detailed in the HMS on the basis that it was observed to be a sap feed tree for the Yellow-bellied Glider (Harper Somers O'Sullivan, pers. obs.). Other habitat trees listed in Schedule 2 were noted as part of the 'Grid Pattern' habitat investigations (i.e. collected as part of a 2.25 hectare grid, rather than as individual point data).

**Size Classes**

Each mature tree species collected was afforded a size class: Diameter at Breast Height (DBH) 50-60cm; DBH 60-80cm; DBH 80-100cm; DBH >100cm.

### *2.4.2 Hollow Bearing Trees*

Hollow bearing trees are classified as habitat trees within Schedule 2 of the Habitat Management Strategy. Accordingly, every tree hollow within the development zone was detailed. Thirteen (13) of the twenty-two (22) threatened fauna species recorded in the HEZ utilise tree hollows, therefore the collection of this data provides an accurate overview of the distribution of this critical habitat resource. The attributes collected for each hollow bearing tree were based on a review of Gibbons and Lindenmayer (2002). The data collected includes:

Tree Species: (*List Species)

Entrance Diameter: 2-10cm; 11-20cm; and > 20cm

Number of Hollows: 2-10cm (*Count); 11-20cm (*Count); and > 20cm (*Count)

Type of Hollow: Main stem; Crown branch; Fire scar; Fissure

### *2.4.3 Grid Pattern Habitat Investigations*

To obtain an overview of a broad range of ecological and environmental variables, the development zone was split into 150m x 150m grids (2.25ha) within which information on a number of ecological attributes was collected. The location of the grid cells is shown in Figure 2-1.

These habitat investigations collected both qualitative and semi-quantitative data, ranging from individual species distributions, to specific habitat features for threatened species (as per Schedule 2 of the HMS)

and disturbance and degradation regimes. The ecological / environmental attributes collected within each grid are shown in Table 2-2. The variables collected were based on scientifically recognised principles of habitat definition/quality, specifications of HMS, replicate survey methods of Ecotone Ecological Consultants (1999), and in consultation with the NPWS.

### *2.4.4 Threatened Species Surveys*

During the course of the detailed development zone surveys, all threatened species encountered in the field were recorded. The significant amount of time spent on the ground during the course of these diurnal surveys allowed for a significant number of observations of threatened flora and fauna species.

Details collected for threatened flora in the field included – Species; Number Observed; Date Observed; and Field Notes.

This was undertaken for all flora species with the exception of *Grevillea parviflora* ssp. *parviflora*, which occurs in large swathes across the site. Those large numbers necessitated that it be afforded a density measure per 150m x 150m grid, rather than actual counts, which were not considered realistically possible given the magnitude of such an undertaking.

Details collected for threatened fauna in the field included – – Species; Number Observed; Observation Type; Date Observed; and Field Notes.

**Figure 2-1 150m x 150m Grid Pattern Locations**

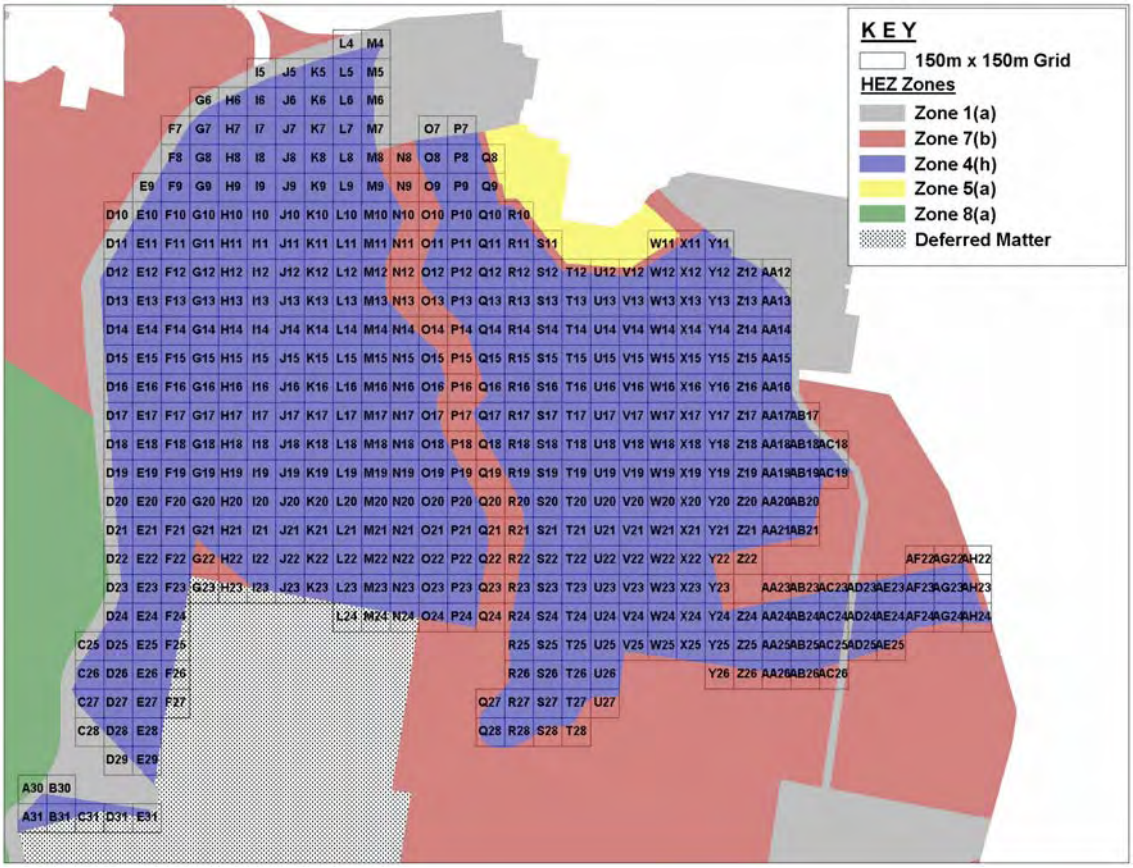


**Table 2-2 Ecological / Environmental Attributes collected within 150m x 150m Grids**

| Feature / Attribute | Variables | Value | Threatened Species Targeted |
|---|---|---|---|
| *Grevillea parviflora* subsp. *parviflora* | • Absent<br>• Low density (<50 plants)<br>• Medium density (50–200 plants)<br>• High density (>200 plants) | Determine the relative abundance of the species within the development zone. Density rather than actual counts provided due to the large size of the population(s). | *Grevillea parviflora* subsp. *parviflora* |
| Other Threatened Flora Species | Detailed as encountered in the field. | Determine distribution and abundance throughout the development zone. | *Acacia bynoeana, Callistemon linearifolius Eucalyptus parramattensis* subsp. *decadens, Rutidosis heterogama* |
| Regionally Significant Flora | Presence / Absence index for significant species including *Grevillea montana, Macrozamia flexuosa* and *Corymbia eximia* | Determine relative distribution within development zone | - |
| *Allocasuarina* sp. | Presence / Absence index | Determine extent of this habitat resource within development zone | Glossy Black-Cockatoo |
| Mistloetoe sp. | Presence / Absence index | Determine extent of this habitat resource within development zone | Regent Honeyeater / Painted Honeyeater |
| Threatened Fauna Species | Detailed as encountered in the field. | Determine distribution and abundance throughout the development zone | Any threatened fauna species encountered |
| Hollow / Fallen Timber | • None<br>• Low density (1-5)<br>• Moderate density (6-10)<br>• High density (>10) | Measure of general habitat quality | Brown Treecreeper, Grey-crowned Babbler, Speckled Warbler, Tiger Quoll |
| Understorey Diversity | • Low Diversity<br>• Moderate Diversity<br>• High Diversity | Measure of general habitat quality | |
| Understorey Nectar Species | • Low Density<br>• Moderate Density<br>• High Density | Measure of general habitat quality | Squirrel Glider, Grey-headed Flying Fox, Honeyeaters |
| Logging / Firewood Collection | • No evidence<br>• Light<br>• Moderate<br>• Severe | Measure of general habitat quality / level of disturbance | - |
| Fire History | • No evidence<br>• Light<br>• Moderate<br>• Severe | Measure of general habitat quality / level of disturbance | - |
| Erosion / Soil Disturbance | • No evidence<br>• Light<br>• Moderate<br>• Severe | Measure of general habitat quality / level of disturbance | - |
| Rubbish Dumping | • No evidence<br>• Light<br>• Moderate<br>• Severe | Measure of general habitat quality / level of disturbance | - |
| Weeds | • No evidence<br>• Light<br>• Moderate<br>• Severe | Measure of general habitat quality / level of disturbance | - |
| Feral Animals | • No evidence<br>• Light<br>• Moderate<br>• Severe | Measure of general habitat quality / level of disturbance | - |
| Special Habitat Features | Noted as encountered in the field | Detail any particular habitat feature that may be potentially valuable to threatened species (eg. rock outcrops, raptor nest, etc.) | All potentially occurring species |

## 2.5 Additional targeted threatened species surveys

In addition to those threatened species surveys previously conducted within the HEZ study area, including Bell (2001, 2004), Ecotone (1999; 2000, 2002b), Harper Somers (2002), Harper Somers O'Sullivan (2002), and University of Newcastle (2001), further targeted surveys for a select number of species were conducted so that a more comprehensive overview of the occurrence of these species within the HEZ could be attained. A number of survey methods were employed to target both individual species, as well as a range of flora and fauna species. These included:

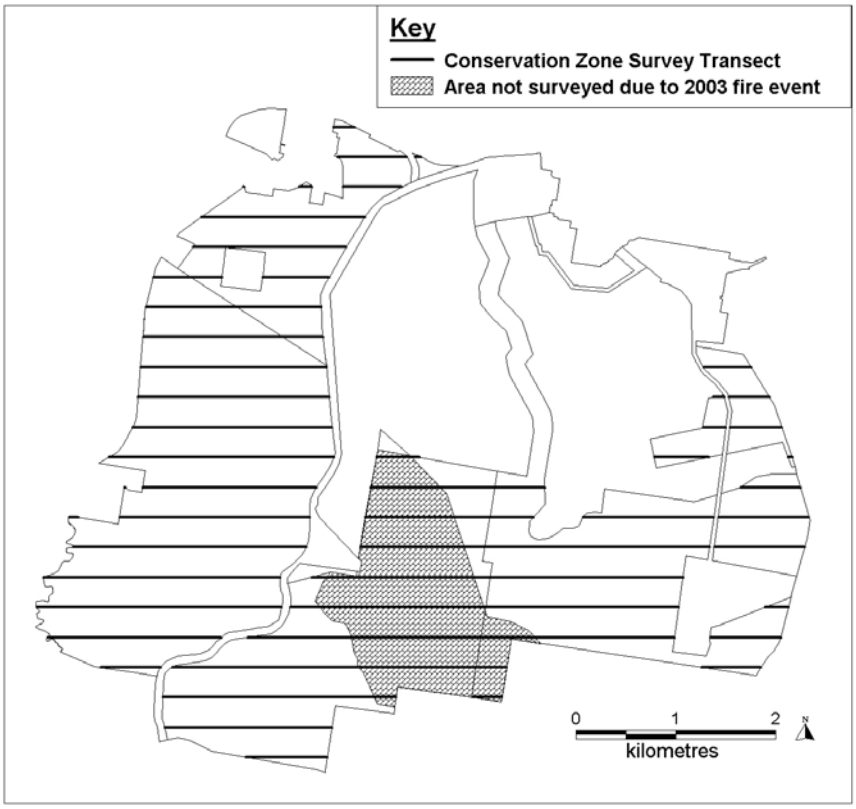
### *2.5.1 Conservation Zones Transects*

The conservation zones of the HEZ study area were systematically "reconnaissanced" in east-west diurnal walking transects separated by 300 metres - totalling 66 km of survey (see Figure 2-2). This was undertaken by GPS navigation and data collection along each particular transect.

The main target of these surveys was to find additional occurrences of threatened flora species including *Acacia bynoeana*, *Callistemon linearifolius*, *Eucalyptus glaucina*, *Grevillea parviflora ssp. parviflora*, and *Rutidosis heterogama*. In locations where threatened flora species were found along transects, then more detailed surveys were also undertaken in the vicinity to obtain further records / population counts.

This survey method also allowed for opportunistic observations of a number of threatened fauna species including diurnal birds (eg. woodland birds) and some mammals (eg. Yellow-bellied Glider feed scars). This survey method was not undertaken over the majority of the Tomalpin section of Werakata National Park (former Aberdare State Forest) due to a spring 2003 fire event.

**Figure 2-2 Conservation Zone Survey Transects**



### 2.5.2 Green-thighed Frog

Given the cryptic nature of the species ecology, several approaches to determine the species occurrence, habitat requirements and habitat distribution within the study area were undertaken. This involved targeted summer breeding event surveys and habitat mapping.

**Targeted summer breeding event surveys**

Areas of suitable habitat within both development and conservation zones of the HEZ have been surveyed during and immediately after heavy summer rains during 2002/03 and 2003/04 summers.

However, in the event of breeding event(s) being missed, pools deemed potentially suitable for the species will be surveyed for the presence of tadpoles in the weeks following heavy rain events. This will be undertaken by visual observations and where necessary scoop netting. Care will be taken in scooping individuals, given the apparent fragility of the Green-thighed Frog tadpole.

Tadpoles that cannot be positively identified in the field are proposed to be carefully transported to the University of Newcastle where they will be reared under the supervision of Dr. Michael Mahony. A scientific research licence to undertake these studies has been obtained (S11035, A3408).

All frog surveys will be conducted following the hygiene protocols described by NPWS (2000b).

However, due to insufficient summer rains, no further records of the species were obtained during the 2002/2003 and 2003/2004 breeding seasons. Accordingly these surveys will need to be repeated over following summer season(s).

**Habitat Mapping**

All creeklines within the 4(h) development zone and representative areas of the conservation zones (such as along Chinamans Hollow Creek - where the species was previously recorded) of the HEZ were walked with GPS and each section or 'reach' of stream was afforded a habitat suitability ranking. This was undertaken in order to more accurately assess the extent and distribution of potential habitat for the species throughout the HEZ. Some consideration was also afforded to the extent of the likely Green-thighed Frog habitat in the general locality.

The habitat suitability ranking for the Green-thighed Frog was based on the following scale:

**Unsuitable Habitat**
*Areas that the Green-thighed Frog is highly unlikely to utilise for either breeding, foraging or sheltering habitat.*
**Definitions:**

- Creekline filled in; and/or
- Concrete channel; and/or
- Low quality habitat that has a high level of disturbance (eg. clearing, grazing, containing debris and dumped rubbish, weeds, pollution).

**Low Quality Habitat**
*Areas where the Green-thighed Frog is considered to have some minor chance of occurrence and have the potential to utilise the area for foraging or sheltering purposes only.*
**Definitions:**

- Dry intermittent stream with no pock-mark depressions or areas capable of forming pools, however containing relatively intact riparian / fringing vegetation; and/or
- Creekline with permanent to ephemeral pools that are moderately degraded (eg. some clearing, weeds, pollution); and/or
- Dams with open water and little or no riparian / fringing / emergent vegetation; and/or

- Moderate quality habitat that has some level of disturbance (eg. clearing, grazing, weeds, pollution, erosion).

**Moderate Quality Habitat**

*Areas where the Green-thighed Frog is considered to have a moderate chance of occurrence and have the potential to utilise the area for breeding, foraging and sheltering purposes. Some areas such as the small dry intermittent streams within the Spotted Gum / Ironbark Forest associations would have otherwise been mapped as Low Quality Habitat if not for the recording of the species within these areas.*

**Definitions:**

- Ephemeral stream with some pock-mark depressions or areas capable of retaining water and containing relatively intact riparian / fringing vegetation (including drier Spotted Gum / Ironbark associations); and/or
- Stream with permanent to semi-permanent pools divided by overland flow paths and containing relatively intact riparian vegetation including sedges; and/or
- Intact wetlands (semi-permanent to ephemeral in nature) containing riparian, fringing, or emergent vegetation; and/or
- High quality habitat that has some level of disturbance (eg. clearing, grazing, weeds, pollution, erosion).

**High Quality Habitat**

*Areas where the Green-thighed Frog is considered to have the highest chance of occurrence and have the potential to utilise the area for breeding, foraging and sheltering purposes.*

**Definitions:**

- Ephemeral stream with broad overland flow paths, pock-mark depressions and/or oxbows capable of retaining water, intact riparian vegetation including sedges, and little or no disturbance and/or
- Known occurrences where the species has been previously recorded.

### 2.5.3 *Eucalyptus parramattensis ssp. decadens*

Surveys for this species within the development zone included total counts, whereas the species occurrences elsewhere within the study area was based on conducting population estimates following the methodology of Keith (2000) and Krebs (1998).

This involved locating and mapping the boundaries of the species occurrences and extrapolating population size based on counts of trees within a number of replicate random transects within each occurrence. In total 26 (50m x 10m) transects were conducted over 9 disjunct population occurrences. Variables collected within each transect included number of trees and notes were taken on size and age structure, fire history and levels of disturbance.

A mean estimate of the population size was calculated from the multiplication of the mean number of trees within each occurrence by the area of occupancy of that occurrence. Confidence limits on the population estimate were calculated by the use of a program provided with Krebs (1998), using the 'Stratified Sampling' procedure.

### 2.5.4 *Problematic Eucalypts*

For problematic species noted in the field by Bell (2004) and Harper Somers O'Sullivan, namely *Eucalyptus glaucina*, *Eucalyptus* sp. aff. *agglomerata*, and *Eucalyptus* sp. aff. *camfieldii*, specialist input from Ken Hill (eucalypt expert from the National Herbarium of New South Wales) was sought to determine status

and distribution of the species within the HEZ. Of the above mentioned eucalypt species, the latter two are considered to potentially represent new species.

### *2.5.5 Outstanding Matters*

Additional surveys and/or population estimates are potentially required for a number of threatened flora species including *Acacia bynoeana*, *Eucalyptus glaucina*, and *Rutidosis heterogama*. Whilst occurrences of these species have been detailed to varying degrees, some additional surveys may be required in the near future to assist in the conduct of threatened species impact assessments during the ongoing development of the HEZ.

Taxonomic studies on the two new and undescribed eucalypt taxa (*Eucalyptus* sp. aff. *agglomerata, and Eucalyptus* sp. aff. *camfieldii*) will also continue with the National Herbarium of NSW.

## 2.6 Limitations

A number of limitations / deficiencies were experienced during the course of these investigations and / or are inherent in the results data. These include:

- The majority of the HSO ECMP data is based on diurnal observations and habitat investigations. For example, broadscale terrestrial and arboreal mammal trapping across a range of habitats within the HEZ has not been undertaken to determine which areas may be particularly important for certain species. Previous mammal trapping surveys undertaken by Ecotone (1999), HLA Envirosciences (2001) and Harper Somers (2002), combined with detailed habitat assessment and secondary indication searches somewhat compensate for this survey limitation;

- There is a bias towards the ecological significance of the HEZ development zone, as this area has been the subject of detailed surveys, whereas the conservation zones have only been surveyed in a more broadscale manner;

- The results of threatened species surveys are also somewhat biased to those threatened species which are easily detected such as diurnal / sedentary birds, perennial plants, and some mammals;

- Identification of several threatened species was troublesome due to factors such as fire history, taxonomic uncertainties, lack of suitable vegetative material, etc. This was particularly true for species regenerating from rootstock after a fire event, and includes *Callistemon linearifolius* and *Grevillea parviflora* ssp. *parviflora*;

- Fire events hampered threatened flora and fauna species surveys in some areas including the majority of the Tomalpin section of Werakata National Park (see Figure 2-2) and in small areas within the development zone;

- Some outstanding threatened species issues remain to be resolved and / or require further surveys;

- A number of limitations were experienced during the detailed GPS development zone surveys. These include: the parameters / species collected were based on a draft version of the Habitat Management Strategy (Ecotone 2002); accuracy of point data in some areas may be greater than one metre due to poor GPS signal quality under thick vegetation cover; the area around Hebburn No.2 colliery was not accurately surveyed due to access restrictions and occupational health and safety issues; identification of tree hollows was undertaken from ground observations only (see Gibbons and Lindenmayer (2002) for further information on potential biases); identification of some tree species including

redgums, stringybarks and ironbarks may be erroneous due to lack of fruiting material, hybridisation, etc.; and a GPS software (Pathfinder Office / Terrasync) glitch within the customised ecological dictionary which did not allow the addition of new species found in the field (such as Eucalypt species);

- The collated threatened species records within the HEZ vary in accuracy and reliability. For example, HSO GPS records are generally accurate to within 1 metre, whilst data obtained from the Atlas of NSW Wildlife is only accurate to within one kilometre;

- Ecosystems / species distributions are dynamic in nature and are likely to change in time, therefore the data presented should only be viewed as a 'snapshot in time'. To compensate for this limitation it is a recommendation of this report that prior to any development within the HEZ, that the ECMP data in the immediate vicinity of the proposed development be verified by an ecologist in the field; and

- Within the HEZ LEP study area, several zoning boundaries inconsistencies are apparent within data obtained from Cessnock City Council (CCC) (circa 2001 & 2003) and the boundaries of the national park estate. This report utilises the information obtained from CCC (2001).

Where possible, these above mentioned limitations have been taken into consideration with regards to results interpretations, threatened species assessments, and conclusions.

## 2.7 Qualifications, Licensing, and Certification

***Qualifications***

The Ecological Constraints Master Plan (ECMP) was primarily undertaken by ecologists from Harper Somers O'Sullivan including Lucas Grenadier (B App Sc (EAM) Hons), Mark Evans (B App Sc (ERM)), Mick Roderick (B App Sc (EAM)), and Craig Anderson (B App Sc (EAM)). A number of sub-consultants were also employed for the production of the ECMP, as detailed below in 'Certification'.

***Licensing***

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licences A2428, A2675, A2698, A3408, S10300, and S11035.

- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture;

- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture; and

- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Ref No: AW2001/014) issued by NSW Agriculture.

## ***Certification***

The following persons and organizations have assisted or been utilized for the production of the ECMP:

**GIS Programs and Modelling:**

Paul Grambauer
Spatial ASSIST Pty Ltd
PO Box W154
West Cessnock NSW 2325.
Tel. 0421 952 304
Fax. 02 4991 4477

**Vegetation Survey and Mapping:**

Stephen Bell
Consultant Botanist
Eastcoast Flora Survey
PO BOX 216 Kotara Fair NSW 2289
Tel/ Fax: 02 4956 2952

**Plant Species Identification:**

Royal Botanic Gardens
National Herbarium of NSW
The Domain
Mrs. Macquaries Road
Sydney NSW 2000
Tel. (02) 92318111
Fax. (02) 9251 7231

**Anabat Bat Call analysis:**

Glenn Hoye
Fly By Night Bat Surveys Pty Ltd
PO Box 271
Belmont NSW 2280
Tel. (02) 49477794
Fax. (02) 49477537

**Hair and Scat Analysis:**

Barbara Triggs
"Dead Finish"
Genoa VIC 3981

### Additional Information Sources

**Flora & Fauna Surveys, and Habitat Management Strategy within the HEZ (commissioned by Cessnock City Council)**

Ecotone Ecological Consultants Pty. Ltd.
39 Platt Street,
Waratah NSW 2298
Tel. (02) 49684901
Fax. (02) 49684960

**Green-thighed Frog Research:**

Dr Michael Mahony
School of Biological Sciences
University of Newcastle
Callaghan NSW 2308

# 3 RESULTS

*This chapter details the results from Harper Somers O'Sullivan detailed Ecological Constraints Master Plan surveys as well as information collated from the other flora and fauna species surveys conducted within the Hunter Economic Zone to date.*

## 3.1 Flora

*Information for the following Section 4.3.1 has been extracted from Bell (2004) in a study commissioned for Harper Somers O'Sullivan to fulfil flora survey and vegetation mapping requirements for the HEZ (provided in full in Appendix B).*

A total of over 382 plant taxa have been recorded with the HEZ Study Area to date, including nine (9) rare or threatened plant species. Threatened and rare species include *Acacia bynoeana, Callistemon linearifolius, Eucalyptus glaucina, Eucalyptus fergusonii* subsp. *dorsiventralis, Eucalyptus parramattensis* subsp. *decadens, Grevillea parviflora* subsp. *parviflora, Grevillea montana, Macrozamia flexuosa* and *Rutidosis heterogama*. In addition, two eucalypt taxa (*Eucalyptus* sp aff *agglomerata* & *Eucalyptus* sp aff *camfieldii*) occur on the site which possibly represent new species. While these potential new species are not currently recognised as rare or threatened, they remain of some significance until further information is collected.

Of particular note, the HEZ Study Area supports a surprising number of eucalypt species (29) and orchid species (24) within a relatively small area, which is indicative of the diversity of vegetation present. Of the 262 recognised eucalypts in New South Wales, over 10% occur within the 3300ha study area. When compared against the results of several other studies on the east coast of Australia, the HEZ Study Area is un-paralleled in the diversity of eucalypts presently documented within areas less than 15000 ha in size.

### *3.1.1 Flora Assemblages*

Five (5) vegetation communities have been delineated and described within the REMS framework for the HEZ study area, including two (2) endangered ecological communities, as shown in Figure 3-3. A brief summary of each is provided below:

**Unit 13: Central Hunter Riparian Forest**

A variable community occupying narrow zones along tributaries of the major creeks, excluding the broader alluvial flats. Dominant canopy species include *Eucalyptus canaliculata, Angophora floribunda, Eucalyptus moluccana, Casuarina glauca* (in places), and various *Melaleuca* species. Variants occur based primarily on local soil type (sand vs clay).

**Unit 17: Lower Hunter Spotted Gum-Ironbark Forest**

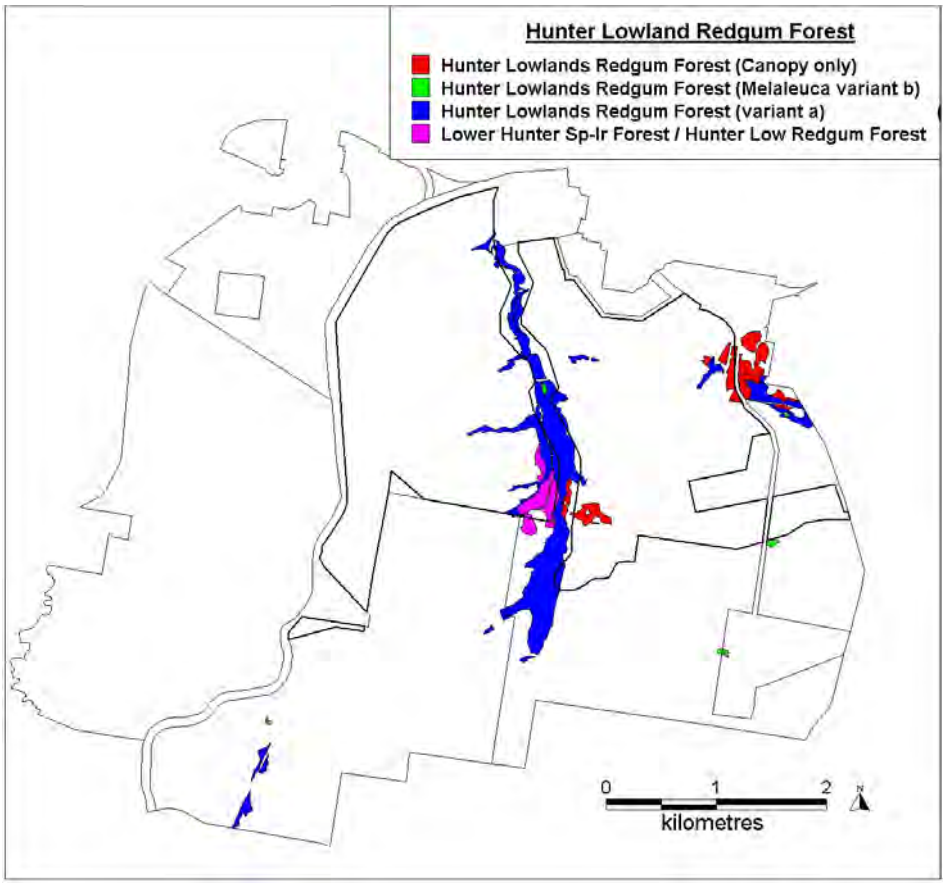
Characterised by Spotted Gum (*Corymbia maculata*) and various Ironbarks (predominantly *Eucalyptus fibrosa*). Other canopy species include *Eucalyptus agglomerata* (atypical form), *Eucalyptus beyeriana, Eucalyptus punctata*, and in a few restricted locations, *Corymbia eximia*. Dominance by *Melaleuca nodosa* in the shrub layer is indicative of past disturbance in some areas.

**Unit 19: Hunter Lowland Redgum Forest**

A community generally dominated by Redgums (*Eucalyptus tereticornis, Eucalyptus amplifolia* subsp. *amplifolia, Eucalyptus glaucina*) and other species such as *Angophora floribunda, Eucalyptus punctata,* and occasionally *Eucalyptus crebra*. Understorey is grassy with scattered shrubs due to past disturbance. In some creek lines with impeded drainage, thickets of *Melaleuca linariifolia*, *Melaleuca styphelioides* and occasionally *Callistemon salignus* develop, over an understorey of sedges such as *Carex appressa* and grasses.

This community is listed as an endangered ecological community under the *Threatened Species Conservation Act 1995* (TSC Act.). The distribution of the community within the HEZ (Bell 2004) is shown in Figure 3-1.

