The Vertebrate Fauna of North-western Wollemi National Park

Project funded under the Central Branch Parks and Wildlife Division
Biodiversity Survey Priorities Program

Information and Assessment Section
Metropolitan Branch
Environmental Protection and Regulation Division
Department of Environment and Conservation (NSW)
June 2006

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FINAL REPORT

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All photographs are held by DEC. To obtain a copy please contact the Bioregional Data Group Coordinator, DEC Hurstville

Cover Photos

All photos by Narawan Williams except feature photo by Elizabeth Magarey.

Front cover

Feature Photo, Widden Valley escarpment
Treefern
Large Forest Bat
Rock outcrop in Widden Valley
Lace Monitor

Back cover

Stuttering Frog
Grassy Woodland on Gospers Mountain
Wedge-tailed Eagle
Grass Tree

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OVERVIEW

North-western Wollemi National Park comprises almost 185 000 hectares of land within the catchments of the Goulburn, Capertee and Cudgegong Rivers. The diversity of animals located therein is one of the most impressive of all the national park areas in NSW. This is not surprising, given the large number of environments that fall within its boundary, and the convergence of a number of regional and environmental influences. The study area supports species typical of the Sydney sandstone hinterland, central western slopes and central tablelands. In no other location in NSW are so many fauna species from all three of these regions found within one conservation reserve.

The recent systematic surveys have identified numerous threatened species in the study area and greatly improved the understanding of species distribution, status and conservation priorities. Of the 40 threatened species for which the study area provides habitat, two species in particular, the Stuttering Frog and Brush-tailed Rock-wallaby are of extremely high conservation concern due to their continued decline in numbers and distribution in recent years. These species will require active management to ensure their survival in the long term. Furthermore, twelve threatened species are partly or wholly dependent on woodland and forest habitats within the dry fertile lower slopes and valleys that follow the northern, north-western and south-western boundaries of the park. These habitats comprise the 'Upper Goulburn Valleys and Escarpment' and 'Sydney Basin Western Escarpment' Mitchell Landscapes, which together constitute a unit of very high conservation importance. A large number of threatening processes operate within these high priority landscapes, which should be the focus of key management actions. Pest species were found to be widespread across the study area, including within the high priority Landscapes. Of these, Foxes and Wild Dogs are likely to pose the greatest immediate threat to native wildlife, while Feral Goat and Feral Deer have the potential to cause significant impact in the future if not further monitored and controlled.

This report compiles and reviews Atlas of NSW Wildlife data on terrestrial vertebrate fauna and documents the extensive systematic surveys undertaken by the Department of Environment and Conservation between 1997 and 2006. A total of 394 systematic survey sites have sampled the birds, frogs, bats, reptiles, arboreal and terrestrial mammals. This is the first time that a thorough inventory of all vertebrate fauna known and likely to occur within the study area has been compiled. Some of the key findings are summarised below.

- Three hundred and fifteen (315) species of native terrestrial vertebrate fauna are known to inhabit north-western Wollemi National Park. This is made up of 18 species of frog, 52 reptile species, 198 bird species, nine species of arboreal mammal, 17 ground mammal species and 21 bat species. In addition, 16 species of introduced fauna have been recorded in the study area, including 13 ground mammals and three birds.
- Thirty-six species listed on the NSW Threatened Species Conservation Act (1995) are known to occur in the study area, and a further three are considered highly likely to occur. Seventeen of the threatened species primarily occur on the deeply incised sandstone plateaux that occupy the majority of the study area, while at least twelve rely on habitats within the dry fertile lower slopes and valleys below the escarpment. Habitats such as the latter have been extensively cleared in the Goulburn, Capertee and Hunter Valleys and remain under considerable pressure. The preservation of these habitats in north-western Wollemi National Park therefore has high regional and state-wide conservation significance.
- The endangered Stuttering Frog was discovered in two locations in December 2005, which is the first time it has been recorded in almost one million hectares of the northern Blue Mountains and Yengo reserves. This large frog appears to be close to extinction from the southern half of its former range, and the records constitute one of only a few known extant populations south of the Hunter Valley. Fresh evidence of the endangered Brush-tailed Rock-wallaby was sighted at two locations, including the observation of five individuals in May 2006. These sightings confirm that colonies persist within the study area but are currently small and patchily distributed, requiring management action to ensure their survival. Other highly significant threatened species sightings made during surveys include that of Broad-headed Snake, Regent Honeyeater, Eastern Cave Bat and Spotted-tailed Quoll.
- A number of threatened species were found to be widespread and relatively abundant across the study area and are considered to currently be secure in the reserve. This list includes Red-crowned Toadlet, Gang-gang Cockatoo, Glossy Black-cockatoo, Powerful Owl and Yellow-bellied Glider.
- Numerous species reach the north-westerly limit of their range within the area, including Red-crowned Toadlet, Giant Burrowing Frog, Crescent Honeyeater and Leaf-tailed Gecko. Other species that are more common in central western NSW approach their eastern limits in the area, including Inland Broad-nosed Bat and Diamond Dove. Yet other species that are common in moist coastal forests were recorded for the first time so far from the coast, including Emerald Dove and Golden-crowned Snake. Furthermore, a handful of species more typical of the north approach their southern limit in the study area, such as Robust Velvet Gecko and Leaden Delma. The Blotched Blue-tongue reaches the very north of its known range within the study area, and was yet another unexpected find. These examples demonstrate the importance of Wollemi National Park in its conservation of such a wide range of juxtaposing environments.

The surveys and inventory have contributed greatly to knowledge of the current composition and distribution of wildlife across the study area. The project has identified fauna habitat associations, highlighted threatened species issues, identified priority areas for threat abatement and future land acquisition, and provided key recommendations for further targeted survey and monitoring. This information will be vital to future successful management of fauna in the reserve. The data collected for this project will later be used to model habitat preferences for threatened species across the region. Meanwhile the surveys provide baseline information that will enable a reliable assessment of the importance of the reserve to the protection of biodiversity attributes at a local, regional and state-wide level.

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1 INTRODUCTION

1.1 PROJECT AIMS

The Central Branch Parks and Wildlife Division (PWD) of the NSW Department of Environment and Conservation (DEC, formerly NSW National Parks and Wildlife Service (NPWS)) has established a biodiversity survey priorities (BSP) program for DEC managed estate within the Branch. This program recognises that information which documents the biodiversity values held within reserves is fundamental to successful reserve management and to generating an improved understanding of the contribution reserves make to the protection of vegetation communities, plant and animal populations and their habitats. Currently there is only sparse and incomplete information that describes the role reserves play in ensuring the viability of fauna species across large regions and local areas.

Typically the largest reserves, which potentially offer a significant contribution to biodiversity conservation, are the most poorly understood and the most deficient in data quality and quantity. The BSP program goes some way towards addressing this information shortfall by surveying the most poorly known reserves first and combining this work with larger regional conservation assessment projects.

Currently the Hunter region is the focus of considerable biodiversity assessment and environmental planning investigation. In terms of human population it represents one of the fastest growing regions in the state and extreme pressures are being placed on many of the habitats. Knowledge of the values of the large sandstone reserves that fringe the southern Hunter and Goulburn Valleys is fundamental to understanding the conservation priorities for many species. In 2003, the northern half of Wollemi National Park was recognised as having low levels of information on its fauna values and was identified as a priority for wildlife survey (NPWS 2003a). The north-eastern section of Wollemi National Park (Hunter Range Area) was the subject of study in 2004-05, following which a report on *The Vertebrate Fauna of North-eastern Wollemi National Park* was produced (DEC 2005a). North-western Wollemi National Park (Mudgee Area) was the next priority, and the focus of study in 2005-06. The specific objectives of the 2005-06 project are to:

- Document, review and collate pre-existing data on terrestrial vertebrate fauna.
- Carry out systematic field sampling of all terrestrial vertebrate fauna groups to establish baseline data for future conservation assessment and monitoring works.
- Identify and profile threatened fauna species and other regionally significant fauna that are known or likely to occur.
- Identify broad-scale patterns in fauna occurrence and habitat use across the study area and identify habitats of particular conservation significance.

The 2005-06 program and report are designed to accompany DEC (2005a) and together provide comprehensive information on vertebrate fauna across the entire northern half of the National Park.

1.2 BACKGROUND

Wollemi National Park comprises an area of approximately 488 620 hectares, making it the second largest national park in the state (NPWS 2001a). The area examined herein (the study area) is confined to the north-west of the park, within the Central Branch's Mudgee Area. This is roughly the area that is north of the Capertee River and west of Mount Monundilla. The study area encompasses approximately 184 210 hectares, just under 40 percent of Wollemi National Park. This area is located approximately twenty kilometres east of Rylstone and 100 kilometres north-west of the Sydney metropolitan area (Map 1).

The northern half of the study area, north of the Hunter Range, drains into the Goulburn River and eventually the Hunter River, incorporating the catchment of Widden Brook and the eastern half of the Bylong River catchment. A small section in the central west of the study area, just east of Olinda, drains west into the Cudgegong River, and eventually to the Macquarie River. The southern half of the study area drains via Wollemi Creek and the Capertee River to the Colo River and on to the Hawkesbury River.

The northern boundary of the study area is deeply indented and follows the southern escarpment of the Hunter Valley. Private lands border the park on the valley floors, which are primarily used for cattle grazing, agriculture and horse studs. Goulburn River National Park abuts the study area at its north-western corner, but is separated along the north-eastern boundary by farming lands on both sides of the Goulburn River. The study area is bound to the east and south by the remainder of

Wollemi National Park. Coricudgy and Nullo Mountain State Forests lie adjacent to the central western part of the study area, while the remainder of the western boundary is largely marked by the commencement of the open grazing lands of the central western slopes of NSW. Crown lands and private lands adjoin the western boundary of the park (Map 1).

Wollemi National Park forms part of the Greater Blue Mountains World Heritage Area, which was inscribed on the World Heritage List in November 2000. Sections of the park also form part of the Wollemi Wilderness Area, which was declared in March 1999. The eastern half of the study area, roughly south and east of Emu Creek, is part of this Wilderness Area. Areas of the national park that are declared as wilderness are managed in accordance with the Wilderness Act 1987, which involves the closure and rehabilitation of vehicular access routes, and cessation of maintenance of walking tracks and routes.

Two small additions were made to Wollemi National Park in February 2007, after completion of the BSP project. These additions are still marked as inholdings in the maps located herein, and are located around Kerry Mountain and Mount Coriaday, north of Mount Coricudgy.

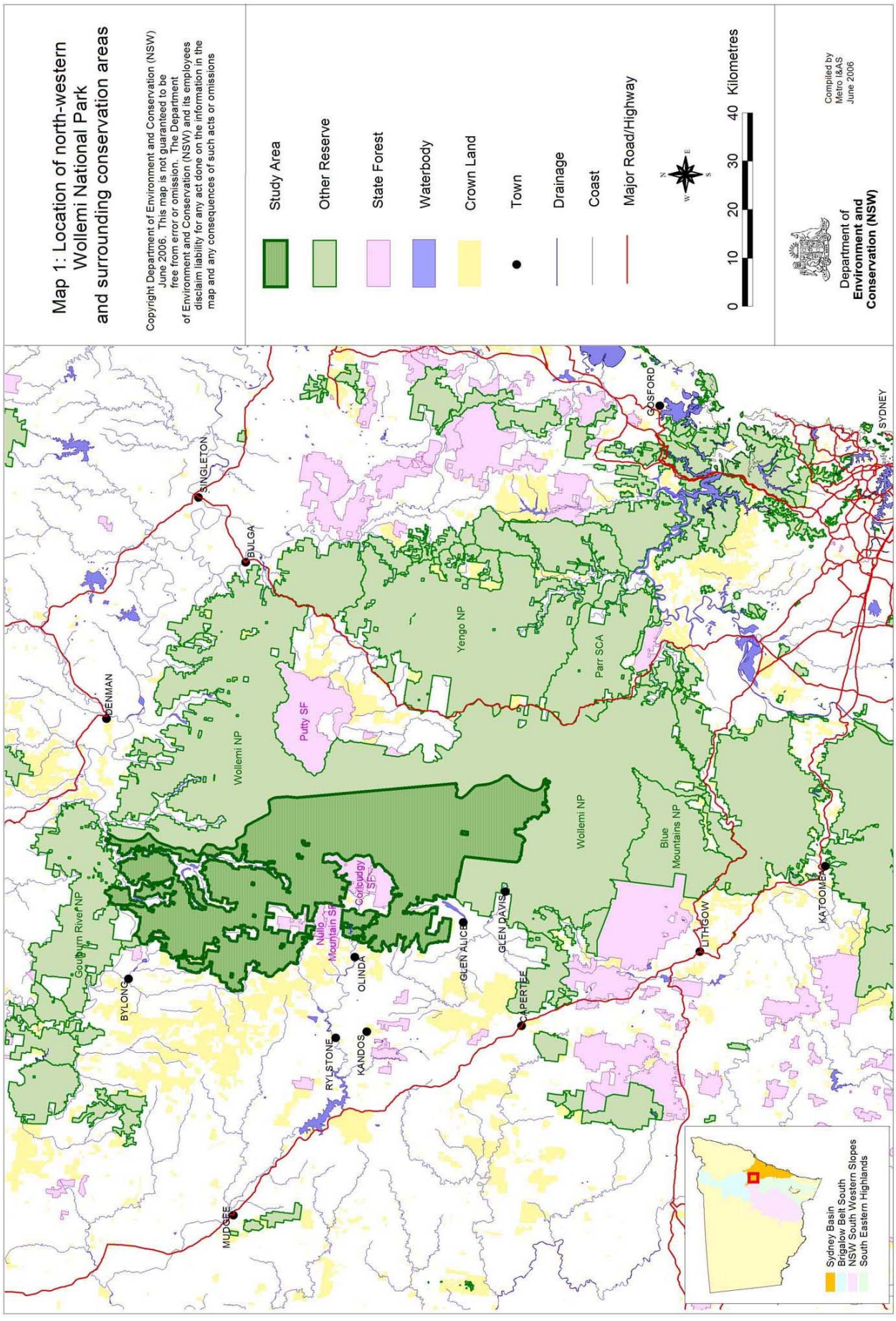
1.3 ENVIRONMENT

1.3.1 Biogeography

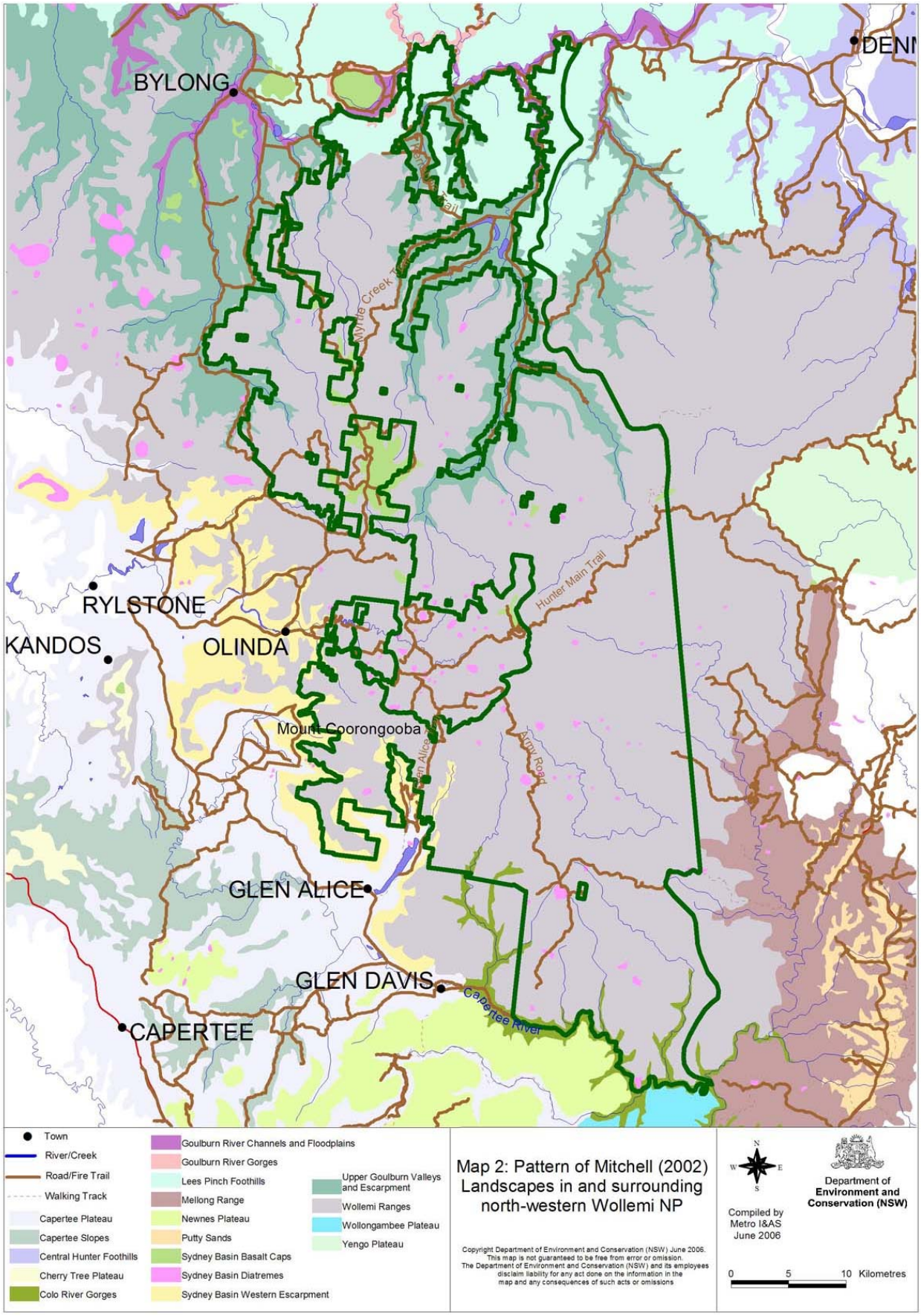
The study area lies near the north-western edge of a distinct environmental region known as the Sydney Basin Bioregion (Thackway & Cresswell 1995). This Bioregion extends from just north of Batemans Bay to Nelson Bay on the central coast, and almost as far west as Mudgee (inset Map 1). The Bioregion is characterised by a temperate climate with warm summers and no dry season (NPWS 2003b). This Bioregion has been broken down into Subregions by Morgan (2001) and further into Landscapes by Mitchell (2002). There are three Subregions located partly within the study area. The Kerrabee Subregion encompasses the northern third of the study area and is characterised by finely dissected sandstone plateaux, with Permian shale outcropping in broad gently undulating valleys (Morgan 2001). The Wollemi Subregion encompasses the large majority of Wollemi National Park and is characterised by dissected Triassic sandstone plateaux with benched rock outcrops, and numerous small basalt caps (NPWS 2003b). The Capertee Subregion includes a small part of the south-western corner of the study area, south and west of Tayan Peak. It is characterised by low hilly landscapes of Permian shales and siltstones, and areas of Triassic sandstone or Tertiary basalt capping hills (Morgan 2001). Table 1 provides a list of the Mitchell Landscapes that are present in a significant amount within the study area, while Map 2 shows where each occurs. Three additional Mitchell Landscapes, the 'Capertee Plateau', 'Goulburn River Gorges' and 'Wollongambe Plateau' occupy too small a portion of the study area to warrant inclusion in discussion. For a detailed description of the Landscapes see Mitchell (2002).

Landscape name	Percentage of study area occupied by the Landscape	Location within the study area and major characteristics
Lees Pinch Foothills	7.5	Hills and upper slopes along the northern fifth of the reserve. Narrabeen sandstone with low rainfall.
Goulburn River Channels and Floodplains	0.2	Floodplains of lower Widden Valley and Goulburn Valley. At the extreme northern boundary of the reserve. Alluvial.
Upper Goulburn Valleys and Escarpment	8.2	Lower slopes and valleys along the northern boundary. Includes the lower valleys of Widden Brook, Blackwater Creek, Emu Creek, Myrtle Creek, Kerrabee Creek, Bylong River, Lee Creek and their major tributaries. Permian-derived soils with sandstone talus.
Wollemi Ranges	80.2	Large majority of the study area. Encompasses the dissected Narrabeen sandstone plateaux. Narrabeen and a small amount of Hawkesbury Sandstone.
Sydney Basin Basalt Caps	0.5	Basalt caps in the northern half of the reserve including Nullo Mountain, Kerry Mountain, Mount Monundilla and the private properties 'Gowrie Hut' and 'Box Ridges'.
Sydney Basin Diatremes	0.7	Remnant volcanic features scattered throughout the 'Wollemi Ranges' Landscape. Well known diatremes include Box Hole Clearing and that west of Gospers Mountain.
Sydney Basin Western Escarpment	1.5	Forms the south-western boundary of the study area along the edges of the Capertee and Cudgegong River Valleys.
Colo River Gorges	1.2	Finger-like intrusions protruding into the far south of the study area along Coorongooba, Gospers and Girribung Creeks.

Table 1: Summary of Landscapes within north-western Wollemi National Park based on Mitchell (2002)



Map 1: Location of study area and surrounding conservation areas



Map 2: Pattern of Mitchell (2002) Landscapes in and surrounding north-western Wollemi National Park

Situated close to the north-western edge of the Sydney Basin, the study area shares some climatic and topographic features with adjacent Bioregions, including the Brigalow Belt South, the NSW South Western Slopes and the South-eastern Highlands (inset Map 1). These influences lead to a rather unique mix of environments. Wollemi National Park lies between Goulburn River, Gardens of Stone, Yengo and Blue Mountains National Parks, a system of reserves which protects the sandstone-based links between the Sydney, Hunter and Central West regions of New South Wales.

1.3.2 Geology and geomorphology

Wollemi National Park is based on four strata of sedimentary rock listed here from oldest to youngest: the Permian coal measures; the Narrabeen and Hawkesbury sandstones and shales; and the Wianamatta shales (NPWS 1997a). These rock strata tilt upward to the north-west (NPWS 1997a). Erosion activity has weathered away most of the Wianamatta and Hawkesbury series, exposing the Narrabeen group (NPWS 1997a). Weathering of the sandstones and claystones of this group has given the park its characteristic dissected landscape, dominated by many deep valleys, cliffs and narrow gorges. The majority of land within the study area contains rugged hills with rounded summits, irregularly benched slopes often littered with boulders and frequent sandstone outcrops, and narrow valleys (Story *et al.* 1963). Soils formed from the Narrabeen sandstones are generally very shallow, characterised by low nutrient levels, particularly of phosphorous (NPWS 1997a). Deep sand flats occur along the Upper Cudgegong River and associated tributaries, while sandy alluvium occurs along wider valley floors in the north of the study area. Hawkesbury sandstone outcrops in the far south of the study area, along the Wollemi and Wirraba Ranges and south-east of Gospers Mountain.

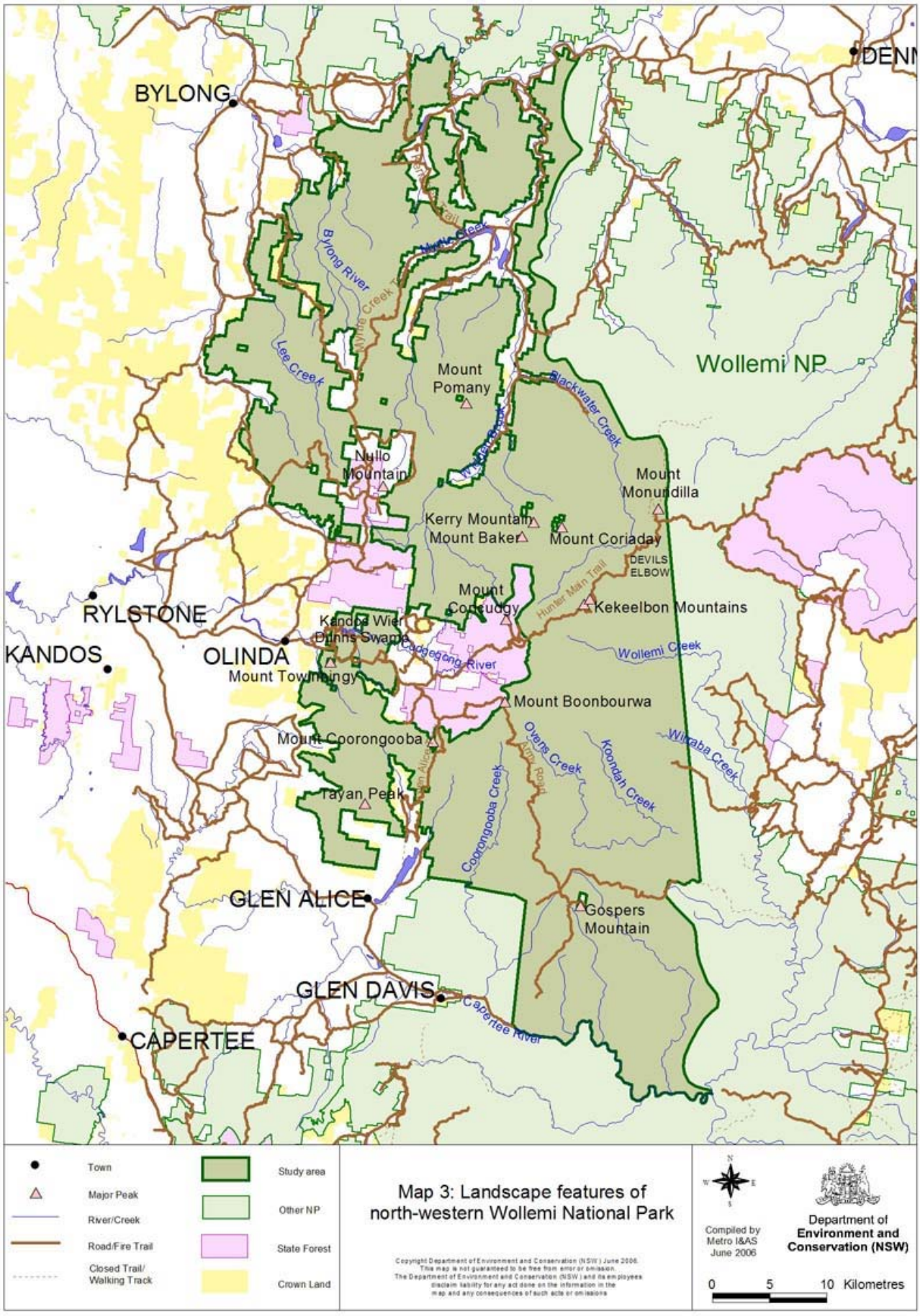
The Permian coal measures outcrop as steep slopes along the northern perimeter of the study area, visible beneath the clifflines that run along the large river valleys. The slopes are often littered with sandstone rubble and boulders, known as talus, that have fallen from the cliffs above. This stratum weathers to form moderately fertile clay loams (NPWS 1997a), with fragments of sandstone or shale (Story *et al.* 1963).

Tertiary basalt caps are a feature of the region, occurring as readily distinguishable landmarks, the most significant being Nullo Mountain and Mount Coricudgy, just to the west of the study area. Basalt caps occurring within the study area include Kerry Mountain, Mount Coriaday, Mount Baker, Mount Towinhingy, Gospers Mountain, Mount Pomany, Mount Boonbourwa, Mount Coorongooba and the Kekeelbon Mountains, amongst others (Map 3). Tayan Peak is a symmetrical cone rising 180 metres above the sandstone plateau, with a volcanic crater on its northern side (Mosley 1989). It is a unique landscape feature in the study area and has been identified as a significant geological site in NSW (Schon 1984 in NPWS 2001a).

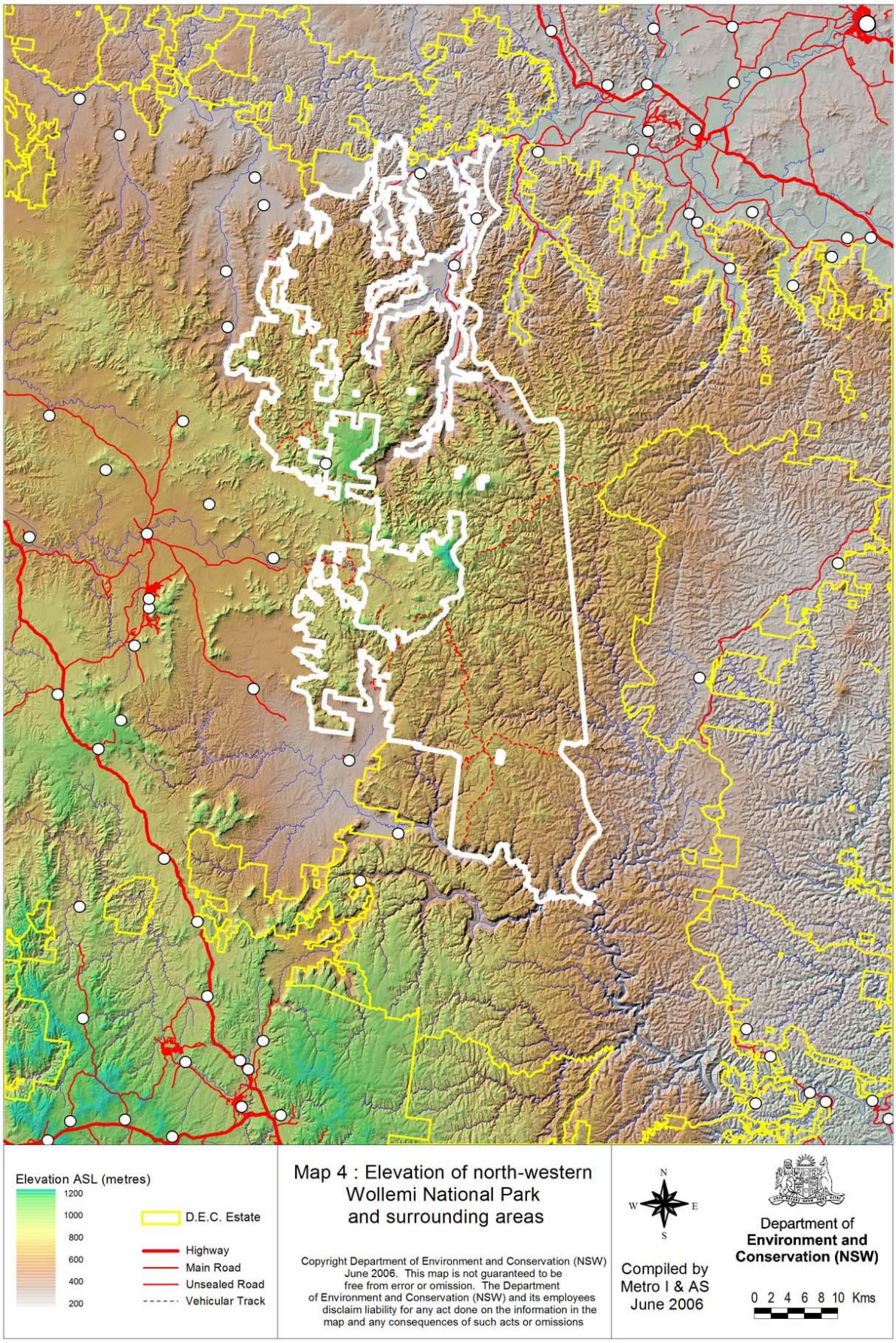
Also scattered throughout the study area are ‘diatremes’ that hold rich basalt-derived soils. These were formed as extinct volcanic vents eroded away faster than the surrounding sandstone into which they were intruded, often leaving saucer-shaped depressions and valleys (NPWS 2001a). These hollows are also known as ‘holes’, ‘craters’ or ‘clears’, and some examples within the study area are Box Hole Clearing, Swampy Hole (lying to the west and east of the Army Road respectively) and Gospers Hole. Diatremes can also be found in saddles or on the sides of ridges, identifiable only from close proximity due to the change in vegetation and the absence of sandstone outcropping (Macqueen 2005). It is estimated that hundreds of diatremes occur in north-western Wollemi National Park, many more than are currently mapped (Macqueen 2005).

