The Vertebrate Fauna of the Wollangambe and Upper Wolgan area

Wollemi and Blue Mountains National Park

Department of **Environment & Climate Change** NSW

THE VERTEBRATE FAUNA OF THE WOLLANGAMBE AND UPPER WOLGAN AREA

WOLLEMI AND BLUE MOUNTAINS NATIONAL PARKS

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OVERVIEW

This survey was undertaken in the south-western portion of Wollemi National Park (NP) and north-west of Blue Mountains NP. This area comprises approximately 101 200 hectares of land south of the Capertee Valley extending to the Newnes Plateau and bounded to the east by the Capertee and Colo Rivers. This area is part of the Wollemi Wilderness, and is maintained in as much of a natural state as is possible. It is managed in its entirety by the Upper Mountains Area of the Department of Environment and Climate Change (NSW).

The report documents surveys of vertebrate fauna undertaken by the Department in 1997-98, 2005, 2007 and 2008-09 and reviews and collates data from the Atlas of NSW Wildlife. It reviews threatened species, highlighting significant species and habitats requiring specific management actions. A total of 97 systematic survey sites have sampled birds, frogs, reptiles and mammals. Survey access was limited by a lack of trails, particularly in the eastern parts of the area. Effort has therefore been targeted toward habitats that have been undersampled in other fauna surveys in the local area and region. Together with Biodiversity Survey Priority surveys in adjacent reserves there is now an excellent picture of what fauna can be found in the most common habitats of the Greater Blue Mountains.

Key findings are summarised below.

- 279 native vertebrate fauna species have been recorded within south-west Wollemi and north-west Blue Mountains NPs. This total is comprised of 19 frogs, 46 reptiles, 157 native diurnal birds, 8 nocturnal birds and 49 native mammals. In addition, 14 introduced species have been detected.
- There are at least 32 threatened fauna species present in the study area, three of which are very high priorities for dedicated conservation management: the Brush-tailed Rock-wallaby, Blue Mountains Water Skink and, if rediscovered, the Stuttering Frog. The existing Brush-tailed Rock-wallaby monitoring program should remain a high priority for continuation and expansion.
- Fauna of the area that are of significance at a statewide or national scale are the large population of Brush-tailed Rock-wallabies in the Wolgan Valley and the exceptional population of Large-eared Pied Bats in the Glow Worm Tunnel – Galah Mountain area.
- The area is mostly comprised of fauna habitats typical of the Greater Blue Mountains – open sclerophyll forests and woodlands on sandstone soils. This habitat is well reserved but very important in the conservation of a number of threatened species including the Gang-gang Cockatoo, Glossy Black-cockatoo, Red-crowned Toadlet, Rosenberg's Goanna, Broad-headed Snake and Giant Burrowing Frog. These species generally have few threatening processes acting upon them within the reserves and no specific management actions required.
- Conversely, the area also contains small amounts of some of the most poorly reserved fauna habitats in NSW – Grassy Box Woodlands and high elevation Upland Swamps. These support large numbers of threatened species including the Regent Honeyeater, Turquoise Parrot, Hooded Robin, Speckled Warbler, Black-chinned Honeyeater, Diamond Firetail and Brown Treecreeper in the Grassy Box Woodlands and the Blue Mountains Water Skink in the Upland Swamps.
- Grassy Box Woodlands, Upland Swamps and the escarpment and pagoda formations have been highlighted as priority fauna habitats for the area. These three habitats should be given special consideration when undertaking fire management and prioritised for pest and weed management. Aside from the rock-wallaby monitoring program, directing conservation resources to these three habitats confers the greatest benefit to threatened fauna in the study area.
- Fire management in the area needs to consider potential impacts on the Large-eared Pied Bats and control burns should be conducted outside the early spring-summer breeding period.
- Pest management should continue to focus on the peripheries of the reserves around the Wolgan and Capertee Valleys and in the priority fauna habitats: Grassy Box Woodlands and high elevation Upland Swamps. Feral Pigs have been identified as a particular biodiversity concern if populations increase in the future.
- Land acquisition for biodiversity should focus on Grassy Box Woodlands and Upland Swamps. Such acquisition will assist conservation of threatened faunal both locally and nationally.

The data collected for this project is a baseline that can be built on in the future. It will also be used to model habitat for threatened species across the northern Sydney region and develop regional conservation priorities.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND AND RATIONALE

In 2003, the Parks and Wildlife Group of the Department of Environment and Climate Change (hereafter known as The Department) established the Biodiversity Survey Priorities (BSP) program for NPWS estate in Central Branch. This program came about with the recognition that information on biodiversity values within reserves is fundamental to their successful management. The program also helps us understand the contribution that reserves make to the conservation of animal and plant communities across their range.

View over the inaccessible sandstone expanse of Wollemi NP from the trail to Mt Cameron. © Narawan Williams

Prior to establishment of the program, there were large gaps in our knowledge of the biodiversity values of reserves in Greater Sydney. Typically the biggest reserves were the most data deficient due to their vast and inaccessible nature (NPWS 2003a). The BSP program addresses this information shortfall by surveying the most poorly known reserves and targeting the least understood habitats and species within those areas. The results of these surveys are also a vital component of regional conservation planning projects that deliver targeted management advice for threatened species and priority habitats across Greater Sydney.

In 2003, Wollemi NP and more inaccessible parts of the Blue Mountains NP had very little biodiversity information available. They were considered a survey priority for the BSP, and over the following years significant progress has been made toward obtaining a comprehensive coverage of quality data on vertebrate fauna. The program has surveyed north-east Wollemi NP (Hunter Range Area, DEC 2005a), north-west Wollemi NP (Mudgee Area, DEC 2007a) and south-east Wollemi (Hawkesbury Area, DECC 2008a). Of the Blue Mountains NP, the program has completed north-east Blue Mountains NP (Hawkesbury Area, DECC 2008b), with the southern Blue Mountains largely covered by surveys in the water catchments of the area (DECC 2007a, b). In 2008-9, covered in this report, some of the most inaccessible wilderness in the whole Greater Blue Mountains was targeted – in south-west Wollemi and north-west Blue Mountains NPs (Upper Mountains Area).

1.2 PROJECT AIMS

The primary objectives of the surveys were to:

- Review existing systematic survey effort across the study area and identify gaps for particular fauna groups, habitats or areas.
- Undertake field sampling of terrestrial vertebrate fauna groups to fill the gaps identified above using systematic, replicable techniques to establish a baseline data set.
- Store this systematic survey data in corporate databases to make it accessible to land managers and the broader community for use in conservation planning and biodiversity monitoring.

The specific objectives of this report are to:

- Document the methodology of the survey techniques applied.
- Collate, review and document information on the terrestrial vertebrate fauna of the study area, bringing together results of the current survey with those of previous studies to provide a current species inventory.

- Identify broad-scale patterns in fauna occurrence and habitat use across the study area and identify habitats of particular conservation significance.
- Identify and profile threatened fauna species and pest species that are known or likely to occur.
- Identify priorities for conservation and management of fauna and fauna habitats in the study area.
- Review specific biodiversity issues concerning potential control burning to be conducted in the Glow Worm Tunnel area.

1.3 STUDY AREA

1.3.1 Location and context

Wollemi and Blue Mountains NPs occupy an extensive area of dissected sandstone plateaux west of Sydney. The portion of these parks covered in this survey lies east of Gardens of Stone NP (near Lithgow) and west of the Colo River (Map 1). It is bounded to the north by the Capertee River and to the south by Newnes State Forest and Bells Line of Road. It is approximately 101 200 hectares and is part of the Greater Blue Mountains World Heritage Area.

The study area is located within a large system of protected areas on sandstone geologies that run around the western rim of the Sydney Basin. To the south and east lies the remainder of Blue Mountains NP, and to the north and north-west the remainder of Wollemi NP.

Map 1: Location of the study area and surrounding conservation reserves.

1.3.2 Biogeography, geology, geomorphology and soils

The study area is part of the Sydney Basin Bioregion (Thackway and Cresswell 1995) which extends from just north of Batemans Bay to Nelson Bay on the Central Coast, and almost as far west as Mudgee. The Bioregion is characterised by a temperate climate with warm summers and no distinct dry season (NPWS 2003b). The study area is largely part of the Blue Mountains Plateau, which occupies a large portion of the western Sydney Basin. It incorporates some areas above 1000m in elevation around Newnes Plateau that have a distinctive climate, typical of higher elevation environments in the region. The study area also includes the Wolgan and Capertee Valleys which are very different environments due to lower elevation and different geologies.

Pagodas in this area are derived from Narrabeen Series sandstones. Old Coach Rd, Wollemi NP. © Martin Schulz

The geology of the study area is characterized by sedimentary rocks of Triassic Age. The oldest exposed rock stratum is the Narrabeen Series, comprised primarily of quartz-lithic sandstone but also holding bands of fine-grained shale. The vast majority of the study area is Narrabeen Series – a stratum that is highly variable in the field. Large bands of shale occur within the sandstone and it is the varying combinations of shale and sandstone that result in the different properties of soils. The spectacular pagodas that characterise parts of the study area are derived from Narrabeen Series sandstones.

Hawkesbury Sandstone, which overlies the Narrabeen Series, covers a very minor part of the area (less than 10%) – mostly in the south-east near Mount Irvine and Mount Wilson. These coarse-grained quartz sandstones include some minor shale lenses, though these are less frequent and usually much thinner than those associated with the Narrabeen Series. The siliceous soils derived from Hawkesbury Sandstone are some of the poorest soils in the world (Gold and Prineas 1978).

There are a number of tertiary aged basalt caps and diatremes in the area, including Mt Cameron, Mt Budgary, Galah Mountain and Tambo Limb. In addition, there are small areas on the slopes of Mt Wilson and Mt Irvine, though the majority of basalt soil in this area is cleared and private ownership – testimony to its high fertility and suitability for agriculture.

In the south of the study area there are a number of hanging swamps found on the plateaux around Newnes and on sides of hills at higher elevations. These hanging swamps are formed by water percolating through the porous sandstones from ridge tops meeting with impervious bands of shale or claystone which block the downward movement of water and causes it to flow horizontally along these layers and emerge on the surface (Pickett and Alder 1997).

Underneath the Narrabeen sandstones lies the Illawarra Coal Measures. Colluvial Narrabeen Group over coal measures can be found where the plateau drops off toward the Wolgan and Capertee Valleys. Meanwhile, alluvial deposits occur around the Capertee and Wolgan Rivers themselves. Deep alluvial soils tend to have a moderate to high fertility, derived from accumulation of organic matter. As with basalt, this soil type is primarily found outside the Park boundary where it is utilised for grazing.

1.3.3 Elevation

Most of the area lies between 600 and 900 metres above sea level (asl). The western reaches of the Colo and Capertee Rivers drop as low as about 300m. The Galah Mountain area, in the south-west of the Study Area, averages over 1000m asl.

1.3.4 Climate

The climate of the study area reflects the range in elevation. Much experiences a climate typical of the Sydney Basin hinterlands at moderate elevations, however high elevations in the south and south-west have a unique climate, as does the Wolgan and Capertee Valleys.

1.3.5 Vegetation

There is no fine-scale vegetation mapping that encompasses the entire study area. Parts are covered by the recent Vegetation of the Western Blue Mountains (DEC 2006a). Wollemi is covered by the coarser mapping of Bell (1998), however the only consistent vegetation map for the region is outdated mapping by the Royal Botanic Gardens (at 1:100000 scale) (Royal Botanic Gardens 1990). The BSP program aims to complete fine-scale mapping for those areas not already covered by 2011.

A small and low diversity upland swamp in the Galah Mountain area, Wollemi NP. © DECC

Broadly, the study area is dominated by dry sclerophyll woodlands and forests typical of the sandstone hinterland of the Sydney Basin. In high elevation areas, such as around Galah Mountain, a unique suite of montane flora can be found. This area also supports numerous upland swamps – another interesting and unique habitat. Upland swamps in the Park tend to be smaller, drier and less diverse than swamps at even higher elevations within the adjacent Newnes State Forest (see photo above).

The slopes of the Wolgan and Capertee Valley support talus slope woodland on the colluvial and Permian soils that occur there. Very little of the high conservation value grassy box woodland occurs within the Park, mostly being found just outside the park boundary on the lower slopes and open valley floors.

1.4 PROJECT TEAM

This project was instigated and managed by the Information and Assessment Section, Metropolitan Branch, Environmental Protection and Regulation Group, DECC. Funding was provided by the Central Branch, Parks and Wildlife Group, Biodiversity Survey Priorities Program. Elizabeth Magarey, Kylie Madden and Daniel Connolly were primarily responsible for the management of this project. Elizabeth Magarey and Kylie Madden undertook field survey planning and logistics. Kylie Madden wrote the report and produced the maps; Martin Schulz and Daniel Connolly commented on an earlier draft of the report. 2008-9 (BSP) field surveys were undertaken by Narawan Williams, Martin Schulz, Kylie Madden and Elizabeth Magarey, with assistance provided by James Dawson, Ron Avery, Tim Hager, Dave Thompson and Neil Stone. Staff of the Upper Mountains Area provided assistance in planning, communications and logistical support. Kerry Oakes designed the report cover and formatted the report.

2 METHODS

2.1 PRE-EXISTING FAUNA DATA

2.1.1 Major sources of non-systematic records

The Atlas of NSW Wildlife is the state's key fauna database and was the primary resource for existing data within the study area. Sightings have been entered into the Atlas over several decades. Opportunistic records within the Atlas of NSW Wildlife derive from observations made by: park rangers and field officers; bushwalkers and naturalists; scientific researchers working in the area; neighbouring landholders and other visitors to the park; and the specimen register of the Australian Museum. These records have various levels of reliability depending on the type of observation and the spatial accuracy of location, as well as the certainty and identification experience of the observer.

In addition to the above, several dedicated surveys have been undertaken, either on a small scale or for particular fauna groups or species. The known surveys are summarised below.

- Bird surveys by the Royal Australian Ornithologists Union (RAOU) (undertaken between 1977 and 1981; Blakers *et al.* 1984) and by Birds Australia (undertaken in 1999 and 2000; Barrett *et al*. 2003). RAOU data is at a coarse spatial scale and there is no guarantee that these sightings actually occurred at the given point locality. Consequently, care must be taken when interpreting these records. Most data collected in the more recent Birds Australia surveys has a higher degree of spatial accuracy. There are a number of points within the study area or just outside it in the Wolgan and Capertee Valleys and Mt Wilson area, providing valuable contextual data for this study.
- Surveys for the Stuttering Frog undertaken over the summer of 1999-2000. These involved call playback and passive listening undertaken at 6 locations, with sites primarily located around Mt Wilson in Wollangambe Creek, Yarramun Creek and tributaries in this area. Just outside the study area, surveys for the Stuttering Frog were undertaken at Zircon Creek south of Lindfield Park and on the Bowen River.
- Fauna survey of the Newnes Plateau and Colo River Area by the Australian Museum in 1979 (Kingston *et al.* 1979). This survey involved Elliott trapping for small mammals, cage trapping for larger mammals, mist netting for bats, bird census, pitfall trapping and spotlighting. Much of the data collected was entered into the Australian Museum database and hence is contained within the Atlas of NSW Wildlife.
- Bat survey of abandoned mining sites in the Wolgan Valley and around Glen Davis in 2005. Survey included video monitoring, harp trapping, ultrasound recording and mist netting with recommendations made for the management of these sites (Epacris Environmental Consultants 2005).

2.1.2 Systematic fauna survey data

Prior to the current study, only one project had included implementation of systematic fauna survey techniques in the study area. Six standard sites were conducted in the Glow Worm Tunnel area in 1998 for the Comprehensive Regional Assessment (CRA) Surveys (Table 1, see Section 2.3 for explanation of techniques employed).

Table 1: Systematic fauna survey effort prior to BSP surveys.

	Diurnal bird survey	Diurnal herpetofauna	Harp trapping	Bat ultrasonic call recording	Nocturnal streamside search	Nocturnal call playback	Elliott A trapping	Transect spotlighting survey	Number or records stored in Atlas	Locations of sites	Timing of Survey
Comprehensive Regional Assessment (CRA) Surveys	6	6	5	8	2	4	2	2	375	Glow Worm Tunnel area	February 1998

2.2 SURVEY STRATIFICATION AND SITE SELECTION

The aim of the 2008-09 fauna survey was to proportionately sample the full range of habitat types contained within study area. The primary surrogate used for habitat type was a stratification grid that was created to incorporate the following biotic and abiotic variables: parent geology/soil type; aspect; elevation; landscape position; and broad vegetation structure. The classes used for each variable are presented in Table 2. The stratification grid was used to undertake a gap analysis of previous systematic fauna survey effort, and to identify strata that had not been previously sampled, or had been undersampled in proportion to the area they occupy within the park. The strata identified in this gap analysis were prioritised for sampling. In addition to the stratification, the distributions of existing survey sites and fauna sightings across the study area were examined to identify 'spatial gaps' in fauna knowledge. The selection of sites within specific strata was prioritised towards filling large spatial gaps in fauna data wherever possible.

Table 2: Classes used for stratification of study area.

Parent geology/Soil type	Aspect	Elevation	Landscape position	Broad vegetation structure
• Narrabeen Sandstone • Hawkesbury Sandstone • Basalt • Hanging Swamp • Alluvium • Sandstone Colluvium	• Exposed • Sheltered • Intermediate • Flat	• Greater than 600 metres above sea level • Less than 600 metres above sea level	• Gully • Not a gully	• Woodland • Tall forest • Rainforest • Heathland • Hanging Swamp • Impeded Woodland

Sites were initially selected using ArcGIS 9.2, utilising the stratification layer in combination with topographic maps. Once in the field, proposed site locations were ground-truthed to ensure they were representative of the intended stratum, had not been affected by recent burning or other habitat modification, and comprised a single vegetation community. If these criteria were not met, an alternative location was found.

Systematic survey sites were 100 by 200 metres in area and, where possible, were spaced a minimum of one kilometre from each other (two kilometres for nocturnal call playback surveys). In some cases during hikes into remote country, due to the terrain and the time taken to walk between sites, survey sites were placed closer than one kilometre. In this case, care was taken to ensure that adjacent sites sampled different habitats and that animals were never double counted.

Map 2 shows the placement of sites across the study area. This map includes all systematic surveys undertaken within the study area by DECC between 1998 and 2009 (i.e. during both CRA and BSP programs).

Rainforest had been poorly sampled in the past and was targeted in a walk to Constance Gorge, Wollemi NP. © Martin Schulz

2.3 SURVEY TECHNIQUES

The systematic fauna survey methods used were based on those developed by the NPWS for the Comprehensive Regional Assessments (CRAs) (NPWS 1997) and used as a standard throughout the agency ever since. The techniques were used to sample the following vertebrate fauna groups: diurnal and nocturnal birds, diurnal and nocturnal reptiles, bats, arboreal mammals, amphibians, and terrestrial mammals. Consistency in the use of these techniques allows comparison between fauna species detected across different vegetation types and environments within the study area.

Furthermore, this approach allows comparisons with future surveys of the park and of environments elsewhere.

Survey teams were supplied with field proformas to facilitate comprehensive, consistent recording of field data and to increase accuracy and efficiency of data entry into the DECC Biodiversity Survey Subsystem (BSS) of the Atlas of NSW Wildlife computer database. The names of observers and recorders were noted on every data sheet to aid data verification and entry.

2.3.1 Systematic site-based methods

Site attributes

A site attribute form, aiming to characterise fauna habitat, was filled out at every systematic site where survey techniques were conducted. A 20 by 20 metre quadrat typical of the overall 100 by 200 metre site was used for the assessment. The site attribute locates and describes the site in a format that is comparable to other sites. Data relating to physio-geographic, disturbance, structural and floristic, microhabitat and stream categories were recorded. Standard codes provided by the Australian Soil and Land Survey Handbook (McDonald *et al*. 1990), particularly for vegetation (i.e. Walker and Hopkins 1990) were used wherever possible.

Diurnal bird survey

Diurnal bird censuses comprised a twenty-minute observation and listening search within a two hectare (100 by 200 metre) area, conducted by an experienced bird surveyor. Censuses were conducted only during periods of relatively high bird activity (usually in the early morning) and reasonable detectability (e.g. low wind and cicada activity). All surveys were undertaken in spring and summer. All bird species and the abundance of each taxa seen or heard were recorded. Individuals were scored as on-site if they were detected within the two hectare plot. Individuals recorded outside the plot, in adjacent vegetation types or flying overhead were recorded as off-site.

Diurnal herpetofauna search

A standard half hectare (50 by 100 metre) area was searched for one person-hour at each site (standardised regardless of the number of persons searching). Censuses were restricted to spring and summer during the period between mid-morning to late afternoon, when temperature and insolation are sufficient to ensure maximum reptile activity. Surveying was not conducted on overcast or rainy days or in extreme heat.

Active searching for reptiles. © Dave Thompson

This census technique entailed active searching of potential reptile and frog microhabitats within the half hectare area. Active or basking reptiles were identified by sight or captured and identified by the use of keys. Sheltering or cryptic species were detected by searching around, under and within fallen logs, litter, decorticating and fallen bark, rock outcrops and other likely shelter sites. Incidental observations of other fauna were also recorded.

Nocturnal site spotlighting survey

This census comprised searching for arboreal mammals along a 200 metre transect within a site for one half a person hour. Fifty watt spotlights were used to scan the vegetation for animals and enable detection of reflected eye shine. Surveyors also listened intently for fauna calls during the survey period. All fauna observed or heard within the census period were recorded, noting whether they were on or off site.

Harp trapping

While ultrasonic recorders were used principally to detect high-flying bat species, collapsible bat traps, known as harp traps (Tidemann and Woodside 1978), captured low-flying species. Generally, two nights of trapping were conducted at each bat trap site, in spring and summer. Sites were selected for their perceived potential to interrupt bats along their flight paths, and were usually positioned on tracks or creek lines or in gaps between trees where adjacent vegetation may ‘funnel’ flying bats.

Traps were checked each morning and bats were identified by external morphology, forearm measurement and body weight, and keyed out where necessary using Parnaby (1992a) and Churchill (1998, 2008). Animals were released on the following night at the point of capture.

Bat ultrasonic ('Anabat') call recording

Ultrasonic recorders (Corben 1989) are particularly useful for detection of high-flying species, which often comprise more than one third of an area's bat species (Parnaby 1992b), yet are under sampled by harp trapping (Richards 1992). Additionally, ultrasonic detectors also record low-flying species, which is particularly useful in situations not suited to the deployment of harp traps. The method requires the recording and identification of high frequency, echo-location "calls" made by bats, which, except for one or two species, are ultrasonic (i.e. inaudible to humans). All recordings were made during spring and summer, when bat activity is highest.

CRA

The recording equipment for the surveys consisted of an Anabat II® detector and a tape recorder. Census duration was 30 minutes. Censuses were conducted between dusk and up to two hours after dusk; a peak activity period for microchiropteran bats. A 40 kilohertz calibration tone was recorded for a few seconds at the start and end of each recording session and sometimes at intervals during the recording period.

Harp trap set to catch bats in the upper reaches of Deans Creek, Wollemi NP. © Dave Thompson

BSP

The recording equipment for the surveys consisted of an Anabat II® detector and digital flash card recorder, housed within a Tupperware box for weather protection. The box was set up in locations where bats were expected to fly, such as over water bodies, at cave entrances and along tracks. The Anabat was set to commence detection at dusk and turn off at dawn. During the night, a delay switch operated to turn on the recording device when bat activity was detected and then de-activate the device while no bat activity was occurring. The equipment was left in each location for one night only, and then moved elsewhere. A 40 kilohertz calibration tone was recorded for a few seconds at the start and end of each recording session.

Anabat recordings were transferred onto computer and analysed by Narawan Williams, a recognised expert in this field. Identification was designated as definite, probable or possible, following the methodology of Parnaby (1992b) and Pennay *et al.* (2004). Reference calls were collected for a number of species in order to document local call patterns and to assist with the identification and verification of non-reference calls.

Nocturnal streamside search

Streamside searches for frogs were undertaken for half a person hour in one of two ways: in stream or gully habitats a 200 metre stretch was searched, while at standing water bodies a half hectare (50 by 100 metre) area was surveyed. The searches were only conducted on warm, dark, humid and wet nights or nights within two days of rain. All frogs, and other animals, identified visually or by call within the time period were recorded, together with the weather conditions at the time of the survey.

Nocturnal call playback

Nocturnal birds and mammals are often detected only when they vocalise for territory or social contact, behaviour which can be elicited by broadcasting specific calls. A standard survey census involved broadcasting the calls of each of the four large forest owls - Powerful Owl, Masked Owl, Sooty Owl and Barking Owl - from the centre of a site. Prior to call broadcasts, on arrival at the site, the

surrounding area was searched by spotlight for five minutes to detect any fauna in the immediate vicinity and then a ten minute period of listening was undertaken.

A pre-recorded compact disc or MP3 of each species' call series was played, amplified through a megaphone. Calls of each species were played for five minutes, followed by a five minute listening period. The surrounding area was again searched by spotlight after a final ten minute listening period. After the census, the response or presence of any fauna, date and time that response occurred, and weather details such as amount of cloud cover was recorded. Very windy and rainy periods were avoided where possible. Censuses conducted in poor weather were noted.

Elliott trapping

This technique involved setting 10 Elliott A traps at approximately twenty metre intervals along a 200 metre transect through a site. Traps were baited with a mixture of peanut butter, oats and honey. Traps were left in place for four nights, checked and emptied every morning soon after dawn. Any animals captured within the traps were identified, sexed if possible, and released.

2.3.2 Transect based methods

Transect spotlighting survey

The method employed varied on a site by site basis, and was only undertaken during the CRA surveys. A team of two surveyors walked or drove along a transect, varying between 300 metres and eight kilometres in length, searching for arboreal mammals with 50 watt spotlights. An AMG was calculated for each sighting along the transect and entered into the data sheet.

2.3.3 Opportunistic methods

Predator and herbivore scat and pellet collection

The presence of hairs, and occasionally skeletal remains, in predator scats and owl pellets can result in the identification of prey species with a high level of confidence and is hence an efficient sampling technique for prey animals. In addition, the recording of predator or non-predator scats constitutes records for the species that deposits the scat, providing locality records for species such as the Spotted-tailed Quoll, Fox, Dingo, Wild Dog and Feral Pig. Due to the unmeasurable time delay between prey ingestion and defecation and distance moved in the intervening period, the location in which the prey animals lived cannot be accurately known. Therefore, this technique is useful only for detecting the species presence within a general area. However, it has been shown previously that predators defecate an average of two kilometres from the point of prey ingestion (Lunney *et al.* 2002).

Infrared motion sensing camera set facing a trap baited with sardines and a chicken carcass. © Martin Schulz

Predator scats were collected, placed in paper envelopes, labelled and sent to specialist Barbara Triggs for analysis. Hair samples were identified using the techniques described by Brunner and Coman (1974). Identifications were classified into three levels of reliability: definite, probable and possible. The location of herbivore scats was also noted on an opportunistic basis to indicate the presence of an animal. If there was any doubt in herbivore scat identification in the field, samples were brought back for identification by an expert.

Infrared cameras

Five infrared motion sensor cameras were deployed in the Glow Worm Tunnel – Old Coach Road area of Wollemi NP. Each camera was set in a clear area facing a cage trap baited with sardines, peanut butter rolled oats and honey and an uncooked chicken carcass. Cameras were left for three weeks and set to take photos only when the motion sensor or infrared sensor detected the potential presence of an animal. On collection of the cameras, photos were downloaded and the species seen were recorded as opportunistic sightings in the BSS database.

Searches of caves and overhangs

Where time permitted, caves and overhangs were thoroughly searched with a head torch for animals such as cave-roosting bats, geckos and nesting birds, and for owl pellets and predator scats.

Incidental records

Surveyors driving or walking through the study area recorded the location of threatened or other under-recorded fauna when these taxa were seen or heard. Particular animals targeted by this technique were those under-sampled by systematic surveys, including large ground mammals, non-vocalising birds, and secretive, shy and/or rare animals. The date, time, map grid location (usually obtained from a GPS) and microhabitat of the animal were recorded on a data sheet.

2.4 SURVEY TIMING

Table 3 summarises the timing of the 2005 and 2008-09 BSP surveys and the techniques that were undertaken in each period.

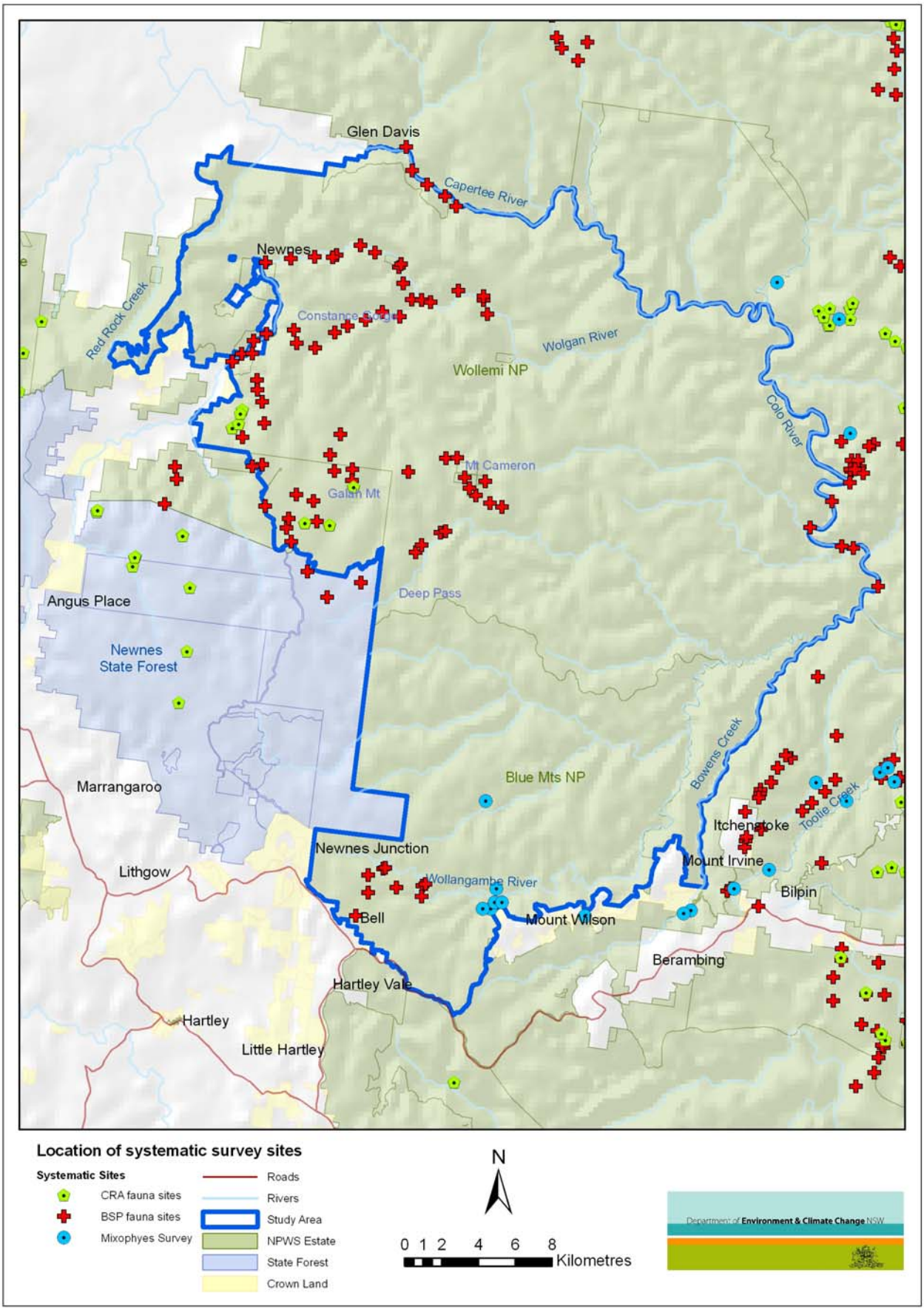
Table 3: Timing of the BSP 2008-09 systematic fauna surveys.

Survey program	Timing	Techniques employed	Location
Biodiversity Survey Priorities Year 1 (BSP)	Oct to Nov 2005	Diurnal bird census, reptile search, site spotlighting, bat call detection, harp trapping, nocturnal streamside search, Elliott trapping, opportunistic methods.	South-east of Glen Davis, Capertee River, Wollemi NP.
Biodiversity Survey Priorities Year 5 (BSP)	Oct 2007	Diurnal bird census, reptile search, site spotlighting, bat call detection, nocturnal call playback, nocturnal streamside search, opportunistic methods.	Colo River on eastern boundary of area.
Biodiversity Survey Priorities Year 6 (BSP)	Oct 2008 – Feb 2009	Diurnal bird census, reptile search, site spotlighting, bat call detection, harp trapping, nocturnal call playback, nocturnal streamside search, Elliott trapping, opportunistic methods.	Wolgan Valley, Mt Cameron, Glow Worm Tunnel - Galah Mt, Wollangambe Crater and River.
Biodiversity Survey Priorities Year 6 (BSP)	March 2009	Nocturnal call playback, opportunistic methods.	Glow Worm Tunnel area.

2.5 SURVEY SITE LOCATIONS AND EFFORT

For the 2008-09 project, DECC established and surveyed 72 systematic survey sites. Also within the study area were nine sites from BSP surveys in the Colo River area from 2007-8 and four from the Capertee River area from 2005. Map 2 shows the location of these survey sites, together with the six systematic survey sites established during the CRA surveys. A breakdown of sites by technique type and broad vegetation type is presented in Table 4.

Surveys effort was constrained by a lack of access roads meaning that sampling the full spatial extent of the study area was untenable. Rather, survey effort was targeted toward those fauna habitats that are unique to the study area and/or poorly sampled across the region. Fauna surveys over the last five years in adjoining portions of Wollemi and Blue Mountains NP and the nearby Yengo and Kanangra-Boyd NPs and Parr SCA have built an excellent regional picture of fauna habitats and distribution in the most widely distributed habitats. Surveys of adjacent areas informed management recommendations about the most common fauna habitats. In addition, some remote kayaking/rafting trips down the Colo and Capertee Rivers (in 1979 and as part of the BSP surveys in 2007) provided invaluable information about the western edge of the study area. Future survey effort would be best directed toward filling the spatial gaps that remain in this area, with this requiring the use of a helicopter and remote hiking and kayaking/rafting teams.



Map 2: Location of systematic fauna survey sites.

Table 4: **Vegetation types currently mapped within the study area and corresponding allocation of systematic fauna survey effort as of May 2009. Note that this vegetation mapping is extremely broad, and is only an indication of the vegetation communities where survey work has been completed.**

Vegetation Type (Royal Botanic Gardens 1990)	Area (hectares)	Diurnal bird survey	Diurnal herpetofauna search	Nocturnal site spotlighting survey	Harp trapping	Bat ultrasonic call recording	Nocturnal streamside search	Nocturnal call playback	Elliott A or cage trapping	Transect spotlighting
Blue Mountains Sandstone Plateau Forest	25760.3	18	15	9	7	5	2	6	2	1
Blue Mountains Sedge Swamps	56.1									
Capertee Valley Woodland	7.7									
Colo Gorge Forest	383.0	1								
Gully Rainforest	47.0									
Hawkesbury-Narrabeen Sheltered Forest	806.5									
Moist Basalt Cap Forest	626.9	2	3	1				1		
Montane Gully Forest	837.3	1	1							
Montane Rainforest	8.9									
Newnes Plateau Shrub Swamp	147.4	2	3	1	1			1		
Open Mottled Gum Woodland	223.0	1	1						1	
Pagoda Rock Complex	16649.7	12	9	5	4	3	1	3		1
Scribbly Gum-Stringybark Woodland	46.6									
Sydney Sandstone Gully Forest	15919.6	1	2	1			1			
Sydney Sandstone Ridgetop Woodland	31892.1	2	1	1			1			
Talus-slope Woodland	7783.0	21	16	16	9	2	5	5	3	
Other	253.9	1						1		

3 FAUNA SPECIES INVENTORY AND OVERVIEW OF SURVEY RESULTS

3.1 REVIEW OF PRE-EXISTING FAUNA RECORDS

All records of vertebrate fauna for the study area in the Atlas of NSW Wildlife were reviewed as part of this project. A number of records were identified as having a low degree of spatial accuracy, or as potential mis-identifications or database errors. Table 5 provides a list of all species that have been removed from the fauna inventory given in Appendix A, together with the reason for their removal. The list of these removed species has been detailed in this section of the report as it is possible that some of the species will be confirmed to occur in the study area in the future. This table includes species that are likely to be vagrants having only been recorded on one or two occasions with a low spatial accuracy. It is unlikely that such species, if they occur at all, are regular visitors to the area. Any future species inventories for the area should also remove these species as they do not need to be considered when developing management priorities.

Table 5: Fauna species on the Atlas of NSW Wildlife where there is doubt about their occurrence in the study area. These have been removed from the species inventory provided in Appendix A.

Scientific Name	Common Name	Reason for omission from species inventory
Australasian Grebe	*Tachybaptus novaehollandiae*	Single record from 1979 of low spatial accuracy. Waterbird with little habitat within the parks. Commonly recorded in dams and wetlands near the park.
Australian Reed-Warbler	*Acrocephalus australis*	Single record from 1979 of low spatial accuracy. Little habitat within the parks. Several records from outside the park in open country in the Capertee Valley.
Australian Shelduck	*Tadorna tadornoides*	Single record from 1980 of low spatial accuracy. Waterbird with little habitat within the parks. There is a recent record from Gooloolinboin Station 3km outside of the reserves.
Australian White Ibis	*Threskiornis molucca*	Single record from 1979 of low spatial accuracy. Waterbird with little habitat within the parks. Numerous accurate records from nearby farmland.
Purple Swamphen	*Porphyrio porphyrio*	Single record from 1979 of low spatial accuracy. Waterbird with little habitat within the parks. Numerous accurate records from nearby farmland.
Little Black Cormorant	*Phalacrocorax sulcirostris*	Single record from 1979 of low spatial accuracy. Waterbird with little habitat within the parks. Numerous accurate records from nearby farmland.
Intermediate Egret	*Ardea intermedia*	Single record from 1979 of low spatial accuracy. Waterbird with little habitat within the parks.
Great Egret	*Ardea alba*	Single record from 1979 of low spatial accuracy. Waterbird with little habitat within the parks.
White-necked Heron	*Ardea pacifica*	Two records of low spatial accuracy from before 1980. Waterbird with little habitat within the parks. Numerous records from nearby open country.
Musk Duck	*Biziura lobata*	Single record from 1996 noted as being from 'Glen Davis' but with a point location 300m inside Wollemi NP in inappropriate habitat. Likely to occasionally occur on larger farm dams and wetlands outside the reserves.
Emerald Dove	*Chalcophaps indica*	Single record from 1979 of low spatial accuracy. Rarely recorded elsewhere in Blue Mountains and Wollemi NPs. Record requires confirmation.
Whistling Kite	*Haliastur sphenurus*	Single record from 1979 of low spatial accuracy. Unlikely though possible – requires confirmation.
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	Single record from 1977. Well outside known range of this bird. Likely misidentification of Glossy Black-cockatoo or location error.
Oriental Cuckoo	*Cuculus saturatus*	Single record from 1986 by reliable observer in the Newnes Valley. Vagrant to area.