**Figure 3-1 Distribution of Hunter Lowland Redgum Forest within the HEZ**

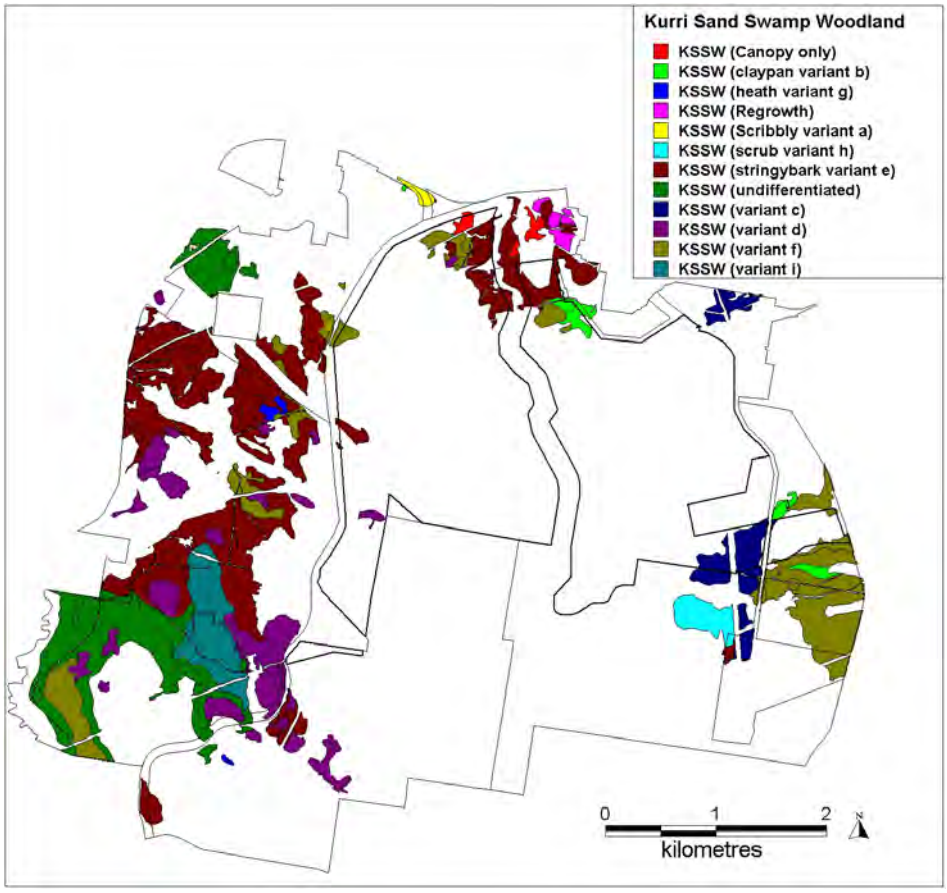



**Unit 35: Kurri Sand Swamp Woodland**

Kurri Sand Swamp Woodland is a highly variable vegetation type which comprises a number of observable combinations of canopy and understorey species. Most occur on sandy soils and support a range of heathy understorey plants, but others are present on claypans in close proximity to sand deposits. Canopy species present within the broader KSSW include *Angophora bakeri, Corymbia gummifera, Eucalyptus agglomerata, Eucalyptus resinifera, Eucalyptus parramattensis subsp. decadens, Eucalyptus fibrosa, Eucalyptus punctata, Eucalyptus racemosa,* and *Eucalyptus capitellata*. Scrub and heath variants are also present, where a stunted and widely spaced canopy of trees occurs.

This community is listed as an endangered ecological community under the *Threatened Species Conservation Act 1995* (TSC Act.). The distribution of the community within the HEZ (Bell 2004) is shown in Figure 3-2.

**Figure 3-2 Distribution of Kurri Sand Swamp Woodland within the HEZ**




**Unit 46: Freshwater Wetlands**

A few small wetland areas are present in the study area, most of which have been formed from man-induced activities. These have yet to be sampled in detail, but consist of at least two variants. The first occurs in drainage lines in the east where the construction of Leggetts Drive has created wetlands dominated by *Baumea articulata* and *Philydrum lanuginosum*. The second is dominated by *Typha orientalis*, which colonises disused water storages such as dams.

### *3.1.2 Conservation Status of Vegetation Communities*

Much of the vegetation within the HEZ supports vegetation of conservation significance, either through the presence of threatened or rare plant species, or endangered ecological communities. Other vegetation types are considered regionally significant due to their general rarity, or their lack of adequate reservation in formal conservation reserves.

**Unit 13: Central Hunter Riparian Forest**

A few major streams within the HEZ support a vegetation type that is most closely identifiable with the Central Hunter Riparian Forest of NPWS (2000a). However, there are several floristic differences worthy of mention. Along parts of Swamp Creek, such as in the Neath portion of Werakata National Park, a deeply incised channel supports fringing *Casuarina glauca* with *Melaleuca stypheloides* and *Melaleuca linariifolia*, over an understorey which includes *Baumea juncea* and *Phragmites australis*. The presence of *Casuarina* and *Baumea* here suggests a strong saline influence not evident elsewhere in the Park.

In other areas, small sandy alluvial rises adjacent to drainage lines support a vegetation characterised by *Angophora floribunda* and *Eucalyptus punctata*, over an understorey of species such as *Leptospermum trinervium, Pteridium esculentum, Banksia oblongifolia, Lomatia silaifolia* and *Imperata cylindrica* var. *major*. This type is currently recognised as a variant of the Central Hunter Riparian Forest, but possibly is more closely related to the Warkworth Sands Woodland EEC near Singleton. That EEC occurs on aeolian sand dunes associated with Wollombi Brook, and it is possible that the vegetation within Tomalpin is a scaled-down version associated with sandy deposition from the Kurri Sand deposits. Further survey and analysis is required to clarify the floristic relationships here, but until that time these sandy rises are considered at least regionally significant.

**Unit 17: Lower Hunter Spotted Gum-Ironbark Forest**

The Lower Hunter Spotted Gum-Ironbark Forest represents a vegetation type that was formerly quite widespread on the floor of the Hunter Valley (NPWS 2000a). Forests between Beresfield and Cessnock represent the core of its distribution, although much of this occurs in State Forest and has been managed for timber production for many years. Within the region, NPWS (2000a) have mapped an extant distribution of 26917ha, which represents a reduction of 59% of its former range. Under the criteria of Landsberg (2000), this vegetation type classifies as vulnerable due to a substantial decline in distribution (Criteria A).

Extensive areas of the HEZ study site support components of the Lower Hunter Spotted Gum-Ironbark Forest. This is particularly the case in the areas including and surrounding the development zone. Areas around Mt Tomalpin in the south-west support a different form of this community. Bell (2001a) has mapped approximately 1600 ha of this vegetation type for Werakata National Park, which plays a critical role in its conservation in the region. NPWS (2000a) report only 1873 ha of this community from all conservation reserves.

**Unit 19: Hunter Lowland Redgum Forest**

Hunter Lowland Redgum Forest has been identified as a regionally significant vegetation community by NPWS (2000a), and is listed as an Endangered Ecological Community under the NSW *TSC Act 1995*. Within the HEZ, Hebburn Creek catchment supports good examples of this community. As far as is known, Werakata National Park (with 7ha) represents the only formal conservation reserve protecting examples of this vegetation type in the region.

There is considerable variation within the Hunter Lowland Redgum Forest, much of it related to soil drainage and disturbance history. Areas suffering from frequent fires tend to support a higher component of grass species, while in other areas shrubs such as *Bursaria spinosa* and *Melaleuca nodosa* are prevalent. In poorly drained depressions where runoff forms small billabongs and ponds, *Melaleuca linariifolia* thickets occur offering specialised fauna habitat. The latter areas are poorly represented in Werakata National Park.

**Unit 35: Kurri Sand Swamp Woodland**

The Kurri Sand Swamp Woodland [as delineated by NPWS (2000a)] was determined as an Endangered Ecological Community under the *Threatened Species Conservation Act 1995* in July 2001. The description of this community as listed in the TSC Act legislation includes a list of plant species which characterise the unit. When compared against several vegetation types present in the HEZ, there are clear differences in the dominant and component species which make including them within the TSC Act definition difficult. This issue has been raised previously in regard to the vegetation present within Werakata National Park (Bell 2001a). The overall description of the community in the determination, particularly its biophysical components, is generally consistent with the field situation, but there are important discrepancies. Bell (2001a) considered parts of the vegetation within Werakata NP as a variant of the Kurri Sand Swamp Woodland of NPWS (2000a), and mapped approximately 70 ha of this variant within the Park, and stated that nowhere was the Kurri Sand Swamp Woodland as defined in the TSC Act represented.

Survey as part of the current project has confirmed and extended the variations evident within the Kurri Sand Swamp Woodland alluded to in Bell (2001a). Several forms of what may be considered part of the KSSW are present within the HEZ, and indeed in the wider Cessnock-Kurri region. The floristic composition in all of these is heavily dependant on soil type (specifically the relative proportions of sand and clay) and the related drainage patterns.

The Kurri Sand Swamp Woodland and its variations show strong affinities to parts of the western Sydney vegetation. NPWS (2000b) describe and map the natural vegetation of the Cumberland Plain, where they identify four communities occurring on two different deposits of Tertiary alluvium. The distribution of these four communities is reportedly related to the extent of exposure of soils from three depositional phases, and local drainage conditions. Consequently, vegetation dominated by ironbarks (Castlereigh Ironbark Forest) occurs on soils with a high clay content, while more sandy soils support Scribbly Gum (Castlereigh Scribbly Gum Woodland). Typically, soils with a high clay content underlie sandy soil but tend to be exposed through erosion around the edges of deposits. Poorly drained depressions support a swamp woodland (Castlereigh Swamp Woodland), while shallow deposits of Tertiary alluvium over shale soils, or localised concentrations of iron-indurated gravels, support a transitional forest (Shale Gravel Transition Forest). A fifth community with a sparse canopy but with a dense understorey of *Melaleuca nodosa* (Cooks River Clay Plain Scrub Forest) was included as a sub-unit of the Castlereigh Ironbark Forest.

Further survey and analysis is required in all areas outside of the HEZ supporting the TSC Act-defined Kurri Sands Swamp Woodland to more clearly understand floristic relationships. Until this is done, there is no way of confidently assigning conservation status levels to the variations described in this report, as no comparable data is yet available.

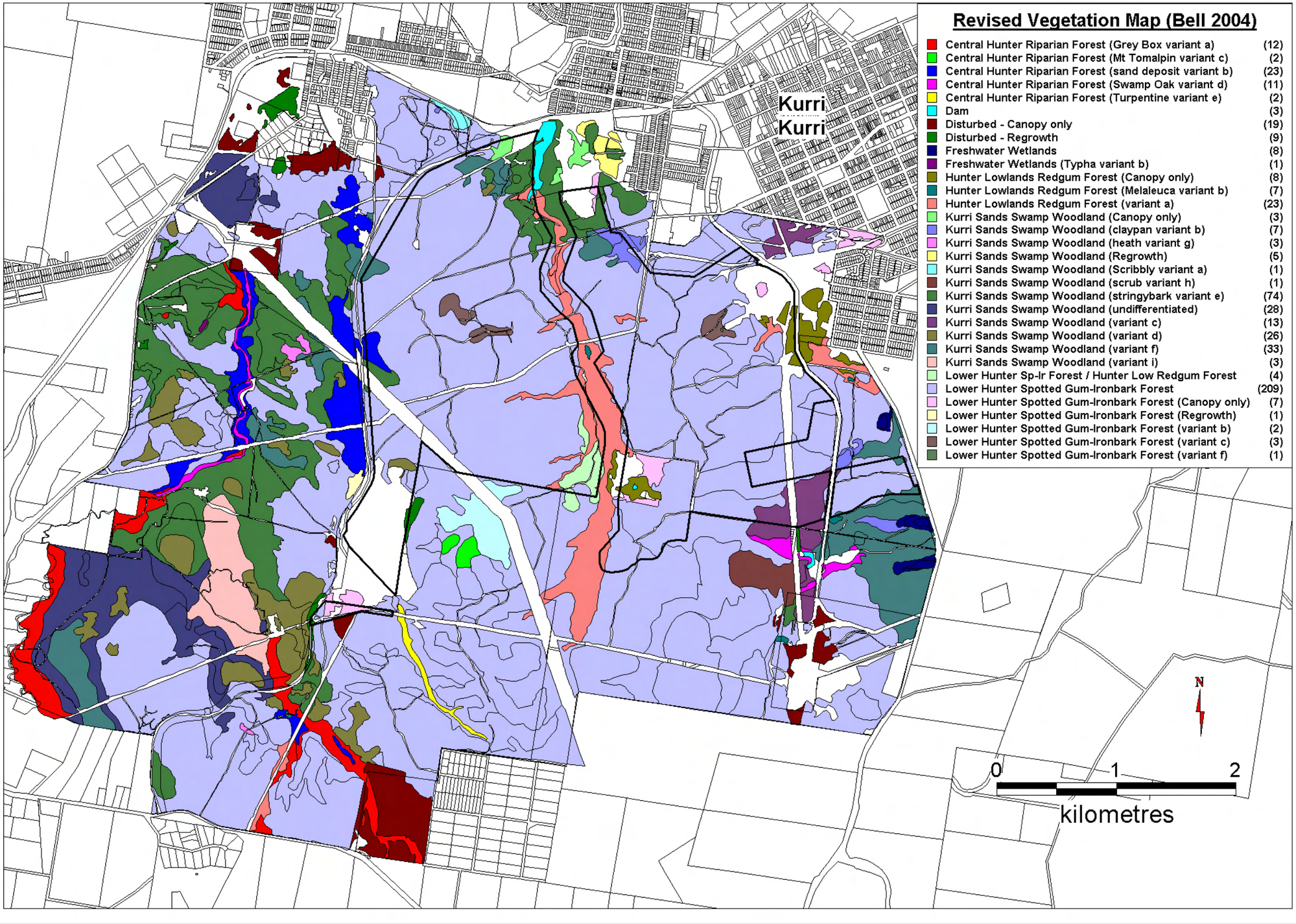
### *3.1.3 Threatened / Significant Flora Species*

During the course of ecological surveys within the HEZ, one endangered (*Acacia bynoeana*), five vulnerable (*Callistemon linearifolius, Grevillea parviflora* subsp. *parviflora*, *Eucalyptus glaucina, Eucalyptus parramattensis* subsp. *decadens, Rutidosis heterogama*), three rare (*Eucalyptus fergusonii* subsp. *dorsiventralis, Grevillea montana*, *Macrozamia flexuosa*) and several species of regional significance (see Table 7 in Appendix B) have been detected. In addition, two potential new species of eucalypt (*Eucalyptus* sp aff *agglomerata* & *Eucalyptus* sp aff *camfieldii*) have been found within the HEZ.

Further information on threatened and rare flora species is shown in Section 4.2 of Appendix B.

An assessment of individual threatened flora species distribution and abundance within the HEZ is shown in Appendix A.

**Figure 3-3 Revised Vegetation Map (Bell 2004)**



## 3.2 Fauna Assemblages

A total of 239 vertebrate fauna taxa have been recorded within the HEZ Study Area to date, including twenty-two (22) threatened species, and a number of other regionally significant species. As such it could be stated that the area contains a high diversity of fauna species, including a relatively large number of threatened species. This is particularly true when it is considered that the vast majority of these species have been recorded from forested (i.e. fairly homogenous) habitats. The number of bird, frog, reptile, and mammal taxa is shown in Table 3-1, whereas a complete list of fauna species recorded within the HEZ is provided in Appendix C.

**Table 3-1 Fauna Assemblages**

| Faunal Group | Number of Species Recorded | Number of Threatened Species Recorded |
|---|---|---|
| Bird | 156 | 12 |
| Frog | 16 | 1 |
| Reptile | 22 | 0 |
| Mammal | 45 | 9 |
| Total | 239 | 22 |

The faunal diversity is representative of the habitats present within the HEZ study area. Such habitats are fairly diverse and this has enabled a high diversity of species to exist within a relatively large and intact natural landscape. Indeed, the HEZ study area comprises a significant component of one of the largest remnant forested areas on the floor of the Lower Hunter Valley. This feature equates to a significant habitat opportunity for native fauna species, particularly given the largely continuous nature of the habitat. Such habitat remnants are important to a range of threatened, or otherwise significant, fauna species that are susceptible to habitat fragmentation.

The HEZ is also somewhat unique in that it appears to occur within a transition zone between the more coastal environs and the western influences of the Hunter Valley and as a result a number of species occur at or near the limits of their respective distributions on a sub-regional scale. Examples of this include several 'woodland' bird species that are resident within the HEZ that are rarely recorded east of the study area. These include such species as *Chthonicola sagittata* (Speckled Warbler), *Coracina papuensis* (White-bellied Cuckoo-shrike), *Petroica multicolor* (Scarlet Robin), *Lichenostomus fuscus* (Fuscous Honeyeater) and *L. leucotis* (White-eared Honeyeater). The area also seems to form a transitional zone between Antechinus species known from predominantly eastern and western habitats, being *Antechinus stuartii* (Brown Antechinus) and *A. flavipes* (Yellow-footed Antechinus) respectively.

### 3.2.1 Threatened Fauna Species

Twenty-two (22) threatened fauna species have been recorded within the study area to date. These species include:

| | |
|---|---|
| *Litoria brevipalmata* | Green-thighed Frog |
| *Hamirostra melanosternon* | Black-breasted Buzzard |
| *Calyptorhynchus lathami* | Glossy Black-Cockatoo* |
| *Climacteris picumnus victoriae* | Brown Treecreeper* |
| *Pomatostomus temporalis temporalis* | Grey-crowned Babbler |
| *Chthonicola sagittata* | Speckled Warbler |
| *Lathamus discolor* | Swift Parrot* (only in Tasmania) |
| *Neophema pulchella* | Turquoise Parrot* |
| *Tyto novaehollandiae* | Masked Owl* |
| *Tyto tenebricosa* | Sooty Owl* |
| *Ninox strenua* | Powerful Owl* |
| *Xanthomyza phrygia* | Regent Honeyeater |
| *Melithreptus gularis gularis* | Black-chinned Honeyeater |
| *Phascolarctos cinereus* | Koala |
| *Petaurus australis* | Yellow-bellied Glider* |
| *Petaurus norfolcensis* | Squirrel Glider* |
| *Falsistrellus tasmaniensis* | Eastern Falsistrelle* |
| *Miniopterus australis* | Little Bentwing-bat* |
| *Miniopterus schreibersii oceanensis* | Eastern Bentwing-bat |
| *Mormopterus norfolkensis* | East-coast Freetail-bat* |
| *Scoteanax rueppellii* | Greater Broad-nosed Bat* |
| *Myotis adversus* | Large-footed Myotis* |

* Hollow dependent species (source: Gibbons & Lindenmayer 2002).

An assessment of individual threatened fauna species distribution and abundance within the HEZ is shown in Appendix A.

## 3.3 Development Zone Surveys and Habitat Assessment

Over 20,000 points (eg. hollow-bearing trees), lines (eg. creeks), and regions (eg. grid variables) of ecological information have been collected as part of Harper Somers O'Sullivan's detailed development zone / central conservation corridor surveys. The majority of this information is summarised in Table 3-2, Table 3-3 and Table 3-4.

**Keystone Mature Tree Species**

A total of 5222 keystone mature tree species were detailed within the 4(h) lands and the central 7(b) conservation corridor (see Table 3-2). The higher densities of mature trees occurred in the southern sections bordering the conservation zones, along Chinamans Hollow Creek, and in the south-western quarter of the development zone. The most common tree species detailed were the Broad-leaved Ironbark (3142), Grey Gum (898), Forest Red Gum (451), and Spotted Gum (430).

The data shows that whilst mature trees were relatively widespread throughout the majority of the development zone, previous and ongoing land-use activities including historical mining activities (particularly 'pit-propping' timber getting), high fire frequency and ongoing firewood collection appear to have impacted upon the density of this habitat feature.

**Hollow-bearing Trees**

A total of 2979 hollow-bearing trees containing 7216 hollows including 533 large (ϕ>20cm), 2008 medium (ϕ11-20cm), and 4675 small hollows (ϕ2-10cm) were detailed within the 4(h) lands and the central 7(b) conservation corridor (see Table 3-2). The higher densities of hollow bearing trees occurred in the central southern and south-western quarter of the development zone. When the tree hollow data was converted to number per 150m x 150m grid, only 5 grids were found to contain more than 76 hollows.

The highest density of hollow-bearing trees and tree hollows was contained within the Hunter Lowland Redgum Forest community, whilst the main vegetation community within the development zone - the Lower Hunter Spotted Gum – Ironbark Forest contained the majority of tree hollows at somewhat lower densities (see Table 3-3). The data shows that whilst tree hollows were relatively widespread throughout the majority of the development zone, previous and ongoing land-use activities including historical mining activities and ongoing firewood collection appear to have impacted upon the density of occurrence of this critical habitat resource. These statements are also supported by the conclusions reached by Ecotone (2000).

The average of 3.66 hollow-bearing trees per hectare obtained for the HEZ (see Table 3-3) would place it at a lower range for the estimates of the number of hollow-bearing trees used by vertebrate fauna in Australia, which ranges from 0.4 – 14 trees per hectare (Gibbons and Lindenmayer 2002). In the forests of south-east Queensland, Smith (1998) estimated that demand for hollows by hollow dependent fauna was 9.9 per hectare in dry Spotted Gum Forest, which is similar to the availability of hollows within the HEZ (combined size class average of 9.16 per hectare). From this information it can be inferred that the demand for hollows is likely to exceed that which is currently available and as such the availability of hollows is likely to be a limiting factor for the size and distribution of fauna populations.

The extent of this habitat resource can be utilised to model the potential habitat and occurrence of the thirteen (13) threatened fauna species recorded within the HEZ that are reliant on tree hollows for at least one aspect of their lifecycle.

**Table 3-2 Mature and Hollow-bearing Tree Data**

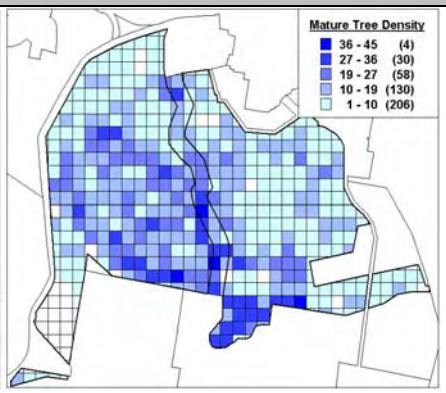
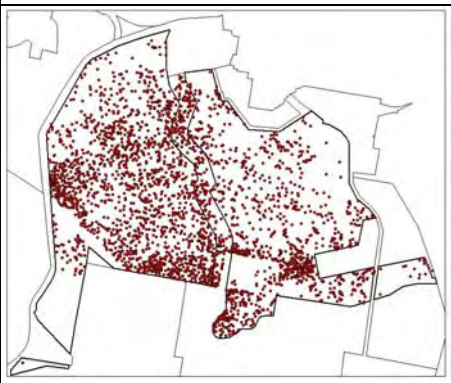
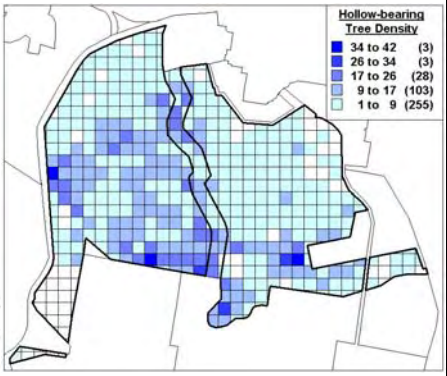
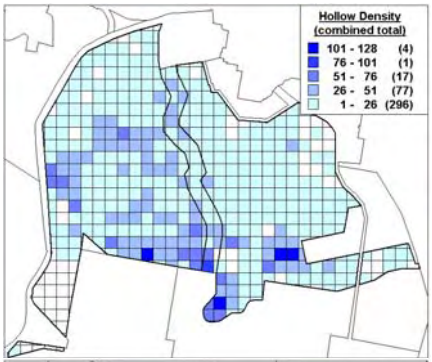
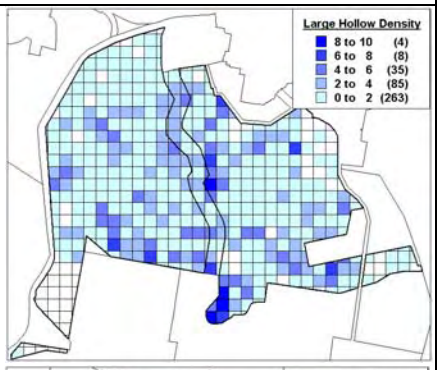
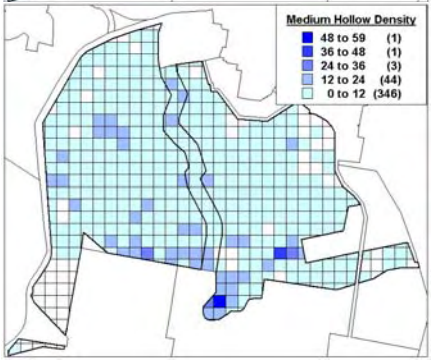
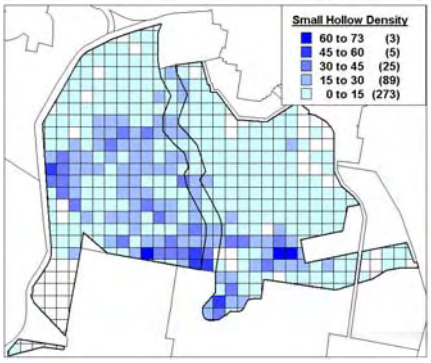
| Feature | Number Recorded | Map(s) |
|---|---|---|
| Mature Trees | 5222 (total) |  Raw Point Data   Density per 150m x150m Grid |
| Hollow-bearing Trees | 2979 (total) |  Raw Point Data   Density per 150m x150m Grid |
| Tree Hollows | 7216 (combined total)<br><br>533 (ϕ>20cm) Large Hollows<br><br>2008 (ϕ11-20cm) Medium Hollows<br><br>4675 (ϕ2-10cm) Small Hollows |         |

**Table 3-3 Vegetation Communities and Tree Hollow Density**

| Vegetation Community | Extent (ha) | Hollow Trees | | Size ϕ2-10cm | | Size ϕ11-20cm | | Size ϕ>20cm | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. | Density (ha) | No. | Density (ha) | No. | Density (ha) | No. | Density (ha) |
| Lower Hunter Spotted Gum / Ironbark Forest | 665.1 | 2321 | 3.49 | 3762 | 5.66 | 1604 | 2.41 | 399 | 0.6 |
| Kurri Sand Swamp Woodland | 73.2 | 299 | 4.08 | 341 | 4.66 | 145 | 1.98 | 63 | 0.86 |
| Hunter Lowland Redgum Forest | 48.6 | 262 | 5.39 | 415 | 8.54 | 200 | 4.12 | 56 | 1.15 |
| Combined Total | 786.9 | 2882 | 3.66 | 4518 | 5.74 | 1949 | 2.48 | 518 | 0.66 |

*Notes: Extent of vegetation communities does not include disturbed remnants (mapped as Xr / Xs). Several small areas of an ecotonal community mapped as 17/19, have been included within the "Lower Hunter Spotted Gum Ironbark Forest" for the purposes of this assessment.*

## Grid Pattern Habitat Investigations

The results of the 150m x 150m grid pattern habitat investigations are shown in Table 3-4. These variables were collected to obtain an overview of a broad range of ecological and environmental variables for the HEZ, which can be utilised for strategic planning purposes, threatened species modelling, and ongoing land management (such as the rehabilitation of degraded areas).

The results show that whilst habitat resources are present for a number of species, degradation regimes have impacted upon a number of these resources and led to an overall reduction in the quality of habitat across the site.

## Threatened Species Surveys

During the course of the development zone surveys by Harper Somers O'Sullivan, a large number of threatened flora and fauna species records were obtained. Threatened species most commonly recorded included:

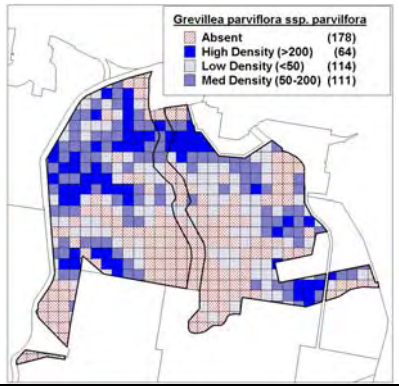
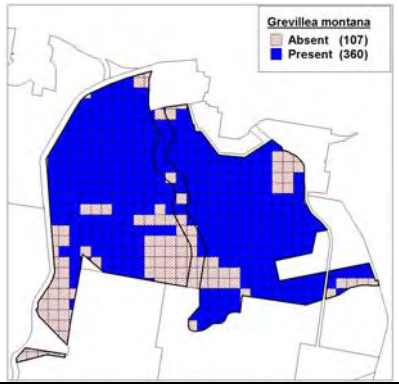
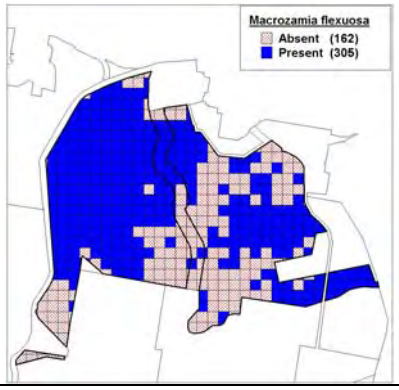
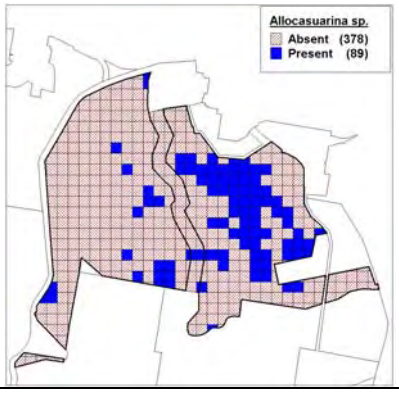
**Flora** – *Callistemon linearifolius, Eucalyptus parramattensis* subsp. *decadens,* and *Rutidosis heterogama.*

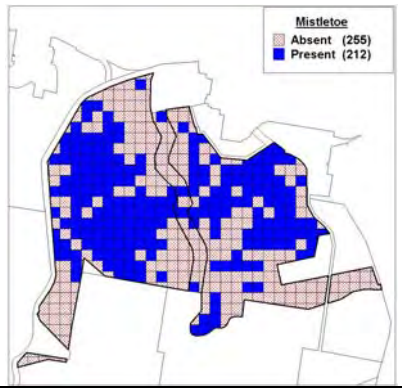
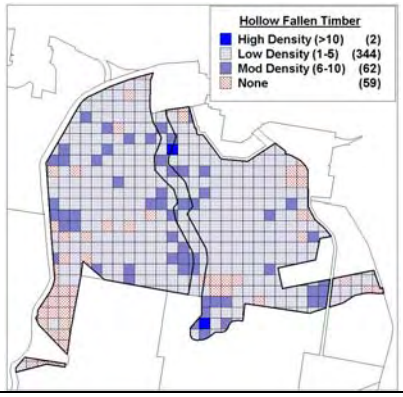
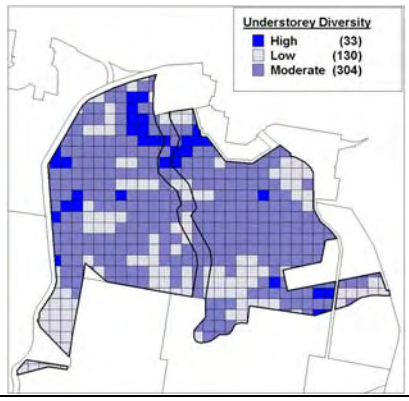
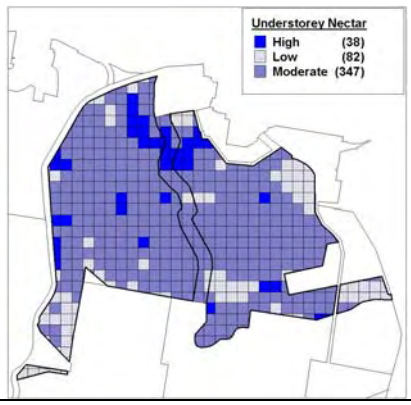
**Fauna** – Black-chinned Honeyeater, Brown Treecreeper, Grey-crowned Babbler, and Yellow-bellied Glider.