1.3.3 Elevation

The highest elevations occur across the centre of the study area, around the sides of Nullo Mountain and Mount Coricudgy, and at Kerry Mountain and Mount Coriaday which are each over 1100 metres above sea level (asl) (Map 4). Tayan Peak also towers over the surrounding landscape, reaching 1150 metres asl. The Hunter Range, extending between Mounts Coricudgy and Monundilla, forms the watershed between the Hunter and Hawkesbury Catchments, and lies at between approximately 700 and 1000 metres asl within the study area. The remainder of the sandstone plateau ranges between roughly 600 and 800 metres asl, with occasional basalt caps rising above this and deep gorges dropping sharply down to about 400 metres asl. The northern boundary is defined by steep escarpments that drop sharply from 500 metres down to 300 or so metres asl, before opening into the wide and largely privately owned valley flats that gradually drop to approximately 100 metres asl before reaching the Goulburn River. The southern extremity of the study area also drops off very sharply, formed by escarpments that drop from 600 metres to the Capertee River at 300 metres asl.



Map 3: Landscape features of north-western Wollemi National Park



Map 4: Elevation of north-western Wollemi National Park and surrounding areas

1.3.4 Climate

Long term climate patterns across the study area are directly related to topography. The western two thirds of the study area are influenced by westerly moving continental air masses, with more elevated areas such as the basalt-capped mountains subjected to local orographic climatic effects (Bell 1998). The far south-eastern section is influenced more by coastal air masses, which generally carry more rain (Bell 1998). Seasonality of rainfall is consistent across the park, with the highest falls generally occurring between January and March (Bell 1998).

Generally the areas that lie above 1000 metres asl receive approximately 1000 millimetres of rain per year and have a mean annual temperature of between 10 and 11 degrees Celsius and a temperature range of between minus two and 24 degrees. The majority of the sandstone plateau receives in the order of 800 millimetres of rain per year, with a mean annual temperature of between 12 and 14 degrees Celsius.

The escarpments and valleys in the north are the driest parts of the study area, receiving on average between 600 and 700 millimetres of rain per annum. The mean annual temperature ranges between 14 and 17 degrees Celsius, with a mean maximum of between 28 and 33 and a mean minimum of between one and four degrees Celsius. The Capertee Valley, to the immediate south of the study area is also dry; the Glen Alice area receives an average of less than 700 millimetres of rain per year and relatively warm temperatures. This rainshadow effect generally continues north along the western boundary of the park, resulting in generally low rainfall (below 700 millimetres per annum) along the western escarpment.

1.4 VEGETATION

Bell (1998) provides detailed discussion of the vegetation of Wollemi National Park. Following is a very brief overview of broad patterns across the study area. North-western Wollemi National Park supports a diverse and complex array of vegetation communities. While much of the vegetation is characterised by sclerophyllous eucalypt forests and woodlands, a number of savannah woodland, rainforest, heath and native cypress pine communities are also found in small and disjunct patches. The species composition of the vegetation communities varies in response to regional climatic influences and geology. Three broad botanical divisions occur within the study area. Vegetation characteristic of the Central West Slopes of NSW is found on the northern half of the study area in dry, warm environments. NSW Central Tableland influences extend across elevated country through the middle of the area. Influences of the coastal hinterland that dominate the Central Coast botanical division are found in the south-eastern quarter.

Plate 1: Example of vegetation occuring on Permian sediments in the 'Lees Pinch Foothills' Landscape © E. Magarey/DEC

The 'Lees Pinch Foothills' in the north are characterised by low rainfall and moderately low fertility soils. Ridges are dominated by *Acacia* woodlands, with rocky heaths on exposed rock plates. Exposed slopes support woodlands dominated by Grey Gum (*Eucalyptus punctata*) and Stringybarks (such as *E. sparsifolia*), while Blakely's Red Gum (*E. blakelyi*), Rough-barked Apple (*Angophora floribunda*) and Forest Oak (*Allocasuarina torulosa*) occur on more sheltered slopes and gullies. The most sheltered situations contain a dry rainforest of Grey Myrtle (*Backhousia myrtifolia*) and Rusty Fig (*Ficus rubiginosa*). Below the Narrabeen sandstone escarpment, low rainfall and more fertile Permian sediments result in the growth of woodlands characteristic of the Upper Goulburn

Plate 2: Example of vegetation occuring on ridgetops and exposed slopes in the 'Wollemi Ranges' Landscape © H. Achurch/DEC

Valley. These woodlands are dominated by Slaty Box (*E. dawsonii*), Grey Box (*E. moluccana*), Grey Gum and occasionally White Box (*E. albens*) (Plate 1). Shrub density is relatively low (though still present) and grass cover is higher than on the sandstone plateaux. Valley flats that run like fingers into the park boundary support a variety of closely related vegetation types that variously include Red Gums (*E. blakelyi* and *E. tereticornis*), Ironbarks (including *E. crebra* and *E. fibrosa*), Rough-barked Apple, Grey and White Box and River Oak (*Casuarina cunninghamiana* subsp. c*unninghamiana*) in the canopy. Woodland and forests of similar structure are found along the south-western boundary of the park, though the communities differ floristically due to different regional and climatic influences. Much of the vegetation in the 'Upper Goulburn Valleys and Escarpment', 'Sydney Basin Western Escarpment' and 'Goulburn River Channels and Floodplains' Landscapes has been cleared, and either remains under agriculture today or is regenerating.

The vegetation of the 'Wollemi Ranges' Landscape covers the large majority of the study area. Dry sclerophyllous forests and woodlands dominate the ridges and exposed slopes with Sydney Peppermint (*Eucalyptus piperita*), Narrow-leaved Stringybark *(E. sparsifolia*), Smooth-barked Apple *(Angophora costata*), Silvertop Ash (*E. sieberi*), Grey Gum and Red Bloodwood (*Corymbia gummifera*) being common (Plate 2). These communities are characterised by a highly diverse and profusely flowering shrub layer from the families Fabaceae and Proteaceae. This includes well-known plant groups such as Wattles (*Acacia* spp.), Banksias (*Banksia* spp.), Epacrids (Epacridaceae) and Peas (Fabaceae).

Plate 3: Example of sheltered gully forest along a creekline in the 'Wollemi Ranges' Landscape © N. Williams/DEC

Sheltered forests and gullies within this landscape support contrasting vegetation communities. The deepest slot canyons feature impressive stands of warm temperate rainforest dominated by Coachwood (*Ceratopetalum apetalum*) and Sassafras (*Doryphora sassafras*) (Plate 3). These grade into tall wet sclerophyll forests with a canopy of Blue Gums (*E. deanii/E. saligna*) and Turpentine (*Syncarpia glomulifera*). These latter forests are widespread throughout the central and eastern sections of the study area. Small areas of vestigial vegetation are found in the most protected of canyons, the last traces of vegetation of the once wetter environment. The Wollemi Pine (*Wollemia nobilis*) in the most dramatic example, although the sub-tropical rainforest found in small areas of deep gorges on basalt-enriched soils are also noteworthy.

The vegetation occurring on the 'Sydney Basin Basalt Caps' Landscape is determined by local patterns of elevation and rainfall. Elevated caps that receive high rainfall, such as Mount Coriaday and Kerry Mountain, support montane forest dominated by Silvertop Stringybark (*E. laevopinea*), Eurabbie (*E. bicostata*) and Brown Barrel (*E. fastigata*), with Mountain Grey Gum (*E. cypellocarpa*) and Blue Mountain Ash (*E. oreades*) and occasionally Red Gums on the slopes (Plate 4). Sheltered aspects on these high elevation peaks sometimes feature rainforest dominated by Sassafras. Lower elevation and lower rainfall peaks in the north-west and south of the study area are characterised by White Box and Grey Box woodlands. Vegetation of the 'Sydney Basin Diatremes' again vary with rainfall. Lower rainfall diatremes contain White Box and Grey Box woodlands. Those at moderate to high rainfall, but low elevation, contain Blue Gum and Turpentine forests, while those at higher elevation support forest dominated by Ribbon Gum (*E. viminalis*) and Rough-barked Apple.

Plate 4: Northern slope of Tayan Peak showing grassy woodland on basalt soil © M. Schulz/DEC

The Central Tablelands exert their greatest

influences on the vegetation that stands on the deep sands around Dunns Swamp. The area is characterised by a low woodland of Scribbly Gum (*E. rossii*) and Brittle Gum (*E. mannifera*), with varying densities of Stringybarks, Grey Gum and Rough-barked Apple depending on local topographic patterns.

1.5 HISTORY OF LAND USE

Darkinjung Aboriginal people occupied the area now known as Wollemi National Park for at least 12 000 years prior to European settlement (NPWS 2001a). Sadly, little is known of Darkinjung history in the region. Aboriginal people are known to have at least travelled through the sandstone plateaux, sandy valleys and swamps, fertile volcanic diatremes and basalt mountains, the last holding particular spiritual significance (Macqueen 2004). In 2001 approximately 120 Aboriginal sites had been officially recorded within the entire park, though the actual number is expected to be far greater (NPWS 2001a). Bushwalkers exploring more remote sections of the park, such as the area east of Army Road and north and south of the Hunter Main Trail regularly encounter hand stencils and other paintings in caves and overhangs (M. Jessop pers. comm., Macqueen 2005). The landscape as a whole is also culturally significant, with stories often expressed through "Dreaming Tracks" that provide a spiritual connection between the Aboriginal sites and the land (NPWS 2001a). A summary of the region's Aboriginal heritage can be found in Macqueen (2004).

Early European attitudes to the Wollemi area were based on their perception of it as an unproductive, remote and undesirable landscape (NPWS 2001a). The rugged features, low nutrient soils and dry climate prevented use of the area for settlement or primary industry (NPWS 2001a) and as a result large tracts of the reserve have not been subject to European modification. The large majority of the study area was left as vacant Crown land until the gazettal of the national park in 1979. This stands in stark contrast to the Hunter and Goulburn Valley floors and the central western slopes, which were extensively cleared for agriculture, settlements and mining. However, some areas of the current national park have been affected by adjacent land uses. Pastoralists settled the Capertee Valley in the 1820s, and the Widden Valley during the 1830s and 40s (NPWS 1997a), clearing large tracts of land on the valley floors and lower slopes. Nullo Mountain was settled in the 1840s and occupation was established on Gospers Mountain in 1877, soon followed by Kerry Mountain (NPWS 1997a). Pastoralists bush-grazed Cattle along major creeklines and ridges running in from the northern boundary of the study area (such as Widden Brook), as well as on some basalt caps and diatremes scattered throughout what is now national park (for example that near the headwaters of Wirraba Creek). Evidence of these pastoral activities remain within the northern and north-western boundaries of the park, where much woodland on the lower slopes is regenerated from past clearing, as well as within the cleared or regenerating vegetation on basalt caps and diatremes. Low intensity Cattle grazing continues to occur in small sections of the National Park adjacent to cleared lands. Sporadic low-scale timber getting has been undertaken in a few areas, particularly around Koondah Creek (Colley and Gold 2004) and Wirraba Range (B. Wilson pers. comm.), while firewood collection and felling for fenceposts is likely to have occurred in the vicinity of agricultural areas. The defence force held a lease around Army Road and Gospers Mountain for many years, where troops underwent large scale training exercises, including the use of a dirt airstrip. Army exercises were also undertaken along the Wirraba Range (Mosley 1989).

1.6 FIRE

Little is known about traditional Aboriginal burning practices in Wollemi National Park, or the fire regime prior to the 1950s. Fire has long been a regular feature of the environment and the area is characterised by a highly flammable mix of fire-adapted flora, except in the most sheltered gullies. Human causes of bushfires account for 49 percent of all known fires across the park, with the remainder of known causes attributed to lightning strikes (DEC 2004a). Large areas of Wollemi National Park have been periodically burnt by major fires every three to ten years, with over half of the reserve being burnt within the last ten years (DEC 2004a). In comparison to the rest of the park, the study area has burnt less frequently, particularly in its north-western two thirds.

The following is a summary of recent fire history prior to the 2005-06 BSP surveys. The most recent wildfire at that time had burnt the far south of the study area, on the western side of the Army Road south of Mount Boonbourwa and south of Gospers Mountain, in the summer of 2002/2003. This area has been subject to more frequent fires than the remainder of the study area, with between one and three wildfires over the last 20 years (DEC 2004a). The area east of the Army Road and south of the Hunter Main Trail has a varied fire history, with the most recent wildfire ranging from 8 to 20 years ago, and a relatively low fire frequency (DEC 2004a). The area north of the Hunter Main Trail also has a varied fire regime, but the time since last wildfire is generally long and large tracts of land have not been affected by wildfire since at least the 1950s. The area between Widden Valley and Emu Creek

last burnt in the 1980s, while the Lee Creek Valley burnt in the summer of 1994-95. The majority of the Glen Alice area has not been subject to wildfire since the 1970s.

In December 2006, after completion of the BSP surveys and of the draft version of this report, a wildfire burnt a large portion of the study area. The fire spread from Mount Coricudgy in all directions, reaching Glenn Alice in the south-west, and the junction between Widden Brook and Blackwater Creek in the north-east. The intensity of the fire varied greatly, depending on daily weather conditions. Some sheltered rainforest gullies burnt, while others are thought to have remained unscathed.

2 METHODS

2.1 PRE-EXISTING FAUNA DATA

Prior to the current study, knowledge of the terrestrial vertebrate fauna of north-western Wollemi National Park was limited. Some of this knowledge had been stored in the Atlas of NSW Wildlife, the state's major fauna database. This database was the primary resource used to access existing data on the fauna of the study area. Several small-scale fauna studies had been undertaken within the park for which records had not been entered into the Atlas of NSW Wildlife. These include: biodiversity assessment of the Glen Alice fuel management burn (Washington & Mullins Imrie 1998); National Parks Association biodiversity survey of Dunns Swamp (Tame 1997); fauna assessment of the proposed Myrtle Grove fuel management burn (Bell 1997); and a survey of fauna between Wheelbarrow Gap and Wilsons Clearing (Goldney & Cardale 1993). Where possible, results from these surveys have been included in the discussion of species occurrence and distributions.

Approximately half of the records within the Atlas prior to the summer of 2005-06 derive from the licensed data sets of Birds Australia. These records were collected in two stages. The first period was prior to 1984 (primarily 1977-1981) when a large number of records were gathered as part of the Bird Atlas published by the Royal Australasian Ornithologists Union (RAOU) (Blakers *et al.* 1984). The method used by Birds Australia at this time involved designating a ten-minute spatial grid, based on easting and northing lines, and attributing all sightings within that grid to coordinates at the centre of the grid. Six such grid centres lie within the study area. This data is spatially inaccurate and there is no guarantee that all or even any of these sightings actually occurred at the given location. Consequently some of this bird data presents a misleading picture of the species composition of Wollemi National Park. The second period of Birds Australia data collection occurred between 1998 and 2002 for the second Bird Atlas (Barrett *et al.* 2003). Most of the records collected during this period have a higher degree of spatial accuracy and are more useful for the purposes of this project. Observations arising from this data were sourced from major access points, particularly the Widden Valley, Kerrabee Arm, Dunns Swamp and Glen Alice.

The other half of the records within the Atlas of NSW Wildlife prior to 2005 derive from systematic surveys undertaken as part of the NSW Comprehensive Regional Assessment (CRA) process, which sought to provide a broad overview of the conservation value of public lands in eastern NSW. Work was undertaken in 1997 and centred on the Myrtle Creek Trail (from Nullo Mountain to the head of Myrtle Creek), Growee/Spring Log Creek Trail, the Hunter Range (from Mount Coricudgy to Mount Monundilla), Dunns Swamp, and the Army Road (from Box Hole Clearing to Geebung Ground and Gospers Mountain). These surveys were undertaken by NPWS using the systematic techniques described below (NPWS 1997b).

A relatively small number of records were derived from the specimen register of the Australian Museum. Remaining records within the Atlas were derived from observations made by park rangers and field officers, bushwalkers and naturalists, scientific researchers working in the area, and other visitors to the park. These records have various levels of reliability depending on the type of observation, as well as the certainty and experience of the observer.

2.2 SURVEY STRATIFICATION AND SITE SELECTION

The aim of the survey stratification and site selection process was to proportionately sample the full range of habitat types contained within north-western Wollemi National Park. Choosing an appropriate data layer(s) to develop stratification proved difficult. A two stage approach was therefore adopted.

2.2.1 Gap analysis and selection of priority areas for survey

The first step undertaken was to classify the vegetation communities mapped by Bell (1998) into broader strata that represented the main fauna habitat types within the park. The vegetation formations and classes defined by Keith (2004) were used in this process. The Keith (2004) classification relates vegetation communities to broad statewide distributions and influences, thereby providing a meaningful basis for examining fauna composition patterns. Thirty broad strata were generated (see Table 2).

Prior to the commencement of this project 50 systematic fauna survey sites had been established within the study area as part of the CRA program. The CRA sites were concentrated along the easily accessible major trails leaving immense portions of the study area unsurveyed. In addition, not all survey techniques were undertaken at each site. The site selection process undertaken for the 2005-06 survey season ensured that the data collected would complement, rather than duplicate, work that

had previously been undertaken within the study area. A gap analysis was performed to identify the amount of previous systematic fauna survey effort within each broad stratum. Broad strata that had not previously been sampled or had been under-sampled (where the amount of previous survey effort was less than that predicted by the proportional size of the stratum) were prioritised for sampling.

Secondly, an assessment was undertaken to identify significant gaps in the spatial distribution of systematic fauna survey sites within the study area. Thirdly, for logistical reasons survey points were required to be on or within ten kilometres of a road. The exception to this latter rule was survey sites accessed by helicopter, which sought to fill the vast spatial gap in the south-eastern section of the study area. These three factors were used to select priority regions of the study area to be targeted for survey in the spring/summer season of 2005-06.

2.2.2 Finer scale selection of survey sites

Once the priority regions were selected, the primary strata used for specific site selection were vegetation type and landscape features. The currently available vegetation mapping (Bell 1998) is not designed to provide accurate detail of individual sites. Vegetation type alone could not be relied upon for site stratification as field inspection revealed significant errors in the modelling, particularly under-representation of creekline habitats. An effort was therefore made to sample the full topographic variation within each of the priority regions (i.e. to sample the range of aspects and positions in the landscape from exposed ridgeline to most sheltered gorge).

In the field, the proposed site locations were ground-truthed to ensure that they were representative of the intended stratum, had been minimally 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, 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.

The location of access trails and the large amount of travelling time between areas (especially when walking in difficult terrain) limited selection of survey sites. Due to time and budgetary constraints and the fact that fauna survey is very labour intensive, not all spatial gaps in sampling could be filled. The most notable shortfall was the failure to access the range between Widden and Myrtle Creek, and between Myrtle Creek and the north-western boundary of the park.

Table 3 presents the area of each broad stratum and the corresponding survey effort for each fauna survey technique. Appendix A provides the specific AMG and survey techniques undertaken at each survey site, while Map 5 shows the placement of sites across the study area. The tables and map include all systematic surveys undertaken within the study area by DEC between 1997 and 2005 (i.e. during both CRA and BSP programs).

2.3 SURVEY METHODS

The systematic fauna survey methods used were based on those developed by the NPWS Biodiversity Survey Coordination Unit (NPWS 1997b). 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, it will allow comparisons with future consistent surveys of the park and of environments elsewhere.

Field 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 DEC Biodiversity 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.

Broad strata (derived from Bell (1998) into the statewide vegetation classes of Keith (2004))	Area of strata (hectares)*	Proportion of study area occupied by strata (%)	No. of diurnal bird surveys^	No. of diurnal reptile surveys	No. of site spotlight surveys	No. of harp trapping bat sites	No. of ultrasonic bat detector sites	No. of owl call broadcast sites	No. of nocturnal streamside searches for frogs	No. of Elliott trap sites	No. of hairtube sites
Sydney Hinterland Dry Sclerophyll Forests	50445	27.389	33	37	15	16	11	16	4	5	4
Sydney Hinterland Dry Sclerophyll Forests (Sheltered)	45221	24.552	25	23	12	13	8	10	5	6	5
Southern Tableland Dry Sclerophyll Forests	22264	12.088	31	27	16	17	18	14	2	3	4
Western Slopes Grassy Woodlands (Shrubby)	18523	10.057	51	40	21	11	1	13	3	1	1
Western Slopes Dry Sclerophyll Forests	17779	9.653	8	10	3	1	0	2	0	0	0
Sydney Montane Dry Sclerophyll Forests	6052	3.286	12	13	4	5	5	6	3	1	4
Sydney Coastal Dry Sclerophyll Forests	3996	2.170	5	4	3	2	2	1	0	1	1
North Coast Wet Sclerophyll Forests	3759	2.041	9	8	3	0	3	3	2	0	1
Western Slopes Grassy Woodlands	2975	1.615	18	13	11	9	4	5	1	1	0
Western Slopes Dry Sclerophyll (Sheltered)	1866	1.013	0	0	0	0	0	0	0	0	0
Sydney Montane Heaths	1632	0.886	5	5	3	0	1	1	0	3	0
Central Gorge Dry Sclerophyll Forests (Sheltered)	1523	0.827	1	0	0	0	0	0	0	0	0
Northern Warm Temperate Rainforests	1459	0.792	3	4	0	1	0	0	0	0	0
Cleared	1402	0.761	2	2	1	5	2	4	0	1	0
Western Slopes Rocky Heath	1248	0.677	1	1	0	0	0	0	0	0	0
Southern Escarpment Wet Sclerophyll Forests	1017	0.552	8	6	4	1	0	0	0	0	0
Southern Tableland Grassy Woodlands	965	0.524	7	7	4	2	3	5	0	1	2
Central Gorge Dry Sclerophyll Forests	823	0.447	2	1	1	2	0	1	0	0	1
Southern Warm Temperate Rainforests	479	0.260	4	5	2	0	1	1	0	1	0
Dry Rainforests	327	0.177	0	0	0	0	0	0	0	0	0
Eastern Riverine Forests	234	0.127	2	0	0	3	0	0	0	0	0
Subtropical Rainforests	63	0.034	2	1	1	0	1	1	1	0	0
Tableland Grassy Woodlands	42	0.023	1	1	1	0	0	1	0	0	0
Coastal Tall Open Forests	28	0.015	1	1	2	0	1	0	0	1	0

Broad strata (derived from Bell (1998) into the statewide vegetation classes of Keith (2004))	Area of strata (hectares)*	Proportion of study area occupied by strata (%)	No. of diurnal bird surveys^	No. of diurnal reptile surveys	No. of site spotlight surveys	No. of harp trapping bat sites	No. of ultrasonic bat detector sites	No. of owl call broadcast sites	No. of nocturnal streamside searches for frogs	No. of Elliott trap sites	No. of hairtube sites
Alluvial Swamp	24	0.013	2	1	1	0	0	0	0	0	0
Montane Bogs	13	0.007	1	1	1	0	0	0	0	0	0
Basalt Herbfield	12	0.007	0	0	0	0	0	0	0	0	0
Montane Swamps	4	0.002	0	0	0	0	0	0	0	0	0
Sedgeland	3	0.002	0	0	0	0	0	0	0	0	0
Basalt Shrubland	1	0.001	0	0	0	0	0	0	0	0	0
Total	184179	100	234	211	109	88	61	84	21	25	23

* areas based on GIS data layers and do not equal gazetted area of reserve.

^ Includes sites established during Comprehensive Regional Assessment and Biodiversity Survey Priorities surveys. Transect spotlight surveys are not included in this table as these traverse a variety of vegetation types. Sixteen such censuses were undertaken during CRA surveys.

Note also that broad strata presented here are derived from modelled vegetation unit as mapped and do not always equal vegetation community in the field. In particular, gully forest and rainforest is not well mapped, and therefore appear under-sampled in the above table, while drier forest types appear over-sampled. In reality, gully habitats were sampled as part of this project in rough proportion to their occurrence in the field.

Table 2: Area of each broad strata (derived from Keith 2004) within north-western Wollemi National Park and corresponding allocation of systematic survey sites.

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 & 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 BSP surveys were conducted in spring and summer, while a small number of CRA surveys were undertaken in autumn. All bird species and abundance of individuals 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.

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 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 (Plate 5). 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 creeklines or in gaps between trees where adjacent vegetation may ‘funnel’ flying bats.

Traps were checked each morning. Captured bats were identified by external morphology, forearm measurement and body weight, and keyed out where necessary using Parnaby (1992a) and Churchill (1998). 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. 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, that is, 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.

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 waterbodies, 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, 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. Troublesome calls were further verified by Michael Pennay. 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; 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 (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) Sooty Owl (*T. tenebricosa*) and Barking Owl (*N. connivens*) - 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 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. The majority of censuses were undertaken in autumn and winter.

Elliott trapping

This technique involved setting ten 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.

Hair tube sampling

During CRA, twenty large hair-sampling tubes (nine centimetre diameter, after Scotts and Craig 1988) were placed at 100 metres intervals along a two kilometre transect. Alternate tubes were baited with meat or a mixture of peanut butter, honey and rolled oats. During BSP ten large hair-sampling tubes were placed at approximately twenty metre intervals along a 200 metre transect. All tubes were baited with a mixture of peanut butter, honey, rolled oats and sardines. In both cases each tube was fitted with adhesive paper to collect hairs of small and medium sized mammals that were attracted to the bait. Tubes were left on site for a minimum of ten nights. Hair samples were identified using the techniques described by Brunner and Coman (1974) by an expert in the field, Barbara Triggs. Identifications were classified into three levels of reliability: definite, probable and possible.

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/insectivore 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 at 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 (*Dasyurus maculatus*), Fox (*Vulpes vulpes*), Dingo (*Canis lupus dingo*), Wild Dog (*C. lupus familiaris*), Feral Pig (*Sus scrofa*) and the large forest owls. Due to the unmeasurable time delay between prey ingestion and defecation, the location in which the prey animals lived cannot be accurately known, so 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).

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 and insectivore 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.

Searches of caves and overhangs

When come across, caves and overhangs were thoroughly searched with a head torch for animals such as cave-roosting bats, geckos and nesting birds, as well as for animal traces such as owl pellets and bat guano.

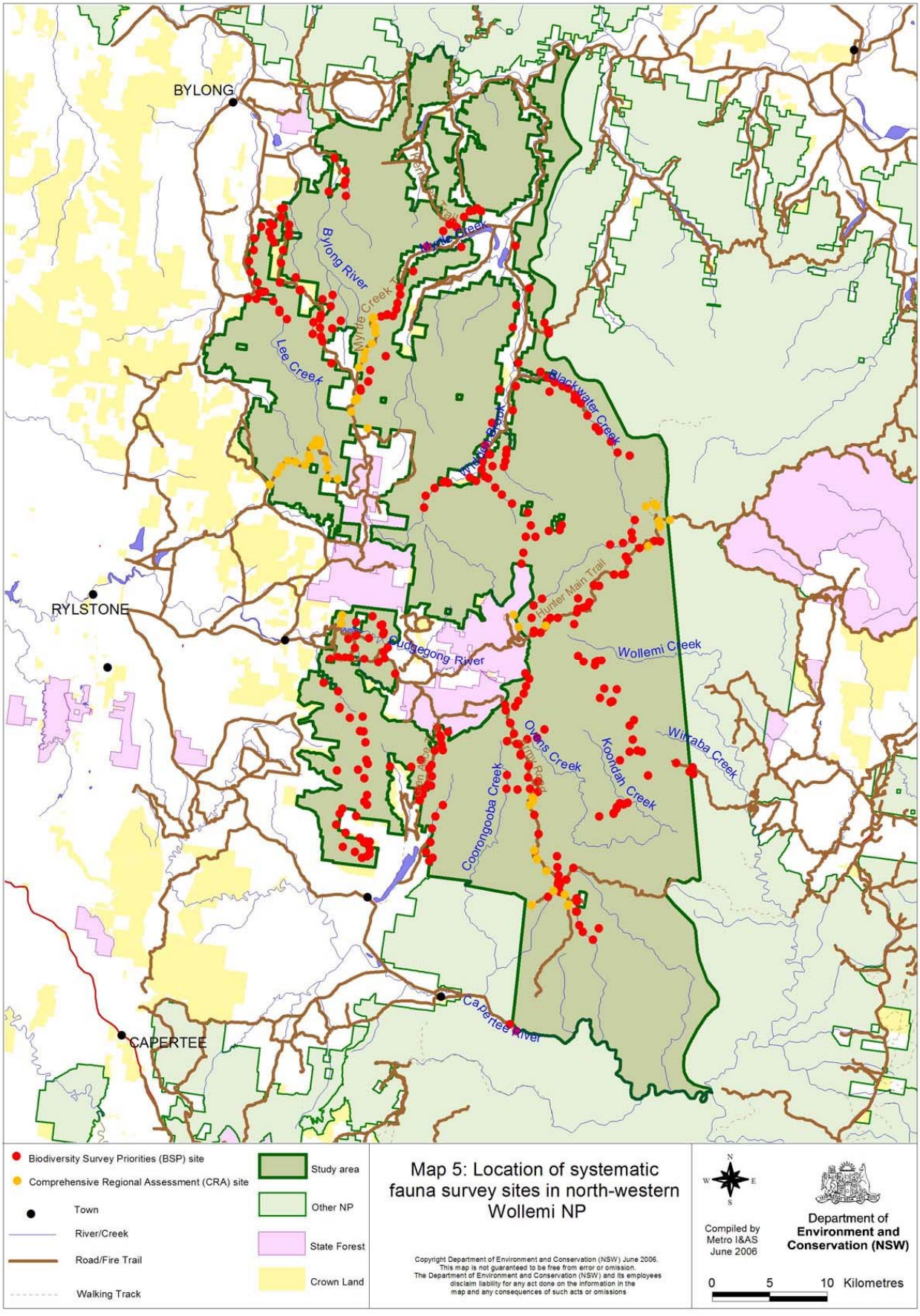
Incidental records

Surveyors driving or walking through the study area recorded the location of interesting fauna when it was 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.

2.3.4 Targeted searches for Brush-tailed Rock-wallaby

After the sighting of an adult Brush-tailed Rock-wallaby (*Petrogale penicillata*) in Myrtle Creek in March 2006, further targeted surveys were commissioned to estimate the extent of wallaby occupation and the approximate number of individuals in the immediate vicinity of the sighting. These surveys were undertaken between the 22nd and 26th May 2006 and were funded by the Brush-tailed Rock-wallaby Recovery Team. The surveys included the following:

- Searches for Brush-tailed Rock-wallaby in shelter sites, sunning areas and connecting habitat corridors along Bylong River (near Bylong Trail crossing), Myrtle Creek (including slopes and clifflines east and west of the creek from Lovers Leap to the point where Myrtle Trail leaves the creekline), and Red Creek (from Widden Brook to 2.5 kilometres upstream)
- Searches for Brush-tailed Rock-wallaby scats in the above areas.
- Searches for predator and introduced herbivore scats in the above areas, including collection and analysis of predator scat contents. This was undertaken in an attempt to assess the level of threat posed to the Brush-tailed Rock-wallaby in these areas, and collect any evidence of direct predation.



Map 5: Location of systematic survey sites in north-western Wollemi National Park

2.4 SURVEY TIMING

As summarised above, systematic field surveys have been undertaken within north-western Wollemi National Park over a number of years. Table 3 summarises the timing of these surveys and the techniques that were undertaken in each period.

Survey program	Timing	Techniques employed
Comprehensive Regional Assessment (CRA)	January to May 1997	Diurnal bird census, reptile search, transect spotlighting, site spotlighting, 30 minute bat call detection, harp trapping, nocturnal call playback, nocturnal streamside search, hair tubes, elliott trapping, opportunistic methods
Biodiversity Survey Priorities (BSP)	August 2005	Nocturnal call playback, opportunistic methods
	September 2005 – February 2006	Diurnal bird census, reptile search, site spotlighting, harp trapping, all night bat call detection, nocturnal streamside search, nocturnal call playback, elliott trapping, opportunistic methods
	March – April 2006	Nocturnal call playback, hair tubes, opportunistic methods

Table 3: Timing of DEC systematic fauna surveys within north-western Wollemi National Park

2.5 DATA ANALYSIS

A small amount of exploratory multivariate data analyses were undertaken to identify patterns of diurnal bird and reptile occurrence in relation to major habitat types within the study area. The software package *Primer 5 for Windows* (version 5.2.9) was used for this purpose. The major vegetation classes into which sites were categorised for these analyses are: Heathland; Dry Sclerophyll Forest; Grassy Woodland; Sheltered Dry Sclerophyll Forest; Wet Sclerophyll Forest (grassy); Wet Sclerophyll Forest (shrubby); Rainforest; and Forested Wetland. To further elucidate patterns within the Dry Sclerophyll Forest group, sites were further categorised by underlying geology into: Narrabeen; Hawkesbury; and Permian. Only a subset of systematic survey sites were used, namely those that had both diurnal bird and diurnal herpetofauna censuses undertaken at them. Analyses were undertaken on the combined results of the bird and herpetofauna censuses undertaken at each site. Analyses were based on species presence-absence data, as this is not sensitive to fluctuations in abundance counts. For the diurnal birds, all records noted as 'above canopy' were excluded because it is not known if they were actually using the habitat or not. However, both 'on-site' and 'off-site' bird records were included. Analysing bird and reptile data simultaneously meant that some differences were primarily driven by bird species, and others by reptile species. Caution therefore had to be applied when interpreting the fauna groups separately, and to the separate discussion presented in Sections 3.3 and 3.4.