Scientific Name	Common Name	Reason for omission from species inventory
White-breasted Woodswallow	*Artamus leucorynchus*	Single record from 1979 of low spatial accuracy.
Plum-headed Finch	*Neochmia modesta*	116 records, all from a single locality listed as Glen Davis, but placed, probably inaccurately, 300m within Wollemi NP in unsuitable habitat. This bird is a rare inhabitant of the grassy woodlands of the Capertee Valley. Very little habitat or no habitat for this bird currently exists within the reserves in this area.
Dwyer's Snake	*Parasuta dwyeri*	Single undated museum record listed as Glen Davis but placed within the boundary of Wollemi NP. Unlikely to be correct.
Western Banjo Frog	*Limnodynastes dorsalis*	Single undated museum record from near Mt Wilson. Well outside known range of this species. Likely to be a misidentification or miscoding of the closely related Eastern Banjo Frog, *L. dumerilii*.
Great Barred Frog	*Mixophyes fasciolatus*	Single undated museum record from near Mt Wilson. Outside known range of this species. Likely to be a misidentification or miscoding of the related Stuttering Frog, *M. balbus* or possibly *M. iteratus*.
Desert Tree Frog	*Litoria rubella*	Single museum record from 1973. Well outside known range of this frog. Likely to be a misidentification or miscoding of the closely related Bleating Tree Frog, *L. dentata*.

3.2 FAUNA SPECIES INVENTORY

A total of 278 native vertebrate fauna species have been recorded within south-west Wollemi and north-west Blue Mountains NPs, excluding species listed in Table 5. This total is comprised of 19 frogs, 46 reptiles, 156 native diurnal birds, 8 nocturnal birds and 47 native mammals. In addition, 14 introduced species have been detected.

Table 6 presents the total numbers of native, threatened and introduced fauna known to occur within the study area. A complete species list for all terrestrial vertebrate fauna groups is provided in Appendix A.

Table 6: Number of vertebrate fauna accurately recorded within the study area.

Total number of native fauna species known to occur	279
Number of species listed as threatened on TSC Act	32
Number of species listed as threatened on EPBC Act	10
Number of introduced species	14

A total of 224 fauna species were recorded during the BSP surveys. The surveys increased the number of fauna records within the study area by 50%, from 6064 to over 12315.

3.2.1 Amphibians

There are 19 species of frog confirmed from the study area (Appendix A). Three of these were recorded for the first time by the BSP program: Bibron's Toadlet, the Giant Burrowing Frog (a Vulnerable species under the TSC Act) and the Stoney Creek Frog. Four of these 19 frogs are currently listed on the TSC Act and are covered in greater detail in Section 4 of this report.

The frog fauna is typical of the Greater Blue Mountains, with all the characteristic sandstone species represented including the Blue Mountains Tree Frog, Giant Burrowing Frog and Red-crowned Toadlet. A few species, such as the Broad-palmed Frog, Eastern Dwarf Tree Frog and Spotted Grass Frog are reflective of more open country on the peripheries of the reserves in the Wolgan and Capertee Valleys. The Stuttering Frog, Stoney Creek Frog and Lesueur's Frog, on the other hand, are only present because of the larger waterways and moister forests that occur in some of the deeply incised gorges and valleys in the area.

The Tusked Frog has a brightly marbled underbelly which might be designed to startle would-be predators. It reaches the far south-west limit of its range in the study area. © Martin Schulz

The ubiquitous Common Eastern Froglet was found in almost every environment. It was detected 208 times during the BSP surveys, more than twice as often as the next most-commonly recorded species, the Stoney Creek Frog (70 new records). The Stoney Creek Frog has only recently been described – having been split from Lesueur's Frog. While both these closely related species occur in the study area, the Stoney Creek Frog is the more common. Many older records of Lesueur's Frog will actually be the Stoney Creek Frog.

The Tusked Frog is an interesting frog that is uncommon in the Greater Blue Mountains. It is known to be decreasing across its range (Frogs Australia Network 2007) and may become a conservation issue in the future. The upper side of this frog is a camouflaged drab mottled brown colour, but the underside is striking marbled white, black and red (see photo above). Males have distinctive tusks on the lower jaw that fit into cavities in the upper jaw. The study area is the extreme south-west of its range – it typically prefers moister and warmer habitats in the coast and hinterland of the mid-north and north coast of NSW. There is only a single record for this frog in the study area, from a tributary near the junction of Wollemi Creek and the Colo River (Kingston *et al.* 1979). There are an additional four records, including recent records, from within 5km of the boundary and it is expected that a small amount of habitat occurs in this warmer, wetter north-eastern section of the study area.

Two threatened species, the Stuttering Frog and Littlejohn's Tree Frog, were not detected during the BSP surveys, despite having been recorded from the study area in the past. The Stuttering Frog has declined markedly across much of its range, probably due to disease, but habitat remains relatively widespread throughout the study area – for instance in the mesic forests along Deans Creek and Rocky Creek. Littlejohn's Tree Frog is often found in creeks draining upland swamps, such as are found particularly in the south of the study area. This species is notoriously difficult to detect and is one of the least recorded frogs in NSW for this reason (Lemckert 2005). Both of these threatened frogs will be discussed further in Section 4 of this report.

3.2.2 Reptiles

Forty-six species of reptile have been confirmed from the study area, including two Endangered species (listed under the TSC Act), the Broad-headed Snake and Blue Mountains Water Skink, and a Vulnerable species, Rosenberg's Goanna (Appendix A). These three species will be considered in detail in Section 4 of this document.

The reptile count includes thirteen species of snake, two goannas, one turtle, 23 skinks, four dragons and three geckos. Most of the species are typical of the sandstone expanses of the Greater Blue Mountains. This area has a high diversity of reptiles that shelter in the rock outcrops and crevices, such as the Coppertail Skink, Cunningham's Skink and Lesueur's Velvet Gecko.

Also present is a distinctive suite of cool-climate specialists that are adapted to the higher elevations found in the south of the study area. These include the Blotched Blue Tongue, Highland Copperhead, Tussock Cool-skink, Tussock Skink and Yellow-bellied Water Skink.

The most commonly recorded reptile was the Pale-flecked Garden Sunskink, one of two species of *Lampropholis* to occur in the area. Both are small litter-dwellers and are extremely abundant - there have been 208 sightings of this skink overall. Other litter-dwelling skinks are also very common such as the Red-throated Skink, Three-toed Skink and Weasel Skink.

Other skinks are far less regularly seen, such as the Southern Rainbow-skink. This beautiful lizard has only been seen once within the study area – just inside Wollemi NP on the Capertee River. They are much more likely to be found in the open grassy woodlands of the valley floors that are largely in private ownership.

This area has a notably high diversity of snakes, including two species of Colubrids (generally non-dangerous, rear-fanged snakes), the Common Tree Snake and Brown Tree Snake. Both of these species are very uncommon within the Greater Blue Mountains, particularly the Brown Tree Snake. In addition, there is one python, the Diamond Python, one blind snake, with the remainder comprising front-fanged snakes (Elapids) – the most venomous family of snakes in the world. This list includes the Common Death Adder for which there is only a single record from a ridge near the Wollangambe River and Bungleboori Creek junction. Despite the lone record, the Death Adder is expected to occur patchily throughout the entire study area; however its cryptic nature means that it is very rarely observed. On the other hand, the Red-bellied Black-snake has been recorded 17 times, testimony not only to how common this species is, but how easily observed it is. This snake is found in most habitats in the study area.

A male Southern Rainbow-skink in vibrant breeding colours. This lizard is found on the lower slopes of the Capertee and Wolgan Valleys and in grassy woodland habitats poorly represented in the reserve system. © Martin Schulz

There are two large monitors that live in the study area – the Lace Monitor and the Rosenberg's Goanna. The Lace Monitor is far more common than the Rosenberg's Goanna, having been seen a total of 17 times as opposed to only twice. These two goannas are relatively similar looking and could be easily confused and it is possible that Rosenberg's Goannas have been overlooked in the past. The most recent record of this threatened species came from an automatic motion-detecting camera set off Old Coach Road during the recent BSP surveys.

Three geckos have been recorded in the study area; most commonly Lesueur's Velvet Gecko, followed by the Broad-tailed (or Leaf-tailed) Gecko. The Stone Gecko has been recorded only twice – reflective of the fact this gecko is generally more common in open wooded country than in sandstone environments.

3.2.3 Native diurnal birds

After reviewing old records and compiling new data, there are at least 157 native diurnal birds that definitely occur in the study area (Appendix A). Some of these are sedentary, while others are migratory, seasonal visitors or nomads.

Ten diurnal bird species are listed as threatened under the TSC Act; the Regent Honeyeater, Gang-gang Cockatoo, Glossy Black-cockatoo, Turquoise Parrot, Brown Treecreeper (eastern subspecies), Black-chinned Honeyeater (eastern subspecies), Square-tailed Kite, Hooded Robin, Speckled Warbler and Diamond Firetail. Of these, the study area supports sizeable amounts of habitat for only the Gang-gang Cockatoo and Glossy Black-cockatoo. Other threatened birds prefer the more open woodlands of the Capertee and Wolgan Valley floors and lower slopes. This habitat is currently restricted within the reserves. These species will be discussed individually in Section 4 of this report.

Also of conservation significance are several species that are in decline, though they have not yet been listed on TSC or EPBC Acts (Barrett *et al.* 2003). These are: the Rockwarbler; White-winged Chough; Spotted Quail-thrush and Red-browed Treecreeper. In addition, there are a number of species that have declined in the Sydney Basin Bioregion in recent years (Barrett *et al.* 2003). These include the Jacky Winter, Restless Flycatcher, Wedge-tailed Eagle, Nankeen Kestrel, Dusky Woodswallow, Australian Pipit, Scarlet Robin, White-winged Triller and White-throated Needletail. The national parks of the Greater Blue Mountains play an integral role in the ongoing regional conservation of habitats for these species.

The most common diurnal birds in the study area are those that live in the typical shrubby dry sclerophyll forest that dominates the study area and the rest of the Greater Blue Mountains. Ubiquitous and abundant birds include the Pied Currawong, White-throated Treecreeper, Spotted Pardalote, Yellow-faced Honeyeater, New Holland Honeyeater and Noisy Friarbird. These are not only generalists but are also highly vocal or highly visible, making them easy to detect during survey work.

The Beautiful Firetail had been rarely recorded in the study area before the BSP surveys, however targeted surveying of upland swamps found it to be relatively common in this restricted habitat. © Martin Schulz

A distinctive group of birds can be found in the rainforests and wet sclerophyll forests that occur in the sheltered gullies and gorges of the study area, for instance along Dean's Creek, Constance Gorge, Rocky Creek, Wollangambe River and Colo River in the far east of the study area. This list includes the Yellow-throated Scrub-wren, Large-billed Scrub-wren, Brown Gerygone and fruit-eating pigeons such as the Top-knot Pigeon and Brown Cuckoo-dove. Many birds from this group were unknown from the study area prior to this project. However, targeted surveying of rainforest and wet forest gullies has shown that, although patchily distributed, these typically coastal and near-coastal range species extend far further west than previously thought.

Another distinctive group of birds is associated with the upland or 'hanging' swamps that characterise the higher elevation parts of the study area. This is another habitat that had not been sampled prior to this survey. Species such as the Southern Emu-wren were previously unknown from the area, while the Beautiful Firetail was found to be relatively common in its preferred upland swamp habitat. Other birds from this group included the Tawny-crowned Honeyeater and Painted Button-quail.

The most important assemblage of diurnal birds in terms of conservation is that belonging to the grassy woodlands that are poorly represented within the reserves. This group of birds has more species of conservation concern than all others combined. Many are listed as Vulnerable or Endangered on the TSC and EPBC Acts, and most of the remainder have been identified as 'declining birds of the sheep wheat belt' (Barrett *et al.* 2003). This is because of the massive clearing of grassy woodland habitat that has occurred in previous decades and the tiny proportion that exists within the conservation reserve system. Birds from this group include the Regent Honeyeater, Square-tailed Kite, Turquoise Parrot, Hooded Robin, Painted Honeyeater, Speckled Warbler, Brown Treecreeper and Diamond Firetail (all listed as threatened) and the Jacky Winter, Southern Whiteface, Western Gerygone, Fuscous Honeyeater, Double-barred Finch, and Weebill as other examples from this group.

3.2.4 Nocturnal birds

The suite of nocturnal birds occurring in the study area is typical of the Greater Blue Mountains. Eight species are confirmed to occur including five owls (Southern Boobook, Barking Owl, Masked Owl, Powerful Owl and Sooty Owl), the Tawny Frogmouth, Australian Owlet-nightjar and White-throated Nightjar (Appendix A). All of the owls (aside from the Southern Boobook) are listed on the TSC Act and will be discussed individually in Section 4 of this report.

The most commonly recorded night birds were the Southern Boobook, Australian Owlet Nightjar and Tawny Frogmouth. All occupy a wide range of environments and can be readily detected throughout the year. Some of the other owls are habitat specialists, such as the Sooty Owl which is only found in moist forests and rainforests. It was not known from the study area prior to this survey as these habitats are generally remote in this region and had not previously before been surveyed for this fauna group. The Barking Owl, for which there are three records, prefers the open grassy woodlands that mostly occur adjacent to the reserves in the Wolgan and Capertee Valleys. All three records of this owl occur within 120 metres of the park boundary and there is very little habitat for this owl within the reserves at present.

The Masked Owl, like the Sooty Owl, had not been recorded in the study area prior to these surveys. This owl prefers higher productivity environments, such as can be found along Deans and Rocky Creeks. It is expected that this rare owl would be primarily found in similar environments throughout the study area.

3.2.5 Arboreal mammals

At least nine arboreal mammals have been found in the study area (Appendix A). This includes most possums and gliders known from the whole Greater Blue Mountains and reflects the diversity of environments encompassed. The list includes common species such as the Common Brushtail and Ringtail Possums, as well as some threatened species such as the Koala, Yellow-bellied Glider and Eastern Pygmy-possum. Others arboreal mammals are the Feathertail Glider, Greater Glider and Short-eared Possum. A further threatened species, the Squirrel Glider, has been recorded from the Galah Mountain area by a single observer on one night in 1998. Revisitation of this area in 2009 failed to find any Squirrel Gliders, or any habitat that we would now consider to be typical for this glider, and we have listed it as currently 'unconfirmed'. In the Greater Blue Mountains, Squirrel Gliders are overwhelmingly found in open, grassy woodlands rather than the sandstone sclerophyll forests that dominate the plateau. Thus far, BSP surveys of the slopes of the Capertee and Wolgan valleys have failed to locate Squirrel Gliders, only finding the closely related Sugar Glider. However, Squirrel Gliders are notoriously difficult to detect and it is possible that they will be found on the peripheries of the parks in the Wolgan and Capertee Valleys in the future. There is very habitat for the Squirrel Glider in the reserves at present.

The most commonly recorded arboreal mammal was the Common Brushtail Possum, followed by the Greater Glider and Common Ringtail Possum. These three species are well adapted to the dry sandstone woodlands, forests and gully systems of the area and can be found in a range of environments. The Common Brushtail Possum is more abundant in open woodlands on fertile soils, where as the Greater Glider prefers taller forests. Short-eared Possums (also known as Mountain Brushtail Possums) are mostly found in moister gullies and forests along with Yellow-bellied Gliders. Feathertail Gliders are extremely difficult to detect and were not recorded from the study area prior to the BSP program. There are now seven records for this elusive mammal – a low number that belies the fact that is spread throughout the reserves. Another species that had not been recorded prior to the BSP program is the Eastern Pygmy Possum. A single individual was found on the Old Coach Road in 2009 confirming their existence in the plateau forests of the study area.

3.2.6 Native ground mammals

There are eighteen different types of native ground mammals found in the study area (Appendix A). This number is typical of most of the Greater Blue Mountains. The list includes the two monotremes (the Platypus and Short-beaked Echidna), the Long-nosed Bandicoot, three small dasyurids (the Brown, Yellow-footed and Dusky Antechinus), one large dasyurid (the Spotted-tailed Quoll), four native rodents (the Bush, Swamp and Water Rats and the New Holland Mouse), five macropods (Red-necked and Swamp Wallabies, Brush-tailed Rock-wallaby, Eastern Grey Kangaroo and Common Wallaroo), the Common Wombat and the Australian Dingo.

Two native ground mammals are listed on the TSC Act, the Spotted-tailed Quoll and Brush-tailed Rock-wallaby. Both will be dealt with in greater detail in Section 4. There is a well-studied population of Brush-tailed Rock-wallabies in the Wolgan Valley, though few records exist in the Atlas of NSW Wildlife. Four new records for the Brush-tailed Rock-wallaby were obtained along the escarpments of the Colo River during the BSP surveys of 2007. The current survey program did not obtain any new records of the Spotted-tailed Quoll, despite targeting this species with baited camera stations in the Glow Worm Tunnel area. It is still expected that this cryptic animal occurs in low densities across the study area.

Of the Kangaroos and Wallabies found in the area, the most commonly recorded was the Eastern Grey Kangaroo, followed by the Red-necked Wallaby and Swamp Wallaby. The Common Wallaroo is restricted to the more western parts of Wollemi NP, particularly around the Wolgan and Capertee Valleys, and has only been recorded on seven occasions.

Records of small ground-dwelling mammals are concentrated in areas where limited Elliott trapping has been undertaken. However, we have good information for most of these animals in the Greater Blue Mountains and information can be extrapolated to unsurveyed areas. The very commonly trapped Bush Rat and Brown Antechinus are likely to be abundant across the range of forested environments in the reserves, while the Swamp Rat is much scarcer and primarily restricted to upland swamps. The Yellow-footed Antechinus is found mostly in more 'western' environments on the peripheries of the reserves such as occurs on the slopes of the Capertee and Wolgan Valleys. The Dusky Antechinus has also been recorded, though not recently, and is likely to occur in moister environments throughout the study area. A final species, the New Holland Mouse, is only known from a single record and has not been found in the BSP surveys. Nonetheless, it is

expected to occur patchily throughout the study area, particularly in sandy areas, as it does through the remainder of the Blue Mountains and Wollemi NPs. A final species, the Common Dunnart, is likely to occur in the area though it has not yet been trapped in any survey undertaken.

Two dingoes cautiously investigate a baited trap. They were captured on a remote camera stationed just off Old Coach Road, Wollemi NP. Dingoes were also heard howling near here and may be responsible for the apparent absence of foxes in this area. © DECC

The Platypus was confirmed to occur in the Capertee and Colo Rivers by the BSP program. This creature, although shy and rarely seen, is expected to exist wherever suitable habitat persists in the study area. They generally prefer larger rivers and creeks with vegetated banks where they can build their burrow. The other Australian monotreme, the Echidna, lives in a range of habitats across the study area.

The Australian Dingo was recorded from the study area for the first time, and is known from other parts of Wollemi, Blue Mountains and Yengo NPs. Unfortunately, tracks and scats cannot be used to separate Dingoes from Feral Dogs and hybrids and so all but four records from the BSP program have been entered into the Atlas of NSW Wildlife as Wild Dog/Dingo. Given the evidence that Dingoes do occur in the area, it is highly likely that some of these records should actually be attributed to Dingoes. No DNA testing has been undertaken; however in February 2009 the distinctive howl of the Dingo was recorded during a spotlight search on Old Coach Road (two to three animals) and also from the start of Galah Mountain Rd. These two records are quite close together and it is likely the same pack is responsible for both records. A further record was obtained from motion-sensing cameras set on Old Coach Rd and another photo taken on Glow Worm Tunnel Rd. Physical characteristics of the Dingoes photographed would suggest that they have a very high degree of genetic integrity.

A recent study in Yengo NP included genetic testing of Dingoes trapped in soft-jaw traps in the centre of that park, and found trapped animals to have a high degree of pure Dingo heritage (up to 98%) (T. Horwood pers. comm.). The Dingo is listed as Vulnerable on the IUCN Red List of Threatened Species due to a 30% decrease in numbers across its distribution (Corbett 2004). Populations from Sturt NP, the coastal ranges and some coastal parks have been nominated as Endangered under the TSC Act (Colong Wilderness Foundation 2002). In contrast to this, Dingoes are declared a pest animal under the Rural Lands Protection Act (1998) (RLP Act). Nevertheless, DECC recognises the expectation amongst the community that the Dingo be conserved (NPWS *et al.* 2000, Fleming *et al.* 2001, DEC 2005c). Wollemi and Blue Mountains NPs are considered to be important for the conservation of the Dingo in a submission to the RLP Act by all key land management agencies (NPWS *et al.* 2000, DEC 2005c). It is recommended that research be extended to Wollemi and Blue Mountains NPs to: ascertain patterns in the level of Wild Dog/Dingo hybridisation in the area; identify key areas of Dingo purity and Wild Dog invasion using non-destructive techniques; and enable the formulation of a management plan that balances the need for Dingo conservation and Wild Dog control within the study area.

Interestingly, the Dingo is increasingly regarded as an important conservation tool, with recent research confirming that Dingoes regulate arid-zone ecosystems. Without Dingoes, Foxes and large herbivores increase in number while lizards and, in some areas, small mammals decline almost to extinction (Letnic *et al.* 2009, M. Letnic in prep.). While the forested environments of eastern Australia are yet to be similarly investigated, the Dingo is likewise the top-order predator and is certainly playing an important role in the Greater Blue Mountains. Research in the southern Blue Mountains suggests that there is little difference in the ecological role played by Dingoes, Feral Dogs and hybrids (B. Purcell in prep.). It is worthwhile noting that Foxes were exceedingly and unusually rare in the study area with only two new records from the BSP program and none from the Glow Worm Tunnel - Galah Mountain area.

3.2.7 Bats

There are up to nineteen species of insectivorous bats and one flying-fox found in the study area (Appendix A). The study area supports a diverse and abundant bat fauna. Aside from that done by DECC, little surveying for bats has occurred in the study area and nine species had not been recorded other than from DECC systematic surveys. At least six species are listed as Vulnerable on the TSC Act; the Large-eared Pied Bat, Eastern False Pipistrelle, Eastern Bentwing-bat, Large-footed Myotis, Greater Broad-nosed Bat and Eastern Cave Bat. A further threatened species, the East-coast Freetail-bat is unconfirmed but possible. Each of the threatened bats will be discussed further in Section 4.

The Large-eared Pied Bat is a threatened species that was found in unprecedented numbers in the Glow Worm Tunnel - Galah Mountain area of Wollemi NP. © Martin Schulz

The composition of the microbat fauna is largely typical of Greater Blue Mountains, although bat species more typical of higher elevations were well represented. The Glow Worm Tunnel – Galah Mountain area appears to have a particularly rich and abundant bat fauna with exceptionally large numbers and a great diversity of species being trapped, both in 1998 and in 2009. In particular, the capture of 51 Large-eared Pied Bats is of note as this threatened bat is usually rarely encountered. The Glow Worm Tunnel – Galah Mountain area is where the majority of Large-eared Pied-bats were caught. The unparalleled abundance, along with the recording of young bats (indicating that breeding occurs nearby) means that this area needs to be recognised as extremely important to the conservation of this bat. This species will be discussed further in Section 4.

Some of the insectivorous bats have only been recorded by ultrasonic call and are yet to be confirmed by trapping. For example, two separate Freetail-bat species of the genus *Mormopterus*; the Eastern Freetail-bat commonly referred to as M*ormopterus species 2* and the Southern Freetail-bat commonly referred to as *Mormopterus species 4* (long penis form). A third species of *Mormopterus* (although recently placed in the genus *Micronomus*), the East-coast Freetail-bat (*M. norfolkensis*), is the only one that has been actually sighted (a single record from a cave from 2005). However, this typically tree-hole roosting species has not been documented using caves as roosts (e.g. Churchill 2008; Hoye *et al.* 2008; M. Schulz pers. comm.) and therefore this record is puzzling and requires confirmation. Due to the taxonomic difficulties with the Freetail-bats, some doubts remain about exactly what members of this group are present in the reserves. It is unlikely that any species extensively use the sandstone country. However, the Wolgan and Capertee Valleys provide good potential habitat for all three species mentioned above, with perhaps the Southern Freetail-bat the most likely species to occur. Further survey work in the grassy woodlands of the valley floors is required to provide a better understanding of the occurrence of the various Freetail-bats in the reserves.

3.3 INTRODUCED SPECIES

3.3.1 Introduced mammals

There are nine species of introduced mammal from the study area. This list includes three carnivores: the Feral Cat, Fox and Feral Dog; three herbivores: the European Rabbit, Feral Donkey and Feral Cattle; the Feral Pig and an introduced rodent, the House Mouse. Some of these are likely to be widespread throughout the area, such as the Fox and Feral Cat, while others are limited to particular areas or habitats, such as the Feral Donkey and European Rabbit.

Some of these pest species have the potential to impact considerably on the biodiversity values of the reserves, either now or in the future. Others are unlikely to ever increase greatly in numbers, be numerous within the park boundaries or be a conservation issue. For example, the Fox is well known to be a voracious predator of native wildlife and is common within the Greater Blue Mountains. Although the Fox appears to be surprisingly uncommon within this study area, it has great potential to impact on threatened species and

other native animals. It will be discussed further in Section 4 of this report. On the other hand, the Black Rat is only known from the very peripheries of the reserves, for example in cleared land around Mt Irvine. It undoubtedly occasionally occurs within the sandstone expanses of the parks as well, as it does in the remainder of the Greater Blue Mountains, however its occurrence is likely to be associated with disturbance or human habitation. It is not considered to be a conservation concern, with studies suggesting that the native Bush Rat (*Rattus fuscipes*) will outcompete the introduced Black Rat in a natural setting. Other introduced mammals that are considered to be of lesser conservation concern include the House Mouse and Feral Donkey. Like the Black Rat, these species are largely confined to disturbed areas.

3.3.2 Introduced birds

There are five introduced birds recorded from within or immediately adjacent to the study area; the Common Myna, House Sparrow, Red-whiskered Bulbul, Spotted Turtle-dove and Common Starling. This is more species than in many parts of the Greater Blue Mountains due to the proximity of the heavily modified areas of the Wolgan and Capertee Valleys and settlements between Clarence and Bilpin. None of these birds appear to have the capacity to invade undisturbed sandstone vegetation (DECC 2007a, 2007b). However, several are a significant conservation issue in Grassy Box Woodlands where the Common Myna and Common Starling will compete with threatened native birds and mammals for hollows. The Spotted Turtle-dove, Red-whiskered Bulbul and House Sparrow are unlikely to be a significant conservation issue wherever they occur. The Common Myna and Common Starling, along with the Eurasian Blackbird will be discussed in detail in Section 4 of this report. The Eurasian Blackbird has not been confirmed within the boundaries of the reserves; however it has been recorded immediately adjacent and is known to be expanding its range into undisturbed vegetation and even wilderness.

3.4 ADDITIONAL SPECIES THAT HAVE THE POTENTIAL TO OCCUR

Records from within five kilometres of the study area provide insight into what species may occur, but have gone undetected. Table 7 lists species that are highly likely to occur within the study area but have thus-far gone undetected. Additionally, species that were detailed in Table 5 may also potentially occur.

Table 7: Additional species that have been recorded within five kilometres and are likely to also occur in the study area.

Scientific name	Common name	Reason it is considered likely to occur
Lewin's Rail	*Rallus pectoralis*	Recorded from hanging swamps in nearby Newnes SF and may occur in hanging swamps within the reserves.
Barn Owl	*Tyto alba*	There are three records of this common owl within 5km of the study area. It is most likely to be associated with open vegetation and disturbed environments.
Brush Bronzewing	*Phaps elegans*	Brush Bronzewing are not uncommon through denser vegetation in the Greater Blue Mountains. There are four records within close proximity of the study area and they are expected to be found, particularly in and adjacent to the upland swamp areas around the Newnes Plateau.
Common Dunnart	*Sminthopsis murina*	This species is rarely encountered but widespread throughout the Greater Blue Mountains and almost certainly occurs within the study area.
Common Scaly-foot	*Pygopus lepidopodus*	This species is rarely encountered but widespread throughout the Greater Blue Mountains and almost certainly occurs within the study area.
Pink-tongued Lizard	*Cyclodomorphus gerrardii*	Pink-tongued Lizards are uncommon in this part of the Greater Blue Mountains where they reach the extreme south of their range. They are likely to occur in the low elevation wetter parts of the study area.
Rainbow Lorikeet	*Trichoglossus haematodus*	Rainbow Lorikeets are nomadic and will use the area occasionally when particular food resources are available.
Smooth Toadlet	*Uperoleia laevigata*	This frog is common and widespread through the Greater Blue Mountains and is likely overlooked due to its cryptic nature.
Painted Honeyeater	*Grantiella picta*	Painted Honeyeaters have been recorded three times in the Capertee Valley, including one spatially inaccurate record that sits just within the boundary of Wollemi NP. Painted Honeyeaters

Scientific name	Common name	Reason it is considered likely to occur
		probably occasionally use grassy woodlands that occur within Wollemi NP along the Capertee and Wolgan Rivers.
Swift Parrot	*Lathamus discolor*	The Endangered Swift Parrot is regularly recorded in the Capertee Valley. They will certainly pass through the study area and probably use winter-flowering Eucalypts that occur on the Wolgan and Capertee Rivers on occasion.
Grey-headed Flying-fox	*Pteropus poliocephalus*	This threatened bat will use the study area occasionally when suitable tree species flower. A single undated museum specimen labelled 'Glen Davis' is inaccurately placed within the park.
Black Rat	*Rattus rattus*	The Black Rat is likely to occur within the study area wherever there is disturbance associated with European settlement.
Eurasian Blackbird	*Turdus merula*	Introduced Eurasian Blackbirds have been recorded in a number of localities in close proximity to the study area and are likely to be expanding their range into more remote parts.

4 PROFILES OF THREATENED AND PEST SPECIES

Large-footed Myotis – one of six Vulnerable bat species confirmed to inhabit the study area. © Martin Schulz

This section provides a profile of each threatened fauna species and key pest species known or considered highly likely to occur within south-west Wollemi and north-west Blue Mountains NPs. The aim of these profiles is to provide: a background on the species biology; a summary of threats to the species; an assessment of how well the species is protected in the region; a map of known records of the species in the study area and the surrounding five kilometres; and an appraisal of the distribution and status of the species in the study area. Due to the spatial inaccuracy of records from the first Birds Australia Atlas, these records have not been included on the species distribution maps. Similarly, records with a low reliability of identification have not been included on the maps.

4.1 THREATENED SPECIES

GIANT BURROWING FROG

Species Profile

The Giant Burrowing Frog (*Heleioporus australiacus*) is a large rotund ground-dwelling frog. Its powerful limbs are used to excavate burrows where it can stay for long periods of time during unfavourable conditions. This species has a large black tadpole with a purple ventral surface that takes up to eleven months to metamorphose (Anstis 2002). The species has two disjunct populations, with one restricted to sandstone geology of the Sydney Basin as far south as Jervis Bay, and the other to the south between Narooma and eastern Victoria (NPWS 2001a). It has been suggested that this disjunct distribution may reflect two separate species, though at present evidence is inconclusive (Penman *et al.* 2004).

Giant Burrowing Frog © M. Schulz

Threats

The primary threat to the Giant Burrowing Frog in NSW is development of its preferred habitat for housing and agriculture (NPWS 2001a). Other threats are not well known but may include alteration of drainage patterns, infection by Chytrid fungus, road mortality, water pollution, frequent fire, forestry operations (DEC 2006b), and predation by Foxes and Feral Cats. Long wall mining may be a significant future threat in the region (NSW Scientific Committee 2005a).

Local and Regional Conservation Status

The Giant Burrowing Frog is listed as Vulnerable under the TSC Act and the EPBC Act. Populations close to Sydney are thought to have declined considerably, with tadpoles being encountered far less frequently than in the past (Anstis 2002). This frog has been recorded within most Sydney Sandstone reserves including Royal, Ku-ring-gai Chase, Garigal and Brisbane Waters NPs and across the Woronora Plateau. There are fewer records from Blue Mountains, Nattai, Wollemi and Yengo NPs and Bargo SCA. Overall, the Giant Burrowing Frog is well represented within the reserve system in the Sydney Basin Bioregion.

Giant Burrowing Frogs have only been recorded from a single locality within the study area, in a remote section of Wollemi NP on the walking trail to Mt Cameron (Map 3). At this site approximately 20 large black tadpoles distinctive to the species were discovered in a pool of water. This frog has been found in an additional 10 locations within five kilometres of the study area and is expected to occur throughout where suitable habitat exists. It is largely confined to the Narrabeen and Hawkesbury sandstones, especially where fish free streams and pools occur for breeding.

The Giant Burrowing Frog appears to be secure in the Greater Blue Mountains reserve system, and no specific management actions are required in the study area at this stage. General management of erosion, pest species and arson (or overly frequent fire) should be sufficient to ensure its long-term survival in the area. Species-specific management may be required in the future if Chytrid fungus is discovered to be affecting populations.

STUTTERING FROG

Species Profile

The Stuttering Frog (*Mixophyes balbus*) is a large frog that becomes highly camouflaged in the wet leaf litter of the forest floor. After summer rains the males make a call that includes a soft stuttering. The thin barring on the limbs in combination with the blue crescent above the iris distinguishes it from other *Mixophyes* in NSW (Barker *et al.* 1995). It is usually associated with small flowing streams in rainforest or wet sclerophyll forest (Anstis 2002), where it feeds on insects and smaller frogs (Gilmore and Parnaby 1994). It breeds in spring and summer and has very long-lived tadpoles that are capable of surviving over winter (Anstis 2002). It was once found along the coast and ranges between northern NSW and Victoria, though it is now found only patchily through its former distribution (Daly 1998).

Stuttering Frog © M. Schulz

Threats

The main threats to the species are thought to be habitat fragmentation and degradation, which can lead to the isolation of sub-populations, increased vulnerability to other threats, and to local extinction (NSW Scientific Committee 2002a). The Stuttering Frog is threatened by the introduced pathogen, Chytrid fungus (Hunter and Gillespie 2006). The disease is known to have seriously affected populations of the closely related Fleay's Barred Frog (*M. fleayi*) (Berger *et al.* 1998), and has been recorded in Stuttering Frog tadpoles and metamorphs in the southern Blue Mountains (DECC 2009a) and Macquarie Pass (Gaia Research 2006a). This frog is also potentially threatened by predation by exotic fish including Plague Minnow (*Gambusia holbrooki*) (NSW Scientific Committee 1999a) and Brown Trout (*Salmo trutta*). Climate change is likely to have a negative impact on the Stuttering Frog in the future (Hunter and Gillespie 2006).

Local and Regional Conservation Status

The Stuttering Frog is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. Within NSW, nearly all records are within the three eastern Bioregions (DECC 2009a). In the southern portion of its range the frog has declined dramatically (Gaia Research 2006b) and within the greater southern Sydney region only two populations are known to survive (DECC 2007b). North of Sydney the species is more widely distributed, but still with only very patchy occurrence (NSW Scientific Committee 2002a). In the Sydney Basin Bioregion this frog is known to persist within a few public lands including Watagan, Blue Mountains and Wollemi NPs (DECC 2009a).

In the study area, the Stuttering Frog has been recorded at only a single historic location near Mt Wilson where a number of (undated) Museum specimens were collected (Map 3). There are a further three historic locations known from within 5km of the study area, with the most recent being from the Newnes Plateau area from 1979. Unfortunately there is a chance that the Stuttering Frog is now extinct in south-west Wollemi and north-west Blue Mountains NPs, with targeted searches in 1999 and the current survey program failing to locate it. However, there is considerable suitable habitat in wilderness areas, and only further survey can confirm whether or not populations of this frog remain. The discovery of Stuttering Frog in two locations in north-western Wollemi NP in December 2005 (DEC 2007a) lends hope to finding further populations in rarely visited wilderness areas.

Further surveys of sheltered creek headwaters and associated rock pools within coastal and hinterland warm temperate rainforest are recommended. Higher rainfall areas should be targeted. The vegetation mapping currently being undertaken in Wollemi NP (DECC in prep.) will assist with the selection of survey sites. Surveys should be undertaken in spring or summer, particularly after rain, when individuals are most vocal and active. Any targeted frog surveys must be undertaken with strict adherence to frog hygiene protocols to ensure diseases are not spread between populations or catchments. Should a population(s) be discovered it would be of very high conservation significance. The greatest threat to the survival of the Stuttering Frog in the reserve system is infection by Chytrid fungus. Testing for Chytrid fungus should therefore be incorporated into any targeted surveys for the species.

RED-CROWNED TOADLET

Species Profile

The Red-crowned Toadlet (*Pseudophryne australis*) is a small, strikingly coloured, litter-dwelling frog. It is restricted in its distribution, generally only occurring on the Hawkesbury and Narrabeen sandstone geologies of the Sydney Basin. This frog lays its eggs in moist leaf litter, relying on rain to wash the eggs into ephemeral ponds where they can complete their development (NPWS 2001b). It is gregarious, being found in colonies of up to 30 individuals (Barker *et al.* 1995), breeding at any time of year in order to take advantage of unpredictable rainfall events (Thumm and Mahony 2002). The Red-crowned Toadlet has a high level of reproductive failure (Thumm and Mahony 2002) and due to its size and morphology, has only a limited ability to disperse.