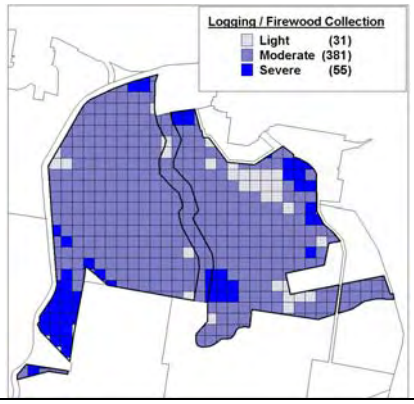
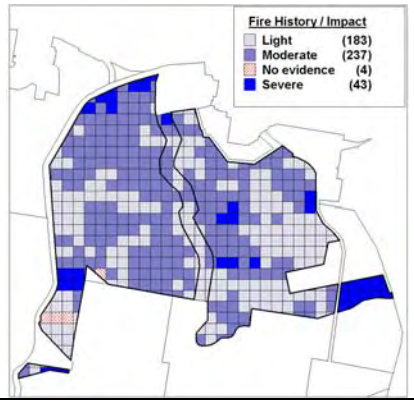
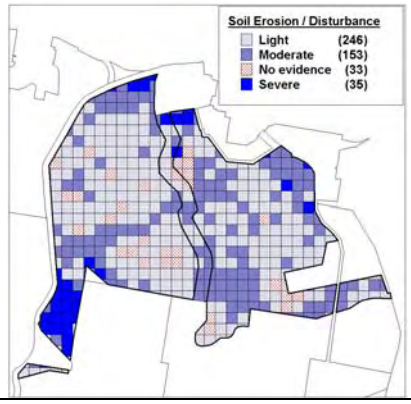
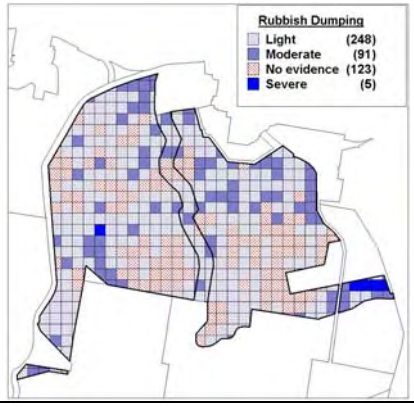
Of particular note, no further records of the Green-thighed Frog and the nationally endangered Swift Parrot and Regent Honeyeater have been obtained during the recent surveys despite targeted efforts. This is due primarily to a lack of suitable conditions (ie. Green-thighed Frog – no significant summer rainfall events and low water table due to drought; Swift Parrot / Regent Honeyeater - no significant flowering of Spotted Gum within the locality since 2000).

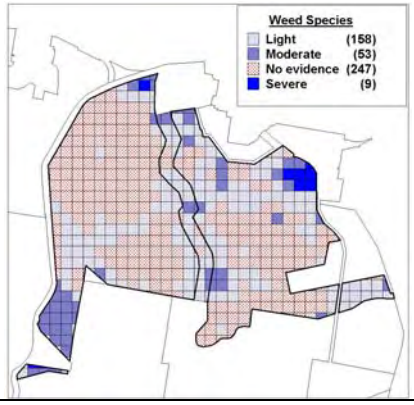
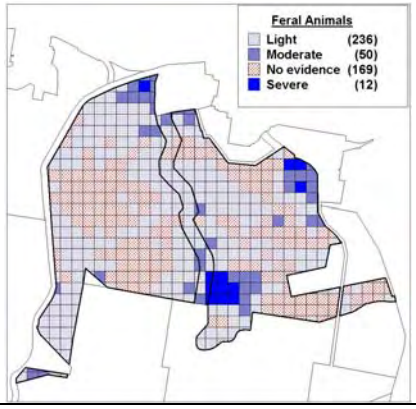
Nonetheless, threatened species habitats within the HEZ have been detailed as part of the ECMP investigations and further information on individual threatened species occurrences is provided in Chapter 4 and Appendix A.

**Table 3-4 Results of Grid Pattern Surveys**

| Feature / Attribute | Results | Map |
|---|---|---|
| *Grevillea parviflora* subsp. *parviflora* | Found to occur in over 60% of the HEZ development zone, with high densities recorded over large areas of the western half as well as in small areas in the east.<br><br>The species tends to occur in a clustered distribution, and was predominately found within the Lower Hunter Spotted Gum – Ironbark Forest and Kurri Sand Swamp Woodland communities.<br><br>Data represents estimates of the density of above-ground stems only, and is not indicative of population sizes. Research currently in progress is attempting to clarify the taxonomic position of *Grevillea parviflora* within the *Grevillea linearifolia* complex in the lower Hunter Valley and Central Coast (Driscoll & Bell in prog.). |  |
| *Grevillea montana* | Extremely widespread throughout the HEZ development zone, being found within 77% of grids surveyed.<br><br>The species was commonly recorded within both the Lower Hunter Spotted Gum – Ironbark Forest and Kurri Sand Swamp Woodland communities. |  |
| *Macrozamia flexuosa* | Widespread throughout the HEZ development zone, being found within 65% of grids surveyed.<br><br>The species was commonly recorded within both the Lower Hunter Spotted Gum – Ironbark Forest and Kurri Sand Swamp Woodland communities. |  |
| *Allocasuarina* sp. | Occurrence noted due to status as primary foraging resource for the threatened Glossy Black-cockatoo. *Allocasuarina torulosa* (Forest Oak) was present as an understorey species across approximately 19% of the HEZ development zone within the Lower Hunter Spotted Gum – Ironbark Forest community. The species generally only occurred as scattered trees and was nowhere common.<br><br>Its distribution is predominately clustered around areas in the central eastern portions of the development zone. |  |

| Feature / Attribute | Results | Map |
|---|---|---|
| Mistletoe | Occurrence noted due to status as a preferred foraging resource for the threatened Painted Honeyeater and the threatened Regent Honeyeater. Present as parasitic species within Eucalyptus trees throughout approximately 45% of the HEZ development zone, in both the western and eastern portions. |  |
| Hollow / Fallen Timber | The occurrence of this habitat resource is generally sparse, with a low density recorded throughout the majority of the development zone. Higher densities were recorded along Chinamans Hollow Creek in the Hunter Lowland Redgum Forest.<br><br>In some areas the density has been artificially increased by illegal logging and firewood collection with levelled tree stumps / trunks being left on the ground, whilst in other areas density has been decreased by dry timber collection. |  |
| Understorey Diversity | Attribute information collected as a general indicator of habitat quality for all fauna species. Majority of HEZ development zone (65%) found to constitute areas of moderate understorey diversity. Areas of lowest understorey diversity correlated with the more heavily disturbed/cleared areas, whilst areas of highest understorey diversity correlate with the distribution of the generally diverse Kurri Sands Swamp Woodland community. |  |
| Understorey Nectar | Attribute information collected as a general indicator of habitat quality for all fauna species, and in particular for nectivorous threatened species such as Squirrel Glider, Grey-headed Flying Fox, Painted and Regent Honeyeaters.<br><br>The majority of the development zone was shown to have a moderate density and diversity of nectar producing understorey species from families such as Fabaceae, Mimosoideacae, Myrtaceae, and Proteaceae.<br><br>The areas of highest understorey diversity were generally found within the Kurri Sand Swamp Woodland community. |  |

| Feature / Attribute | Results | Map |
|---|---|---|
| Logging / Firewood Collection | Widespread and arguably one of the greatest threats to habitat viability within HEZ. Numerous tracks from illegal operators / collectors dissect the entire site. Ongoing management of the threat including strict enforcement / fines are required to preserve habitat quality, particularly within conservation zones. |  |
| Fire History / Impact | The HEZ site has a high fire frequency due primarily to arson. It is likely that much of the area has been subjected to fire on average once every 2-3 years, including during the summers of 2000-2001 and 2002-2003.<br><br>Accordingly, changes in vegetation community composition are evident throughout the development zone with fire tolerant/resistant species being more common. Areas in the eastern and central northern portions of the development zone are most severely affected by fire, thereby impacting upon the habitat quality within these areas. |  |
| Erosion / Soil Disturbance | Attribute collected as a measure of general habitat quality, as well as level of disturbance. The majority (60%) of the HEZ development zone was found to have either no evidence or only light levels of erosion / soil disturbance.<br><br>Areas with moderate and/or high levels of erosion/soil disturbance generally correlated with areas of cleared vegetation, including the internal track network used by firewood collectors and motorbike riders and areas used in the past for grazing and mining.<br><br>Creeklines were also observed to have high erosion potential and were highly eroded in a number of locations. |  |
| Rubbish Dumping | Due to the close proximity of the HEZ to the urban areas of Cessnock and Kurri Kurri there is a long history of rubbish dumping on the site, particularly along the main vehicular assess points into the site such as along Main Road 195 and the tracks leading from Kurri Hospital.<br><br>A large number of wrecked and/or burnt out car bodies were also found to be present. Cars dumped on the site are often set alight, thereby contributing to an increased fire frequency and a pollution hazard. |  |

| Feature / Attribute | Results | Map |
|---|---|---|
| Weeds | Weeds generally represent a minor problem, due predominately to the low nutrient content of the soils. Nonetheless there are minor to severe incursions of weeds in areas that are highly disturbed such as in the northern sections of the site near Weston, along tracks and clearings through the site and around garden refuse.<br><br>Common weed species include Lantana, Privet, Purple Top, and Blackberry. |  |
| Feral Animals | Some evidence of feral animals was observed in a number of locations, with evidence of rabbits (mainly along Chinamans Hollow Creek), foxes and domestic / feral dogs most commonly encountered.<br><br>A fenced off area (approximately 30ha) in the central southern portion of the development zone was used by a small population of domestic horses. |  |

# 4 THREATENED SPECIES ASSESSMENT

*This chapter provides an assessment of the threatened species issues within the HEZ, including adequacy of reservation.*

Currently, six (6) threatened flora species, twenty-two (22) threatened fauna species, and two (2) endangered ecological communities have been recorded within the HEZ study area. All of these species / communities are listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act), whilst seven (7) species are listed as nationally threatened under the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act).

Key information relating to the recorded threatened species / communities is detailed in Table 4-2. Additional information on individual species occurrence, distribution, and population sizes within the HEZ is shown in Appendix A.

The information presented herein shows that adequate conservation outcomes appear to have been achieved for the majority of 28 threatened species and one of the endangered ecological communities (Kurri Sand Swamp Woodland). Nonetheless, adequate conservation outcomes cannot be conclusively demonstrated for several species and/or these species have been found to maintain significant populations / occurrences within the 4(h) development zone. The species of most potential concern in this regard and the vegetation communities present within the development zone are detailed below in Table 4-1.

**Table 4-1 Key Threatened Species and Vegetation Communities**

| Species / Community | Comments | 8(a) Zone - Nat Park | 7(b) Zone – Cons. | 4(h) Zone – Dev. | 1(a) & 5(b) Zones |
|---|---|---|---|---|---|
| Acacia bynoeana (TSC Act & EPBC Act) | No population estimates undertaken to date. Further populations likely to be found within the conservation zones of the HEZ. | - | 75% (3 populations) | 25% (1 population) | - |
| Callistemon linearifolius (TSC Act) | Further individuals are likely to be found within Werakata NP. Results are somewhat biased to 4(h) zone which has been the subject of detailed surveys. Identification of a large number of individuals proved problematic. | 13% (627 individuals) | 10% (487 individuals) | 76% (3640 individuals) | 1% (51 individuals) |
| Eucalyptus glaucina (TSC Act & EPBC Act) | Potential habitat based on extent of Hunter Lowland Redgum Forest in which it occurs. Considerable amount of hybridisation occurring making accurate population counts of the species near impossible. | ? (potential habitat 3%) | several areas (potential habitat 59%) | several areas (potential habitat 30%) | one area (potential habitat 8%) |
| Rutidosis heterogama (TSC Act & EPBC Act) | Species occurs in large population numbers (> 20,000 individuals). Extent based on the area of occupancy. | 10% | 21% | 67% | 2% |
| Green-thighed Frog (TSC Act) | Current knowledge based on initial records (March 2002) and on assessment of potential habitat. | ? (some potential habitat present) | 2 pop. | ? (potential habitat present) | ? |
| Swift Parrot (TSC Act & EPBC Act) | Extent of potential habitat based on the occurrence of HLRF and LHSGIF within the HEZ (Bell 2004). Records somewhat biased to the observations of local bird watchers. | 1 record (potential habitat 31%) | 2 records (potential habitat 28%) | 6 records (potential habitat 36%) | 1 record (potential habitat 5%) |
| Regent Honeyeater (TSC Act & EPBC Act) | Extent of potential habitat based on the occurrence of HLRF and LHSGIF within the HEZ (Bell 2004). | - (potential habitat 31%) | - (potential habitat 28%) | 2 records (potential habitat 36%) | - (potential habitat 5%) |
| Brown Treecreeper (TSC Act) | Relatively common within the 4(h) zone including 2 breeding records, representing eastern limit in the Hunter Valley. Also common within the 7(b) zone. | 2 locations | 2 locations | 4 locations | - |
| Hunter Lowland Redgum Forest (HLRF) (TSC Act) | Endangered Ecological Community. Majority of occurrence along Chinamans Hollow Creek and several smaller tributaries. | 3% (4 ha) | 59% (71 ha) | 30% (36 ha) | 8% (9 ha) |
| Kurri Sand Swamp Woodland (KSSW) (TSC Act) | Endangered Ecological Community. Appears to be adequately conserved (84% of occurrence) within conservation zones of the HEZ study area. | 54% (393 ha) | 30% (231 ha) | 9% (66 ha) | 7% (52 ha) |
| Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF) | Regionally significant community that provides potential habitat for a number of key threatened species including Swift Parrot, Regent Honeyeater, and Brown Treecreeper. | 33% (590 ha) | 26% (457 ha) | 36% (654 ha) | 5% (93 ha) |

**Table 4-2 Threatened Species and Endangered Ecological Communities recorded within the HEZ Study Area**

| Scientific Name | Common Name | TSC Status | EPBC Status | Records within HEZ | | | Recorded Occurrence within the HEZ |
|---|---|---|---|---|---|---|---|
| | | | | Dev. 4(h) | Cons. 7(b) | Cons. 8(a) | |
| **Flora (6 threatened species)** | | | | | | | |
| *Acacia bynoeana* | Bynoe's Wattle | E | V | ✓ | ✓ | - | Recently found in HEZ. Surveys to date have found 1 occurrence in the 4(h), and 4 occurrences within the 7(b) zone (representing possibly 3 populations). Appears to occur in small population numbers within KSSW. |
| *Callistemon linearifolius* | | V | - | ✓ | ✓ | ✓ | Population of around 4,800 individuals found to date, majority of which occurs in the 4(h) zone, with a substantial population also within Werakata NP. Re-sprouting / juvenile specimens difficult to ID, therefore some occurrences may in fact be other Callistemon species. |
| *Eucalyptus glaucina* | Slaty Red Gum | V | V | ✓ | ✓ | - | Red gums through the HEZ show evidence of interbreeding between *E. glaucina* and *E. tereticornis*. Currently found within 4(h) and 7(b) zones within HLRF. Ken Hill (RBG) has inspected several areas of HEZ and provided further comment on the species. Important occurrences include central conservation corridor (7(b)), the "horse paddocks" (DP1037092) and immediately north of Hebburn Dam. |
| *Eucalyptus parramattensis subsp. decadens* | Earp's Gum | V | V | ✓ | ✓ | ✓ | Population estimate of approximately 26,000 individuals in the HEZ. 160 hectares of occupied habitat within the conservation zones & 45 hectares in the development zones (including 4(h), 1(a), and 5(a)). 948 individual mature trees detailed within the 4(h) zone. |
| *Grevillea parviflora subsp. parviflora* | | V | V | ✓ | ✓ | ✓ | Relatively widespread in the HEZ (extant over 1300ha). 4(h) zone occurrence mapped within 2.25ha grids. Common in 7(b) zone, although only occurs in low densities in NP. Rhizome study has been completed – (up to 8 stems per plant, stems >1m apart). NPWS funded study into species ongoing. |
| *Rutidosis heterogama* | | V | V | ✓ | ✓ | ✓ | Recently found in HEZ. Occurs in large population numbers (>20,000 individuals). Restricted to eastern half of HEZ. Majority of population and area of occupancy (67%) is within 4(h) zone. |
| **Fauna (22 threatened species)** | | | | | | | |
| *Litoria brevipalmata* | Green-thighed Frog | V | - | ?✓ | ✓ | - | Found in creeklines within 7(b) & 4(h) zones. Habitat quality within 4(h) and Chinamans Hollow Creek (7(b)) mapped. Targeted breeding event surveys have failed to detect any further occurrences and detail specific habitat requirements. Lack of suitable summer rains has hampered efforts. |
| *Hamirostra melanosternon* | Black-breasted Buzzard | V | M | ✓ | ✓ | ✓ | Ecotone (1999) records from 8(a) & 4(h) zones. No further recent evidence found. The species has not been previously recorded within the Hunter Region (according to HBOC records) and it is considered likely that the individuals observed were either very rare vagrants or were mis-identified. |
| *Calyptorhynchus lathami* | Glossy Black-Cockatoo | V | - | ✓ | ✓ | ✓ | Several / occasional records within the HEZ including 4(h), 7(b), and Werakata NP. Most suitable habitat occurs within slopes associated with Mount Tomalpin (NP). Potential habitat (Allocasuarina sp.) in 4(h) zone mapped within 2.25ha grids (200ha containing *A. torulosa*). |
| *Climacteris picumnus victoriae* | Brown Treecreeper | V | - | ✓ | ✓ | ✓ | Relatively common resident. Main occurrences in 4(h) and eastern 7(b) zone, and several records within Werakata NP. Two breeding records (nest locations) in 4(h) zone. |
| *Pomatostomus temporalis temporalis* | Grey-crowned Babbler | V | - | ✓ | ✓ | ✓ | Relatively common resident, with at least 5 family groups recorded (up to 8 individuals per group). Cessnock LGA appears to be one of the strongholds for the species in the region. |
| *Chthonicola sagittata* | Speckled Warbler | V | - | ✓ | ✓ | - | Uncommon resident in low numbers. Records from north-west 4(h) and eastern 7(b) zones. |
| *Lathamus discolor* | Swift Parrot | E | E | ✓ | ✓ | ✓ | Occurs in HEZ during blossom of winter flowering eucalypts (migratory species from Tasmania). Majority of records in 4(h). Protection of these known sites is a DEH requirement upon HEZ. Mature tree species mapped in 4(h) and in compensatory habitat areas of 7(b). |

| Scientific Name | Common Name | TSC Status | EPBC Status | Records within HEZ | | | Recorded Occurrence within the HEZ |
|---|---|---|---|---|---|---|---|
| | | | | Dev. 4(h) | Cons. 7(b) | Cons. 8(a) | |
| *Neophema pulchella* | Turquoise Parrot | V | - | ✓ | - | - | Uncommon nomadic visitor. Only recorded in western 4(h) (Atlas records). Records span 10 years, although the species has not been recorded during any formal fauna surveys within the HEZ. |
| *Tyto novaehollandiae* | Masked Owl | V | - | ✓ | ✓ | - | Uncommon Resident. Several records within HEZ, although potential habitat present throughout. |
| *Ninox strenua* | Powerful Owl | V | - | ✓ | ✓ | ✓ | Resident with several records from 4(h), 7(b) and NP. Diurnal roosts found in dense creekline vegetation (7(b) lands). Potential habitat throughout HEZ. |
| *Tyto tenebricosa* | Sooty Owl | V | - | ? | - | - | A single Atlas record from Kurri Kurri, which is considered to be a dubious record. |
| *Melithreptus gularis gularis* | Black-chinned Honeyeater | V | - | ✓ | ✓ | ✓ | Common resident, with records of up to 6 individuals. Numerous records in 4(h), 7(b) & 8(a) zones. |
| *Xanthomyza phrygia* | Regent Honeyeater | E | E, M | ✓ | - | - | Irregular visitor, only recorded in western 4(h) (Atlas records). Most likely to occur in HEZ during blossom of winter flowering eucalypts. |
| *Phascolarctos cinereus* | Koala | V | - | ?✓ | ✓ | ✓ | Rare resident / visitor? A small population likely to be present within the wider locality. High fire frequency and feral animals is unlikely to see recovery of the population. Main feed species mapped in 4(h) zone. |
| *Petaurus australis* | Yellow-bellied Glider | V | - | ✓ | ✓ | ✓ | Uncommon Resident, recorded from 4(h), 7(b) and NP areas. Chinamans Hollow Creek (HLRF) and Mount Tomalpin appear to be key habitat areas. Potential habitat modelled on the occurrence of Grey Gums and Forest Red Gums (mainly within Hunter Lowland Redgum Forest). |
| *Petaurus norfolcensis* | Squirrel Glider | V | - | ?✓ | - | ✓ | Rare resident? Individual record from western slope of Tomalpin Hill, and further records from the immediate locality, however the 4(h) zone appears to be dominated by Sugar Gliders (HSO *pers. obs*). |
| *Falsistrellus tasmaniensis* | Eastern Falsistrelle | V | - | - | ✓ | ✓ | Several records from the HEZ, and potential habitat throughout. Tree hollow dependent species. Records based on echolocation call detection within lower elevations within the region are generally considered to be erroneous (Murray *et al* 2002). |
| *Miniopterus australis* | Little Bentwing-bat | V | - | - | - | ✓ | Uncommon resident /dispersive nomad? (single record only). Potential foraging habitat throughout HEZ. In the absence of preferred roost sites, this species may be dependant on tree hollows for roosting habitat. |
| *Miniopterus schreibersii oceanensis* | Eastern Bentwing-bat | V | - | ✓ | ✓ | ✓ | Common resident /dispersive nomad, recorded in the majority of bat surveys within the HEZ. Potential foraging habitat throughout the HEZ, although potential roost sites not determined. |
| *Mormopterus norfolkensis* | East-coast Freetail-bat | V | - | - | - | ✓ | Uncommon resident? (single record only). Tree hollow dependent species. Potential foraging and roosting habitat throughout the HEZ. |
| *Myotis adversus* | Large-footed Myotis | V | - | ?✓ | ?✓ | - | Uncommon resident in suitable habitat? (single record only from around Hebburn Dam). The preferred habitat associated with dams, larger creeklines, wetlands, and associated riparian vegetation. |
| *Scoteanax rueppellii* | Greater Broad-nosed Bat | V | - | - | ✓ | - | Uncommon resident? (single record only). Tree hollow dependent species. Potential foraging and roosting habitat throughout the HEZ. |
| **Endangered Ecological Community (2 vegetation communities)** | | | | | | | |
| Hunter Lowland Redgum Forest (HLRF) | | EEC | - | ✓ | ✓ | ✓ | Mainly restricted to Chinamans Hollow Creek (7(b)) and several of its smaller tributaries (mainly in 4(h) zone). 121ha mapped occurrence within HEZ (Bell 2004 data), which is significantly less than the 374ha previously mapped by Ecotone (2000). |
| Kurri Sand Swamp Woodland (KSSW) | | EEC | - | ✓ | ✓ | ✓ | Approximately 703ha mapped occurrence within HEZ. High variation in community throughout. (S. Bell data). Majority of occurrence in NP and 7(b) zones. |
| **Total Number of Threatened Species / Communities Recorded** | | | | **25** | **24** | **20** | In total, 28 threatened species and 2 endangered ecological communities have been recorded. |

*Notes: (V) = Vulnerable Species – refer to status under the Threatened Species Conservation Act 1995 (TSC Act) and Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)*
*(E) = Endangered Species – refer to status under the TSC Act and EPBC Act*
*(M) = Migratory Species listed under the EPBC Act (EEC) = Endangered Ecological Community – refer to status under the TSC Act and EPBC Act*

# 5 ECOLOGICAL IMPACT OF THE TOTAL LOSS OF HABITATS FROM THE 4(H) ZONE

*This chapter details the ecological implications that would result from the total clearance of the Zone 4(h) – Hunter Employment Zone (as an approach that assumes a worst-case impact scenario will be utilised by the Department of the Environment and Heritage for the HEZ assessment / approvals process).*

By assuming a worst-case impact scenario, in which the development zone is totally cleared, an assessment can be provided which details whether significant impacts are expected to threatened species, vegetation communities and other ecological attributes. Such an assessment can be utilised to provide an indication of which species / communities / ecological attributes need to be the focus of further conservation measures. This approach was deemed necessary after consultation with the Department of the Environment and Heritage (DEH). Included within this assessment are the two/three proposed Chinamans Hollow Creek road crossings through the central 7(b) conservation corridor.

In summation, significant impacts would be expected to the majority of threatened species and endangered ecological communities. There would be potential for several species / communities which are currently not threatened to be placed at risk of being threatened.

A certain amount of scientific uncertainty also exists in relation to the potential impacts associated with the reduction of the HEZ remnant, as a number of species may drop below thresholds that can sustain populations in the longer term. Nonetheless, a significant amount of known and potential habitat for threatened species / a vegetation communities has been reserved by the HEZ LEP.

It should be pointed out, however, that the total clearing of the 4(h) zone is currently not permissible under the provisions of the HEZ Local Environment Plan (LEP), objectives of the 4(h) zone, and the guidelines of the Environmental Management Strategies.

## 5.1 Threatened Flora

Of the six threatened flora species currently recorded within the HEZ, five are considered likely to be significantly impacted upon by the total clearance of the Zone 4(h) – Hunter Employment Zone (see Table 5-1).

**Table 5-1 Significance of Impacts on Threatened Flora**

| Species | Significant Impact Likely | Impact Details | Reasoning |
|---|---|---|---|
| *Acacia bynoeana* | □ | Loss of one population (unknown size). | Rare and endangered species in scattered locations and low population numbers throughout range. |
| *Callistemon linearifolius* | □ | Loss of 3640 individuals (76% of HEZ pop$^{n}$.). | Loss of majority of known HEZ population. |
| *Eucalyptus glaucina* | □(?) | Loss of most 'genetically pure' stands and over 30% of potential habitat within HEZ. | Potential loss of population(s) known to contain a greater concentration of the *E. glaucina* genotype. Edge effects on remaining habitat. Additional loss of habitat through proposed creek crossings. |
| *Eucalyptus parramattensis subsp. decadens* | □(?) | Loss of 948 individuals (approx. 4% of HEZ pop$^{n}$.) and 17ha of occupied habitat (8% of HEZ occurrence). | Majority of population within conservation zones (mainly 7(b)), however majority of the Kurri population occurs outside of reserve. |
| *Grevillea parviflora subsp. parviflora* | □(?) | Loss of 640ha of occupied habitat (48% of HEZ occurrence). | Species occurs in large population numbers within the locality. Research underway to clarify the taxonomic status of the species within the region. |
| *Rutidosis heterogama* | □ | Loss of over 235ha of occupied habitat (67% of HEZ occurrence). | Largest extent of occurrence and population size currently known within the region and potentially within the species range (S. Bell *pers. comm.*). |

## 5.2 Threatened Fauna

Of the twenty-two threatened flora species currently recorded within the HEZ, approximately ten are considered to have some realistic potential to be significantly impacted upon by the total clearance of the Zone 4(h) – Hunter Employment Zone (see Table 5-2).

A significant amount of scientific uncertainty exists about the potential impacts to threatened fauna species on the basis that how certain species will respond to a reduction of the HEZ remnant cannot be accurately quantified. A precautionary approach would infer that these impacts could be potentially significant.