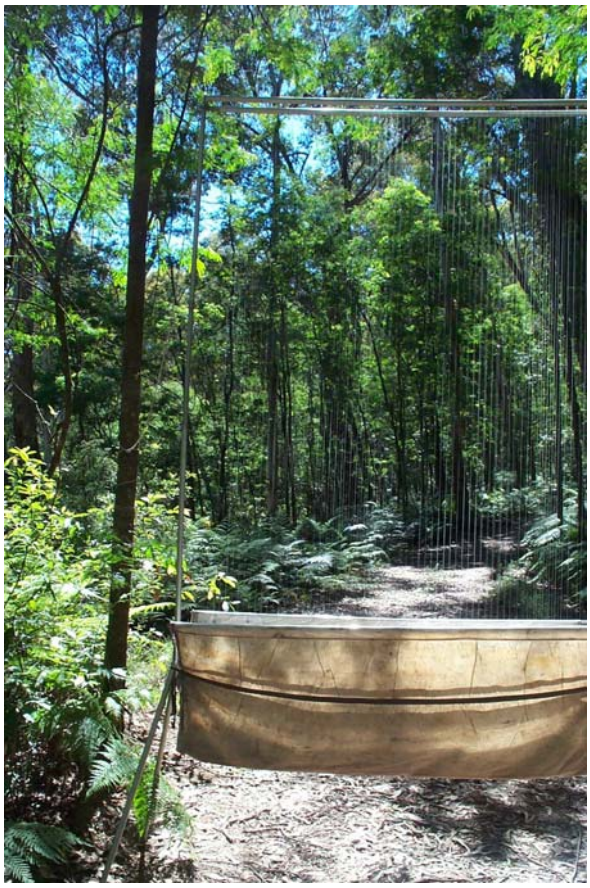


Plate 5: Harp trap placed across a fire trail to sample microbat species © DEC

Detail of the analyses undertaken is presented in Appendix B. In summary: similarity matrices were used to identify groups of sites that contained similar suites of birds and reptiles; analysis of similarities (ANOSIM) was used to test for differences between the bird and reptile fauna of the major habitat groups; and SIMPER was used to identify fauna species that characterise site groupings identified in the Similarity Matrices and ANOSIM.

3 RESULTS AND DISCUSSION

3.1 OVERVIEW

DEC has established and surveyed a total of 394 systematic fauna survey sites within north-western Wollemi National Park, of which 326 were surveyed in 2005-06 and four in 2004-05 as part of the Biodiversity Survey Priorities fauna survey program. These sites cover the dominant habitats and landscapes present within the study area, and were surveyed during spring, summer and autumn. In addition to these surveys, members of Birds Australia have contributed significantly to the number of fauna records for the study area, as have numerous DEC staff, scientific researchers, and members of the public.

A total of 315 species of native vertebrate fauna are now known to occur in north-western Wollemi National Park, of which 279 (90 %) were recorded during the 2005-06 surveys. This total includes 36 species listed as threatened under the NSW Threatened Species Conservation Act (TSC Act) (1995), of which nine are also listed under the Commonwealth Environmental Protection and Biodiversity Conservation Act (EPBC Act) (1999). Sixteen introduced fauna species have been recorded within the study area to date, including thirteen ground mammals and three birds. An additional twelve native species (including three threatened species) have been recorded on the Atlas of NSW Wildlife for which there is some doubt regarding their occurrence in the park proper, as will be discussed below. A complete species list for all terrestrial vertebrate fauna groups is provided in Appendix C.

In addition to the above fauna, a further 51 species have been recorded within a five kilometre radius of the study area boundary (see Appendix D). This includes seven additional threatened species, of which two, the Swift Parrot (*Lathamus discolor*) and Large-footed Myotis (*Myotis adversus*), are considered highly likely to also occur within the study area.

The value of systematic fauna survey is apparent in the contribution it has made to the knowledge of fauna within the study area and the building of a species inventory. The CRA surveys, undertaken in 1997-98, added 71 species to the list of known fauna within north-western Wollemi National Park, and the BSP program, undertaken between 2004-06, added a further 45 species to the study area database. Figure 1 indicates the increase in the known number of fauna species within the study area over time, primarily as a result of dedicated systematic fauna survey. Furthermore, the BSP surveys increased the number of fauna records within the park more than three-fold, from 4667 to over 16 000. The locations of survey sites are shown in Map 5.

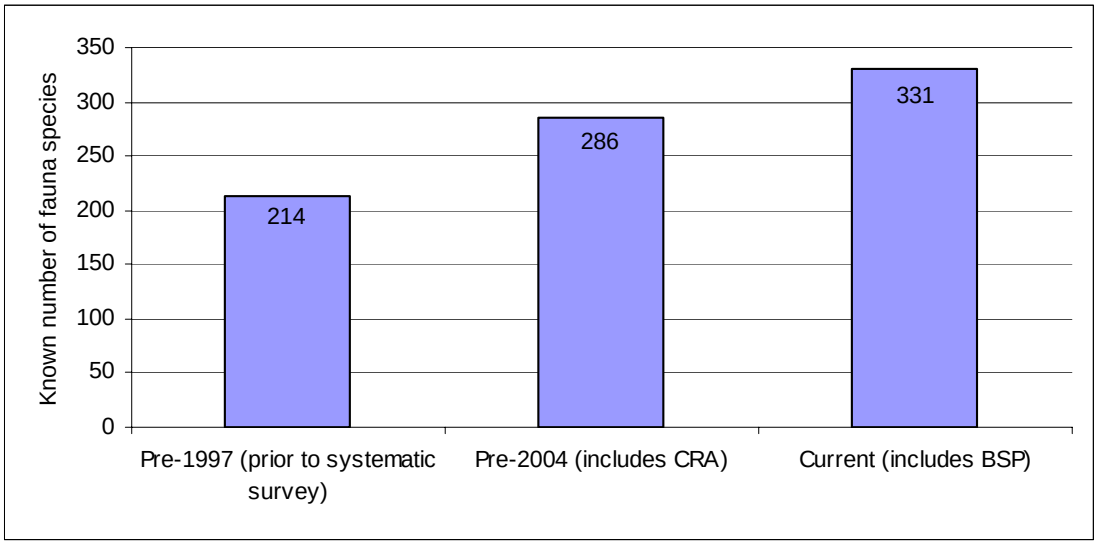


Figure 1: **Number of species recorded on the Atlas of NSW Wildlife within north-western Wollemi National Park, showing increase following systematic fauna survey**

3.2 FROGS

The systematic surveys between 1997 and 2006 confirmed the presence of 17 species of frog within the study area, of which twelve have not been detected by any other method (Appendix C). Single records exist for an additional two species: the Broad-palmed Frog (*Litoria latopalmata*) has been recorded recently, while a specimen of the endangered Booroolong Frog (*Litoria booroolongensis*) was collected in 1980. It is unknown whether the Booroolong Frog still occurs within the study area, as will be discussed in Section 5 below. Given this, the number of frog species definitely known to occur in north-western Wollemi National Park is 18, including nine Myobatrachidae (ground frogs), which lack toe discs and rarely climb trees, and nine Hylidae (tree frogs), which have toe discs and frequently climb trees or rocks (Robinson 1993). The occurrence of the Stuttering Frog (Plate 6) is of high conservation significance, as the species is listed as endangered in NSW and vulnerable nationally. There are only two other recent records of this frog within a 50 kilometre radius of the study area. The presence of the Giant Burrowing Frog (*Heleioporus australiacus*) and Red-crowned Toadlet (*Pseudophryne australis*), both listed as vulnerable under the TSC Act (1995), is also significant as both of these species reach the northern limit of their known range within the study area. These threatened species will each be discussed further in Section 5.

The success of frog surveys is largely dependent on the immediate weather, season and recent climatic conditions. In the lead up to the 2005-06 systematic survey period, the weather was relatively dry, providing poor conditions for conducting frog surveys. However, storms and heavy downpours occurred prior to and during a number of the spring and summer surveys, providing a window of opportunity to sample the frog fauna. As the duration of optimum conditions was limited, only a small number of systematic nocturnal streamside searches were undertaken. Frogs were also encountered on an opportunistic basis during these times as they used the wet weather to disperse and were encountered on roads and trails and during other systematic survey techniques such as site spotlighting, diurnal herpetofauna searches and nocturnal call playback.

Plate 6: Stuttering Frog on minor tributary of Wollemi Creek. © N. Williams/DEC

3.2.1 Discussion of species occurrence

Ground frogs

By far the most widespread and abundant frog species is the Common Eastern Froglet (*Crinia signifera*), which was observed or heard calling in all of the medium and large creeklines that were visited during the surveys, ranging from those within She-oak forest and Box - Red Gum woodland to tall moist Blue Gum Forest. This small frog calls consistently throughout the year and so is easily detected by auditory surveys, though it usually remains quite visually inconspicuous. The Red-crowned Toadlet was the next most-commonly recorded species, detected in numerous locations in the higher elevation sections of the park, on and south of the Hunter Range (see Map 9). The closely related Bibron's Toadlet (*Pseudophryne bibronii*), which has a similar call but strikingly different markings, is more widely distributed. It has been recorded in a number of small creeks and drainage lines ranging from Wattle and Cousins Creeks at moderately low elevation in the north to Gospers Creek at relatively high elevation in the south. All but one of the records for this species occur on or near higher fertility soils, derived from either Permian or basalt geologies, suggesting that the species prefers enriched soils, as has been found to be the case in the greater southern Sydney region (DEC 2006a). The high frequency of detection of Bibron's Toadlet within the study area is

Plate 7: Lesueur's Frog (note blue thighs) on Sugarloaf Creek © M. Schulz/DEC

important, as this species is thought to have declined in abundance in many parts of its range, including lowland areas in the greater Sydney area, as well as the Brigalow Belt South and Nandewar Bioregions (Andren 2004). The Bullfrog (*Limnodynastes dumerilii*) has been seen or heard calling at 14 locations, each in the northern half of the study area including along Bylong River, Blackwater Creek, Lee Creek and Ganguddy Creek near Dunns Swamp. Interestingly, both subspecies (*L. d. dumerili* and *L. d. grayi*) occur within the area and in some cases, such as Ganguddy Creek, at the same location.

The remaining ground frog species have each only been recorded sporadically and include (followed by the number of locations at which they have been detected) the Spotted Marsh Frog (*Limnodynastes tasmaniensis*, 7), Striped Marsh Frog (*Limnodynastes peronii*, 5), Giant Burrowing Frog (6), Ornate Burrowing Frog (*Limnodynastes ornatus*, 2), and Stuttering Frog (1). The low numbers of records of the *Limnodynastes* species is likely to be a result of limited survey effort under good conditions, rather than an indication of true rarity. They are each likely to occur in still pools of moderately sized creeks or rivers, as well as flooded grasslands and dams (Anstis 2002).

Tree frogs

Of the tree frogs that occur in north-western Wollemi, the Green Stream Frog (*Litoria phyllochroa*) and Peron's Tree Frog (*Litoria peronii*) have been detected most frequently, at 33 and 34 locations respectively. The Green Stream Frog is usually found in flowing streams, and is expected to occur within all of the drainage systems in the study area, particularly in or near taller forest. The Peron's Tree Frog is less widespread. This species requires still water to breed in, and is therefore restricted to pools in larger creeks and rivers, as well as artificial waterbodies such as dams. It occurs along the Capertee and Cudgegong Rivers, as well as in or beside dams near the boundary of the park, such as at Gospers and Kerry Mountain and within the Widden and Glen Alice Valleys. The Blue Mountains Tree Frog (*Litoria citropa*) has been recorded at 17 locations, each within sheltered gullies that retain almost permanent flowing water, such as Blackwater, Ovens and Numietta Creeks. The discovery of the Blue Mountains Tree Frog in north-eastern (DEC 2005a) and north-western Wollemi National Park is exciting, as this animal was not previously known to occur in the region and constitutes a north-westerly range extension for the species. The only records north of this within the NSW Wildlife Atlas come from Barrington Tops, a remnant area of rainforest and wet sclerophyll forest, with habitats similar to those in which the Blue Mountains Tree Frog was located within northern Wollemi National Park. The presence of such a species indicates the refugia properties that are provided by deeper sheltered gullies in Wollemi.

Keferstein's Tree Frog (*Litoria dentata*) has been detected at 14 widely spaced locations, including adjacent to still pools in creek lines, in farm dams beside the park and in trees far from water. Records of the Green Tree Frog (*Litoria caerulea*) are also widely spaced, but are all located near the boundary in the north of the park, in a variety of habitat types. The remaining five tree frog species have each been recorded only a handful of times, being Verreaux's Tree Frog (*Litoria verreauxii*, 3), Broad-palmed Frog (1), Stoney Creek Frog (*Litoria wilcoxii*, 2) and Lesueur's Frog (*Litoria lesueuri*, 1). The occurrence of the latter two species is interesting, as they have only recently been defined as two separate species. The Hawkesbury-Nepean River System is thought to be the geographical boundary for the distribution of these two species, with Lesueur's Frog occurring to the south and Stoney Creek Frog to the north (Donnellan & Mahony 2004). The species ranges overlap in this river system, but had previously only been reported in separate tributaries less than 25 kilometres apart (Donnellan & Mahony 2004). The species were recorded within two kilometres of each other near Dunns Swamp in October 2005, with the Stoney Creek Frog on the Cudgegong River and Lesueur's Frog (Plate 7) on Sugarloaf Creek. In November 2005 both species were recorded within the same pool on the Capertee River, just west of the study area boundary. Furthermore, both species were observed on Wollemi Creek, east of the study area, during CRA surveys, where distinct groups of each species were seen within 100 metres of each other, exhibiting a different call and showing no sign of intermediate morphology (K. Madden pers. comm.). The species complex has been recorded from other parts of Wollemi National Park prior to 2004, however it is unknown to which species these records belong. These results yield important new information regarding the distribution and cross-over of Lesueur's Frog and Stoney Creek Frog, and are worthy of further investigation in the region.

3.2.2 Other species that have the potential to occur in the study area

In addition to the above, there are seven frog species that have been recorded within five kilometres of the park boundary, of which two are considered highly likely to also occur within the study area, yet have remained undetected to date. The Smooth Toadlet (*Uperoleia laevigata*) is likely to occur around or adjacent to ditches and dams that are located near the boundary of the drier parts of the study area. The Painted Burrowing Frog (*Neobatrachus sudelli*) probably occurs within the dry, western-influenced

environments below the northern and western escarpments, as was found to be the case in north-eastern Wollemi National Park (DEC 2005a) and Goulburn River National Park (NPWS 2001b). This latter species remains underground much of the time, buried in deep alluvial sandy soils, and emerges only after heavy rain; hence it can easily go undetected. It is also possible that Fletcher's Frog (*Lechriodus fletcheri*) and the Great Barred Frog (*Mixophyes fasciolatus*) occur in the higher rainfall areas of the park, within patches of rainforest and wet sclerophyll forest in the most sheltered sandstone gullies and canyons. There is also a chance that the Red-eyed Tree Frog (*Litoria chloris*) occurs, as the species is known to occur at a few locations in north-eastern Wollemi National Park (DEC 2005a) within habitats that also exist within the current study area. The study area lies near the extremity of the known distributions for all of these latter three species, so further research into whether they occur and their distribution in the region is warranted. Such research needs to be undertaken in late spring or summer during wet conditions and outside of a drought period.

3.2.3 Review of species records

A single Jervis Bay Tree Frog was recorded at Dunns Swamp in 2000. However, this is a coastal frog not known to occur on the western slopes. The record is considered to be a misidentification and therefore has not been included in the totals provided in this report.

3.3 REPTILES

The DEC surveys between 1997 and 2006 confirmed the presence of 50 species of reptile in north-western Wollemi National Park, of which 24 were not known to occur prior to systematic surveys. An additional two species have been recorded in the park by casual observers, bringing the total number of known reptile species to 52. This total includes one species of turtle, five geckos, three legless lizards, five dragons, two monitors, 24 skinks and twelve snakes (Appendix C). One of these species, the Broad-headed Snake (*Hoplocephalus bungaroides*) is listed as Endangered under the NSW TSC Act (1995) and Vulnerable under the commonwealth EPBC Act (1999), while a second, the Rosenberg's Goanna (*Varanus rosenbergi*) is listed as Vulnerable under the TSC Act (1995). These species have been recorded at three and six widely spaced locations respectively, and will be discussed in detail in Section 5 of this report.

3.3.1 Systematic survey findings

A total of 211 systematic diurnal herpetofauna searches have been undertaken in north-western Wollemi National Park between 1997 and 2006. Forty-two reptile species were detected by this method. Based on these census results, the most common reptile species in the study area is the Pale-flecked Garden Sunskink (*Lampropholis guichenoti*), detected during 70 (33 % of) reptile searches. This is followed by the Dark-flecked Garden Sunskink (*Lampropholis delicata*, 65 sites), Lesueur's Velvet Gecko (*Oedura lesueurii*, 63 sites), Copper-tailed Ctenotus (*Ctenotus taeniolatus*, 46 sites) and White's Rock-skink (*Egernia whitii*, 43 sites, Plate 8).

Plate 8: White's Rock-skink © N. Williams/DEC

The results of the multivariate analyses performed on systematic survey data indicate that some reptile species have clear preferences for particular vegetation classes. Based on vegetation class alone, the most clearly distinct vegetation groups in terms of the reptile assemblage are the rainforests and the heathlands. Rainforests, mostly located in deep sandstone gorges, were found to be generally depauperate in reptile species, with only the Broad-tailed Gecko (*Phyllurus platurus*, also known as Southern Leaf-tailed Gecko) found to be relatively common. This large gecko is usually located under rocks or in rock crevices, often leaving behind shed skin, which is also readily identifiable. The fauna assemblage typical of wet sclerophyll forests with a mesic shrubby layer included a larger number of reptile species, namely Warm-temperate Water-skink (*Eulamprus heatwolei*), Eastern Water-skink (*E. quoyii*) and Dark-flecked Garden Sunskink. This last species is also common in sheltered dry sclerophyll forests, together with the Pale-flecked Garden Sunskink and to a lesser extent the Eastern Water-skink and Broad-tailed Gecko. The factors determining such habitat preferences are beyond the scope of this report, however it can be assumed that the broad vegetation classes used for the analysis are a surrogate for more detailed micro-climatic and micro-habitat requirements. All of the reptile species common in the more sheltered forest types (rainforest, wet sclerophyll forest and sheltered dry sclerophyll forest) are typical of coastal hinterland sandstone environments. They are thus expected to be most common in the centre and south of the study area, where the climate,

geology and topography is most closely aligned to coastal hinterland patterns. Of these species, the Warm-temperate Water-skink has the most restricted distribution in the study area, only occurring at moderately high altitudes, including along the Hunter Range, and on Mounts Coricudgy, Boonbourwa, Kerry and Coriaday.

The reptile fauna of the heathland habitats is a stark contrast to that of the sheltered forests, and is dominated by species that flourish on and around exposed rock outcrops. The most commonly detected reptile species in this vegetation class are the Copper-tailed Ctenotus and White's Rock-skink and to a lesser extent Lesueur's Velvet Gecko. Both the Dark-flecked and Pale-flecked Garden Sunskinks were located within heathlands, but at quite low frequency. The species that were not detected within heathlands also yield important information, as it suggests the exposed nature of these areas to be beyond the ecological tolerance of these species. Reptiles that were noticeably absent from heathlands included the Broad-tailed Gecko, Weasel Shadeskink (*Saproscincus mustelinus*), Yellow-bellied Three-toed Skink (*Saiphos equalis*), Eastern Water-skink and Eastern Water Dragon (*Physignathus lesueurii lesueurii*).

The shrubby dry sclerophyll forest vegetation class encompasses a diverse range of habitats, at a variety of elevations and climatic conditions. When classed together, these habitats were not found to exhibit a significantly different fauna assemblage compared to the other vegetation classes. Instead, the most frequently detected reptiles reflect the species that are most abundant across the whole study area, including Lesueur's Velvet Gecko, Dark and Pale-flecked Garden Sunskinks, Copper-tailed Ctenotus and White's Rock-skink. However, there was found to be a significant difference between the fauna assemblage of sites in dry sclerophyll forest on Permian sediments and on Narrabeen and Hawkesbury sandstone-derived soils. This difference is likely to be driven by climatic, fertility and landscape differences, for which the broad geological classes are a surrogate. The shrubby dry sclerophyll forests on Permian soils are closely aligned in terms of their reptile assemblage to the grassy woodlands, as they also occur along the dry northern and western talus slopes. The Tree-base Litter-skink (*Lygisaurus* (now *Carlia*) *foliorum*) and South-eastern Morethia Skink (*Morethia boulengeri*) are common on these dry talus slopes, yet very rarely detected on the Narrabeen or Hawkesbury sandstones. The Tree-crevice Skink (*Egernia striolata*) is also more common in these environments than on the sandstones. Conversely, Dark-flecked and Pale-flecked Garden Sunskinks, White's Rock-skink, Copper-tailed Ctenotus and Red-throated Cool-skink (*Bassiana platynota*, now known as *Acritoscincus platynotum*) were more frequently detected in dry sclerophyll forests on Narrabeen and Hawkesbury sandstone. This result was expected, as it reflects the regional influences on different parts of the study area. The reptile fauna along the northern and western escarpment is dominated by species typical of the central western slopes that extend towards the coast only where drier environments occur, (such as in the Hunter and Goulburn River Valleys) as well as species more common in northern NSW. Though not highlighted in the analyses, species that also fit into this category are the South-eastern Slider (*Lerista bougainvillii*) and Southern Rainbow-skink (*Carlia tetradactyla*). The species present on the Hawkesbury and Narrabeen sandstones, however, are typical of Sydney coastal hinterland environments and are each abundant across the sandstone reserves of the northern and southern Blue Mountains.

A more unexpected finding was that Jacky Lashtail (*Amphibolurus muricatus*) and Broad-tailed Gecko were each somewhat more frequently detected on Permian than on Narrabeen dry sclerophyll forests. The reasons for this are unknown and require further investigation, but may be linked to the fact that the Permian dry sclerophyll forest classes incorporated many gully sites, while the Hawkesbury and Narrabeen sandstone sites were largely located on ridges or exposed slopes. A number of reptile species did not exhibit differences in detection rate between different types of dry sclerophyll forest, including Lesueur's Velvet Gecko and Eastern Stone Gecko, amongst others. Presumably the presence of these species is determined by finer scale micro-habitat features than were examined herein.

3.3.2 Discussion of other species occurrence

Many of the less commonly detected reptiles species did not feature in the multivariate analysis, yet form an integral part of the study area's reptile inventory and are worthy of discussion.

Geckos

The two gecko species not discussed above were each detected for the first time in the study area during the 2005-06 DEC surveys. The Thick-tailed Gecko (*Underwoodisaurus milii*, also known as Barking Gecko) was detected at fourteen locations, along the northern and western slopes and escarpment as well as around Dunns Swamp. The Robust Velvet Gecko (*Oedura robusta*) was observed just twice, once in Cedar Creek gorge and once near the boundary between the park and

private lands on the trail to Gowrie Hut, south of Bylong. This species has the north coast at the centre of its distribution in NSW, where it inhabits dry sclerophyll forests and woodlands. It has not been recorded further south than the Watagan State Forest, situated approximately 30 kilometres south of the current records. The discovery of the gecko within north-western Wollemi National Park, together with recent discoveries in north-eastern Wollemi and Goulburn River National Parks and Manobalai Nature Reserve, contributes important information about the species towards the southern limit of its known range.

Legless lizards

All of the legless lizard species that are now known to occur in the park were first detected during the BSP surveys and have each been recorded on just two occasions. This is due to their highly cryptic nature and tendency to take cover under rocks or logs, or in leaf litter or grass tussocks, when disturbed. The Leaden Delma (*Delma plebeia*) reaches the southern limit of its distribution at the Hunter Valley and ranges. Little is known of this rare species, with only 27 sightings recorded on the Atlas of NSW Wildlife, most of which fall within the Hunter Valley and Ranges and the Nandewar Bioregion. This species is likely to occur at further sites in the dry northern valleys and lower slopes, such as was found to be the case on north-eastern Wollemi (DEC 2005a). The two other species of legless lizard, Burton's Snake-lizard (*Lialis burtonis*) and Southern Scaly-foot (*Pygopus lepidopodus*, Plate 9) are likely to be more widespread than records indicate, as elsewhere they are known to occur in a wide range of habitat types, both north, south, east and west of the study area.

Plate 9: Southern Scaly-foot © N. Williams/DEC

Dragons

Of the five species of dragon recorded in the study area, the most interesting discovery made during the BSP surveys was of the Nobbi Lashtail (*Amphibolurus nobbi*, Plate 10). This animal was observed at two locations on the slopes east of Lee Creek, within dry Box – Cypress woodland. The Nobbi Lashtail ranges from the coast and ranges of Queensland and far north New South Wales around to the western slopes of the Great Dividing Range and into South Australia (Wilson & Swan 2003). Aside from one record near Lithgow, the sightings made in 2006 are the furthest south that the species has been recorded on the eastern side of the ranges. The species is common further north, in Goulburn River National Park and Manobalai Nature Reserve and crown lands, and is one of the most abundant dragons in the Brigalow Belt South Bioregion (DEC 2005b). The species is known to inhabit dry environments (Cogger 1996) and its occurrence in the north-west of the study area is likely to be linked to the low rainfall and the presence of dry forests and woodlands. The distribution of the dragon in the upper Hunter Valley has been linked to occurrence of the Cypress Pine (R. Wells pers. comm.). The subspecies of these dragons were not recorded, but are likely to belong to *A. nobbi nobbi*.

Plate 10: Nobbi Dragon east of Lee Creek © N. Williams/DEC

Neither the Jacky Lashtail, Eastern Bearded Dragon (*Pogona barbata*) or Eastern Water Dragon have been recorded on the Hunter Main Trail, and of these only the Eastern Water Dragon has been detected in the vicinity of Mount Coricudgy. These three dragons have been more frequently detected in lower lying areas, particularly along the Army Road (Jacky Lashtail and Eastern Bearded Dragon), north and south of Dunns Swamp (all species) and along major creeklines (Eastern Water Dragon). The distribution of the Mountain Heath Dragon (*Tympanocryptis diemensis* now known as *Rankinia*

diemensis) is markedly different from this. This small dragon reaches its greatest abundance in higher altitude areas, including along the Hunter Range and around Mount Coricudgy, and has only occasionally been recorded in the far north of the park. The Mountain Heath Dragon is a frequent sight along the Army Road and near Gospers Mountain, as well as around Dunns Swamp and sandstone ridges south of the Hunter Range.

Monitors

The Lace Monitor (*Varanus varius*) is a relatively common sight throughout the sandstone reserves of the Sydney Basin, and north-western Wollemi National Park is no exception. This goanna is the second largest native carnivore in eastern Australia (second to the Dingo) and is a habitat generalist that forages across a large home range for carrion, nesting birds, reptile eggs, mammals and invertebrates (Guarino 2001). The species was recorded on close to 30 occasions in a wide range of habitat types, including at both high and low elevation. The Bell's form of this species, which has broad black and pale yellow bands on the body and tail, was seen on at least two occasions in the north-west, near Bylong River and Lee Creek. This form occurs in northern NSW and west of the ranges (Wilson & Swan 2003) and is yet another testament to the regional influences on this part of the study area. The Rosenberg's Goanna was much less frequently sighted. The six records obtained are scattered in both the north and centre of the park, as will be discussed on Section 5. The sightings made during the 2005-06 surveys are the furthest north-west that the species has been recorded on the Atlas of NSW Wildlife and contribute important information to the understanding of the species distribution and ecology.

Skinks

The occurrence of two species of Worm-skink, the Two-clawed Worm-skink (*Anomalopus leuckartii*) and Punctate Worm-skink (*Anomalopus swansoni*), is interesting. The Punctate Worm-skink has a very restricted distribution, occurring only in the northern half of the Sydney Basin Bioregion from just north of Sydney to the Hunter Valley (DEC 2006b). The DEC surveys undertaken in the Hunter Range area in 2004-05 increased the number of records for this species eight fold and found the lizard to be common on well-drained ridges, slopes and alluvial gullies in the Upper Hunter (DEC 2005b). Interestingly, though the Punctate Worm-skink was found in the Baerami Valley and on the ridgeline separating this valley from Widden Valley, it was not located during any of the 50-odd herpetofauna censuses undertaken in Widden, Myrtle, Lee or Bylong Valleys, or elsewhere in the study area. This result suggests that the ridge dividing the Widden and Baerami Valleys is the western limit of the species distribution. The Two-clawed Worm-skink, on the other hand appears to be moderately common on creek flats and lower slopes in the Widden and Myrtle Valleys, as it was found to be in Baerami and Hungerford Valleys in north-eastern Wollemi (DEC 2005a). This latter species was also recorded once in the Bylong River Valley, and is likely to be widespread in the Upper Goulburn Valleys and escarpments. The Upper Hunter and Goulburn River Valleys form the southern limit of this species' distribution.

In addition to the Eastern Water-skink and Warm-temperate Water-skink mentioned above, two further *Eulamprus* species occur, namely the Bar-sided Forest-skink (*Eulamprus tenuis*) and the Cool-temperate Water-skink (*E. tympanum*). The occurrence of Bar-sided Forest-skink was to be expected, as this species also occurs across north-eastern Wollemi and Yengo National Parks (DEC 2006b). Though this arboreal lizard was only recorded at nine locations, these locations are widely scattered and it is expected to occur at low density across the study area. The discovery of Cool-temperate Water-skink was more of a surprise, and uncertainty remains regarding its distribution in the study area. It was positively identified at only one location, near the headwaters of Blackwater Creek, just east of Mount Coricudgy. It is possible that other *Eulamprus* seen on the Hunter Range were also Cool-temperate Water-skink. However this lizard is difficult to identify from the Warm-temperate Water-skink at a distance, and individuals could not be captured to positively verify their identity. The Cool-temperate Water-skink has not previously been detected within the vicinity of north-western Wollemi National Park. The closest records on the Atlas of NSW Wildlife are located 70 kilometres to the south (north-east of Blackheath) and 80 kilometres to the north (in Barrington Tops National Park). However, the species does have a rather disjunct distribution, only occurring in montane areas, usually above 600 metres asl (DEC 2006b). Its occurrence east of Mount Coricudgy is therefore in line with known habitat preferences, as was the microhabitat in which the lizards were observed. Further survey would be required to determine the distribution and abundance of this species on the Hunter Range.

Both the Blotched Bluetongue (*Tiliqua nigrolutea*) and the Common Bluetongue (*T. scincoides*) have been recorded in north-western Wollemi, though only once and three times respectively. A Blotched Bluetongue was seen in thick grass during a herpetofauna census on a basalt-capped summit three

and a half kilometres north-west of Tayan Peak, in October 2005. This was an exciting discovery, as it constitutes a 40 kilometre northerly range extension for the species. The Blotched Blue-tongue is common in the upper Blue Mountains, frequently recorded above 800 metres asl near the towns of Katoomba, Blackheath and Lithgow and west towards Winburndale Nature Reserve (DEC 2006b). In the north of its range the lizard only occurs in montane and sub-alpine environments (Wilson & Swan 2003). The habitat in which the lizard was located in north-west Wollemi (Plate 4) is typical for the species, being montane grassy open forest though at 750 metres above sea level it is lower in altitude than most records. The wide low-lying Capertee Valley separates this location from other known localities of the species. The Blotched Bluetongue may also occur on other basalt peaks within and adjacent to the study area, such as Tayan Peak, Nullo Mountain or Mounts Coricudgy and Coriaday. Further survey would be required to ascertain this. The Common Blue-tongue has been recorded twice on the Hunter Main Trail and once on the Nullo Mountain Trail, south of 'Box Ridges'. However, this species is known to occur in a wide variety of habitats, from the coast to semi-arid areas west of the Great Dividing Range (Swan *et al.* 2004). It is therefore expected to be more widespread in the study area than records indicate, though it may only remain at relatively low density.