Red-crowned Toadlet © M. Schulz

Threats

Development of ridgetop land and creek headwaters is the primary threat to the Red-crowned Toadlet. Other threats may include habitat alteration due to frequent fire, bush rock removal, water pollution and Chytrid fungus (NPWS 2001b). The species may also be impacted upon by the removal of dead wood and trees and by habitat alteration due to longwall mining (NSW Scientific Committee 2003a, 2005a).

Local and Regional Conservation Status

The Red-crowned Toadlet is listed as Vulnerable under the NSW TSC Act (1995). Suitable habitat for this species is widespread across the sandstone plateaux of the Sydney Basin Bioregion, with major populations occurring in the upper Blue Mountains, around the mouth of the Hawkesbury River and on the Woronora Plateau extending to Royal NP. Throughout its range it has been recorded in numerous reserves, from Yengo and Wollemi NPs in the north to Barren Grounds Nature Reserve in the south (DECC 2009a).

The Red-crowned Toadlet was first recorded in the study area in 1978 in a remote region near the junction of the Colo and Capertee Rivers (Kingston *et al.* 1979). It has been recorded an additional six times since then, in widely dispersed locations across the study area, including the current BSP surveys where some individuals were recorded off Old Coach Road in Wollemi NP (Map 3). There is also a cluster of records from immediately outside the reserves near Mt Irvine. Similar to the remainder of the Greater Blue Mountains it is expected that this frog is not uncommon, especially on the higher rainfall sandstone plateaux. It tends to be found underneath leaf litter or in dense vegetation at the edge of pools or seepage areas on first and second order creeks and drainage channels.

The Red-crowned Toadlet is restricted to the sandstone geologies of the Sydney Basin Bioregion, with the large reserves, particularly Blue Mountains, Wollemi and Yengo NPs playing a vital role in the conservation of this species over the long term. As known threats for this species are not significant problems within most of these reserves, the Red-crowned Toadlet is considered to currently be secure within the area and does not require any targeted management action. Ongoing general enforcement of laws governing bushrock collection, trail bike erosion and collection of firewood are likely to be sufficient to manage this species successfully. This frog is well adapted to fire and occasional fire events are unlikely to be an issue. The impact of overly frequent fire is more uncertain and should be avoided, as per general fire management. Specific management of this frog may be required in the future if Chytrid fungus is discovered to be affecting populations or if scientific research confirms that frequent fire imposes a significant threat to the species in wilderness areas.

LITTLEJOHN'S TREE FROG

Species Profile

Littlejohn's Tree Frog is a poorly-known species that was only recently taxonomically separated from the Jervis Bay Tree Frog (*L. jervisiensis*) (White *et al.* 1994). It is confined to coastal environs at scattered locations from the Watagan Range west of Gosford to eastern Victoria (Barker *et al.* 1995). Littlejohn's Tree Frog is also known as the Heath Frog, though it can be found in many different habitats, including sedgelands, wet and dry sclerophyll forests and woodlands (Lemckert 2005). Males call at any month of the year, with a review of records from NSW suggesting a peak around February (Lemckert 2005). Males will call from elevated positions beside ponds and creeks (Anstis 2002) with breeding habitat not restricted to any particular type of water body, having been found in streams, temporary pools and dams (Lemckert 2005).

Littlejohn's Tree Frog © H. Jessup

Threats

Littlejohn's Tree Frog is one of the most infrequently recorded frogs in NSW (Lemckert 2005) and consequently, very little is known about threats operating on this species. The NSW Scientific Committee (2000a) lists the following as potential threats: limited dispersal from small populations, which increases the risk of local extinction; clearing of native vegetation and reduced habitat availability; and inappropriate fire practices (including pre- and post-logging burns and control burning) that disturb breeding habitat. It is possible that this species is particularly susceptible to frog Chytrid fungus. Lemckert (2005) states that although the species will definitely tolerate some degree of disturbance, it has never been found in fully cleared areas. The NSW Scientific Committee (2005a) listed this species as one that is likely to have habitat affected by subsidence due to longwall mining. Predation by introduced fish and yabbies is another potential threat to this frog (G. Daly pers. comm.).

Local and Regional Conservation Status

Littlejohn's Tree Frog is listed as Vulnerable under the TSC Act and under the EPBC Act. Scattered records occur within the Sydney Basin and South East Corner Bioregions, where it appears to have declined significantly over the past 20 years. The paucity of records would suggest that it is extremely rare, though Lemckert (2005) cautions that it is likely to be under-recorded due to the lack of information available on which to base targeted surveys. Within the Sydney Basin Bioregion they are currently known from the Watagans and Blue Mountains NPs and the Woronora Plateau, and they are regularly recorded at Barren Grounds NR.

There is a single historic location for Littlejohn's Tree Frog in the study area. In 1972, four museum specimens were collected in the Blue Mountains NP from near the Mt Wilson turnoff near Bell (Map 3). There is another old record from 1963 from Mt Wilson itself, just outside the park. The lack of recent records is typical of what is observed for this species across Greater Sydney and supports suggestions that this frog has fairly recently become far rarer. Encouragingly, there is a recent record from within 5km of the study area from near Mt Tootie from BSP surveys in 2007. In this area the species was found in habitat where there were many sedges, such as Saw-sedge (*Gahnia sieberiana*) and Black Bog Rush (*Schoenus melanostachys*), as well as shrubs such as Tantoon (*Leptospermum polygalifolium*). Similar habitats occur in the study area, as do significant areas of Upland Swamp, a habitat with which it has been associated elsewhere in the Sydney Basin (DECC 2007b).

The status of Littlejohn's Tree Frog in the study area, and indeed through the remainder of the Greater Blue Mountains is currently unknown. Recent records are very rare within the region and the species is considered a high conservation priority, particularly at known breeding sites. It is recommended that further surveys for Littlejohn's Tree Frog be undertaken in creek headwaters and Upland Swamps to establish the extent of the population(s) in the study area and make an assessment of the current risks to their ongoing survival. The greatest threat to the survival of Littlejohn's Tree Frog in the reserve system is likely to be infection by Chytrid fungus. Testing for Chytrid fungus should therefore be incorporated into any targeted surveys for the species.

BLUE MOUNTAINS WATER SKINK

Species Profile

Blue Mountains Water Skink © M. Schulz

The Blue Mountains Water Skink (*Eulamprus leuraensis*) is a medium-sized semi-aquatic lizard that can be identified by the markings on its back, consisting of four narrow golden to white stripes on a dark brown to black background. It has a very restricted distribution, being known from between the Newnes Plateau and just south of Hazelbrook. The Blue Mountains Water Skink is found in a naturally fragmented habitat of high elevation sedge and shrub swamps that have boggy soil. Characteristic plant species in these swamps include Button Grass (*Gymnoschoenus sphaerocephalus*), Blady Grass (*Lepidosperma limicola*), Yellow Flag (*Xyris ustulata*) and Weeping Baeckia (*Baeckia linifolia*) (LeBreton 1996). The skink is active on warm sunny days from September to late April, when it forages in grasses for a range of insects including grasshoppers, flies, moths, weevils and wasps (NPWS 2002d).

Threats

The Blue Mountains Water Skink is particularly vulnerable to threatening processes because of the small number and isolation of its populations and its limited geographic distribution. Key threats include habitat loss, habitat degradation due to nearby urban developments (such as sedimentation, pollution and weed invasion of swampy habitats), predation by Cats and inappropriate fire regimes (NPWS 2001g). It has also been highlighted as a species likely to be threatened by swamp drainage from longwall mining (LeBreton 1996; NSW Scientific Committee 2005a).

Local and Regional Conservation Status

The Blue Mountains Water Skink is Endangered under the NSW TSC Act (1995) and the Commonwealth EPBC Act (1999) and is one of Australia's rarest lizards. All currently known locations are within the Sydney Basin Bioregion, though potential habitat may also occur further west (LeBreton 1996). Just over 40 locations are known, with most being from Blue Mountains NP and Newnes SF, though other sites exist on Crown Reserve and in the Blackheath and Katoomba Special Areas. The majority of known locations from the Blue Mountains occur very close to urban settlements. A recovery plan has been finalised that outlines the key objectives and actions to be undertaken in order to ensure the long-term survival of the skink (NPWS 2001g).

No new records of the Blue Mountains Water Skink were found inside the reserves, despite targeted searches of high-altitude swamps. There is a single existing record for the study area from a swamp in a drainage line in the upper reaches of the Wollangambe River on the outskirts of Bell (Map 3). There are recent records for swamps immediately adjacent to Wollemi NP in the Newnes State Forest, for example in Dinner Creek Swamp and Budgary Creek Swamp and many more records exist within the State Forest where rainfall is higher and more suitable habitat exists (Map 3). Habitat investigated in Upper Deans Creek Swamp was not suitable as the peat layer had been largely destroyed in a hot fire, making this swamp too dry. North of Galah Mountain, there are some additional swamps that appear to have more suitable habitat, but thus far searches have failed to locate the skink here (I. Baird pers. comm.).

This skink is a very high priority for the study area as any known location is of local, regional and national significance. Upland Swamps need to be protected from degrading processes, particularly erosion and sedimentation, clearing, swamp draining (by erosion or other disturbances) and overly frequent or very intense fire. Upland Swamps must be protected from processes occurring upstream that impact on hydrology and water quality, such as urban runoff, clearing, track construction or water channelling. Where this species occurs in close proximity to urban development, measures should be taken to lessen the impact by feral and domestic Cats. Fox and Feral Pig control may also benefit this skink. Making additions to the reserve system of swamps that are known habitat for this lizard would be one of the best measures to improve its conservation status.

ROSENBERG'S GOANNA

Species Profile

Rosenberg's Goanna (*Varanus rosenbergi*) (also known as Heath Monitor) is a large, powerful lizard that occurs in the greater Sydney Basin and the Southern Highlands, but then discontiguously through Victoria, South Australia and south-western Western Australia (King and Green 1999). It is superficially similar to the common Lace Monitor (*V. varius*). It can be distinguished from the Lace Monitor by the fine barring on its lips and tail and the spots on front and back legs. This goanna is known to be associated with sandstone environments in this region, but is relatively cryptic and can be difficult to detect. It is usually found in heath and woodlands where it shelters in burrows, hollow logs and rock crevices (Cogger 2000).

Rosenberg's Goanna © N. Williams

Threats

Rosenberg's Goanna is particularly threatened in urban fringes due to development of the flat sandstone ridge tops that are its preferred habitat, as well as road mortality (NPWS 2002a). Goannas have been identified as taking poison 1080 baits (Thomson and Kok 2002) and thus may be impacted upon by Wild Dog and Fox control programs. Eggs and juveniles may also be vulnerable to predation by Feral Cats and Dogs (DEC 2005d). Rosenberg's Goanna is listed as a species adversely affected by the Key Threatening Process removal of dead wood and dead trees (NSW Scientific Committee 2003a).

Local and Regional Conservation Status

Rosenberg's Goanna is listed as Vulnerable under the TSC Act. The NSW population was once thought to be restricted to the Hawkesbury and Narrabeen sandstones (particularly coastal areas such as Ku-ring-gai Chase NP, Woronora Plateau and Morton NP), but survey work conducted by DECC over the last few years has confirmed it to be present elsewhere in the region, with confirmed sightings from outside the sandstone reserves in Abercrombie River and Turon NPs. In addition, there are anecdotal records of this species from the south-western slopes as far west as Bathurst and for the region around Goulburn (R. Wells pers. comm.), Braidwood and parts of the ACT (M. Schulz pers. comm.). The species is moderately well represented in conservation reserves in the Sydney Basin, including in Wollemi, Yengo and Blue Mountains NPs (DECC 2009a).

Rosenberg's Goanna has been recorded on only two occasions in the study area, once during the CRA surveys of 1998 on Galah Mountain Road, and then in 2009 from the current survey program (Map 3). The recent sighting from open pagoda woodland off Old Coach Road in Wollemi NP was of an adult Rosenberg's Goanna investigating a baited trap and its image captured on a remote camera. There is a third record within 2.5km of the study area from BSP surveys in 2007 in the Grassy Hill region of Wollemi NP. Records of Rosenberg's Goanna are sparsely scattered across Blue Mountains and Wollemi NPs, and in the study area the species is likely to be sparsely distributed across the reserves, particularly on ridgelines and upper slopes in heathy vegetation with or without a canopy present. Rosenberg's Goannas are probably encountered more often than is recorded on the Atlas of NSW Wildlife, but difficulties untrained individuals have in separating it from the Lace Monitor resulting in it being under reported.

Within the system of reserves that run around the western rim of the Sydney Basin, there are few threats to the species, and its habitat is well conserved in the region. Predation by introduced carnivores is likely to be the most significant threat currently acting upon the species, though this goanna has successfully co-existed with Dingoes for 4000 years. General management of fox numbers (which probably prey on juveniles) is likely to benefit this reptile; however no specific management actions are required in this area at this time.

BROAD-HEADED SNAKE

Species Profile

The Broad-headed Snake (*Hoplocephalus bungaroides*) spends the cooler part the year under sandstone exfoliations and around rock outcrops, and the summer sheltering in tree hollows (Webb and Shine 1997). It averages about 60 centimetres in length and is recognisable by its black and yellow patterning. It is restricted to the sandstone environments of the Sydney Basin between Wollemi NP and southwest of Nowra. It has disappeared from Port Jackson and Middle Harbour and the western edge of its distribution around Bathurst. It is primarily a nocturnal ambush predator (NPWS 1999a).

Broad-headed Snake © M. Schulz

Threats

The main threats to the Broad-headed Snake are the removal and disturbance of bush rock (Shine and Fitzgerald 1989) and collection of specimens from the wild by snake-collectors (NPWS 1999a). Other potential threats include: urbanisation of sandstone ridge tops; logging operations; and altered fire regimes including an increase in vegetation density due to long term fire suppression that results in a reduction in winter habitat (Pringle *et al.* 2003). Feral animals may threaten the species through both predation and disturbance (NPWS 1999a), in particular the disturbance of rock outcrops by Feral Goats (Murphy 1996). Habitat alteration by longwall mining and the removal of dead wood and dead trees may also impact upon this snake (NSW Scientific Committee 2005a, 2003a).

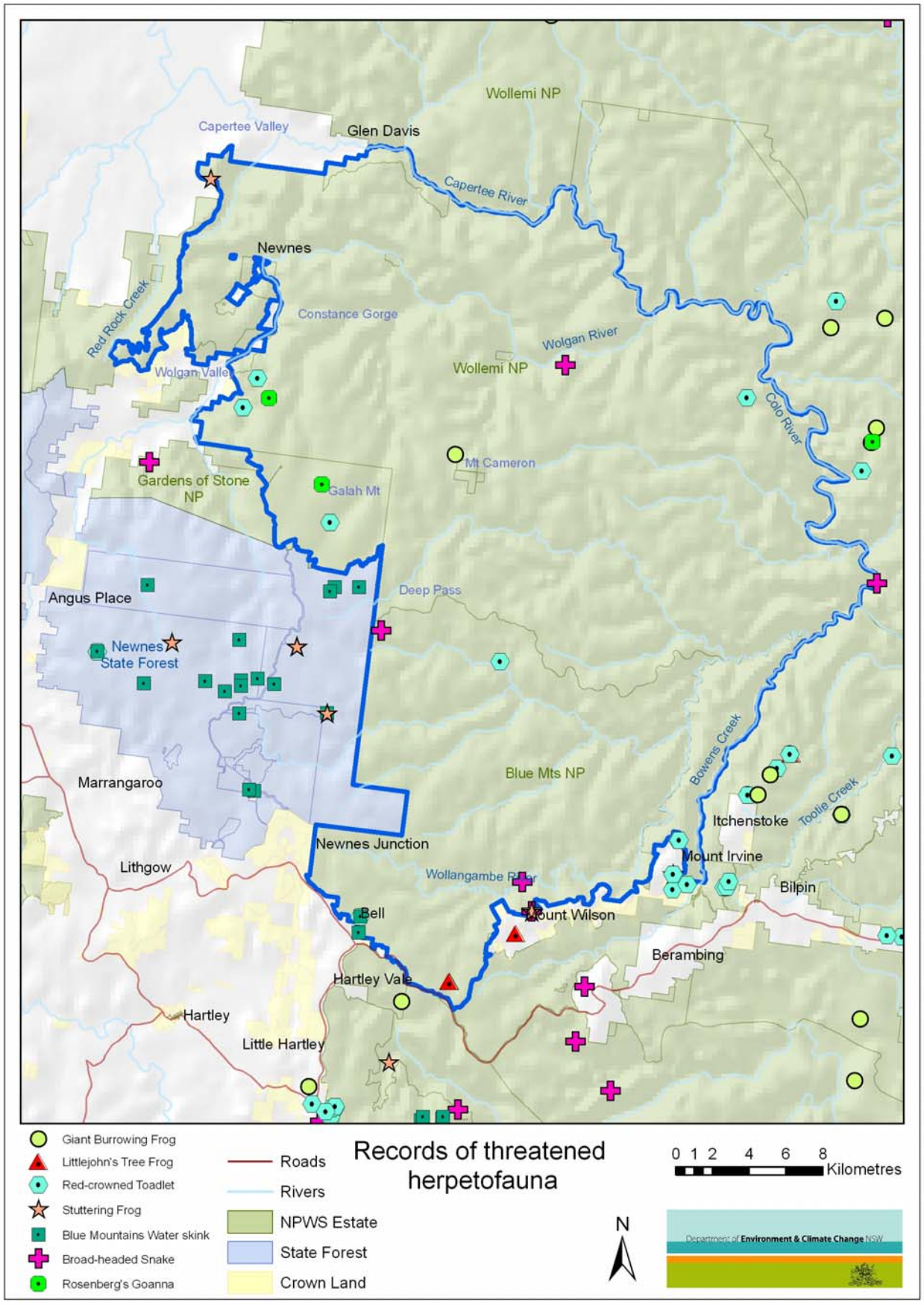
Local and Regional Conservation Status

The Broad-headed Snake is Endangered under the TSC Act and Vulnerable under the EPBC Act. It is restricted to the Hawkesbury and Narrabeen sandstones of the Sydney Basin Bioregion and has disappeared from many locations where it was once well-known to occur. Remaining strongholds appear to be the upper Blue Mountains, southern Wollemi and Royal NPs extending on to the Woronora Plateau. There is also a population in eastern Morton NP, west of Nowra, where recent targeted surveys in high quality habitat detected two individuals in approximately 27 hours of searching by expert herpetologists (P. Craven pers. comm.).

The Broad-headed Snake has been recorded in five disparate locations within the study area (Map 3). Only one record is old, a museum specimen from 1900 from Mt Wilson. All other records are from 1998 onwards, with the most recent from off Deep Pass Trail on a rock outcrop above a tributary of Dingo Creek in Blue Mountains NP in 2008. In 2007, a BSP kayaking survey of the Colo River found a Broad-headed Snake sheltering in a rock overhang on the Colo River on the extreme eastern edge of the study area. Another record comes from a targeted Broad-headed Snake helicopter survey from 1999 and the final is a recent Atlas submission for Whungee Whengee Canyon. Together, these widely spaced recent records suggest that the study area is very important for the Broad-headed Snake.

Threats in the study area may include: previous and current disturbance to and removal of bush rock leading to low availability of winter shelter sites; frequent high intensity wildfire; and possibly predation by introduced carnivores. The relative importance and degree of impact of these threats is unknown. Management would ideally commence with gaining a better understanding of its distribution and status. However, due to the notorious difficulty in detecting this snake, further survey is uneconomical and unlikely to provide much return. Rather, it is recommended that DECC staff, canyoners and bushwalkers are encouraged to submit records of chance encounters to the Atlas of NSW Wildlife. Anecdotally, this snake is frequently encountered in canyons, however these sightings rarely make it to the Atlas.

Management should focus on ensuring that access to mapped areas of extensive outcropping and exfoliating rock is restricted. General management of foxes and arson (and overly frequent fire) are also likely to benefit this snake. Given that this area seems to be important for the Broad-headed Snake, all areas with large amounts of sandstone outcropping and exfoliating rock should be considered to be of high conservation significance.



Map 3: Threatened herpetofauna records within the study area and surrounds.

GANG-GANG COCKATOO

Species Profile

The Gang-gang Cockatoo (*Callocephalon fimbriatum*) is a small, stocky cockatoo with dark grey feathers on its body, narrowly margined with pale grey, orange and red (Pizzey and Knight 1999). Both sexes have a wispy crest that is curved forward and twisted, with the males crest and head being a bright fiery red. The species is endemic to south eastern Australia, ranging from the mid north coast and central tablelands of NSW to far south west Victoria and occasionally into South Australia (Higgins 1999). Gang-gangs are seasonally nomadic, inhabiting tall mountain forests and woodlands in the summer then moving to lower altitudes to drier, open eucalypt forests and woodlands in the winter (Higgins 1999) when they may also be found in urban areas and farmlands. They are gregarious in nature and primarily arboreal, roosting in tall trees and foraging in pairs or family groups for seeds, berries, fruits, nuts and insects in the canopy or occasionally in the understorey or on the ground (Higgins 1999). The Gang-gang Cockatoo requires hollows in large trees for breeding (Pizzey and Knight 1999).

Gang-gang Cockatoo © M. Schulz

Threats

Threats to the Gang-gang Cockatoo are poorly known but are thought to include habitat destruction and degradation; in particular the loss of food trees and large old trees required for roosting and breeding (NSW Scientific Committee 2001a, 2005b, 2008). An important threat is that a large amount of winter habitat has been cleared for agricultural and urban development. Competition for nest hollows with other species may also be problematic (NSW Scientific Committee 2001a), while Psittacine Circoviral (Beak and Feather) Disease may threaten small populations that are already stressed (DEH 2004b). Climate change may alter the extent and nature of the cool temperate vegetation that the species utilises (Olsen *et al.* 2003, NSW Scientific Committee 2005b).

Local and Regional Conservation Status

The Gang-gang Cockatoo is listed as a Vulnerable Species under the TSC Act. The listing was made on the basis of a decline in the reporting of this species across its distribution between 1984 and 2002, though the reliability of this trend was low (Barrett *et al.* 2003). In the Sydney Basin Bioregion it is abundant south of the Hunter River, though there are relatively few records in the Sydney and Wollongong urban areas. Numerous records of the species occur within many reserves, including Kanangra-Boyd, Blue Mountains, Nattai, Wollemi and Yengo NPs. However, there are few nesting records within the region.

There are over 45 records of the Gang-gang Cockatoo from the study area and many more from the 5km surrounding it (Map 4). Records have been collected over a range of years and throughout the full scope of environments, from the highest elevations to the slopes of the Wolgan and Capertee Valleys. Records have been collected during spring, summer, autumn and winter, suggesting that the study area provides habitat for the cockatoo all year round, including nesting habitat. Of the known potential threats to this species, the only ones relevant to the study area are reduced availability of tree hollows from previous logging operations, high intensity crown fires that result in broadscale loss of primary food source (e.g. eucalypt fruits) and potentially climate change.

South-west Wollemi and north-west Blue Mountains NPs are clearly important to the local and regional conservation of the Gang-gang Cockatoo. However, this species is widespread and common throughout the Greater Blue Mountains and there are few threats operating within the reserve system. No targeted conservation management actions are currently required for the Gang-gang Cockatoo in this area, though general management that seeks to prevent the loss of old hollow-bearing trees is likely to benefit the species.

GLOSSY BLACK-COCKATOO

Species Profile

The Glossy Black-cockatoo (*Calyptorhynchus lathami*) is a medium to large black cockatoo, which has a diagnostic black-brown head, the female with yellow patches. Both sexes have orange-red tail panels. This cockatoo is usually seen in pairs or trios (a male and female with dependant young) in eucalypt woodland or forest, where it nests in large hollows. This species feeds almost exclusively on Sheoaks (*Allocasuarina* species including *A. verticillata, A. torulosa* and *A. littoralis*) (Higgins 1999). Two subspecies are restricted to eastern Australia between Queensland (Eungella) and eastern Victoria, with the nominate *lathami* found in NSW, and a third, isolated, endangered subspecies on Kangaroo Island (South Australia) (Higgins 1999).

Glossy Black-cockatoo © H. Jessup

Threats

The major threat appears to be habitat destruction for agricultural or residential development, causing the removal of nesting and feeding sites and also increased competition from more open habitat species such as Galahs. Because many *Allocasuarina* species are fire sensitive, inappropriate burning regimes may affect food supplies (NSW Scientific Committee 2000b). In addition, the removal of dead wood and dead trees is a Key Threatening Process that may impact on this species (NSW Scientific Committee 2003a), as is competition from Feral Honeybees (*Apis mellifera*) (NSW Scientific Committee 2002b) and the loss of hollow-bearing trees in relation to reduced availability of nesting sites (NSW Scientific Committee 2008). In addition, DEH (2004b) lists the Glossy Black-cockatoo as a species that has exhibited symptoms of Psittacine Circoviral (Beak and Feather) Disease.

Local and Regional Conservation Status

The Glossy Black-cockatoo is listed as Vulnerable under the TSC Act. Being a large, conspicuous bird there are numerous records in the coastal third of the state, though it is also found on the western slopes and an apparently isolated population occurs in the Narrandera-Lake Cargelligo area of the Riverina (NSW Scientific Committee 1999b). Relatively large areas of the Sydney Basin provide suitable habitat for the species and there are a large number of records throughout the Bioregion (DECC 2009a). Feeding habitat is well protected, occurring in numerous DECC reserves, including Morton, Nattai, Blue Mountains, Ku-ring-gai Chase, Yengo and Wollemi NPs. However, nesting habitat is poorly known.

There are records of 70 individual Glossy Black-cockatoo at 20 locations within the study area (Map 4). Some of these are actual sightings, while some are records of feeding activity in the form of chewed *Allocasuarina* cones. This cockatoo has primarily been recorded in gully lines and sheltered slopes, as this is where Forest Oak (*Allocasuarina torulosa*) often occurs, though it is also infrequently recorded in more exposed locations, such as where Black She-oak (*Allocasuarina littoralis*) grows. The slopes of the Wolgan River and Rocky Creek where they meet appear to be particularly important with eight locations recorded from this area. Other similar gully systems that have not been visited are likely to be just as important for this bird. There are no nesting records documented, although it is likely to breed in the reserves.

The Glossy Black-cockatoo appears to be widespread and not uncommon in south-west Wollemi and north-west Blue Mountains NPs and it is doubtlessly an important area for the local and regional conservation of the bird. Here and elsewhere in the Greater Blue Mountains the Glossy Black-cockatoo appears to be secure and seems to have few threats acting upon it within the reserve system. No specific management actions are currently required for the Glossy Black-cockatoo in the study area. Fire management may be necessary in the future if research indicates that burning regimes are reducing the abundance or distribution of *Allocasuarina* species and trees supporting nesting hollows.

TURQUOISE PARROT

Species Profile

Turquoise Parrot © DECC

The Turquoise Parrot (*Neophema pulchella*) is a small, brightly coloured parrot, distinguished by its bright green upper parts, yellow under parts and blue face and shoulder patch. The male is considerably brighter than the female, and also has a red shoulder band. The bird usually occurs in pairs or small family parties in eucalypt woodlands and open forests that have a ground cover of grasses. It nests in tree hollows, and has a usual clutch size of two to five eggs (Higgins 1999). It is restricted to eastern Australia, where its range has contracted by over 50 percent since the 1890s (Garnett and Crowley 2000).

Threats

Garnett and Crowley (2000) summarise the main threats as: clearing for agriculture, which has greatly reduced the overall distribution of the species; predation by Cats and Foxes; loss of hollows that are used for nesting in managed forests; and inappropriate burning regimes that may favour a shrubby rather than a grassy understorey. The species is listed as potentially threatened by the removal of dead wood and dead trees (NSW Scientific Committee 2003a). Psittacine Circoviral (Beak and Feather) Disease is not known from this species, but has been recorded in the congeneric Orange-bellied Parrot (*N. chrysogaster*) (DEH 2004b). The species may also be threatened by competition for nesting sites with introduced birds, such as the Common Myna, as well as Feral Honeybees and the loss of feeding habitat due to the invasion of native plant communities by exotic grasses (NSW Scientific Committee 2003b).

Local and Regional Conservation Status

The Turquoise Parrot is listed as Vulnerable under the TSC Act. Within NSW it appears to be most abundant along the western slopes (Nandewar, Brigalow Belt South and NSW South West Slopes Bioregions) and in the Sydney Basin Bioregion (DECC 2009a). In the latter, this parrot is most commonly found within dry grassy woodland environments in the Hunter and Capertee Valleys and to a lesser extent the Cumberland Plain. Important conservation reserves in this Bioregion include Wollemi, Yengo and Goulburn River NPs, Munghorn Gap Nature Reserve and Yerranderie SCA.

The Turquoise Parrot has been recorded 12 times from the study area, primarily from the slopes of the Capertee Valley, Capertee River and Red Rock Creek (Map 5). There are many more sightings just outside the reserves in the Capertee Valley itself. This reflects the strong preference this parrot has for grassy woodlands rather than sandstone woodlands and forests. There is a single reliable record from well within the reserves, from the BSP surveys in October 2008 where an individual was sighted on the flats of the Wolgan River opposite Kitchen Camp. This shows that, although patches are small, there is suitable habitat for the Turquoise Parrot away from the reserve peripheries.

Overall, the present gazetted boundaries of south-west Wollemi and south-east Blue Mountains NPs support relatively little suitable habitat for the Turquoise Parrot. However, a large proportion of Turquoise Parrot habitat in the Goulburn, Capertee, Wolgan, Hunter and Howes Valleys, and on the Cumberland Plain, has been cleared in the past for agriculture, or is still under threat from urban development and expansion of mining activities. Therefore, all habitat conserved in reserves has high conservation value. The study area provides a small yet significant contribution to the regional conservation of the species. At present there are few management actions that could be taken to improve the conservation of this parrot within the reserves – aside from weed management in the few river flats that are reserved. The greatest benefit to this species would come through expanding the edges of Wollemi NP to include more of the valley slopes and floors and more high conservation value grassy woodland environments.

BROWN TREECREEPER (EASTERN SUBSPECIES)

Species Profile

The Brown Treecreeper (*Climacteris picumnus*) is a medium-sized brown bird that is similar in appearance to the Red-browed and White-throated Treecreepers. It is distinguished from both by its slightly larger size, distinctive pale eyebrow stripe and distinctive call. It is a bird of eucalypt woodlands with a grassy or open shrub understorey and abundant fallen timber and/or dead trees. Unlike most treecreepers, it spends approximately half of the time on the ground feeding on insects, particularly ants and beetles, taken from live and dead trees, fallen branches and off the ground. It occurs in pairs or small groups in permanent territories where it breeds in tree hollows (Higgins *et al.* 2001). The eastern subspecies (*victoriae*) occurs along the coast and ranges in Victoria, New South Wales and south-east Queensland, with the other two occurring further west (*picumnus*) and north (*melanotus*) (Schodde and Mason 1999).

Brown Treecreeper © M. Schulz

Threats

The eastern subspecies of the Brown Treecreeper is one of a suite of woodland birds that have declined throughout their range due to habitat clearance (Reid 1999). Studies show populations cannot persist in habitat fragments smaller than 300 hectares, mostly because females must either disperse or suffer from preferential mortality. As with most treecreepers, once extinction occurs in a remnant, natural recolonisation is unlikely (Garnett and Crowley 2000). Competition for tree hollows from introduced species such as the Common Starling and Feral Honeybee is also problematic (Higgins *et al.* 2001; NSW Scientific Committee 2001b). Further processes impacting on this bird are the removal of dead wood and dead trees (NSW Scientific Committee 2003a), the loss of hollow-bearing trees (NSW Scientific Committee 2008) and grazing, which reduces the diversity of ground-dwelling invertebrates and hence food availability (NSW Scientific Committee 2001b).

Local and Regional Conservation Status

The eastern subspecies of the Brown Treecreeper is listed as Vulnerable under the TSC Act. It is found through all the eastern Bioregions in NSW, though it is least common in the South East Coast and Australian Alps, and has declined significantly within the Sydney Basin and NSW North Coast. Within the Sydney Basin Bioregion, this bird is restricted to open woodlands of the central tablelands and open coastal plains and valleys such as the Capertee and Hunter Valleys and the Cumberland Plain (DECC 2009a). These environments are all characterised by agricultural and urban clearing with scattered small isolated fragments of native vegetation. The species is very close to extinction from the Cumberland Plain (DECC 2007b). Habitat exists in few reserves within the Sydney Basin Bioregion though it can be found in Yerranderie SCA, Nattai NP (Burragorang and Nattai Valleys), Goulburn River NP and Manobalai NR and on the edges of Wollemi, Yengo and Blue Mountains NPs.

There are only six spatially accurate records of the Brown Treecreeper from within the study area. Most of these are from the lower slopes of the Capertee Valley near Glen Davis, close to the edge of the reserve (Map 5). However, the current BSP surveys located two birds in a patch of mature White Box near the confluence of Rocky Creek and the Wolgan River, well within the boundaries of Wollemi NP. There are a multitude of records adjacent to Wollemi NP from the Capertee Valley floor and other valleys that are in private ownership. These results show that while most suitable habitat exists outside the reserve system, the small patches of intact Grassy Box Woodlands that occur along the larger rivers of the parks are certainly utilised used by the Brown Treecreeper, though patches are probably not large enough to support viable populations on their own.

South-west Wollemi currently includes only a small amount of peripheral habitat for the Brown Treecreeper and north-west Blue Mountains NP probably has no suitable habitat. Nonetheless, because only tiny amounts of Brown Treecreeper habitat are found in public lands or reserves, all habitat that is conserved has high conservation value. South-west Wollemi NP therefore provides a small yet significant contribution to the regional conservation of the species which could be expanded in the future should more Grassy Woodland habitat be added to the reserve system. Potential threats to the species within the study area may include grazing by introduced herbivores and competition for hollows from the Feral Honeybee, Common Myna and Common Starling.

BLACK-CHINNED HONEYEATER (EASTERN SUBSPECIES)

Species Profile

The Black-chinned Honeyeater (*Melithreptus gularis*) is a small, stocky and short-tailed honeyeater. It is distinguished from other related honeyeaters by its relatively larger size, bright blue or jade green eye-wattle and distinctive call. This bird is nomadic, moving within and between drier eucalypt woodlands that feature Ironbark and/or Box species. It is usually found in pairs or small groups of up to twelve and feeds on insects, nectar and lerps. There are two subspecies, which have in the past been named as two separate species. The eastern, nominate subspecies (*gularis*) is found along the inland slopes of the Great Dividing Range, extending to the coast in the Sydney Basin and Clarence River Valley of NSW, and again between Brisbane and Rockhampton, Qld, as well as into south-eastern South Australia. The 'Golden-backed Honeyeater' (*laetior*) is widespread across north Australia (Higgins *et al.* 2001).

Black-chinned Honeyeater © DECC

Threats

The eastern subspecies of the Black-chinned Honeyeater is one of a suite of woodland birds that have declined throughout their range due to habitat clearance (Reid 1999). They are threatened by fragmentation of woodland habitat and do not appear to survive in remnants less than 200 hectares (NSW Scientific Committee 2001c). The species appears to occur naturally at low densities (NSW Scientific Committee 2001c) and is relatively mobile, so the reason they disappear from small fragments is not well understood (Garnett and Crowley 2000). This bird is likely to experience high levels of competition from aggressive honeyeaters associated with smaller fragments and may suffer increased nest predation from birds such as the Pied Currawong (NSW Scientific Committee 2001c).

Local and Regional Conservation Status

The eastern subspecies of the Black-chinned Honeyeater is listed as Vulnerable under the TSC Act. Scattered records occur in the eastern half of the state, with the highest numbers occurring in the Nandewar, Sydney Basin and NSW South West Slopes Bioregions (DECC 2009a). In the Sydney Basin region most records come from drier areas with fertile soils such as the Capertee and Hunter Valleys and western Sydney, where it is often associated with winter-flowering tree species such as White Box (*Eucalyptus albens*) and Spotted Gum (*Corymbia maculata*). All of these areas have been heavily cleared in the past and remain subject to numerous ongoing threatening processes. Most of the records for the species are outside of conservation areas. However, it has been recorded in a small number of DECC reserves, notably Goulburn River and Werakata NPs and Munghorn Gap Nature Reserve, as well as the edges of Yengo and Wollemi NPs (DECC 2009a).

There are 16 spatially accurate records of the Black-chinned Honeyeater in the study area, half of which are from near Glen Davis and along the Capertee River and the other half are from along the Wolgan River (Map 5). Ten of these records come from BSP surveys of the area. There are many more records from immediately outside the reserve system on the floors of the Capertee and other valleys in private ownership. These results show that while most habitat exists outside the reserve system, suitable habitat does occur along the larger rivers and adjacent lower slopes within Wollemi NP. Little habitat is thought to exist within north-west Blue Mountains NP. As there is little Black-chinned Honeyeater habitat in reserves anywhere in the region, the relatively small amounts that occur within the study area are likely to be important to the regional conservation of the bird. Any additions of Grassy Box Woodlands or Ironbark-dominated woodland to the reserves will improve the conservation status of this bird in the area.

The Black-chinned Honeyeater is a mobile species that moves around the landscape in response to local flowering events. It may occur wherever there is Box or Ironbark and on lower Narrabeen sandstone slopes in lower rainfall areas. Potential threats within the study area are not known and hence no management actions can currently be recommended aside from targeting higher-productivity environments for addition to the reserve system.

REGENT HONEYEATER

Species Profile

The Regent Honeyeater (*Xanthomyza phrygia*) is a medium-sized honeyeater with striking black and yellow plumage. It typically favours Box-Ironbark woodland, though it also utilises River Oak forests and coastal habitats such as Swamp Mahogany (*Eucalyptus robusta*) or Spotted Gum (*Corymbia maculata*) dominated forest. It is semi-nomadic and seems to undertake complex movements, generally dependent on where flowering food trees are available. It feeds on nectar, lerps and insects and nests in the crown of eucalypts where it usually lays two or three eggs. It is endemic to south-eastern Australia, formerly occurring between central Queensland and South Australia. It is now rare in Queensland and probably extinct in South Australia, with a general range contraction in the other two states (Higgins *et al.* 2001). There is probably only a single population of approximately 1500 individuals remaining, with numbers thought to still be decreasing (Garnett and Crowley 2000).