**Table 5-2 Significance of Impacts on Threatened Fauna**

| Species | Significant Impact Likely | Impact Details | Reasoning |
|---|---|---|---|
| Green-thighed Frog | □ | Loss of areas of potential habitat and potential loss of population(s). | Only known occurrence on the floor of the Hunter Valley. Likely degradation of known habitat sites. |
| Black-breasted Buzzard | □ | Loss of potential habitat | Very rare vagrant. More suitable habitat widespread throughout species range. |
| Glossy Black-Cockatoo | □ | Loss of 200ha of potential habitat containing *Allocasuarina torulosa*. | More suitable habitat elsewhere within the region (such as the Watagans Range). A general paucity of large areas containing a reliable food source within HEZ. |
| Brown Treecreeper | □ | Reduction in size and distribution of an important regional population, including loss of two known breeding sites. | Eastern breeding limit on a sub-regional scale. Relatively large and significant population. Impacts from a reduction of the HEZ remnant on this species cannot be accurately quantified. |
| Grey-crowned Babbler | □ | Potential loss of at least two family groups. | Species appears to be relatively secure within the broader locality. May be able to exist within a developed landscape. |
| Speckled Warbler | □(?) | Loss of potential habitat (759ha of forested habitat). | Known individuals and habitat maintained within conservation zones. Impacts from a reduction of the HEZ remnant on this species cannot be accurately quantified. |
| Swift Parrot | □ | Loss of known and potential habitat (690ha) and 671 mature feed trees (Spotted Gum & Forest Red Gum) in a key habitat area. | Endangered species with known site fidelity. HEZ forests are considered to be of a national significance for this species. Potential for tree retention and replanting as part of the HEZ project. |
| Turquoise Parrot | □(?) | Loss of either local population and/or loss of potential habitat for nomadic birds. | Species appears only to be resident within the Hunter Region in areas west of the HEZ. |
| Masked Owl | □(?) | Loss of potential nesting habitat (533 large hollows) and hunting habitat (877ha of forested habitat and cleared ecotones). | Although not commonly recorded, the Masked Owl is widely distributed within the Hunter Region. |
| Powerful Owl | □(?) | Loss of potential nesting habitat (533 large hollows) and hunting habitat (759ha of forested habitat and 7216 tree hollows). | Species is relatively common within the region. Known roost sites within the central 7(b) corridor would also be compromised (ie. no surrounding habitat). |
| Sooty Owl | □ | Loss of non-preferred potential habitat | Species is unlikely to occur within the HEZ (dubious record). |
| Black-chinned Honeyeater | □ | Loss of potential habitat (759ha of forested habitat) and likely significant reduction in population. | Reduction in one of the species strongholds in the lower Hunter region. Impact from a reduction of the HEZ remnant on this species cannot be accurately quantified. |
| Regent Honeyeater | □(?) | Loss of known and potential habitat (690ha) and 671 mature feed trees (Spotted Gum & Forest Red Gum). | HEZ is likely to represent a significant habitat resource for this species on a regional scale, although areas around Quorrobolong appear to be more significant. |
| Koala | □ | Loss of non-preferred habitat (690ha) and potential for further reduction of any local population. | Small local population (if extant) would be likely to place at further risk of extinction. Key habitat / corridors retained through zoning configuration. More common elsewhere within the region. |
| Yellow-bellied Glider | □(?) | Reduction in size and distribution of an important regional population. Unlikely to be able to persist within central 7(b) corridor. | Main occurrence limited to around Tomalpin Hill. Impacts from a reduction of the HEZ remnant on this species cannot be accurately quantified. |
| Squirrel Glider | □(?) | Loss of potential habitat (759ha of forested habitat). | HEZ does not appear to be a stronghold for the species. Relatively widespread elsewhere throughout the Hunter region. |

| Species | Significant Impact Likely | Impact Details | Reasoning |
|---|---|---|---|
| Eastern Falsistrelle | (?) | Loss of potential roosting (7216 tree hollows) and foraging habitat (759ha). | Incremental loss of habitat within the species range, although the HEZ may be particularly important to this species if its occurrence can be confirmed. More suitable habitat in higher elevations. |
| Little Bentwing-bat | (?) | Loss of potential roosting? (7216 tree hollows) and foraging habitat (759ha). | Incremental loss of habitat within the species range. Significant amount of habitat reserved by HEZ LEP. |
| Eastern Bentwing-bat | (?) | Loss of potential foraging habitat (759ha). | Incremental loss of habitat within the species range, although roost sites unlikely to be impacted upon. Significant amount of habitat reserved by HEZ LEP. |
| East-coast Freetail-bat | (?) | Loss of potential roosting (7216 tree hollows) and foraging habitat (759ha) | Incremental loss of habitat within the species range. Significant amount of habitat reserved by HEZ LEP. |
| Large-footed Myotis | (?) | Loss of potential roosting (7216 tree hollows) and foraging habitat (759ha) | Incremental loss of habitat within the species range. Some habitat maintained within waterbodies and creeklines. Significant amount of habitat reserved by HEZ LEP. |
| Greater Broad-nosed Bat | (?) | Loss of potential roosting (7216 tree hollows) and foraging habitat (759ha) | Incremental loss of habitat within the species range. Significant amount of habitat reserved by HEZ LEP. |

## 5.3 Vegetation Communities

Significant impacts would be expected to the vegetation communities that occur within the 4(h) zone (see Table 5-3), although any determination of overall significance would need to take into consideration the areas reserved within the conservation zones of the HEZ.

**Table 5-3 Significance of Impacts on Vegetation Communities**

| Community | Significant Impact Likely | Impact Details | Reasoning |
|---|---|---|---|
| Hunter Lowland Redgum Forest | | Loss of 36ha (30% of HEZ occurrence). Total loss of 0.5% of extent of community. | Endangered Ecological Community. Highly fragmented and poorly reserved across its distribution. |
| Kurri Sand Swamp Woodland | (?) | Loss of 66ha (9% of HEZ occurrence). Total loss of 2.8% of extent of community. | Endangered Ecological Community. Majority of HEZ occurrence reserved within conservation zones. |
| Lower Hunter Spotted Gum / Ironbark Forest | (?) | Loss of 654ha (36% of HEZ occurrence). Total loss of 2% of extent of community. | Loss of restricted variants such as Yellow Bloodwood. Further justification for nomination of this community as an EEC. |

## 5.4 Other Significant Ecological Attributes

A significant reduction in the amount and availability of key habitat resources would occur, including the loss of 5222 mature trees and 2979 hollow-bearing trees containing 7216 hollows, as well as a number of other components of the HEZ ecosystem.

Rare (ROTAP listed) flora species - *Grevillea montana* and *Macrozamia flexuosa* would incur reduction in areas of occupancy of 726ha and 616ha respectively.

# 6 CONSERVATION PLANNING / FRAMEWORK FOR THE HEZ

*This chapter provides a strategic assessment of the ecological issues relating to the establishment of an effective conservation framework for the HEZ, with particular reference to Zone 4(h) – Hunter Employment Zone.*

The current zoning configuration of the HEZ was created by the HEZ LEP (Amendment No.60) in 2001, in which over 70% of the study area was reserved for conservation purposes. This rezoning was based on information gathered prior to the rezoning process, including broadscale ecological information (primarily Ecotone 1999; 2000). Since the rezoning, more intensive surveys of the site, combined with additional NSW Scientific Committee determinations, have resulted in 28 threatened species and 2 endangered ecological communities being recorded within the HEZ study area to date.

The information collated shows that the HEZ study area is one of the most ecologically significant parcels of remnant bushland on the floor of the Hunter Valley. It contains significant occurrences of threatened / rare species and vegetation communities that are poorly conserved elsewhere, and provides an integral component of a regional corridor linking sizeable areas of bushland within the Cessnock LGA south to the Watagan Range (Bell & Murray 2001).

In light of this significance and the additional threatened species matters, how the current HEZ zoning layout conserves these attributes needs to be reviewed. The purpose of this review is to detail how an adequate conservation outcome can be achieved for all the identified significant ecological attributes in conjunction with the development of the HEZ industrial estate. This approach, in which both environmental and development considerations are incorporated into the overall decision making process is one of the key principles of Ecologically Sustainable Development (ESD). It will also play an important role in fulfilling Cessnock City Council's objectives of the Zone No. 4(h) – Hunter Employment Zone (see Section 1.2) and allow for a more streamlined environmental approvals process for development within the HEZ.

This approach was also deemed necessary, as there has been no previous strategic assessment that identifies which areas of the 4(h) development zone are of a high conservation value and there has been no previous discussion into what would be an acceptable and effective reserve system to fulfil the objectives of the zone. Whilst habitat conservation within the development zone is dealt with in Schedule 2 of the Habitat Management Strategy (Ecotone 2002), no strategic assessment was undertaken. Without a strategic assessment, habitat conservation within the development zone would be only dealt with following development approval (as specified by Schedule 2), and would run the risk of being undertaken in an ad-hoc manner without due consideration into the effective conservation of a number of threatened species, vegetation communities and biodiversity in general.

## 6.1 Factors for Consideration

The development of the conservation framework for the HEZ was based on a strategic assessment of the following factors:

- Occurrence, distribution, and significance of threatened species population(s) and endangered ecological communities;
- General principles of habitat conservation, wildlife corridors, and habitat linkages (e.g. minimizing edge and fragmentation effects);
- Parameters required for the protection and management of threatened species / communities;
- Consideration of site-specific issues (e.g. the zoning configuration) and other 'non-ecological' constraints (e.g. under-mining / archaeological issues); and
- Parameters required for the development of a large-scale industrial estate.

This strategic assessment can also be placed as a series of questions:

- Are the threatened species, endangered ecological communities, and other significant ecological attributes that have been recorded within the HEZ study area adequately reserved by the current zoning configuration?
- What are the scientifically recognized principles of habitat conservation and wildlife corridor design that need to be taken into consideration?
- What are the important features and requirements that need to be taken into consideration for the protection and management of these species / communities?
- What are the other non-ecological site-specific constraints and issues that can be incorporated into a conservation framework, and how do they affect land-use configuration within the development zone?
- What are the logistical requirements that need to be taken into consideration for the development of a large-scale industrial estate, and how do they impact upon habitat conservation measures?

An additional conservation framework that significantly strengthens the existing conservation framework, as set out in the LEP, can be achieved by the due consideration and implementation of the above mentioned factors.

### 6.1.1 Threatened Species and Endangered Ecological Communities

The occurrence, distribution, and significance of the 28 threatened species and 2 endangered ecological communities recorded on the site are summarised in Chapters 4 and 5, and further detailed information is provided in Appendix A. The information collated to date can be summarised into the following key points:

- Adequate conservation outcomes appear to have been achieved for the majority of 28 threatened species and one of the endangered ecological communities (Kurri Sand Swamp Woodland);

- Adequate conservation outcomes cannot be conclusively demonstrated for several species and/or these species have been found to maintain significant populations / occurrences within the 4(h) development zone (these have been previously detailed in Table 4-1 and Chapter 5). The species / communities of most potential concern in this regard include:

  Threatened Flora
  - *Acacia bynoeana*
  - *Callistemon linearifolius*
  - *Eucalyptus glaucina*
  - *Rutidosis heterogama*

  Threatened Fauna
  - Green-thighed Frog
  - Swift Parrot
  - Brown Treecreeper

  Endangered Ecological Communities
  - Hunter Lowland Redgum Forest

  (For several species, particularly *Eucalyptus glaucina* and the Green-thighed Frog, and Hunter Lowland Redgum Forest, a significant amount of potential habitat is reserved within the central 7(b) conservation corridor along Chinamans Hollow Creek).

- A number of other threatened species may be significantly impacted upon in the 'worst-case scenario' involving the total clearance of the 4(h) development zone (see Chapter 5), however this is considered unlikely to occur as it would not be consistent with a number of state and local planning instruments.

- The two eucalypt taxa (*Eucalyptus* sp aff *agglomerata* & *Eucalyptus* sp aff *camfieldii*) that possibly represent new species, whilst not currently recognised as rare or threatened, remain of some significance until further information is collected. Nonetheless, both species have been found to occur within the conservation zones of the HEZ.

- A number of other threatened species, whilst considered to have an adequate reservation within the conservation zones, would also benefit from additional conservation and/or protection measures. Such species include (but not restricted to):

  Flora
  - *Eucalyptus parramattensis* ssp. *decadens*, and *Grevillea parviflora* ssp. *parviflora.*

  Fauna
  -Yellow-bellied Glider, Regent Honeyeater, Black-chinned Honeyeater, Grey-crowned Babbler and Powerful Owl.

- A number of potentially occurring threatened species such as *Cryptostylis hunteriana*, *Tetratheca juncea*, Grey-headed Flying-fox, and Spotted-tailed Quoll have habitats which are widely represented in the conservation zones of the HEZ.

### *6.1.2 Habitat Conservation and Wildlife Corridor Design*

An assessment of the issues relating to habitat conservation and wildlife corridor design within HEZ indicates:

**Current Zoning Configuration**

- The overall zoning layout in which large continuous areas of reserved habitats (7(b) and 8(a) zones) are maintained provides for an effective reservation design (rather than these areas being fragmented or smaller). This is particularly important, as the diversity of threatened species recorded within the HEZ is likely to be due in part to the relatively large size of the remnant.

- The current zoning configuration provides adequate conservation outcomes for the majority of the threatened species issues (as previously stated in Section 6.1.1), as well as those that have the potential to occur.

- The 7(b) environmental protection (conservation) zone has been shown to be of a comparatively high ecological significance in relation to the current zoning configuration, for a variety of threatened flora and fauna species as well as the high diversity of significant vegetation community types. Some of the 7(b) zoning permissibility's (such as the ability to subdivide along boundaries) has the potential to impact upon these ecological attributes in the medium to long term, if these areas are developed.

  Given the fact that the 7(b) lands are essential for maintaining conservation outcomes within the HEZ study area, investigations are currently underway by HEZ Pty Ltd and Cessnock City Council to have the building entitlements removed from the 7(b) lands within HEZ, and to commit land owners (HEZ Pty Ltd, Mindaribba Local Aboriginal Land Council, and the NSW Crown) to the conservation of these areas in perpetuity (Matthew Somers *pers.comm.*).

- Areas of Zone 1(a) have been shown to be of some conservation value as they contain threatened species such as *Eucalyptus glaucina*, *Eucalyptus parramattensis* ssp. *decadens* and Kurri Sand Swamp Woodland (approximately 2% of total distribution).

**Zone 4(h) - Hunter Employment Zone**

- Whilst some form of habitat conservation and the establishment of wildlife corridors is required to fulfil Cessnock City Council's objectives of the zone and to assist in the adequate conservation of several threatened flora and fauna species, the issue is complicated by the fact that the development of the site will be user driven and no pre-emptive subdivision is permitted under the LEP (with the exception of a broad-scale generic 'masterplan' concept).

- Any establishment of pre-determined wildlife corridors / conservation areas may limit the types of development seeking to locate to the site. For example, users seeking development footprints of 50-100 hectares have approached HEZ Pty Ltd (Matthew Somers *pers. comm.*). Such types of development are unlikely to be sited within the HEZ without impacting upon ecologically significant areas and/or threatened species habitats. Nonetheless, ecological impacts can be minimised through appropriate development sequencing, siting of development footprints away from ecologically sensitive / significant areas (where possible), and by the implementation of the relevant schedules of the Habitat Management Strategy.

- Relatively large areas of the 4(h) zone occur as Lower Hunter Spotted Gum – Ironbark Forest (654ha) and are dominated by Broad-leaved Ironbark (*Eucalyptus fibrosa*). This species was the most commonly recorded mature tree species and is one of the least valuable species for threatened fauna (eg. mature trees were found to contain few hollows). As such, these areas along with other cleared / disturbed sites offer preferred development potential from an ecological perspective.

- Broad-scale clearing / industrial development within the 4(h) zone is likely to:
  - lead to the long-term decrease in a number of species, including potential loss of several species from the locality;
  - place species / communities which are currently not threatened at risk of being threatened, including *Grevillea montana*, *Macrozamia flexuosa*, and Lower Hunter Spotted Gum – Ironbark Forest (2.4% of total distribution within Zone 4(h)); and
  - place additional pressures on bordering conservation zone(s).

- The 4(h) Hunter Employment Zone has been shown to be of a higher conservation value than previously indicated by Ecotone (2000).

- Development along the boundaries of conservation zone(s) is likely to have impacts that extend into the adjoining conservation zones (ie. edge effects). As such, habitats bordering existing conservation zones may play an important role in buffering the impacts of development on the adjoining conservation zones.

**Central Zone 7(b) Conservation Corridor**

- The central 7(b) environmental protection (conservation) zone along Chinamans Hollow Creek leading to Hebburn Dam provides for a key wildlife corridor through the development zone and is important for the protection of the Hunter Lowland Redgum Forest community and several threatened species. It also provides the basis from which additional conservation outcomes could be achieved and in the establishment of wildlife corridors through the development zone.

- Despite this significance, the central 7(b) conservation corridor is generally against the principles of effective reserve design (eg. see Primack 1993). This is due to the fact that it has a high edge to area ratio (ie. it is long (2.75 kilometres) and relatively narrow (175-200 metres)), and is only connected at one point to the core conservation zones of the HEZ study area where it unfavorably forms a 'bottle-neck' (currently being vegetated for less than 100 metres wide due to previous land-use activities) and where it will also be traversed by the main arterial road route into the HEZ.

  At the road crossing, terrestrial and arboreal fauna will need to be diverted through a fauna underpass (currently being designed by engineers from Parsons Brinckerhoff in consultation with ecologists from Harper Somers O'Sullivan) and potential overpasses (intact canopy cover / additional tree plantings). Nonetheless, this may prove to be a significant barrier for a number of species.

- At least one (potentially two) other road crossing(s) of the 7(b) zone are currently proposed to service the estate. The additional road crossings have been located on ecological advise, and are currently proposed to be situated along existing powerline easements and tracks. Nonetheless, it is considered likely that they will further impact upon the viability of the corridor.

- In the event of broad-scale development of the 4(h) zone, the central 7(b) conservation corridor alone is unlikely to be able to sustain population(s) of a number of the threatened species that have been recorded along its length, including the Green-thighed Frog, Yellow-bellied Glider and Powerful Owl. To be effective, this area must remain viably connected to conserved lands to the south.

- The current zoning boundaries of the corridor do not accurately reflect the location of Chinamans Hollow Creek and in several sections the creekline comes to within 40 metres of the zone boundary.

Investigations are currently underway into adjusting the zoning confriguration of the corridor to adequately buffer the creekline.

- Proposed additional infrastructure crossings may also impact upon the viability of the corridor to function as both a wildlife corridor and a core conservation area.

**Habitat Quality and Availability**

- The density and distribution of critical habitat resources (such as hollow-bearing trees) combined with the high degradation regimes (such as fire frequency and feral animals) are likely to be the greatest limiting factors to the size and distribution of fauna populations.

- The areas of highest quality habitat, particularly the relatively intact open forest communities that contain higher densities of mature and hollow bearing trees would be more likely to support viable populations of a number of threatened fauna species including Yellow-bellied Glider, Squirrel Glider and Powerful Owl.

- A management regime that protects the areas of highest habitat quality rather than protecting small areas where particular threatened species have been recorded is likely to more adequately protect the biodiversity of the HEZ.

- Degradation regimes including the high fire frequency, firewood collection, rubbish dumping, feral animals and other anthropogenic influences have significantly impacted upon the ecological attributes of the HEZ study area in a number of areas including conservation zone(s).

**Habitat Management Strategy (HMS)**

- As the primary ecological guiding document for development within the HEZ, the draft HMS has been shown to be inadequate in a number of areas and would be unlikely to fulfil some of its specified objectives. The information presented within this ECMP report should be incorporated into future versions of the HMS and thereby, in part, assist in the fulfilment of these objectives.

- Habitat conservation measures detailed in the HMS such as the installation of nest boxes in retained habitats may prove to be a valuable resource for hollow dependent fauna.

**'HEZ Link Road' Study Area**

- As part of the development of the HEZ estate, a link road that connects Leggetts Drive (MR 195) to John Renshaw Drive is proposed to be constructed (DA lodgement pending). The link road dissects a 489 hectare patch of bushland that contains the largest remnant patch of Kurri Sand Swamp Woodland and has been shown to be of a high conservation value for a number of threatened species (HSO 2003). Recommendations were made within HSO (2003) to revert the current zoning of the land from Zone 1(a) to a conservation zoning (Zone 7(b)). In light of this recommendation and to further strengthen conservation outcomes in the locality, investigations are currently underway by HEZ Pty Ltd and Cessnock City Council to have areas of vacant crown land within the Link Road study area (approx. 370ha) reverted to a 7(b) zoning (Matthew Somers *pers.comm.*). Such an action would substantially increase conservation outcomes within the locality for Kurri Sand Swamp Woodland, and threatened species such as *Acacia bynoeana* (potential habitat present), *Eucalyptus parramattensis* ssp. *decadens* (large population present), *Grevillea parviflora* ssp. *parviflora*, Speckled Warbler, and Squirrel Glider (population(s) present).

## 6.2 Key features for inclusion into an Additional Conservation Framework

Based on a consideration of the relevant factors discussed in Section 6.1, the following points represent the key features that should be sought for inclusion into a habitat conservation framework within the 4(h) development zone:

- Significant habitats bordering existing conservation zones (site development away from conservation zones where possible (ie. utilise these areas for buffer lands, landscaping, etc));

- Areas of high habitat quality and diversity (as defined by collected variables such as density of mature and hollowing bearing trees, levels of disturbance, etc.);

- Significant occurrences of threatened species including:

  - *Acacia bynoeana*, *Callistemon linearifolius*, and *Rutidosis heterogama* (which require conservation of actual occurrence).

  - Swift Parrot and Regent Honeyeater (which require the protection of the Swift Parrot Habitat Sites as part of the Condition of Approval for the HEZ Spine Road EPBC2002/782 and conservation of mature winter-flowering eucalypts).

  - Green-thighed Frog (which requires conservation of creeklines and riparian habitats).

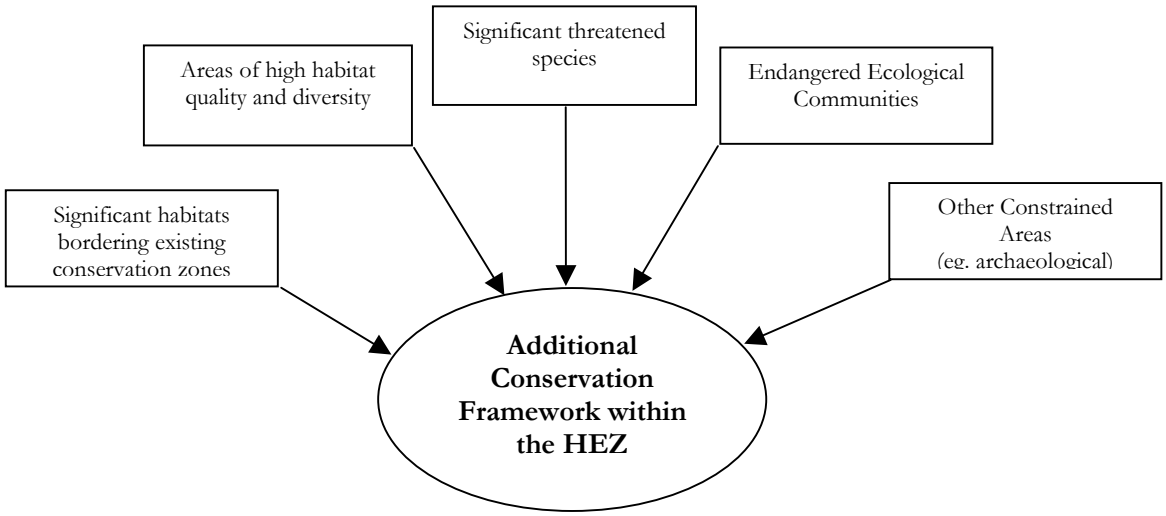
  Conservation of these species habitats will inadvertently assist to conserve a number of other threatened species including Brown Treecreeper and Powerful Owl.

- Endangered ecological communities including Hunter Lowland Redgum Forest. Conservation of these communities will inadvertently conserve habitat for a number of threatened species including *Eucalyptus glaucina*, Green-thighed Frog and the Yellow-bellied Glider; and

- Significant archaeological sites located along the western boundary of the central conservation corridor along Chinamans Hollow Creek (currently under investigation by Neville Baker, ERM). To be assessed for inclusion into potential conservation framework.

These features are also graphically presented in Figure 6-1.

**Figure 6-1 Key Features for Inclusion into an Additional Conservation Framework**




By the consideration of the above-mentioned features / constraints, an appropriate development sequencing regime should be established that:

1. Attempts to avoid ecologically significant areas where possible by the siting of development in least ecologically constrained areas first;

2. Attempts to retain ecologically significant areas within development buffer lands and landscaped areas; and is

3. Flexible enough to be user driven and allow large-scale users / development footprints to occur within the site.

Following the consideration of the features shown in Figure 6-1, a number of potential conservation frameworks for the development zone have been developed and these are shown in Figure 6-2. Each of the potential frameworks has a number of positives and negative outcomes associated with them, relating to achieved conservation and economic outcomes.

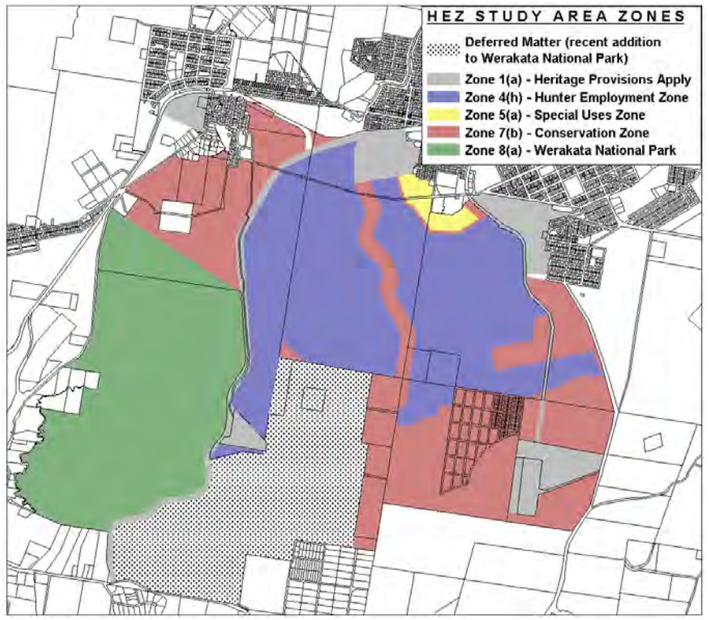
Of the options shown, Options 3-4 are potentially the most realistically favourable from an ecological perspective, as they allow for the conservation of several key threatened species, increase the viability of the adjoining conservation zones, and provide clear building envelopes for the HEZ estate. However, adoption of conservation scenarios such as these will incur impacts on the social and economic benefits derived from development of the HEZ. Social and economic benefits flowing into local communities this is one of the primary goals of the HEZ project.

**Figure 6-2 Potential Additional Conservation Frameworks for the HEZ**

## OPTION 1 - NO ADDITIONAL CONSERVATION FRAMEWORK (Current zoning)

**Positives**
- Maximum developable area
- Significant economic and social benefits
- Conservation outcomes achieved for the majority of threatened species and vegetation communities

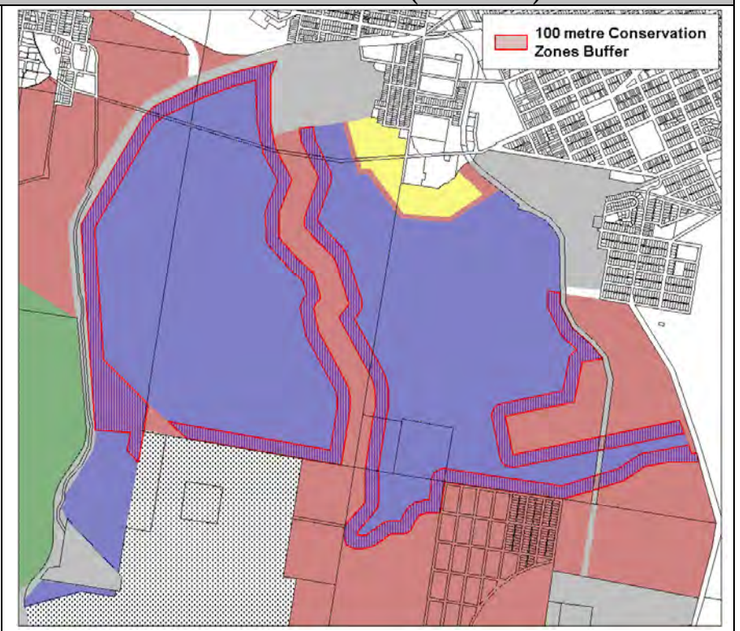
**Negatives**
- Significant ecological impacts
- A number of threatened species / vegetation communities not adequately conserved
- Not consistent with some of the objectives of the 4(h) zone, the Environmental Management Strategies, and DEH requirements
- Potential for ad-hoc retention of habitats within development zone




## OPTION 3 - BUFFERING CONSERVATION ZONES FRAMEWORK (100 metres)

**Positives**
- Increased conservation outcomes of several key threatened species including Callistemon linearifolius, Eucalyptus glaucina, Green-thighed Frog and the Hunter Lowland Redgum Forest
- Buffering of the impacts of development onto the adjoining conservation zone(s).
- Substantially increases the viability of the central 7(b) conservation corridor
- Large central areas allowing development and associated significant economic and social benefits

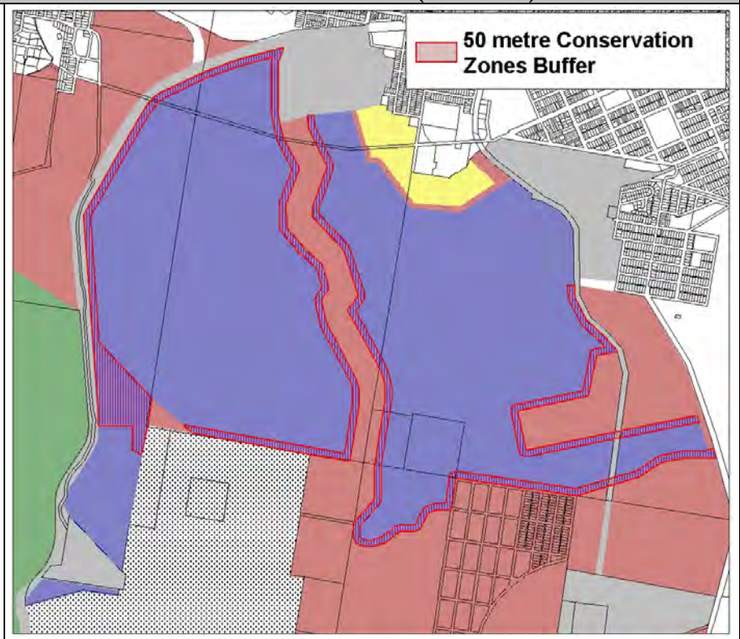
**Negatives**
- Reduction in potential developable area by 190 hectares
- Remaining potential for significant ecological impacts in several key habitat areas
- Already impacted upon by the HEZ Spine Road
- May not be consistent with some of the objectives of the 4(h) zone and the Environmental Management Strategies, in particular the Habitat Management Strategy.