Snakes

Only one species of blind-snake, the Blackish Blind-snake (*Ramphotyphlops nigrescens*), has been recorded within the study area. This species is widespread and appears to be quite abundant. It has been recorded at 21 locations, including during 16 (8 % of) herpetofauna censuses, when it is usually located under rocks and occasionally under logs. Blind-snakes are notoriously difficult to detect and the species is likely to be even more abundant than records indicate.

The Elapids are the most diverse and frequently encountered group of snakes in the park, with ten species confirmed. All but the Red-bellied Black Snake have been recorded on fewer than ten occasions, reflecting their generally cryptic nature. Records of the Red-bellied Black Snake are widespread, but most concentrated around Dunns Swamp and to a lesser extent in the vicinity of the Army Road. Though the species has not been recorded on the Atlas of NSW Wildlife within the Widden or Myrtle Creek Valleys, landholders regularly observe the species in this area (B. Tindale pers. comm.) and it is considered likely to occur in all of the northern valleys in the vicinity of creeks and swampy areas. Interestingly, the frequency of encounters with Red-bellied Black Snake has declined in the Myrtle Creek area since 2002 (B. Tindale pers. comm.), which is likely to be a reflection of the species retreating or declining in numbers during the current drought. Within the park boundary, the Mainland Tiger Snake (*Notechis scutatus*) has only been recorded greater than 700 metres asl, consistent with the fact that away from the coast it is generally more common in mountainous areas (DEC 2006a). However, an individual was observed in the Glen Alice valley on lower slopes east of Numietta Creek at approximately 400 metres asl. The protection of this snake species within the park has conservation significance as it has been reported to have declined in numbers in some parts of its range, particularly the Sydney Metropolitan area (A. White pers. comm.). Records of the Small-eyed Snake are also restricted to higher altitudes, where it was located on Narrabeen and Hawkesbury sandstone as well as on basalt caps in areas such as Kerry Mountain and Mount Coriaday, the Hunter Range, Army Road and Grassy Mountain. It is uncertain, however, whether the distribution of these records represents a true absence from lower lying areas along the northern and western escarpments, or simply that the species survives in low densities and was not detected.

The Southern Death Adder (*Acanthophis antarcticus*) and Yellow-faced Whipsnake (*Demansia psammophis*) have each been observed at three locations. The Variable Black-naped Snake (*Suta spectabilis dwyeri*) and Golden-crowned Snake (*Cacophis squamulosus*) have each been recorded at two locations (including the latter once just outside of the park boundary in Goulburn River National Park), while the Eastern Bandy-bandy (*Vermicella annulata*) and the Eastern Brown Snake (*Pseudonaja textilis*) have been seen at one site each. Such low detection rates make it difficult to assess the distribution or abundance of the species in the study area. The records of Golden-crowned Snake are quite unusual. Particularly interesting is the individual that was located under a rock on a dry Box – Ironbark – Cypress slope in the Widden Valley. Confirmed sightings of this species do not occur elsewhere in the region, with the nearest records on the Atlas of NSW Wildlife (aside from the one in Goulburn River National Park) located 70-odd kilometres to the north-east (near Mount Royal National Park) and south-east (south of Putty State Forest). The Golden-crowned Snake is predominantly a coastal species, normally inhabiting rainforest or wet sclerophyll forest, or moister areas in dry sclerophyll forest (Swan *et al.* 2004). These Goulburn River and Wollemi National Park records form significant outliers from this pattern, and thus contribute important information about the species' ecological tolerances.

The Diamond Python (*Morelia spilota spilota*) has only been reported from two locations, namely between Hefrons Hole and Wilsons Clearing, and between the Cudgegong River and Hanging Rock.

However this large snake would almost certainly be more widespread than these records suggest, particularly in the sandstone gullies and gorges south of the Hunter Range. The Diamond Python favours rainforest and wet sclerophyll forest (Swan *et al.* 2004) such as occur in these sheltered environments.

Turtles

The Eastern Snake-necked Turtle (*Chelodina longicollis*) has most frequently been recorded near the periphery of the park as well as at Dunns Swamp and on the Capertee River. This species is largely restricted to permanent waterbodies, such as farm dams and larger creeks and rivers with long still pools, but may travel overland through adjacent parts of the study area during summer rains.

3.3.3 Other species that have the potential to occur in the study area

An examination of the species recorded within a five kilometre radius of the study area boundary, but not therein, provides some indication of animals that may have as yet gone undetected within the park (Appendix D). The Short-necked Turtle (*Emydura macquarii*) that is recorded on the Atlas of NSW Wildlife on the Merriwa River, 4.5 kilometres north of the study area, is likely to in fact belong to a different subspecies than is recorded, as a taxonomic review has been undertaken since the date of the record (see Wilson & Swan 2003). The record could be either a Sydney Basin Short-necked Turtle (*Emydura macquarii dharuk*) or a Hunter River Short-necked Turtle (*E. m. gunabarra*). A second turtle that is most likely to belong to this species was observed basking on an emergent rock in Dunns Swamp near Kandos Weir in 2004, though due to the long distance of observation a positive identification could not be achieved (E. Magarey pers. obs.). As this latter location is in a western-flowing river system, and due to the large size of the individual, the turtle has the potential to belong to the Macquarie Short-necked Turtle subspecies (*E. m. macquarii*), which is widespread in the Murray-Darling drainage system (Cann 1998). Further surveys would be required at Dunns Swamp in order to confirm which short-necked turtle species occurs.

The Sand Monitor (*Varanus gouldii*) is relatively common in the Hungerford Valley (DEC 2005a) and has been recorded less than one kilometre north of the park boundary on two occasions. This moderately-sized Goanna is likely to also occur along the northern and north-western slopes of the study area, where on average less than 650 mm of rain falls per annum. The Eastern Ranges Rock-skink (*Egernia modesta*) has the potential to occur in the far north, in habitats similar to where it was located in north-eastern Wollemi National Park (DEC 2005a). The Spotted Black Snake (*Pseudechis guttatus*) is known to occur in the northern alluvial valleys, and may also inhabit some of the major creeklines, flats and lower slopes within the park boundary. Both the Tussock Cool-skink (*Pseudemoia entrecasteauxii*) and Grassland Tussock-skink (*P. pagenstecheri*) are high altitude species that have been recorded around Nullo Mountain, and have the potential to occur in parts of the study area that lie above 800 metres asl, including east of Mount Coricudgy, Kerry Mountain and Mount Coriaday. The Mustard-bellied Snake (*Drysdalia rhodogaster)* also has the potential to occur in these high altitude environments. The Highland Copperhead, though not recorded in the Atlas of NSW Wildlife, has been reported from the area (Goldney & Cardale 1993), and also has the potential to inhabit areas above 600 metres asl. The Eastern Brown Tree Snake (*Boiga irregularis*) in contrast would probably only occur in the south-east of the study area if at all, particularly in sandstone caves and crevices with rainforest or forest nearby. Lastly the Proximus Blind-snake (*Ramphotyphlops proximus*) may have gone undetected due to its highly cryptic nature.

3.3.4 Review of species records

In addition to the above, the Atlas of NSW Wildlife holds records of two further snake species: the Top End Carpet Python (*Morelia spilota variegata*), reported once near the Gospers Mountain airstrip; and the Stephen's Banded Snake (*Hoplocephalus stephensii*), reported twice near Dunns Swamp campground. These sightings are likely to be mis-identifications or data entry errors. North-western Wollemi National Park is not within the known range for either the Top End Carpet Python, a snake of northern Australia (Wilson & Swan 2003), or Stephen's Banded Snake, which occurs in moist coastal forests, mostly in northern NSW (Swan *et al.* 2004). These species have thus not been included in the species inventory presented in this report.

3.4 NATIVE DIURNAL BIRDS

A complete list of all native diurnal bird species that have been recorded within north-western Wollemi National Park is provided in Appendix C. This list includes some species that are likely to represent spatial or identification inaccuracies (see Section 3.4.4). Following a review of records conducted for this report, it is concluded that 189 native diurnal bird species definitely occur within the study area. This includes eleven species that are listed as Vulnerable and two species that are listed as Endangered under the NSW TSC Act (1995), of which one species, the Regent Honeyeater, is also

listed as Endangered under the Commonwealth EPBC Act (1999). Nine of these threatened species are largely dependent on the dry woodlands that occupy the talus slopes below the northern and western escarpments, while others are more widespread through the sandstone plateaux. These threatened species will be discussed further in Section 5. Scientific names for bird species in the following discussion are presented in Appendix C.

Plate 11: Eastern Yellow Robin © J. Cooper

Also of conservation significance is the presence of a number of species that are thought to be in decline, though they have not yet been listed on either the TSC or EPBC Acts. A recent review of bird records across the nation identified numerous species that appear to have declined in numbers in recent years (Barrett *et al.* 2003). Of the species identified, the following occur within north-western Wollemi NP: Rockwarbler; White-winged Chough; Spotted Quail-thrush; Red-browed Treecreeper and Flame Robin. In addition, a number of species that have been located within the study area are thought to have declined within the Sydney Basin Bioregion in recent years (Barrett *et al.* 2003). These include the Jacky Winter, Wedge-tailed Eagle, Nankeen Kestrel, Dusky Woodswallow, White-backed Swallow, Brown Falcon, Australian Pipit, Scarlet Robin, White-winged Triller and White-throated Needletail. The presence of these species suggests that Wollemi National Park, together with the neighbouring national parks of the Blue Mountains and Hunter Range, play an important role in the ongoing regional conservation of their habitats. The Plum-headed Finch is listed as a species of conservation significance in the Brigalow Belt South and Nandewar Bioregions, as it has been affected by alteration of native grasslands, grazing and loss of woodland habitat (Andren 2004). This granivorous bird has been recorded three times within or immediately adjacent to the study area (but not by DEC), and may be in decline in this region also.

3.4.1 Systematic survey findings

The DEC surveys undertaken between 1997 and 2006 recorded the presence of 168 species of native diurnal bird, of which 13 have not been recorded by any other method. One hundred and forty-eight of these species were observed during the 234 systematic diurnal bird censuses, with the remaining 20 species only recorded by opportunistic sightings. Based on the systematic diurnal bird survey results, the most common bird species in the park in spring and summer is the Spotted Pardalote, which was recorded during 202 (86 %) of the diurnal bird censuses. This is a small bird that feeds by gleaning leaves for invertebrates (particularly psyllids and lerps) and is capable of inhabiting a wide range of habitat types, from dry woodlands in the northern and western escarpments to tall mesic forest and rainforest in the sheltered sandstone gullies. Also frequently recorded during diurnal bird censuses were the Yellow-faced Honeyeater (186 sites), White-throated Treecreeper (183 sites), Grey Shrike-thrush (150 sites), Grey Fantail (150 sites), Brown Thornbill (148 sites), Pied Currawong (145 sites), Eastern Yellow Robin (141 sites, Plate 11), Rufous Whistler (140 sites) and Eastern Spinebill (140 sites). All of these birds are not only habitat generalists, but are also highly vocal or highly visible, making them easy to detect during bird surveys in both woodland and forest throughout the study area.

The results of analyses based on data collected during the bird and herpetofauna censuses indicate differences in the bird assemblage between major vegetation classes. Though a number of species, including those listed in the previous paragraph, are habitat generalists and occur in the majority of vegetation classes, other species prefer particular habitat characteristics and are more abundant in or restricted to particular vegetation classes. Detecting such patterns was the aim of the multivariate analyses of the results of the bird and reptile censuses. As expected, the most distinct differences in bird assemblages were found to occur between the rainforest habitats and the dry grassy woodland habitats. The other habitats lie between these two extremes, with wet sclerophyll forests and sheltered dry sclerophyll forests grouping towards the rainforest end of the scale and non-grassy dry sclerophyll forests scattered throughout the middle of the scale. It must be noted that the patterns discussed below reflect habitat preferences only in the spring and summer months. Many bird species utilise different habitats in the autumn and winter.

A distinct bird group occurs within the rainforests and wet sclerophyll forests with mesic shrubby understoreys that occur in the sheltered sandstone gullies and basalt caps through the centre of the study area. As well as supporting more generalist species such as Spotted Pardalote and Grey Fantail, these habitats share a distinct wet forest bird assemblage that includes the Lewin's

Honeyeater, Rufous Fantail and Black-faced Monarch. However, only the well-developed rainforests support Yellow-throated Scrubwren, Large-billed Scrubwren, Brown Gerygone, Bassian Thrush and Rose Robin. Brown Gerygone was detected during all of the diurnal bird censuses undertaken in rainforests. Many bird species common in the wet sclerophyll forests also occur in sheltered dry sclerophyll forests, such as the Golden Whistler, Eastern Spinebill, White-browed Scrubwren, Superb Lyrebird, Striated Thornbill, Eastern Whipbird and Crimson Rosella. The Grey Shrike-thrush and Rufous Whistler tended to be more common in the sheltered dry sclerophyll forests.

The shrubby dry sclerophyll forests are typified by the habitat generalist species mentioned above. When classed together the shrubby dry sclerophyll forests were not found to exhibit a distinctly different fauna assemblage compared to the other vegetation classes. This result is likely to be because of the diverse range of habitats that the 'dry sclerophyll forest' class includes. When underlying geology is taken into account, however, the dry sclerophyll forests on Permian soils are seen to have a distinctively different bird community than those on Narrabeen and Hawkesbury sandstone-derived soils. The shrubby dry sclerophyll forests on Permian soils have many bird species in common with the grassy woodlands, as both occur along the escarpment footslopes and alluvial flats in the north and west of the park where rainfall is moderately low and soil fertility generally high. These habitats each commonly support (in addition to the generalist species above) Mistletoebird, Weebill, Yellow-tufted Honeyeater, White-naped Honeyeater and the threatened Brown Treecreeper and Black-chinned Honeyeater. The Australian Magpie, Australian Raven, Laughing Kookaburra, Grey and Pied Butcherbirds and Brown-headed Honeyeater are each also more common in the grassy woodlands and dry sclerophyll forests on Permian soils than they are on sandstone woodlands. Interestingly, the Rockwarbler was found to occur more frequently on the Permian than the sandstone geologies, despite being near the north-western limit of its range in these habitats and typically thought to be a sandstone species. This result may be attributable to the significant amount of microhabitat available along the talus slopes, in the form of large boulders fallen from the sandstone escarpment above, together with overhangs and caves.

The bird species occurring at high frequency in exposed dry sclerophyll forests on Hawkesbury and Narrabeen sandstone, but low frequency on Permian soils, include White-eared Honeyeater, Striated Thornbill, Brown Thornbill and Eastern Spinebill. In terms of the bird assemblage, heathlands share many species with the exposed dry sclerophyll forests on sandstone, including White-eared Honeyeater, Grey Shrike-thrush, Laughing Kookaburra and Pied Currawong.

3.4.2 Discussion of other species occurrence

Many native diurnal bird species did not feature in the multivariate analyses, but are never-the-less a feature of north-western Wollemi National Park and worthy of mention.

Birds of prey

Thirteen species are known to occur within the study area. These birds are most frequently detected on an opportunistic basis, rather than during systematic censuses, making it difficult to accurately assess habitat preferences. The most commonly observed species is the Wedge-tailed Eagle (recorded on 36 occasions), a large raptor with a distinctive flight silhouette that is usually seen soaring high above the tree canopy. The Brown Goshawk, Brown Falcon and Nankeen Kestrel are also common, the latter frequently seen perched on dead stags or man-made structures at the interface between cleared and forested lands. The remaining nine species have each been recorded on fewer than ten occasions and include the Peregrine Falcon, Collared Sparrowhawk, Black-shouldered Kite, Little Eagle, Australian Hobby, White-bellied Sea-eagle, Grey Goshawk, Letter-winged Kite and Square-tailed Kite, listed in decreasing order of the number of times they have been recorded. The pattern of detection of these species gives some indication of the type of habitat utilised most frequently. The Brown Falcon, Black-shouldered Kite and Nankeen Kestrel are most frequently observed near the park boundary as they utilise cleared lands adjacent to the park for hunting reptiles, rodents and insects (N. Williams pers. comm.). In contrast, the Brown Goshawk, Grey Goshawk and Collared Sparrowhawk forage largely within forests and woodlands, and are therefore more widespread throughout the study area proper. The Peregrine Falcon is also likely to be most common along the northern and western escarpments, as it would nest and roost in caves and cliff edges, foraging for birds within both cleared and forested lands. The protection of habitat for the Brown Falcon and Black-shouldered Kite on the edges of the park is important as both species have been reported by Birds Australia to have declined in numbers in the Sydney Basin Bioregion since the 1980s (Barrett *et al.* 2003).

Waterbirds

The number of bird species occurring within north-western Wollemi National Park is elevated by the presence of Dunns Swamp on the damned Cudgegong River. Many waterbird species have been observed on this large waterbody but nowhere else in the study area, including the Hardhead, Musk Duck, Hoary-headed Grebe, Australasian Grebe (though also recorded in dams and farmlands at the boundary of the park), Darter, Great Cormorant, Little Black Cormorant, Pied Cormorant, Great Egret, Black-necked Stork, Eurasian Coot, Dusky Moorhen, Purple Swamphen, Spotless Crake, Latham's Snipe and Australasian Reed-warbler. As these species prefer large permanent swamps and ponds with established aquatic vegetation, none of them would be expected to occur within the habitats that comprise the large majority of the park, though they may fly over and occasionally visit dams or other permanent waterbodies on the study area periphery.

Pigeons and Doves

The BSP surveys recorded a large number of dove and pigeon species using north-western Wollemi National Park. These are (followed by the number of locations at which recorded): Wonga Pigeon (108); Common Bronzewing (90); Peaceful Dove (40); Crested Pigeon (17); Bar-shouldered Dove (2 by DEC and once by a landowner (P. Lonrigan pers. comm.)); Brown Cuckoo-dove (3); Brush Bronzewing (14); Diamond Dove (2); and Emerald Dove (1). While the first two of these species are common across sandstone reserves of the Sydney Basin and the next three would be expected to live near the boundaries of the park, the discovery of the latter three was quite interesting. An Emerald Dove was seen and heard calling in warm temperate Coachwood-Sassafras rainforest on a tributary of Koondah Creek in November 2005. Such habitat is typical of the species, but it is unusual for it to be recorded so far from the coast and is the most westerly record of the species in central NSW. Birds Australia has previously reported the species further east in the region, in the vicinities of Appletree Flat, Putty Road (near Parsons Creek) and the Wolgan River. The Brush Bronzewing also approaches the western limit of its distribution in NSW within the region, though it has also been recorded in Goulburn River National Park. In contrast, the Diamond Dove is a bird of inland NSW, visiting the coast only during dry periods and mostly in summer (Pizzey & Knight 1999). The sighting of this species in northern Wollemi (in the Glen Alice and Bylong Valleys) is therefore a case of opportunistic timing and an indication of drought conditions further west. It is important to note that the dove has only been observed below the western and northern escarpments, and would be unlikely to occur on the sandstone plateaux. Yet again, the juxtaposition of eastern and western species demonstrates that northern Wollemi lies at the confluence of bioregional influences.

Patterns across the study area

A number of bird species approach the edge of their known range within north-western Wollemi National Park. This includes birds that are near their northern limit, including the Gang-gang Cockatoo, Rockwarbler, Pilotbird and Crescent Honeyeater. The Rockwarbler is restricted to the Sydney Basin, where it is usually seen hopping around rock outcrops or piles of sandstone boulders. The abundance of this species across northern Wollemi National Park (DEC 2005a) and Goulburn River National Park (NPWS 2001b) suggests it to be secure at this north-western limit of its range, despite reported declines elsewhere in the Sydney Basin (Barrett *et al.* 2003). The north and west of the study area also provides habitat for a suite of species that are more typical of dry woodlands on the central western slopes, west of the Great Dividing Range. Included in this suite are many of the threatened 'declining woodland birds' (see Section 5), as well as White-browed Babbler, Western Gerygone, Jacky Winter, White-winged Chough and Striped Honeyeater. In stark contrast, the Australian Brush-turkey is typical of north-coast rainforests, and approaches its south-westerly distribution limit in Wollemi National Park. This bird was found to inhabit a number of gully lines in the centre and north of the study area, as well as wet sclerophyll forests at high elevation along the Hunter Range. A further suite of species approach the western limit of their distribution, including the Brown Gerygone and Black-faced Monarch, and are largely restricted to the higher rainfall coastal hinterland environments through the central sandstone plateaux. The fact that all of these birds, each with divergent habitat requirements, are accommodated is a testament to the area's microhabitat and landscape diversity.

As mentioned above, it is important to note that the large majority of bird surveys have been undertaken in the spring and summer, providing a profile of the avifauna in these seasons. Numerous bird species have different distribution during the colder months, either migrating out of the area (e.g. Yellow-faced Honeyeater), migrating into the area (possibly Swift Parrot), or becoming more wide ranging within the area in response to decreased insect activity and therefore having less specific habitat allegiances (e.g. Silvereye, Australian Museum 1979). Yet other species are nomadic in response to flowering events: Noisy Friarbird and New Holland Honeyeater, for example, both forage

on a variety of tree and shrub species, often congregating in large numbers to gather nectar; Painted Honeyeater feeds almost exclusively on mistletoes of the genus *Amyema* and is nomadic in response to the fruiting of mistletoes and the abundance of rainfall (Keast 1968, Pizzey & Knight 1999). Such movements highlight one of the important conservation roles played by large contiguous areas of wilderness, such as that of which the study area is a part, in the provision of a wide range of connected microhabitats that are capable of accommodating many species during different seasons and different stages of their life cycle.

3.4.3 Other species that have the potential to occur in the study area

Twenty-three additional native diurnal bird species have been recorded within a five kilometre radius of the study area, yet not within it (Appendix D). This list gives some insight into species that may occur within the park yet gone unrecorded to date. Of these species, the following are considered likely to occur, followed by the type of habitat which they may inhabit: Australian Pelican (Dunns Swamp); Cattle Egret (farmland interface); Australian White Ibis (farmland interface and Dunns Swamp); Pacific Baza (open forest and woodland, particularly along water courses); Swift Parrot (Box – Ironbark woodland); Southern Whiteface (farmland interface in the north); White-cheeked Honeyeater (variety of forest types); Masked Woodswallow (variety of woodlands and open forests); Little Grassbird (Dunns Swamp). The Black-breasted Buzzard, Black Kite, Black Falcon, White-breasted and Black-faced Woodswallows are each likely to be rare visitors to the study area. In addition, Emu was found to be quite common in Goulburn River National Park during DEC surveys in 2001, and it is possible that the species also occurs in low numbers below the north-western escarpment of Wollemi National Park.

3.4.4 Review of species records

A large proportion of the bird records in the Atlas of NSW Wildlife are derived from Birds Australia datasets. As mentioned above, records collected during the first Birds Australia survey (between 1978 and 1981) have a very low degree of spatial accuracy and there is no guarantee that any of the sightings attributed to a certain point actually occurred at that location. Ten species recorded during the first Birds Australia survey have not been detected within the study area by any other method. Table 4 presents a list of these species and an assessment of whether the bird is actually likely to occur within the park. The bird list for the study area is artificially elevated by the inclusion of the first two species in Table 4, and thus they have not been included in the species totals presented in this report. The last eight species listed in the table have the potential to utilise habitats present within the park proper, and therefore have been included in the species totals.

Species common name	Date last recorded	Comment
Horsfield's Bushlark	1978	Known to prefer grasslands and croplands and is unlikely to inhabit the park proper.
Zebra Finch	1979	Probably only an occasional visitor to the region during times of drought. Unlikely to utilise habitats in the park proper.
Whistling Kite	1978	May utilise pasture near the park boundary or occasionally occur at Dunns Swamp.
Black-fronted Dotterel	1981	Known to utilise dams near the boundary of the park but otherwise only likely to occur at Dunns Swamp.
Black Swan	1978	Prefers large open wetlands and swamps. May occasionally occur at Dunns Swamp but unlikely to occur elsewhere in the park.
Yellow-billed Spoonbill	1978	May utilise dams and pasture near the park boundary or occasionally occur at Dunns Swamp. Unlikely to occur elsewhere within the park.
Straw-necked Ibis	1978	Would utilise dams and paddocks in cleared lands, but may roost in trees within the park boundary. Also may occur at Dunns Swamp.
Barking Owl	1979	Likely to occur within the park boundary in dry woodland habitats.
White-backed Swallow	1981	May occur along major watercourses and forage within the boundary of the park, particularly in summer during drought conditions.
Golden-headed Cisticola	1978	May utilise rank grasslands near the park boundary or the edges of Dunns Swamp. Unlikely to occur elsewhere within the park.

Table 4: Native diurnal bird species recorded only during the first Birds Australia survey

The Spectacled Monarch has been recorded on a single occasion, thought to be heard calling on Army Road south of Box Hole Clearing in 1997. However, the bird was not sighted and since the call resembles that of rosellas (Pizzey & Knight 1999), it is possible that it was mis-identified. The Spectacled Monarch is typically located in coastal rainforests and thickly vegetated gullies, rather than the exposed sandstone habitat where it was recorded. It is most common in northern Queensland

(Barrett *et al.* 2003), but individuals have been seen as far south as Port Stephens ((Pizzey & Knight 1999). The occurrence of Spectacled Monarch in the park is possible, but considered unlikely, and would require further for confirmation.

A single report of a Green Catbird exists on the Atlas of NSW Wildlife, from Coorongooba Creek west of Cyrils Rocks, in 1986. This location is quite far west for this species, which usually occurs in more coastal rainforests and timbered watercourses (Pizzey & Knight 1999). Though there is a possibility that the species occurs in the park it is considered unlikely, and therefore has not been included in the species' totals in this report.

The close examination of diurnal bird records in the Atlas of NSW Wildlife undertaken for this report has led to a revision of the number of species known to occur within north-western Wollemi NP. With the removal of spatially inaccurate records and possible mis-identifications (see Appendix C), 188 species are now known to occur.

3.5 NOCTURNAL BIRDS

The DEC surveys confirmed the presence of eight species of nocturnal bird through a range of survey techniques including nocturnal call playback, site spotlighting, and opportunistically. A ninth species, the Barking Owl, was recorded by Birds Australia in 1979 in the vicinity of the Widden Valley. The Barking Owl, together with the Powerful, Sooty and Masked Owls, is listed as Vulnerable under the NSW TSC Act (1995).

3.5.1 Systematic survey findings and discussion of species occurrence

Eighty-five nocturnal call playback surveys for the threatened owls have been undertaken in the study area. Response rates were low, with the Powerful Owl responding to 10 censuses (12 %), the Sooty Owl to three (4 %) and the Masked Owl to one (1 %). These results differ from those obtained in north-eastern Wollemi, where the Powerful Owl was less frequently detected (responding to 5% of playback censuses) and the Barking Owl more frequently (responding to 6% of playback censuses). The owl response rates obtained across northern Wollemi National Park were generally low in comparison to those obtained in the greater southern Sydney region, where Powerful Owl responded to 16 % of censuses, Sooty Owl to 9 %, Masked Owl to 3 % and Barking Owl to 0.8 % (DEC 2006a). Though the Barking Owl was not detected by CRA or BSP surveys it is considered highly likely to persist in the Goulburn River Valley escarpments and valleys, in similar dry woodland habitats as it was located in north-eastern Wollemi National Park in 2004 (DEC 2005a). The Barking Owl and other threatened owls will be discussed in more detail in Section 5 of this report.

The composition of vertebrate prey items located in the regurgitated pellets of the threatened large forest owls collected during 2005-06 conformed to the results of previous studies (e.g. Kavanagh 2002a). The Powerful Owl pellet analysed was composed entirely of arboreal mammals, namely Greater Glider (*Petauroides volans*), Common Ringtail Possum (*Pseudocheirus peregrinus*) and Sugar Glider (*Petaurus breviceps*). The Sooty Owl pellet analysed had a mix of native ground and arboreal mammals, including Brown Antechinus (*Antechinus stuartii*), Bush Rat (*Rattus fuscipes*) and Sugar Glider.

The remaining five nocturnal bird species are all common and widespread throughout reserves in the greater Blue Mountains and Hunter regions. The Southern Boobook (*Ninox boobook*) is the most widespread and frequently recorded of the nocturnal bird species in the study area, heard calling during 35 (42 %) of nocturnal call playback surveys and 65 (60 %) of site spotlighting surveys, as well as 37 times opportunistically. It has been detected within all of the major habitat types, including gullies, slopes and ridgetops on both Permian and Narrabeen Sandstone geologies. Such habitat diversity is typical of the species, which occurs across Australia from coastal rainforest to desert mulga (Pizzey & Knight 1999), and is perhaps attributable to its diverse and adaptable diet (McNabb 2002). Despite this, reporting rates of the Southern Boobook have apparently declined across the Sydney Basin Bioregion between 1981 and 2001 (Barrett *et al.* 2003), making its abundance in large reserves such as Wollemi National Park important. In contrast to the Boobook, the Barn Owl (*Tyto alba*) has only been recorded in two locations, each on the perimeter of the park in the Widden Valley. The Barn Owl is a nomadic species, its occurrence dictated by the distribution and density of rodents (M. Schulz pers. comm.). It may utilise other parts of the study area where rodents occur near the agriculture-forest margin, such as the Glen Alice, Lee Creek or Bylong River Valleys. The Barn Owl is however unlikely to occur within denser forested areas, as it depends on open country, such as grassy woodlands or grasslands, for hunting its prey.

The call of the Australian Owlet-nightjar (*Aegotheles cristatus*) was heard during 26 nocturnal call playback surveys, 30 site spotlighting censuses and eleven diurnal bird surveys, as well as opportunistically on 22 occasions. Though very vocal, and thus easily detected by its call, this bird is

hard to spot and has only been seen four times during the DEC surveys. The Australian Owlet-nightjar records are widely distributed throughout the study area, but are most dense in the west, particularly the north-western gullies and slopes below the escarpment. The larger White-throated Nightjar (*Eurostopodus mystacalis*) is also widespread, but less frequently detected, having been seen or heard calling at a total of 25 locations during DEC surveys. These observations were made at a variety of points in the landscape, however the majority derive from ridgetops and upper slopes, or else from near the boundary between cleared and forested land. The White-throated Nightjar usually forages for insects at canopy height, particularly within larger gaps in the canopy (N. Williams pers. comm.). This tendency to utilise more open vegetation types may explain its pattern of distribution within the study area.

The Tawny Frogmouth (*Podargus strigoides*) was encountered in all areas of the park that were targeted for systematic survey, from the dry escarpments and gullies in the north to higher elevation forests on the Hunter Main Trail and Gospers Mountain. This result is to be expected, as this distinctive bird is common in forests and woodlands throughout the Sydney Basin, and indeed has been recorded in a wide range of habitats across the Australian continent (Pizzey & Knight 1999). It is capable of persisting in disturbed environments, and is often seen perched on fence posts and paddock trees in the agricultural landscape, and even within parks and gardens in the Sydney metropolitan area. Part of this adaptability may be attributable to its varied and opportunistic diet, which includes insects, frogs, rodents and other small ground-dwelling animals.

3.6 ARBOREAL MAMMALS

The DEC surveys undertaken between 1997 and 2006 confirmed the presence of nine species of arboreal mammal within north-western Wollemi National Park, of which four had not been recorded prior to the CRA surveys and an additional two were not known prior to BSP surveys (Appendix C). Some uncertainty exists about the occurrence of a tenth species, the Koala (*Phascolarctos cinereus*). A single scat identified to probably belong to a Koala was collected on lower Blackwater Creek in September 2005, but the identification was not confirmed. Given the existence of suitable habitat, and the fact that Koalas are known to still occur in similar environments in north-eastern Wollemi National Park (DEC 2005a), it is considered highly likely that the species occurs within the study area, though probably only at low abundance. The Koala, together with the Eastern Pygmy-possum (*Cercartetus nanus*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*), is listed as Vulnerable under the NSW TSC Act (1995). These species will be discussed further in Section 5 of this report. The remaining six species are more common within particular habitats of the Sydney Basin, as discussed below.