Regent Honeyeater © DECC

Threats

Land clearance for agriculture has removed about three-quarters of habitat that was suitable for the Regent Honeyeater across its range. The remaining habitat is highly fragmented, and continues to be degraded by the removal of larger trees as well as grazing by domestic stock and Rabbits (NPWS 1999b). Habitat alteration may also advantage more aggressive honeyeaters, such as miners (*Manorina* spp.) and friarbirds (*Philemon* spp.), which may displace the Regent Honeyeater.

Local and Regional Conservation Status

The Regent Honeyeater is listed as Endangered under the TSC Act and under the EPBC Act. Within NSW the greatest numbers occur in the Sydney Basin, Nandewar and New England Tableland Bioregions (DECC 2009a). Important areas in the Sydney Basin are the Capertee and lower Hunter Valleys, the northern Cumberland Plain and the Central Coast. The species is primarily observed outside of reserves, although a small number of parks are regularly used, including Goulburn River and Nattai NPs (in the Burragorang Valley), Munghorn Gap Nature Reserve, and occasionally Wollemi NP (DECC 2009a).

Regent Honeyeaters have been recorded at up to 16 occasions within south-west Wollemi NP. All these records come from the Birds Australia 2 Atlas or from birdwatchers around Glen Davis and not all are spatially accurate. There are several more within the park boundary from the Birds Australia 1 Atlas, but these are almost certainly actually from the Capertee Valley itself and have not been included on the map. There were no new sightings of this honeyeater from recent DECC surveys, although none of these surveys were undertaken in the winter months. Just outside of the reserves there are several hundred other sightings from the Capertee Valley floor reflecting the high level of reporting of this very rare bird.

Collation of existing records clearly demonstrates that the best quality habitat for the Regent Honeyeater lies immediately adjacent to Wollemi NP in the low rainfall, grassy woodlands of the Capertee Valley, and to a lesser extent in other valleys in the area (Map 5). It is likely that small patches of White Box within the reserves, such as occur along the Capertee River and Wolgan River, are occasionally used by this bird. However, the importance of these patches requires targeted winter surveys over several years when the White Box is flowering.

Clearing has greatly reduced the available habitat in the region. Much remaining high quality habitat within the region is fragmented and continues to be degraded or under pressure from development, though conservation works in the Capertee Valley are working hard to improve the situation for this bird. Any habitat that is preserved within the reserve system has high conservation significance. Though the study area contains only a small amount of peripheral habitat, it may none-the-less contribute to the network of foraging resources available to the Regent Honeyeater in the region.

Despite the rarity of this bird, targeted management actions within the park system are difficult to prescribe due to its nomadic nature and the relatively small amount of high-quality habitat currently reserved. Clearly, high conservation value Grassy Box Woodlands along the Capertee and Wolgan Rivers and other larger rivers in the study area should be a priority fire protection and for general weed and pest management. Targeting this habitat for addition to the reserve system, particularly known breeding locations for the Regent Honeyeater, would confer the greatest benefit to this bird.

SQUARE-TAILED KITE

Species Profile

The Square-tailed Kite (*Lophoictinia isura*) is a medium-sized, long-winged raptor with a diagnostic white face (Marchant and Higgins 1993). It is endemic to the Australian mainland, where it is most often recorded within 250 kilometres of the coast (Garnett and Crowley 2000). In southern Australia it is most regularly recorded in open eucalypt forest and woodland, where it hunts at canopy level feeding on birds, including eggs and nestlings, and insects (Marchant and Higgins 1993). Breeding pairs utilise a large home range (up to 100 square kilometres) during the breeding season. Square-tailed Kites migrate to northern Australia after breeding has completed, though the dispersal route is unknown (Marchant and Higgins 1993).

Square-tailed Kite © T. Tarrant

Threats

Loss of habitat through land clearance is likely to be a major threat (NPWS 1999c), though it has been suggested that the Square-tailed Kite may also have benefited from partial clearance (Garnett and Crowley 2000). NPWS (1999c) also lists illegal shooting, egg collection, disturbance of nest trees and inappropriate fire regimes as potential threats.

Local and Regional Conservation Status

The Square-tailed Kite is listed as Vulnerable under the NSW TSC Act (1995) due to a decline in abundance across this state. Within NSW, records are located in all Bioregions, though there are only scattered records from the South Eastern Highlands. Important locations within the Sydney Basin Bioregion are the Shoalhaven/Jervis Bay area and the drier woodlands on more fertile soils such as the Capertee Valley, Goulburn River area and the northern Cumberland Plain. Breeding has been recorded from all of these locations except the last, and records exist for a number of reserves including Jervis Bay and Goulburn River NPs (DECC 2009a).

The Square-tailed Kite has been recorded on three occasions within the study area, all within south-west Wollemi NP (Map 4). Two of these records are NSW Bird Observers records from the Glen Davis area (from 1989 and 1992) and are possibly a little spatially inaccurate, though there is no doubt they were seen within close proximity of the park if not within it. The final record is from 2008 from the current BSP survey program when a lone individual was seen cruising close above the canopy on a hike to Mt Cameron. There are a further three records within 5km of the reserve boundary, two within the Capertee Valley and one in the Wolgan Valley. It is in these open valleys that we would expect to see this raptor most regularly. However, the sighting from near Mt Cameron confirms that the species also uses the interior of the reserves. Given this, the Square-tailed Kite is considered likely to occur elsewhere in the reserves, particularly the woodlands on Permian geologies on the slopes and floors of the Capertee and Wolgan Valleys where it is likely to be an occasional visitor and may potentially breed in spring/early summer.

As this bird is semi-nomadic and has rarely been seen in the study area, there are no management recommendations that can be prescribed. Targeting for reservation the higher productivity woodlands on the slopes and valley floors adjacent to the current reserve system would be a way to improve the conservation value of these parks to the Square-tailed Kite.

SPECKLED WARBLER

Species Profile

The Speckled Warbler (*Pyrrholaemus sagittata*) is a small, primarily ground-dwelling bird. It is similar in size to the Buff-rumped Thornbill (*Acanthiza reguloides*) but can be identified by its boldly streaked underbody, distinctive facial pattern, noticeably longer tail and distinctive call. It usually occurs in low shrub thickets and adjacent grassy understorey of dry sclerophyll forests and woodlands dominated by eucalypts. It feeds on insects and seeds with most foraging occurring on the ground. Pairs, and occasionally trios, live permanently in large (up to twelve hectares) territories where a well-concealed domed nest is built on the ground in grass tussocks, usually under logs or other cover. Two to four (usually three) eggs are laid, though breeding success can be low. The Speckled Warbler is endemic to south-eastern Australia, occurring between Maryborough in south-eastern Queensland western Victoria (Higgins and Peter 2002).

Speckled Warbler © M. Schulz

Threats

The Speckled Warbler is one of a number of woodland birds that has declined in density throughout its range due mainly to agricultural land clearing (Reid 1999). Speckled Warbler populations are estimated to have declined by at least twenty percent in the last fifteen years (Traill and Duncan 2000). Populations in small isolated vegetation patches may experience local extinction due to natural fluctuations (Garnett and Crowley 2000). Extinction occurs in areas that do not support vegetation patches greater than 100 hectares in area (NSW Scientific Committee 2001d). The species nests and forages on the ground and hence is susceptible to predation by exotic mammalian predators and loss of ground cover by stock and Rabbit grazing and weed invasion (NSW Scientific Committee 2001d, Garnett and Crowley 2000). Speckled Warbler is listed as potentially adversely affected by the Key Threatening Process of invasion of native plant communities by exotic perennial grasses (NSW Scientific Committee 2003b), as well as by inappropriate fire regimes that alter vegetation structure.

Local and Regional Conservation Status

The Speckled Warbler is listed as Vulnerable under the NSW TSC Act (1995). It is widespread in the eastern Bioregions of the state, extending as far west as the Cobar Peneplain, but is scarce or absent from the South East Coast and Australian Alps. Within the Sydney Basin Bioregion most records are from dry woodlands, including the Burragorang Valley, lower Hunter Valley, Cumberland Plain and Goulburn River Valley. Its preference for woodlands on higher fertility soils means that it mostly occurs outside the reserve system though it does occur in Nattai and Goulburn River NPs and the fringes of Wollemi and Yengo NPs as well as Munghorn Gap and Manobalai Nature Reserves (DECC 2009a).

There are six records of the Speckled Warbler from within the study area, all from the edges of Wollemi NP (Map 5). Three are from the Capertee River area and the other three are from the Wolgan Valley. All records from the Wolgan Valley come from the recent BSP surveys and most from just within the Park boundary. There are over 30 records from within 5km of the National Park on the Capertee Valley floor and other valleys in that area. This reflects the fact that the Speckled Warbler is another species that is dependent on woodlands growing on higher-productivity soils that are largely unreserved.

Although there is not a large amount of Speckled Warbler habitat within the reserve, the woodlands that support them have high local and regional conservation significance, as the majority of habitat elsewhere in the region remains threatened by agricultural, industrial and urban development. These woodlands should be a high priority for general weed and pest species management, especially with regard to invasive grasses, the presence of Foxes and Feral Cats and the loss of fallen timber. Burning that completely removes the shrub thicket layer should also be avoided in areas where Speckled Warblers are present. South-west Wollemi NP provides a small yet significant contribution to the regional conservation of the species which could be expanded in the future should more Grassy Woodland habitat be added to the reserve system.

HOODED ROBIN (SOUTH-EASTERN SUBSPECIES)

Species Profile

The Hooded Robin (*Melanodryas cucullata*) is a medium-sized bird that typically occurs in eucalypt woodland or *Acacia* shrubland. The adult male is distinctive, having a black hood and upper body combined with a white shoulder stripe. The adult female is mostly grey with a dark-brown wing. Both sexes have a white wing stripe and underparts and a prominent white side-panel on the tail, which along with their larger size and call, distinguish this species from the Jacky Winter (*Microeca fascinans*) and female *Petroica* Robins. This bird uses dead or fallen timber as perches, from which they pounce to feed mainly on insects and small lizards (Garnett and Crowley 2000). It usually occurs as pairs, though cooperative breeding is also common, with normally two or three eggs laid in a cup-shaped nest placed in a horizontal fork (Higgins and Peter 2002). There are four subspecies covering most of Australia. The two subspecies in New South Wales are *picata,* which extends from north-western NSW through to the Kimberleys in Western Australia, and the nominate (*cucullata*) which occurs between Queensland and South Australia (Schodde and Mason 1999).

Hooded Robin © M. Schulz

Threats

The south-eastern subspecies of the Hooded Robin has been identified as one of a number of birds that have declined in the sheep-wheat belt of central west NSW due to the degradation and fragmentation of woodland habitats (Reid 1999). Populations do not persist even in large fragments of remaining habitat, although the precise reason for this is as yet unknown (Garnett and Crowley 2000). Habitat modification and a reduction in food availability through grazing by stock and weed invasion may also be threats (NSW Scientific Committee 2001e, 2003b). Eggs and young have been known to be predated upon by native avian predators and possibly by the Fox (Higgins and Peter 2002), Feral Cat and Black Rat. The Key Threatening Process removal of wood and dead trees is also likely to adversely affect the species.

Local and Regional Conservation Status

The south-eastern subspecies of the Hooded Robin is listed as Vulnerable under the NSW TSC Act (1995). It has been recorded in most Bioregions in New South Wales, though is rare in the Australian Alps, South Eastern Highlands and Riverina Bioregions, and is restricted in the NSW North Coast Bioregion. Within the Sydney Basin Bioregion it is virtually restricted to the Hunter, Capertee and Burragorang Valleys where it is closely associated with the drier woodland habitats. It has virtually disappeared from the Cumberland Plain (Keast 1995). Within the Sydney Basin it has been recorded from a limited number of reserves including Wollemi, Nattai and Goulburn River NPs and Munghorn Gap Nature Reserve, though most records are on the boundary of the reserves where higher fertility soils occur.

There are two records of Hooded Robin from inside the boundary of the study area, both Birds Australia 2 Atlas records from south of Glen Davis (Map 4). The spatial accuracy of these records is reasonable but they may actually be from outside the boundary of the park where most records are found – some 37 further locations are recorded from the Capertee Valley within 5km of the boundary of the park. There is another record from Newnes township just 100m outside the boundary of the park. No Hooded Robins were recorded in the recent BSP surveys, although no winter bird surveys were conducted when this species may be more likely to occur. Of all the declining woodland birds, the Hooded Robin is likely to have the least habitat in conservation reserves.

Habitat for the Hooded Robin would once have been widespread across the Capertee and Wolgan Valleys and the smaller valley systems of the area. Clearing for agriculture has reduced the available habitat to isolated paddock trees and remnants of Box-Red Gum Woodland on creek flats and lower escarpment slopes. As so little habitat for this bird exists within the park, it is difficult to prescribe conservation management actions for this area. However, even the smaller inholdings of higher fertility soils are likely to be important for the robin. Landholders in inholdings, for instance around Newnes, and on the peripheries of the park should be encouraged to retain paddock trees (even if they are dead), fallen timber and other perch sites for the species. The protection of dry woodlands on creek flats both on the reserve and on adjoining private lands is vital to the survival of the species within the region. Expanding Wollemi NP to include more high-quality Grassy Box Woodlands in the Capertee and Wolgan Valleys (or other valleys in the area) would be an effective way of improving the conservation status of the Hooded Robin in the area.

DIAMOND FIRETAIL

Species Profile

The Diamond Firetail (*Stagonopleura guttata*) is an attractive finch with a red eye, beak and rump (Pizzey and Knight 1999). It is most frequently encountered in Eucalypt-dominated communities that have a grassy understorey, where it feeds mainly on grass seeds (Garnett and Crowley 2000). The Diamond Firetail is somewhat nomadic, in response to the distribution and abundance of seeding native grasses. The species is usually encountered in pairs, though is known to form small flocks in autumn, winter and early spring. It builds bottle-shaped nests in trees or sometimes mistletoe, usually producing four to six eggs (Pizzey and Knight 1999). The species is endemic to south-eastern Australia, with records extending from Rockhampton (Queensland) to the Eyre Peninsula and Kangaroo Island (South Australia) (Pizzey and Knight 1999). Most populations occur on the inland slopes of the Great Dividing Range with only small pockets of habitat occurring near the coast (Blakers *et al.* 1984).

Diamond Firetail © C. Ramsay

Threats

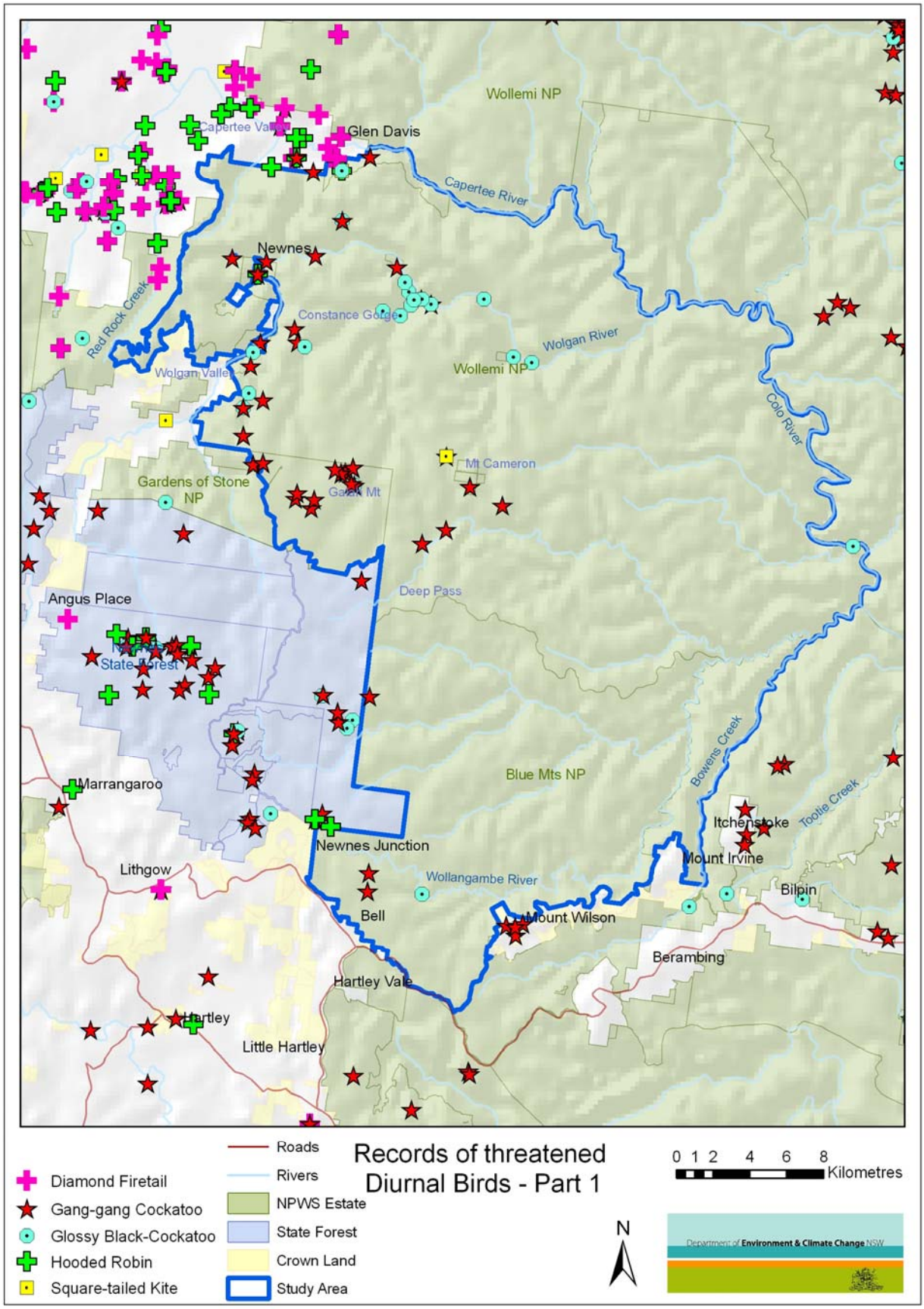
Habitat for the Diamond Firetail has been largely cleared and it is included in the list of woodland birds that have dramatically declined in the sheep-wheat belt of central west NSW (Reid 1999). It appears unable to survive in areas with no remnants larger than 200 hectares (NSW Scientific Committee 2001f). Remaining habitat is threatened with degradation by over-grazing and the spread of exotic grasses, which may result in the loss of key food plants and possibly competition from flock-foraging Red-browed Finches (*Neochmia temporalis*) (Garnett and Crowley 2000, NSW Scientific Committee 2003b). Predation by Foxes and Feral Cats may be another threat (as the species forages on the ground) (Smith *et al.* 1995); as well as inappropriate fire regimes that alter vegetation structure.

Local and Regional Conservation Status

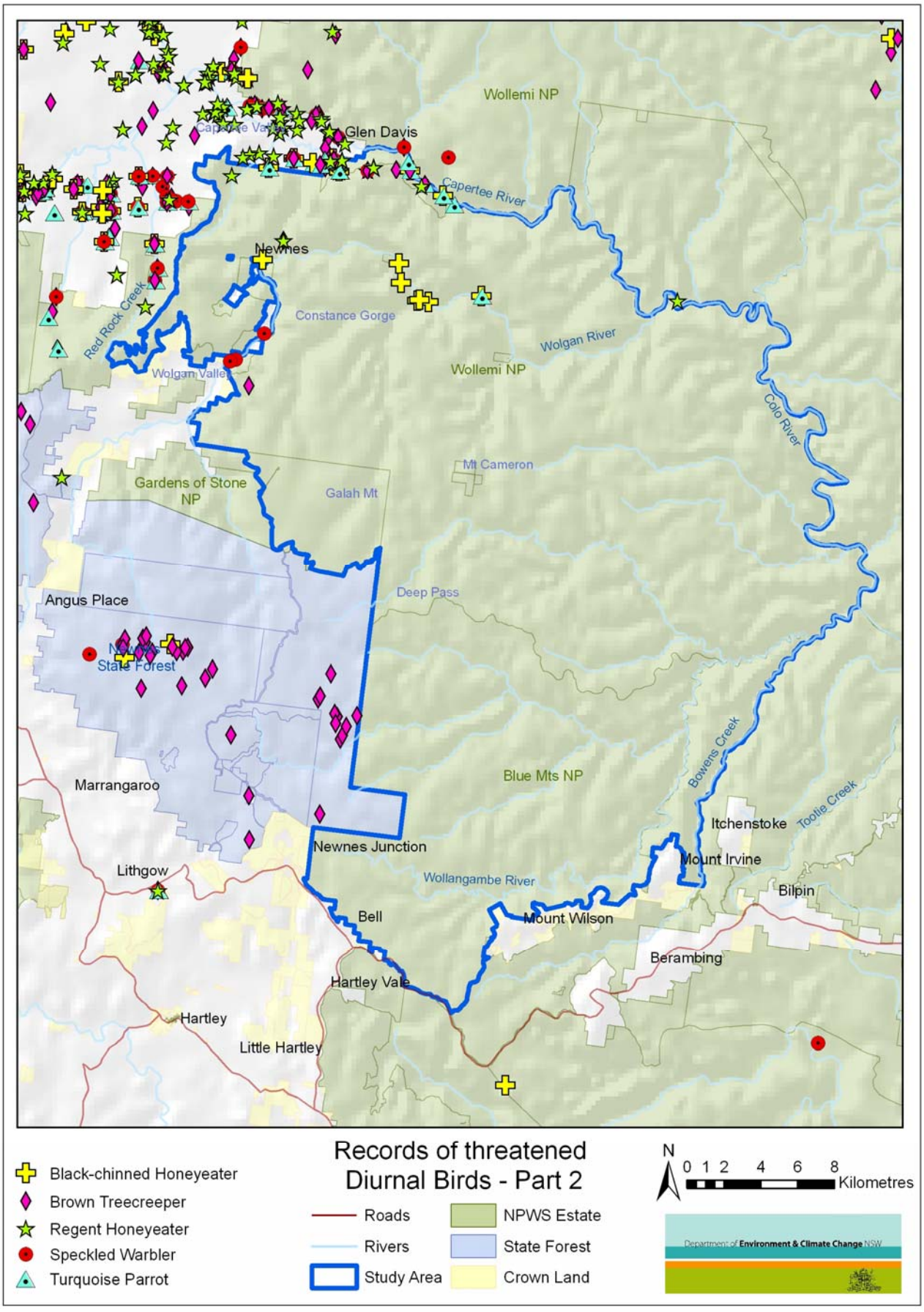
The Diamond Firetail is listed as Vulnerable under the NSW TSC Act (1995). It is known from the eastern two thirds of the state. Within the Sydney Basin Bioregion the species is closely associated with grassy box woodlands found on the more fertile soils on the inland valleys and plains, including the Capertee, upper Hunter and Burragorang Valleys, and occasionally on the Cumberland Plain. These environments are generally poorly represented in reserves, though records are known from the Burragorang Valley in Nattai NP, Goulburn River NP and Munghorn Gap NR and the boundaries of Wollemi NP (DEC 2009a).

There is only a single record of the Diamond Firetail from within the boundaries of the reserves in the study area (Map 4). It is from south of Glen Davis and is a Birds Australia 2 record from 1998. There are over 40 records of Diamond Firetails from within 5km of the study area boundary, all from the Capertee and adjoining valleys. No new records were obtained from the recent BSP surveys, although it is likely to occasionally range into the reserve, particularly in the Glen Davis area. There is very little habitat for the Diamond Firetail within the reserves at present and therefore few management recommendations that can be applied.

Grassy Box Woodlands that do occur in the reserve should be a focus of pest and weed control due to their high conservation value to this and other species. Any additions of this type of woodland to the reserve perimeters would improve the regional conservation of the Diamond Firetail. Landholders occupying properties with grassy woodlands that are inholdings or on the edges of the park should be encouraged to manage their land for the Diamond Firetail. Such management includes no new clearing, avoid the removal of fallen timber, improving connectivity between woodland patches and the control of exotic grasses, Foxes and Feral Cats.



Map 4: Part one of threatened diurnal bird records within the study area and surrounds.



Map 5: Part two of threatened diurnal bird records within the study area and surrounds.

BARKING OWL

Species Profile

The Barking Owl (*Ninox connivens*) is of intermediate size between the larger Powerful Owl and the Southern Boobook. It has dark brown upper-parts and coarse brown streaking on its breast (Higgins 1999). It is often identified by its call, which is a dog-like double bark that can be confused with Fox or Dog barks. The Barking Owl usually inhabits dry open eucalypt forests and woodlands, where it is associated with hydrological features such as rivers and swamps (Taylor *et al.* 2002a). It nests in hollows, usually of large eucalypts, where it lays one to three eggs. It is an opportunistic feeder, eating more insects than other large forest owls, but consumes small terrestrial and arboreal mammals and birds during the breeding season. The race *connivens* occurs east of a line connecting Cooktown (Queensland) and the Flinders Ranges (South Australia) with an isolated population in the south west of Western Australia. Other races occur across northern Australia, in New Guinea and the Moluccas (Higgins 1999).

Barking Owl © M. Schulz

Threats

The main identified threat to the species is habitat destruction, particularly the removal of woodlands and forests from more low-lying fertile areas for agriculture (Taylor *et al.* 2002b). Remaining habitat is often subject to degradation through grazing or forestry operations that fell old-growth and over-mature trees, thus reducing available nest sites (NPWS 2003c). However, the owl is frequently located at the edge of forest blocks adjacent to cleared land, possibly due to increased prey availability at such locations (Taylor *et al.* 2002b). Other threats include predation (particularly of fledglings), mortality from collisions with fences and vehicles, secondary poisoning from rodenticides, collection of firewood and removal of dead wood and trees, loss of hollow trees and competition from Feral Honeybees (Garnett and Crowley 2000, NSW Scientific Committee 1998, 2008). The long generation time of this species (ten years) is further compromising the ability of this owl to recover after population declines (NSW Scientific Committee 1998).

Local and Regional Conservation Status

The Barking Owl is listed as Vulnerable under the TSC Act. Records occur throughout NSW, though it is rarer in the far west and at higher altitudes (DECC 2009a). Records are scattered throughout the Sydney Basin Bioregion, the most important locations appearing to be the Capertee and Hunter Valleys. Within this Bioregion very few records are located within conservation reserves, with most being on private lands (DECC 2009a). However, recent DECC surveys have obtained a small number of records from the dry woodlands in Yengo and northern Wollemi NPs as well as Manobalai Nature Reserve and Crown Lands.

There are only three records of the Barking Owl within the study area – all within metres of the Wollemi NP boundary (Map 6). Two of these are from the Newnes ruins/Little Capertee Creek area (from 1996 and 2001) and the other is a Birds Australia record from south-west of Glen Davis from 1998. A further three records occur on the Capertee Valley floor within 5km of the study area. This reflects the scarcity of this owl in the region and its preference for high-fertility open woodlands over the sclerophyll forests that dominate Wollemi and Blue Mountains NPs. There is very little habitat for the Barking Owl in the study area other than on the lower slopes of the Capertee and Wolgan Valleys, along those rivers and other patches of open grassy woodland that occur.

Although there is little suitable habitat in the study area, what does occur is still of high conservation significance as most of this high-quality habitat in the Capertee, Goulburn and Hunter Valleys and on the Cumberland Plain has been cleared for agriculture, industry and settlements and remaining patches are under continued pressure from these threats. As the major threat to this owl is habitat loss, there are few if any recommendations that can be made for managing it within conservation reserves. The best way to improve the conservation of this species in the area would be to target Grassy Box Woodlands for addition to the reserve peripheries. Encouraging neighbouring landholders to retain hollow-bearing trees and leave fallen timber will assist in the conservation of this owl in the region.

POWERFUL OWL

Species Profile

Powerful Owl © N. Williams

The Powerful Owl (*Ninox strenua*) is the largest owl in Australia. It has a small, round head and long tail, is dark brown above with prominent off-white barring, and paler underneath. It inhabits various forest habitats, though it usually breeds and roosts in dense forest types, including rainforest and wet sclerophyll forest. It hunts in more open forests, where it feeds mainly on arboreal mammals, particularly Common Ringtail Possums and Greater Gliders (Kavanagh 2002a). This owl usually nests in a hollow in a eucalypt, and normally lays two eggs. It usually maintains a territory of between 300 and 1500 hectares, with size dependent on habitat quality and prey density. The species is endemic to eastern Australia, being recorded between Eungella (Queensland) to near the South Australia-Victoria border (Higgins 1999).

Threats

Past land clearance for agriculture has reduced the habitat available for the Powerful Owl (Garnett and Crowley 2000), particularly the availability of nest sites. The owl can, however, survive in areas with some levels of disturbance, such as in selectively logged forests (Kavanagh 1997) and suburban bushland areas of Brisbane, Sydney and Melbourne (Garnett and Crowley 2000, DECC 2008c). Whether or not the owl can survive in urban areas depends on how much prey is available (Chafer 1992) and if there are suitable nesting/roosting sites (Debus and Chafer 1994). Other threats include predation of fledglings by Foxes and secondary poisoning, though neither is thought to be a significant cause of mortality (DEC 2006c). In addition, the foliage roosts of the Powerful Owl are vulnerable to regular hazard reduction burning (DEC 2006c). Loss of hollow-bearing trees is also likely to affect this species (NSW Scientific Committee 2008), including a loss of these trees as a result of hazard reduction burns.

Local and Regional Conservation Status

The Powerful Owl is listed as Vulnerable under the TSC Act. Within NSW, the majority of records occur within the three coastal Bioregions, but occasional sightings have also been made further west. It is regularly recorded throughout the Sydney Basin Bioregion, from the rural-urban fringes of the Sydney Metropolitan area to west of the Dividing Range onto the Central Tablelands. Recent work within the Sydney Catchment Authority Special Areas (Woronora and Warragamba) has found Powerful Owls to be in higher densities and more widespread within the sandstone country of the Sydney Basin than previously thought (DECC 2007b). Most reserves within the Sydney Basin Bioregion support this owl, though they are at lower densities in the drier environments of the north-west.

There are seven records of the Powerful Owl from within the study area – three of which are from the recent BSP survey: two from call playback surveys on the Wolgan River and the third from a distinctive breast feather found on the upper reaches of Deans Creek in the Galah Mt area of Wollemi NP (Map 6). The final record comes from 1995 from Old Coach Road. There are a further three recent records from the Wolgan Valley area (J. Pascoe pers comm.). Outside of the study area there are an additional seven records within 5km, all within the sandstone plateaux – mostly from the Newnes Plateau.

Although there are few sightings of this owl in the study area, the spread of records indicates that there is a large amount of habitat available. It is likely that this area supports a moderate density of Powerful Owls as seen in similar areas within the Greater Blue Mountains. The higher productivity forests of the Wolgan River appear to support higher densities than the surrounding plateaux forests.

The Powerful Owl is considered to be secure in the Sydney Basin and there are few management recommendations for protected areas. Nonetheless, breeding sites are very important and should any be discovered in the future, care should be taken that they are not destroyed by fire or other activities. Management of the owl across the region should be undertaken in accordance with the state-wide recovery plan (DEC 2006c).

MASKED OWL

Species Profile

The Masked Owl (*Tyto novaehollandiae*) is a large owl that is distinguished from the Barn Owl by its larger size, more thickset and hunchbacked appearance, fully feathered legs and bigger feet (Higgins 1999). It inhabits a wide range of open forest and woodland habitats, requiring large hollows for roosting and nesting and open areas for hunting. It feeds mostly on ground-dwelling mammals such as rats and Antechinus, and occasionally on birds, Sugar Gliders and insects (Kavanagh 2002a). It appears to forage near ecotones, either at the boundary of forests of different structural composition or at the forest edge, and may thus benefit from the mosaic of burnt-unburnt patches in the landscape after fire (DEC 2006c). The owl has a home range of 800 to 1200 hectares (Kavanagh 2002c). The local subspecies *novaehollandiae* was formerly found in coastal areas from Fraser Island (Queensland) to Carnarvon (Western Australia), though its range has contracted, particularly in Western Australia (Garnett and Crowley 2000). Other subspecies occur in Tasmania, northern Australia and New Guinea (Higgins 1999).

Masked Owl © R. Jackson

Threats

The primary threat is clearance of native forest for agriculture and urban development, and the resulting fragmentation of habitat (Garnett and Crowley 2000). It will not persist in forest patches smaller than 200 hectares (Kavanagh 2002b). In NSW, core areas for this owl are the Central Coast and Lower Hunter Valley where little habitat is in reserves and is under continued pressure from urban and industrial development. The owl may be affected by logging, through removal of hollows or reduction in foraging habitat due to vigorous regrowth (Garnett and Crowley 2000). It has been suggested that modern mosaic logging operations do not cause major changes to the abundance of the species (Kavanagh 2002b). The removal of dead wood and dead trees and loss of hollow-bearing trees is considered to be a Key Threatening Process affecting this species (NSW Scientific Committee 2003a, 2008).

Local and Regional Conservation Status

The Masked Owl is Vulnerable under the TSC Act. Most records in NSW are located within the coastal bioregions with a few records further west (DECC 2009a). Within the Sydney Basin Bioregion, the woodlands of the coastal plains between Wyong and Port Stephens support high numbers with concentrations also occurring in the south coast and to a lesser extent in the southern Blue Mountains. The Masked Owl is found within many DECC reserves in Greater Sydney, including Royal, Blue Mountains, Nattai, Kanangra-Boyd, Brisbane Water, Wollemi and Dharug NPs and Berowra Valley Regional Park (DECC 2009a). Few of these parks have high quality habitat for the owl and there are few nesting records within these parks.

The Masked Owl has been recorded on five occasions within the study area; all very recently. All records are from the Wolgan Valley/Deans Creek/Wolgan River area (Map 6). Three are from the BSP surveys in late 2008 and a further two are from survey work conducted for a PhD in this area (J. Pascoe pers comm.). There are a further two records from within 5km of the study area, one from Newnes SF, the other from near Mt Haystack on Bowens Creek. These results are consistent with other survey results for the Greater Blue Mountains where there is a very low response rate to call-playback surveys in sandstone forests and woodlands, with greatest success being achieved from higher fertility forests and woodlands.

The three Masked Owl records from the Wolgan Valley in a single week of surveying is a particularly high success rate and indicates that this area is very important to the local conservation of this owl. Similar environments nearby are also likely to be very good habitat for the Masked Owl. As the key threat to this owl is clearance of native vegetation, there are few management recommendations for on-reserve management. Any activity that results in the loss of hollow-bearing trees should be avoided, particularly along the Wolgan River. Should any breeding sites be discovered in the future, they should be protected from any interference or destruction in control burns. Management of the owl in the region should be undertaken in accordance with the state-wide recovery plan (DEC 2006c).

SOOTY OWL

Species Profile

The Sooty Owl (*Tyto tenebricosa*) is a medium to large 'barn' owl, with sooty grey plumage that is finely spotted and flecked with white. It is found in tall wet forests, including wet sclerophyll and rainforest, where it is often first detected by its distinctive 'falling bomb' call. It roosts and breeds in tree hollows (often located in old emergent trees) as well as in deep sandstone overhangs or dark caves (DEC 2006c). It is usually located within 100 metres of a stream (Kavanagh 1997). Pairs probably maintain permanent territories that are between 200 and 800 hectares in area, depending on the availability of prey (Higgins 1999). The species feeds on a wide range of arboreal and terrestrial mammals (Kavanagh 2002a). In Australia the subspecies *tenebricosa* is distributed along the east coast between Queensland and Victoria. A smaller subspecies (*arfaki*) occurs in New Guinea (Higgins 1999).

Sooty Owl © R. Jackson

Threats

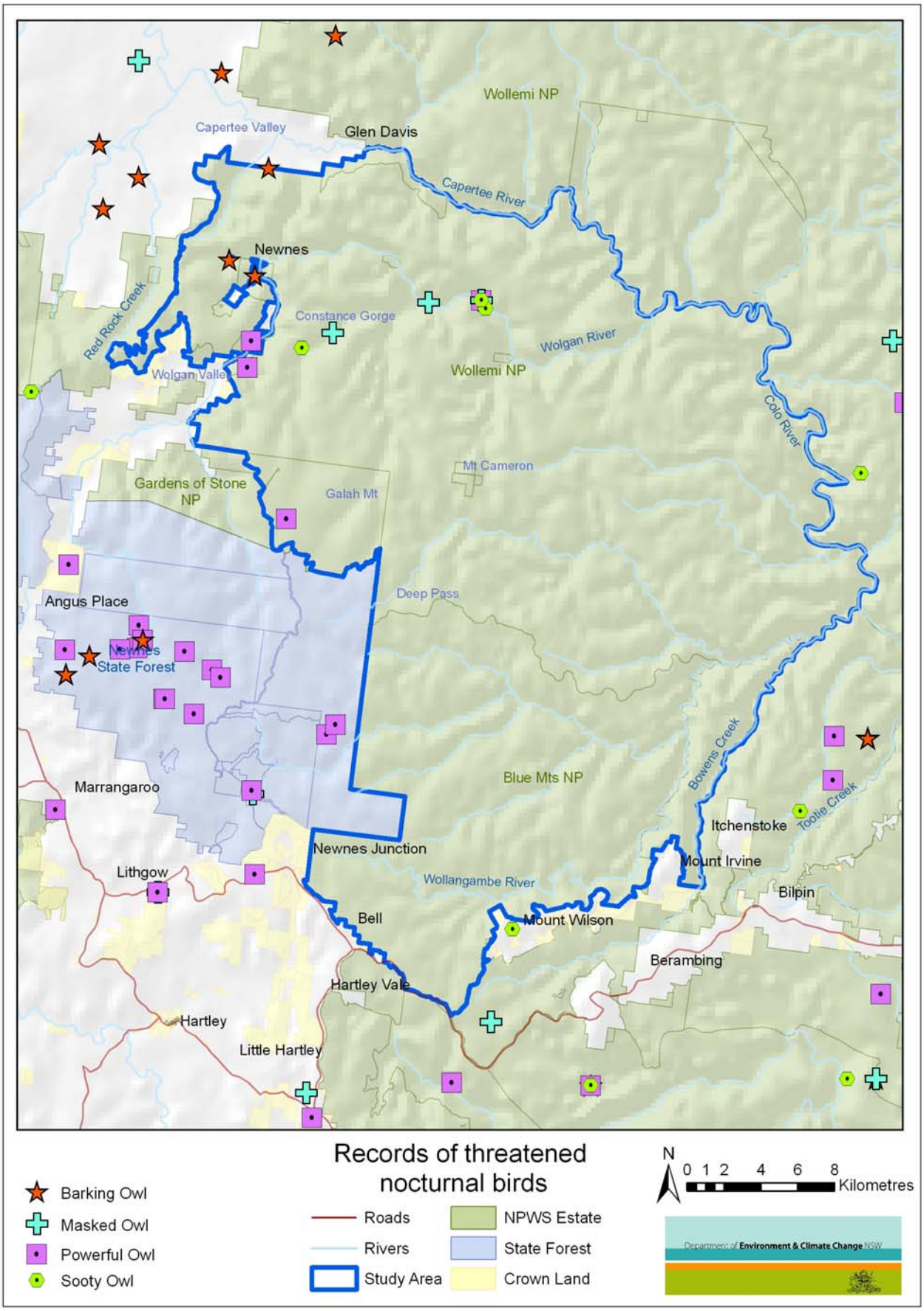
Garnett and Crowley (2000) list the main threat as habitat clearance for agriculture and urban development, along with additional fragmentation or degradation caused by logging, burning and dieback. The exact impacts of logging remain unclear (Higgins 1999). Where the species is at the margins of its ecological tolerance, frequent fire may threaten its occurrence when it results in the replacement of mesic plants with fire tolerant species and impacts on nest and roost sites. The Sooty Owl is a highly specialised species occupying a narrow range of habitats, which makes it particularly vulnerable to climate change (NSW Scientific Committee 2000c). Localised threats include disturbance at roosts in sandstone overhangs, including by the lighting of campfires and altering vegetation cover at the overhang entrances (DECC 2008c).