## OPTION 2 - BUFFERING CONSERVATION ZONES FRAMEWORK (50 metres)

**Positives**
- Some increased conservation outcomes of several key threatened species including Callistemon linearifolius, Eucalyptus glaucina, Green-thighed Frog and the Hunter Lowland Redgum Forest
- Buffering of the impacts of development onto the adjoining conservation zone(s).
- Some increase in the viability of the central 7(b) conservation corridor
- Large central areas allowing development and associated significant economic and social benefits

**Negatives**
- Reduction in potential developable area by 105 hectares
- Remaining potential for significant ecological impacts in key habitat areas
- Already impacted upon by the HEZ Spine Road
- May not be consistent with some of the objectives of the 4(h) zone and the Environmental Management Strategies, in particular the Habitat Management Strategy.




## OPTION 4 – SELECT KEY CONSERVATION AREAS

**Positives**
- Increased conservation outcomes of several key threatened species including Acacia bynoeana, Green-thighed Frog and the Hunter Lowland Redgum Forest
- Conservation of select areas of high quality habitat
- Large central areas allowing development and associated significant economic and social benefits

**Negatives**
- Reduction in potential developable area by approximately 90 hectares
- Some remaining potential for significant ecological impacts
- Some key threatened species not adequately conserved

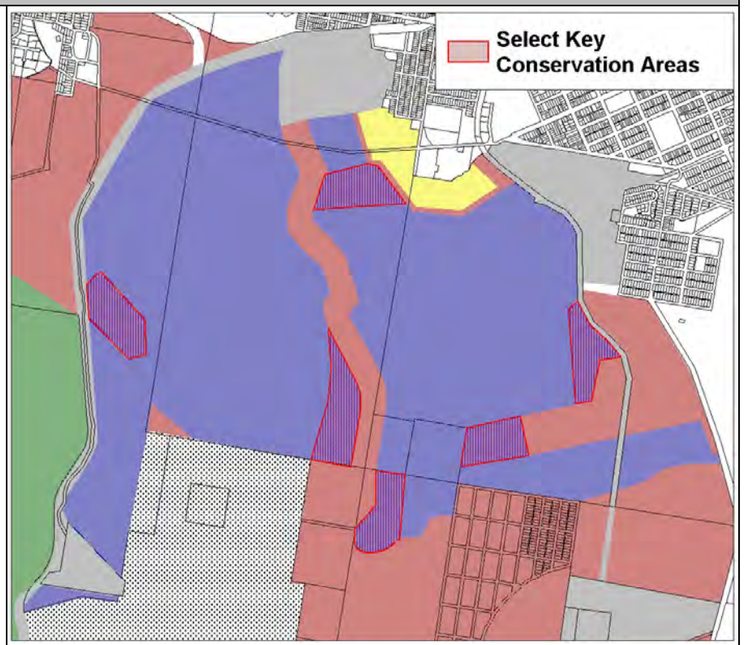


**Figure 5-2 Continued**

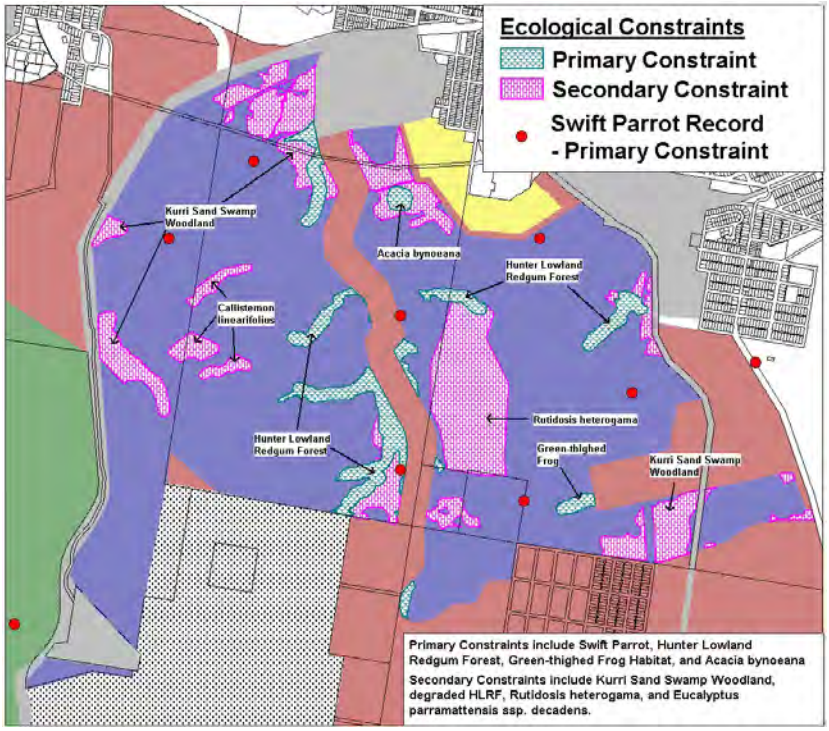
## OPTION 5 – CONSERVATION OF KEY THREATENED SPECIES / COMMUNITIES

**Positives**

- Adequate conservation outcomes of the majority of key threatened species including Acacia bynoeana, Callistemon linearifolius, Eucalyptus glaucina, Eucalyptus parramattensis ssp. decadens, Swift Parrot, Green-thighed Frog and the Hunter Lowland Redgum Forest
- Potential for some forms of development within secondary constrained areas
- Increases the viability of the central 7(b) conservation corridor

**Negatives**

- Reduction in potential developable area by approximately 175 hectares
- No clear building envelopes for large-scale industrial development and logistics of developing the estate likely to be difficult
- Not based on establishment of wildlife corridors and areas of high quality habitat. Ad-hoc conservation in some areas.



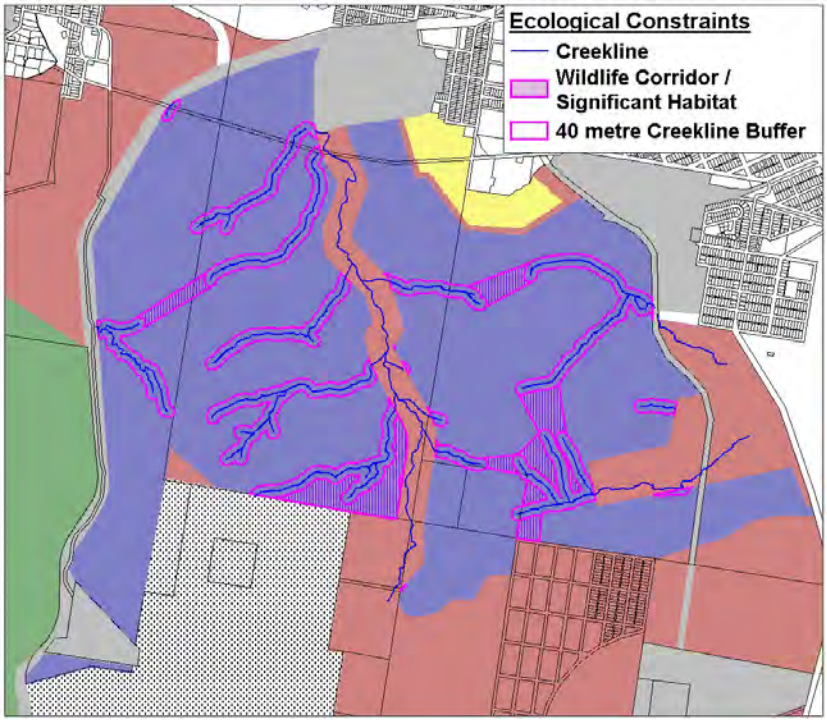

## OPTION 6 – CONSERVATION OF CREEKLINES, WILDLIFE CORRIDORS & SOME SIGNIFICANT HABITAT

**Positives**

- Increased conservation outcomes of several key threatened species including Callistemon linearifolius, Eucalyptus glaucina, Green-thighed Frog and the Hunter Lowland Redgum Forest
- Potential for some forms of development within constrained areas / wildlife corridors
- Increases the viability of habitats within the 4(h) zone and the central 7(b) conservation

**Negatives**

- Reduction in potential developable area by approximately 155 hectares
- No clear building envelopes for large-scale industrial development
- Logistics of developing the estate difficult
- High edge to area ratio along corridors (viability and management difficulties)
- Some threatened species not adequately conserved



# 7 CONCLUSION & OUTCOMES

*This chapter details the key outcomes of the report and showcases a potential 'way forward' for the resolution of the ecological issues relating to the development of the Hunter Economic Zone industrial estate.*

The intended purpose of this initial draft (February 2004) of the ECMP report is to enable strategic decisions to be made at a local, state, and commonwealth government level which take into consideration the economic, social, and environmental benefits of the HEZ estate. Key outcomes and a potential way forward detailed therein include:

- Detailed ecological investigations have been undertaken within the HEZ study area and the extent of the current knowledge of the ecological attributes of the HEZ has been provided;

- The results of the collated data have been interpreted with consideration to the principles of Ecologically Sustainable Development (in which both environmental and development considerations were incorporated into the decision making process) and of the objectives of the Zone 4(h) – Hunter Employment Zone;

- With these principles in mind, several potential conservation framework(s) for the development zone has been formulated (see Figure 6-2). A framework resembling Option 3 or 4 is potentially the most favourable from an ecological perspective, whilst Option 1 is that favoured from a development perspective;

- A development sequencing regime has been proposed that:
  - Attempts to avoid ecologically significant areas where possible by the siting of development in least ecologically constrained areas first;
  - Attempts to retain ecologically significant areas within development buffer lands and landscaped areas;
  - Flexible enough to be user driven and allow large-scale users / development footprints to occur within the site.

- Impacts resulting from the total clearance of the 4(h) zone have been detailed, as an approach that assumes a worst-case impact scenario will be utilised by the Department of the Environment and Heritage for the HEZ assessment and approvals process;

- The data has been presented in a format that can be readily utilised for the conduct of threatened species assessments including Eight-Part Tests (under the provisions of the *Environmental Planning and Assessment Act 1979*) and referrals under the *Environment Protection and Biodiversity Conservation Act 1999*;

- Development that occurs in accordance with the conservation framework (when finalised through this consultative process), or will not significantly impact upon the conservation zones, should have a streamlined state and commonwealth environmental approvals process, and thereby provide a greater level of security to development within the estate;

- Further surveys and research will be undertaken on the additional outstanding threatened species matters. Additional input will be required from the National Herbarium of New South Wales to resolve the undescribed eucalypt taxa;

- Whilst not showcased in this current report, a number of GIS modelling tools have been developed and these can be incorporated into future versions of the ECMP (eg. to provide analysis of the consequences of differing development / conservation scenarios) and in the Development Application (DA) approvals process (eg. automated impact assessment reports);

- Investigations are currently underway by HEZ in consultation with HSO into the potential for adjusting the rezoning configuration within the development zone, such as central 7(b) conservation corridor along Chinamans Hollow Creek to be more inline with the ecological constraints;

- Detailed ecological data has been provided that can be incorporated into the Habitat Management Strategy and assist the fulfilment of the objectives of the Zone 4(h) – Hunter Employment Zone;

- When core conservation areas have been agreed upon, further information / recommendations will be provided to ensure that these areas are adequately protected and managed to ensure their integrity and compatible co-existence with surrounding large-scale industrial development; and in conclusion

- Input is sought from government departments on the suitability of the content of the report and in the formulation of an adequate conservation framework for the HEZ.

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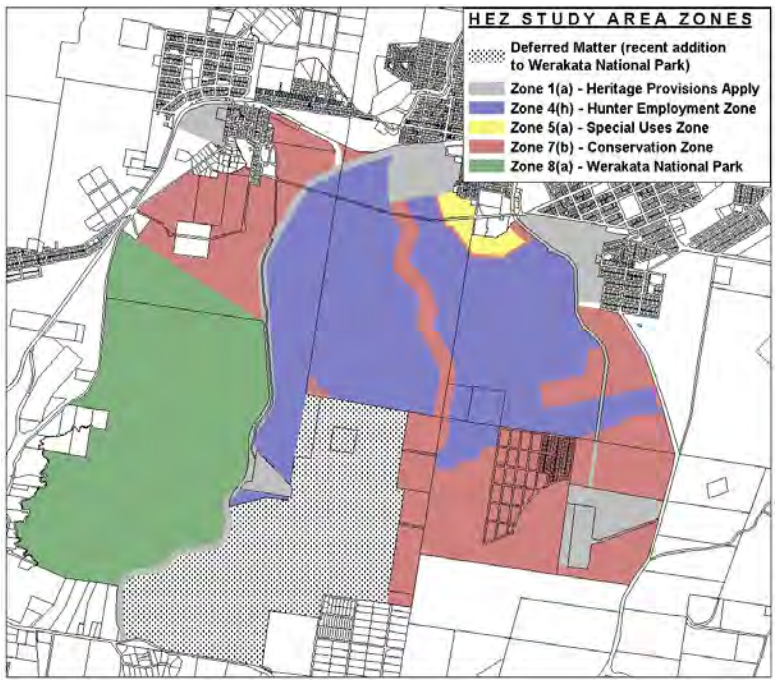
# APPENDIX A: THREATENED SPECIES HABITAT PROFILES AND DISTRIBUTION WITHIN THE HEZ

# Threatened Species Profiles:

| | |
|---|---|
| *Acacia bynoeana* | |
| *Callistemon linearifolius* | |
| *Eucalyptus glaucina* | |
| *Eucalyptus parramattensis* subsp. *decadens* | |
| *Grevillea parviflora* subsp. *parviflora* | |
| *Rutidosis heterogama* | |
| *Litoria brevipalmata* | Green-thighed Frog |
| *Hamirostra melanosternon* | Black-breasted Buzzard |
| *Calyptorhynchus lathami* | Glossy Black-Cockatoo |
| *Climacteris picumnus victoriae* | Brown Treecreeper |
| *Pomatostomus temporalis temporalis* | Grey-crowned Babbler |
| *Chthonicola sagittata* | Speckled Warbler |
| *Lathamus discolor* | Swift Parrot |
| *Neophema pulchella* | Turquoise Parrot |
| *Tyto novaehollandiae* | Masked Owl |
| *Tyto tenebricosa* | Sooty Owl |
| *Ninox strenua* | Powerful Owl |
| *Xanthomyza phrygia* | Regent Honeyeater |
| *Melithreptus gularis gularis* | Black-chinned Honeyeater |
| *Phascolarctos cinereus* | Koala |
| *Petaurus australis* | Yellow-bellied Glider |
| *Petaurus norfolcensis* | Squirrel Glider |
| *Falsistrellus tasmaniensis* | Eastern Falsistrelle |
| *Miniopterus australis* | Little Bentwing-bat |
| *Miniopterus schreibersii* | Eastern Bentwing-bat |
| *Mormopterus norfolkensis* | East-coast Freetail-bat |
| *Scoteanax rueppellii* | Greater Broad-nosed Bat |
| *Myotis adversus* | Large-footed Myotis |

**Reference Figure: HEZ Zoning Boundaries**



# *Acacia bynoeana*
# Bynoe's Wattle

**Status**: Endangered (TSC Act 1995)
Vulnerable (EPBC Act 1999)

Extracted from Bell (2004): During surveys for the present study four new populations of the endangered *Acacia bynoeana* were discovered, confirming recent records of the species for the Cessnock area. Importantly, the populations at the HEZ appear to be quite sizeable, with rough estimates (based on previously reported densities; see Bell & Driscoll 2002; Bell & Driscoll in review) of more than 3000 plants. The determination of *Acacia bynoeana* as an endangered species under the TSC Act 1995 states that most populations comprise 1-5 individuals, with perhaps 300-500 plants within the State. However, these estimates are almost certainly not based on field assessment, as recent studies have confirmed that most populations in the northern parts of the known range comprise at least 200 plants, occasionally up to 2000 plants (Bell & Driscoll in review). While detailed counts of the Cessnock populations have yet to be done, it is likely that similar trends will be apparent.

Of further interest in regard to the HEZ populations is the presence of *Acacia bynoeana* in previously undocumented habitat. A regional analysis of all known populations of this species is currently underway, with the aim of identifying suitable habitat for potential new populations in the wider region (Bell & Driscoll in prog.). The recent finds in vegetation broadly defined as Kurri Sands Swamp Woodland infers that considerable areas of potential habitat exist in the wider Cessnock area.

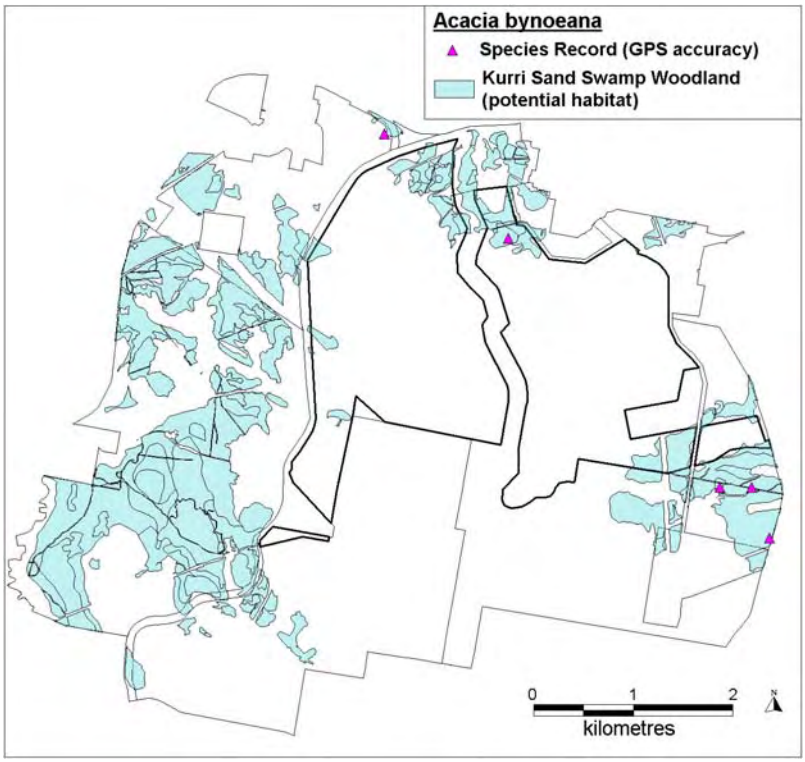
**Notes:** Further surveys to estimate population sizes within the HEZ are required, and elsewhere within the Cessnock LGA.

## Distribution and Mapping

**Survey Methods:**
- Targeted surveys by Bell (2004) across select areas of the study area (see Appendix B);
- HSO detailed 4(h) development zone surveys (see Section 2.4);
- HSO Conservation Zone transects (see Section 2.5.1).

**Modelling (variables)**: Potential habitat based on extent of Kurri Sand Swamp Woodland.

**Map:**




**Records / Population within the HEZ**: 4 populations

Development Zone 4(h): 1 population (unknown size)
Conservation Zone 7(b): 3 populations (unknown size)
National Park Zone 8(a): -
Other Zones (1(a) & 5(a)): -

# *Callistemon linearifolius*

**Status**: Vulnerable (TSC Act 1995)

Extracted from Bell (2004): Spencer & Lumley (2002) indicate that *Callistemon linearifolius* occurs in dry sclerophyll forest on the coast and adjacent ranges chiefly from the Georges River to the Hawkesbury River on the Central Coast. It is a large shrub 3-4m in height with linear to linear-lanceolate leaves and bearing red flowers during Spring and Summer. This species is currently listed as Vulnerable (Schedule 2) on the NSW *Threatened Species Conservation Act 1995*, and carries a conservation risk code of 2RCi (Briggs & Leigh 1996).

Binns (1996) and Bell (2001a) had previously recorded *Callistemon linearifolius* from several locations in Aberdare State Forest/ Werakata NP. During the current survey, this species was recorded in several new locations, mostly within the understorey of Lower Hunter Spotted Gum-Ironbark Forest. Both existing and new records of *Callistemon linearifolius* confirm that this species occurs within the North Coast botanical subdivision.

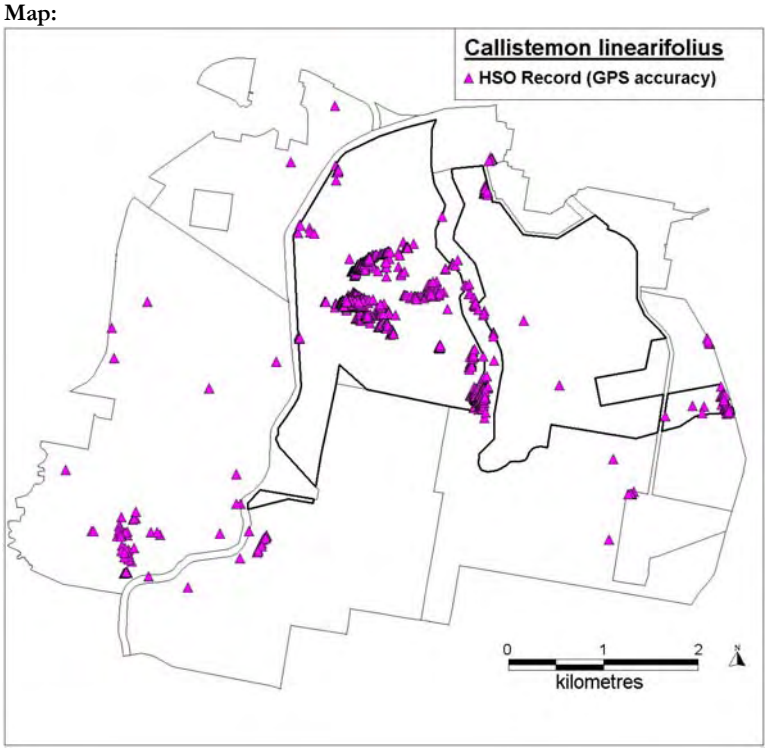
**Notes**:
- Identification of juveniles problematic, and some records may be in fact actually be *C. rigidus* or *C. linearis*.
- Further individuals / populations likely to occur, especially within the Werakata National Park section of the HEZ (recently burnt).

## Distribution and Mapping

**Survey Methods:**
- General surveys by Bell (2004) across select areas of the study area (see Appendix B);
- HSO detailed 4(h) development zone surveys ie. located every individual (see Section 2.4);
- HSO Conservation Zone transects and additional targeted surveys (see Section 2.5.1).

**Modelling (variables)**: None

**Map:**




**Records / Population within the HEZ**: 4805 individuals

Development Zone 4(h): 3640 individuals (76%)
Conservation Zone 7(b): 487 individuals (10%)
National Park Zone 8(a): 627 individuals (13%)
Other Zones (1(a) & 5(a)): 51 individuals (1%)

# *Eucalyptus glaucina*
# Slaty Red Gum

**Status**: Vulnerable (TSC Act 1995)
Vulnerable (EPBC Act 1999)

Extracted from Bell (2004): Hill (2002) describes *Eucalyptus glaucina* as a tree to 30 m in height, locally frequent but sporadic in grassy woodland on deep moderately fertile and well-watered soils near Casino and from Taree to Broke. This species is currently listed as Vulnerable (Schedule 2) on the NSW *Threatened Species Conservation Act 1995*, and is also listed as 3VCa by Briggs & Leigh (1996). Populations of *Eucalyptus glaucina* are known from Selection Flat Flora Reserve on the NSW North Coast, where presumably more than 1000 individuals occur (Briggs & Leigh 1996), and also in part of Werakata National Park (Bell 2001a). In his survey of State Forests, Binns (1996) did not record *Eucalyptus glaucina* from anywhere within the Morisset forestry district, but suggested that if it did occur it would most likely be on the lower slopes or valley flats of Pokolbin State Forest.

Scattered individuals of *Eucalyptus glaucina* were recorded south of Kurri hospital, around Hebburn Dam, and near the "horse paddock" (DP1037092), where it occurs in Hunter Lowland Redgum Forest with *Eucalyptus tereticornis, Eucalyptus amplifolia* subsp. *amplifolia* and occasionally *Angophora floribunda*. As with most other occurrences of this species in the Hunter Valley, most sites have been grazed in the past, leaving an open grassy understorey with only scattered shrubs. In a visit to the site, Ken Hill (National Herbarium of NSW) confirmed the identifications and indicated that there is a considerable amount of hybridisation occurring with *Eucalyptus tereticornis*, and that it would be a very difficult task to provide accurate population counts of the species without examining every tree, supported by genetic studies. Preservation of the species in this area would best be achieved through protection of the Hunter Lowland Redgum Forest in which it occurs.

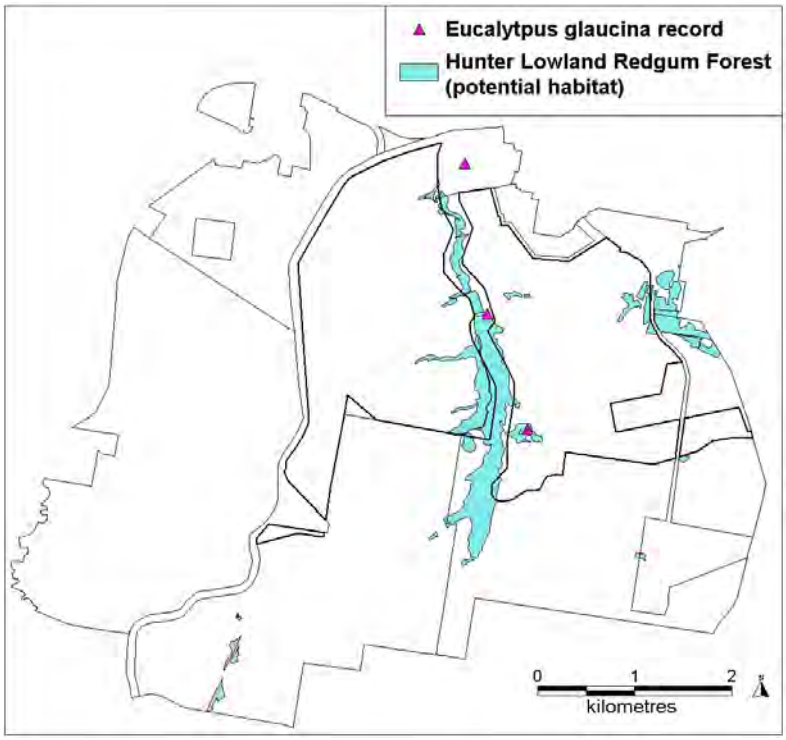
**Notes**:
- Hybridisation occurring with *Eucalyptus tereticornis;*
- Occurs outside of Hunter Lowland Redgum Forest in several areas, such as immediately east of Hebburn Dam (Zone 1(a))
- very difficult task to provide accurate population counts of the species without examining every tree, supported by genetic studies.

## Distribution and Mapping

**Survey Methods:**
- Targeted surveys by Bell (2004) across select areas of the study area (see Appendix B);
- Specialist input from Ken Hill, National Herbarium of NSW (see Section 2.5.4);
- HSO Conservation Zone transects (see Section 2.5.1).

**Modelling (variables)**: Potential habitat based on extent of Hunter Lowland Redgum Forest.

**Map:**




**Records / Population within the HEZ**: In a least three distinct areas. Potential habitat over 121 hectares.

Development Zone 4(h): one occurrence (30% potential habitat)
Conservation Zone 7(b): several occurrences (59% potential habitat)
National Park Zone 8(a): ? (3% potential habitat)
Other Zones (1(a) & 5(a)): one occurrence (8% potential habitat)

# *Eucalyptus parramattensis* subsp. *decadens* Drooping Red Gum

**Status**: Vulnerable (TSC Act 1995)
Vulnerable (EPBC Act 1999)

Extracted from Bell (2004): *Eucalyptus parramattensis* is a small smooth barked tree, locally frequent in dry sclerophyll woodland on sandy soils in low, often wet sites (Hill 2002). Subspecies *decadens* is currently listed as Vulnerable on Schedule 2 of the NSW *Threatened Species Conservation Act 1995*, and apart from populations within Werakata NP, there are no other occurrences within dedicated conservation reserve (Murray & Bell 2002.). Extensive areas of this subspecies do occur on the Tomago Sandbeds north of Newcastle, this area acting as a psuedo-conservation reserve through its management as an emergency water supply by the Department of Land and Water Conservation (Bell & Fallding 2002).

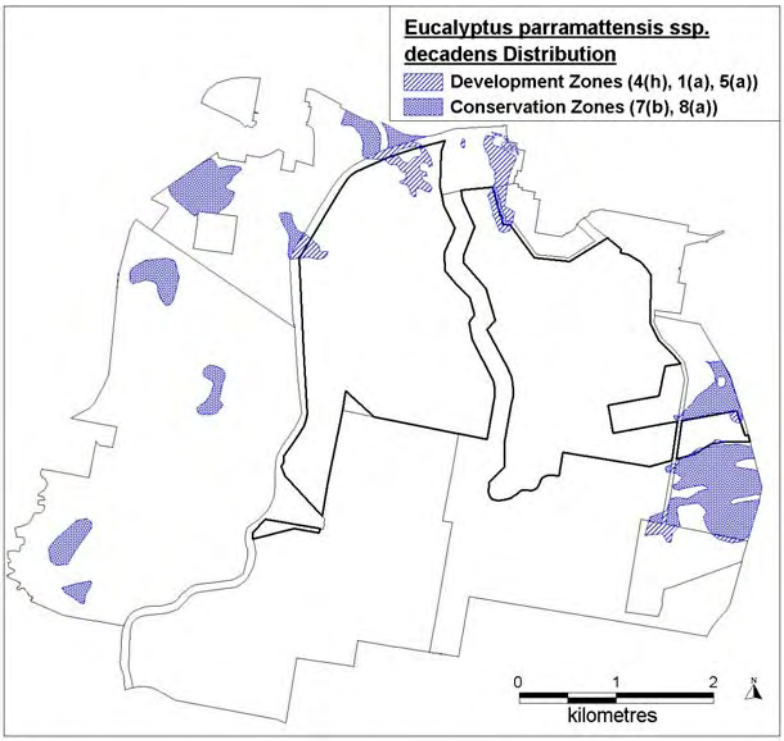
Within the HEZ, *Eucalyptus parramattensis* subsp. *decadens* has a limited distribution linked to Kurri Sand Swamp Woodland. Although some areas of *Eucalyptus parramattensis* subsp. *decadens* are present within Werakata NP, the vast majority of the Kurri population of this taxon occurs outside of reserve (Bell 2001a).