Plate 12: Common Brushtail Possum © N. Williams/DEC

3.6.1 Systematic survey findings and discussion of species occurrence

One hundred and nine systematic site spotlight censuses were undertaken within the study area during CRA and BSP surveys. Based on the spotlight survey results, the most frequently encountered species of arboreal mammal is the Common Brushtail Possum (*Trichosurus vulpecula*, Plate 12), detected during 46 (42 % of) censuses. This large possum was also detected during 18 nocturnal call playback censuses, five hair tube lines and 56 times opportunistically. The Common Brushtail Possum is most abundant at lower elevations and has been recorded at twice as many locations on Permian sediments than Narrabeen Sandstone. It has not been recorded at more than 925 metres asl in the study area, and appears most abundant in the dry Box woodlands on the northern escarpment slopes and valleys. This result is consistent with the pattern observed in north-eastern Wollemi National Park in 2004-05 (DEC 2005a). Across NSW, the Common Brushtail Possum has been located more frequently in drier open forests and woodlands (Kavanagh 2004), particularly along watercourses. Furthermore, their distribution is not limited by the presence of large hollows, as they are known to utilise a range of den sites, from stags to fallen logs and rock crevices (Kerle 2001).

The Greater Glider is also widespread, its bright eye-shine detected during 44 (40 % of) site spotlight censuses, as well as nine nocturnal call playback surveys, 85 times opportunistically and remains in one Powerful Owl pellet, one Spotted-tailed Quoll scat and one Fox scat. The distribution of Greater

Glider records is markedly different from that of the Common Brushtail Possum, due to a difference in habitat preferences. Greater Gliders are known to prefer tall forests, particularly in higher elevation areas with flat topography and enriched soils (e.g. Kavanagh *et al.* in Kavanagh & Wheeler 2004, DEC 2006a). Within the study area, the species was found to be largely absent from the dry low elevation talus slopes in the north, with just four sightings made in the more sheltered gullies, often where Rough-barked Apple occurs. In contrast, the Greater Glider is the most frequently encountered arboreal mammal in higher elevation areas such as along the Hunter Main Trail (and around Mount Coricudgy and Kerry Mountain), the Army Road, particularly in the vicinity of Gospers Mountain, as well as west of Nullo Mountain and north and south of Dunns Swamp. The most important factors that contribute to habitat selection of the Greater Glider are thought to be the level of nutrients in eucalypt leaves and buds (their only food) and the availability of high hollows in large old trees (Kerle 2001). Peppermint forests contain high levels of nutrients in their leaves (Kerle 2001) and the occurrence of Peppermint eucalypt species on the Hunter Main Trail and Army Road is likely to account for the high abundance of Greater Glider there. Interestingly, this glider was also found to be quite common in the Glen Alice valley, in richer areas where tall Box, Rough-barked Apple and/or Mountain Grey Gum grow.

The Sugar Glider is more frequently detected by its distinctive yapping call than by its eye-shine or movement. Of the 28 spotlighting censuses during which this species was recorded (26 % of sites), three times were by visual observation and 25 times were by hearing the call. In addition, this small mammal was detected during 19 (23 % of) nocturnal call playback censuses, 37 times opportunistically as well as remains in one regurgitated Powerful Owl pellet and one Sooty Owl pellet. The Sugar Glider uses a variety of habitats, but requires suitable trees with hollows for nesting and sufficient foraging material, particularly nectar and pollen, *Acacia* gum, the sap of certain eucalypts and invertebrates (Suckling 1995a). It has been detected within each of the major habitat types within the study area, including the dry alluvial gully and talus slope woodlands in the north and west, wet and dry sclerophyll forests on the sandstone gullies and plateaux and the montane forests around Mount Coricudgy and the Hunter Range. This species smaller body size, lower energy demands, and more diverse diet enable it to occupy many environments not inhabited by the closely related Squirrel Glider (Quin 1995). Within the study area the Squirrel Glider has only been recorded in the low elevation alluvial Box - Red Gum - Rough-barked Apple woodlands and forests in the north, as will be discussed further on Section 5.

Though the Yellow-bellied Glider was detected during just 21 spotlight censuses, it was seen or heard calling 63 times opportunistically, as well as during 15 nocturnal call playback surveys. The habitat preferences of this species will be discussed further in Section 5, but it is widely distributed in gully lines and sheltered slopes throughout the study area, as well as on some ridgelines and deep sandy plateaux, particularly where Grey Gum and/or other tall smooth-barked eucalypts occur.

The remaining arboreal mammals have each been recorded on many fewer occasions than the above species. The Common Ringtail Possum prefers habitats with a well developed mid-stratum or shrub layer, in which to forage, shelter and build its spherical nests (dreys) (Davey in Kerle 2004). The species also sometimes build nests in tree hollows and rock overhangs (M. Schulz pers. comm.). In the north of the study area the Common Ringtail Possum has only been located in sheltered situations, such as on Cedar, Cousins, Table Bay and Blackwater Creeks. In the higher rainfall areas it has been located in a wider variety of situations, such as on Mount Coricudgy, Mount Monundilla and the Hunter Range, though the majority of records are still on sheltered slopes and gullies, where a dense sub-canopy layer exists.

The Feathertail Glider (*Acrobates pygmaeus*) is cryptic and was not known to occur within the study area until the BSP surveys. During these surveys it was detected at eight locations, including seven times during spotlight censuses and once a during nocturnal call playback survey. On at least four of these occasions this small agile marsupial was discovered amongst the blossom of flowering trees, including Grey Gum, Grey Box and Rough-barked Apple. The Feathertails' diet consists primarily of nectar, insect honeydew and arthropods (Goldingay & Kavanagh 1995). Therefore careful slow scanning of flowering feed tree species is an effective way to detect this animal, particularly when it is stationary whilst licking nectar from blossoms. The small number of observations of Feathertail Gliders in the study area is not sufficient to ascertain patterns of habitat use, but the species is likely to be much more abundant and widespread than records indicate. The slightly larger Eastern Pygmy-possum is also very elusive, and again was not known from the study area prior to the 2005-06 DEC surveys. As will be discussed in Section 5, this predominantly nectar-feeding possum was only detected by hair and remains, including bone fragments located in a Fox scat (see also Section 3.10.2 on feral predator scat analyses).

The Mountain Brushtail Possum (*Trichosurus caninus*) has been detected at just eight locations in the study area, including four times by hair tube surveys on the Growee and Nullo Mountain Trails, three times opportunistically on Mount Coricudgy, Mount Monundilla and the Hunter Range and probably once during a spotlight census on a tributary of Koondah Creek (this last individual was heard but could not be seen to completely confirm identification). The species was not located in lower elevation forests and woodlands in the north and west of the study area, consistent with results from similar habitats in north-eastern Wollemi National Park (DEC 2005a). This result is to be expected, as the Mountain Brushtail Possum is known to prefer tall forests at higher elevation (Kerle 2001). Within the study area, this species was not located below 500 metres asl and most frequently above 600 metres asl.

3.7 NATIVE GROUND MAMMALS

Ground mammals are difficult to sample systematically as they either require a large, labour intensive trapping effort (e.g. dasyurid and rodent species), are large bodied, wide-ranging habitat-generalists (e.g. wombats, wallabies, kangaroos), or they prefer inaccessible and precarious habitats (e.g. Brush-tailed Rock-wallabies). Hence, due to time constraints, fewer sites could be sampled for ground mammals than the other fauna groups. The majority of records for large ground mammals, such as wombats and macropods, have come from opportunistic sightings, while a number of small ground mammal records have come from predator scat analyses. A limited amount of Elliott trapping was undertaken, resulting in the capture of three native species, while hair tube lines resulted in the identification of an additional four native ground mammals.

The DEC surveys between 1997 and 2006 confirmed the presence of fifteen species of native ground mammal, of which two were recorded for the first time during CRA surveys and four for the first time during BSP surveys. Burrows and scats of a sixteenth species of native ground mammal, the Swamp Rat (*Rattus lutreolus*), have been identified by bushwalkers in several diatremes south of the Hunter Range (Macqueen 2005). A seventeenth species, the Platypus (*Ornithorhynchus anatinus*) is known to occur at Dunns Swamp (C. Pavich pers. comm.). Two of the native ground mammal species, the Spotted-tailed Quoll and Brush-tailed Rock-wallaby are listed as threatened under both state and federal legislation. The confirmation of the persistence of both of these species within the study area in 2006 is exciting, as they have both suffered recent and drastic population declines across the state. The preservation of habitat for these species within north-western Wollemi National Park, together with neighbouring reserved lands, has high conservation significance, as will be discussed further in Section 5 of this report.

3.7.1 Systematic survey findings and discussion of species occurrence

Wombat

By far the most commonly recorded ground mammal within the study area is the Common Wombat (*Vombatus ursinus*), detected over 230 times by direct observation, burrow entrances, and its distinctive, often prominently placed, scats. This distinctive animal was also the most commonly recorded ground mammal during recent surveys of north-eastern Wollemi (DEC 2005a) and northern Yengo (DEC 2005c) National Parks, Manobalai Nature Reserve (DEC 2005b) and across the southern Blue Mountains reserves (DEC 2004b, 2004c, 2004d). The abundance of records can largely be attributed to the readily-recognisable scats, however, and does not necessarily indicate true greater abundance than some macropod species, for example. The varied diet of the Common Wombat (including a mix of grasses, sedges, rushes, and roots of shrubs and trees (McIlroy 1995)), together with its adaptability, enables it to utilise a wide variety of habitat types. Evidence of the species has been recorded in all areas of the park subject to systematic survey, in the full range of elevation, rainfall, and vegetation classes, from exposed dry sclerophyll woodland and heath to sheltered gully rainforest. Though the wombat forages and travels through all of these habitats, it would only breed in habitats with a soil type that enables burrow construction. Sadly, a number of individuals observed in 2005-06 had mange, a debilitating disease caused by mites that alters animal behaviour and eventually leads to death. This disease appeared most prevalent at the boundary between the park and cleared lands. However, further research would be required to confirm such a boundary effect and ascertain the affect of the disease on local populations.

Macropods

In addition to the Brush-tailed Rock-wallaby, four species of macropod have been recorded within the study area, a suite of species shared with north-eastern Wollemi and Yengo National Parks (DEC 2005a, c). As in these areas, the most commonly recorded macropod is the Swamp Wallaby (*Wallabia bicolor*, otherwise known as Black Wallaby, Plate 13), detected at over 170 widely distributed locations. This species is a browser that feeds on a wide variety of forbs, ferns, shrubs,

grasses, fungi and vines (Hollis *et al.* 1986), and is thus not limited to grassy habitats like many other macropod species. The species typically occurs in habitats with at least moderately dense undergrowth, which in the study area includes most gully lines and sheltered slopes, as well as shrubby dry sclerophyll forests. A large number of the Swamp Wallaby records derive from remains found in Wild Dog/Dingo scats (see Section 3.10.2). The Red-necked Wallaby (*Macropus rufogriseus*) prefers to feed on grasses and herbs, and has been found in other areas to shelter in dense vegetation during the day and emerge to feed in grassy areas at night. This medium-sized wallaby has been recorded at over 70 locations in the study area, again in a wide variety of habitat types but most frequently in the vicinity of grassy areas. Interestingly, the species was not recorded on the sandstone geologies along the Hunter Range, but was frequently seen on or near the basalt soils of Mount Coricudgy and Kerry Mountain, where more grassy habitats predominate.

Plate 13: Swamp Wallaby © N. Williams/DEC

Less commonly recorded macropods in the park are the Common Wallaroo (*Macropus robustus*, recorded at 50 locations) and the Eastern Grey Kangaroo (*Macropus giganteus*, recorded at 25 locations). The distribution of records of the Common Wallaroo indicate a clear preference for the low rainfall, low elevation sections of the park, particularly the Lee Creek, Bylong River, Myrtle Creek, Widden Brook and Glen Alice Valleys. A similar pattern was observed in north-eastern Wollemi National Park (DEC 2005a) and is to be expected given that this large robust mammal is well adapted to drier environments. The Common Wallaroo is likely to be more abundant than records suggest, frequently going undetected due to its shy nature not readily identifiable scats. Steep escarpments and rocky hills are a constant feature of this species preferred habitat (Poole 1995); and such features in the form of talus slopes, rocky escarpments and sandstone outcrops and overhangs abound in the north and west of the study area. Records of the Eastern Grey Kangaroo are concentrated around the perimeters of the park, mostly adjacent to cleared agricultural lands. This species has a clear preference for open grassy habitats for foraging that are adjacent to woodlands for shelter.

Monotremes

Only one species of monotreme was recorded during the BSP and CRA surveys, the Short-beaked Echidna (*Tachyglossus aculeatus*, Plate 14). This unmistakable egg-laying mammal predominantly eats termites and ants and is found in almost all terrestrial environments across Australia (Menkhorst & Knight 2001). Recent DEC surveys have indicated it to be widespread across the sandstone reserves of the upper Hunter and southern Blue Mountains. Though the Echidna has been directly observed on just two occasions, traces of the animal have been located at over 70 locations throughout the park, in the form of scats or of characteristic diggings in the side of ants nests or termite mounds.

Plate 14: Short-beaked Echidna © N. Williams/DEC

Australia's second species of monotreme, the Platypus (*Ornithorhynchus anatinus*), has been observed on a number of occasions at Dunns Swamp (C. Pavich pers. comm.). In addition, an individual was seen on the Capertee River two and a half kilometres west of the study area boundary during DEC surveys in November 2005, swimming and floating on the surface of a large pool in the river. This species would also occur elsewhere on the Capertee River, as well as potentially in some of the other permanent watercourses in the park, such as Blackwater and Wollemi Creeks or the Cudgegong River.

Small ground mammals

Small ground mammals were surveyed using Elliott traps and hair tubes, which were set at 23 and 17 sites respectively. Four species of small native ground mammal were detected by these methods, being the Bush Rat, Brown Antechinus, Yellow-footed Antechinus (*Antechinus flavipes*) and Dusky Antechinus (*A. swainsonii*), listed in order of the number of times detected using these methods. Three further species have been detected using other methods: the Common Dunnart (*Sminthopsis*

murina, seen during a herpetofauna search and once in a Fox scat), Water-rat (*Hydromys chrysogaster*, seen four times opportunistically) and Swamp Rat (identified by bush walkers).

Plate 15: Bush Rat after capture in an Elliott trap © N. Williams/DEC

The Bush Rat and Brown Antechinus are both common and widely distributed throughout the park. The Bush Rat (Plate 15) was captured at 16 (70 % of) Elliott trap sites and 17 % of hair tube sites, while the Brown Antechinus was detected at nine Elliott sites (39 %) and 26 % hair tube sites respectively. Both species have been recorded most frequently in the wet and dry sclerophyll forests on the sandstone plateaux, where they would both be very common and abundant in appropriate habitats. The Yellow-footed Antechinus is less widespread, detected by DEC at just one Elliott trap site and one hair tube site. Prior to the DEC surveys the species had recorded at four locations. The records of Yellow-footed Antechinus are all in the northern half of the park, yet in a range of habitat types from woodland along a small tributary of Widden Brook to montane rainforest on the eastern side of Mount Coricudgy. The Dusky Antechinus has been recorded twice, detected once by a hair collected in a hair tube near the headwaters of Blackwater Creek, and once from remains in a Wild Dog scat found on the Kerrabee Trail. The Common Dunnart also appears to be only sparsely distributed, with one found under a log on the northern slope of Tayan Peak and one found in forest in the Wollemi Creek catchment. This latter species is known elsewhere to inhabit a wide range of woodlands and open forests, but is notoriously difficult to trap with Elliott traps or hair tubes. It thus may be more widespread in the park than records currently indicate. The Water-rat on the other hand has quite specific habitat requirements, occurring in permanent fresh or brackish water, particularly near swampy areas (Olsen 1995). The species appears quite abundant on the Cudgegong River near Dunns Swamp, where individuals as well as traces of activity (in the form of Crayfish shells left in overhangs and on rocks in the centre of the river) have been found. The Water-rat also occurs on Ovens Creek in the south-eastern quarter of the study area, and is likely to inhabit other permanent creeks in this area, including Wollemi Creek and the Capertee River.

The distribution of Long-nosed Bandicoot (*Perameles nasuta*) in the study area remains poorly understood, as survey techniques were not undertaken to specifically target this medium-sized nocturnal marsupial. Individuals have only been observed directly on three occasions. Bandicoots leave behind distinctive conical-shaped diggings, created as they dig for invertebrate prey (Triggs 1996). Such foraging traces have been recorded at a further 17 locations. However, the species of Bandicoot cannot be confidently determined from diggings alone, as they could have been made by either the Long-nosed Bandicoot, Northern Brown Bandicoot (*Isoodon macrourus*), or even the Long-nosed Potoroo (*Potorous tridactylus*). As the Long-nosed Bandicoot is more common in the study area it can be expected to have made many of the observed conical-shaped diggings. The locations of the diggings and the Long-nosed Bandicoot sightings are all south of the Hunter Range, and with the exception of those in the Glen Alice Valley, generally occur in the higher rainfall areas of the park. This is to be expected, as the Long-nosed Bandicoot is primarily a coastal species, and may not tolerate the dry conditions prevalent along the northern escarpment. Recent surveys in southern Sydney have also found this species to prefer high rainfall areas (DEC 2006a). This distribution of the Long-nosed Bandicoot in northern Wollemi requires further study, however, as it is known to occur within low rainfall habitats in north-eastern Wollemi National Park (DEC 2005a). As discussed below, further survey would also be required to confirm whether the Northern Brown Bandicoot and/or Long-nosed Potoroo exist within the study area.

Dingoes

There is no direct evidence regarding the extent to which Dogs within the study area have Dingo heritage. Currently, all of the Wild Dogs recorded have been entered into the Atlas of NSW Wildlife under the name 'Dingo/Wild Dog' (*Canis lupus*) as it is not possible to ascertain the ancestry of individuals without DNA testing. However, all of the individuals that were directly observed during the 2005-06 surveys exhibited marked domestic Dog morphological characteristics and are probably at least partially derived from farm Dogs. These Dogs were all observed within fifteen kilometres of each other along the Army Road. The Army Road may provide a conduit for the spread of domestic Dog varieties into more remote sections of the park. Recent research undertaken within Yengo National Park has indicated that Dogs in the core of the park have a very high degree of Dingo heritage, exhibited in their DNA, appearance and behaviour (T. Horwood pers. comm.). It is unknown whether a similar pattern occurs in Wollemi National Park, but it is possible that Dingoes persist in remote

sections of the park, far from roads and farmlands. The Dingo has been listed as regionally significant in the Brigalow Belt South, Nandewar and Upper and Lower North-east New South Wales (Andren 2004), and a species of conservation concern in the greater southern Sydney region (DEC 2006a). It is recommended that the research program being undertaken in Yengo National Park be expanded to cover northern Wollemi National Park also. Such research should aim to: ascertain patterns in the heritage of Dogs/Dingoes across the region; identify key areas of Dingo purity and Wild Dog invasion; provide an understanding of the dynamics of social, territorial and foraging behaviour; provide an understanding of the interaction between Dingo/Dog packs and other predators; and hence provide the basis for informed management strategies. At the very least, genetic material should be collected from any dead Dogs, and sent for analysis to determine the animal's heritage. Ideally, such research should be undertaken before broad-scale Wild Dog control programs are implemented or continued, particularly in more remote areas.

3.7.2 Other species that have the potential to occur in the study area

In addition to the above, a further four species of native ground mammal have been recorded within a five kilometre radius of the study area, yet not within it (Appendix D). It is likely that the New Holland Mouse (*Pseudomys novaehollandiae*) does occur in the study area, as it was found to be relatively widespread in the adjacent north-eastern section of Wollemi National Park (DEC 2005a) as well as in Goulburn River National Park (NPWS 2001b). The New Holland Mouse reaches the western limit of its distribution in central NSW in this region, so the discovery of the species in the study area would be interesting. Northern Brown Bandicoot also has the potential to occur, as it was detected from a Sooty Owl roost in Wollemi Creek, just 3.5 km to the east of the study area. The Parma Wallaby (*Macropus parma*) has been recorded in northern Yengo National Park. However, it is considered unlikely to inhabit the study area as habitat is marginal and there is considerable uncertainty about the reliability of the records in the local area.

There is uncertainty about the occurrence of the Long-nosed Potoroo in the study area. This species is listed as Vulnerable under the NSW TSC Act (1995). CRA hairtube surveys undertaken west of Nullo Mountain in 1997 captured a hair that was later identified to 'probably' belong to a species of Potoroo (*Potorous* sp.). Furthermore, in 1998 skeletal remains of at least four Long-nosed Potoroo were identified from a Sooty Owl roost in Wollemi Creek, approximately 3.5 km east of the study area. The species was also apparently collected by the CSIRO in the Myrtle Creek Valley in 1970. However, there is serious doubt regarding the reliability of this latter record, as the location notes describe the Illawarra, and it is highly likely that it has been erroneously entered into the Atlas of NSW Wildlife. The Long-nosed Potoroo is primarily a coastal species in south-eastern Australia, occurring in heathy woodland or rainforest and wet sclerophyll forests with dense ground cover interspersed with more open areas for foraging (Menkhorst & Knight 2001). Based on the proximity of confirmed records, and the presence of potential habitat, it is considered possible that Long-nosed Potoroo does also occur in the study area. Habitat exists in the higher altitude areas and in some of the more sheltered gully systems. Further survey is required to confirm this species is occurrence, and methodology for this is recommended in Section 4.6. Due to the current level of uncertainty, a profile has not been generated for the species in Section 5 of this report.

A number of possible sightings of the Eastern Quoll (*Dasyurus viverrinus*) have been reported from the Nullo Mountain area (C. Pavich pers. comm.). This species was once widely distributed throughout south-eastern Australia (probably including the study area), but is now considered to be extinct on the mainland (NPWS 1999h). Confirmation that the species is still extant in NSW would be extremely significant. Currently the Eastern Quoll is only known to occur in Tasmania. Further investigations of the sightings are therefore warranted, and a suggested methodology is outlined in Section 4.6 below. Confirmation of the species occurrence would trigger the immediate launching of a research programme to assess the status of the population, identify any threats, and determine the appropriate recovery actions, in line with recommended priority actions for the species (DEC 2005o).

3.7.3 Review of species records

The Southern Brown Bandicoot (*Isoodon obesulus*) has been reported to occur between Wheelbarrow Gap and Wilsons Clearing (Goldney & Cardale 1993). However north-western Wollemi National Park is well outside the known range of this endangered species and this report is considered to be a mis-identification.

3.8 BATS

The Microchiroptera, or microbats, are a sub-order of bats that are generally small, feed almost exclusively on insects and navigate using echolocation (Churchill 1998). The DEC surveys undertaken between 1997 and 2006 confirmed the presence of 20 species of microbat, including both

tree and cave-roosting species. Only five of these species were known to occur prior to systematic surveys. Eight of the microbat species now known to occur in north-western Wollemi National Park are listed as Vulnerable, namely the Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), East-coast Freetail-bat (*Mormopterus norfolkensis*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*, Plate 16), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Greater Long-eared Bat (*Nyctophilus timoriensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*) and Eastern Cave Bat (*Vespadelus troughtoni*). In addition, one species of Megachiroptera (commonly known as fruit bats) has been recorded within the park, the Grey-headed Flying-fox (*Pteropus poliocephalus*). This species is also listed as Vulnerable under both state and federal legislation, and brings the total number of bats now known to occur in the study area to 21. The threatened species will be discussed in greater detail in Section 5, but where relevant are also referred to below.

3.8.1 Systematic survey findings

A total of 112 harp trapping sites were surveyed between 1997 and 2006, resulting in the capture of sixteen species of microbat. In terms of frequency of capture, the Little Forest Bat (*Vespadelus vulturnus*) is the most common species, captured in 81 (72 % of) traps. Next most frequently captured were the Chocolate Wattled Bat (*Chalinolobus morio*, 47 % of traps), Large Forest Bat (*Vespadelus darlingtoni*, 45 %) and Gould's Long-eared Bat (*Nyctophilus gouldi*, 43 %). This is a slightly different result than was achieved in north-eastern Wollemi National Park, where the Large Forest Bat was captured far less frequently. The Gould's Wattled Bat (*Chalinolobus gouldii*, 23 %) and Large-eared Pied Bat (also 23 %) were also frequently captured.

In addition to the harp traps, ultrasound calls were recorded and analysed from 61 survey sites. The Anabat censuses resulted in the detection of a different set of 18 species. The same three species were most commonly detected by this method as by capture in harp traps, namely Large Forest Bat (54 % of Anabat sites), Chocolate Wattled Bat (52 %) and Little Forest Bat (51 %). However, the Eastern Bentwing-bat was much more frequently detected by Anabat than harp trap (28 % Anabat sites as opposed to only three per cent of harp trap sites). Gould's Wattled Bat and Large-eared Pied Bat were also frequently detected by Anabat (30 % and 25 % of sites respectively). The difference in species' detection rates between the harp traps and Anabats largely results from differences in bat behaviour and foraging habits, combined with the type of call the bats emit. The Long-eared Bats (*Nyctophilus* spp.) have only been detected by harp trapping, as the species of this genus cannot be reliably distinguished by their ultrasonic call using standard parameters (Pennay *et al.* 2004). These bats can orientate and forage without using echolocation (Churchill 1998). When Long-eared Bats do emit calls these consist of a relatively weak pulse that travels only a short distance (N. Williams pers. com.). For these reasons, short indistinct call sequences are often all that is recorded by ultrasound recording devices. In contrast, species that forage in open areas or above the tree canopy, including the Yellow-bellied Sheathtail-bat, Eastern Bentwing-bat and the Freetail-bats (*Mormopterus* spp.) are much more frequently detected by Anabat and comparatively rarely captured in harp traps. These results highlight the need to apply a diversity of survey methods to adequately sample the bat community in any given area.

Plate 16: Eastern False Pipistrelle © N. Williams/DEC

3.8.2 Discussion of species occurrence

The study area supports a diversity of microbat species, with the number of species recorded the same as that of north-eastern Wollemi National Park, and greater than that recorded across the entire greater southern Sydney region (19 species, DEC 2006a). The rich mix of bat species is attributable to the large range of microhabitats, environments and landscape features present within the park.

Tree-roosting microbats

Several species, including some of the most commonly recorded such as Little Forest Bat, Chocolate Wattled Bat and Gould's Long-eared Bat, are habitat generalists, occurring in a wide range of environments from the dry woodlands on the northern creeklines and talus slopes, across the sandstone plateaux and to the high elevation basalt peaks. These are all tree-roosting species that

are generally more tolerant of fluctuations in temperature and humidity at roosting sites and therefore occupy a broad range of habitats (Churchill 1998). However, some tree-roosting species are more specialised. For example the Large Forest Bat, though common, has not been recorded below 500 metres asl in the study area, and is most frequently detected above 600 metres. A similar finding has been made for this species in the southern Blue Mountains (DEC 2004b), providing further evidence to the theory that the species is best adapted to cooler higher rainfall climates (Churchill 1998).

The distribution of the tree-roosting Freetail-bats correlates with regional influences on the study area and the distribution of preferred microhabitats. The East-coast Freetail-bat and Eastern Freetail-bat (*Mormopterus* sp. 2) are both typically eastern Australia animals, occurring along and to the east of the Great Dividing Range (Churchill 1998). Correspondingly, both species have been recorded most frequently on the sandstone plateaux, and are absent from the dry northern perimeter. In contrast, the Southern Freetail-bat (*Mormopterus* sp. 4 (long penis form)) is more common in western NSW, typically inhabiting dry or semi-arid areas inland of the Great Dividing Range (Churchill 1998). This species has only been detected near the western boundary of the study area, including within the drier environments of the Lee Creek Valley. Interestingly, however, all three species were detected by Anabats placed on the Capertee River and facing over a farm dam bordering the park in the Glen Alice Valley. It is unusual to record these three species together, and once again demonstrates the confluence of environments contained within north-western Wollemi NP. Permanent water was present at both of these locations and it is likely that the bats were coming in to drink or forage, the water attracting species that would normally roost in quite different environments from each other. Similarly both inland and coastal species of Broad-nosed Bat are found within the study area: the Eastern Broad-nosed Bat (*Scotorepens orion*) and the Inland Broad-nosed Bat (*Scotorepens balstoni*). The Eastern Broad-nosed Bat is more widespread, detected nine times by ultrasonic call and once in a harp trap, most frequently in the southern half of the study area, but also in the north-west. The Inland Broad-nosed Bat was detected three times by harp trap and twice by Anabat, but only along the western boundary of the study area.

The White-striped Freetail-bat (*Tadarida australis*) is one of only two species of bat in central NSW that emit navigation calls that are audible to humans (the second being the Yellow-bellied Sheathtail-bat). This enables the bat to be detected on an opportunistic basis during a range of night time survey techniques including site spotlighting and nocturnal call playback, as well as by the Anabat detector. The White-striped Freetail-bat is a fast-flying species that is adapted to foraging in open areas or above the tree canopy, usually 50 metres or more above the ground (Churchill 1998). It is therefore rarely captured in harp traps, and was not detected by this method. Never-the-less, due to its strong and audible echo-location pulse, the White-striped Freetail-bat is one of the most frequently recorded bats in the study area, detected at almost 120 locations that encompass the full range of environments. In contrast, the Yellow-bellied Sheathtail-bat is uncommon, recorded on only one (see Section 5).

Cave-roosting microbats

Four obligate cave-roosting bat species have been recorded within the study area, supported by the abundance and complexity of sandstone caves and overhangs. These caves are generally fairly shallow, however, and provide few of the truly “dark” roost sites that are preferred by some species such as Eastern Bentwing-bat. Three of the cave-roosting species are widespread across the study area, namely the Large-eared Pied Bat (recorded at 40 locations), Eastern Bentwing-bat (30 locations) and Eastern Horseshoe-bat (*Rhinolophus megaphyllus*, 31 locations). The distribution of records of the former two species are mapped and discussed in Section 5. The Eastern Horseshoe-bat is widely distributed, recorded from Lee Creek and Widden Brook Valleys in the north, through ridges and gullies on the sandstone plateau, to Gospers Mountain in the south. Roosts of the species were encountered four times, once in a deep recess adjacent to Redbank Creek, and three times in sandstone overhangs near the headwaters of Koondah and Wirraba Creeks. The Eastern Horseshoe-bat is listed as regionally significant in the Brigalow Belt South Bioregion and of conservation significance in Nandewar (Andren 2004) as these are amongst the very few areas that the bat occurs on the western side of the Great Dividing Range. For the same reason, the occurrence of the Eastern Horseshoe-bat in western Wollemi and Goulburn River National Parks holds significance to the conservation of the species at the western edge of its range in central NSW.

The Eastern Cave Bat has been positively recorded on just four occasions, each in the northern half of the study area (see Map 17). As will be discussed in Section 5, these are amongst the most southerly records for the species, and together with records recently collected in north-eastern Wollemi, northern Yengo and Goulburn River National Parks, have greatly increased the understanding of the species in the Sydney Basin Bioregion. Two of the sightings of the Eastern Cave Bat were of roosting individuals, including in a sandstone overhang south of Blackwater Creek and in a deep crack in the ceiling of a large sandstone overhang south of Dunns Swamp. Neither of these roost sites showed

evidence of being a maternity colony. The species can be very difficult to distinguish using ultrasonic call, so its abundance and distribution may be underestimated in relation to bats that can be detected by this method.

3.8.3 Other species that have the potential to occur in the study area

Of the additional bat species recorded within a five kilometre radius of north-western Wollemi National Park, only the threatened Large-footed Myotis (*Myotis macropus*) is considered likely to also occur within the study area. This species has twice been recorded on the Capertee River, just west of the study area, and has the potential to also forage near permanent water along major drainage channels within the study area, such as elsewhere on the Capertee River, along Blackwater and Wollemi Creeks or along the Cudgegong River including at Dunns Swamp. This species is discussed further in Section 5.

A historic record of Little Red Flying-fox (*Pteropus scapulatus*) also occurs on the Capertee River, approximately six kilometres west of the study area boundary. Little Red Flying-foxes set up more temporary camps than those of other flying-fox species as they are reliant on flowering blossom that usually only lasts four to six weeks (Churchill 1998). It is possible that Little Red Flying-foxes utilise north-western Wollemi National Park on rare occasions, when eucalypts are in heavy flower or when food resources are limited elsewhere. However they have not been recorded within either the neighbouring north-eastern Wollemi or northern Yengo National Parks to date (DEC 2006b).