Local and Regional Conservation Status

The Sooty Owl is listed as Vulnerable under the TSC Act. Within NSW it is largely restricted to the three coastal Bioregions, with a few records in the extreme east of the South Eastern Highlands Bioregion. The distribution of this species in the Sydney Basin Bioregion is strongly tied to the presence of wet sclerophyll forests and rainforests. The Illawarra escarpment behind Wollongong and the Watagan Ranges between the Central Coast and Newcastle support the largest areas of high quality habitat (NPWS 2002a). In these areas it has been most often recorded in Illawarra Escarpment and Jilliby SCAs, with other records in Royal, Blue Mountains and Bouddi NPs (DECC 2009a).

The Sooty Owl was recorded in the study area for the first time during the current BSP surveys. Three records were obtained in the Wolgan River area, one in Constance Gorge and the other two downstream of the confluence of Rocky Creek and the Wolgan River (Map 6). A further three recent records have been obtained in this general area by university research in the area (J. Pascoe pers comm.). All records are from sheltered taller mesic forests or rainforests in gorges or deep valleys. There are a further four records within 5km of the study area, all from similar environments. This habitat type is very restricted in the study area. However, where it occurs it is likely to support territories of the Sooty Owl. In this area, Sooty Owls foraging territories are likely to range well beyond these small mesic refugia (M. Turton pers. comm.).

As the greatest threat to the Sooty Owl is habitat loss, there are few management directives for on-park conservation management. The greatest threat to the Sooty Owl in the reserve system is likely to be changes in vegetation characteristic resulting from frequent fire and climate change, leading to a reduction in the availability of suitable mesic habitat and the loss or alteration of prime roosting habitat. Fire management practices should aim to ensure at least some mesic and rainforest vegetation are always left in a long unburnt state. As with all the large forest owls, management of the owl in the region should be undertaken in accordance with the state-wide recovery plan (DEC 2006c).



Map 6: Threatened nocturnal bird records within the study area and surrounds.

EASTERN PYGMY-POSSUM

Species Profile

The Eastern Pygmy-possum (*Cercartetus nanus*) is a very small possum that is found in a wide variety of habitats, including rainforest, sclerophyll forest and woodland and heaths. It is generally nocturnal, and is an opportunistic omnivore, including nectar, pollen, insects, seeds and fruit in its diet (Tulloch 2003). Each individual has a number of nests, which are usually constructed in tree hollows, throughout their territory. The species will move through tree, shrub and ground layers (Ward and Turner 2008). It is patchily distributed between far south east Queensland and the far south east of South Australia, and Tasmania, though it is only found at higher altitudes in the north of its range and is generally more abundant in southern latitudes (Bowen and Goldingay 2000; Menkhorst 1995a). It is very difficult to detect without the use of pitfall trapping (Tulloch 2001) and hence its distribution and abundance may often be underestimated.

Eastern Pygmy-possum © N. Williams

Threats

The NSW Scientific Committee (2001g) listed the following potential threats to the Eastern Pygmy-possum: isolated sub-populations with little dispersal potential which increases the risk of local extinction; habitat loss and fragmentation caused by clearing; inappropriate fire regimes that may affect understorey plants; the loss of nest sites through intensive forestry and firewood collection; and predation by Foxes and Feral Cats.

Local and Regional Conservation Status

The Eastern Pygmy-possum is listed as Vulnerable under the TSC Act. This listing appears to be chiefly based on Bowen and Goldingay (2000), which showed that despite intensive survey effort throughout the known distribution, relatively few individuals have been detected. However, the survey techniques used in many of these surveys may have underestimated the abundance of this species. Kavanagh (2004) concluded that the species is inadequately studied in NSW for its conservation status to be accurately assessed. Records of the Eastern Pygmy-possum are sparsely distributed throughout eastern NSW and in the central west and north west of the state, with the majority of records from the South East Corner and Sydney Basin Bioregions (DECC 2009a). Within the Sydney Basin records are concentrated within the Blue Mountains, Central Coast and the Woronora Plateau. The species has been recorded in a number of reserves including Dharawal, Morton, Royal, Blue Mountains, Ku-ring-gai Chase, Wollemi and Brisbane Water NPs (DEC 2009a).

The Eastern Pygmy-possum was recorded in the study area for the first time during the current BSP surveys. A single individual was found late at night on Old Coach Road in Wollemi NP (Map 7). There are no further records within a 5km radius of the study area. Despite this apparent scarcity, the Eastern Pygmy-possum is a highly cryptic animal, and survey techniques that target the species, particularly pitfall trapping, have only been undertaken to a very limited extent. This possum is highly likely to be more widespread than this single record indicates. Based on observations across the rest of the Greater Blue Mountains, it is most likely to occur anywhere where there are woodlands that have a dense shrub layer and an abundance of flowers, particularly of the genus Banksia. It is also likely to occur wherever there are Upland Swamps. This would include the entire Glow Worm Tunnel-Galah Mountain area and other high elevation parts of Wollemi NP and higher rainfall parts of the Blue Mountains NP.

Records of Eastern Pygmy-possum in the study area are too sparse to assess the current status of the species. An intensive targeted trapping program would be required in order to assess the abundance and distribution of the Eastern Pygmy-possum within the locality and region. However, as habitat for the Eastern Pygmy-possum is well reserved in the Sydney Basin, further surveys are a low priority. The largest threat to Eastern Pygmy-possum within the study area is likely to be predation by the Fox and Feral Cat, although numbers of the former species are not high in the reserves at present.

SPOTTED-TAILED QUOLL

Species Profile

The Spotted-tailed Quoll (*Dasyurus maculatus*) is a medium-sized marsupial carnivore identifiable by its rufous to dark brown fur and white spots on the body and tail. It is essentially terrestrial, but is an agile climber. It feeds on a variety of birds, reptiles, mammals and invertebrates and will also take carrion and domestic poultry (NPWS 1999d). Juveniles eat mostly invertebrates, small mammals and birds; while adults mostly eat medium-sized mammals (Belcher *et al.* 2008). Within NSW the species utilises a variety of habitats, including sclerophyll forest and woodlands, coastal heath and rainforest.

Spotted-tailed Quoll © N. Fenton/DECC

Threats

Key threats to the Spotted-tailed Quoll are habitat loss, degradation and fragmentation (Belcher 2004); predation and competition by introduced mammals such as Feral Pigs, Feral Cats, Foxes and Dogs; disease such as toxoplasmosis; road mortality; and direct mortality at the hands of humans (Mansergh 1984). Wild Dog control, through the competitive release of Foxes, also has the potential to impact on the Spotted-tailed Quoll (Glen and Dickman 2005). There is some evidence that aerial, ground and mound baiting using 1080 (sodium monofluoroacetate) poses a risk to Quoll populations (Belcher 2004; Murray and Poore 2004; Claridge *et al.* 2006), however other research contradicts this (e.g. Kortner and Watson 2005). The Spotted-tailed Quoll may be affected by the following Key Threatening Processes: removal of dead wood and dead trees; high frequency fire; the removal of bushrock; and the loss of hollow-bearing trees (NSW Scientific Committee 1999c, 2000b, 2003a, 2008).

Local and Regional Conservation Status

The Spotted-tailed Quoll is listed as Vulnerable under the TSC Act and as Endangered under the EPBC Act. The southern populations are believed to have contracted in range by up to 50 percent in recent years (Maxwell *et al.* 1996). Within NSW the species has been most frequently recorded in the NSW North Coast, Sydney Basin and South East Corner Bioregions (DECC 2009a). There are few recent records for the Sydney Basin Bioregion, though it is still seen with some regularity on the Central Coast between Hornsby and Newcastle, in the Blue Mountains and to a lesser extent in the Kangaroo Valley (DECC 2009a). The following reserves in the Sydney Basin have recent records: Blue Mountains, Kanangra-Boyd, Brisbane Water, Popran and Wollemi NPs (DECC 2009a).

There are four records of the Spotted-tailed Quoll from the study area, the oldest being a museum specimen from 1967 and the most recent a sighting from 2003 (Map 8). No Quolls were seen during the recent BSP surveys, despite actively targeting them in the Old Coach Road area of Wollemi NP with remote cameras. This lack of success does not mean that there are no Quolls in the area as they are notoriously difficult to detect. However, densities are most likely low as they are through the remainder of the Greater Blue Mountains. There are over 20 sightings, including at least five roadkills, are from within 5km of the study area from inhabited areas between Clarence and Bilpin.

Management actions for the Spotted-tailed Quoll would ideally commence with gaining a better understanding of the species current distribution and status. However, due to the difficulty in detecting this species, further surveys would be expensive and likely to provide little return. Therefore, further surveys are given a low to moderate priority unless better surveying techniques become available (i.e. the use of remote cameras proves to be successful in surveying for this species in this region). Greater priority should be given to increasing public awareness of the Spotted-tailed Quoll, its identification and conservation status, and to encouraging neighbours and park visitors to report any sightings, together with accurate location information. Management should focus on mitigation of threatening processes that continue to act within the reserve system including competition and predation from Foxes and Feral Cats and potentially high frequency fire. The most recent research shows that Dingoes will suppress Fox numbers in arid areas (Letnic *et al.* 2009) and this is likely to apply to coastal environments as well. Pest species management must consider interactions between Quolls, Dingoes/Wild Dogs and Foxes and the potential impact of 1080 baiting, with the results of latest research incorporated into any feral animal control programs.

KOALA

Species Profile

The Koala (*Phascolarctos cinereus*) is a distinctive, iconic arboreal mammal of eucalypt forests and woodlands. It feeds on a wide range of eucalypt and other tree species, though in a local area a few species will be preferred almost exclusively. Historic records and recent research (DECC 2007b) suggest that the Koala generally has a preference for higher fertility soils. Individuals spend most of the day resting in dense foliage or the forks of trees, and are most active following sunset (NPWS 1999e). Home range varies depending on the density of food trees and population size. In coastal areas of NSW home ranges vary between 15 and 100 hectares, with individuals, particularly dispersing juveniles, known to travel up to 50 kilometres (Martin and Handasyde 1995; NPWS 1999e). During the breeding season (spring and summer) adult males have a distinctive carrying bellowing call that often is the first indication of this species' presence.

Koala © M. Schulz

Threats

The greatest threats to the Koala are fragmentation and degradation of habitat for urban development, agriculture and mining (NPWS 2008b; Martin *et al*. 2008). Reed *et al.* (1990) reported on a survey in 1986-87 which found that the Koala had disappeared from 50 to 75 percent of its known range in NSW and populations had been lost from many localities, particularly on the southern and western edges of their distribution. Other threats to the Koala include: fire; mortality from Dogs and motor vehicles; and infection by *Chlamydia* which causes *keratoconjunctivitis* (an infection of the eyes) and infertility (NPWS 1999e; 2008b). In NSW, *Chlamydia* affects animals that are already stressed and it is not considered to be a major problem (Menkhorst 1995b, NPWS 2008b).

Local and Regional Conservation Status

The Koala is listed as Vulnerable under the TSC Act. The species is widespread across the eastern third of the state, with a number of records throughout the Sydney Basin Bioregion. In this Bioregion, concentrations of records occur around the Central Coast, Blue Mountains, the fringes of the Cumberland Plain and the Woronora Plateau (DECC 2009a). Records from reserves within the Sydney Basin are uncommon, though it is found in Morton, Dharug, Nattai, Blue Mountains, Brisbane Water, Wollemi and Yengo NPs (DECC 2009a). Recent surveys found that south-east Wollemi, southern Yengo NP and Parr SCA together support a significant Koala population on DECC estate (DECC 2008a).

There are 14 records of the Koala from the study area (Map 7). Most are from the west of Wollemi NP between Newnes SF and Constance Gorge where a population centre appears to exist. In addition, two widely spaced records are from Blue Mountains NP (Bowens Creek and near Clarence). No new records of Koala were found during the recent BSP surveys, however this species is difficult to detect unless they are at high densities. It is likely that Koalas may occasionally be found in any part of the study area, though high quality habitat is probably limited to the higher fertility soils that occur around the Galah Mountain-Old Coach Road area. New vegetation mapping will greatly assist in determining where else suitable habitat for the Koala exists (DECC in prep).

At this point it is difficult to determine the extent of Koala habitat in the area and the importance of this habitat to the overall conservation of the species in the region. It can be said that the population densities do not appear to be anywhere near as high as they are in other parts of the Greater Blue Mountains (e.g. Southern Yengo NP and Parr SCA and Nattai NP) where over 30 individuals might be encountered in a BSP survey season. As the greatest threat to the Koala is clearance of habitat and this does not operate within the reserve, there are few management recommendations that can be prescribed. Fortunately, the key population centre is away from the main roads, and so road mortality appear to be far less of an issue here than in other areas. Likewise, predation by Wild Dogs/Dingoes is only an issue where other threats have reduced the population, for instance on the Mid North Coast of NSW. High frequency fire should be avoided in Koala habitat and control burns should not be conducted in Spring and Summer when Koalas are breeding.

YELLOW-BELLIED GLIDER

Species Profile

Yellow-bellied Glider © J. Winter/DECC

The Yellow-bellied Glider (*Petaurus australis*) is a medium-sized nocturnal marsupial found in tall open sclerophyll forests of eastern Australia. As an arboreal species, it requires mature hollow bearing trees within which to den during the day, and at night from which to leap and glide using a membrane that extends from the wrists to the ankles (NPWS 1999f). It is characterised by grey fur above and a whitish to orange fur beneath with large bare ears. The species is more often heard than seen, as it frequently emits a distinctive throaty call, which can be heard from some distance (Goldingay 2008). It feeds on eucalypt nectar, sap, manna and invertebrates found under shedding bark. Its feeding habits can leave V-notched incisions in the bark of eucalypts, with individuals and family groups demonstrating a preference for individual trees within their territory (Mackowski 1988). Across the Sydney Basin there appears to be a preference for Grey Gum as a feeding tree. The glider utilises a home range of between 30 and 65 hectares (Goldingay and Kavanagh 1991).

Threats

Yellow-bellied Gliders are threatened by the reduction of shelter sites within hollow-bearing trees lost through clearing, fragmentation or timber extraction (NPWS 1999f, NSW Scientific Committee 2008). In particular, logging of high-productivity forests is a major threat to the species across its range (NPWS 2003d). Another important threat is habitat fragmentation, with greater than 15 000 hectares required to conserve a viable population (Goldingay 2008). Predation by Feral Cats and Foxes is also thought to contribute to the species' vulnerability. Impacts of fire regimes are poorly understood, although some studies suggest that high-intensity fire reduces populations and the availability of food resources (NPWS 1999f, 2003d). This species is occasionally entangled on barbwire fences, including a record in 2000 in forest north of Werakata SCA (DECC 2008f). The Yellow-bellied Glider may also be impacted by loss of dead standing trees, loss of feed trees and competition from honey bees (NSW Scientific Committee 2002b, 2003a).

Local and Regional Conservation Status

The Yellow-bellied Glider is listed as Vulnerable under the TSC Act. Within NSW, records are largely concentrated within the coastal Bioregions, being NSW North Coast, Sydney Basin and South East Corner, as well as parts of the South East Highlands Bioregion (DECC 2009a). Recent surveys have significantly expanded the knowledge of its distribution and habitat preferences in the Sydney Basin. For example, as little as ten years ago the species was thought to be uncommon in the greater southern Sydney region, however, the converse has been found to be the case (DECC 2007b). Numerous records are known from a large number of reserves including Jervis Bay, Morton, Nattai, Blue Mountains, Yengo, Watagans and Wollemi NPs amongst others (DECC 2009a). In fact, the large number and wide distribution of records of Yellow-bellied Glider that have been collected in the past decade, together with the extent to which threatening processes (logging and land clearing) have been controlled, has led some researches to suggest that the conservation status accorded to the species should be reviewed and possibly down-listed (Kavanagh 2004).

There are 23 records of the Yellow-bellied Glider from the study area; all but two from the recent BSP surveys (Map 7). All sightings are from the north of the study area within Wollemi NP, exclusively from the valley and gullies of that area, including along the Wolgan River, Rocky Creek, Deans Creek and the Capertee River. This glider does not appear to be as common in the study area as further north through central Wollemi NP and Putty State Forest, but never-the-less it is likely to be present in the majority of well developed wet sclerophyll forests.

Recent surveys in the northern part of the Greater Blue Mountains concur with findings in the greater southern Sydney region, that Yellow-bellied Gliders are widespread and common throughout the moderate to high rainfall areas in the large sandstone reserves of the Sydney Basin. Most threats outlined in the species recovery plan are not present within large sections of these reserves. The Yellow-bellied Glider can thus be considered relatively secure in the Sydney Basin Bioregion, and does not currently require any specific management actions in the study area.

SQUIRREL GLIDER

Species Profile

The Squirrel Glider (*Petaurus norfolcensis*) is a nocturnal marsupial that inhabits dry sclerophyll forests and woodlands, where it shelters in leaf-lined nests in tree hollows. It is similar in appearance to the smaller and more common Sugar Glider. However, the Squirrel Glider is generally larger, has a longer more pointed face, longer and narrower ears, a bushier tail and lacks the persistent yapping call of the Sugar Glider. It has a varied diet, including insects, nectar, pollen, seeds, *Acacia* gum and sap from eucalypts (van der Ree and Suckling 2008). It usually occurs in family groups consisting of one male, one or more females and their dependant young. Home ranges are thought to vary between 0.65 and 8.55 hectares, depending on habitat quality. The Squirrel Glider is a hollow dependent species that is patchily distributed along the east coast and inland slopes from north Queensland to Victoria (NPWS 1999g) in habitats that comprise sufficient numbers of hollow-bearing trees for shelter and winter flowering plant species for food (Quin 1995).

Squirrel Glider © N. Williams

Threats

The greatest threat to the Squirrel Glider is loss of habitat by broad scale clearing for agriculture (Kavanagh 2004). Most clearing in NSW has occurred in open forests and woodlands growing on relatively fertile soils on gentle topography, especially in river valleys (Lunney and Leary 1988), which comprises the prime habitat of the Squirrel Glider. NPWS (1999g) lists further threats to the Squirrel Glider as: loss of nesting resources when the availability of hollow bearing trees are lost through fragmentation or timber extraction; predation by Feral Cats and Foxes; and the entanglement of individuals on barbed-wire fences. The species is also listed as susceptible to the following Key Threatening Processes: removal of dead wood and trees (NSW Scientific Committee 2003a); ecological consequences of high frequency fire (NSW Scientific Committee 2000b); loss of hollow-bearing trees (NSW Scientific Committee 2008) and competition for tree hollows with Feral Honeybees (NSW Scientific Committee 2002b).

Local and Regional Conservation Status

The Squirrel Glider is listed as Vulnerable under the TSC Act. It occurs patchily throughout the eastern Bioregions of NSW, and is only recorded regularly in the NSW North Coast, Nandewar and Sydney Basin (DECC 2009a). Across its range, habitat for the Squirrel Glider occurs primarily outside of public lands (Kavanagh 2004). In the Sydney Basin Bioregion the dry woodlands of the Central Coast are a stronghold for the species (Smith and Murray 2003). Elsewhere in the Bioregion the species has only been patchily recorded at very low densities, including in a small number of reserves such as Yengo, Wollemi, Blue Mountains, Dharug, Goulburn River and Werakata NPs (DECC 2009a).

There are three records of the Squirrel Glider in the study area (Map 7). All three are from the same observer in the Galah Mountain-Glow Worm Tunnel area of Wollemi NP from the CRA surveys in 1998. Although it is considered likely that the Squirrel Glider could occur in the study area, there is some question about these particular records. Through the Sydney Basin the Squirrel Glider is most often found within drier woodlands on somewhat enriched soils, particularly in alluvial valleys. These records are all from ridgetop sclerophyll woodland and revisitation of these locations in 2009 specifically to confirm the presence of this glider found neither any evidence of it nor likely habitat. Nonetheless, the slopes and valley floors of the Capertee and Wolgan Rivers and other valleys in the area support suitable habitat and may have populations of this rare glider.

South-west Wollemi NP supports only a small amount of marginal habitat for the Squirrel Glider and north-west Blue Mountains NP likely has none. However, as much of the remaining habitat in the region is still under threat from further fragmentation and development, all suitable habitat that is conserved has high conservation value. It is important to determine if there are in fact Squirrel Gliders in Wolgan and Capertee Valleys as recent BSP surveys found only Sugar Gliders despite suitable looking habitat.

The Squirrel Glider is subject to ongoing threats even within the reserve system, including low density of hollows due to past land use, the presence of barbwire fences in some areas and predation by the Fox and Feral Cat. Management of the Squirrel Glider in these reserves will require further survey to determine the species current extent. In addition, adjoining landholders should be encouraged to maintain paddock trees near the park boundaries, even if dead, in order to ensure a sufficient supply of tree hollows.

BRUSH-TAILED ROCK-WALLABY

Species Profile

The Brush-tailed Rock-wallaby (*Petrogale penicillata*) is a medium-sized macropod, with distinctive face markings, black paws, and long brush-like tail. It lives in either loose piles of large boulders with subterranean holes and passageways; cliffs with many mid level ledges covered by overhangs; or isolated rock stacks, usually sheer sided and often girdled with fallen boulders (NPWS 2008a). Most sites where it still occurs have a northerly aspect (Eldridge and Close 2008). The Brush-tailed Rock-wallaby was once abundant and ubiquitous throughout the mountainous country of south-eastern Australia, from the Grampians in western Victoria to Nanango in south-east Queensland (Short and Milkovits 1990). This wallaby has declined dramatically in the west and south of its former range, and populations have become more fragmented throughout (NSW Scientific Committee 2003c).

Brush-tailed Rock-wallaby © C. Ramsay

Threats

Historically the greatest threat was hunting for skins and as an alleged agricultural pest ((Eldridge and Close 2008). Today the greatest threats are introduced predators, competition with introduced herbivores (especially Feral Goat, Rabbits and domestic stock), habitat modification by fire, vegetation clearing, disease transmission (toxoplasmosis and hydatosis) by feral carnivores (NSW Scientific Committee 2003c) and inbreeding (Environment ACT 1999). It typically exhibits low migration rates between colonies, impeding recovery of small populations.

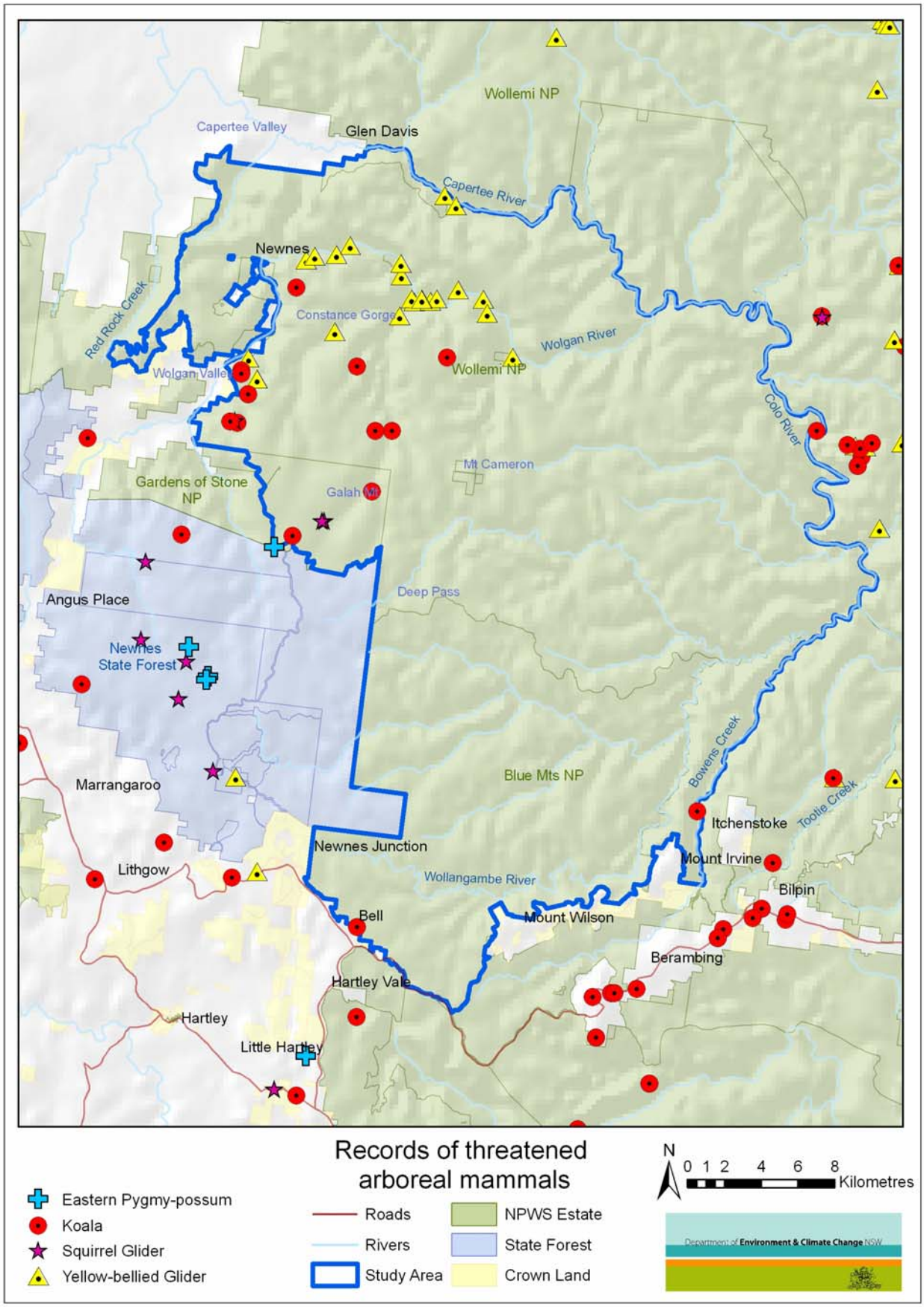
Local and Regional Conservation Status

The Brush-tailed Rock-wallaby is Endangered under the TSC Act and as Vulnerable under the EPBC Act. Wallabies of the Sydney Basin Bioregion are a distinct Evolutionary Significant Unit (ESU) that includes populations in Kangaroo Valley, Jenolan Caves, the Hunter Valley and the Warrambungles. This central ESU is one of the most depleted in NSW and all sites within it are of very high conservation significance (NSW Scientific Committee 2003c). Recent records from reserves within the Sydney Basin are mostly from Yengo, Wollemi, the Watagans and Morton NPs and Parr SCA as well as a recently discovered colony in Nattai NP (DEC 2004a).

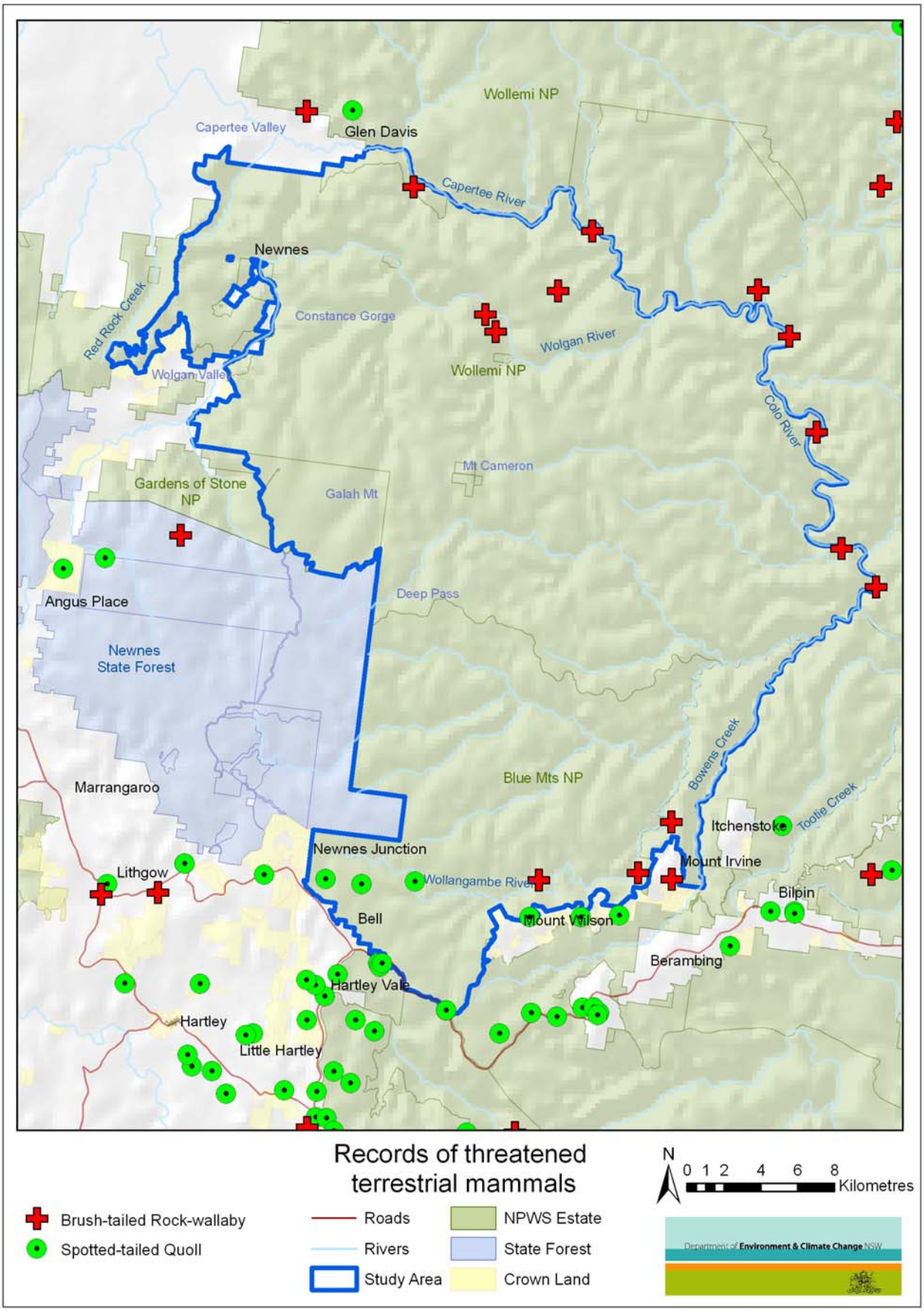
There are thirteen separate locations recorded for the Brush-tailed Rock-wallaby in the study area, the earliest from 1977 and the most recent from 2008 (Map 8). They occur in the rocky gorges and escarpments adjacent to four major waterways: the Capertee, Wolgan, Colo and Wollangambe Rivers though small colonies are likely scattered throughout the area where suitable habitat occurs. The most important populations occur below the escarpment in Capertee and Wolgan Valleys, with around 150 individuals known from this latter area (N. Stone pers. comm.). The Capertee and Wolgan Valley colonies have been the subject of a monitoring program for the last ten years and both sites are Fox control sites under the Fox TAP. There is evidence that both populations are expanding with several new sites occupied in recent surveys – either Fox control (that is now conducted off and on-park) or better conditions after the recent drought and severe fires of 2003 might be behind this expansion (N. Stone pers. comm.). Overall, this species appears stable in the study area, though the dire situation this wallaby faces elsewhere means that it should remain a top priority for conservation management. Additionally, the size and stability of populations in the Colo and Wollangambe River Valleys and satellite populations in the Wolgan Valley are poorly known.

The Brush-tailed Rock-wallaby population in the Wolgan River area is one of the most significant populations in the Sydney Basin ESU. Continued monitoring and conservation management of this population are high priorities as this site holds conservation significance at a local, regional and national scale. The population that exists along the Colo River may also be sizable and of importance, however access difficulties make high level management of this area untenable. Throughout the study area more small populations are likely to exist. Further survey and investigation into these populations is a relatively high priority and the recording of sightings elsewhere by the public be encouraged.

Known colonies should continue to be high priorities for conservation management and monitoring. Fox and Rabbit control and careful fire management are all important where rock-wallabies persist. Management of this species should be coordinated with the state-wide recovery program for the species.



Map 7: Threatened arboreal mammal records within the study area and surrounds.



Map 8: Threatened ground mammal records within the study area and surrounds.

EAST-COAST FREETAIL-BAT

Species Profile

East-coast Freetail-bat © N. Williams

The East-coast Freetail-bat (*Micronomus norfolkensis* formerly *Mormopterus norfolkensis*) is one of a group of bats that are still not fully taxonomically described (Churchill 2008). It is currently believed that it can be distinguished from others in the group by its long forearm, upright ears and robust build (Parnaby 1992a). Reinhold *et al.* (2001) describes the ultrasonic call as "a pattern of alternating pulses", making it unique among Freetail-bats, though it can also call without this pattern. It is poorly known, but appears to be largely restricted to the east of the Great Dividing Range between Brisbane (Queensland) and Picton (New South Wales) (Duncan *et al.* 1999, Parnaby 1992a). It favours dry eucalypt forest and woodland, though has also been captured in rainforest and wet sclerophyll forest (Churchill 2008). It usually roosts in tree hollows (Gilmore and Parnaby 1994), though it has been recorded in the roof of a hut and under the metal caps of telegraph poles (Churchill 2008).

Threats

Threats to this bat are poorly known, though it is suspected that agricultural clearing, development and logging have serious impacts (Duncan *et al.* 1999). The species' entire known distribution lies within an area of concentrated human population density and increasing urban development. The East-coast Freetail-bat are considered to be threatened by the Key Threatening Process of the removal of dead wood and trees; the loss of hollow-bearing trees; high frequency fires; and pesticide use (NSW Scientific Committee 2000b, 2003a, 2008; NPWS 2002c).

Local and Regional Conservation Status

The East-coast Freetail-bat is Vulnerable under the TSC Act. Most records in NSW occur within the NSW North Coast, South East Corner and Sydney Basin Bioregions. Within these bioregions it prefers the coastal plains and larger incised valleys of the Dividing Range, with relatively large numbers of records from the Cumberland Plain, Central Coast and Hunter Valley (DECC 2009a). The majority of records for the species within the Sydney Basin Bioregion occur outside of reserves. However, it has been detected within Nattai, Blue Mountains, Dharug, Wollemi, Yengo and Marramarra NPs and Western Sydney Regional Park (DECC 2009a).

There are two records of the East-coast Freetail-bat from the study area, both from the Capertee Valley/River area (Map 9). One record is an ultrasonic call recording from BSP surveys in 2005 from alongside the Capertee River, approximately 5.5km south-east of Glen Davis. The other record is from a survey of a mine close to Glen Davis in that same year where an individual was recorded by Anabat. Although it has yet to be confirmed by trapping, the ultrasonic calls appear to be consistent with that expected for the species (M. Turton pers. comm.; N. Williams pers. comm.). These records suggest that a population may occur in the Capertee Valley area. East-coast Freetail-bats are rarely captured in harp traps as they are a high-flying species that prefers open wooded country where there are few flyways. Nonetheless, its status should remain unconfirmed for the study area until further research into the Freetail-bats of the area has been completed (refer to Section 3.2.7). Records for this bat are sparsely scattered throughout the adjacent sandstone reserves and are mostly from ultrasonic call analysis, with a small number of records to the north in Wollemi NP and to the east in Yengo NP and Parr SCA (DECC 2009a).

Recent work in the southern Sydney region has found the East-coast Freetail-bat to be strongly associated with fertile valleys and plains (DECC 2007b). Within the study area, this includes the Capertee Valley, Wolgan Valley and other areas with enriched soil, though they will also move through more open areas of the sandstone plateaux. The majority of the study area is at best only peripheral habitat for the East-coast Freetail-bat. Further survey work targeting the several Freetail-bat species that appear to occur in the Grassy Woodlands on the peripheries of the reserves would be the only specific management recommendation. General conservation management of these open woodlands that aims to avoid the loss of hollow-bearing trees and overgrazing will also benefit this bat.