## Distribution and Mapping

**Survey Methods**:
- HSO targeted surveys, population estimates, and mapping within conservation zones (see section 2.5.3);
- HSO detailed 4(h) development zone surveys ie. located every individual excluding juveniles (see Section 2.4).

**Modelling (variables)**: Actual occurrence

**Map:**




**Notes**:
- A significant portion of the population occurs in the 7(b) conservation zone in the eastern edge of the HEZ.
- May occur as scattered individuals elsewhere within the Werakata National Park section of the HEZ.

**Records / Population within the HEZ**: Based on statistical analysis, the HEZ population estimate is 25,666 individuals (95% confidence limits of 21,248 to 30,084). An additional 948 mature trees were detailed within the 4(h) development zone. A total of 203 hectares of occupied habitat occur within the HEZ.

Development Zone 4(h): 948 mature trees (17ha occupied habitat)
Conservation Zone 7(b): (123ha occupied habitat)
National Park Zone 8(a): (37ha occupied habitat)
Other Zones (1(a) & 5(a)): (26ha occupied habitat)

# *Grevillea parviflora* subsp. *parviflora*

**Status**: Vulnerable (TSC Act 1995)
Vulnerable (EPBC Act 1999)

Extracted from Bell (2004): *Grevillea parviflora* is a low spreading dense to erect open shrub 0.3-1m tall, occurring from the north-western Sydney region to the Cordeaux-Appin area, in moist heath or woodland on clay soils (Olde & Marriot 1995; McGillivray 2000). Both subsp. *parviflora* and subsp. *supplicans* have been listed on the NSW *Threatened Species Conservation Act 1995*, the former as Vulnerable (Schedule 2). Subspecies *parviflora* (as it is currently circumscribed) was recorded within Werakata National Park by Bell (2001a), and is also known from Karuah Nature Reserve (Bell 2002). No other records are known from within conservation reserve in the Hunter Valley area, nor from elsewhere within its known distribution (NSW Scientific Committee 1998).

Research currently in progress is attempting to clarify the taxonomic position of *Grevillea parviflora* within the *Grevillea linearifolia* complex in the lower Hunter Valley and Central Coast (Driscoll & Bell in prog.). Numerous forms of what is currently described as *Grevillea parviflora* have been examined, and it is likely that several new taxa within this group may be recognised. The HEZ forms an important component of this research, which is likely to continue for several more months.

Estimates of *Grevillea parviflora* subsp. *parviflora* s. lat. have been made by HSO Ecology staff for the entire HEZ site of over 3 million above ground stems (HSO 2002). A rhizome study carried out involved the excavation of 12 plants, resulting in an average of three above ground stems per plant, and ranging between two and eight stems. While the taxon is certainly common where it occurs, it is possible that true *Grevillea parviflora* in the strictest sense is quite rare.

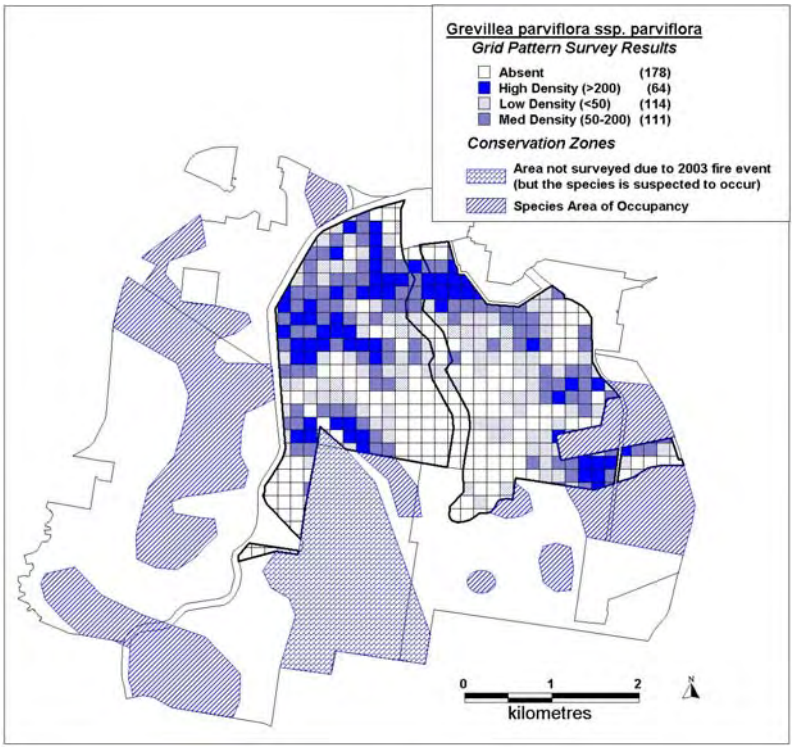
**Notes**:
- species is widely distributed throughout the HEZ, although only appears to occur in low densities within Werakata National Park
- research ongoing into the species taxonomic status

## Distribution and Mapping

**Survey Methods**:
- HSO conservation zone walking transects (ie. presence / absence) (see section 2.5.1);
- HSO detailed 4(h) development zone surveys ie. based on estimates of density per 150m x 150m grid (see Section 2.4.3).

**Modelling (variables)**: Results of Grid Pattern Surveys (Density variables) and Conservation Zone Transects (presence / absence).

**Map:**




**Records / Population within the HEZ**: HSO (2002) previously estimated 3.3 million (above ground stems) occur within the HEZ.

Development Zone 4(h): 640ha occupied habitat
Conservation Zone 7(b): 395ha occupied habitat
National Park Zone 8(a): 305ha occupied habitat (potential a further 300ha)
Other Zones (1(a) & 5(a)): present, but not detailed

# *Rutidosis heterogama*

**Status**: Vulnerable (TSC Act 1995)
Vulnerable (EPBC Act 1999)

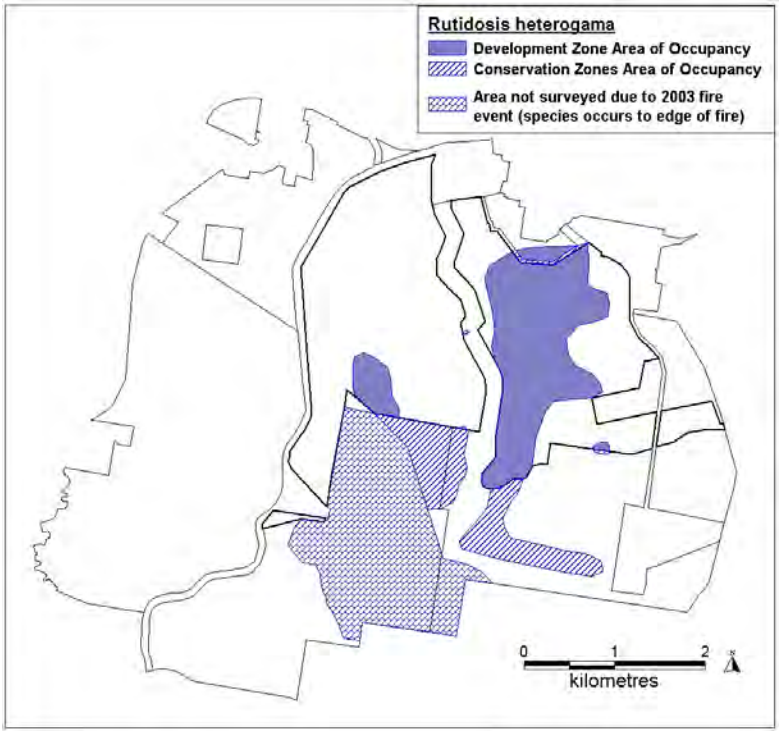
Extracted from Bell (2004): Harden (1992) describes *Rutidosis heterogama* as occurring in heath and along disturbed roadsides, from Maclean to the Hunter Valley. This species was detected within the development zone at HEZ by a third party during the current study, and several new locations were subsequently discovered. On current knowledge, the eastern half of the HEZ site, including the 4(h) development and 7(b) conservation zones, appears to be a major stronghold for the species within the Hunter region. While many plants were evident in recently burnt sites where additional light was available, the species was still present in unburnt areas with moderate shrub cover. It also occurs well distant from established trails in undisturbed areas. Of interest is the occurrence of this species at HEZ in the Lower Hunter Spotted Gum-Ironbark Forest, a habitat differing to the heath described by Harden (1992). A recent population of this species discovered in the Wyong region also occurs within a Spotted Gum – Ironbark forest type (Bell & Driscoll, unpubl. data).

## Distribution and Mapping

**Survey Methods**:
- HSO conservation zone walking transects (see section 2.5.1);
- General surveys by Bell (2004) across select areas of the study area (see Appendix B);
- HSO detailed 4(h) development zone surveys (see Section 2.4) Some areas yet to be surveyed.

**Modelling (variables)**: Actual occurrence. Presence / Absence index for the development zone (per 150m x 150m) will be developed with some additional surveys.

**Map:**




**Notes**:
- Due to sporadic occurrence and difficulty to find outside of flowering season, the species is likely to occur elsewhere within both the development and conservation zones in the eastern portions of the HEZ and further surveys may be required (such as recently burnt sections of Werakata NP).
- Statistically robust population estimates may also be required to more accurately determine the HEZ population size.

**Records / Population within the HEZ**: Widespread in the eastern portions of the HEZ. In large population numbers, over 20,000 individuals recorded to date.

Development Zone 4(h): 235ha occupied habitat
Conservation Zone 7(b): 73ha occupied habitat
National Park Zone 8(a): 37ha occupied habitat
Other Zones (1(a) & 5(a)): 7ha occupied habitat

# *Litoria brevipalmata*
# Green-thighed Frog

**Status**: Vulnerable (TSC Act 1995)

Found in isolated localities, along the coast and ranges from the NSW central coast to south-east Queensland, in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath. Breeding occurs following heavy rainfall events in late spring and summer, with frogs congregating around large, temporary pools where males generally only call for one or two nights. Breeding may occur just once or twice per year or not at all and breeding success may be highly variable.

The recording of the species within the HEZ by HSO represents the first record(s) within the catchment of the Hunter River. Although the species breeding sites have not been determined within the HEZ, it is considered possible that any creekline and/or low lying area capable of holding water for extended periods may provide potential habitat for this species. Further populations are also considered likely to occur within the locality, including Bow Wow Gorge (Bell & Murray 2001).

The majority of the high quality habitat occurs along Chinamans Hollow Creek (central 7(b) conservation corridor). The recording of the species in an area of medium quality habitat (see map) indicates that these areas should also be considered to be of a significant value.

Creeklines within the HEZ have been shown to have high erosion potential and in some cases are highly eroded. The species habitat is under threat from this erosion, including the upstream and downstream migration of 'erosion heads'.

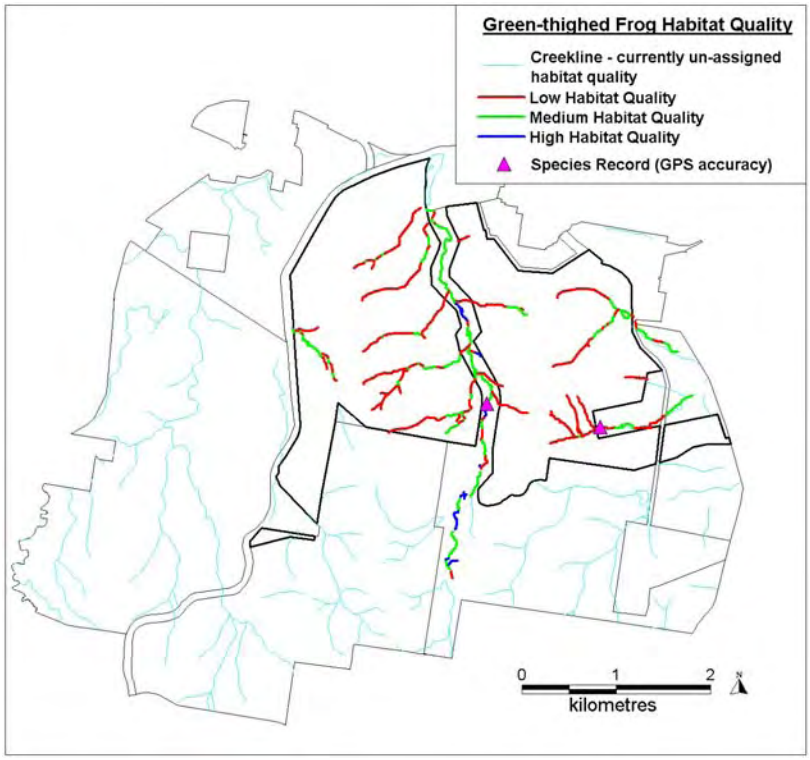
**Notes**:
- No further records of the species were obtained, despite targeted surveys during the 2002/2003 and 2003/2004 summer seasons. This is predominantly due to lack of suitable conditions including low water table and insufficient heavy summer rains.
- Further surveys are required to determine the species specific habitat requirements and distribution within the HEZ, and in the wider locality.

## Distribution and Mapping

**Survey Methods**:
- Targeted breeding event surveys and habitat assessment within the 4(h) zone and select areas of the 7(b) conservation zone (see 2.5.2).

**Modelling (variables)**: Creeklines afforded a habitat quality ranking for the species, based on pre-determined criteria.

**Map:**




**Records / Population within the HEZ**: Two records of juveniles by HSO (2002) in two catchment areas (tributaries of Swamp Creek and Wallis Creek).

Development Zone 4(h): ? potential habitat present
Conservation Zone 7(b): 2 records (further potential habitat present)
National Park Zone 8(a): ? some potential habitat present, although main creeklines, including Swamp Creek, contain permanent water and have steep banks, and as such are unlikely to be utilised by the species.
Other Zones (1(a) & 5(a)): -

# *Hamirostra melanosternon*
# Black-breasted Buzzard

**Status**: Vulnerable (TSC Act 1995)

Raptor that occurs in woodlands, scrubs and grasslands, mainly west of the divide. This species is distributed over inland areas of eastern Australia, through the centre and northern South Australia to western and north-western Australia. It lives singly or in pairs, frequenting open country and nesting in belts of timber growing on plains or along watercourses.

The species was recorded in three locations within the HEZ, including conservation and development zones by Ecotone (1999). In two locations a pair of the birds was observed. Despite extensive bird surveys throughout the HEZ no further evidence of this species has been noted.

Although there are several records of the species within the lower Hunter Valley (Atlas of NSW Wildlife data), this species has not been previously recorded in the Hunter Region (according to HBOC 1993-2002 - despite over 400 species having been recorded within this period) and no records were obtained east of approximately Dubbo by the New Atlas of Australian Birds (Barrett *et al.* 2003). It is considered possible that the individuals recorded by Ecotone (and elsewhere within the Hunter Valley) are either very infrequent vagrants or have been mis-identified (possible mis-identification with dark-morph Little Eagle, Spotted Harrier or Square-tailed Kite).

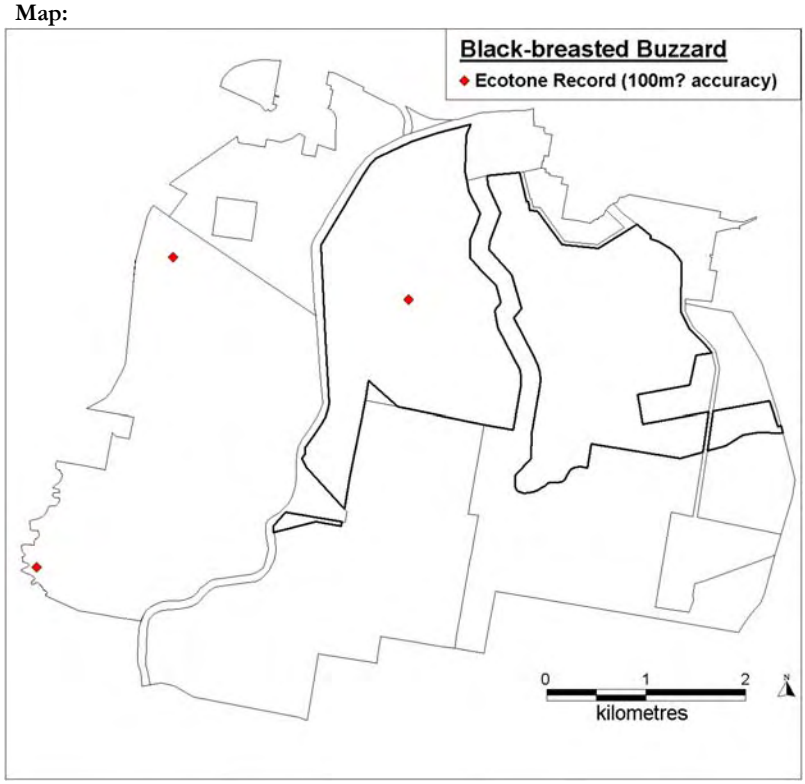
**Notes**:
- Species has not been previously recorded in the Hunter Region (according to HBOC records)
- Individuals either very infrequent vagrants or have been mis-identified.

## Distribution and Mapping

**Survey Methods**:
- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: None.

**Map:**




**Records / Population within the HEZ**: Three Ecotone Ecological Consultants records (1999), including in pairs.

Development Zone 4(h): ? potential habitat throughout
Conservation Zone 7(b): ? potential habitat throughout
National Park Zone 8(a): ? potential habitat throughout
Other Zones (1(a) & 5(a)): ? potential habitat throughout

# *Calyptorhynchus lathami*
# Glossy Black-Cockatoo

**Status**: Vulnerable (TSC Act 1995)

The Glossy Black-Cockatoo is a dusky brown to black Cockatoo with a large beak and a broad red band through the tail. The female usually has irregular pale yellow markings on the head and neck and yellow flecks on the underparts and underwing. They are usually seen in pairs or small groups feeding quietly in *Allocasuarina* trees. They require large tree hollows for nesting and a reliable source of *Allocasuarina* trees over a broad range.

The species is relatively widespread in the Lower Hunter and Central Coast region (Murray, Bell and Hoye (2002); HBOC records), although there are very few recorded nest locations (HBOC 2002).

The species appears to be an irregular visitor to the HEZ, probably due to the general paucity of large areas containing a reliable food source (in the form of *Allocasuarina* trees). Therefore, it is also considered unlikely to nest within the HEZ. HSO Grid Pattern Surveys detailed the extent of this habitat resource within the development zone, although no evidence of usage of the area (ie. via chewed *Allocasuarina* cones) was noted.

More suitable habitat occurs along the slopes of the Tomalpin Hill section of Werakata National Park where *A. torulosa* (Forest Oak) occurs in greater densities.

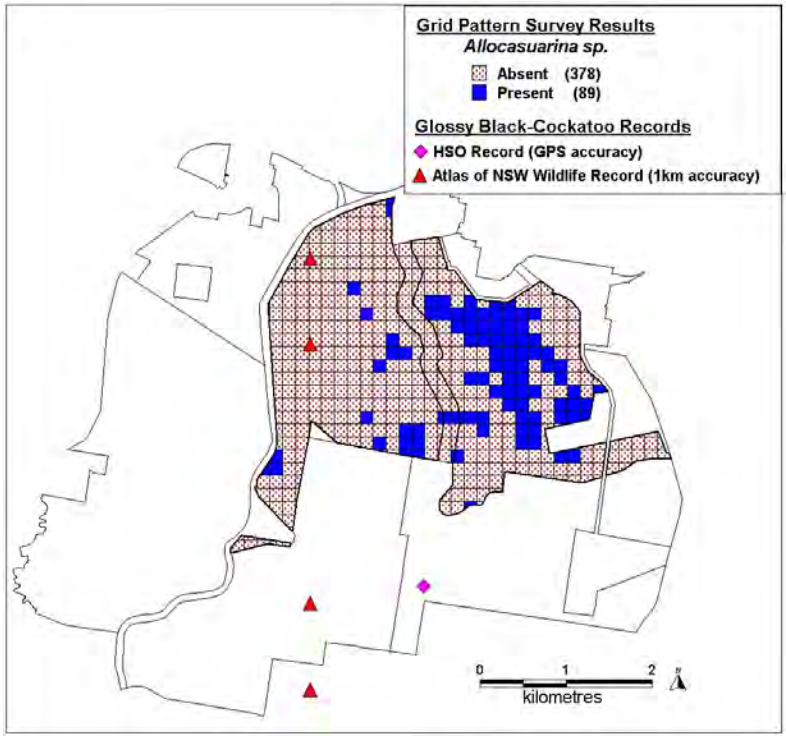
**Notes**:
- Likely to be an irregular visitor to the HEZ
- More suitable habitat for the species occurs along the Watagan Range and the species appears to be fairly common in that area (authors *pers. obs*).

## Distribution and Mapping

**Survey Methods**:
- Feed tree species (*Allocasuarina* sp.) noted as a presence / absence index within 150m x 150m grids within the 4(h) development zone.
- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Development Zone only – presence / absence index for feed tree species (*Allocasuarina* sp.).

**Map:**




**Records / Population within the HEZ**: Irregular visitor, occasional records.

Development Zone 4(h): 2 recorded locations. 200 hectares containing *Allocasuarina torulosa.*
Conservation Zone 7(b): potential habitat present
National Park Zone 8(a): 2 recorded locations - *Allocasuarina torulosa* (Forest Oak) more common along slopes
Other Zones (1(a) & 5(a)): some potential habitat present

# *Climacteris picumnus victoriae*
# Brown Treecreeper

**Status**: Vulnerable (TSC Act 1995)

This species frequents drier forests and woodlands, particularly woodland lacking a dense understorey. Also occurs within more open areas where there are sufficient logs, stumps and dead trees nearby. Feeds on invertebrate larvae and small insects, particularly ants. Utilises hollows for roosting/nesting.

Within the Lower Hunter, this species appears to be locally common in areas of suitable habitat, such as within portions of the HEZ and at Ellalong Lagoon (HSO 2003). Within the HEZ this species was recorded from several locations within the 4(h) zone. Other incidental records have also been noted from the southern portion of the 7(b) zones. Several records also exist within Werakata NP (Atlas of NSW Wildlife; Ecotone 2002). This species was evidenced as breeding within the HEZ at two locations within the 4(h) zone. Potential habitat for this species is widespread across the HEZ, generally in association with the Lower Hunter Spotted Gum / Ironbark Forest community and to a lesser extent the Hunter Lowland Redgum Forest.

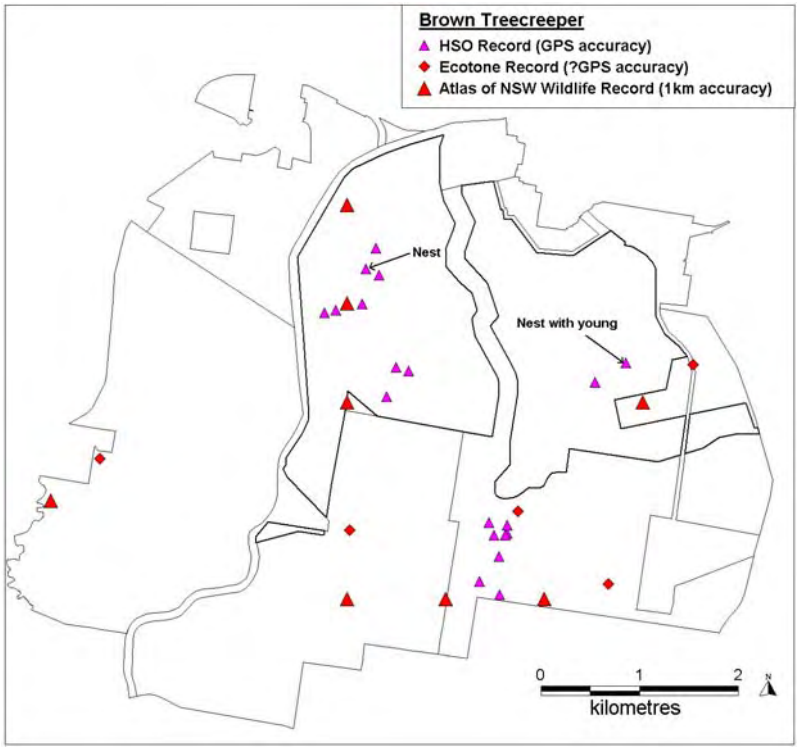
Within the Hunter Region, this species is more regularly recorded in habitats within and to the west of the HEZ and any records of this species from east of the area are scattered and irregular (HBOC records). No breeding records have been noted from habitat to the east and as such the HEZ may represent the eastern breeding limit for this species on a sub-regional scale.

## Distribution and Mapping

**Survey Methods**:
- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: None shown, although most likely to occur within Lower Hunter Spotted Gum / Ironbark Forest containing a higher density of tree hollows.

**Map:**




**Notes**:
- Locally common within sections of the HEZ
- Potential habitat widespread within the HEZ

**Records / Population within the HEZ**: Relatively common resident, with records of up to 5 individuals. Breeding record in the eastern portion of the development zone represents the most easterly known record in the Hunter Valley.

Development Zone 4(h): At least three distinct sub-population(s)
Conservation Zone 7(b): At least one important sub-population(s) in the south-east of the study area
National Park Zone 8(a): Two records / sub-population(s) around Tomalpin Hill and in the west near Kearsley.
Other Zones (1(a) & 5(a)): ? provides some supplementary habitat

# *Pomatostomus temporalis temporalis*
# Grey-crowned Babbler

**Status**: Vulnerable (TSC Act 1995)

This species occupies woodlands with tall shrubs, regenerating trees and an intact ground cover. It appears unable to persist in cleared and fragmented habitats. Also threatened by aggressive competitors, such as Noisy Miners, and nest-competitors, such as Pied Currawongs and Australian Ravens. It often occurs in family groups and several birds within each group assist with nesting activities.

Several records of this species have been recorded within the HEZ study area, Werakata National Park and surrounding areas (HSO 2002; Ecotone 1999; University of Newcastle 2001; NPWS Atlas of NSW Wildlife 2003; authors *pers. obs.*). Within the HEZ the majority of records have been from areas along the central conservation corridor, including nests observed therein. These records have been predominantly from areas that have undergone selective clearing / habitat disturbance. Potential habitat is widespread throughout the HEZ, although generally the preferred habitat attributes are found within the forested areas that abut cleared / disturbed habitats.

Additional records from the locality are known from Quorrobolong, Ellalong, Mulbring and Pokolbin (Atlas of NSW Wildlife 2003; Harper Somers O'Sullivan 2003b; HBOC records). Many nesting records have also been noted from these areas. Although recorded more commonly from habitats to the west of the HEZ study area, records of this species from areas to the east are regular (HBOC records). As such, the species appears to be relatively secure within the broader locality.

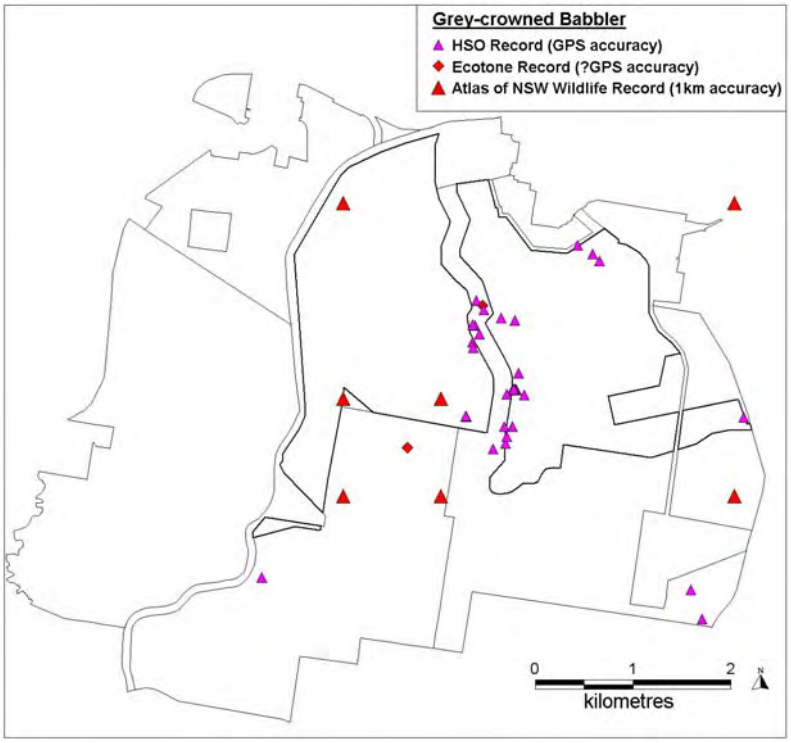
**Notes**:
- Species is relatively common within the Cessnock LGA.

## Distribution and Mapping

**Survey Methods**:
- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: None shown, although recorded within most vegetation communities, usually in close proximity to disturbed areas.

**Map:**




**Records / Population within the HEZ**: Relatively common resident, with at least 5 family groups recorded (up to 8 individuals per group).

Development Zone 4(h): At least 2 family groups
Conservation Zone 7(b): At least 1 family group
National Park Zone 8(a): At least 1 family group
Other Zones (1(a) & 5(a)): ? 1 family group

# *Chthonicola sagittata*
# Speckled Warbler

**Status**: Vulnerable (TSC Act 1995)

This species occurs within woodland areas where ground cover consists of grass, fallen leaves and bark Feeds on insects, insect larvae and small seeds. Nests are constructed of dried grasses and bark strips and are camouflaged under a tuft of grass usually beneath fallen branches or at the base of a small shrub.

Records of this species within the HEZ study area are irregular and uncommon. Those noted records have been predominantly from areas within the 7(b) zone (HSO records; Atlas of NSW Wildlife). Records are also known from Werakata National Park (University of Newcastle 2001). Potential habitat is widespread throughout the HEZ, although the preferred habitat attributes are generally found within the open forested areas.