3.8.4 Review of species records

A single record of the Little Mastiff-bat (*Mormopterus planiceps*) exists within the Atlas of NSW Wildlife, identified from ultrasonic call during CRA surveys. The *Mormopterus* have undergone significant taxonomic revision since this time, with *M. planiceps* split into two species in NSW: Southern Freetail-bat (*M.* sp. 4 (long penis form)) and Inland Freetail-bat (*M.* sp. 3 (short penis form)). The identity of the *Mormopterus* detected during the CRA is not known, but since the Southern Freetail-bat has been recorded since, it is expected to belong to this taxon. It must be noted, however, that Inland Freetail-bat has recently been recorded in north-eastern Wollemi National Park (DEC 2005a), and therefore has the potential to also occur in the study area.

The Southern Forest Bat (*Vespadelus regulus*) was also recorded during the CRA surveys. However since only unclear ultrasound recordings were collected and a positive identification could not be achieved, these records are considered to be suspect. This bat has never been captured using harp traps in the study area, suggesting that much of the habitat in the reserve is not suitable for the species.

3.9 DISTRIBUTION OF THREATENED SPECIES

Fauna habitats vary widely in their spatial extent, with some being widespread, some naturally restricted and others heavily depleted due to clearing. They also vary greatly in their level of modification and number of threatened fauna. These disparities occur largely because threatening processes operate unequally across the landscape, with habitats that occur on more fertile soils experiencing greater disruption than habitats on less fertile, rocky and steep areas. The result of this is that some environments provide habitat for a disproportionately large number of threatened species.

The distribution of threatened species records in relation to the largest Mitchell Landscapes present in north-western Wollemi National Park are presented in Table 5. For each species, the landscape containing the greatest proportion of the total number of records is highlighted in bold. The 'Wollemi Ranges' clearly hold the greatest proportion of threatened fauna records overall and is the most significant Landscape for at least seventeen threatened species. However, this Landscape is massive and covers a large proportion of the study area (see Table 1). In relation to the proportion of land encompassed therein, the 'Upper Goulburn Valleys and Escarpment' Landscape has a particularly high concentration of threatened fauna records. The 'Sydney Basin Western Escarpment' also holds a proportionately high number of records for many threatened species. In combination, these last two Landscapes hold the large majority of habitat for at least twelve threatened fauna species. As only a restricted amount of these Landscape types is conserved within the regions reserve system, these threatened species are arguably of the highest conservation priority.

The Landscapes extend both inside and outside of the national park boundary, approximately one kilometre in either direction but further into the park along major creeklines. They primarily encompass Box – Gum – Ironbark woodlands, with dominant canopy species including Grey Box, Slaty Box, Red Gum, Grey Gum, Rough-barked Apple and various Ironbarks.

Common name	Mitchell Landscape						
	Lees Pinch Foothills	Upper Goulburn Valleys and Escarpment	Wollemi Ranges	Sydney Basin Basalt Caps	Sydney Basin Diatremes	Sydney Basin Western Escarpment	Colo River Gorges
Giant Burrowing Frog	0	0	**89**	0	0	11	0
Red-crowned Toadlet	0	0	**100**	0	0	0	0
Stuttering Frog	0	0	**100**	0	0	0	0
Rosenberg's Goanna	0	0	**100**	0	0	0	0
Broad-headed Snake	0	0	**100**	0	0	0	0
Gang-gang Cockatoo	1	10	**72**	4	7	5	0
Glossy Black-cockatoo	4	18	**75**	0	2	1	0
Turquoise Parrot	0	**61**	19	0	0	7	9
Brown Treecreeper (eastern subspecies)	4	**51**	16	0	0	21	5
Speckled Warbler	3	**57**	24	1	0	9	1
Painted Honeyeater	0	**100**	0	0	0	0	0
Black-chinned Honeyeater (eastern subspecies)	2	**59**	14	0	0	20	3
Regent Honeyeater	0	**50**	**50**	0	0	0	0
Hooded Robin (south-eastern form)	0	**50**	10	0	0	40	0
Grey-crowned Babbler (eastern subspecies)	33	**67**	0	0	0	0	0
Diamond Firetail	0	**74**	0	0	0	26	0
Barking Owl	0	**50**	0	0	0	0	0
Powerful Owl	0	8	**92**	0	0	0	0
Masked Owl	0	**50**	**50**	0	0	0	0
Sooty Owl	0	0	**88**	0	13	0	0
Spotted-tailed Quoll	0	33	**67**	0	0	0	0
Eastern Pygmy-possum	0	0	**100**	0	0	0	0
Yellow-bellied Glider	0	27	**61**	0	4	4	1
Squirrel Glider	0	**83**	17	0	0	0	0
Brush-tailed Rock-wallaby	0	30	**60**	0	10	0	0
Grey-headed Flying-fox	0	0	**50**	0	0	0	0
Yellow-bellied Sheathtail-bat	0	**100**	0	0	0	0	0
East-coast Freetail-bat	0	0	0	0	0	11	11
Large-eared Pied Bat	4	18	**65**	0	2	11	2
Eastern False Pipistrelle	0	7	**77**	7	7	0	0
Eastern Bentwing-bat	0	32	**57**	2	2	2	2
Large-footed Myotis	0	0	0	0	0	0	**75**
Greater Long-eared Bat	**80**	20	0	0	0	0	0
Greater Broad-nosed Bat	0	0	**70**	0	0	0	10
Eastern Cave Bat	**62**	0	38	0	0	0	0
Total	**3**	**31**	**50**	**1**	**2**	**8**	**2**

Table 5: Percentage of threatened fauna records in each Mitchell Landscape (includes all DEC records located within and five kilometres surrounding north-western Wollemi National Park)

3.10 INTRODUCED SPECIES

3.10.1 Introduced mammals

The 2005-06 DEC surveys confirmed the presence of ten species of feral introduced mammal in north-western Wollemi National Park. This includes species that are well established and widespread (Fox and Wild Dog, Plate 17), species that are widespread but have mostly been recorded at the edge of the park or in disturbed areas (Rabbit (*Oryctolagus cuniculus*), House Mouse (*Mus musculus*) and Feral Pig (*Sus scrofa*)) and species that have only been reported on a few occasions (Feral Cat (*Felis catus*), Feral Goat (*Capra hircus*), Deer (*Cervus* sp.), Brown Hare (*Lepus capensis*) and Black Rat (*Rattus rattus*)). Three additional species (Cattle (*Bos taurus*), Sheep (*Ovis aries*) and Horse (*Equus caballus*)) were also recorded, however these are expected to be escaped farm animals (Cattle and Sheep) or animals being used for recreation (Horse scats recorded on Myrtle Trail and Army Road). The distribution of introduced carnivores and omnivores within the study area is presented in Map 6 and of herbivores in Map 7.

Plate 17: Wild Dog/Dingo near Gospers Mountain © H. Achurch/DEC

Two species of introduced carnivore are abundant within the study area (Map 6). The Wild Dog (or Dingo/Dog) has been directly observed on just four occasions but detected by its scats at over 100 locations, while the Fox has been directly observed on six occasions and identified from its scats at over 60 locations (Map 6). It is difficult to ascertain from these records the preferred habitats of Wild Dogs or Foxes within the study area, as the scats were mostly collected from roads and trails where they are easily visible. However both species have been recorded in all major environments, ranging from the dry northern and western gullies and talus slopes to the high altitude forests on the Hunter Range. Of the areas surveyed, Wild Dogs appeared to reach their greatest density along the Army Road, where 24 scats were collected along a five kilometre stretch. The Army Road may provide a conduit for the invasion of domestic Dog varieties into more remote sections of the park. Wild Dogs/Dingoes are known to occur within these more remote sections, as many scats were collected near helicopter drop-off points in the south-eastern section of the park, and evidence of activity has been collected by bushwalkers (Macqueen 2005). A third species of introduced carnivore, the Feral Cat, is less frequently detected, recorded by its footprints at four locations and scats at a fifth. Two of these records are deep within the park, while the other three are located fairly close to its boundary. The Feral Cat is a very elusive animal and because scats are typically buried and difficult to locate, it is much less frequently detected by scat location than are Foxes or Wild Dogs/Dingoes. It is therefore unclear whether the low number of Feral Cat sightings actually reflects low density, or is simply because the animal has largely gone undetected.

The most frequently recorded introduced herbivore is the Rabbit, observed on 23 occasions, detected by its scats at 24 locations and from remains in predator scats at a further five sites. The majority of these records were collected near the perimeter of the study area (Map 7), with almost half of the records being located within the 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes. Here Rabbits abound within the more fertile grassy areas and are highly visible along roads and trails and at the edges of bushland. Due to the high number of threatened species that occur in these Mitchell Landscapes, the Rabbit may be having a disproportionately large impact in these environments. The species has also been recorded up to six kilometres inside of the park boundary, but usually near areas that have suffered some disturbance in the past such as diatremes near Gospers Mountain and Tayan Peak. The exception to this is its occurrence along Blackwater Creek and in the sandy country north of the Cudgegong River. Never-the-less, the impact of Rabbits is expected to be limited in extent. Even more limited is the impact of Brown Hare, recorded at just two locations including Dunns Swamp and the Widden Valley.

The distribution of Feral Pigs in the study area appears to be quite limited. These animals leave distinctive traces from foraging and wallowing behaviour, as well as easily recognisable scats, and are therefore easy to detect when present. However, the animals have only been recorded in the western half of the study area, namely neighbouring the 'Hillview' property south of Bylong, north of Nullo Mountain, on Towinhingy Creek (Map 6) and in the vicinity if the Glen Alice Trail (Washington & Mullins Imrie 1998). The pest may also occur in other areas that have high fertility soil, grassy ground cover or are at high elevation (DEC 2006a), such as near Mounts Coricudgy and Coriaday. However, no evidence of Feral Pig has been recorded in the dry northern valleys or talus slopes, nor on the sandstone plateaux, and it is unlikely to be a problem in these areas.

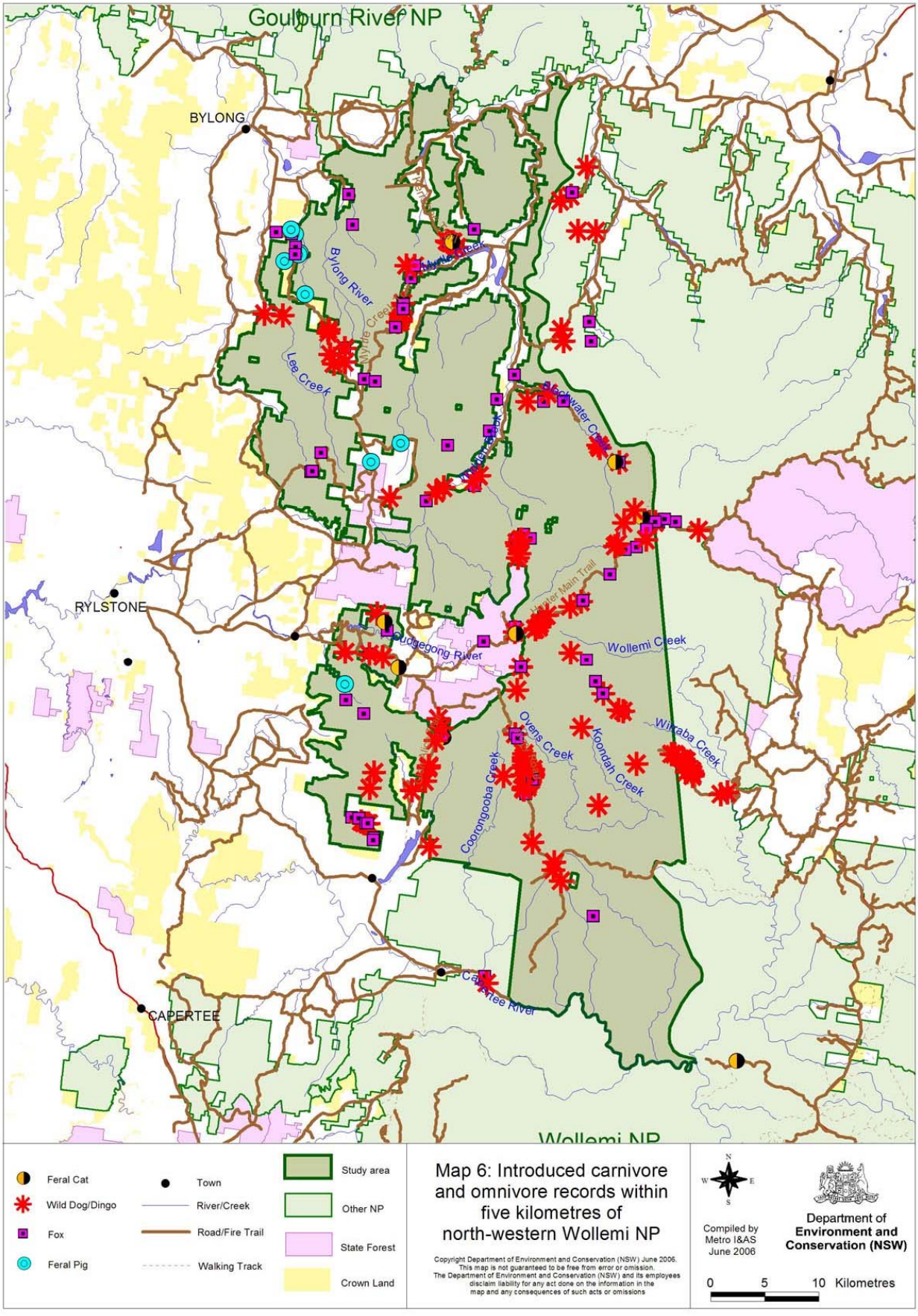
The distribution of introduced rodents (House Mouse and Black Rat) is largely restricted to the perimeter of the park, or areas that have previously been inhabited such as the Livery Stable and Geebung Ground. Feral Goats pose a much greater threat. To date they have mostly been recorded near the park perimeter, but also once on the Bylong River (at a site where Brush-tailed Rock-wallaby scats were also located), once in Cedar Creek gorge and once in the vicinity of the Glen Alice Trail by Washington & Mullins Imrie (1998)). Feral Goats have the capacity to further invade bushland, particularly the dry rocky and hilly lands along the northern and western slopes and escarpments. The distribution of Feral Deer is not well understood and warrants further investigation. During the 2005-06 surveys Deer scats and footprints were observed at one location just north of the old Deer farm at 'Box Ridges'. It is unknown whether this record represents a lone escaped or released animal, or a wild population. If the latter is the case then the species has the potential to spread and could pose a threat to native ecosystems through alteration of vegetation structure and competition. It is recommended that surveys be undertaken to ascertain the extent of Feral Deer in the park, and if a population is discovered that action be taken to prevent its spread.

Cattle have been recorded at eight locations within the national park, up to four kilometres inside the boundary. Though these are likely to be escaped or wandering farm animals, they may still be having an impact on the bush, particularly along major creeklines. Depending on its intensity, Cattle grazing is likely to be affecting the regeneration of some plants, spreading weeds, fouling waterholes and causing harm by trampling and compacting the soil. These impacts may have flow-on effects for the native fauna that rely on these creek-line habitats.

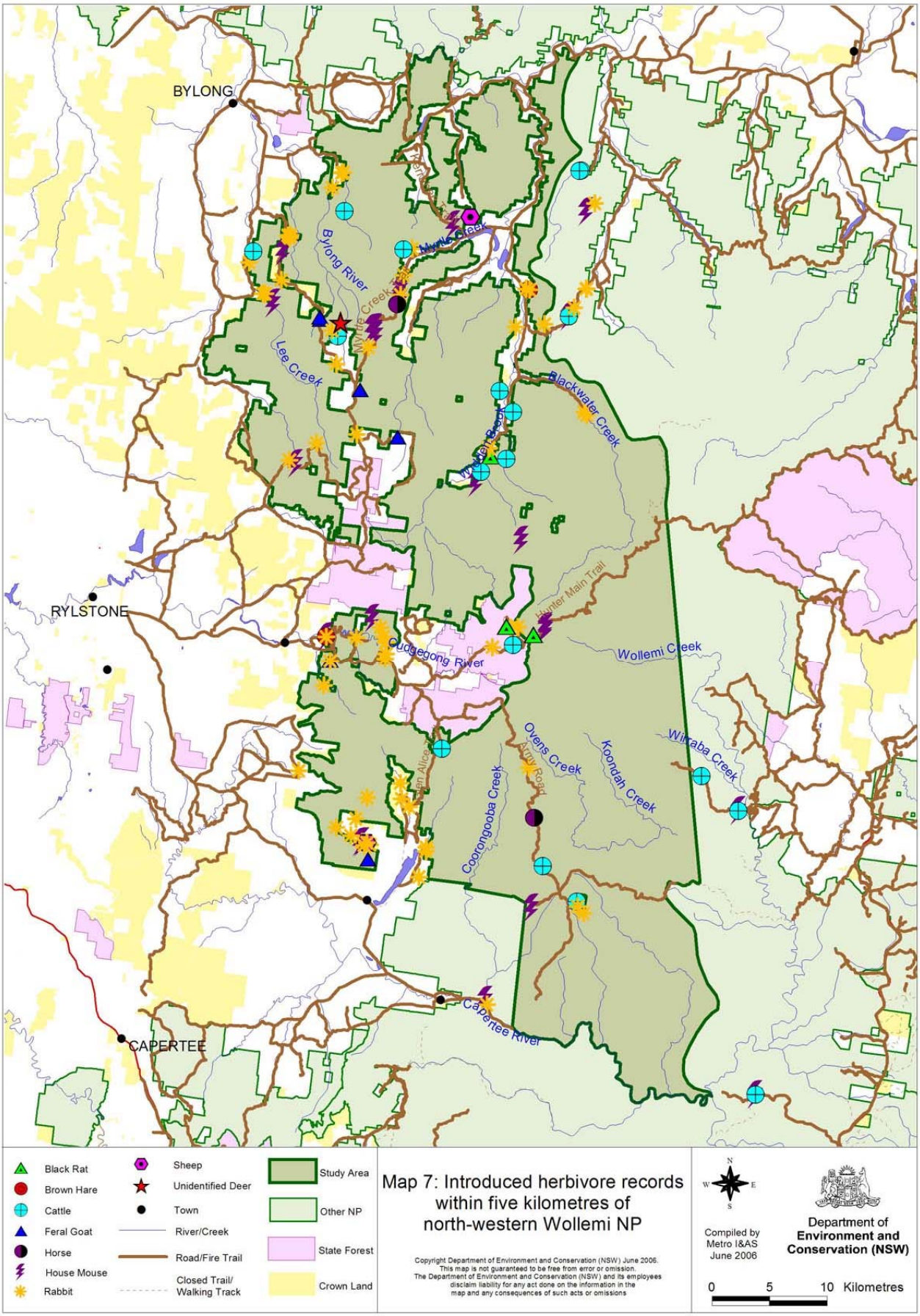
The introduced mammal species are likely to be having a significant negative impact on the native terrestrial flora and fauna of the study area. Six of the species are listed as a Key Threatening Process under the TSC Act (1995) and the EPBC Act (1999), as they are known to adversely affect threatened species and have the potential to cause other species to become threatened. The threats posed to native fauna by each of these animals are summarised below. In addition, Wild Dogs pose a threat through predation, and have been declared a pest species throughout NSW under the Rural Lands Protection Act (1998).

- Predation by the Fox is a major threat to the survival of native Australian fauna, with non-flying mammals weighing between 35 and 5500 grams and ground-nesting birds at greatest risk (NSW Scientific Committee 1998a). Species of particular concern are the Spotted-tailed Quoll and Brush-tailed Rock-wallaby. Fox predation has been implicated in limiting habitat choice and population size of a number of medium-sized marsupials (NSW Scientific Committee 1998a). The fact that Foxes prey upon native animals within the study area is evident from scat analysis, as summarised in Section 3.10.2 below.
- Feral Cats threaten native fauna by direct predation, being capable of killing vertebrates up to three kilograms (NSW Scientific Committee 2000a). Preference is shown for mammals weighing less that 220 grams and birds less than 200 grams, but reptiles, and amphibians are also eaten (NSW Scientific Committee 2000a). 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 House Mice) fluctuates widely (NSW Scientific Committee 2000a).
- Feral Rabbits impact negatively on indigenous fauna species via competition for resources, alteration of the structure and composition of vegetation, ring-barking of trees and shrubs and digging of burrows, which in turn contribute to soil erosion (NSW Scientific Committee 2002a). They compete for food and/or shelter with some native fauna species, such as the Brush-tailed Rock-wallaby (NSW Scientific Committee 2002a), and are thought to have contributed to the extinction of several small mammal species (DEH 2004a). Feral Rabbits form the major component of the diet of Feral Cats and Foxes in many areas and can maintain populations of these predators at high levels. Sharp declines in Rabbit numbers (such as those caused by disease outbreaks) can cause these introduced predators to prey on indigenous fauna species to a greater extent than they would otherwise be able to (Smith and Quin 1996).
- Feral Goats have a major impact on native vegetation through soil damage and overgrazing and can cause significant habitat degradation by trampling, deposition of droppings, and the introduction of weeds (NSW Scientific Committee 2004a). They can compete with native animals for food, water and shelter (NSW Scientific Committee 2004a) and have particularly been implicated as a threat to the Endangered Brush-tailed Rock-wallaby through competition (NSW Scientific Committee 2003a) and to the Broad-headed Snake through habitat disturbance (Murphy1996). Feral Goats may also have an impact on roosting habitat of cave-dwelling bats such as the Vulnerable Large-eared Pied Bat.
- Feral Pigs compete for food resources with native fauna and actively predate upon native birds, reptiles, bird and reptile eggs, and frogs. They spread weeds and diseases such as root-rot fungus (*Phytophthora cinnamomi*) (DEH 2004b). Through their wallowing, rooting and foraging habits they are capable of significant habitat destruction including alteration of drainage patterns and soil structure (NSW Scientific Committee 2004b).
- Feral Deer impact on native fauna through environmental degradation caused by overgrazing, trampling, ring-barking, dispersal of weeds, acceleration of erosion, concentration of nutrients and degradation of water quality (NSW Scientific Committee 2004c). Feral Deer may compete with native herbivores for food, particularly in times of drought or after fire.

Clearly the potential for introduced predators and herbivores to significantly impact on native fauna in the study area is of concern. Comprehensive targeted survey of the species, assessment of their impacts and interrelationships with other predator and prey species, both native and introduced, followed by appropriate management actions, should remain a high priority for park management. Suggestions to help guide feral animal control are provided in Section 4.4 of this report.



Map 6: Introduced carnivore and omnivore records within five kilometres of north-western Wollemi National Park



Map 7: Introduced herbivore records within five kilometres of north-western Wollemi National Park

3.10.2 Predator scat analysis

The analysis of Wild Dog/Dingo and Fox scats yields interesting information about the mammal prey composition of the predators diet. Sixty Fox and 91 Wild Dog/Dingo scats were collected and analysed during the course of the DEC surveys, and the results are presented in Figure 2. Only general conclusions can be drawn from these results due to the fact that bulky prey items will be excreted in more than one scat and hence their frequency in scats is likely to be an over-representation of the number of individuals ingested. Furthermore, identification from hair and remains is more reliable for some species than others, resulting in over-representation of these species in the dataset.

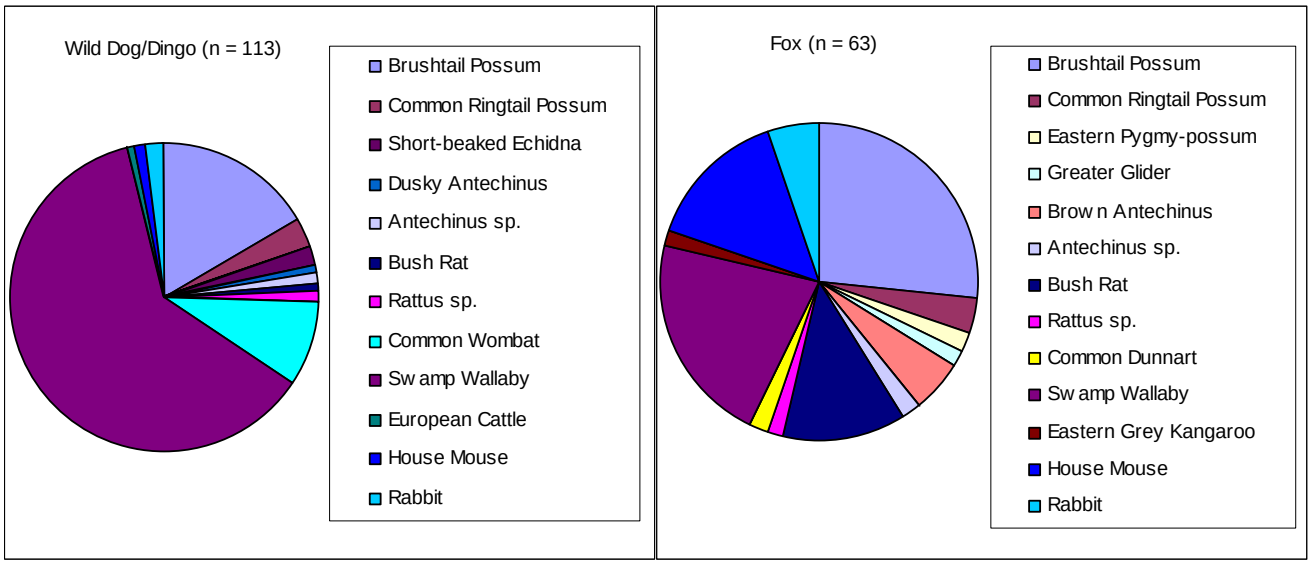


Figure 2: Mammal prey items (hair and skeletal remains) identified from predator scats collected in north-western Wollemi National Park during CRA and BSP surveys

It is clear from Figure 2 that the mammalian component of the diet of both predators is dominated by native ground mammals, which comprise 76 % of remnants identified from Wild Dog/Dingo scats and 46 % from Fox scats. The Fox appears to have a more varied diet, which includes 34 % arboreal mammals and 20 % introduced ground mammals. Contents of the Wild Dog/Dingo scats analysed is dominated by the Swamp Wallaby, and to a lesser extent the Common Wombat, with 20 % comprised of arboreal mammals and only 4 % introduced ground mammals.

3.10.3 Introduced birds

Introduced birds have only been recorded on the perimeter or just outside the boundary of the reserve (Map 8). Two species, the Common Starling (*Sturnus vulgaris*) and Common Myna (*Acridotheres tristis*) occur at the interface between cleared and forested lands, recorded on the boundary twice and once respectively. Both species are currently more common in cleared farming country, including in the Widden, Lee Creek and Capertee Valleys. This result is typical of Common Starlings, whose preferred habitat in Australia is disturbed lands such as urban areas, pastoral country and gardens (Pizzey & Knight 1999). The Common Myna is also usually closely associated with human habitation though the species will inhabit open grassy woodlands remnants supporting hollow-bearing trees (Pell & Tidemann 1997). A third species, the Eurasian Blackbird (*Turdus merula*), has been recorded by Birds Australia on the boundary of the park, east of Numietta Creek in the Glen Alice Valley. This bird is also more common in open country, but has the potential to invade open woodlands and forests (Pizzey & Knight 1999).

Of these three introduced species, the Eurasian Blackbird has the greatest potential to invade far into the park, including along all the major creeklines that run through the sandstone ranges. Eurasian Blackbirds have the ability to survive in relatively undisturbed areas of native vegetation, and hence may pose a significant threat to native species. This may be through direct competition with species such as Bassian Thrush (*Zoothera lunulata*) or through preying on native invertebrates (Garnett & Crowley 2000). It is also implicated in the spread of some invasive weed species such as Blackberry (Loyn & French 1991). The Eurasian Blackbird is thought to be gradually expanding its range and increasing in number through bushland south of Sydney (DEC2006a), and was reported by Barrett *et al.* (2003) as a species that had increased in the frequency of recordings across its Australian distribution between 1984 and 2002. Thus, though the Eurasian Blackbird has to date only been

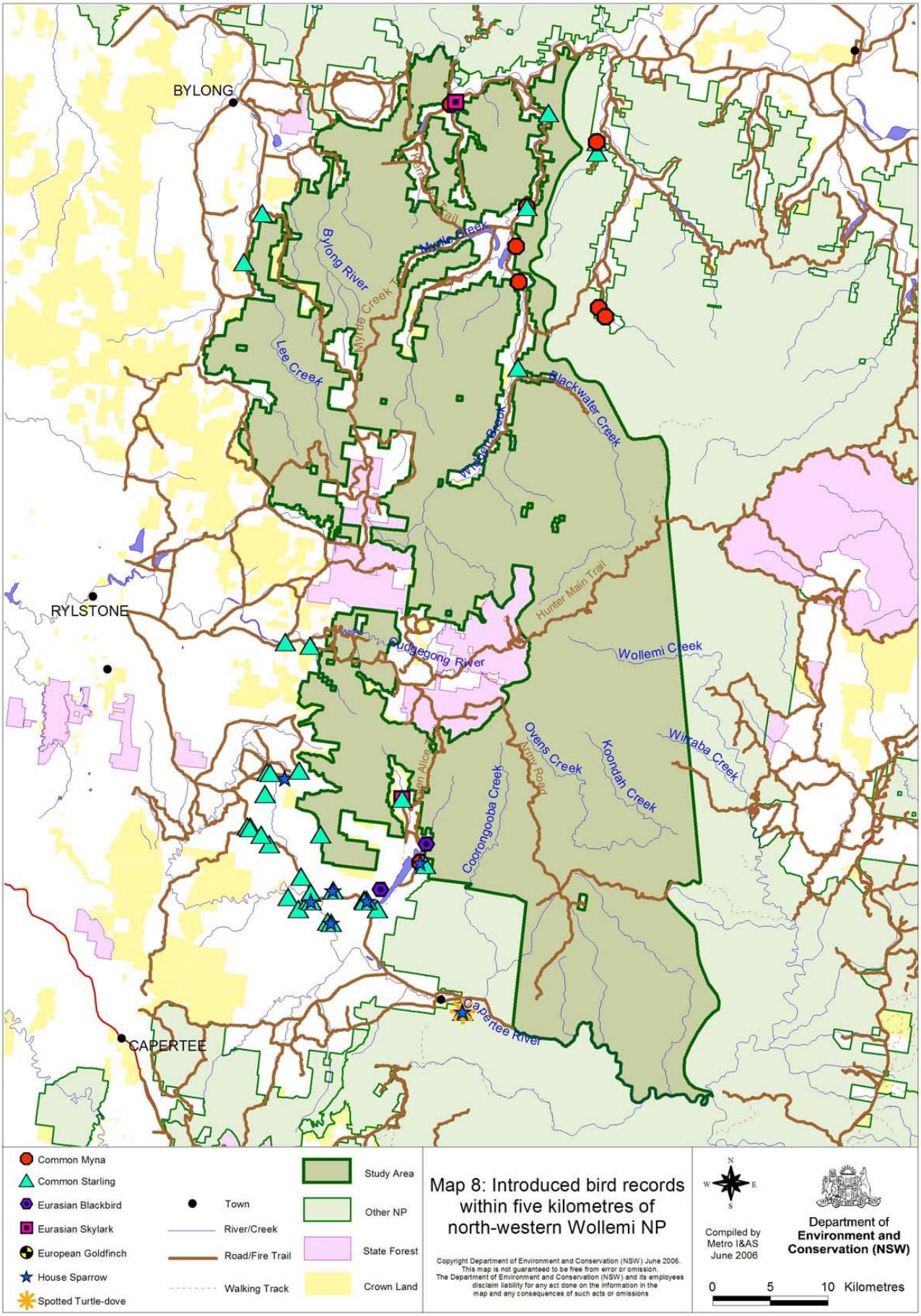
recorded on the boundary of the park, it has the potential to significantly impact on native fauna species further into the park in the future.