LARGE-EARED PIED BAT

Species Profile

Large-eared Pied Bat © M. Schulz

The Large-eared Pied Bat (*Chalinolobus dwyeri*) has large ears, a black body and bands of white fur along the sides of the underbelly (Parnaby 1992a; Churchill 2008). Its ultrasonic call is readily distinguishable from all other species (Reinhold *et al.* 2001). It has been recorded from scattered locations between Rockhampton and Ulladulla (Hoye and Schulz 2008) in a wide range of habitats, including wet and dry eucalypt forest, Cypress (*Callitris*) forest and sub-alpine woodland (Duncan *et al.* 1999). It is a cave-roosting species that roosts in overhangs and 'pock-holes' on vertical cliff walls. It has also been detected roosting in disused mine shafts, overhangs and in abandoned Fairy Martin (*Petrochelidon ariel*) nests (2008; Hoye and Schulz 2008). It prefers the 'twilight' area of caves and overhangs and may be dependent on sandstone outcrops (Duncan *et al.* 1999; Hoye and Schulz 2008). The Large-eared Pied Bat is poorly understood, particularly in terms of its roosting requirements, foraging habits and other aspects of its biology.

Threats

The primary threat is the destruction or interference of roosting and maternity sites (Duncan *et al.* 1999). It is possible that mining-induced subsidence (particularly coal mining in sandstone areas of NSW) may destroy roost sites. Other potential threats include high frequency fires in both roost and prime foraging areas; habitat destruction for agriculture and urban development; impacts of forestry operations and predation by feral animals (Duncan *et al.* 1999). In addition, Feral Goats may disturb roosts in overhangs (M. Schulz pers. comm.).

Local and Regional Conservation Status

The Large-eared Pied Bat is listed as Vulnerable under the TSC Act and also as Vulnerable under the EPBC Act. The Sydney Basin is extremely important to the species, holding a large proportion of overall records. Only scattered records occur outside the Sydney Basin Bioregion. There is a concentration of records within the reserves of the Greater Blue Mountains, including Nattai, Blue Mountains, Yengo and Wollemi NPs (DECC 2009a). Habitat modelling in the Southern Blue Mountains suggests that this bat is rare in areas of unbroken sandstone plateaux and is far more common in higher productivity woodlands or when there are higher fertility soils nearby (DECC 2007b).

The study area is exceptionally important to the Large-eared Pied Bat with trapping rates far in excess anywhere else in its range. In total, 54 individuals of this rare bat have been trapped, 51 of these in the recent BSP surveys and three in the CRA surveys of the region in 1998. These bats were trapped at fourteen separate locations across the study area (Map 9). Most bats were trapped in the Glow Worm Tunnel – Galah Mountain area, including young animals, and it is this area that appears to be the most important. The presence of young bats in this area indicates that there is a maternity roost or roosts nearby. This is of paramount importance as there are no maternity sites known for this bat from anywhere in Greater Blue Mountains and aspects of its breeding biology remain an enigma. Maternity roosts are likely to be in the pagoda country that exists in the vicinity of Old Coach Road and the Glow Worm Tunnel. Pagoda country in this area should be managed as being extremely important to the Large-eared Pied Bat. Although pagodas exist elsewhere in the region, it is likely to be the combination of the rocky refuges and the proximity of higher fertility soils on the Newnes Plateau and in the Wolgan and Capertee Valleys that make the area particularly good habitat.

This area appears to be the most significant location for this bat anywhere in its range, and thus holds local, regional and national significance and must be managed accordingly. General conservation management of Foxes and Grassy Box Woodlands will benefit the species. Fire management, however requires careful and targeted thought as to how it will affect the Large-eared Pied Bat, particularly potential breeding habitat. While this bat is undoubtedly adapted to fire to some extent, control burns should be conducted outside of the breeding period (late spring to early summer). Control burns should avoid the pagoda and sandstone escarpments where this bat most likely roosts and breeds. Additionally, as the location of wintering roosts are also unknown it is recommended that any control burns be undertaken in the autumn months.

EASTERN FALSE PIPISTRELLE

Species Profile

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) is a large (up to 70 millimetres) bat similar to the Greater Broad-nosed Bat (*Scoteanax rueppellii*). It is distinguished by the possession of two pairs of upper incisors, a gap between the incisors and the canines, and larger ears (Parnaby 1992a; Churchill 2008). Its ultrasonic call pattern can be easily confused with various species of *Scotorepens* and the Greater Broad-nosed Bat, though good quality calls can be distinguished (Reinhold *et al.* 2001). It is patchily distributed throughout its range in south-eastern Australia, between south-east Queensland and western Victoria, and Tasmania. It appears to prefer wet forested habitats, particularly riparian or high rainfall areas, with large trees (taller than 20 metres) (Menkhorst and Lumsden 1995). It may be more common at high elevations (Law *et al.* 2008), though it has been recorded between sea level and 1500 metres in Victoria (Menkhorst and Lumsden 1995) and Tasmania (M. Schulz pers. comm.). It usually roosts in hollows in *Eucalyptus*, though it has been recorded in caves (Churchill 2008) and buildings (Law *et al.* 2008). It may hibernate over winter and has been known to travel at least twelve kilometres from its roost site (Churchill 2008).

Eastern False Pipistrelle © N. Williams

Threats

Threats to the species are poorly known, but appear to comprise: disturbance to winter roosting and breeding sites, including loss of hollow-bearing trees; loss of trees for foraging; and application of pesticides in or adjacent to foraging areas (DEC 2005e). The Eastern False Pipistrelle is listed as impacted by the Key Threatening Process removal of dead wood and trees and loss of hollow-bearing trees (NSW Scientific Committee 2003a, 2008). The impact of high frequency fires is unknown but may be significant through the loss of hollow-bearing trees.

Local and Regional Conservation Status

The Eastern False Pipistrelle is listed as Vulnerable under the TSC Act. The species is known from the Sydney Basin Bioregion and the South Eastern Highlands Bioregion (DECC 2009a). Although relatively rarely encountered, this bat has been reported from a number of reserves in the Sydney Basin, particularly at higher elevations in Wollemi, Nattai, Blue Mountains, Kanangra-Boyd and Gardens of Stone NPs (DECC 2007b, 2009a).

A total of five individuals have been trapped at four locations within the study area, all but one within the higher elevation Glow Worm Tunnel – Galah Mountain area (Map 9). Ultrasonic call detection has placed the species at a further two locations in this same region. All records are from either the BSP surveys in 2008-9 or from the CRA surveys in 1998. This result is a relatively high reporting rate for this bat and reflects the high-quality habitat that occurs in the Glow Worm Tunnel area. Harp trapping in lower elevations of the Capertee and Wolgan Valleys located a single individual at a site on Rocky Creek at about 450m elevation – none were trapped below this elevation. This pattern of far lower densities at lower elevations is consistent with trapping results elsewhere in the Sydney Basin (DECC 2007b).

Results suggest that forests above elevations of 1000m above sea level in the Glow Worm Tunnel Road – Galah Mountain area are particularly good habitat for the Eastern False Pipistrelle. It may be the higher elevation itself or the coincidental occurrence of higher fertility soils supporting taller forest that is responsible for the higher than normal trap rate. A similar situation occurs on the Boyd Plateau – another 'hot spot' for this species. Management recommendations for on-reserve management are few as most threatening processes do not operate within conservation areas. Fire management of the Glow Worm Tunnel – Galah Mountain area needs to ensure that the diverse and abundant bat fauna of this area is not excessively disrupted by control burns. In general, this means following general conservation guidelines of mosaic burning and avoiding overly frequent fires. Avoiding burning during the breeding season (late spring to early summer) is also recommended, although further study on the impact of fire on bats needs to be undertaken before more specific recommendations can be prescribed.

EASTERN BENTWING-BAT

Species Profile

The Common Bentwing-bat (*Miniopterus schreibersii*) comprises three distinct taxa in Australia (Duncan *et al.* 1999). The subspecies *oceanensis* extends between central Victoria and Cape York Peninsula (Duncan *et al.* 1999) and is commonly referred to as the Eastern Bentwing-bat. It utilises a wide variety of habitats where it usually roosts in caves, disused mines and road culverts (Churchill 2008). It is a fast flying species that usually feeds above the canopy (Churchill 2008) and has been known to travel up to 65 kilometres away from roosts in a night (Dwyer 1966). Though individuals often use numerous non-breeding roosts, they congregate en masse at 12 known large maternity roosts and a number of smaller sites to breed (Hoye and Hall 2008). Individuals may travel up to several hundred kilometres from maternity to overwintering roosts (Hoye and Hall 2008).

Eastern Bentwing-bat © N. Williams

Threats

Damage and disturbance to roosting sites are the greatest known threats to this species. For example, only relatively few nursery caves are used, hence significant population changes can occur if these sites are damaged (Hoye and Hall 2008). Disturbance by the public of hibernating colonies can lead to starvation due to the loss of energy reserves (Gilmore and Parnaby 1994). Modification to feeding habitat by agriculture and urban development may also be a problem (Gilmore and Parnaby 1994). Some individuals are preyed upon by Feral Cats and, less often, Foxes (Dwyer 1995). Land subsidence due to longwall mining may also impact on sandstone caves and waterways that provide habitat for this species (NSW Scientific Committee 2005a). This species is highly susceptible to inappropriate gating of cave/mine entrances, resulting in roost abandonment (Thomson 2002).

Local and Regional Conservation Status

The Eastern Bentwing-bat is listed as Vulnerable under the NSW TSC Act (1995). It is widely distributed in the eastern third of NSW, with the number of records decreasing with distance from the coast (DECC 2009a). This bat is widespread within the Sydney Basin Bioregion, though there are clusters of records the Lower Hunter and Central Coast, Cumberland Plain, Woronora Plateau and across the southern Blue Mountains. Individuals have been recorded in a diverse range of habitats in a number of reserves (DECC 2009a). Roost sites for the species, particularly maternity sites, are much less frequently recorded and are poorly reserved.

The Eastern Bentwing-bat has been trapped or observed at eight separate locations within the study area (Map 9). It has been recorded by ultrasonic call detection at a further six locations. All records are from the 2008-9 BSP surveys, the 1998 CRA surveys or a targeted bat survey of disused mines in the area (Epacris Environmental Consultants 2005). The latter survey targeted known roost locations, surveyed these and provided management recommendations. The most significant roost site for the Eastern Bentwing-bat was found to be in Starlight Canyon in the northern escarpment of the Wolgan Valley where approximately 2000 individuals were roosting. This very important natural site is also likely to be a winter hibernating location. Also important are a disused adit just south of Glen Davis where there were up to 1000 individuals and another disused mine several kilometres upstream from the Newnes mining area (around 100 individuals) (Epacris Environmental Consultants 2005). The majority of the other locations come from the Glow Worm Tunnel – Galah Mountain area where foraging bats have been trapped.

The study area is important for the Eastern Bentwing-bat at a local, regional and perhaps statewide scale. This is because of the presence of at least two important roost sites and the potential for there to be many smaller roosts in the disused mines of the area. Although no maternity roosts have been identified at this stage, it is possible that they may also occur within the area. Management for this species needs to focus on roost sites and should follow guidelines set out in the 2005 report on the major sites in the area (Epacris Environmental Consultants 2005). This report recommends interpretive signage at the Starlight Canyon site to advise canyoners against disturbing the bats with loud noises or torches, particularly during cooler months when they are hibernating. In addition, fire management should consider the impact of control burns on roost sites, completely avoiding them where possible.

LARGE-FOOTED MYOTIS

Species Profile

The Large-footed Myotis (*Myotis adversus*) has undergone a recent taxonomic review. Australian Myotis are now considered to belong to two separate species. The Southern Myotis (*M. macropus*) is found in the coastal region and along the Murray River between South Australia and south-east Queensland. The Northern (*M. moluccarum*) occurs in Queensland and across the Top End (Duncan *et al.* 1999, Churchill 2008). Even though Myotis can be recorded from up to 20 metres using Anabat, its call can be difficult to distinguish from *Nyctophilus* species (Reinhold *et al.* 2001). Trapped individuals are easily distinguished from other species by their disproportionately large feet, which they use to rake prey comprising insects and small fish from the surface of water (Churchill 2008). It occurs in a wide variety of habitats as long as water is nearby, roosting in caves, tree hollows, vegetation and artificial structures such as bridges and mines - usually over or near water (Churchill 2008).

Large-footed Myotis © M. Schulz

Threats

The threats to this species are poorly known, but it is probably sensitive to changes in water quality including sedimentation (from vegetation clearing and logging), eutrophication (sewage and fertiliser run-off), pollution and altered flow regimes (Duncan *et al.* 1999). Roosting sites may be susceptible to disturbance by such activities as recreational caving, roadworks or forestry activities (Duncan *et al.* 1999, Gilmore and Parnaby 1994). Replacement or repair of bridges, road culverts or water supply tunnels is another threat to this species, which may roost in such structures in large numbers (R. Williams pers. comm.). Land subsidence due to longwall mining may also impact on sandstone caves and waterways that provide habitat for this species (NSW Scientific Committee 2005a). In some areas this species roosts in tree hollows (e.g. Churchill 2008); therefore threats that impact on hollow-bearing trees and dead standing trees may also impact roosting habitat of this bat.

Local and Regional Conservation Status

The Large-footed Myotis is listed as Vulnerable under the TSC Act. Throughout its range, it is primarily a coastal species and there are few records outside of the maritime Bioregions. In the Sydney Basin Bioregion it is strongly associated with the coastal plains and hinterland environments of the Central Coast, Cumberland Plain and Illawarra. Representation in reserves is relatively poor, however records are known from Nattai, Royal and Popran NPs and Dharawal SCA (DECC 2009a).

The Large-footed Myotis has only been recorded at two locations in the study area, both on the Capertee River between five and seven kilometres downstream from Glen Davis (Map 9). These records come from BSP surveys of the area in 2005 and are of Myotis observed foraging above the water. At one of these sites the observation has been further clarified by a confirmed ultrasonic call recording. It is highly likely that the Large-footed Myotis is present along all of the larger waterways in the study area including the Wolgan, Colo and Wollangambe Rivers. All larger waterways in the study area should be considered to be potential habitat for this bat.

The presence of suitable habitat for this species within south-west Wollemi and north-west Blue Mountains NPs is important as this bat is not often recorded within conservation reserves. Its habitat is poorly conserved across its range so any suitable habitat that does exist in the reserve system is of conservation importance. Nonetheless, few threats exist within the park system and therefore there are no specific management actions to be prescribed for this species. Replacement of any structures that exist over water such as bridges should always be done ensuring it does not impact on roosting bats. General conservation management, including weed management, of the rivers and creeklines of the area will also benefit the Large-footed Myotis.

GREATER BROAD-NOSED BAT

Species Profile

The Greater Broad-nosed Bat (*Scoteanax rueppellii)* is a large microchiropteran bat usually found in gullies draining east from the Great Dividing Range between south-eastern New South Wales and north Queensland (Atherton Tablelands). The species can readily be confused with the Eastern False Pipistrelle from which it can be distinguished by its single pair of upper incisors and its smaller ears (Parnaby 1992a). The Greater Broad-nosed Bat utilises creeks and forest clearings for hunting below 500 metres in altitude (Churchill 2008; Hoye and Richards 2008). It usually roosts in tree hollows, in cracks and fissures in trunks or under exfoliating bark, though it may also utilise old buildings (Hoye and Richards 2008). The ultrasonic call of the Greater Broad-nosed Bat is easily confused with species of *Scotorepens* and with the Eastern False Pipistrelle (Pennay *et al.* 2004).

Greater Broad-nosed Bat © N. Williams

Threats

The threats to this species are poorly known, but are thought to include: disturbance to roosting and breeding sites; clearing and fragmentation of foraging habitat; and application of pesticides and herbicides in foraging areas or near waterways (Duncan *et al*. 1999; DEC 2005f). Forest harvesting may remove suitable hollows and alter the availability of prey (Duncan *et al.* 1999). Loss of hollow-bearing trees may also impact on this species (NSW Scientific Committee 2008). The impact of high frequency fires is unknown but may be significant through the loss of hollow-bearing trees.

Local and Regional Conservation Status

The Greater Broad-nosed Bat is listed as Vulnerable under the NSW TSC Act (1995). The majority of records are found in the coastal bioregions, with some records in the New England Tableland Bioregion and South-eastern Highlands Bioregion (DECC 2009a). Within the Sydney Basin the species is mainly restricted to the eastern half of the Bioregion, with the greatest density of records on the Central Coast, and to a lesser extent the Cumberland Plain and the southern Blue Mountains. The species is reasonably well reported from DECC reserves, including Nattai, Kanangra-Boyd, Blue Mountains and Wollemi NPs (DECC 2009a).

There are only three locations known for the Greater Broad-nosed Bat within the study area, all along the Capertee River. Two records are from the 1978 survey of the Capertee and Colo Rivers (Map 9; Kingston *et al.* 1979). The final record is an unconfirmed Anabat recording from this same vicinity from the BSP surveys of 2005. Without further records it is unclear as to how important the study area is to the local, regional or statewide conservation of this bat.

Habitat modelling and detailed assessment of the species distribution in greater southern Sydney found the Greater Broad-nosed Bat to be closely aligned to taller forests, particularly in flatter areas (DECC 2007b). This knowledge and surveys conducted throughout the remainder of the Greater Blue Mountains show that the low fertility sandstone plateaux provides only very marginal habitat for this bat. Despite considerable trapping effort and ultrasonic call recording in the Glow Worm Tunnel – Galah Mountain area there has been no indication that this bat resides there. Instead small numbers are expected to occur adjacent to the lower reaches of larger watercourses where there is a distinct valley floor supporting tall riparian and lower slope forest, including patches of rainforest.

The Greater Broad-nosed Bat remains a poorly understood species and is thought to be only sparsely scattered across its entire range (Parnaby 1992b). Continued scientific survey and research of the species is crucial to guiding its conservation management. At this point there are no management actions that can be suggested for this species for the study area as it remains to be clarified how much, if any, high quality habitat exists there. Irregardless, few threats to this species are active within the reserve system and general conservation management should be sufficient. However, it is highly recommended that hollow-bearing live trees and standing dead trees be protected.

EASTERN CAVE BAT

Species Profile

Eastern Cave Bat © N. Williams

The Eastern Cave Bat (*Vespadelus troughtoni*) is a small mustard yellow-brown bat with dark wings. This bat is difficult to distinguish by ultrasonic call, as the frequency and call pattern overlaps with that of the Little Forest Bat (*V. vulturnus*) (Pennay *et al.* 2004). The Eastern Cave Bat has a predominantly tropical distribution from Cape York in Queensland to Kempsey in NSW, with smaller numbers recorded south to the Sydney Basin (Law *et al.* 2005). The western limit appears to be the Warrumbungle Range, with a single record from southern NSW, east of the ACT (DEC 2005g). General habitat preferences seem to range from dry open forest and woodland in the west and inland through to moister wet eucalypt forest and rainforest along the coast (Churchill 2008; DEC 2005g). A cave-dwelling species, it roosts in small groups in reasonably well lit areas near the entrances of sandstone overhangs, mine tunnels, boulder piles and occasionally buildings (Churchill 2008). It has also been discovered roosting in disused Fairy Martin (*Petrochelidon ariel*) mud nests (Schulz 1998).

Threats

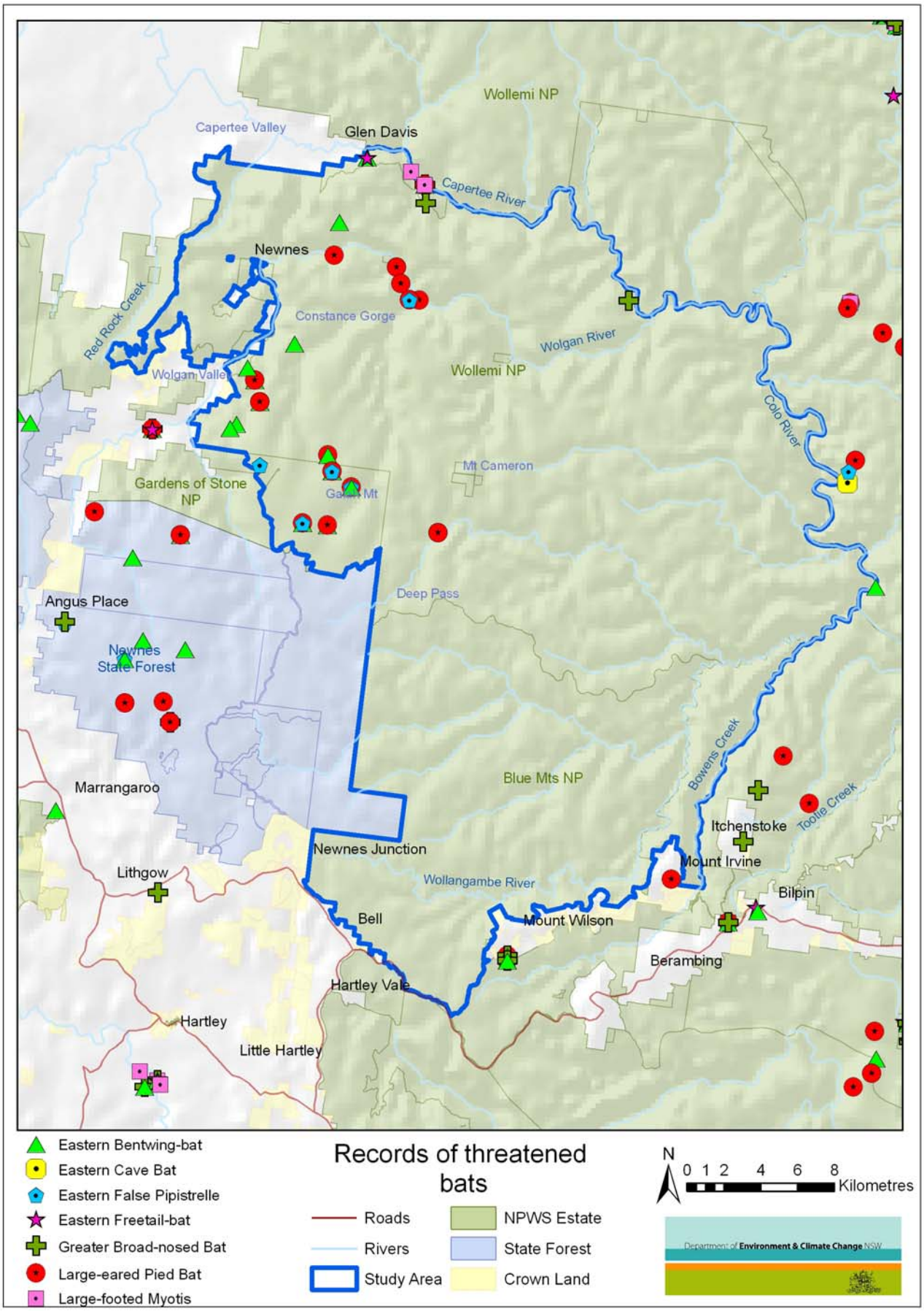
Threats to this bat are poorly understood as little is known about its habitat preferences, diet and breeding requirements. As for other cave-dwelling bats destruction or disturbance of roosting and maternity sites, and the surrounding forest and woodland, is likely to be the main threat (DEC 2005g). In addition, altered fire regimes and consequential habitat modification and from practices such as timber harvesting and grazing may impact this species (DEC 2005g). Direct damage or disturbance to roosting sites can result from mining operations or recreational activities such as caving (DEC 2005g). Application of pesticides near foraging areas is also likely to impact, through reduction of invertebrate populations and accumulation of toxins within the bats' tissues. Other threats include predation by Feral Cats and Foxes (DEC 2005g); in addition to Feral Goats impacting roosts and roost collapse through longwall mining (NSW Scientific Committee 2005a).

Local and Regional Conservation Status

The Eastern Cave Bat is listed as Vulnerable under the TSC Act. The majority of records occur in the North Coast and Sydney Basin Bioregions, with a few records in the Brigalow Belt South Bioregion and one record south of Ulladulla on the NSW South Coast (DECC 2009a). It is reported in low numbers from reserves including Wollemi, Yengo, Goulbourn River and Warrumbungle NPs and Arakoola and Manobalai NRs (DECC 2009a).

The Eastern Cave Bat has only been recorded at a single location within the study area; from the Colo River where four individuals were found roosting in the honeycomb weathering of an overhang in 2007 (Map 9). The closest known localities for the species are in northern Yengo and northern Wollemi NPs, which (together with Goulburn River NP and Manobalai NR) appear to be somewhat of a stronghold for the species in the Sydney area. This record is one of the most southerly records for the species on the Atlas of NSW Wildlife. Although this record is on the extreme eastern boundary of the study area, it is likely that the Capertee and Colo Rivers act as a conduit for this species from further north. This bat is likely to be found in rock overhangs, caves and pockholes in cliff faces along the escarpments of the Capertee, Wolgan and Colo Rivers; but probably only occurs in low abundance.

The study area appears to lie at the southern limit of a stronghold for the species in the Goulburn River and Hunter Valleys. It probably supports only a small amount of habitat and a small number of individuals. Further research into the ecology of the species is required to obtain a better understanding of distribution and habitat requirements, in order to accurately assess its conservation status in the study area. It is possible that the Eastern Cave Bat is more widespread, but due to difficulties in identification has been overlooked or misidentified in previous survey work. The greatest threat to the species in the study area is likely to be predation by Foxes and Feral Cats, and potentially high intensity fire in the vicinity of roost sites, but as the species remains so poorly understood specific management recommendation cannot be provided at this stage.



Map 9: Threatened bat records within the study area and surrounds.

4.2 PEST SPECIES

WILD DOG

Species Profile

Wild Dogs are the feral descendants of domesticated European Dogs, introduced into Australia with first British settlement. They are found throughout a range of habitat types, though they are most often associated with areas that have been cleared for agriculture. Wild Dogs prey on a range of medium to large mammals, such as kangaroos and wallabies, though they will also consume reptiles, birds, insects and carrion. Prey may also include livestock, and pest species, including Rabbits and Pigs (Fleming *et al.* 2001). Wild Dogs will interbreed with the Dingo (*C. l. dingo*). Wild Dogs are unlikely to impact on native fauna as significantly as other introduced predators because the native dog, the Dingo, has been a top-order carnivore for approximately 5000 years (Savolainen *et al.* 2004). Species that survived the arrival of the Dingo should be able to co-exist with Wild Dogs, with exceptions occurring when other threatening processes are involved, such as habitat loss, disease and altered fire regimes causing populations of threatened fauna to already be small and fragmented.

Wild Dog © G. Steenbeeke/DECC

Impacts

Wild Dogs are a declared pest species under the RLP Act. They impact on a number of threatened mammals and birds including the Brush-tailed Rock-wallaby, Koala and Long-nosed Potoroo (NPWS 2002c, 2008b; NSW Scientific Committee 2003c). They have also been found to carry diseases, such as Cryptosporidium and Hydatid disease, which may be transmissible to humans. Domestic Dogs threaten Dingo populations by interbreeding with them.

Local and Bioregional Conservation Status

Wild Dogs are not protected under the NP&W Act. Wild Dogs are widespread throughout the Bioregions of the Dividing Range and some coastal areas, though populations of Dingoes are increasingly being recognised and becoming the subject of conservation management. It is important to note that most records for Wild Dogs on the Atlas of NSW Wildlife come from scats or tracks where it is impossible to tell if an animal is a Domestic Dog, Dingo or hybrid.

There are six records of Wild Dog/Dingo for the study area from scats (Map 11). These records could equally be Domestic Dogs, Dingoes or hybrids. In addition, there are four animals identified as Dingoes from the BSP surveys in the Old Coach Road – Galah Mt area, two from photographs, and two from howling. All canids in the Old Coach Road area during the BSP surveys had the physical characteristics of Dingoes, though Domestic Dogs/hybrids are seen in the Wolgan Valley (J. Pascoe pers. comm.).

Wollemi NP is important for the conservation of the Dingo (NPWS *et al.* 2000, DEC 2005c), and Wild Dog management must be balance against conservation of this unique and iconic subspecies. It is recommended that genetic research conducted in Wollemi NP to: ascertain patterns in the level of Domestic Dog/Dingo hybridisation in the area and identify key areas of Dingo purity. Having said this, research in the Burragorang Valley has found no difference between the ecological role filled by Dingoes and hybrids (B. Purcell in prep.).

Within the study area, the threatened species most vulnerable to predation by the Wild Dog is the Brush-tailed Rock-wallaby. Control of Wild Dogs at rock-wallaby sites is not currently undertaken and is not considered necessary at this time (N. Stone pers. comm.). Control of Wild Dogs currently focuses on the peripheries of the reserves where they impact on landholders, e.g. the Capertee Valley. Baiting is also conducted on private land and in Newnes State Forest by the Rural Lands Protection Board. Strategic targeting of the reserve peripheries may also help prevent incursions of domestic dogs and hybrids further into the park where they will come into contact with Dingoes. Given the recent evidence that Dingoes control Fox numbers and aid the conservation of small mammals and lizards (Letnic 2007; Letnic *et al.* 2009), any control programmes must be undertaken in conjunction with Fox management and employ a cooperative cross-tenure approach. Aerial baiting is not recommended for this area due to the potential impact on Spotted-tailed Quoll and Dingo populations. Closing and revegetating tracks into remote areas may help to control the incursion of Wild Dogs into the centre of the park, particularly wilderness areas.

Fox

Species Profile

The European Red Fox is a small, lithe canid that occurs naturally in Europe, Asia, North America and North Africa. Foxes were successfully introduced for sport hunting in Victoria in the 1870s and since then they have spread rapidly throughout the southern two-thirds of mainland Australia and have recently been introduced to Tasmania. Foxes are generalist predators and will prey on vertebrates and invertebrates, including crayfish. Unlike Feral Cats, they will also scavenge carrion and consume plant material such as berries.

Fox © N. Williams

Impacts

Predation by the Fox is listed as a Key Threatening Process under the TSC Act and EPBC Act and it is also listed as a pest species under the RLP Act. It is known to impact on a range of native species by either preying on them or competing with them for food and other resources. In particular medium-sized mammals, ground-dwelling and semi-arboreal mammals, ground-nesting birds and chelid tortoises are considered to be affected (Dickman 1996a, NPWS 2001d). As pests in an agricultural landscape, Foxes are known to prey on lambs and domestic fowl and can be a significant problem in some areas. Foxes have been shown to have a role in regulating the populations of some of their prey species, including Eastern Grey Kangaroo (*Macropus giganteus*) (Banks *et al.* 2000).

Local and Regional Status

Foxes are ubiquitous throughout vegetated, rural and urban areas of the eastern half of NSW, including the Sydney Basin and South Eastern Highlands Bioregions. They are an extremely common species, and even though they are under-recorded off park, there are few areas without sightings. In response to the listing of predation by this species as a Key Threatening Process, a Threat Abatement Plan (TAP) was endorsed in 2001. This Plan outlines management priorities for NSW including a research program investigating Fox control and threatened species populations (NPWS 2001d).

Foxes are typically widespread across Wollemi and Blue Mountains NPs, and in some areas they can be very common. However, in the study area there are only five confirmed records - a very low number. Two of these are from the Galah Mountain area (one from 1998 and the other from 2009); one is from the Capertee River and the other from the Wolgan River (Map 11). While there is little doubt that Foxes are more common than records indicate on the reserve perimeters, and in the Upper Wolgan (N. Stone pers. comm.), there is no evidence of high Fox numbers away from cleared land. It is possible that this may be due to the Dingo population, with recent evidence showing Dingoes will greatly suppress Fox numbers (Letnic *et al.* 2009).

Foxes have been continuously controlled in the Wolgan and Capertee Valley areas for some time, including along the key access tracks to Newnes, around the Brush-tailed Rock-wallaby sites and on approximately 7-8 private properties adjoining Wollemi NP (N. Stone pers. comm.). Despite this, Foxes continue to be sighted in this area and ongoing control is necessary given the high conservation value of the fauna habitats in this area and the large number of threatened species found there. In the wilderness areas, however, Fox numbers appear to be low at this point and there is little need for control measures.

Aside from the Grassy Woodlands in the Capertee and Wolgan Valleys, other habitats that could be the focus of Fox management are the Upland Swamps that occur in the south of the study area – particularly where populations of the Blue Mountains Water Skink are found. Elsewhere in the Sydney Region, local extinctions have occurred from Upland Swamps with Foxes thought to be a significant part of the equation. Upland Swamps are habitat for a large number of ground dwelling birds and small mammals that are particularly susceptible to introduced predators, such as the Southern Emu-wren, Beautiful Firetail and Swamp Rat.

Closing roads, tracks and other cleared access ways, particularly through or adjacent to Upland Swamps and other thick vegetation may help minimise incursion of Foxes and mitigate their impacts on ground-dwelling fauna. In addition, protecting the Dingo population may also be a legitimate conservation strategy to control Foxes, particularly in Wilderness areas.

FERAL CAT

Species Profile

The Cat is a medium-sized carnivore that was first domesticated in the eastern Mediterranean about 3000 years ago (IUCN 2005). The exact origin of the Cat in Australia is unknown, however they were deliberately introduced into the wild during the 19th Century to control Rabbits, Rats and Mice (Rolls 1984) and are now found in virtually all terrestrial habitats across the continent, except some of the wettest rainforests (Environment Australia 1999a). Feral Cats can survive with limited access to water, obtaining moisture from their prey (Newsome 1995). They prefer live prey and while small mammals make up the majority of their diet they will also take birds, reptiles, frogs, fish and insects (Dickman 1996b). They are capable of killing vertebrates up to two kilograms in weight but prefer smaller species weighing less than 220 grams (Dickman 1996b).

Feral Cat © M. Schulz

Impacts

Predation by Feral Cats is listed as a Key Threatening Process under the TSC Act and under the EPBC Act and this species has been listed by the World Conservation Union as among 100 of the 'World's Worst Invaders' (IUCN 2005). Although it is known that Feral Cats prey on native animals, the details and extent of their impact remain poorly understood. Predation by Feral Cats has been implicated in the extinction and decline of many species of mammals and birds on islands around Australia, and in NSW has been linked to the disappearance of thirteen species of mammal and four species of birds (NSW Scientific Committee 2000d). Current impacts on native fauna are likely to be most severe in modified, fragmented environments and in areas where the abundance of alternative prey (such as Rabbits and Mice) fluctuates widely (NSW Scientific Committee 2000d). In Australia, Feral Cats are not recorded to have impacted on any species of reptiles, amphibians, fish or invertebrates (Dickman 1996b). The impact of domestic and stray Cats on native wildlife in suburbia and urban bushland remains poorly understood and controversial.

Local and Regional Status

There are records of the Feral Cat from all the Bioregions in NSW, with concentrations in the urban areas on the coast. The majority of records within the Sydney Basin Bioregion are from within 50 kilometres of the coast and to the north of the Shoalhaven River, while they are much more thinly scattered in the South Eastern Highlands Bioregion. It is highly likely that this species occurs at low densities in most environments and conservation parks from the smallest to the largest reserves such as Wollemi and Kosciusko NPs.

There are no documented records of the Feral Cat from within the study area. However, there are a number of records within half a kilometre of the boundary (Map 11) and there is no doubt that this pest species occurs within the reserves. For example, Feral Cats have been sighted with increasing regularity around the edges of Wollemi NP in the Wolgan Valley (N. Stone pers. comm.). The Feral Cat is an elusive animal and because scats are typically buried and difficult to locate, it is much less frequently detected than Fox or Wild Dog/Dingo. It is most likely that the species occupies most habitats in the study area at a low density, with concentrations around the perimeters of the park. Anecdotal evidence from the south coast of NSW suggests that where Foxes are baited there can be an increase in the number of Feral Cats, though this has not been studied or proven (M. Schulz pers. comm.). A study currently underway of niche overlap between Feral Cats and other top order predators in the Wolgan Valley will shed more light on the diet of Feral Cats in the Wolgan Valley and the complex interaction that occur with Foxes and Wild Dogs (J. Pascoe in prep.).

If Feral Cat numbers continue to be high in the Wolgan Valley area a targeted removal program may be necessary, especially given the large number of threatened species that occur there. In order to gain a more accurate picture of Feral Cat populations in the study area, DECC staff and other visitors to the reserve should be encouraged to report all Feral Cat sightings for entry in the Atlas of NSW Wildlife.

FERAL PIG

Species Profile

Feral Pig © DECC

Feral Pigs in Australia are descendants of various domestic breeds that were introduced by the first English settlers (DEH 2004c). Since that time, there have been repeated escapes from domestic stock and intentional releases of animals for recreational hunting (DEH 2003). Feral Pigs are now found across Australia, reaching highest densities in eastern NSW, the ACT, Queensland and through northern Australia to the Kimberley Region (NSW Scientific Committee 2004). They occupy a wide range of habitats, but are restricted by their requirement for shade and access to water (Choquenot *et al.* 1996). Throughout their range, Feral Pigs show a preference for moist habitats, such as riparian zones, swamps, wet sclerophyll forests and forested gullies (NSW Scientific Committee 2004). Feral Pigs have a varied diet that includes grasses, bulbs, tubers, roots, seeds, fruit, mushrooms, carrion, vertebrate and invertebrate prey (NSW Scientific Committee 2004).

Impacts

Pigs are a declared pest species throughout NSW under the RLP Act. Predation, habitat degradation, competition and disease transmission by Feral Pigs is listed as Key Threatening Processes under the TSC Act and the EPBC Act and the species has been listed by the World Conservation Union as among 100 of the 'World's Worst Invaders' (IUCN 2005). The species poses a significant threat to native species and ecological communities through its behaviour and feeding habits. The Feral Pig consumes a range of birds, reptiles, frogs, small mammals and soil invertebrates (Pavlov 1995) and competes with native fauna for food resources (NSW Scientific Committee 2004). They cause extensive habitat alteration by wallowing, rooting and foraging, including: destruction of plants, reduced regeneration of plants, alteration of soil structure, spread of weeds, creation of drainage channels in swamps, reduction of water quality and spread of disease such as root-rot fungus (*Phytophthora cinnamomi*) (DEH 2004c).

Local and Regional Status

The Feral Pig occurs across the Sydney Basin Bioregion, especially around Goulburn River NP and the Boyd Plateau. It has also been recorded in high numbers between Tumut and Bega in the South Eastern Highlands Bioregion, with many records from reserves such as Kosciusko NP and Tinderry NR (DECC 2009a). It is common on both private and public land, although it is certainly under-recorded outside of the reserve system.