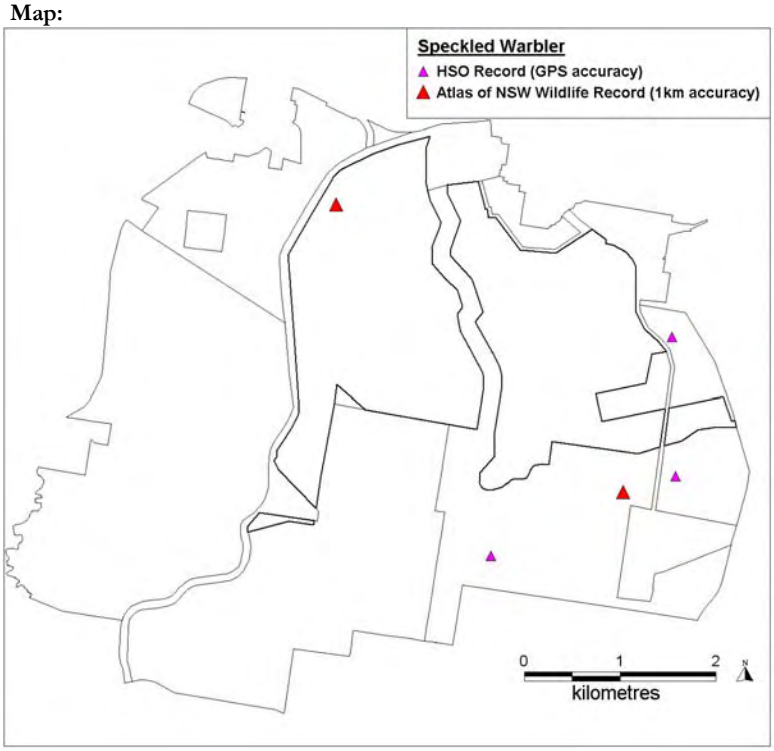
Additional records from the locality are also known from Kurri Kurri, Paxton South, Quorrobolong, Ellalong, Mulbring and the Surveyors Creek / Buttai area around the northern extreme of the Sugarloaf Range (HSO 2003; Atlas of NSW Wildlife 2003; HBOC records).

## Distribution and Mapping

**Survey Methods**:
- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: None shown, although most likely to occur within Lower Hunter Spotted Gum / Ironbark Forest with sparse understorey.

**Map:**




**Notes**:
-

**Records / Population within the HEZ**: Uncommon resident, in low population numbers.

Development Zone 4(h): ? 1 record - potential habitat present throughout
Conservation Zone 7(b): At least 2 records - potential habitat present throughout
National Park Zone 8(a): ? potential habitat present in forested areas
Other Zones (1(a) & 5(a)): ? potential habitat present in forested areas

# *Lathamus discolor*
# Swift Parrot

**Status**: Endangered (TSC Act 1995)
Endangered (EPBC Act 1999)

On the Australian mainland this species forages in Eucalypt forests and woodlands with large trees having high nectar production. This species nests only in Tasmania. Winter sites are known to vary from year to year, although there is evidence to suggest that there is some degree of site fidelity.

Records of the Swift Parrot are known from the HEZ study area as well as the broader locality. The majority of records from the HEZ study area have been from areas within the 4(h) development zone.

Large numbers of this species were recorded in the locality during 2000. Subsequent targeted surveys / habitat assessments were conducted in this area (including the HEZ study area) by the Swift Parrot Recovery Team in 2002. The results of these investigations concluded that the Spotted Gum / Ironbark forests of the Lower Hunter are of significance to the national population of the species. Such habitat dominates the vegetation of the HEZ and represents a significant habitat resource for this species.

Evidence suggests that the Lower Hunter area has always been utilised by the species regularly (Saunders 2002). The occurrence of the species in the region is associated with the availability of feed resources in the locality (mainly Spotted Gum) as well as the Swamp Mahogany stands in the coastal belt. Records of the species within the Hunter Region are fairly widespread, although there appears to be a trend of occurrences within areas such as the Cessnock LGA and around the southern end of Lake Macquarie (authors *pers. obs;* HBOC records).

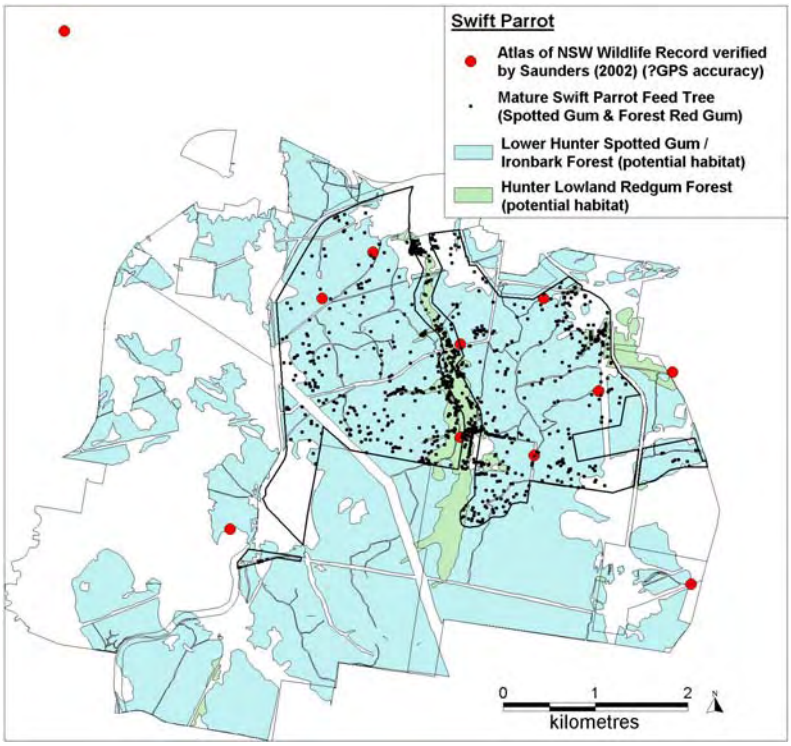
**Notes**:
- Protection of Swift Parrot habitat sites (records) is a DEH requirement (EPBC 2002/782)
- Records based on the observations of local bird watchers.

## Distribution and Mapping

**Survey Methods**:
- Mature winter flowering eucalypts (foraging resource) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.1)
- Targeted surveys and habitat assessment by National Swift Parrot Recovery Officer (Debbie Saunders 2002)
- Extensive diurnal bird census, including during winter months. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Mature winter flowering Eucalypts (Spotted Gum & Forest Red Gum) within the 4(h) and central 7(b) lands. Extent of potential habitat based on the distribution of Lower Hunter Spotted Gum / Ironbark Forest and Hunter Lowland Redgum Forest.

**Map:**




**Records / Population within the HEZ**: Irregular migrant, most likely to occur during extensive flowering of Spotted Gums in the locality.

Development Zone 4(h): 6 records (36% potential habitat)
Conservation Zone 7(b): 2 records (28% potential habitat)
National Park Zone 8(a): 1 record (31% potential habitat)
Other Zones (1(a) & 5(a)): 1 record (5% potential habitat)

# *Neophema pulchella*
# Turquoise Parrot

**Status**: Vulnerable (TSC Act 1995)

The species occurs in Eucalypt woodlands and open forests, with a ground cover of grasses and low understorey of shrubs Breeding pairs nest in small hollow branches of Eucalypts, usually 1m above the ground from August through December and from April to May.

This species has not been recorded from the HEZ during any formal fauna surveys, with the only records being from Atlas of NSW Wildlife data (records which span 10 years). It is considered possible that this species is resident within the HEZ, although the habitats within HEZ are not typical of preferred habitat noted from other locations within the region.

It is also possible that the records of the species from the HEZ are from vagrant or nomadic birds in transit, or that the species has declined in recent years.

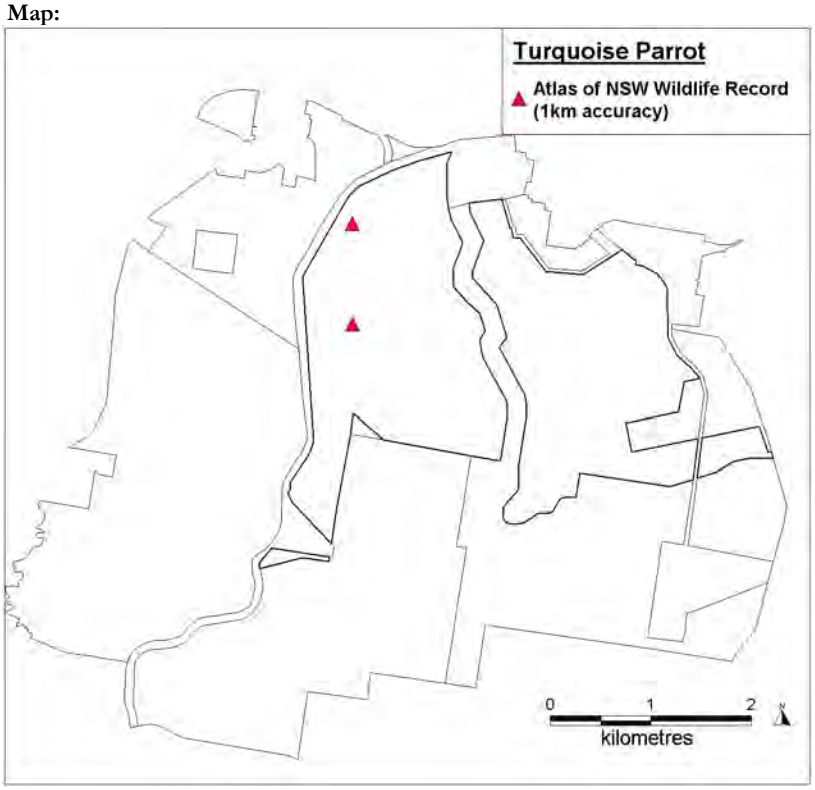
With the exception of ongoing records within the Myall Lakes NP, this species appears only to be resident within the Hunter Region in areas west of the study area (HBOC records).

## Distribution and Mapping

**Survey Methods**:
- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: None shown, although most likely to occur in Lower Hunter Spotted Gum / Ironbark Forest containing a grassy understorey.

**Map:**




**Notes**:
-

**Records / Population within the HEZ**: Uncommon nomadic visitor to the HEZ.

Development Zone 4(h): 2 recorded locations. Potential habitat present
Conservation Zone 7(b): potential habitat present
National Park Zone 8(a): potential habitat present
Other Zones (1(a) & 5(a)): some potential habitat present

# *Tyto novaehollandiae*
# Masked Owl

**Status**: Vulnerable (TSC Act 1995)

This species occupies a range of environments from tall, wet Eucalypt forest to dry woodland, and often, but not always, at the ecotone with cleared land. It nests and often roosts in large Eucalypt tree hollows. The predominant prey species taken are terrestrial mammals.

This species has not been recorded from the HEZ during formal fauna surveys, with the only recorded locations being from Atlas of NSW Wildlife data. The study area may represent a hunting home range (or part thereof) for one or more pairs of the species (which are known to be greater than 1000ha in size). It is considered likely that the entire HEZ study area constitutes potential habitat for this species, including areas containing suitable roosting and nesting habitat.

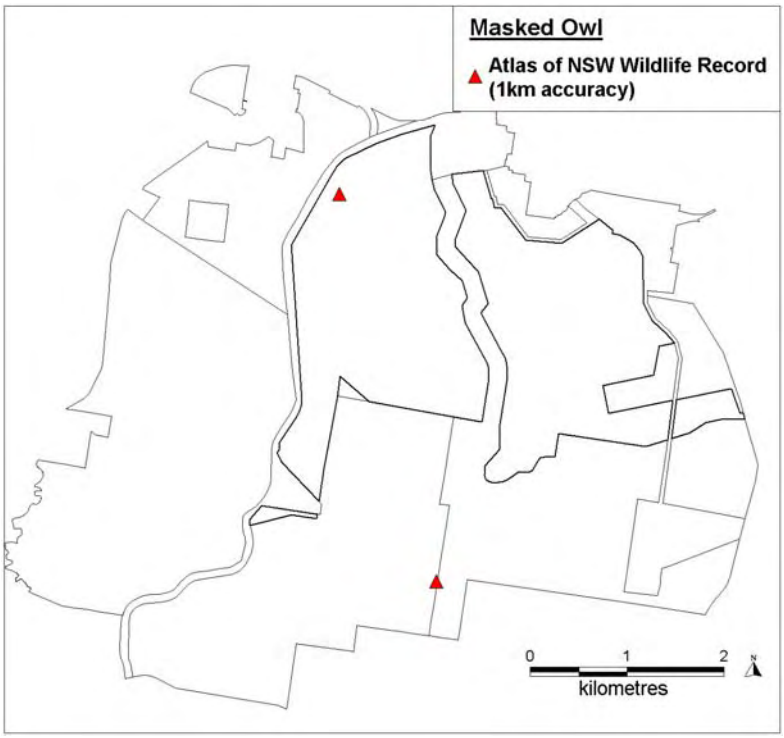
Although not recorded commonly, the Masked Owl is widely distributed within the Hunter Region (HBOC records; Atlas of NSW Wildlife data).

## Distribution and Mapping

**Survey Methods**:
- Hollow bearing trees (potential roosts / nests) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).
- Nocturnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Although not shown, potential roost / nest sites within the 4(h) development zone based on distribution of large hollows (see Table 3-2).

**Map:**




**Notes**:
-

**Records / Population within the HEZ**: Uncommon Resident?

Development Zone 4(h): 1 recorded location. Potential habitat throughout
Conservation Zone 7(b): 1? recorded location. Potential habitat throughout
National Park Zone 8(a): 1? recorded location. Potential habitat throughout
Other Zones (1(a) & 5(a)): Some potential hunting habitat present

# *Ninox strenua*
# Powerful Owl

**Status**: Vulnerable (TSC Act 1995)

This species inhabits a wide range of vegetation types from wet Eucalypt forests with a rainforest understorey to dry open forests and woodlands. It roosts in dense vegetation within such areas and nests within large hollows in mature Eucalypt trees. The predominant prey species taken are medium-sized arboreal mammals.

This species has been recorded by HSO on three occasions as roosting individuals within densely vegetated creekline habitats. Each of these records has been from 7(b) conservation zones. Other recorded locations of the species are from Atlas of NSW Wildlife data within 8(a) and 4(h) lands.

It is likely that a local population of this species is utilising the HEZ as part or the whole of a hunting home range and it is considered that the entire HEZ could provide hunting habitat for this species. Furthermore, suitable prey species have been widely recorded in the study area. It is also considered likely that the species utilises the area for nesting purposes as a significant number of potential nesting sites occur within the larger tree hollows on the study area.

This species is widely distributed in the Hunter Region, having been recorded from a range of habitats throughout the area (HBOC records; Atlas of NSW Wildlife data).

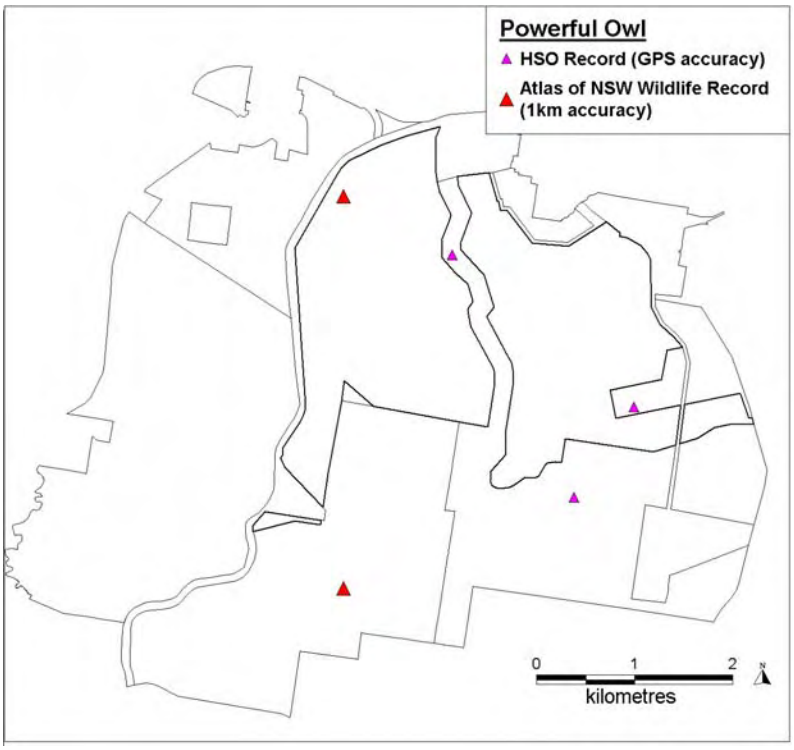
**Notes**:
- Roosts within dense creekline vegetation.

## Distribution and Mapping

**Survey Methods**:
- Hollow bearing trees (potential roosts / nests for the species and arboreal prey) detailed within the he 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).
- Nocturnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Although not shown, potential habitat within the 4(h) development zone based on distribution and density of hollows (see Table 3-2).

**Map:**




**Records / Population within the HEZ**: Resident

Development Zone 4(h): potential habitat throughout
Conservation Zone 7(b): 3 recorded roost locations. Potential habitat throughout
National Park Zone 8(a): 1? recorded location. Potential habitat throughout
Other Zones (1(a) & 5(a)): Some potential hunting habitat present

# *Tyto tenebricosa*
# Sooty Owl

**Status**: Vulnerable (TSC Act 1995)

This species occurs in tall Eucalypt forests, preferring wet sclerophyll forests and rainforest with tall emergent trees containing suitably sized hollows.

The only record of this species within the vicinity of the HEZ is from bushland near Kurri Kurri (Atlas of NSW Wildlife data). This record could potentially be erroneous, given the lack of preferred habitat in the area. It is considered that no areas of preferred habitat exist within the HEZ. Areas of more suitable habitat exist to the south of the HEZ within Bow Wow Gorge (Bell and Murray 2001) and further south along the Watagan Range. Indeed, the vast majority of records for this species within the Hunter Region are from the forested mountain areas, usually in State Forests or National Parks (HBOC records).

**Notes**:
- Likely to be a dubious record

## Distribution and Mapping

**Survey Methods**:
- Nocturnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: None.

**Map:** Not undertaken

**Records / Population within the HEZ**: One record near Kurri Kurri

Development Zone 4(h): -
Conservation Zone 7(b): -
National Park Zone 8(a): -
Other Zones (1(a) & 5(a)): -

# *Melithreptus gularis gularis*
# Black-chinned Honeyeater

**Status**: Vulnerable (TSC Act 1995)

This species occurs in dry Eucalypt woodland within an annual rainfall range of 400-700 mm, particularly within associations containing Ironbark and Box species. It feeds predominantly on nectar, insects and lerp.

This species has been widely recorded within the HEZ from 4(h), 7(b) and 8(a) zoned areas. Recent records have been of groups of up to five individuals observed foraging within the forest canopy. It is considered that the entire HEZ study area contains potential habitat for this species, including areas that could potentially be used as nesting sites.

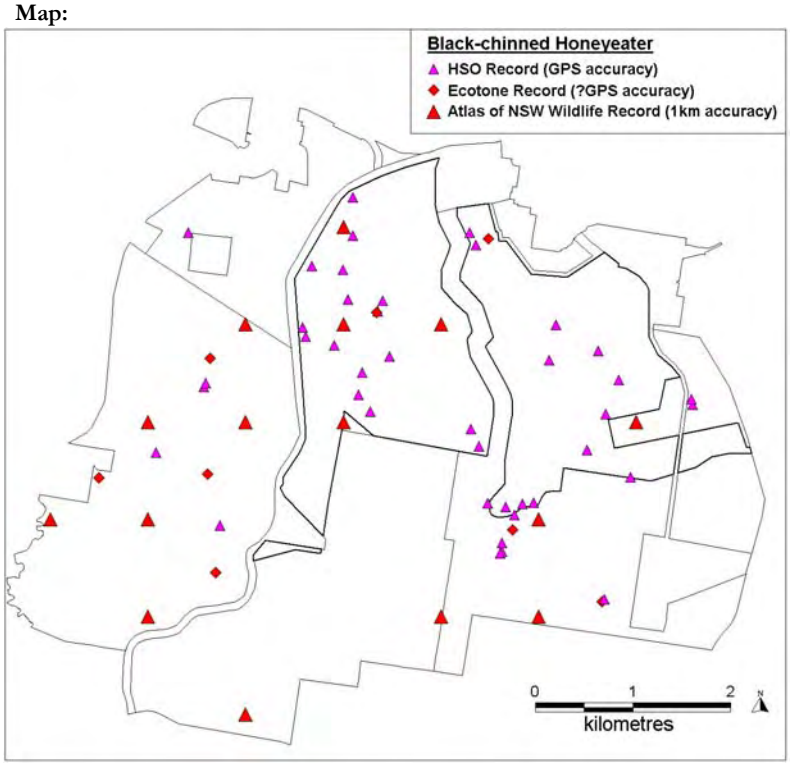
Records of this species in the Hunter Region are fairly widespread, although the majority of records in the Lower Hunter appear to be from the broader Cessnock area (authors *pers. obs;* HBOC records).

## Distribution and Mapping

**Survey Methods**:
- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Although not shown, most likely to occur within Lower Hunter Spotted Gum / Ironbark Forest and occasionally within Kurri Sand Swamp Woodland.

**Map:**




**Notes**:
-

**Records / Population within the HEZ**: Common resident, with records of up to 6 individuals.

Development Zone 4(h): Commonly recorded in western and eastern portions.
Conservation Zone 7(b): Commonly recorded in south-east and occasionally in north-west portions.
National Park Zone 8(a): Mainly recorded from the lower lying Kurri Sand Swamp Woodland portions.
Other Zones (1(a) & 5(a)): Some minor supplementary habitat

# *Xanthomyza phrygia*
# Regent Honeyeater

**Status**: Endangered (TSC Act 1995)
Endangered (EPBC Act 1999)

This species occurs in drier open forest and woodland habitats that contain preferred foraging tree species. Within the region, mostly recorded in box-ironbark Eucalypt associations along creek flats, river valleys and foothills.

Two Atlas of NSW Wildlife recorded locations for this species exist from the HEZ, both within the 4(h) zone in the northern section. No signs of this species were noted during any formal surveys undertaken across the HEZ. Therefore it is likely that this species is an irregular visitor to the HEZ during appropriate periods (such as the flowering of Spotted Gums). No nesting records exist from the HEZ, although nesting attempts have been made by the species at Quorrobolong, to the south of the study area (A. Morris *pers. comm.*).

Potential habitat for this species exists within the vegetation communities that contain winter-flowering Eucalypts. Within the HEZ these generally refer to the Lower Hunter Spotted Gum / Ironbark Forest and Hunter Lowland Redgum Forest. Such habitat is widespread within the HEZ and it is likely to represent a significant habitat resource for this species on a regional scale.

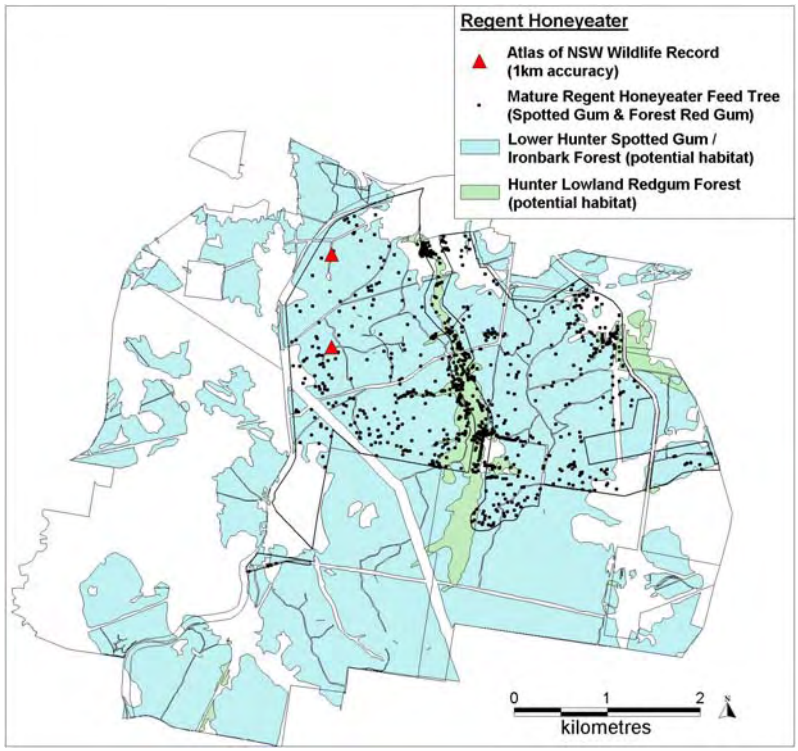
Records of this species within the Hunter Region are widespread in areas that contain suitable habitat. Some areas, such as Morisset, Quorrobolong and the Broke areas appear to be amongst the more favoured localities (authors *pers. obs;* HBOC records).

## Distribution and Mapping

**Survey Methods**:
- Mature winter flowering Eucalypts (foraging resource) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.1)
- Extensive diurnal bird census, including during winter months. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Mature winter flowering Eucalypts (Spotted Gum & Forest Red Gum) within the 4(h) and central 7(b) lands. Extent of potential habitat based on the distribution of Lower Hunter Spotted Gum / Ironbark Forest and Hunter Lowland Redgum Forest.

**Map:**




**Notes**:
-

**Records / Population within the HEZ**: Irregular visitor, occasional records.

Development Zone 4(h): 2 recorded locations (36% potential habitat)
Conservation Zone 7(b): - 28% potential habitat
National Park Zone 8(a): - 31% potential habitat
Other Zones (1(a) & 5(a)): - 5% potential habitat

# *Phascolarctos cinereus*
# Koala

**Status**: Vulnerable (TSC Act 1995)

This species occurs in *Eucalyptus*-dominated forests and woodlands, being more abundant in coastal woodland and open forest, where they have been found in densities as high as ten individuals per hectare. Koalas appear to be limited in their distribution to areas that contain suitable feed trees and habitat linkages.

Within the HEZ, Koalas have been occasionally recorded from the extremities of the site. These records are based mainly on the observations of local residents (eg. see Ecotone 2000 and Univ. of Newcastle 2001). From this information it appears that a small resident population may exist within the locality. Potential habitat exists throughout the HEZ, including preferred foraging trees (being Grey Gums and Forest Red Gums).

This species is moderately well distributed throughout the Hunter Region, although particularly in coastal and sub-coastal habitats. Records of the species in forested habitats that persist on the floor of the Hunter Valley are quite scarce and the species is probably absent from many parts of its former range.

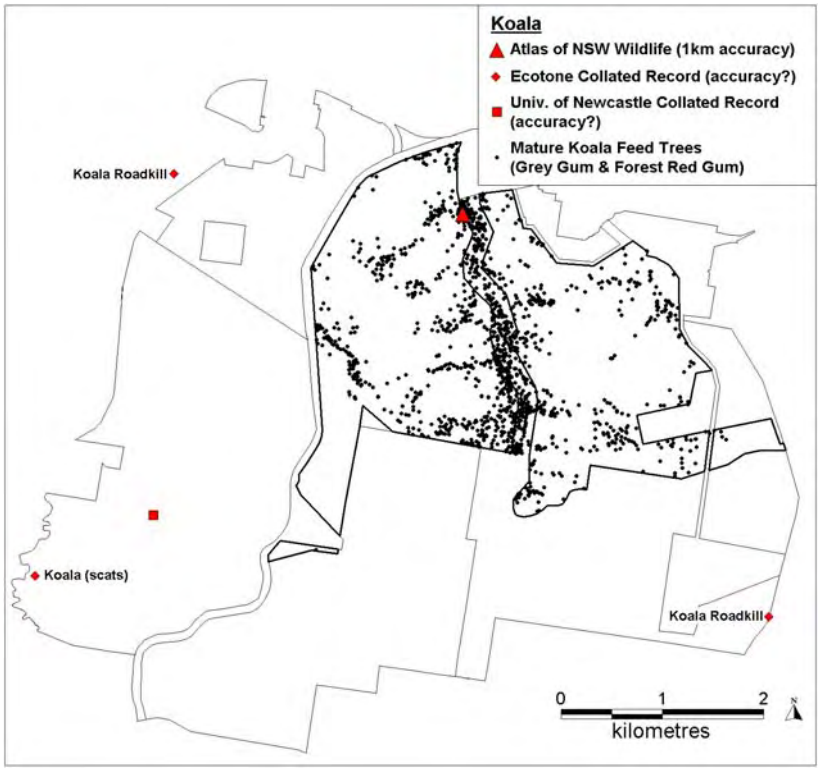
**Notes**:
- High recorded incidence of introduced predators, road kills, and high fire frequency are likely to have substantially reduced population size(s) within the locality.

## Distribution and Mapping

**Survey Methods**:
- Preferred feed tree species detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.1)
- Targeted Koala surveys. Previous survey effort shown in Table 2-1

**Modelling (variables)**: Mature Koala feed trees (Grey Gum and Forest Red Gum) within the 4(h) and central 7(b) lands. Although not shown, extent of potential habitat is most likely based on the distribution of Hunter Lowland Redgum Forest, Central Hunter Riparian Forest and Lower Hunter Spotted Gum / Ironbark Forest.

**Map:**




**Records / Population within the HEZ**: Rare resident / visitor? A small population likely to be present within the locality.

Development Zone 4(h): One recorded location. Potential habitat throughout (although possibly limited to areas containing Grey Gums and Forest Red Gums)
Conservation Zone 7(b): Potential habitat throughout, particularly where Forest Red Gums occur.
National Park Zone 8(a): Potential habitat present.
Other Zones (1(a) & 5(a)): Potential habitat present.

# *Petaurus australis*
# Yellow-bellied Glider

**Status**: Vulnerable (TSC Act 1995)

This species is usually associated with tall, mature wet Eucalypt forests, but are also known from tall dry open forest and mature woodland. The diverse diet of this species is primarily made up of Eucalypt nectar, sap, honey dew, manna and invertebrates found under decorticating bark and pollen. Prefers particular feed tree species. Nests in large Eucalypt hollows.