The threat posed to native animals by the Common Starling and Common Myna is largely limited to the boundaries of the park, particularly the valleys and lower slopes below the northern and western escarpments, and areas that have been subject to disturbance in the past. However, the habitats in this narrow band have high conservation value and thus if introduced birds occur here in moderate to high numbers the threats posed are likely to be significant. The Common Starling is well established in rural areas and is known to compete with native birds and bats for nest sites such as tree hollows. The species coats its nest cavity with a deep lining that quickly becomes contaminated with parasites, such that hollows become unsuitable for other species (IUCN 2005). The Common Startling is also likely to compete for food resources with some native species, and is implicated in the spread of invasive weed species (Loyn and French 1991).

The Common Myna is infamous for its aggressive nature, often seen bullying its own and other species for food, hollow nesting sites and territories, particularly in woodland areas. The species is known to evict native birds, including parrots, Kookaburras (*Dacelo* spp.), Dollarbirds (*Eurystomus orientalis)* and Australian Magpie-larks (*Grallina cyanoleuca*) from their nests, before dumping out their eggs or chicks (Environment ACT 2004). It is also considered to be a threat to the local survival of mammals that depend on tree hollows, such as Sugar Glider, White-striped Freetail-bat and even Common Brushtail Possum (Environment ACT 2004, M. Schulz pers. comm.). There is evidence that the Common Myna is spreading out from urban areas into more rural settings, which may increase the impact on native wildlife. Barrett *et al.* (2003) listed the Common Myna as a species that had increased in the frequency of recordings across their distribution between 1984 and 2002. Local residents in the Upper Hunter Area have noticed increasing numbers of the Common Myna in recent years (J. Barlow pers. comm.). Threatened species that depend on hollows in woodland habitats, such as the Brown Treecreeper and some microbats, are particularly at threat from these introduced species.

Though the Common Starling and Common Myna are unlikely to invade far into the park, the species have the potential to significantly impact on native species in the 'Upper Goulburn Valleys and Escarpment' and 'Sydney Basin Western Escarpment' Landscapes, which are each of high conservation priority. The distribution of Common Myna, Common Starling and Eurasian Blackbird within the valleys that indent the north and west of the park should be monitored. If either species is found to move further into the park, or to increase in number in the woodlands at the edge of the park, action should be taken to control the birds. Any such action must be sure to target the introduced species and not impact on native bird species.

Four further species have been recorded within a five kilometre range of the study area: Spotted Turtle-dove (*Streptopelia chinensis*), Eurasian Skylark (*Alauda arvensis*), House Sparrow (*Passer domesticus*) and European Goldfinch (*Carduelis carduelis*). None of these species are considered likely to occur within the body of Wollemi National Park, however, and therefore do not currently pose a significant threat to native wildlife.



Map 8: Introduced bird records within five kilometres of north-western Wollemi National Park

4 MANAGEMENT RECOMMENDATIONS

4.1 AREAS OF HIGH CONSERVATION SIGNIFICANCE

The sites listed below have exceptional importance for the conservation of vertebrate fauna in the study area, particularly threatened species. Given limited resources, protection and enhancement of these sites and habitats will generate the maximum benefit to threatened species conservation and to vertebrate diversity in the study area.

4.1.1 The 'Upper Goulburn Valleys and Escarpment' and 'Sydney Basin Western Escarpment' Mitchell Landscapes

In proportion to their size, a particularly high number of threatened species occur within the "Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes. These Landscapes hold the large majority of habitat for at least twelve listed species (see Table 5). Furthermore, the large majority of these Landscapes occur outside of reserves and is under continued pressure from agricultural development.

At least six Key Threatening Processes operate in these lower slopes and valleys, which cover the following broad issues: clearing of native vegetation; predation by the Fox; competition and grazing by Feral Goats; competition and grazing by Rabbits; removal of dead wood and trees; bushrock removal. Wild Dogs also pose a threat to native fauna in these zones through predation, as does the invasion of exotic plant species, competition with introduced birds (namely Common Myna, Common Starling and Eurasian Blackbird) and removal of hollow-bearing trees. Furthermore, the heavy load of mistletoe that is present in trees at the boundary between cleared and forested lands (due to ecosystem stress) may endanger the long-term survival of the woodlands in these Landscapes.

- Abatement of the above threatening processes in these Landscapes should be a high priority for park management in accordance with the relevant Threat Abatement Plans.
- Many of the management recommendations provided below in this report, including those regarding fire, cooperative land management, land acquisition, feral animal control and further survey and monitoring should be prioritised to these Landscapes, as indicated.

4.1.2 Known localities of the Stuttering Frog

The Stuttering Frog was discovered at two locations on the northern and southern side of the Hunter Range in December 2005 (Map 9). The first sighting was of three adult frogs, initially detected by their call, while the second sighting was of a small group of tadpoles, thought to be approximately nine months old (age estimated from size by G. Daly). This indicates attempted breeding at the first location, and successful breeding, at least to the tadpole stage, in the second. The discovery of these breeding populations has very high significance for the conservation of the species in the southern half of New South Wales. The Stuttering Frog is known to have disappeared from numerous protected areas, and reservation of habitat alone will not guarantee its survival in north-western Wollemi National Park. The greatest threat to the survival of the Stuttering Frog in these locations is likely to be infection with Chytrid fungus (Chytridiomycosis, *Batrachochytrium dendrobatidis*). As outlined in Section 4.6.1 below, assessment of the level of threat posed by this disease and monitoring of the populations are strongly recommended. Further populations of the Stuttering Frog are considered highly likely to occur within other more remote sheltered gorges and canyons that support warm temperate rainforest.

4.1.3 Known Brush-tailed Rock-wallaby colonies

The BSP surveys confirmed that the Brush-tailed Rock-wallaby is extant within north-western Wollemi National Park. This follows on from confirmation of the species in north-eastern Wollemi National Park in 2004-05 (DEC 2005a). While fresh scats of the species were definitely identified from three locations, a small colony of at least five individuals was observed along Myrtle Creek, just south of 'Myrtle Grove' (Map 15, Williams 2006). This colony holds very high conservation significance. Locations where the Brush-tailed Rock-wallaby has been identified from fresh scats, old scats, or was previously known to occur (Wong 1994 and DEC 2006b) are also highly important (Map 15). Together with habitat in north-eastern Wollemi and northern Yengo National Parks, north-western Wollemi constitutes one of the few remaining strongholds for the species in central NSW.

The Brush-tailed Rock-wallaby appears to have suffered a decline in numbers within northern Wollemi National Park in recent decades, and requires careful targeted management to ensure its survival in the region. The greatest threat to the survival of the wallaby in north-western Wollemi, and particularly

to the Myrtle Creek colony, is likely to be predation by the Fox (and possibly the Wild Dog). Feral Goats have been located on Bylong River and Cedar Creek, but not recorded on Myrtle Creek to date. However, if the species spreads to the Widden Valley or increases in numbers it would pose a significant threat. The known Brush-tailed Rock-wallaby colony, as well as sites where scats have recently been identified, should be the subject of continued research into Fox control as part of the statewide Fox Threat Abatement Plan, as well as further monitoring and research, as recommended in Section 4.6.1 below.

4.1.4 Known localities of the Broad-headed Snake

The recent DEC surveys confirmed that this rarely recorded species persists in the study area. Though it has only positively been recorded on the Atlas of NSW Wildlife from one location in recent years, this observation has high conservation significance as northern Wollemi National Park encompasses the far north-western extent of the species known range. The Broad-headed Snake is likely to also persist in other parts of the Narrabeen sandstone plateaux, particularly remote sections located far from roads and access points. Conservation of inaccessible habitat within the study area is very important to the species as a whole.

4.2 SUMMARY OF RELEVANT RECOVERY PLAN ACTIONS

There are a number of state-wide recovery plans for species that occur within the study area that have been approved by the NSW Minister for the Environment or are in final draft stages. The threats and recovery actions outlined in these plans that are relevant to the study area are discussed below.

4.2.1 Stuttering Frog

Of the threats listed to the Stuttering Frog in the Draft Recovery Plan, the most relevant to the study area is infection by the amphibian Chytrid fungus (Hunter & Gillespie 2006). It is not currently known whether the populations of Stuttering Frog in north-western Wollemi are infected with this disease. Ascertainment of this and, if the disease is located, determination of the extent to which it impacts on the populations is a very high management priority. The key Draft Recovery Actions that are relevant to the study area and should be undertaken as a high priority are as follows:

- Undertake targeted surveys to obtain an accurate understanding of the species status and distribution in the study area, as outlined in Section 4.6.1 below. Such surveys should be coordinated with the state-wide survey program and developed in close consultation with the recovery team.
- Consideration of north-western Wollemi National Park as a site for detailed monitoring and population demographic studies, in close consultation with the recovery team.
- Determination of the impact, if any, of Chytrid fungus.
- Development of management guidelines to ensure the long-term survival of the population(s) in the study area, based on the outcomes of the above research.

4.2.2 Brush-tailed Rock-wallaby

Of the threats listed to the Brush-tailed Rock-wallaby in the Draft Recovery Plan, the most relevant to north-western Wollemi National Park are likely to be predation by the Fox and aspects relating to fire regimes (DEC 2005d). Very hot widespread fires may adversely affect the species by preventing their escape, while frequent burning may change vegetation structure and characteristics at refuge and foraging sites (DEC 2005d). Fire in foraging areas may also act to advantage Rock-wallabies by increasing the availability of 'green pick' (NPWS 2003f). The species recovery plan acknowledges that the threatening processes affecting Brush-tailed Rock-wallabies are poorly understood, multi-level, usually inter-related and the inter-relationships are often complex. Until a better understanding of the threatening processes of the Brush-tailed Rock-wallaby is gained, the control of threatening processes will continue to be problematic.

Specific on-ground management recommendations for the Brush-tailed Rock-wallaby cannot be provided at this stage. Instead, the following guidelines should be followed:

- That management of the Brush-tailed Rock-wallaby sites is coordinated with management of the species across the state. The key to this will be to maintain regular communications with the NSW Brush-tailed Rock-wallaby recovery team.
- That monitoring of known locations be undertaken, as outlined in Section 4.6.1 below.
- That the Myrtle Creek colony be incorporated into the Fox TAP program and that the outcomes of the program guide future Fox control programs.

- That hot wildfires be prevented from entering known Brush-tailed Rock-wallaby colonies when possible.

4.2.3 Large Forest Owls

None of the recovery actions outlined in the Draft Recovery Plan for Large Forest Owls provide specific management recommendations for immediate on ground implementation in Wollemi National Park. Of the listed threats to the species, fire is the most relevant to north-western Wollemi National Park, together with previous logging activities along some creeklines. In light of this, it is recommended that:

- Too frequent hazard reduction burning, using low intensity fire with short burn intervals, not be undertaken within known Powerful Owl or Sooty Owl territories.
- A mosaic pattern be used when fuel reduction burns are undertaken. This will ensure that sufficient refugia are left unburnt, particularly along creek lines and gorges for Powerful and Sooty Owls, while a mix of burnt-unburnt patches contributes to the vegetation structural diversity required for Masked Owls.
- Hollow-bearing trees, both living and dead, be retained, even in semi-cleared country at the park boundary. Furthermore, mature trees should be allowed to develop along creeklines that have previously been logged, in order to provide further nesting and roosting opportunities for the Large Forest Owls in the long term, as well as den sites for prey species.

4.2.4 Barking Owl

Of the threats listed to the Barking Owl in the Draft Recovery Plan, the most relevant are likely to be predation on fledglings by Feral Cats and Foxes, and potentially occupation of hollows by feral Honey Bees (NPWS 2003c). These threats are poorly understood, however, and further research is required before specific management recommendations can be made.

4.2.5 Koala

Though not positively recorded to date, the Koala is expected to occur in very low densities along the northern boundary of the study area. Of the threats listed to the Koala in the Draft Recovery Plan, the most relevant to north-western Wollemi National Park is related to fire. Predation by Dogs may also be a threat, however Koala remains were not located in any of the 113 Dog scats collected in the park during the DEC surveys. Koalas are known to survive extensive and intense wildfires (K. Madden pers. obs. in DEC 2004e), but are threatened in areas where no refugia persist. In Wollemi National Park there are considerable refuge areas in the incised gorges. In most instances the preferred tree species are located in gullies and sheltered slopes or on basalt caps and fertile valley floors.

The Draft Recovery Plan highlights a number of generic recommendations to managing threats to the Koala on reserved lands. In summary these are:

- That fire be excluded, where possible, from areas known to contain Koalas.
- That mosaic patterns be used in fuel reduction burns to ensure refuges of unburnt habitat are always available. Such burns should be carried out outside the spring-summer period when Koalas are breeding and most likely to be on the ground and therefore vulnerable to fire. Burns should avoid crown scorch and crown burns.
- Preferred feed trees not be felled during mop-up operations in areas known to be used by Koalas, or during the construction of fire breaks and fire trails.

4.2.6 Yellow-bellied Glider

Recent surveys for the Yellow-bellied Glider have significantly expanded knowledge on the species' distribution in the Sydney Basin reserve system, indicating it is more common than once considered. Surveys in Wollemi and Yengo National Parks have indicated that the tall forests in sandstone gullies and gorges represent high quality habitat for the Yellow-bellied Glider. These distribution trends are not recognised by the current Recovery Plan for the species (NPWS 2003e). The preferred sap feed tree across the Sydney Basin is the Grey Gum *(E. punctata)*, which is widespread in the eastern and northern part of the reserve.

Of the threats listed to the Yellow-bellied Glider in the Recovery Plan, the most relevant to north-western Wollemi National Park is related to fire. The recovery plan indicates that there are no known studies on the impact of wildfire on the Yellow-bellied Glider. It is likely that as long as wildfire and hazard reduction burning events leave a natural mosaic of varying burn intensities across the

landscape, with unburnt refugia in incised gorges, the Yellow-bellied Glider is unlikely to be threatened on a landscape scale.

4.3 FIRE AND BIODIVERSITY

4.3.1 Lessons so far from the Woronora Plateau post-fire fauna surveys

The impact of controlled burning and wildfire on fauna is poorly understood. Research currently being undertaken by DEC (2004e) is one of few studies to offer a comparison of fauna composition between long unburnt vegetation and vegetation that has undergone an extensive and severe wildfire. Even fewer studies have examined the impacts of frequent burning on the suite of fauna in an ecosystem; more often fire impact studies have been species specific.

The study (DEC 2004e) on the Woronora Plateau in the south of Sydney is the most relevant guide to the impact of extensive and severe wildfire on fauna in north-western Wollemi National Park. Both areas are characterised by dry sandstone woodlands and forests and while rainfall levels differ substantially, there is considerable species overlap for many of the fauna groups. It is not unreasonable to hypothesise that the fauna of Wollemi National Park would respond to fire in a similar way as that on the Woronora Plateau. Research into the impacts of fire on fauna on the Woronora Plateau will continue until five years after the wildfire event (summer 2006-7). A final report detailing findings will then be produced. This report is likely to include key findings that are directly relevant to north-western Wollemi National Park and will assist in the formation of fire management strategies that maximise fauna diversity in the park.

The Woronora Plateau study so far has found that the impacts of wildfire depend on the intensity of the fire. As would be expected, high intensity fire has had a much more dramatic impact on species abundance than has low or moderate intensity fire. Arboreal mammal abundance was found to be greatly reduced in areas of high intensity fire. The richness and diversity of bird assemblages are significantly reduced in sandstone woodlands up the three years following high intensity fire. Honeyeaters are one group of birds that were shown to suffer greatly reduced numbers after three years of the Woronora study. Loss of key habitat resulted in similar downturns in the richness and diversity of reptile species in sandstone woodlands. Most affected three years after the fire were litter-dwelling skinks, while those associated with rocky habitats were less affected though still reduced in abundance.

The Woronora study is showing that the recovery of fauna populations to pre-fire levels takes considerable time. There is evidence of only slow increases in abundance of some species even at three years after fire. Such a trend reinforces that subsequent fires within this time are likely to suppress an already reduced fauna population. The study reveals that while the impacts of the high intensity of fire have been catastrophic in the short term and at a small scale, there has been no recorded loss of species from the Woronora Plateau as a result. This is because there is a mosaic of burn intensities within the study area, with some areas remaining lightly burnt or unburnt. These areas are most likely to act as refugia in which species will survive and from which species will in time recolonise the intensely burnt environments. Subsequent fires that burn unburnt areas after only short fire intervals are likely to severely affect local population numbers.

4.3.2 Recommendations for fire management

Understanding and managing the impacts of fire in high fire frequency environments such as central and southern Wollemi National Park would be aided by fire intensity mapping and the delineation of sensitive fauna habitats. At present there is no information to guide reserve managers as to the degree to which vegetation cover has been burnt. Additionally there is no way of defining the impacts of fire intensity on particular habitats. Currently available vegetation community mapping (Bell 1998) is too coarse and inaccurate for this purpose. As a result we recommend that:

- Fire intensity mapping be carried out following all major wildfire events.
- Detailed vegetation mapping be undertaken across north-western Wollemi National Park to enable clearer delineation of fire sensitive fauna habitats and vegetation communities.
- In the medium term, and subsequent to vegetation mapping, that fauna habitat modelling be undertaken across Wollemi National Park in order to further delineate high conservation value, and/or fire sensitive, habitats. Such a project, in combination with the completion of the Woronora Plateau study and research being undertake elsewhere, would enable the formulation of more prescriptive fire management strategies for biodiversity conservation.

In the mean time, the following generic recommendations for fire management in relation to fauna are made:

- Fire management should always maintain a mosaic of fire regimes.
- Mosaic burning should retain examples of all fauna habitats in a long unburnt state.
- Fire planning should recognise the role of unburnt refugia in the recolonisation of burnt landscapes, particularly after extensive and intense wildfire.
- Unburnt refugia should remain unburnt at the very least for five years following extensive and intense wildfire.

High conservation priority habitats and a number of threatened species warrant particular consideration when planning hazard reduction burns and when attempting to control wildfires. In light of this the following recommendations are made.

- At least until further information is gained, high intensity wildfire should be excluded from the rocky refugia of known extant Brush-tailed Rock-wallaby colonies, from known Stuttering Frog sites, and from known threatened bat cave and overhang roost sites. At this point in time, these sites include:
    - the Myrtle Creek Brush-tailed Rock-wallaby colony, the area of which also incorporates a possible Eastern Bent-wing Bat roost site;
    - the vicinity of Brush-tailed Rock-wallaby records at Box Hole Clearing;
    - rocky refugia along Red Creek and the adjacent slopes in the vicinity of Brush-tailed Rock-wallaby records;
    - the gullies where Stuttering Frogs have been located east of Mount Coricudgy;
    - and Eastern Cave Bat roost sites south of the Cudgegong River and south of Blackwater Creek (see Map 17).
- Threatened species that utilise sandstone ridgetop and upper slope habitats should be taken into account during construction or upgrading of fire trails, particularly Giant Burrowing Frog and Red-crowned Toadlet. Care should be taken not to disturb high quality ridge-top habitat or alter the hydrology of first-order creeklines.
- In areas that are known to be used by the following threatened species, preferred feed trees should not be felled during mop-up operations or during construction of fire breaks and fire trails. This includes: Red Gums and Grey Gum for Koala; Mugga Ironbark, Yellow Box, White Box, Grey Box, Red Bloodwood and Spotted Gum for Swift Parrot and Regent Honeyeater; and trees that support a natural density of mistletoes of the genus *Amyema* for the Painted Honeyeater.
- Too frequent hazard reduction burning, using low intensity fire with short burn intervals, should be avoided within known Powerful Owl or Sooty Owl territories.
- Fire regimes within the 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes should be managed to ensure key habitat features for the threatened species that occur therein are maintained and enhanced. Key habitat features to be retained or enhanced include: diversity of native grasses; moderate density of shrub thickets; fallen logs and standing or fallen dead trees; old hollow-bearing trees.
- Prevention of known Brush-tailed Rock-wallaby refugia sites from high intensity wildfire may require the use of regular control burning of footslopes. Regular burning of footslopes has the potential to increase the amount of foraging material for the Rock-wallabies, but also to reduce the abundance of fire-sensitive species used for shelter, such as figs and mesic vegetation. Management of fire on footslopes used by Brush-tailed Rock-wallabies should aim to achieve a mosaic of habitat types, with patches of long unburnt vegetation retained. Fires must not be allowed to move to rocky refuge sites. Staff responsible for fire management around known Brush-tailed Rock-wallaby colonies should remain in close contact with the Brush-tailed Rock-wallaby Recovery Team to keep informed of latest research results and best-practice management techniques.

4.4 PEST SPECIES AND BIODIVERSITY

Six of the introduced species known to occur within north-western Wollemi National Park are listed as a Key Threatening Process. Of these, predation by the Fox is likely to be having the most significant impact on threatened species in the study area. The impact of Feral Cats is largely unknown, as though the species has only been observed on five occasions, its elusive nature may simply mean that it goes largely undetected. Deer and Pig are at present restricted in range in the study area, but have

the potential to expand and cause problems in the future. As the preferred habitat of Rabbits is highly localised and there is little potential for expansion of their current range in the park, control of Rabbits is currently of low priority. The Feral Goat is also restricted in range, but is known to occur in the vicinity of Brush-tailed Rock-wallaby habitat at Bylong River. Control of the Goat in this area in order to prevent the population's expansion to other Rock-wallaby habitats is thus important. Though not listed as a Key Threatening Process, Wild Dogs pose a significant threat to native fauna through predation and are listed as a pest under the Rural Lands Protection Act (1998). Control of Wild Dogs is currently considered second in priority to Fox control in the study area, while targeted control of Feral Goats is third in priority.

Problems associated with Wild Dogs and Foxes are noted in the Plan of Management for the reserve (NPWS 2001a). In order to help guide feral animal control programs, the following is noted:

- The threatened species considered most sensitive to Fox predation are the Brush-tailed Rock-wallaby and Spotted-tailed Quoll and to a lesser extent the Speckled Warbler, Diamond Firetail, Turquoise Parrot, Koala, Squirrel Glider, Eastern Pygmy-possum, Yellow-bellied Glider and Rosenberg's Goanna. Impacts of Foxes on other threatened species are considered to be low (NPWS 2001c).
- It is unlikely that Foxes can be removed from the study area entirely, so control programs should be centred on priority sites or habitats that will achieve the maximum benefit for biodiversity. Control of Foxes, with regards to their impacts on biodiversity, should be focussed on known locations of the above threatened species and on the Permian slopes and valleys of the 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment'.
- Control of Foxes is most important in the first few years following fire when the ground layer is open providing little refuge for ground-dwelling mammals and birds.
- The foraging efficiency of Foxes seems to be maximal in open habitats where they are able to range widely and freely (Environment Australia 1999). They readily use roads, tracks and other cleared access ways through denser vegetation or complex topography. One option to minimise Fox impacts on threatened species is to reduce such access points to a minimum and to maintain bait stations along those access paths which are retained (Environment Australia 1999).
- Based on the distribution of scats, Wild Dogs appear to reach their greatest density on the Army Road. Wild Dogs and Foxes are also common in the 'Upper Goulburn Valleys and Escarpment' from where 15 % and 20 % of Wild Dog and Fox records derive respectively.
- Priorities for Wild Dog control, with regards to their impacts on biodiversity, are known locations of the Brush-tailed Rock-wallaby, as well as habitats on the Permian slopes and valleys of the 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment'.
- The impact of Fox or Dog removal should be monitored and used to guide further management actions. Baiting (particularly aerial baiting) within the remote sections of the centre of the park should be avoided until further research on the heritage of Dogs/Dingoes is undertaken. Recent research undertaken within Yengo National Park has indicated that hybrid Dogs are most concentrated around the perimeter of the park while dogs in the core of the park have a high degree of Dingo heritage (T. Horwood pers. comm.). A similar pattern may occur within Wollemi National Park. At the very least, genetic material should be collected from an dead Wild Dogs/Dingos located in more remote sections of the study area, and sent for analysis to determine the animals genetic heritage.
- The use of 1080 baiting in areas where Quolls are known should be very carefully considered. Burying baits deeper than seven centimetres below the ground surface (rather than burying them in raised mounds) will decrease the number of baits removed by Quolls (Glen and Dickman 2003).
- Priorities for Feral Goat control are known Brush-tailed Rock-wallaby sites, particularly that on Bylong River. If Goats are located in the vicinity of the Myrtle Creek Brush-tailed Rock-wallaby colony, then control should become an immediate priority. The Feral Goat also poses a threat to the Broad-headed Snake and to roost sites of the Large-eared Pied Bat, and should be controlled if located within the vicinity of known localities of these threatened species.
- Control of Feral Cats is very difficult and at present there are no particular sites that require attention. Further survey into the abundance and distribution of Cats in the area is recommended. Following this, if deemed necessary, control should be considered in the vicinity of records and habitat of Giant Burrowing Frog, Hooded Robin, Grey-crowned Babbler, Diamond Firetail,

Speckled Warbler, Spotted-tailed Quoll, Eastern Pygmy-possum, Squirrel Glider and Eastern Bentwing-bat.

- Should any additional populations of Feral Pig or Deer come to the attention of land managers, or current populations increase in extent, control should be carefully considered. Initial investigations should confidently determine the species of Deer that occur. Deer have recently been recorded to be expanding in distribution in NSW and have a demonstrated propensity to be highly invasive. Deer numbers are thought to be increasing in southern Wollemi National Park (D. Monahan pers. com.). Early management action is essential wherever Feral Deer is recorded.
- Any control programs must consider the impacts that baiting or removal of feral animals from the system are likely to have, and take this into account before going ahead with broad-scale control measures. For example, Dog baiting can have an adverse impact by serving to increase Fox populations and endangering Dingo populations, while evidence collected elsewhere suggests that both Fox and Dog baiting can have an adverse impact on Quoll populations (Belcher 2004) and potentially Rosenberg's Goanna (M. Schulz pers. comm.). Much research is currently being undertaken into the impacts of aerial baiting on Quoll populations, and park managers should be sure to keep up to date with the latest findings as they relate to on-ground actions.
- The distribution of Common Myna, Common Starling and Eurasian Blackbird within the 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment' environments should be monitored, and if the species are found to move further into the park, or to increase in number in the Box woodlands at the edge of the park (on which a number of threatened species depend), action should be taken to control the birds. Any such action must be sure to target the introduced species and not impact on native bird species.

4.5 OFF-RESERVE CONSERVATION AND LAND ACQUISITIONS

4.5.1 Additions to Wollemi National Park

Data collected during BSP and CRA surveys indicate that any acquisitions and additions to Wollemi National Park should be prioritised toward areas within the 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes. Given limited resources reservation of more of the lower slopes and valleys in these areas would provide maximum benefit to threatened species and vertebrate diversity in the study area. Habitats that are of highest value within these landscapes include the lower footslopes adjoining valley flats where one or more of the following are true:

- Tree species such as *Eucalyptus albens/moluccana, E. dawsonii, E. crebra, E. sideroxylon and E. fibrosa* and *E. punctata* are in abundance.
- Creek flats or riparian systems near the edge of cleared country are present and some remnant vegetation remains. This would include tree species of *E. blakelyi, E. tereticornis, E. melliodora, Casuarina cunninghamiania* subsp. *cunninghamiana*.
- Understorey is either present or capable of regenerating on lower slopes or valley floor fragments.
- Remnant trees or remnant patches are not isolated within a cleared environment.
- Older, hollow-bearing tree occur.

4.5.2 Conservation on private lands in the high priority Landscapes

The 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment' Landscapes encompass much private land, on which numerous threatened species are known to occur. Portions of these lands that are adjacent to the park and support Box-Red Gum-Ironbark vegetation, or creek flats and riparian systems with intact vegetation, play a very important role in the ongoing conservation of threatened species in the area. For this reason, landholders should be encouraged to actively participate in conservation programs and/or minimise the undertaking of activities that would decrease the value of these high priority habitats to native fauna. It is recommended that a program be launched across the Hunter and Goulburn River Valleys (Hunter Range and Mudgee Areas) to educate neighbours of the importance of these habitats and encourage them to undertake the following.

- Prevent the progress of relevant Key Threatening Processes. This entails *in situ* retention of fallen wood, dead trees and bushrock, as well as the avoidance of any clearance of native vegetation. In particular, all large trees, whether living or dead, isolated or connected to other vegetation, should be retained as they are likely to provide vital hollow resources.

- Avoid activities that alter the structure of the vegetation, such as frequent burning and over-grazing. Landowners should be strongly encouraged to retain the integrity of the key Box-Red Gum-Ironbark habitats, as well as creekline and riparian vegetation.
- Retain key tree species. For the Painted Honeyeater this includes trees that support a natural density of mistletoes of the genus *Amyema.* For the Regent Honeyeater and Swift Parrot this includes Mugga Ironbark, Yellow Box, White Box, Grey Box and Red Bloodwood. For Hooded Robin this includes paddock trees (even if they are dead), fallen timber and other perch sites.
- Avoid planting of invasive exotic plant species, particularly exotic grasses. These have the potential to invade key habitats and reduce their value to numerous threatened species, particularly the Diamond Firetail and the Speckled Warbler.
- Avoid the use of pesticides in lands adjacent to the park boundary wherever possible.
- Design any new fences that are placed adjacent to the park boundary to have a plain wire (not barbed wire) top strand, to decrease the risk of entanglement of the Squirrel Glider.
- Landowners in the high conservation priority Landscapes could also be made aware of the possibilities available to them to develop conservation partnerships, such as through voluntary conservation agreements.

4.5.3 Co-operative pest management

Control of pests in the study area, particularly in the 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment' Landscapes, will not be successful without the adoption of a cooperative landscape-based approach. Baiting on individual tenures will only provide short-term success due to the high mobility of Foxes and the potential of rapid re-invasion. It is strongly recommended that a co-operative targeted pest management program be developed for the catchments that feed into the study area, across all land tenures including private lands, crown lands State Forests and National Parks.

4.6 FURTHER SURVEY AND MONITORING

4.6.1 Specific threatened species projects

Land managers are faced with an ominous list of threatened fauna species. However, not all threatened species warrant equivalent management efforts. There are a number of threatened species within the study area that at this stage do not require specific targeted management actions to be undertaken. However, other threatened species require specific management actions, further survey and/or monitoring to be undertaken in order to increase their chances of long term survival within the study area. In terms of further survey, research and monitoring, the following programs are suggested, with the first two taking highest priority and the rest listed roughly in order of priority. All of the research programs listed should be undertaken in close consultation with appropriately experienced scientific personnel and experts on the species, as well as with any teams undertaking related work elsewhere in the Department of Environment and Conservation or the federal Department of Environment and Heritage, such as recovery planning or threat abatement planning. In addition to these higher priority projects, suggestions for further work are also included in the threatened species profiles in Section 5.

Brush-tailed Rock-wallaby

It is clear that the number and size of Brush-tailed Rock-wallaby colonies in northern Wollemi National Park has declined in recent decades. While only a few colonies appear to be extant and distribution is patchy, the discovery of fresh scats and the sighting of a breeding colony in 2006 indicates that the species is persisting and is worthy of specific management. The Brush-tailed Rock-wallaby colonies in northern Wollemi and Yengo National Parks have very high significance for the species on a state-wide level, yet are unlikely to survive in the long term without the intervention of park managers. The following programs are therefore highly recommended:

- To carry out further targeted survey along the northern escarpment and slopes, and in the vicinity of confirmed Brush-tailed Rock-wallaby scat sightings, to ascertain whether further colonies are extant, and if so to estimate the colony size, extent, breeding status and health. These surveys should be undertaken in consultation with the Recovery Team, and for consistency initially follow similar methodology as was applied in May 2006 (see Williams 2006). Suggested initial survey areas are Lovers Leap and Bylong River (each where old Brush-tailed Rock-wallaby scats have been found but no live animals recently reported), as well as along escarpments to the north of the Myrtle Creek sightings and the tributary creekline to the west of the sightings.

- To carry out annual monitoring of the colony at Myrtle Creek, in order to ascertain population trends and make an assessment of long term viability. These surveys should be undertaken by a recognised expert in the field, and be designed in consultation with scientific personnel experienced in long-term population monitoring, population demographic studies, and viability assessment. In consultation with the Recovery Team, genetic samples should be taken at some stage to contribute to taxonomic investigations being undertaken to determine the level of differentiation between genetic sub-groups.
- Following the above, colonies and habitats should be prioritised and ranked in terms of their importance to the long-term survival of the species in the region. High priority sites should be the first target of feral animal control and abatement of any other threatening processes that are identified during the study.
- Prior to completion of the above studies, the Myrtle Creek colony should take high priority in short-term park management planning. The site should be considered for inclusion in the state-wide Fox TAP, and as a site of Wild Dog control.