There are only four records of Pigs from south-west Wollemi and north-west Blue Mountains NPs, all collected in the recent BSP surveys from the Mt Cameron area (Map 11). A small population has been observed in this area since the 2002 bushfires (N. Stone pers. comm.). Signs of Feral Pigs have also been reported from Bungalboori Creek and the Wolgan River, though this remains unconfirmed. Feral Pig damage has been observed in swamps in the upper reaches of Deans Creek Swamp and more recent damage in Newnes SF on the edge of Wollemi NP, including Dinner Creek Swamp and Budgary Creek Swamp. Feral Pigs were observed to have excavated crayfish burrows. Not only do Feral Pigs pollute swamps and affect the hydrology, but Giant Dragonfly and Blue Mountains Water Skinks use crayfish burrows for shelter (I. Baird pers. comm.). Based on survey work elsewhere in the Greater Blue Mountains, Feral Pigs occupy only a tiny fraction of suitable habitat in this area and there is real potential for them to become a serious conservation problem. Of particular concern is if Feral Pigs were to reach high levels in the Wolgan or Capertee Rivers, or in the Upland Swamps. Both of these environments are prime Feral Pig habitat as well as being conservation priorities due to the very large number of threatened species that are present. All measures should be taken to ensure that Feral Pigs do not become a problem in these environments.

Some successful control programs have recently been implemented elsewhere in the Sydney Basin (DECC 2007c) and could be applied here, particularly in the Mt Cameron area. Upland Swamps on the boundary of Wollemi NP and Newnes SF should be monitored for Feral Pig activity and if necessary a control program conducted in conjunction with State Forests. Although Feral Pigs are less focused on these Upland Swamps than they were in the height of the drought (I. Baird pers. comm.), the damage they do to these fragile environments can be catastrophic and take a long time to repair.

FERAL DONKEY

There is a small population of Feral Donkeys in the Mount Cameron area – believed to be about twelve individuals (N. Stone pers. comm.). There are two records in the Atlas of NSW Wildlife, one for just north of Mt Cameron on a tributary of Annie Rowan Creek, the other is about 1.5km south-east of the summit (Map 11). Although the impacts of Feral Donkeys in the Greater Blue Mountains are not researched, this species is a serious conservation problem in arid areas and parts of northern and Western Australia (Choquenot 2008). Ideally, this population would be eradicated as resources permit.

Feral Donkey © M. Schulz

EUROPEAN CATTLE

There are occasional reports of cattle from inside the boundaries of the reserves (N. Stone pers. comm.). There is only a single record in the Atlas of NSW Wildlife, from 1977 near the junction of the Wolgan River and Rocky Creek. Recent BSP surveys of this area found no evidence of Feral Cattle; however, it is believed that a handful may still occur in the Wolgan-Capertee link (N. Stone pers. comm.). A successful control program of populations in the Capertee River area removed all known individuals (DECC 2007c). Continued monitoring and, if necessary, eradication of Feral Cattle in the Wolgan-Capertee area is consistent with the Wollemi NP Plan of Management (NPWS 2001e) and should remain a priority.

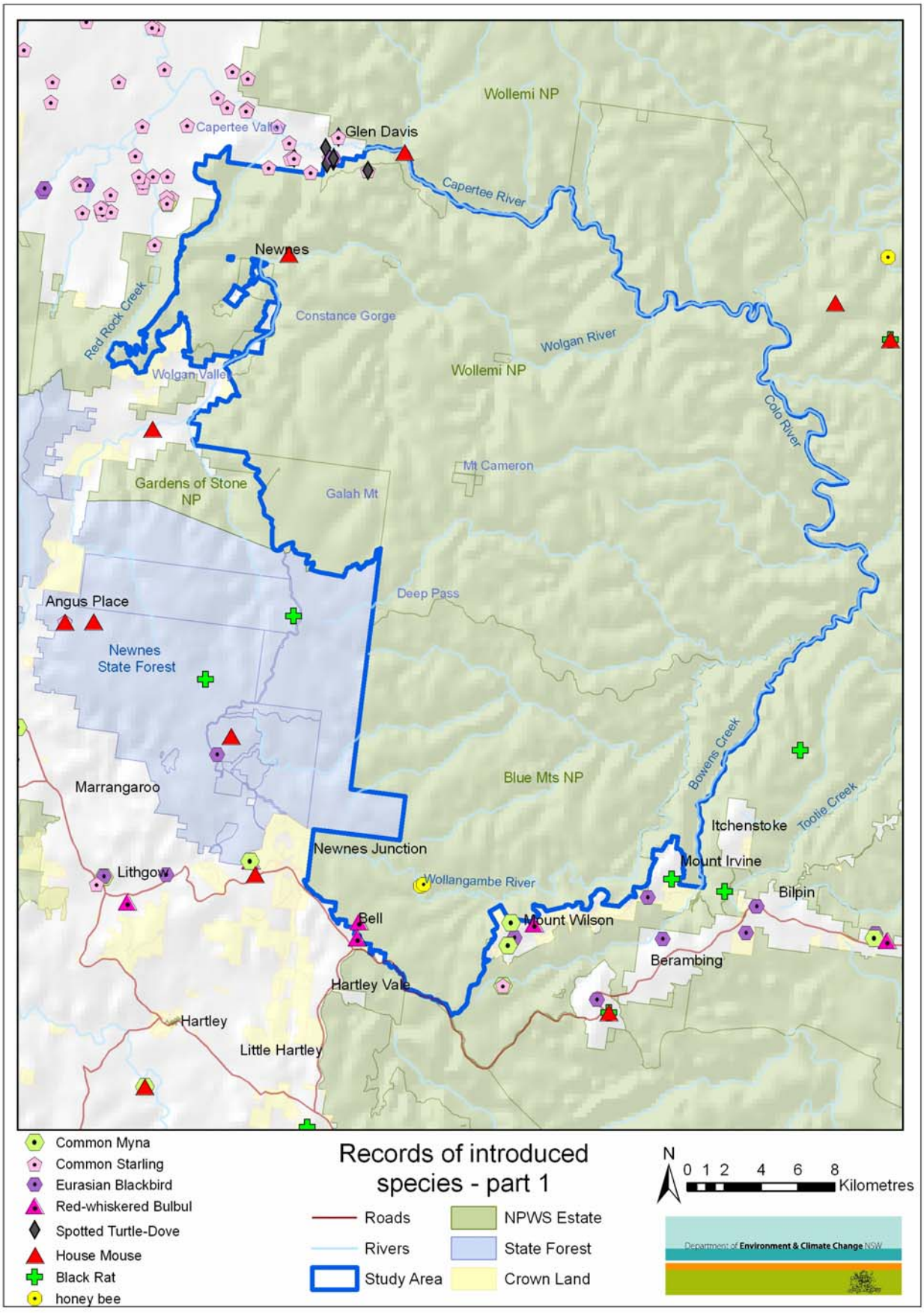
EUROPEAN RABBIT

There are only eight records of European Rabbits from the study area (Map 11). However, they are under-reported and common in several areas, especially on the edges of the reserves and on former grazing land in the Wolgan and Capertee Valleys (N. Stone pers. comm.), as well as in some Upland Swamps. As with the remainder of the Greater Blue Mountains, European Rabbits are very uncommon in the low fertility sandstone plateaux and are concentrated in areas of better soil quality (hence more grasses) or around human habitation. For the study area, this includes the Newnes Plateau and surrounding areas of elevated soil fertility in the Galah Mountain area, and the Capertee and Wolgan River Valleys. At the present time European Rabbits are only a high priority for control in Upland Swamps in the Galah Mountain area where they are at relatively low densities. In this habitat they may impact on a number of regionally threatened species through the alteration of vegetation structure and drainage characteristics and by opening up otherwise dense vegetation for easier access to predators. This situation is particularly the case in Upland Swamps where the Blue Mountains Water Skink occurs. Additionally, it is considered a priority to control European Rabbits where they occur around the Brush-tailed Rock-wallaby populations as they are suspected of competing for food resources.

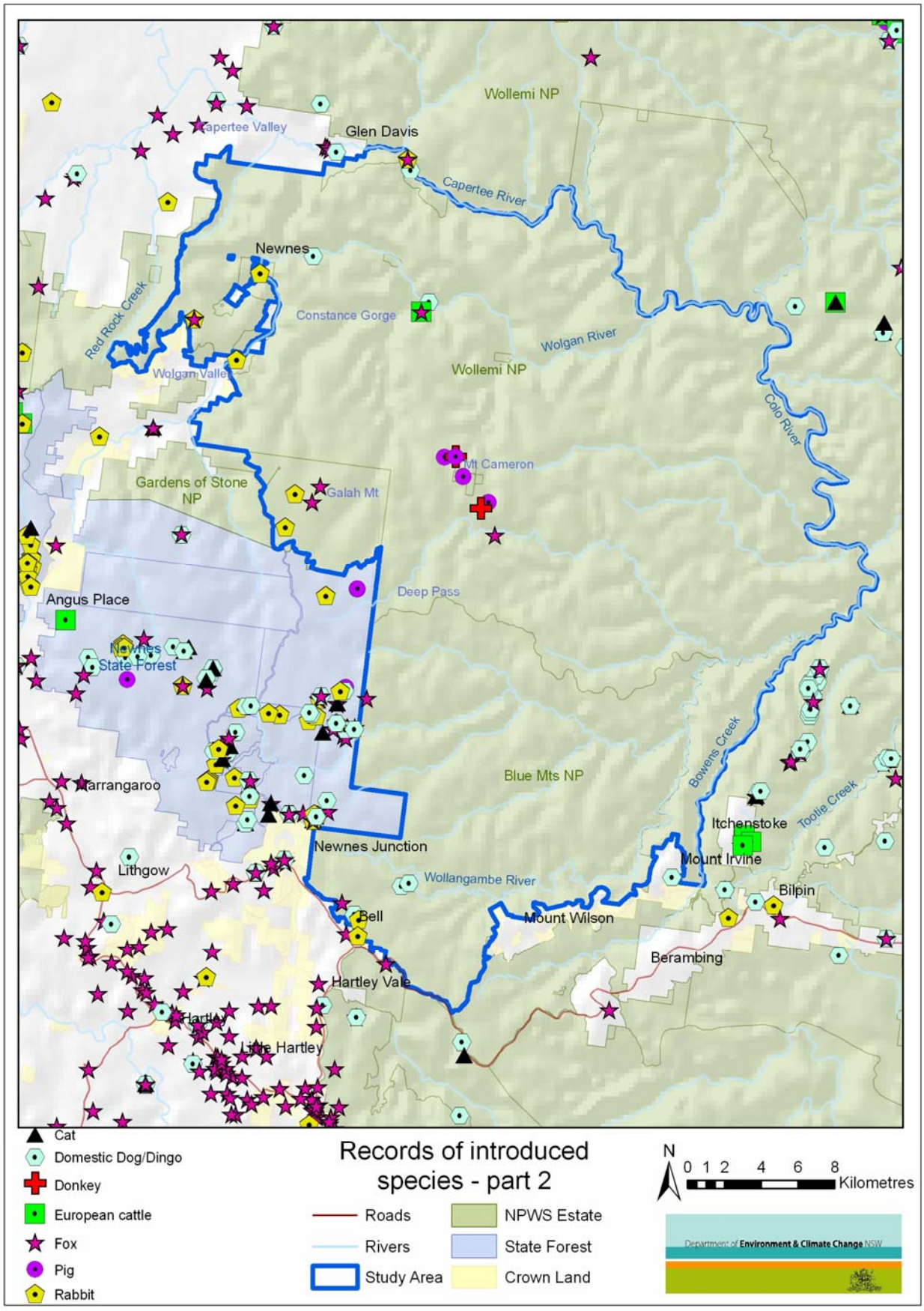
Common Myna © M. Schulz

INTRODUCED BIRDS

Five Introduced bird species are known from the study area; the Common Myna, Red-whiskered Bulbul, Spotted Turtle-dove, Common Starling and House Sparrow (Map 10). In addition, the European Blackbird has been found nearby and is also likely to be found within the reserves and may be expanding its range within the region. Some of these birds are not considered to be a serious conservation issue and are confined to heavily disturbed areas around human settlement e.g. the House Sparrow. Exceptions to this are the Common Myna, Common Starling and European Blackbird. The Common Myna and Common Starling will compete with native hollow-nesting species in the high-conservation value Grassy Box Woodlands of the Wolgan and Capertee Valleys, including the Brown Treecreeper, Swift Parrot and Turquoise Parrot.



Map 10: Part one of introduced mammal records within the study area and surrounds.



Map 11: Part two of introduced mammal records within the study area and surrounds.

5 PRIORITIES FOR FAUNA CONSERVATION AND MANAGEMENT

5.1 THREATENED SPECIES CONSERVATION MANAGEMENT PRIORITIES

Land managers are faced with an ominous list of threatened fauna species, however, not all warrant targeted management at the present time. There are others that require quite specific management, further survey and/or monitoring in order to increase their chances of long-term survival in the area.

Table 8 lists all of the threatened species currently known to occur in the study area, rated as to their priority for conservation management. These ratings are derived from work in the Greater Southern Sydney Region (DECC 2007a, b) and expert knowledge rather than quantitative assessment, and will require review and revision in the future when comprehensive information on the regional conservation status of each species becomes available. The ratings are as follows.

Highest: Species that are likely to become extinct from the study area in the short to medium term without action, and for which the study area is likely to play a crucial role in the regional conservation of the species. These species require management at a site by site level. This category includes species which may already be locally extinct but would be of highest conservation priority if confirmed to be extant in the study area.

High: Species that are at risk of becoming extinct from the region without active management of key habitats and abatement of threats. This category includes species which are rare in the study area, or for which habitat is limited in extent, but for which the study area is never-the-less important to regional conservation, as well as species that are better represented in the study area than in other reserves in the region.

Moderate: Species for which the study area does not support a significant amount of habitat relative to that reserved elsewhere in the region. Though management of these species is not currently the highest priority for the reserves, an increase of pressure on these species elsewhere in the region, or the delineation of key threats within the study area, may require more active management in the future.

Low: Threatened species for which habitat is widespread within the study area and well represented in the reserve system of the region. These species do not require any specific active management in the study area at this stage, other than ongoing conservation reserve management such as the protection of important habitat features such as mature hollow-bearing trees.

Table 8: Threatened fauna species recorded within the study area, their relative management priority, key locations and potential threats.

Priority for management in the study area	Species	Number of records in the study area [1]	Current occurrence confirmed during BSP surveys?	Key locations in the study area	Potential key threats in the study area	Significance of the study area to conservation of the species in region
Highest Priority Require targeted management at a site level	Brush-tailed Rock-wallaby	16 records at 13 locations	Yes	Wolgan Valley, Capertee Valley, Colo River.	Predation by Foxes, possibly Feral Cats and competition with Rabbits.	Very high
	Blue Mountains Water Skink	1	No	Upland Swamps of the higher rainfall areas in the south of the study area – for instance around Bell – and Newnes SF.	High intensity fire, alterations to drainage that affects Upland Swamps, predation by Feral Cats and habitat alteration by European Rabbits.	High
	Stuttering Frog	1	No	May be locally extinct. Habitat occurs in sheltered creek headwaters with rainforest elements	It is not known whether Chytrid fungus occurs, but if present would be a significant threat to this species.	Very High if species is re-discovered.
High Priority Require further survey and/or management of key habitats and key threats	Broad-headed Snake	5	Yes	Although habitat is widespread in study area in sandstone environments this species appears to be highly localised in occurrence. Rock outcrops with exfoliating sandstone on ridgelines and upper slopes and nearby forest with hollow-bearing trees.	Removal and disturbance of winter shelter sites (bush rock), collection of specimens by reptile collectors, removal of dead wood and trees.	High
	Eastern Bentwing-bat	14	Yes	Foraging and temporary roost site habitat widespread throughout area. At least 3 large permanent roost sites are known – Starlight Canyon (2000+ bats), Glen Davis mine (1000+ bats), Wolgan Valley mine (100+ bats).	Roost sites vulnerable to disturbance by park visitors, hot wildfire and predation by the Feral Cat. Inappropriate gating of roost entrances may result in colony abandonment. Potentially application of pesticides adjacent to foraging areas.	Moderate to High. Very high for significant wintering roosts (i.e. more than 50 individuals). If any roosts are found to be maternity sites, then Very High.
	Regent Honeyeater	Up to 16 – many records have low spatial accuracy	No	Habitat restricted to Grassy Box Woodlands, River Oak Woodlands and other open woodlands on the alluvial flats of the Capertee and Wolgan Rivers and Valleys.	Greatest threat is further land clearance and fragmentation occurring off park. General conservation management of Grassy Woodlands is required and targeting these environments for addition to the reserve system.	Moderate

Priority for management in the study area	Species	Number of records in the study area [1]	Current occurrence confirmed during BSP surveys?	Key locations in the study area	Potential key threats in the study area	Significance of the study area to conservation of the species in region
High Priority Require further survey and/or management of key habitats and key threats	Diamond Firetail	1	No	Restricted to Grassy Box Woodlands of the Capertee and Wolgan Valleys	Greatest threat is further land clearance off park. On reserve threats are few, the most important being invasion of Grassy Woodlands by exotic perennials and predation by Feral Cats.	Low
	Hooded Robin	Up to 2	No	Restricted to Grassy Box Woodlands of the Capertee and Wolgan Valleys.	Greatest threat is further land clearance off park. On reserve threats are few but include the loss of dead wood and trees, invasion of Grassy Woodlands by exotic perennials, and predation by Feral Cats.	Low
	Speckled Warbler	6	Yes	Restricted to open woodlands with a shrub understorey on the alluvial flats and valley slopes of the Wolgan and Capertee Valley and other similar valleys in Wollemi NP.	Greatest threat is further land clearance off reserve. On park, the removal of dead timber, loss of shrub layer due to fire, grazing by introduced herbivores and predation by Feral Cats and Foxes.	Moderate
	Squirrel Glider	3 unconfirmed	No	Remains unconfirmed in study area. Probably the slopes and valley floors and riverine flats of the Wolgan and Capertee Rivers.	High frequency fire, predation by Fox and Feral Cat, potentially competition for hollows from Feral Honeybees.	Unconfirmed, possibly Low or Moderate.
	Brown Treecreeper	6	Yes	Restricted to Grassy Box Woodlands and other open woodlands on the slopes, valley floors and banks of the Capertee and Wolgan Rivers and potentially other larger creeks in the study area.	Greatest threat is further land clearance and fragmentation occurring off park. General conservation management of Grassy Woodlands is required and targeting these environments for addition to the reserve system. On reserve threats include loss of hollow-bearing trees, removal of fallen timber and dead trees, predation by Feral Cats, and competition for hollows with Honey Bees and introduced birds.	Moderate

Priority for management in the study area	Species	Number of records in the study area [1]	Current occurrence confirmed during BSP surveys?	Key locations in the study area	Potential key threats in the study area	Significance of the study area to conservation of the species in region
High Priority Require further survey and/or management of key habitats and key threats	Black-chinned Honeyeater	16	Yes	Restricted to open woodlands and Grassy Box Woodlands on the slopes and valley floors of the Wolgan and Capertee Rivers.	Potentially competition from more aggressive honeyeater species.	High
	Square-tailed Kite	3	Yes	Open woodlands of the Capertee and Wolgan Valley slopes but also uses the interior of the parks.	Main threat is habitat loss occurring off park. Few threats on reserve but includes high fire frequency that impact prey species and potential nest trees.	Moderate
	Spotted-tailed Quoll	4	No	Widespread throughout the reserve but appears to occur in very low densities.	Competition with Foxes. Possibly the consumption of 1080 baits (particularly if spread aerially), high fire frequency, removal of fallen timber and the loss of hollow-bearing trees.	High
	Turquoise Parrot	12	Yes	Open woodlands and alluvial woodlands of the Capertee River, Red Rock Creek, Crown Creek and Valley slopes and floors.	Main threat is habitat loss. On reserve, threats include competition for nest sites with honey bees and introduced birds, loss of hollow bearing trees, loss of fallen timber and dead trees, and weed invasion of grassy woodlands.	Moderate
	Barking Owl	3	No	Lower slopes of the Capertee and Wolgan Valleys and other open valleys on the edges of Wollemi NP	Main threat is habitat loss off park. On reserve, greatest threats are the loss of hollow-bearing trees, the removal of dead wood and trees, and competition for nest hollows with honey bees.	Low
	Masked Owl	5	Yes	Taller forests in the Wolgan Valley, Deans Creek and Wolgan River area and similar locations along the Capertee and other larger rivers.	Main threat is habitat loss off reserve. On park the greatest threat is loss of hollow-bearing trees.	Moderate

Priority for management in the study area	Species	Number of records in the study area [1]	Current occurrence confirmed during BSP surveys?	Key locations in the study area	Potential key threats in the study area	Significance of the study area to conservation of the species in region
High Priority Require further survey and/or management of key habitats and key threats	Koala	14	No	Low quality habitat occurs across the reserves though higher quality habitat occurs on enriched soils in the Glow Worm Tunnel – Galah Mountain area.	Widespread hot wildfire that leaves no unburnt refuge areas.	Moderate to Low
	East-coast Freetail-bat	2 unconfirmed	Yes (Anabat only)	Probably the Capertee Valley and potentially the Wolgan and Colo River Valleys.	Habitat loss occurring off park is the main threat to this bat. On reserve, the main threat is the loss of hollow-bearing trees or standing dead trees such as through high intensity fires. If confirmed from any of the mines, canyons or caves in the area, disturbance to these features is the main threat on reserve.	Probably low.
	Large-eared Pied Bat	14	Yes	Widespread though particularly good habitat occurs in the Glow Worm Tunnel – Galah Mt area of Wollemi NP with unprecedented numbers of this bat caught in this area.	Disturbance of roost sites (in Pagoda country around Glow Worm Tunnel – Old Coach Road). High intensity fire and disturbance by park visitors are the most likely threat to these roost sites on park.	Very High
	Large-footed Myotis	2	Yes	Permanent creek lines with open pools including the Capertee, Colo, Wolangambe, Wolgan Rivers.	Few threats on park but include the loss of hollow-bearing trees, the removal of standing dead trees, weed invasion of riparian areas and water pollution.	Moderate
	Littlejohn's Tree Frog	1	No	Not well understood. Potentially occurring in Upland Swamps. Likely to be restricted to the south of the study area where average rainfall is higher.	Potentially small isolated populations which increases the risk of local extinction. It is not known whether Chytrid fungus occurs, but may affect this species if it does.	Unknown but likely to be moderate

Priority for management in the study area	Species	Number of records in the study area [1]	Current occurrence confirmed during BSP surveys?	Key locations in the study area	Potential key threats in the study area	Significance of the study area to conservation of the species in region
Moderate Priority Require management of key habitats and key threats	Barking Owl	3	No	Lower slopes of the Capertee and Wolgan Valleys and other open valleys on the edges of Wollemi NP	Main threat is habitat loss off park. On reserve, greatest threats are the loss of hollow-bearing trees, removal of dead wood and trees and competition for nest hollows with honey bees.	Low
	Sooty Owl	6	Yes	Roosting habitat is restricted to patchily distributed valleys and gullies with vegetation with a mesic influence. Foraging habitat more widespread.	Few threats in reserve system. Potentially future changes in vegetation characteristics and prey abundance from frequent fire and climate change.	Moderate
	Eastern Cave Bat	1	Yes	Roosting habitat is restricted to overhangs in escarpments adjacent to the Colo and most likely the Capertee and Wolgan Rivers and similar environments.	Species approaches southern extremity of its range in the park and may be at the limit of its ecological tolerance. Threats are not known but may include high intensity fire in the vicinity of roost sites, disturbance of roosts, predation by feral carnivores and climate change.	Low
	Greater Broad-nosed Bat	3	Yes – though only by ultrasonic call	Not well understood but appear to be taller forest types particularly in flatter areas. Only records are from the Capertee and Colo River systems, although likely to occur in the Wolgan Valley. Probably not common in sandstone environments.	Few threats within reserve system, with the greatest threats being the loss of hollow-bearing trees and the removal of standing dead trees.	Low
	Eastern False Pipistrelle	4	Yes	Not well understood but appears to be forests on moderate to high fertility soil at higher elevations – for example, in the Galah Mt area of Wollemi NP.	Few threats on reserve aside from the loss of hollow-bearing trees.	Moderate

Priority for management in the study area	Species	Number of records in the study area [1]	Current occurrence confirmed during BSP surveys?	Key locations in the study area	Potential key threats in the study area	Significance of the study area to conservation of the species in region
Lower Priority Do not currently require targeted management actions	Rosenberg's Goanna	2	Yes	Habitat widespread including along ridgelines and upper slopes in heathy vegetation.	No serious threats on reserve, although impacts facing this species are poorly understood.	Moderate
	Red-crowned Toadlet	7	Yes	Habitat widespread in first and second order creek lines and sometimes pools on sandstone ridge tops.	No serious threats on reserve. Chytrid fungus may be identified as a threat in the future.	Moderate
	Giant Burrowing Frog	1	Yes	Habitat widespread. Breeds in the headwaters of minor drainage channels or on larger creek lines with alluvial sand and rocky pools.	No serious threats on reserve. Chytrid fungus may be identified as a threat in the future.	Moderate
	Powerful Owl	7	Yes	Habitat widespread in tall sheltered forests where hollow-bearing trees occur.	Few threats in study area. Frequent fire may damage foliage roosts, alter the abundance of prey species and results in the loss of nest trees.	Moderate
	Gang-gang Cockatoo	45	Yes	Widespread. Primarily taller forests and woodlands along gully lines and on enriched soils around Glow Worm Tunnel - Galah Mountain.	No serious threats on reserve. Climate change may be a significant future threat.	Moderate
	Glossy Black-cockatoo	20	Yes	Widespread. Sheltered forest that includes Forest Oak in the small tree layer.	No serious threats on reserve. Climate change may be a significant future threat if it results in altered fire regimes that reduce the abundance of *Allocasuarina* species.	Moderate
	Eastern Pygmy-possum	1	Yes	Probably widespread, especially in woodlands with a Banksia understorey.	No serious threats on reserve, though overly frequent fire that alters the composition of the understorey is a potential threat to be considered.	Moderate
	Yellow-bellied Glider	23	Yes	Widespread. Sheltered tall open forests.	No serious threats on reserve.	Moderate

[1] Indicates the number of locations accurately recorded on the Atlas of NSW Wildlife.

5.2 KEY THREATENING PROCESSES

A number of Key Threatening Processes (KTPs), as identified under state and federal legislation, are identified within the study area. Table 9 summarises the KTPs that are recognised to occur within the reserves, including threats that are currently considered to be having a significant impact on native fauna or are likely to have serious consequences if not addressed (**shaded red**); threats that are restricted in extent or which are not well understood (**shaded pink**); and threats that may arise in the future (**shaded orange**).

Table 9: Relative priority and key locations of Key Threatening Processes in the reserves.

	Key Threatening Process	Key current locations of threat and areas to target for abatement/management
Highest	Loss of hollow-bearing trees	The lack of hollow-bearing trees in areas of regrowth on the lower slopes and floor of the Wolgan and Capertee Valleys threaten the long-term survival of many hollow-dependent threatened species such as the Brown Treecreeper, Turquoise Parrot, Large Forest Owls and various bats. Further attrition of dead standing trees and remaining old live trees with hollows further threatens these birds and mammals.
	Predation, habitat degradation, competition and disease transmission by Feral Pigs	Although Feral Pigs are not common at present, the threat they pose is very great, especially if they are to increase in high conservation value areas like the Wolgan Valley or the Upland Swamps of the area. They should be a very high priority for continued control to ensure this does not happen. Upland Swamp fauna, in particular Blue Mountains Water Skink and Giant Dragonfly, are particularly at risk.
	Predation by the European Red Fox	Foxes impact on many threatened species. Targeted control is necessary around the Brush-tailed Rock-wallaby sites, around private land in Grassy Woodland in the Capertee and Wolgan Valleys. Foxes are not common though the majority of the study area. Widespread control is not necessary or recommended due to the potential impact on the Dingo which aids in the control of Fox numbers (Letnic *et al.* 2009).
	Removal of dead wood and dead trees	The removal of dead trees will impact threatened hollow-nesting species and the removal of dead wood will result in the loss of foraging habitat of a number of threatened grassy woodland birds and the loss of an important nesting resource for the Speckled Warbler.
Restricted in extent and moderate priority	Ecological consequences of high frequency fire	At present, the study area is not subject to high-frequency fires, though this may alter with climate change. The entire area is at risk, though currently infrequent, high intensity fires are the typical regime for most of the study area. While infrequent, high intensity fires can be problematic for some species, e.g. the Koala; very frequent fires threaten more fauna species, such as through the broadscale loss of tree hollows and food resources.
	Bushrock removal and disturbance	Ridgelines in vicinity of tracks and trails. No evidence of recent bushrock removal or disturbance was collected during the BSP surveys, but historic removal was widespread in accessible parts of the study area (N. Stone pers. comm.). Such removal impacts threatened species, such as the Broad-headed Snake and Red-crowned Toadlet.
	Predation by Feral Cats	The threat of Feral Cats is not thought to be significant throughout most of the study area and they do not appear to be common. However, Upland Swamps, particularly those inhabited by the Blue Mountains Water Skinks on the southern edges of the reserve could be areas for targeted control, in addition to Grassy Woodlands supporting a suite of threatened species. Also the Wolgan Valley has been reported to have high numbers of this predator.
	Competition from Feral Honeybees	Impacts are exaggerated where clearing has occurred in the past due to the reduced availability of tree hollows – for instance in the Capertee and Wolgan Valleys. These areas should be targeted for hive eradication, though destruction of all hives is consistent with the plans of management for these reserves (NPWS 2001e, f).
	Invasion of native plant communities by exotic perennial grasses	The current severity and extent of this threat not mapped. Vegetation mapping currently being undertaken (DECC in prep.) will aid with assessment of current and potential impacts and habitats most at risk. Former grazing land and high conservation value Grassy Woodlands on the Capertee and Wolgan Valleys are most at risk. Species affected include the Diamond Firetail, Hooded Robin and Speckled Warbler.
	Competition and grazing from feral European Rabbit	Rabbits are moderately common in several locations in the study area where higher fertility soil occurs. They are a low priority for control in the Galah Mt area where they are not in high abundance and not thought to threaten any native species. They are common in the Capertee and Wolgan Valleys and may compete with the Brush-tailed Rock-wallaby for food. They also may impact on Upland Swamps supporting the Blue Mountains water Skink and a variety of regionally significant fauna species.
	Predation by the Plague Minnow (*Gambusia holbrooki*)	The Plague Minnow has been observed in the lower reaches of some of the large rivers in the reserves. The impact on this species on various frog species in these areas is unknown.

	Key Threatening Process	Key current locations of threat and areas to target for abatement/management
Possible future threats	Infection of frogs by amphibian Chytrid fungus	Occurrence and distribution is not known. Key areas for research are: creek lines supporting rainforest; headwaters of minor drainage channels; larger creek lines with alluvial sand and rocky pools. All threatened frog species occurring in the reserves may potentially be seriously impacted.
	Human-caused climate change	Potential impact on fauna species poorly understood. Studies currently being undertaken will inform the management of this impending threat. Species most likely to be impacted are those reliant on the small pockets of mesic forest that intersperse the area – e.g. the Sooty Owl and, if still extant, the Stuttering Frog. Species that rely on Upland Swamps are also at risk – e.g. Blue Mountains Water Skink.
	Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations	Not currently known from study area but could impact on healthy populations of several threatened parrots if it were to have an outbreak. Risk of this KTP is at present considered to be low.
	Competition and habitat degradation by Feral Goats	Not currently known from the study area. However, Feral Goats may colonise from nearby areas resulting in competition with the Brush-tailed Rock-wallaby and having adverse impacts on cave-dwelling bats.

In addition, to KTPs a number of other threatening processes are considered to be impacting on the fauna within the reserves. These threatening processes are detailed in Table 10.

Table 10: Other threatening processes acting in the study area.

Process	Key locations of threat
Predation by Wild Dogs and hybridisation between Wild Dogs and Dingoes	The presence of Dingo may reduce Fox and Feral Pig numbers and their impacts. The key areas of threat are the peripheries of the reserve (where Domestic Dogs may invade the park and hybridise with Dingoes).
Competition for hollows with introduced bird species	The Common Myna and Common Starling are both hollow-nesting pest birds that will outcompete native species for this scarce resource. These species are restricted to the edges of Wollemi NP, such as around the Capertee and Wolgan Valleys. Unfortunately, this is where the greatest density of threatened hollow-nesting birds and mammals occurs, including the Brown Treecreeper and Greater Broad-nosed Bat.
Illegal collection of individual specimens of Broad-headed Snake	Rocky outcrops on ridges and exposed slopes adjacent to trails. The intensity of illegal collecting activity is poorly known.
Widespread high intensity fires	Areas particularly vulnerable to high intensity fires include rocky refugia of the Brush-tailed Rock-wallaby, roost sites of cave or escarpment-dwelling bats, Upland Swamps, and anywhere in the study area where no unburnt refugia are left, particularly near core areas for Koala. Fortunately, wildfires are rarely uniform and most times some gully systems are left unburnt or subject to only a low-intensity burn.
Occurrence of Eurasian Blackbirds which compete with native species and spread weeds	Not recorded within the study area at this point, however unlike most pest birds, the Blackbird is spreading into undisturbed forest. Impact on native fauna is likely to be negligible at this stage, and would only require active management if found to spread further into the park.
Application of pesticides in neighbouring farmlands	The extent of this practice and the level of impact on threatened fauna is not known, though bats and insect-eating birds are likely to be the most affected. Areas of greatest impact are likely to the in the Wolgan and Capertee Valleys.
Entanglement in barbed wire fences	Barbed wire fences exist along the perimeter of much of both reserves, with some old fence lines within the reserves. These fences may result in the entanglement of a variety of species, including the Powerful Owl, Squirrel and Yellow-bellied Gliders.
The disease *Chlamydia*	The incidence of this disease in the Koala population frequenting the reserves is unknown. However, it is

Process	Key locations of threat
	likely that only old or sick individuals would succumb.
Inappropriate 1080 baiting e.g. aerial application or the use of uncovered baits	Inappropriate 1080 baiting within the reserves or in adjacent areas may result in the loss of threatened species, such as the Spotted-tailed Quoll and Rosenberg's Goanna.
Pig Dogs	Pigging is a common activity in the adjacent Newnes SF, with some activity also seen in adjoining sections of Wollemi NP. This activity may result in the mortality of a variety of native species.

5.3 HIGH PRIORITY FAUNA HABITATS

High priority fauna habitats are those areas or environments that support a disproportionate number of threatened species, or are habitat to the highest conservation priority fauna in the area. Targeting conservation resources towards these habitats delivers the greatest conservation outcome per dollar. Current vegetation maps for south-west Wollemi NP (Bell 1998) and south-west Blue Mountains NP (Royal Botanic Gardens 1990) are at a scale inappropriate for assessing detailed fauna habitat preferences. Vegetation mapping is currently being revised using aerial photograph interpretation (DECC in prep.). Fine scale delineation of vegetation communities will help accurately map fauna habitats in the area. This report presents an interim prioritisation of habitat types, based on research elsewhere in the Greater Blue Mountains, expert knowledge and results of the current study. The Information and Assessment Section is working towards modelling habitat for threatened species across the northern half of the Sydney Basin (expected completion date 2011). Three high priority fauna habitats have been identified in the study area: Grassy Woodlands, Upland Swamps and the Sandstone Escarpment-Pagoda country.

Regenerating Grassy Woodlands in the Wolgan Valley. © DECC

Grassy Woodlands (including Grassy Box Woodlands, Alluvial Woodlands and the Ironbark-Grey Gum Woodlands on the valley slopes) are the most important habitat for threatened fauna in the study area. This habitat mostly occurs in the Capertee and Wolgan Valleys and lower slopes and along the alluvial flats of these rivers. The original extent of this habitat has been greatly reduced outside of the reserve system, with stands that remain mostly fragmented and regenerating. Even within reserves this habitat is usually recovering from prior disturbance. It supports far more threatened fauna than any other habitat. Confirmed from the study area are the Regent Honeyeater, Black-chinned Honeyeater, Hooded Robin, Diamond Firetail, Speckled Warbler, Square-tailed Kite, Brown Treecreeper, Barking Owl and Turquoise Parrot. Further species that are likely to occur include the Swift Parrot, Squirrel Glider and Painted Honeyeater. Although the key threat to this habitat occurs off-reserve (further depletion and fragmentation by clearing), there are a number of threats in the reserve including: invasion by exotic perennial grasses, loss of hollow-bearing trees and fallen timber, and competition for nest hollows by honey bees. As this environment is largely in a regenerating state even within the reserve system, tree hollows are sparsely distributed, limiting the nesting and roosting resources for many threatened species.

Upland Swamp in the Wollangambe area, Blue Mountains NP. © Narawan Williams

Upland Swamps form an important component of the landscape in the south of the study area and around Newnes Plateau. These swamps support a unique suite of plants and animals including the threatened Blue Mountains Water Skink, Littlejohn's Tree Frog, Giant Burrowing Frog, Red-crowned Toadlet, Rosenberg's Goanna, Turquoise Parrot, Eastern Pygmy-possum, as well as the regionally significant Beautiful Firetail, Southern Emu-wren, Dusky Antechinus and Swamp Rat. Fauna in Upland Swamps are susceptible to several threatening processes including predation by Foxes and Cats (as many Upland Swamp fauna are ground dwelling), grazing and habitat disturbance by the European Rabbit, and frequent fire. Fire opens up normally the dense vegetation cover that characterises this habitat making it more accessible to introduced predators. In addition, the naturally isolated nature of Upland Swamps and the fact that many swamp fauna have poor capacity to disperse means that they are particularly vulnerable to local extinction. The hanging swamps in the south of the study area fall into the Vulnerable Ecological Community 'Blue Mountains Swamps in the Sydney Basin Bioregion'.

Sandstone Escarpments and Pagoda Formations are another important fauna habitat – supporting some of the highest priority fauna in the region, for instance the Brush-tailed Rock-wallaby, Broad-headed Snake (both Endangered under the TSC Act) and the Vulnerable Large-eared Pied Bat. Other threatened fauna that use this environment include the Eastern Cave Bat, Eastern Bentwing-bat, Red-crowned Toadlet and Rosenberg's Goanna. There are fewer threats to this environment overall than to the other high-priority fauna habitats, though high intensity or frequent fire can damage overhangs, sandstone exfoliations and bat roosting sites. For the Brush-tailed Rock-wallaby and larger bat roosts, site-based management is most appropriate.