This species has been recorded from several parts of the HEZ, primarily from secondary indications of the presence of individuals (such as feeding scars, mostly on Grey Gums). The majority of records have been from within the western half of the 4(h) development zone, the central 7(b) conservation corridor, and on the slopes of Tomalpin Hill (Werakata NP). It appears that the HEZ supports a viable population(s) of this species.

Potential habitat exists for this species primarily within those areas containing Forest Red Gums and Grey Gums, which is predominantly within the Hunter Lowland Redgum Forest and some parts of the Lower Hunter Spotted Gum / Ironbark Forest. Within the 4(h) development zone / 7(b) conservation corridor, there is a positive correlation between the occurrence of these animals and the distribution of mature feed trees and density of hollow-bearing trees.

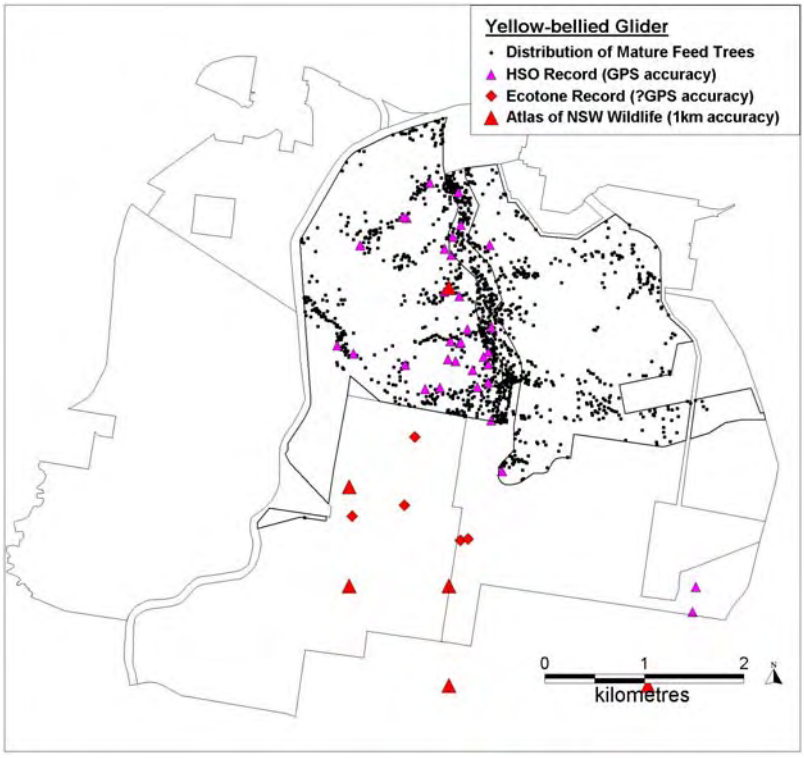
This species occurs in the larger forest remnants and slopes within the Cessnock LGA, including Bow Wow Gorge (Bell & Murray 2001), Paxton, Surveyors Creek, and Watagan and Yengo National Parks (Atlas of NSW Wildlife data).

## Distribution and Mapping

**Survey Methods**:
- Preferred feed tree species detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.1).
- Searches for feeding signs such as incision marks / feeding scars.
- Hollow bearing trees (potential nest sites for the species) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).
- Arboreal mammal surveys. Previous survey effort shown in Table 2-1

**Modelling (variables)**: Mature feed trees (Grey Gum, Forest Red Gum, and Rough-barked Apple) within the 4(h) and central 7(b) lands. Although not shown, most likely to occur within Hunter Lowland Redgum Forest and Lower Hunter Spotted Gum / Ironbark Forest (containing Grey Gums) with higher densities of hollow-bearing trees.

**Map:**




**Notes**:
- Records represent the most significant occurrence of this species on the floor of the lower Hunter Valley.

**Records / Population within the HEZ**: Uncommon resident.

Development Zone 4(h): Relatively common in the western half of the zone.
Conservation Zone 7(b): Mainly restricted to central conservation corridor (Chinamans Hollow Creek), in south-east corner near Richmond Vale Railway Museum.
National Park Zone 8(a): Commonly recorded along the slopes of Tomalpin Hill (population may have been impacted upon by 2003 fire event).
Other Zones (1(a) & 5(a)): Some potential habitat in south-east corner within the Richmond Vale Railway Museum site and immediately north of Hebburn Dam.

# *Petaurus norfolcensis*
# Squirrel Glider

**Status**: Vulnerable (TSC Act 1995)

This species occurs in Eucalypt forests and woodlands where tree hollows are available for nesting sites. Also requires winter foraging resources, such as winter-flowering shrub and tree species.

One record of this species within the HEZ study area exists on the western slope of Tomalpin Hill within Werakata NP (HLA Envirosciences 2001). Additional records of the species occur within the immediate vicinity including in the Kurri Kurri area (Atlas of NSW Wildlife 2003), and within the study area for the HEZ Link Road (HSO 2003). Nocturnal and diurnal observations by HSO indicate that the 4(h) development zone is dominated by Sugar Gliders (authors *pers. obs.*). Fauna surveys within the HEZ by Ecotone (1999; 2000; 2002) and HSO (2002; present study) have failed to detect further occurrences of the species.

Therefore it can be inferred that a local population(s) exists, although potentially only in a number of scattered locations.

Potential habitat for this species can be stated as occurring within the open forested communities that contain higher densities of hollow-bearing trees and understorey nectar producing plants.

The Squirrel Glider is widespread in the Lower Hunter and Central Coast, with populations known from all LGA's including Lake Macquarie, Wyong, Gosford, Port Stephens, Newcastle, Maitland, and Cessnock (Murray *et al* 2002).

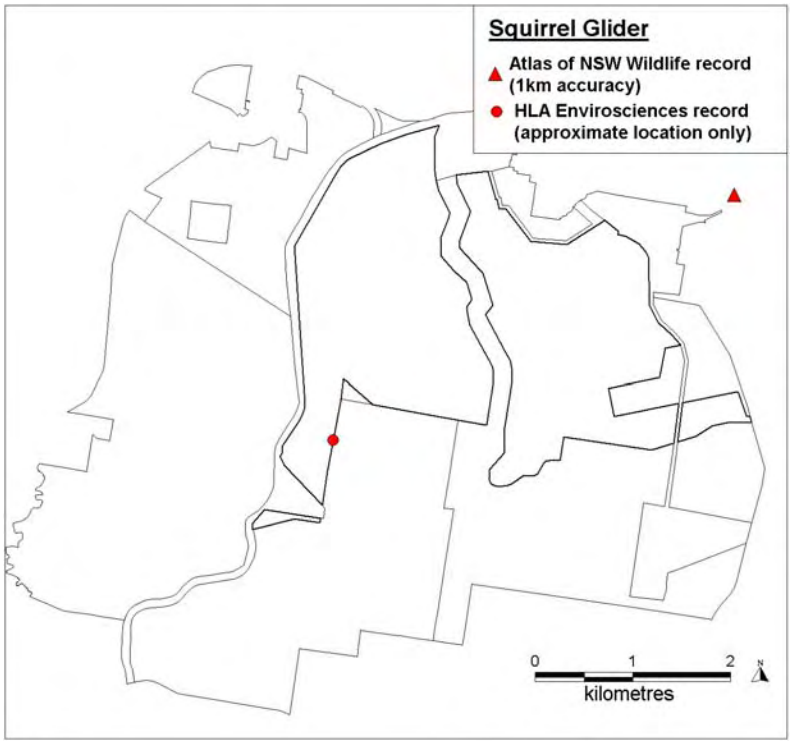
**Notes**:
-

## Distribution and Mapping

**Survey Methods**:
- Density of understorey nectar produced plants detailed within the 4(h) development zone and 7(b) central conservation corridor.
- Hollow bearing trees (potential nest sites for the species) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).
- Arboreal mammal surveys. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Although not shown, most likely to occur within Lower Hunter Spotted Gum / Ironbark Forest with higher densities of hollow-bearing trees and understorey nectar producing plants.

**Map:**




**Records / Population within the HEZ**: Rare resident?

Development Zone 4(h): One record from around Hebburn Colliery No.2 / western slopes of Tomalpin Hill. Potential habitat throughout.
Conservation Zone 7(b): ? Potential habitat present throughout
National Park Zone 8(a): Recorded from the western slopes of Tomalpin Hill. Potential habitat present.
Other Zones (1(a) & 5(a)) ? Potential habitat present.

# *Falsistrellus tasmaniensis*
# Eastern Falsistrelle

**Status**: Vulnerable (TSC Act 1995)

This species inhabits sclerophyll forests from the Great Divide to the east coast. A preference has been noted for wet habitats with trees are more than 20m high. The diet consists of moths, rove beetles, chafers, weevils, plant bugs, flies and ants. It has been observed roosting in holes and hollow trunks of Eucalypts as well as caves and old buildings.

This species has been recorded by Anabat detectors from three locations within the HEZ Ecotone (1999). Two of these have been within Werakata National Park, whilst the other is from the south-eastern corner of the 7(b) lands. Potential foraging habitat occurs throughout the HEZ, although is not typical of that preferred by this species. Potential roosting habitat (in the form of tree hollows) occurs throughout the HEZ.

Records of the species within HEZ may be cases of mis-identification, as this species call (analysed through Anabat software) is commonly confused with the calls of the Greater Broad-nosed Bat – another threatened species that has been found to occur in the open forest habitats of the HEZ (Glenn Hoye *pers. comm.*).

This species has a limited distribution within the Lower Hunter and Central Coast. All confirmed records are from moderate to higher elevations in the Watagan and associated ranges. Records from lower elevations are predominantly based on echolocation call detection, and could be erroneous (Murray *et al* 2002).

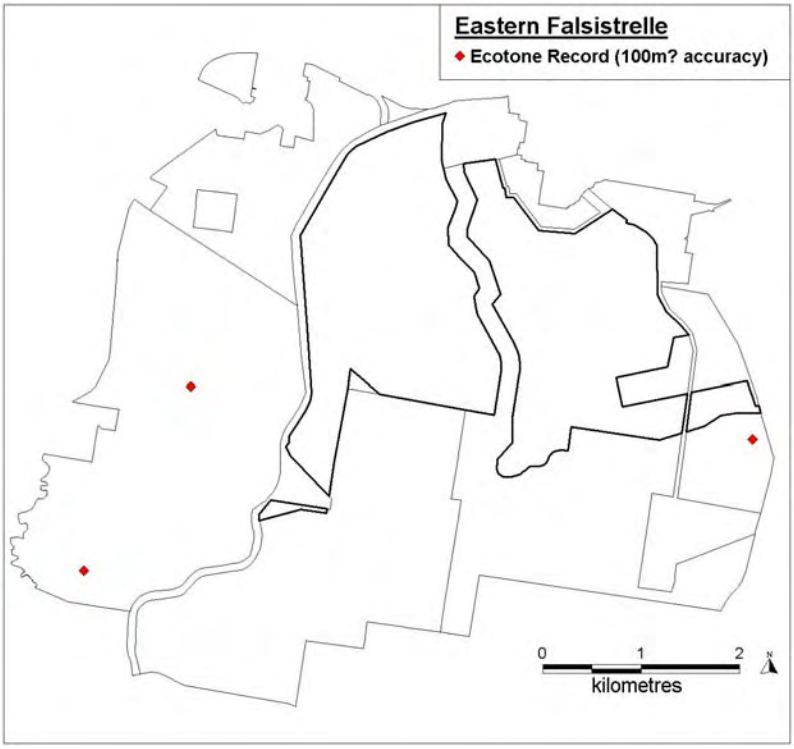
**Notes**:
- Potential for the records of this species to be erroneous.
- Further harp-trapping surveys would be potentially required to confirm the occurrence of this species within the HEZ.

## Distribution and Mapping

**Survey Methods**:
- Hollow bearing trees (potential roost sites for the species) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).
- Targeted bat surveys. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Although not shown, potential roosting habitat within the 4(h) development zone based on distribution and density of hollows (see Table 3-2).

**Map:**




**Records / Population within the HEZ**: Uncommon resident / irregular visitor?

Development Zone 4(h): Potential habitat present
Conservation Zone 7(b): One record, potential habitat present
National Park Zone 8(a): Two records, potential habitat present
Other Zones (1(a) & 5(a)): Some potential habitat present

# *Miniopterus australis*
# Little Bentwing-bat

**Status**: Vulnerable (TSC Act 1995)

This species inhabits tropical rainforest to warm-temperate wet and dry sclerophyll forest occurring along the coastal plains and adjacent ranges from Cape York to the central coast of NSW. It is a sub-canopy hunter with a preference for well-timbered areas but it is also known to hunt in clearings adjacent to forests. It roosts within caves, culverts or similar structures

This species has been noted within the HEZ from a single record within the 8(a) zone (University of Newcastle 2001). The status of local populations of this species is unclear. Potential foraging habitat occurs throughout the HEZ.

This species prefers to roost within caves, mines, culverts etc. Such habitat is not known to exist within the HEZ (though it is suspected that some abandoned mine shafts may subsist). Potential supplementary roosting habitat (in the form of tree hollows) exists commonly across the HEZ. In the absence of preferred roost sites, local populations of this species may be dependant on tree hollows for roosting habitat (G. Hoye *pers. comm.*). It is possible that the lack of preferred roost sites for the species is a limiting factor for local populations of the species. Notwithstanding, tree hollows have been included within habitat assessments as a potential supplementary roosting resource for this species.

This species is widespread throughout the coastal and sub-coastal districts of the Hunter Valley.

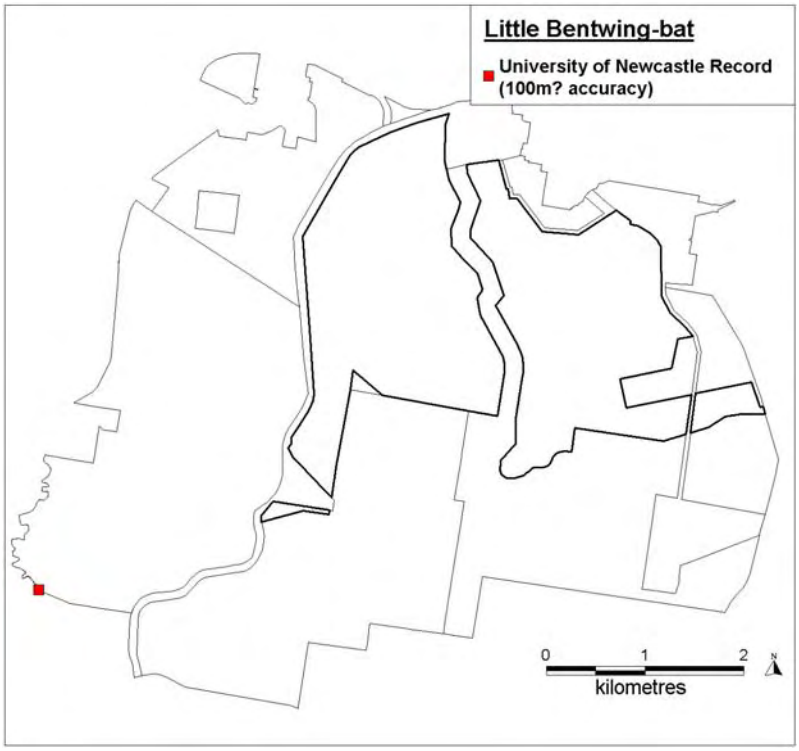
**Notes**:
-

## Distribution and Mapping

**Survey Methods**:
- Targeted bat surveys. Previous survey effort shown in Table 2-1.
- Hollow bearing trees (potential supplementary roost sites) for the species detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).

**Modelling (variables)**: Although not shown, potential roosting habitat within the 4(h) development zone based on distribution and density of hollows (see Table 3-2). Potential foraging habitat throughout.

**Map:**




**Records / Population within the HEZ**: Uncommon resident /dispersive nomad?

Development Zone 4(h): Potential habitat present
Conservation Zone 7(b): Potential habitat present
National Park Zone 8(a): One record, potential habitat present
Other Zones (1(a) & 5(a)): Some potential habitat present

# *Miniopterus schreibersii oceanensis*
# Eastern Bentwing-bat

**Status**: Vulnerable (TSC Act 1995)

This species occurs within the coastal and near coastal areas of the NT and WA and down the east coast from Cape York to Adelaide on the coastal plains and adjacent ranges. This species forages above forest and woodland communities and roosts within caves, culverts or similar structures.

This species has been recorded in the majority of bat surveys within the HEZ, which indicates that a local population is likely to occur within the locality.

Potential roosting habitat may exist within abandoned mine shafts (that are suspected of occurring within the locality) or within other man-made structures, whereas potential foraging habitat occurs throughout the HEZ. This species is not known to utilise tree hollows as supplementary roosting habitat as the Little Bentwing-bat does.

This species is widespread within the Hunter Valley, although few known roost sites have been identified within the region.

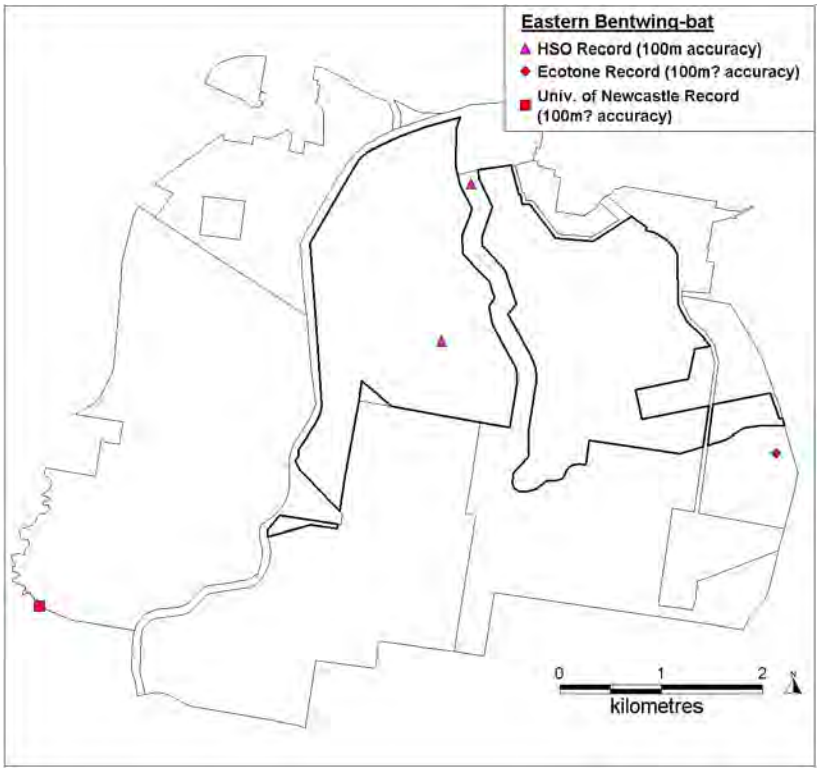
**Notes**:
- The species has the potential to be roosting in abandoned mine shafts and/or other man-made structures within the locality.

## Distribution and Mapping

**Survey Methods**:
- Targeted bat surveys. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: None undertaken. Potential foraging habitat throughout.

**Map:**




**Records / Population within the HEZ**: Common resident / dispersive nomad?

Development Zone 4(h): One record, potential foraging habitat throughout
Conservation Zone 7(b): Two records, potential foraging habitat throughout
National Park Zone 8(a): One record, potential foraging habitat throughout
Other Zones (1(a) & 5(a)): Some potential foraging habitat

# *Mormopterus norfolkensis*
# East-coast Freetail-bat

**Status**: Vulnerable (TSC Act 1995)

This species is found in open forests and woodlands where it forages for insects. It is suspected that open forested areas and the cleared land adjacent to bushland constitutes important habitat for this species, and specific foraging activity may be concentrated over small areas of open water, such as dams and creeks, in and near forests. This species primarily roosts in tree hollows.

Only one record of this species exists from the HEZ, being from the 8(a) zone (University of Newcastle 2001). The status of local populations of this species is unclear. Potential foraging habitat occurs throughout the HEZ. Potential roosting habitat is also found commonly throughout the HEZ.

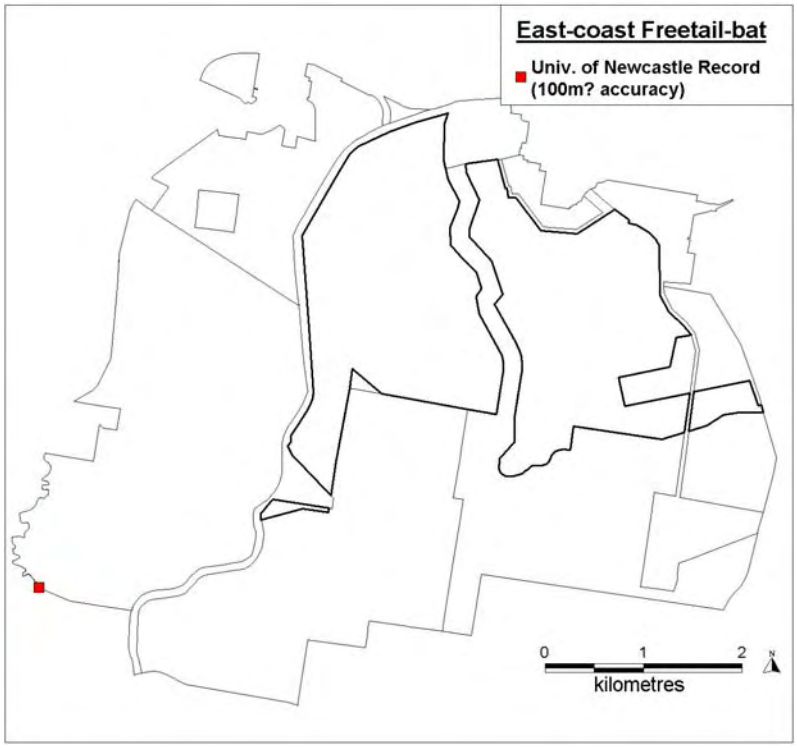
This species is moderately well distributed within the Hunter Valley, although records of the species are generally scarce.

## Distribution and Mapping

**Survey Methods**:
- Hollow bearing trees (potential roost sites for the species) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).
- Targeted bat surveys. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Although not shown, potential roosting habitat within the 4(h) development zone based on distribution and density of hollows (see Table 3-2). Potential foraging and roosting habitat throughout.

**Map:**




**Notes**:
-

**Records / Population within the HEZ**: Uncommon resident?

Development Zone 4(h): Potential habitat present
Conservation Zone 7(b): Potential habitat present
National Park Zone 8(a): One record, potential habitat present
Other Zones (1(a) & 5(a)): Some potential habitat present

# *Myotis adversus*
# Large-footed Myotis

**Status**: Vulnerable (TSC Act 1995)

This species is usually found near large bodies of water, including estuaries, lakes, reservoirs, rivers and large streams. Although usually recorded foraging over wet areas, it also utilises a variety of wooded habitats adjacent to such areas. It roosts in small colonies of between 15 and several hundred individuals with recorded roosts being predominantly within caves, mines and disused railway tunnels, and tree hollows. These roost areas are seldom far from hunting areas.

A tentative record of this species was obtained by HSO Anabat surveys along Chinamans Hollow Creek in close proximity to Hebburn Dam in the north of the study area. The preferred habitat for this species within the HEZ would be associated with dams, larger creeklines, wetlands, and associated riparian vegetation.

Although this species prefers to roost within caves, mines etc, such habitat may not exist within the HEZ (though it is suspected that mine shafts / caves may occur within the locality). Potential supplementary roosting habitat (in the form of tree hollows) exists commonly across the HEZ. In the absence of preferred roost sites, local populations of this species may be dependant on tree hollows for roosting habitat.

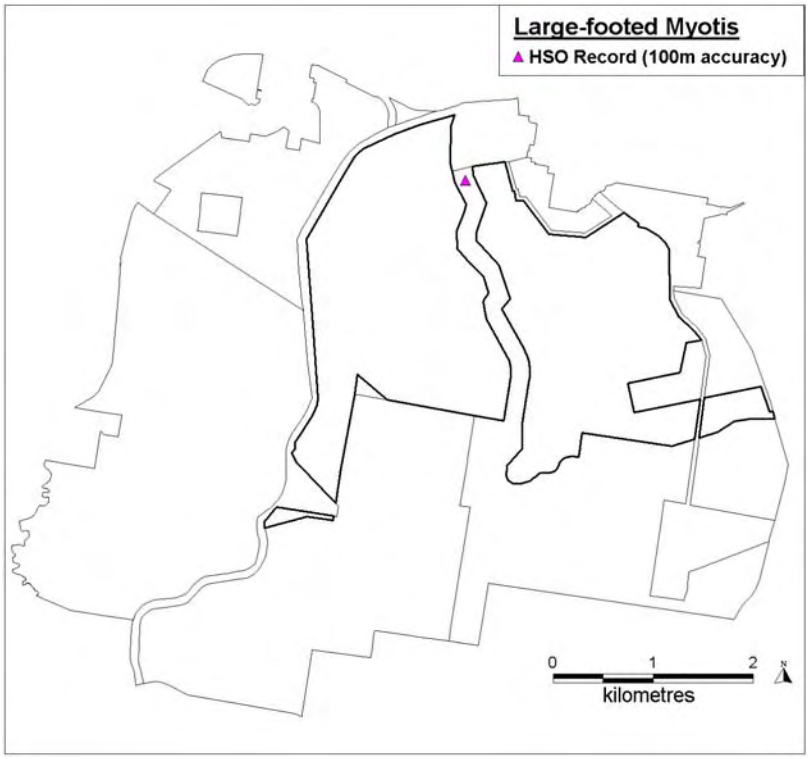
This species is known from scattered localities within the lower Hunter Region.

## Distribution and Mapping

**Survey Methods**:
- Hollow bearing trees (potential supplementary roost sites for the species) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).
- Targeted bat surveys. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Although not shown, most likely to occur around bodies of water (including Hebburn Dam and Chinamans Hollow Creek) and associated areas of riparian vegetation / open forest that contain higher densities of hollow-bearing trees.

**Map:**




**Notes**:
-

**Records / Population within the HEZ**: ?Uncommon resident in suitable habitat

Development Zone 4(h): Potential habitat would be mainly restricted to Chinamans Hollow Creek.
Conservation Zone 7(b): Potential habitat along larger creeklines (Swamp Creek) and ephemeral wetlands in the east along MR 195.
National Park Zone 8(a): Potential habitat along larger creeklines (Swamp Creek and Deep Creek) and wetland near Kearsley
Other Zones (1(a) & 5(a)): Hebburn Dam and surrounding vegetation

# *Scoteanax rueppellii*
# Greater Broad-nosed Bat

**Status**: Vulnerable (TSC Act 1995)

This species occurs in sparsely wooded areas and clearings (ecotones) along the eastern coastal strip of Queensland and NSW. It is generally restricted to the coast and adjacent ranges. This species apparently feeds on large moths and beetles, and some small vertebrates, emerging just after sundown, flying slowly and directly at a height of 3-6 metres, deviating only slightly to catch larger insects. This species roosts in tree hollows.

A single record within the HEZ exists for this species, within the 7(b) land in the south-eastern corner of the study area. The status of this species in the HEZ is unclear, although potential foraging habitat exists throughout the entire study area. Potential roosting habitat also exists in abundance within the HEZ.

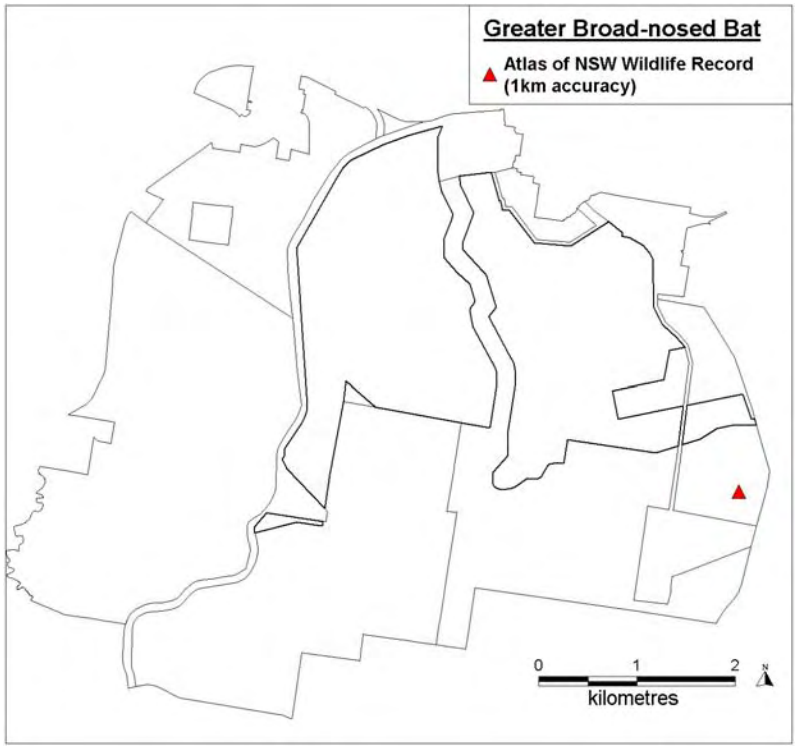
This species is known from scattered localities within the lower Hunter Region.

## Distribution and Mapping

**Survey Methods**:
- Hollow bearing trees (potential roost sites for the species) detailed within the 4(h) development zone and 7(b) central conservation corridor (see 2.4.2).
- Targeted bat surveys. Previous survey effort shown in Table 2-1.

**Modelling (variables)**: Although not shown, potential roosting habitat within the 4(h) development zone based on distribution and density of hollows (see Table 3-2). Potential foraging and roosting habitat throughout.

**Map:**




**Notes**:
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**Records / Population within the HEZ**: Uncommon resident?

Development Zone 4(h): Potential habitat present throughout
Conservation Zone 7(b): One record, potential habitat present throughout
National Park Zone 8(a): potential habitat present throughout
Other Zones (1(a) & 5(a)): Some potential habitat present