Pagoda formation, Wollemi NP. © Martin Schulz

6 MANAGEMENT RECOMMENDATIONS

This section summarises management recommendations for fauna in the study area. These recommendations are intended to complement actions already identified in relevant threatened species Recovery Plans, Priority Action Statements (PAS), Threat Abatement Plans and in Plans of Management. Such documents are readily available and will therefore not be duplicated here. These management recommendations should be reviewed and refined as further information becomes available.

6.1 PRIORITY PEST SPECIES

The following recommendations are made with regard to mitigating the impact of key pest species on threatened fauna and biodiversity.

6.1.1 Feral Pig

- Feral Pigs probably have a greater potential to impact on threatened species than any other introduced species should they be allowed to expand in population size. An annual review of Feral Pig distribution and population size is recommended including a collation and entry into corporate databases of known sightings and areas of potential Feral Pig activity. Staff and visitors should be encouraged to report observations of Feral Pigs, wallows and scats.

- The known population of Feral Pigs at Mount Cameron needs to be investigated as to its size and extent and feasibility of eradication.

- Reports of Feral Pig signs on Bungalboori Creek and on the Wolgan River need to be investigated and if populations exist there it needs to be assessed as to the feasibility of control or eradication.

- Feral Pig numbers must be kept to low levels in priority habitats in the Capertee and Wolgan Valleys. Both Alluvial Woodlands and Grassy Woodlands provide ideal habitat for Feral Pigs and they can reach very high numbers. Monitoring of these environments for Feral Pig activity should be routine.

- Feral Pig numbers should be kept to low levels in the Upland Swamps that occur on the boundary of Wollemi NP and Newnes SF. They are currently more common in the State Forest, however damage has also been noted from within the NP. These Upland Swamps could be monitored annually for Feral Pig damage, particularly during drought when they may congregate here and cause additional damage to already stressed Upland Swamps. If populations have increased a coordinated control program undertaken with State Forests to mitigate the serious damage they can cause to this fragile environment and the threatened species that occur there.

6.1.2 Fox

- The highest priority for Fox control continues to be around Brush-tailed Rock-wallaby colonies, where control has been undertaken for some time. Continued expansion of this program into neighbouring private lands, in coordination with the RLPB, will assist numerous threatened species that occur in Grassy Woodlands.

- Foxes are not common through most of the interior of the reserves and, overall, are not considered to be a serious threat. A broad scale Fox control program is not considered necessary at this time; rather control should remain targeted to specific sites or habitats.

- Any Fox baiting should be undertaken to avoid take by threatened species, such as the Spotted-tailed Quoll and Rosenberg's Goanna.

- Recent research in arid areas has shown Dingoes dramatically reduce Fox numbers which in turn means small mammals and lizards (the main prey of Foxes) are more abundant (Letnic 2007, Letnic *et al.* 2009). It is unknown whether Dingoes directly prey on Foxes or exclude them through competition. While further research needs to be conducted in forested

environments, it is likely that where Dingoes can be protected, such as the Wollemi wilderness, they are an effective and labour-free tool to control Foxes. Research currently underway in the Wolgan Valley that looks at niche overlap between Wild Dogs, Foxes and Feral Cats might deliver further insight into this complex issue (J. Pascoe in prep.).

- Closing unnecessary access trails will reduce the incursions of Foxes, particularly in areas of thick vegetation such as swamps. Foxes readily utilise roads, tracks and other cleared access ways through denser vegetation or complex topography (Environment Australia 1999b). Within wilderness areas this is consistent with the plans of management for Wollemi and Blue Mountains NPs (NPWS 2001e, f).

6.1.3 Wild Dog

- Domestic Dogs, Dingoes and hybrids all occur in the study area. Control of Wild Dogs must balance with conserving the Dingo which is likely playing an important part in regulating the ecosystems of the area.

- Any control of Wild Dogs in the study area should remain focused on the peripheries of the reserve where it abuts grazing land and there is an imperative from landholders (i.e. the Capertee Valley). From a native fauna management perspective, baiting (particularly aerial baiting) within the interior of the park should be avoided – consistent with the Wollemi NP plan of Management (NPWS 2001e). Additionally, any baiting program must be undertaken with care to reduce accidental take by threatened species, such as the Spotted-tailed Quoll and Rosenberg's Goanna.

- Dingoes have been observed in the Glow Worm Tunnel – Galah Mountain area. Further reporting and research by tertiary institutions and others should be encouraged in order to gain a better understanding of where Dingoes occur so they may be better conserved.

- The highest priority for monitoring of Wild Dogs is around extant viable Brush-tailed Rock-wallaby colonies. Although populations of wallabies are stable and control measures are not considered necessary at this time, continued monitoring will ensure that this situation does not change. Remote infrared motion cameras, such as those that have been recently acquired for the Monitoring Evaluation and Reporting (MER) program would be ideal to use in any Wild Dog or Dingo monitoring program.

- Control or monitoring of Wild Dogs/Dingoes around the Koala population in the Glow Worm Tunnel – Galah Mountain area is not considered necessary. Koalas may be threatened by Wild Dogs when populations are isolated and small; however Koalas in this area are part of a large, mostly low-density population that stretches to northern Wollemi and Parr SCA.

6.1.4 European Rabbit

- Populations are present in some Upland Swamps. Given their potential impact on vegetation structure and hydrological regimes eradication is highly desirable. Control of European Rabbit populations in Upland Swamps is considered important to protect the Blue Mountains Water Skink and a variety of regionally significant species, such as the Beautiful Firetail and Southern Emu-wren.

6.1.5 Feral Donkey

- The population of Feral Donkeys at Mt Cameron is currently small (approximately 12 individuals) and at this point is unlikely to pose any significant threat to native fauna in the area. However, given that the potential impacts of this species in the Greater Blue Mountains are unknown and it is a wilderness area, eradication is highly desirable.

6.1.6 Feral Honeybee

- Hives of honeybees should be destroyed wherever they are found to occur as they exclude numerous threatened species from tree hollows (consistent with the Wollemi and Blue Mountains plans of management (NPWS 2001e, f).

- Any focus for eradication efforts should be in the Grassy Woodlands in the Wolgan and Capertee Valleys. These areas have a high diversity of threatened hollow-nesting fauna and a shortage of hollows due to prior land clearance.

6.1.7 Introduced bird species

- Three introduced bird species should be monitored as to their distribution and abundance and potential to impact on native fauna. These birds are the Common Myna, Common Starling and Eurasian Blackbird. Monitoring could involve a dedicated survey and/or a review and collation of records every two years.

- Research by tertiary institutions should be encouraged to examine the interactions between hollow-nesting pest birds and threatened native species such as the Brown Treecreeper and Turquoise Parrot. The Wolgan and Capertee Valleys would be ideal locations to undertake such research. Outcomes would help determine the scale of the threat presented by pest birds in to threatened fauna in these environments.

- Staff and park visitors should be encouraged to record these species when they are observed within the reserves along with observations as to whether they are increasing in a particular area. Observations of interactions between pest birds and threatened species would also be valuable data for addition to corporate databases.

- Control measures are probably not necessary at this point; however these birds are continuing to expand their range. Future monitoring or research should determine the level of threat and the urgency and scale of action to be undertaken. The Common Starling and Common Myna will compete with threatened hollow-nesting species in the Capertee and Wolgan Valleys. The Eurasian Blackbird may eventually invade all areas of moister forest within the study area.

6.2 FIRE MANAGEMENT AND FAUNA

The impact of wildfire and controlled burning on fauna remains poorly understood. Research conducted by DECC on the Woronora Plateau suggests that arboreal mammals, shrub-frequenting birds and litter-dwelling skinks are particularly susceptible to high-intensity fire (DEC 2004b). Although most species recover quickly, this study highlighted the importance of unburnt refugia in the recolonisation of burnt areas. Unburnt refugia remain important for many years after the fire. They provide a population source for depleted areas and provide augmentary food and habitat for animals occupying burnt areas.

Strategies to reduce the impact of hazard reduction burns on fauna include:

- Fire management should aim for a mosaic of fire regimes, consistent with fire management plans for the area (DEC 2006c). Mosaic burning should try to retain some examples of all vegetation communities in a long unburnt state, especially priority fauna habitats (in this area Grassy Woodlands, Upland Swamps and Escarpment and Pagoda country).

- After a large-scale wildfire, as is the typical burning regime in the study area, it is very important to leave unburnt refugia as unburnt for as long as possible. Research on the Woronora Plateau suggests that unburnt refugia are still important after five years.

- Grassy Woodlands supporting declining woodland birds in the Wolgan and Capertee Valleys should not be burnt during the nesting season for these birds. For most birds this is between July and January (Higgins *et al.* 2001; Higgins and Peter 2002).

- Upland Swamps require special consideration with regard to fire management. Elsewhere in the Sydney Basin they have a fauna that is known to be particularly susceptible to fire (DECC 2007a). Their patchy distribution makes recolonisation difficult in the event of local extinction. Fire management should aim to leave some of this habitat type in a long unburnt state. Hot burns in Upland Swamps should be avoided as they can damage the peat layer and destroy the swamp.

- Control burns should be avoided when key eucalypt and *Corymbia* species are in heavy flower to minimise the impact on feeding resources for nectivorous species such as the Black-chinned Honeyeater, Regent Honeyeater and Swift Parrot. Key eucalypt species are Ironbarks (*E. fibrosa* and *E. crebra*) and Grey Gum (*E. punctata*).

- Koala habitat in the Glow Worm Tunnel – Galah Mountain area should not be subject to control burns during the Koala breeding season (spring and summer).

- Specific sites to be avoided in control burns include: nest sites of the large forest owls (none presently known), communal roosts of insectivorous bats (Starlight Canyon, Wolgan Valley Mine and Glen Davis Mine) and Upland Swamps.

Strategies to reduce the impact of wildfire management on fauna include:

- If possible, high intensity wildfire should be excluded from the rocky refugia of Brush-tailed Rock-wallaby colonies.

- Where possible, high intensity fire should be excluded from Upland Swamps as the peat layer can be burnt and the swamp destroyed, as has happened recently in the Upper Deans Creek swamp. The loss of the peat layer reduces the water holding capacity of the swamp and makes it unsuitable for the Blue Mountains Water Skink and Giant Dragonfly.

- High intensity wildfire should be excluded, where possible, from cave roosting bat sites, particularly if any maternity and wintering roosts are discovered. Known important bat roosts include Starlight Canyon, Wolgan Valley Mine and the Glen Davis Mine.

- Hollow-bearing dead or living trees should not be felled during mop-up operations or during construction or upgrading of fire breaks and trails.

- During construction and maintenance of fire trails and firebreaks care should be taken to maintain the natural hydrology of ridge tops and upper slopes and to avoid Upland Swamps.

- Fire intensity mapping should be carried out following all major wildfire events.

6.3 SPECIFIC MANAGEMENT RECOMMENDATIONS FOR CONTROL BURNING IN THE GLOW WORM TUNNEL AREA

Most of the area between Glow Worm Tunnel and Old Coach Roads (the Glow Worm Tunnel area) in Wollemi NP has not been burnt since 1982-3. Most of the surrounding area was severely burnt in the widespread fires of 2003. Therefore, it is likely to have been a very important refugium during the time that the forest to the east of Old Coach Rd has been recovering since the most recent fires.

The area between Glow Worm Tunnel and Old Coach Roads comprises a range of habitats, mostly open woodland and forest with Pagoda formations and sandstone escarpments at the northern end and below this, some taller forest with a mesic influence and tall trees such as Sydney Peppermint (*Eucalyptus piperita*) and Monkey Gum (*E. cypellocarpa*). This area was a focus of surveys in February 2009 in order to determine what threatened fauna could be found there.

Table 11: This table lists threatened fauna that are recorded on the Atlas of NSW Wildlife in the Glow Worm Tunnel area (between Glow Worm Tunnel Road and Old Coach Road).

Common Name	Legal status	Number	Key habitats	Potential impact of control burn	Likely impact of *low intensity Autumn* burn
Brown Treecreeper	V	1	Ironbark woodlands	Record likely inaccurate	N/A
Eastern Bentwing-bat	V	6	Roosting sites in caves in escarpment and pagoda country	Disruption of large roost sites	High
Eastern False Pipistrelle	V	1	Forest on plateau	Loss of hollows	Moderate
Gang-gang Cockatoo	V	13	Forest on plateau	Loss of hollows	Low
Glossy Black-Cockatoo	V	24	Forest in gullies and plateau	Loss of hollows	Moderate
Koala	V	6	Forest on plateau and gullies	Direct mortality	Moderate
Large-eared Pied Bat	V	9	Pagoda and escarpment country	Disruption of roost or breeding sites	High
Powerful Owl	V	1	Entire area	Loss of hollows	Low
Red-crowned Toadlet	V	2	Drainages on plateau	Direct mortality	Low
Yellow-bellied Glider	V	1	Taller forests below escarpment	Loss of hollow and feed trees	Low
Eastern Pygmy Possum (recorded just outside area)	V	1	Forest and woodland with Banksias	Loss of *Banksia* spp.	Moderate

The following recommendations are made regarding the potential control burn in the Glow Worm Tunnel area

- As this area is a long-unburnt refugium and the forest to the east was severely burnt, consideration should be given to delaying a control burn in this area for an additional one or two years. In addition, or as an alternative, consideration should be given to not burning the entire section and leaving some long-unburnt habitat in this state.

- Control burns should be conducted in Autumn, outside of the breeding season for the Koala (Spring-Summer); Large-eared Pied Bat, Eastern False Pipistrelle and Eastern Bentwing-bat (late Spring to Early Summer);

- Control burns should avoid the escarpment and pagoda country in the north of the area as this is likely the breeding and roosting sites for the exceptional Large-eared Pied Bat population that occurs in the area.

- Control burns should avoid, if possible, large stands of *Allocasuarinas* which are important food resources for Glossy Black-cockatoos in the area. Forest to the east of Old Coach Road has been depleted of *Allocasuarinas* since the recent fires (as they are a fire-sensitive species).

- As a moderate to low priority, control burns ideally should leave unburnt some areas of *Banksias* as food resources for the Eastern Pygmy-possum – many *Banksia* species being killed outright by fire and taking many years to flower again. Patches of woodland that have a large number of Banksias exist along both Glow Worm Tunnel and Old Coach Roads, particularly on the eastern side of the latter. Starting the control burn from a short distance off the road would probably leave sufficient nectar resources for this possum. Nonetheless, research in Royal and Heathcote NPs has shown that Eastern Pygmy-possums survive widespread wildfire well (D. Andrew pers. comm.).

6.4 LAND ACQUISITION PRIORITIES FOR FAUNA

There are two key habitats that should be targeted for addition to the reserve system in order to improve the contribution of the reserve to conservation of fauna in the region. These are 1) Grassy Woodlands in the Wolgan and Capertee Valley and nearby smaller valley systems and 2) Upland Swamps that are currently part of Newnes State Forest such as Dinner Creek Swamp.

Grassy Woodlands are extremely poorly represented in the reserve system, both regionally and nationally. Outside the reserve system they have been largely cleared for agriculture. Grassy Woodlands in the Capertee and Wolgan Valleys are of national significance and provide habitat for at least twelve threatened fauna species in the region, including the nationally endangered Regent Honeyeater and Swift Parrot. Many more regionally significant species also use this habitat. Every hectare of this habitat that is added to the reserve improves the contribution the reserve makes to these gravely threatened birds. Adding breeding habitat for the Regent Honeyeater to the reserve would be particularly desirable. Grassy Woodlands that can be suitably managed as part of the large contiguous Greater Blue Mountains reserve system will make an enormous contribution to the conservation of some of the most threatened animals and ecosystems in NSW.

High Elevation Upland Swamps are poorly represented in the reserve system. In the region, swamp communities fall under two separate Endangered Ecological Community determinations (under the NSW TSC Act) – Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion and Blue Mountains Swamps in the Sydney Basin Bioregion. Upland Swamps are most extensive on the Newnes Plateau in the adjacent Newnes SF where rainfall is higher. Upland Swamps in Newnes SF have known populations of the Endangered Blue Mountains Water Skink and Giant Dragonfly whereas most swamps in Wollemi NP are too dry for these species. Additions of Upland Swamp habitat to the National Park, especially some of the larger swamps such as Dinner Creek Swamp or Budgary Creek Swamp, would greatly improve the conservation status of the unique swamp fauna (and flora) of the region. In addition to the Blue Mountains Water Skink and Giant Dragonfly, further regionally important fauna that are common in these swamps are the Beautiful Firetail and Southern Emu-wren.

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APPENDIX A: FAUNA SPECIES RECORDED IN SOUTH-WEST WOLLEMI AND NORTH-WEST BLUE MOUNTAINS NPS

Below is a list of the fauna species recorded within the study area on the Atlas of NSW Wildlife (as at May 2009). Taxonomical nomenclature follows that used on the Atlas of NSW Wildlife, with more updated scientific names noted where relevant. Records are derived from DECC systematic surveys (Biodiversity Survey Priorities (BSP) and Comprehensive Regional Assessment (CRA)), licensed data sets (Birds Australia (BA)) and incidental observations submitted by individuals, including park rangers and field officers; bushwalkers and naturalists; scientific researchers working in the area; and other visitors to the park.

Common Name	Scientific Name	Legal Status	BA	CRA	BSP	Other
FROGS						
Bibron's Toadlet	*Pseudophryne bibronii*	P			x	
Bleating Tree Frog	*Litoria dentata*	P			x	
Blue Mountains Tree Frog	*Litoria citropa*	P			x	x
Broad-palmed Frog	*Litoria latopalmata*	P			x	x
Brown-striped Frog	*Limnodynastes peronii*	P		x	x	x
Common Eastern Froglet	*Crinia signifera*	P		x	x	x
Eastern Banjo Frog	*Limnodynastes dumerilii*	P		x	x	x
Eastern Dwarf Tree Frog	*Litoria fallax*	P				x
Giant Burrowing Frog	*Heleioporus australiacus*	V			x	
Leaf-green Tree Frog	*Litoria phyllochroa*	P			x	x
Lesueur's Frog	*Litoria lesueuri*	P			x	x
Littlejohn's Tree Frog	*Litoria littlejohni*	V				x
Peron's Tree Frog	*Litoria peronii*	P			x	x
Red-crowned Toadlet	*Pseudophryne australis*	V		x	x	x
Spotted Grass Frog	*Limnodynastes tasmaniensis*	P			x	x
Stoney Creek Frog	*Litoria wilcoxii*	P			x	
Stuttering Frog	*Mixophyes balbus*	E1				x
Tusked Frog	*Adelotus brevis*	P				x
Verreaux's Frog	*Litoria verreauxii*	P			x	x
REPTILES						
Barred-sided Skink	*Eulamprus tenuis*	P			x	x
Bearded Dragon	*Pogona barbata*	P			x	x
Black Rock Skink	*Egernia saxatilis*	P			x	x
Blackish Blind Snake	*Ramphotyphlops nigrescens*	P				x
Blotched Blue-tongue	*Tiliqua nigrolutea*	P				x
Blue Mountains Water skink	*Eulamprus leuraensis*	E1				x
Broad-headed Snake	*Hoplocephalus bungaroides*	E1			x	x
Broad-tailed Gecko	*Phyllurus platurus*	P		x	x	x
Brown Tree Snake	*Boiga irregularis*	P			x	
Common Death Adder	*Acanthophis antarcticus*	P				x
Common Tree Snake	*Dendrelaphis punctulatus*	P				x
Copper-tailed Skink	*Ctenotus taeniolatus*	P		x	x	x
Cream-striped Shinning-skink	*Cryptoblepharus virgatus*	P		x	x	x
Cunningham's Skink	*Egernia cunninghami*	P			x	x
Dark-flecked Garden Sunskink	*Lampropholis delicata*	P		x	x	x
Diamond Python	*Morelia spilota spilota*	P			x	x
Eastern Blue-tongue	*Tiliqua scincoides*	P			x	x
Eastern Brown Snake	*Pseudonaja textilis*	P			x	x
Eastern Small-eyed Snake	*Cryptophis nigrescens*	P			x	x
Eastern Snake-necked Turtle	*Chelodina longicollis*	P			x	x
Eastern Water Dragon	*Physignathus lesueurii lesueurii*	P		x	x	x
Eastern Water-skink	*Eulamprus quoyii*	P		x	x	x
Highland Copperhead	*Austrelaps superbus*	P			x	

Common Name	Scientific Name	Legal Status	BA	CRA	BSP	Other
Jacky Lizard	*Amphibolurus muricatus*	P			x	x
Lace Monitor	*Varanus varius*	P			x	x
Lesueur's Velvet Gecko	*Oedura lesueurii*	P		x	x	x
Mainland She-oak Skink	*Cyclodomorphus michaeli*	P				x
Mountain Dragon	*Rankinia diemensis*	P		x	x	x
Mustard-bellied Snake	*Drysdalia rhodogaster*	P			x	x
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*	P		x	x	x
Red-bellied Black Snake	*Pseudechis porphyriacus*	P		x	x	x
Red-throated Skink	*Acritoscincus platynota*	P		x	x	x
Rosenberg's Goanna	*Varanus rosenbergi*	V		x	x	
South-eastern Morethia Skink	*Morethia boulengeri*	P				x
South-eastern Slider	*Lerista bougainvillii*	P		x	x	x
Southern Rainbow-skink	*Carlia tetradactyla*	P			x	
Spotted Black Snake	*Pseudechis guttatus*	P		x		
Three-toed Skink	*Saiphos equalis*	P			x	x
Tiger Snake	*Notechis scutatus*	P			x	x
Tree Skink	*Egernia striolata*	P				x
Tussock Cool-skink	*Pseudemoia entrecasteauxii*	P			x	
Tussock Skink	*Pseudemoia pagenstecheri*	P			x	
Weasel Skink	*Saproscincus mustelinus*	P		x	x	x
White's Skink	*Egernia whitii*	P		x	x	x
Wood Gecko	*Diplodactylus vittatus*	P			x	x
Yellow-bellied Water-skink	*Eulamprus heatwolei*	P		x	x	x
DIURNAL BIRDS						
Australian Brush-turkey	*Alectura lathami*	P			x	x
Australian Hobby	*Falco longipennis*	P	x		x	
Australian King-Parrot	*Alisterus scapularis*	P	x		x	x
Australian Magpie	*Gymnorhina tibicen*	P	x		x	x
Australian Pipit	*Anthus australis*	P	x			x
Australian Raven	*Corvus coronoides*	P	x	x	x	x
Australian Wood Duck	*Chenonetta jubata*	P	x		x	x
Azure Kingfisher	*Ceyx azureus*	P	x		x	
Bar-shouldered Dove	*Geopelia humeralis*	P	x			x
Bassian Thrush	*Zoothera lunulata*	P	x		x	
Beautiful Firetail	*Stagonopleura bella*	P	x	x	x	x
Bell Miner	*Manorina melanophrys*	P	x		x	x
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	x		x	x
Black-eared Cuckoo	*Chalcites osculans*	P	x			x
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	P	x	x	x	x
Black-faced Monarch	*Monarcha melanopsis*	P	x		x	x
Black-shouldered Kite	*Elanus axillaris*	P	x			
Brown Cuckoo-Dove	*Macropygia amboinensis*	P	x		x	
Brown Falcon	*Falco berigora*	P	x		x	
Brown Gerygone	*Gerygone mouki*	P	x	x	x	x
Brown Goshawk	*Accipiter fasciatus*	P	x		x	
Brown Honeyeater	*Lichmera indistincta*	P				x
Brown Quail	*Coturnix ypsilophora*	P	x		x	x
Brown Songlark	*Cincloramphus cruralis*	P	x		x	
Brown Thornbill	*Acanthiza pusilla*	P	x	x	x	x
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V	x		x	x
Brown-headed Honeyeater	*Melithreptus brevirostris*	P	x	x	x	
Brush Cuckoo	*Cacomantis variolosus*	P	x		x	x
Buff-rumped Thornbill	*Acanthiza reguloides*	P	x		x	x
Channel-billed Cuckoo	*Scythrops novaehollandiae*	P			x	x
Chestnut-rumped Heathwren	*Calamanthus pyrrhopygius*	P	x		x	x
Cicadabird	*Coracina tenuirostris*	P	x		x	x
Collared Sparrowhawk	*Accipiter cirrocephalus*	P			x	
Common Bronzewing	*Phaps chalcoptera*	P	x	x	x	x
Crescent Honeyeater	*Phylidonyris pyrrhoptera*	P	x		x	
Crested Pigeon	*Ocyphaps lophotes*	P	x			x

Common Name	Scientific Name	Legal Status	BA	CRA	BSP	Other
Crimson Rosella	*Platycercus elegans*	P	x	x	x	x
Diamond Firetail	*Stagonopleura guttata*	V	x			
Double-barred Finch	*Taeniopygia bichenovii*	P	x			x
Dusky Moorhen	*Gallinula tenebrosa*	P			x	
Dusky Woodswallow	*Artamus cyanopterus*	P	x		x	
Eastern Rosella	*Platycercus adscitus eximius*	P	x		x	x
Eastern Shrike-tit	*Falcunculus frontatus*	P	x	x	x	x
Eastern Spinebill	*Acanthorhynchus tenuirostris*	P	x	x	x	x
Eastern Whipbird	*Psophodes olivaceus*	P	x	x	x	x
Eastern Yellow Robin	*Eopsaltria australis*	P	x	x	x	x
Fairy Martin	*Petrochelidon ariel*	P	x	x		
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	P	x		x	x
Flame Robin	*Petroica phoenicea*	P	x		x	x
Fuscous Honeyeater	*Lichenostomus fuscus*	P	x			x
Galah	*Eolophus roseicapillus*	P	x		x	x
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	x	x	x	x
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	x	x	x	x
Golden Whistler	*Pachycephala pectoralis*	P	x	x	x	x
Golden-headed Cisticola	*Cisticola exilis*	P	x			
Great Cormorant	*Phalacrocorax carbo*	P			x	
Grey Butcherbird	*Cracticus torquatus*	P	x		x	x
Grey Currawong	*Strepera versicolor*	P	x	x	x	x
Grey Fantail	*Rhipidura albiscapa*	P	x	x	x	x
Grey Shrike-thrush	*Colluricincla harmonica*	P	x	x	x	x
Grey Teal	*Anas gracilis*	P	x			x
Hooded Robin	*Melanodryas cucullata*	V	x			x
Jacky Winter	*Microeca fascinans*	P	x		x	x
Large-billed Scrubwren	*Sericornis magnirostris*	P	x	x	x	x
Laughing Kookaburra	*Dacelo novaeguineae*	P	x	x	x	x
Leaden Flycatcher	*Myiagra rubecula*	P	x		x	
Lewin's Honeyeater	*Meliphaga lewinii*	P	x		x	x
Little Button-quail	*Turnix velox*	P			x	x
Little Eagle	*Hieraaetus morphnoides*	P	x			
Little Grassbird	*Megalurus gramineus*	P	x			
Little Lorikeet	*Glossopsitta pusilla*	P	x		x	x
Little Pied Cormorant	*Phalacrocorax melanoleucos*	P	x			x
Little Raven	*Corvus mellori*	P				x
Little Wattlebird	*Anthochaera chrysoptera*	P				x
Magpie-lark	*Grallina cyanoleuca*	P	x			x
Masked Lapwing	*Vanellus miles*	P	x		x	
Mistletoebird	*Dicaeum hirundinaceum*	P	x	x	x	
Musk Lorikeet	*Glossopsitta concinna*	P	x			
Nankeen Kestrel	*Falco cenchroides*	P	x			x
New Holland Honeyeater	*Phylidonyris novaehollandiae*	P	x	x	x	x
Noisy Friarbird	*Philemon corniculatus*	P	x		x	x
Noisy Miner	*Manorina melanocephala*	P	x		x	x
Olive-backed Oriole	*Oriolus sagittatus*	P	x		x	
Pacific Black Duck	*Anas superciliosa*	P	x		x	x
Pacific Koel	*Eudynamys orientalis*	P				x
Painted Button-quail	*Turnix varia*	P			x	
Pallid Cuckoo	*Cuculus pallidus*	P	x			x
Peaceful Dove	*Geopelia placida*	P	x		x	x
Peregrine Falcon	*Falco peregrinus*	P			x	
Pied Butcherbird	*Cracticus nigrogularis*	P	x			x
Pied Currawong	*Strepera graculina*	P	x	x	x	x
Pilotbird	*Pycnoptilus floccosus*	P	x	x	x	x
Rainbow Bee-eater	*Merops ornatus*	P	x			x
Red Wattlebird	*Anthochaera carunculata*	P	x	x	x	x
Red-browed Finch	*Neochmia temporalis*	P	x	x	x	x
Red-browed Treecreeper	*Climacteris erythrops*	P	x		x	x

Common Name	Scientific Name	Legal Status	BA	CRA	BSP	Other
Red-capped Robin	*Petroica goodenovii*	P			x	
Red-rumped Parrot	*Psephotus haematonotus*	P	x			
Regent Honeyeater	*Xanthomyza phrygia*	E1	x			x
Restless Flycatcher	*Myiagra inquieta*	P	x		x	
Rockwarbler	*Origma solitaria*	P	x	x	x	x
Rose Robin	*Petroica rosea*	P	x	x	x	x
Rufous Fantail	*Rhipidura rufifrons*	P	x	x	x	x
Rufous Songlark	*Cincloramphus mathewsi*	P	x			
Rufous Whistler	*Pachycephala rufiventris*	P	x		x	x
Sacred Kingfisher	*Todiramphus sanctus*	P	x		x	x
Satin Bowerbird	*Ptilonorhynchus violaceus*	P	x	x	x	x
Satin Flycatcher	*Myiagra cyanoleuca*	P	x			x
Scarlet Honeyeater	*Myzomela sanguinolenta*	P	x		x	x
Scarlet Robin	*Petroica boodang*	P	x	x	x	x
Shining Bronze-Cuckoo	*Chalcites lucidus*	P	x		x	
Silvereye	*Zosterops lateralis*	P	x		x	x
Southern Emu-wren	*Stipiturus malachurus*	P			x	
Southern Whiteface	*Aphelocephala leucopsis*	P	x			x
Speckled Warbler	*Pyrrholaemus saggitatus*	V	x		x	
Spotted Pardalote	*Pardalotus punctatus*	P	x	x	x	x
Spotted Quail-thrush	*Cinclosoma punctatum*	P	x	x	x	x
Square-tailed Kite	*Lophoictinia isura*	V			x	x
Striated Pardalote	*Pardalotus striatus*	P	x	x	x	x
Striated Thornbill	*Acanthiza lineata*	P	x	x	x	x
Striped Honeyeater	*Plectorhyncha lanceolata*	P				x
Sulphur-crested Cockatoo	*Cacatua galerita*	P	x		x	x
Superb Fairy-wren	*Malurus cyaneus*	P	x	x	x	x
Superb Lyrebird	*Menura novaehollandiae*	P	x	x	x	x
Tawny-crowned Honeyeater	*Gliciphila melanops*	P				x
Topknot Pigeon	*Lopholaimus antarcticus*	P			x	
Tree Martin	*Petrochelidon nigricans*	P	x		x	x
Turquoise Parrot	*Neophema pulchella*	V	x		x	x
Varied Sittella	*Daphoenositta chrysoptera*	P	x		x	
Variegated Fairy-wren	*Malurus lamberti*	P	x		x	x
Wedge-tailed Eagle	*Aquila audax*	P	x		x	x
Weebill	*Smicrornis brevirostris*	P	x		x	
Welcome Swallow	*Hirundo neoxena*	P	x		x	x
Western Gerygone	*Gerygone fusca*	P				x
White-backed Swallow	*Cheramoeca leucosterna*	P				x
White-bellied Cuckoo-shrike	*Coracina papuensis*	P	x		x	
White-browed Babbler	*Pomatostomus superciliosus*	P	x		x	
White-browed Scrubwren	*Sericornis frontalis*	P	x	x	x	x
White-cheeked Honeyeater	*Phylidonyris niger*	P	x			x
White-eared Honeyeater	*Lichenostomus leucotis*	P	x	x	x	x
White-faced Heron	*Egretta novaehollandiae*	P	x			x
White-naped Honeyeater	*Melithreptus lunatus*	P	x		x	x
White-plumed Honeyeater	*Lichenostomus penicillatus*	P	x			
White-throated Gerygone	*Gerygone olivacea*	P	x		x	
White-throated Needletail	*Hirundapus caudacutus*	P	x	x	x	
White-throated Treecreeper	*Cormobates leucophaea*	P	x	x	x	x
White-winged Chough	*Corcorax melanorhamphos*	P	x		x	x
White-winged Triller	*Lalage tricolor*	P	x		x	x
Willie Wagtail	*Rhipidura leucophrys*	P	x		x	x
Wonga Pigeon	*Leucosarcia melanoleuca*	P	x		x	x
Yellow Thornbill	*Acanthiza nana*	P	x		x	x
Yellow-faced Honeyeater	*Lichenostomus chrysops*	P	x	x	x	x
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	P	x			x
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	P	x	x	x	x
Yellow-throated Scrubwren	*Sericornis citreogularis*	P	x		x	x
Yellow-tufted Honeyeater	*Lichenostomus melanops*	P	x		x	x

Common Name	Scientific Name	Legal Status	BA	CRA	BSP	Other
Zebra Finch	*Taeniopygia guttata*	P	x			
NOCTURNAL BIRDS						
Australian Owlet-nightjar	*Aegotheles cristatus*	P	x	x	x	x
Barking Owl	*Ninox connivens*	V	x			x
Masked Owl	*Tyto novaehollandiae*	V			x	
Powerful Owl	*Ninox strenua*	V			x	x
Sooty Owl	*Tyto tenebricosa*	V			x	
Southern Boobook	*Ninox boobook*	P	x	x	x	x
Tawny Frogmouth	*Podargus strigoides*	P	x	x	x	x
White-throated Nightjar	*Eurostopodus mystacalis*	P	x		x	
GROUND MAMMALS						
Brown Antechinus	*Antechinus stuartii*	P		x	x	x
Brush-tailed Rock-wallaby	*Petrogale penicillata*	E1			x	x
Bush Rat	*Rattus fuscipes*	P		x	x	x
Common Wallaroo	*Macropus robustus*	P			x	x
Common Wombat	*Vombatus ursinus*	P		x	x	x
Dingo	*Canis lupus dingo*	U			x	
Domestic dog or Dingo	*Canis lupus*	U			x	x
Dusky Antechinus	*Antechinus swainsonii*	P				x
Eastern Grey Kangaroo	*Macropus giganteus*	P			x	x
Long-nosed Bandicoot	*Perameles nasuta*	P			x	x
New Holland Mouse	*Pseudomys novaehollandiae*	P				x
Platypus	*Ornithorhynchus anatinus*	P			x	x
Red-necked Wallaby	*Macropus rufogriseus*	P		x	x	x
Short-beaked Echidna	*Tachyglossus aculeatus*	P			x	x
Spotted-tailed Quoll	*Dasyurus maculatus*	V				x
Swamp Rat	*Rattus lutreolus*	P				x
Swamp Wallaby	*Wallabia bicolor*	P		x	x	x
Water-rat	*Hydromys chrysogaster*	P			x	x
Yellow-footed Antechinus	*Antechinus flavipes*	P				x
ARBOREAL MAMMALS						
Common Brushtail Possum	*Trichosurus vulpecula*	P			x	x
Common Ringtail Possum	*Pseudocheirus peregrinus*	P		x	x	x
Eastern Pygmy-possum	*Cercartetus nanus*	V			x	
Feathertail Glider	*Acrobates pygmaeus*	P			x	
Greater Glider	*Petauroides volans*	P		x	x	x
Koala	*Phascolarctos cinereus*	V		x		x
Short-eared Possum	*Trichosurus caninus*	P				x
Squirrel Glider	*Petaurus norfolcensis*	V		x		
Sugar Glider	*Petaurus breviceps*	P		x	x	x
Yellow-bellied Glider	*Petaurus australis*	V			x	x
BATS						
Chocolate Wattled Bat	*Chalinolobus morio*	P		x	x	x
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V		x	x	x
Eastern Broad-nosed Bat	*Scotorepens orion*	P		x	x	
Eastern Cave Bat	*Vespadelus troughtoni*	V			x	
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V		x	x	
Eastern Freetail-bat	*Mormopterus ridei (formerly 'Species 2"*	P			x	
East-coast Freetail-bat	*Micronomus norfolkensis*	V			x	x
Eastern Horseshoe-bat	*Rhinolophus megaphyllus*	P		x	x	x
Gould's Long-eared Bat	*Nyctophilus gouldi*	P		x	x	x
Gould's Wattled Bat	*Chalinolobus gouldii*	P		x	x	x
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V			x	x
Large Forest Bat	*Vespadelus darlingtoni*	P		x	x	
Large-eared Pied Bat	*Chalinolobus dwyeri*	V		x	x	x
Large-footed Myotis	*Myotis adversus*	V			x	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	P			x	
Little Forest Bat	*Vespadelus vulturnus*	P		x	x	x
Little Red Flying-fox	*Pteropus scapulatus*	P			x	x

Common Name	Scientific Name	Legal Status	BA	CRA	BSP	Other
Southern Forest Bat	*Vespadelus regulus*	P		x	x	
Southern Freetail-bat	*Mormopterus "Species 4" (big penis)*	P			x	
White-striped Freetail-bat	*Tadarida australis*	P		x	x	x
INTRODUCED SPECIES						
Common Myna	*Acridotheres tristis*	U	x			x
Common Starling	*Sturnus vulgaris*	U	x			
European Cattle	*Bos taurus*	U				x
European Rabbit	*Oryctolagus cuniculus*	U			x	x
Feral Cat	*Felis catus*	U				x
Feral Dog	*Canis lupus familiaris*	U			x	x
Feral Donkey	*Equus asinus*	U			x	
Feral Pig	*Sus scrofa*	U			x	
Fox	*Vulpes vulpes*	U		x	x	x
House Mouse	*Mus musculus*	U			x	
House Sparrow	*Passer domesticus*	U	x			
Red-whiskered Bulbul	*Pycnonotus jocosus*	U	x			x
Spotted Turtle-Dove	*Streptopelia chinensis*	U	x			

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