Stuttering Frog

The Stuttering Frog is known to have disappeared from numerous protected areas, and reservation of habitat alone will not guarantee its survival in north-western Wollemi National Park. As mentioned in Section 4.2.1, further research into this species should be undertaken in the park as part of the national Draft Recovery Plan. The following programs are highly recommended:

- Re-visitation of the two sites discovered in 2005 to determine the impact of the December 2006 wildfire on Stuttering Frog habitat. A reconnaissance survey should be undertaken in late 2007 to determine whether the species persists in these locations.
- Determination of whether amphibian Chytrid fungus is currently present in either of the two known Stuttering Frog populations, or in any other frog species that occur within the catchments of these populations. This should be ascertained by the swabbing of adults and tadpoles (using Chytrid detection swabs) by experienced personnel. If Chytrid is located, an assessment of the level of infection and the impact on the populations should follow. In particular, it would be vital to assess whether the infection with Chytrid fungus it is significantly suppressing recruitment to the adult stage.
- To carry out further targeted survey to ascertain whether further populations occur within north-western Wollemi National Park. These surveys should be centred on habitat types similar to where the two populations were found in 2005, namely where rock pools occur within warm temperate rainforest in sheltered gorges. Survey methodology should follow the standard techniques being developed by the species recovery team. Suggested locations for survey are along the deeply incised upper tributaries of Wollemi Creek, and to a lesser extent tributaries of upper Blackwater Creek. Access will be a major impediment to survey, and will require use of ropes to ascend rock walls and possibly the use of helicopters.
- The two populations discovered in 2005 should be seriously considered as sites for detailed longer term monitoring and population demographic studies, in close consultation with the species recovery team. Such studies should estimate the size and extent of the populations, their health, and their long term viability.
- These surveys must be undertaken with strict adherence to frog hygiene protocols to ensure diseases are not spread between populations or catchments. The Hygiene Protocol for the Control of Disease in Frogs (NPWS 2001e) should be used as a guideline.

Swift Parrot

The Swift Parrot has not been recorded within north-western Wollemi National Park on the Atlas of NSW Wildlife. However, individuals have been seen in close vicinity to the park and it is possible that the species has gone unnoticed within the study area because very few surveys have been undertaken in the winter months. The study area contains numerous winter-flowering tree species, including at least one of the parrot's favoured food trees, White Box. When these trees are in heavy flower, or when other food sources in the region are limited, it is likely that Swift Parrots visit the park. It is recommended that targeted surveys be undertaken during such times, to determine the extent to which the habitat is used. Such surveys need to be undertaken by experienced observers familiar with the species call and could be planned in conjunction with Regent Honeyeater surveys.

Barking Owl

Though the Barking Owl has not recently been recorded within north-western Wollemi National Park, the area contains potential habitat for the species, and may make an important contribution to its regional conservation. It is recommended that further targeted surveys be undertaken in the 'Upper Goulburn Valleys and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes, in order to ascertain whether the species is extant. Surveys should be undertaken using systematic call playback census. If individuals are located, this should trigger management actions within the territories, including protection of roosting and nesting habitats, retention of hollow-bearing trees, and minimisation of disturbance (including fire).

Booroolong Frog

The Booroolong Frog has not been recorded in the study area since 1980. Confirmation of whether this species is extant has important ramifications for the regional conservation of the frog. It is therefore recommended that targeted surveys be undertaken to confidently determine whether the frog persists in north-western Wollemi National Park or not. These surveys should be undertaken after heavy spring or summer rain, by an experienced herpetologist, Sites to target are the permanent and semi-permanent western-flowing rivers and their semi-permanent tributaries, namely Lee Creek, Bylong River, Growee River, Coxs Creek and Cudgegong River (and its tributaries), particularly in areas where riffle zones occur.

Eastern Quoll

Reports of Eastern Quoll sightings near Nullo Mountain and Mount Monundilla warrant investigation and targeted survey. Perhaps the most cost-effective approach to initial investigations would be to use a combination of digital cameras, hair tubes and sand pads. Large meat baits could be used as an attractant, and should be buried into the ground and secured with wire to a central stake. The meat baits should be placed within a sand pad and surrounded with digital cameras that are modified to be triggered by heat and movement. The bait should be left in place for two to three weeks, following the method being trialled in Victoria for Spotted-tailed Quolls (DSE 2007). The bait could also be surrounded by a dense grid of hair tubes, baited with chicken or sardines. The hair tubes should preferably be of a design that has glue on the frontal lip of the tube, and is approximately ten centimetres in diameter, to maximise the possibility of hair capture (D. Andrews pers. comm.). Double-sided tape could also be placed onto the central stake to capture hair from animals wrestling with the meat bait. The bait station(s) should be located in the vicinity of suspected sightings. If photographic evidence of Eastern Quoll is obtained, this would ideally be followed by collection of irrefutable evidence in the form of a blood, tissue or scat sample that can be genetically analysed. This may require the capture of animals, utilising cage traps set for a minimum of seven consecutive nights. Confirmation of the species occurrence would trigger the immediate launching of a research programme to assess the status of the population, identify any threats, and determine the appropriate recovery actions, in line with recommended priority actions for the species (DEC 2005o).

Regent Honeyeater

Targeted survey work is required to determine the relative importance of north-western Wollemi National Park to the conservation of the Regent Honeyeater. The BSP surveys were undertaken towards the end of the flowering period for many key Regent Honeyeater feed tree species, such that the animals' use of the park may have been under recorded. It is recommended that further survey be undertaken in the 'Upper Goulburn Valley and Escarpment' and 'Sydney Basin Western Escarpment' Mitchell Landscapes. These surveys must be undertaken when key feed trees including Red Gum, Yellow Box, Grey Box, White Box and mistletoe on River Oak are in heavy flower. Such surveys need to be undertaken by experienced observers familiar with the species call, and could be planned in conjunction with Swift Parrot surveys. Surveys should be undertaken over at least two flowering seasons, as the species is highly mobile and may not visit the same sites each year. Results of these surveys would give an indication of the role played by north-western Wollemi National Park in the survival of the species as a whole and may have strong implications for the management of the vulnerable habitats along the northern and western perimeter of the study area.

Spotted-tailed Quoll

Further survey work is required to determine the status of Spotted-tailed Quolls in Wollemi National Park and the role that the area plays in the regional conservation of the species. Surveys should involve extensive cage trapping and hair tubing over an extended time period, in areas of potential habitat including moister environments, major gully lines and sheltered lower slopes in the north, east

and south of the study area. Cage trapping is likely to be most successful if traps are set for a minimum of seven consecutive nights (D. Andrews pers. comm.). In addition, surveys for Spotted-tailed Quoll could be undertaken in conjunction with those for Eastern Quoll, employing the use a large meat bait surrounded by digital cameras and hair tubes. A program should also be implemented to encourage neighbours and park visitors to report any sightings of Spotted-tailed Quoll, together with accurate location information and, if possible, a photograph.

4.6.2 Other future work

There is now comprehensive documentation of the fauna characteristics of north-western Wollemi National Park. While additional survey is warranted for some fauna groups, high conservation value habitats and inaccessible parts of the park, a key priority lies in developing information systems that help guide the assessment of wildfire on sensitive fauna habitats.

Fire intensity and detailed vegetation mapping

We recommend that fire intensity mapping be included as a fundamental information resource for park managers. This data should be supplemented by detailed and accurate delineation of vegetation communities from which fauna habitat maps can be derived. Without this information there is no method through which to accurately estimate the impacts of fire on threatened fauna. Nor is it possible to make reliable estimates of populations of the most sensitive species.

Further frog and small terrestrial mammal surveys

The drought of recent years has precluded an understanding of the distribution and abundance of a number of frog species, including Booroolong Frog, Stuttering Frog, and Lesueur's and Stoney Creek Frogs. Since the study area lies close to the extremity of the known range of Fletcher's Frog and Great Barred Frog research into whether they occur and their distribution in the region is warranted. Small terrestrial mammals are not well surveyed as survey for them is labour intensive, costly and often yields few valuable data from which to guide management planning. However, the absence of such survey means information on species such as the Spotted-tailed Quoll, Long-nosed Potoroo and Eastern Pygmy-possum is very limited, thereby restricting the development of effective management guidelines.

Further feral animal surveys

Elsewhere in the state both Feral Deer and Feral Goat have been found to be highly invasive and at high densities have the potential to heavily impact on vegetation structure and threatened fauna species habitats. It is highly recommended that further survey for these species be undertaken across northern Wollemi National Park to determine the species present, current abundance and extent. Where wild populations of Goats or any Deer species are located, immediate management actions are warranted.

Long term monitoring of threatened birds and arboreal mammals in the 'Upper Goulburn Valleys and Escarpment' and 'Sydney Basin Western Escarpment' Mitchell Landscapes

Due to the high number of threatened species that occur along the lower slopes and valleys in the north and south-western perimeters of the study area, and the ongoing threats acting upon these habitats, the establishment of a long term monitoring program is warranted. Such a program would aim to monitor changes in spatial distribution, habitat use and abundance of threatened bird and arboreal mammal species over time. Monitoring sites should be established at a range of distances from the boundary of the park, with replicates at different points up the slope and in different habitat types. The standard systematic bird census can be used in appropriate habitat to survey Turquoise Parrot, Brown Treecreeper (eastern subspecies), Speckled Warbler, Painted Honeyeater, Black-chinned Honeyeater (eastern subspecies), Regent Honeyeater, Hooded Robin (south-eastern form), Grey-crowned Babbler (eastern subspecies), Diamond Firetail and Swift Parrot. Standard systematic spotlight census can be used to survey the Squirrel Glider. Surveys should be undertaken in both spring and late autumn/winter, at least every two years. Censuses must be conducted by experienced observers familiar with the all of the bird species calls. Monitoring sites could also be established in grassy Box woodlands outside of these Mitchell Landscapes, particularly where White Box occurs.

Monitoring of mistletoe load at the boundary between cleared and forested lands

The heavy load of mistletoe that exists at the interface of cleared and forested lands in the 'Upper Goulburn Valley and Escarpment' and 'Sydney Basin Western Escarpment' Landscapes may threaten the long term health of these high conservation value woodlands. Management of this problem is complex, however, as the mistletoe also provides important foraging material for the Painted Honeyeater, as well as numerous other bird species possums, gliders and invertebrates. Mistletoe

loads and associated host tree senescence or death at the boundary of the park should be monitored, at the very least by taking annual photographs at fixed points. If heavy loads are found to result in tree death, or to encroach further into the park, a management plan should be designed and implemented, in consultation with land managers who have addressed the issue elsewhere in south-eastern Australia.

Fauna survey of remote sections of the park

There is a significant gap in the coverage of fauna survey effort across the range between Widden and Myrtle Creek, and between Myrtle Creek and the north-western boundary of the park. Additional survey in this area is likely to assist in providing an improved understanding of distribution trends for some threatened fauna species that are associated with sandstone habitats. However, these surveys are a lower priority than the specific projects outlined above for threatened species, feral species and for the 'Upper Goulburn Valleys and Escarpment' and 'Sydney Basin Western Escarpment' Landscapes.

5 THREATENED SPECIES PROFILES

This section provides a profile of each of the threatened fauna species that is known to occur within north-western Wollemi NP, together with threatened species that have been recorded within a five kilometre radius of the area and are considered highly likely to occur within it. 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 (as at 19th June 2006); and an appraisal of the distribution and status of the species in north-western Wollemi and the surrounding 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 contained herein. Similarly, records with a low reliability of identification have not been included on the maps.

The list of threatened vertebrate fauna for the study area contains records of various levels of reliability. For this reason, a species profile has not been generated for all of the threatened species listed on the DEC Atlas of NSW Wildlife as occurring within the area. Only species that have been directly and reliably observed within the study area, or have been recorded on the Atlas of NSW Wildlife within two kilometres and considered likely to occur within the area, have been afforded a species profile. Table 5 presents all of the threatened species recorded on the Atlas of NSW Wildlife within five kilometres of the study area, together with annotation for each species regarding the latest record, reliability of identification and a rationale for the generation of a species profile.

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within study area[1]		No. of locations within a five kilometre radius of study area[1]	Notes on reliability and date of last record	Species profile generated?
				DEC[2]	Other[3]			
Frogs								
Heleioporus australiacus	Giant Burrowing Frog	V	V	6	0	7	Adult seen in 1997 and several tadpoles seen in 2005-06.	Y
Mixophyes balbus	Stuttering Frog	E	V	2	0	0	Heard calling and tadpoles located during DEC surveys in December 2005.	Y
Pseudophryne australis	Red-crowned Toadlet	V	-	20	0	9	Observed on a number of occasions, mostly recently in December 2005.	Y
Litoria booroolongensis	Booroolong Frog	E	-	0	1	1	Australian Museum specimens collected in 1980 at "Simpsons Gorge", north of Nullo Mountain and in 1979 at Wollemi Creek, just east of the study area.	Y
Reptiles								
Varanus rosenbergi	Rosenberg's Goanna	V	-	5	0	0	Reliably observed within the study area during DEC surveys, most recently in January 2006.	Y
Hoplocephalus bungaroides	Broad-headed Snake	E	V	1	2	1	Historical records exist, and an individual was seen by DEC in September 2005.	Y
Hoplocephalus stephensii	Stephens' Banded Snake	V	-	0	2	0	Reported near Dunns Swamp in 2003, but identification uncertain.	N
Diurnal Birds								
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	0	1	0	Recorded by Birds Australia at Dunns Swamp in May 2001.	Y
Hamirostra melanosternon	Black-breasted Buzzard	V	-	0	0	1	Recorded once flying over Wollemi Creek 4.5 km east of the study area in 2003. Likely to be only an infrequent visitor to the study area and unlikely to rely on habitats therein.	N
Lophoictinia isura	Square-tailed Kite	V	-	0	1	2	Recorded once within the vicinity of Lee Creek in 1985 and twice south-west of the study area in the Capertee Valley.	Y
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	149	23	36	Regularly observed within and around the study area, most recently in April 2006.	Y
Calyptorhynchus banksii	Red-tailed Black-cockatoo	V	-	0	0	1	Highly likely to be a mis-identification. Out of known species range.	N
Calyptorhynchus lathami	Glossy Black-cockatoo	V	-	83	10	19	Regularly observed within and around the study area, most recently in May 2006.	Y
Lathamus discolor	Swift Parrot	E	E	0	0	10	Frequently recorded in the Capertee Valley, south-west of the study area, most recently in 2001. Potential habitat present within the study area.	Y
Neophema pulchella	Turquoise Parrot	V	-	38	5	20	Regularly observed within and around the study area, most recently in February 2006.	Y
Climacteris picumnus victoriae	Brown Treecreeper (eastern subsp.)	V	-	90	21	97	Regularly observed within and surrounding the study area, most recently in May 2006.	Y

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within study area[1]		No. of locations within a five kilometre radius of study area[1]	Notes on reliability and date of last record	Species profile generated?
				DEC[2]	Other[3]			
Pyrrholaemus sagittatus	Speckled Warbler	V	-	47	17	31	Regularly observed within and surrounding the study area, most recently in February 2006.	Y
Grantiella picta	Painted Honeyeater	V	-	3	1	3	Reliably observed within the study area during DEC surveys, most recently in February 2006.	Y
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subsp.)	V	-	47	2	39	Recorded within the study area on numerous occasions, most recently in March 2006.	Y
Xanthomyza phrygia	Regent Honeyeater	E	E	1	8	60	Reliably recorded within and around the study area, most recently in September 2005.	Y
Melanodryas cucullata cucullata	Hooded Robin (south-eastern subsp.)	V	-	5	5	34	Reliably recorded within and around the study area, most recently in February 2006.	Y
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subsp.)	V	-	1	4	10	Reliably recorded within and around the study area, most recently in September 2005.	Y
Stagonopleura guttata	Diamond Firetail	V	-	23	8	55	Frequently recorded within and around the study area, most recently in February 2006.	Y
Nocturnal Birds								
Ninox connivens	Barking Owl	V	-	0	1	7	Recorded once in the study area by Birds Australia in 1979. Reliably recorded around the study area, and potential habitat present within.	Y
Ninox strenua	Powerful Owl	V	-	23	6	3	Frequently recorded within and around the study area, most recently in April 2006.	Y
Tyto novaehollandiae	Masked Owl	V	-	1	0	1	Heard calling during DEC surveys on Towinhingy Creek in March 2006 and in Baerami Valley, approximately 3 km east of the study area, in May 2005	Y
Tyto tenebricosa	Sooty Owl	V	-	7	4	1	Reliably and repeatedly recorded within study area, most recently in March 2006.	Y
Mammals								
Dasyurus maculatus	Spotted-tailed Quoll	V	E	1	2	7	Infrequently recorded in study area, most recently by hair collected in March 2006.	Y
Phascolarctos cinereus	Koala	V	-	1 (prob. only)	0	2	Scat probably belonging to Koala recorded in 2005. Historical record from Nullo Mountain and traces detected to the south-east of the study area during CRA. Potential habitat present.	Y
Cercartetus nanus	Eastern Pygmy-possum	V	-	3	0	0	Identified from remains during DEC surveys in November 2005.	Y
Petaurus australis	Yellow-bellied Glider	V	-	101	0	24	Regularly observed within and surrounding the study area, most recently in May 2006.	Y
Petaurus norfolcensis	Squirrel Glider	V	-	6	0	4	Reliably recorded within the study area, most recently in March 2006.	Y

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within study area[1]		No. of locations within a five kilometre radius of study area[1]	Notes on reliability and date of last record	Species profile generated?
				DEC[2]	Other[3]			
Potorous tridactylus	Long-nosed Potoroo	V		0	0	1	Recorded once in 1970, but spatial reliability is uncertain. Not likely to persist within study area.	N
Macropus parma	Parma Wallaby	V	-	0	0	1	Hair collected and identified as 'possible' Parma Wallaby during CRA surveys in 1997 on south-eastern side of Mount Coricudgy. Very limited potential habitat present within the study area.	N
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	7	11	6	Reliably recorded within the study area, most recently in May 2006.	Y
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	1	0	1	Observed once during DEC surveys in November 2005 and once 4 km east of the park boundary in 1998.	Y
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	1	0	0	Identified from ultrasonic call in January 2006.	Y
Mormopterus norfolkensis	East-coast Freetail-bat	V	-	1	0	5	Identified from ultrasonic call at boundary of park in November 2005.	Y
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	51	2	8	Reliably recorded within the study area, most recently in February 2006.	Y
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	14	0	12	Reliably recorded within the study area, most recently in January 2006.	Y
Miniopterus australis	Little Bentwing-bat	V	-	0	0	1	Detected by Anabat near Wollemi Creek, 4.5 km east of the study area, during CRA surveys in 1998. Likely to be only an infrequent visitor to the study area, and unlikely to rely on or breed in habitats located therein.	N
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	18	0	16	Regularly and reliably recorded within and surrounding the study area, most recently in December 2005.	Y
Myotis adversus	Large-footed Myotis	V	-	0	0	3	Most recently recorded by DEC in November 2005 on the Capertee River, 1.5 km west of the study area. Potential habitat present within the study area.	Y
Nyctophilus timoriensis	Greater Long-eared Bat	V	V	1	0	2	Reliably recorded by DEC in and around the study area, most recently in September 2005.	Y
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	3	0	3	Reliably recorded in and around the study area, most recently in February 2006.	Y
Vespadelus troughtoni	Eastern Cave Bat	V	-	3	0	2	Reliably recorded in and around the study area, most recently in September 2005.	Y

E Endangered V Vulnerable

[1] Numbers indicate the number of locations for the species, rather than the number of individuals

[2] Includes all records collected during CRA and Biodiversity Survey Priorities fauna surveys

[3] Includes records on the NSW Wildlife Atlas obtained from sources other than DEC systematic survey

Table 6: Threatened fauna species recorded within and around north-western Wollemi National Park on the Atlas of NSW Wildlife, as at 19th June 2006

GIANT BURROWING FROG

Species Profile

The Giant Burrowing Frog (*Heleioporus australiacus*) is a large (up to ten centimetres) rotund ground-dwelling frog. Its powerful limbs are used to excavate burrows where they 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 2001d). It has been suggested that this disjunct distribution may reflect two separate species, though at present evidence is inconclusive (Penman *et al.* 2004).

Plate 18: Giant Burrowing Frog © N. Williams/DEC

Threats

The primary threat to the Giant Burrowing Frog in NSW is development of its preferred habitat for housing and agriculture (NPWS 2001d). Other threats are not well known but may include alteration of drainage patterns, infection by Chytrid fungus, road mortality, water pollution, frequent fire and forestry operations (DEC 2006c). As a large, slow moving species, it is also likely to be vulnerable to predation by Foxes and Feral Cats. Long wall mining may be a significant future threat (NSW Scientific Committee 2005a) as it can drain upland swamps that have been shown to be important breeding habitat for the Giant Burrowing Frog.

Local and Regional Conservation Status

The Giant Burrowing Frog is listed as Vulnerable under the NSW TSC Act (1995) and the Commonwealth EPBC Act (1999). The Sydney Basin population is thought to have declined considerably, with tadpoles being encountered far less frequently than in the past (Anstis 2002). The species has been recorded within a number of Sydney Sandstone reserves including Royal, Ku-ring-gai Chase, Garigal and Brisbane Waters National Parks and across the Woronora Plateau. Fewer records have been obtained in Blue Mountains, Nattai and Yengo NPs and Bargo State Conservation Area, as well as the southern section of Wollemi National Park. Penman *et al.* (2004) consider the Giant Burrowing Frog to be well represented within the reserve system in the Sydney Basin Bioregion.

The Giant Burrowing Frog was first recorded within the study area during CRA surveys in 1997, when an adult was seen on the Hunter Main Trail, approximately three kilometres east of Mount Coricudgy. A tadpole was located very close to this locality in 2005, in an upland swamp just north of the Hunter Main Trail (Map 9). Tadpoles of the species have been recorded at four further locations in the park, including Myrtle Creek, a small drainage channel running east of Cottage Rock, Numietta Creek west of Glen Alice and Gospers Creek (Map 9). The locations in which the species has been recorded in the park fall into two main habitat types: within or in the vicinity of upland swamps and near the headwaters of minor drainage channels; or on larger creeklines with alluvial sand and rocky pools surrounded by tall moist forest. The frog is likely to breed in a number of other locations within the reserve, particularly along sandy creeklines with rock pools, such as Wollemi and Koondah Creeks, and in upland swamps that occur in seepage areas on the sandstone plateaux.

Northern Wollemi National Park lies at the extreme north-western limit of the range of Giant Burrowing Frog, with the northern and western escarpments appearing to form the boundary of the species distribution. The role that Wollemi and neighbouring Yengo National Parks play in the conservation of this species is therefore highly significant, and pivotal to ensuring that the species persists at this north-western edge of its distribution. The frog appears to currently be secure within the study area, and does not require any immediate management actions. Management may be required in the future if Chytrid is discovered to be affecting populations, or if scientific research confirms that feral predators and/or frequent fire impose a significant threat to the species in wilderness areas.

STUTTERING FROG

Species Profile

The Stuttering Frog (*Mixophyes balbus*) is a large frog (reaching up to eight centimetres) that is highly camouflaged in the wet leaf-litter of the forest floor. After summer rains the males make a call that includes a soft stuttering, from which the species gets its common name. 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, often in rainforest or wet sclerophyll forests (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 autumn and winter (Anstis 2002). This frog was once found along the coast and ranges between northern NSW and Victoria, though it is now found only patchily throughout its former distribution (Daly 1998, Anstis 2002). Recent research has identified genetic divergence and isolation between populations north and south of the Taree district (N. Doak unpubl. data in Hunter & Gillespie 2006).

Plate 19: Stuttering Frog © N. Williams

Threats

The threats to this species are poorly understood. However, the main ones are thought to be habitat fragmentation and degradation, leading to the isolation of sub-populations and increased vulnerability to other threats and to local extinction (NSW Scientific Committee 2002b). The Stuttering Frog is threatened by the introduced pathogen, Chytrid fungus (Hunter & Gillespie 2006). This fatal disease particularly affects higher altitude frog populations and stream-breeding frog species (NSW Scientific Committee 2003b). 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 (DEC 2004b) 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*) (Daly *et al.* 2002). Climate change is likely to have a negative impact on the Stuttering Frog in the future (Hunter & Gillespie 2006).

Local and Regional Conservation Status

The Stuttering Frog is listed as Endangered under the NSW TSC Act (1995) and Vulnerable under the Commonwealth EPBC Act (1999). Within NSW, nearly all records are within the three eastern Bioregions (DEC 2006b). Within the southern portion of its range, particularly south of Sydney, the frog has declined dramatically in recent times (Daly *et al.* 2002, Gaia Research 2006b) and within the greater southern Sydney region only two localities are known to continue to support the species (DEC 2006a). North of Sydney the species is more widely distributed, but still with only very patchy occurrence (NSW Scientific Committee 2002b). Between the Hunter River and Sydney, known populations are concentrated between Gosford and the Watagan Mountains, with the closest site north of the Hunter being in Barrington Tops (NSW Scientific Committee 2002c). In the Sydney Basin Bioregion this frog is known to persist within a few public lands including Watagan, Blue Mountains and Macquarie Pass National Parks, as well as within Olney, Strickland and Awaba State Forests (DEC 2006b).

Three frogs were heard calling in December 2005 near the convergence of two minor tributaries of Wollemi Creek, south of the Hunter Main Trail (Map 9). One of these individuals was then sighted (Plate 6) in dense leaf litter located on a ledge approximately one metre above a small deep pool of water (Plate 20). Stuttering Frog tadpoles were discovered at a second location, in a rock pool near the headwaters of Blackwater Creek (Map 9). Photographs of the tadpoles were shown to G. Daly and A. White to gain their opinion on identification. Based on their size, these tadpoles are thought to be in the range of nine months old (estimated by G. Daly, pers. comm.). The surrounding habitat at both locations is warm temperate rainforest with Coachwood and Sassafras in the canopy and Treeferns in the understorey. The elevation of both sites is approximately 700 metres asl. This elevation is significant as there is only one other known upland population of the species south of the Hunter Valley, at Mount Werong in the southern Blue Mountains (DEC 2004b).

These sightings indicate that at least one or two breeding populations of Stuttering Frog currently occur within north-western Wollemi National Park. This discovery is very significant, as populations of the species have not previously been recorded in the region. The closest known extant population is located at Barrington Tops, north of the Hunter River, while historic accounts of the species derive from Australian Museum specimens collected in Newnes State Forest in the 1960s and 1970s. In addition, a single individual was sighted at Victoria Falls (40 kilometres south of the Capertee River) in 2002, but it is unknown whether this represents a surviving population. The species appears to be close to extinction in the greater southern Sydney region, though once it was not uncommon through the wetter forests and rainforests of the Blue Mountains and, in particular, the Illawarra Escarpment (G. Daly pers. comm. in DEC 2006a).

The discovery of the population(s) in northern Wollemi yields important information on the current distribution of the species. Further populations are considered highly likely to occur within remote sheltered gorges and canyons in the south-eastern third of the study area, and indeed elsewhere within inaccessible parts of Wollemi National Park. The persistence of the Stuttering Frog in the reserve has extremely high conservation significance and, like all extant populations (Hunter & Gillespie 2006) is considered critical to the long term survival of the species as a whole, and particularly to its survival within the southern half of its current range.

Plate 20: Site of adult Stuttering Frog sighting © N.Williams/DEC

The Stuttering Frog is known to have disappeared from numerous protected areas, and reservation of habitat alone will not guarantee its survival. The greatest threat to the survival of the Stuttering Frog in Wollemi National Park is infection by Chytrid fungus. This virulent disease is thought to have severely affected populations of the species at Macquarie Pass and Mount Werong, where tadpoles carrying the disease appear to die during or shortly after metamorphosis, drastically limiting recruitment to the adult population (DEC 2004b, G. Daly pers. comm.). Neither the Stuttering Frog, nor any other frog species located within the study area, has been tested for Chytrid fungus. It is possible that the minimal amount of human visitation and disturbance has limited the spread of the disease in the park, as in other regions humans are a well-recognised vector for the fungus (which can be transported on wet shoes, car tyres, etc). However, given the widespread occurrence of the pathogen in eastern Australia, it is almost certain to occur at some localities within the study area. It is highly recommended that swabbing be undertaken to test for Chytrid fungus in the adults and tadpoles of the Hunter Range Stuttering Frog population, together with further surveys to assess the extent and approximate size of the population (see Section 4.6.1 of this report). Such surveys must be undertaken with strict adherence to frog hygiene protocols to ensure diseases are not spread between populations or catchments. The Hygiene Protocol for the Control of Disease in Frogs (NPWS 2001e) should be used as a guideline, as should consultation with recognised experts who are up to date with research into frog diseases.

Management actions for the species should be considered in the very near future, in consultation with the NSW species recovery team and the national recovery plan (Hunter & Gillespie 2006). In the mean time, visitation to breeding sites should be restricted and the frogs should remain undisturbed as much as possible.

RED-CROWNED TOADLET

Species Profile

The Red-crowned Toadlet (*Pseudophryne australis*) is a small (20 to 25 millimetres), strikingly coloured litter-dwelling frog. It is fairly restricted in its distribution, generally only occurring on the Hawkesbury and Narrabeen sandstone geologies of the Sydney Basin. The Red-crowned Toadlet lays its eggs in moist leaf litter, relying on rain to wash the eggs into ephemeral ponds where they can complete their development (NPWS 2001f). The species is gregarious, being found in colonies of up to 30 individuals (Barker *et al.* 1995). It will breed at any time of year in order to take advantage of unpredictable rainfall events (Thumm and Mahony 2002).

Plate 21: Red-crowned Toadlet © A. Dudley

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 2001f). The Red-crowned Toadlet has a high level of reproductive failure (Thumm & Mahony 2002) and due to its size and morphology, has only a limited ability to disperse, which is likely to make populations vulnerable to local extinction. 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 2003c, 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 the major populations occurring in the upper Blue Mountains, around the mouth of the Hawkesbury River and the Woronora Plateau extending to Royal National Park. Throughout its range it has been recorded in numerous reserves, from Yengo and Wollemi National Parks in the north to Barren Grounds Nature Reserve in the south (DEC 2006b), including some within the Sydney urban area, such as Lane Cove National Park (DEC 2004f).

The Red-crowned Toadlet was first recorded within the study area during CRA surveys in 1997, when it was detected at two locations near Mount Monundilla and one location west of Gospers Mountain (Map 9). During this time, the species was also detected at several locations further east on the Hunter Main Trail, indicating the species to be fairly common along the Hunter Range, within the headwaters of creeklines that flow both north and southwards. The 2005-06 surveys located Red-crowned Toadlets at additional locations on the Hunter Range, and found the species to also be relatively common in the south-eastern third of the study area (Map 9). This little frog was seen or heard calling in a number of localities on the sandstone plateaux, including seepage areas around the base of pagoda rock formations and in first and second order creeks and drainage channels.

The records of Red-crowned Toadlet in north-eastern and north-western Wollemi National Park are the most north-westerly known localities of the species. The northern and western escarpments appear to comprise the limit of the species distribution, providing further evidence to the assertion that the species is entirely restricted to the sandstone geologies of the Sydney Basin Bioregion. The species has recently been recorded within southern and eastern Wollemi, Yengo, Blue Mountains and Nattai National Parks, providing contiguous habitat for the species around the western edge of the Sydney Basin. The large amount of potential habitat conserved within the sandstone geologies of northern Wollemi National Park is vital to the conservation of the species at the northern extremity of its range, while the largely uninterrupted connection with other reserves contributes to preservation of the full variation of the species across its distribution.

As the majority of threatening processes known for this species are not present throughout the majority of north-western Wollemi National Park, the Red-crowned Toadlet appears to currently be secure within the study area and does not require any immediate management actions. Management 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.

BOOROOLONG FROG

Species Profile

Plate 22: Booroolong Frog © M. Pennay

The Booroolong Frog (*Litoria booroolongensis*) is a medium-sized frog that is similar to others in the *lesueuri* group (*L. lesueuri, L. wilcoxi and L. jungguy*) (Donnellan and Mahony 2004). The Booroolong Frog may be reliably distinguished by the extension of the webbing to the base of the first inner toe pad on the hind foot, a mottled dorsum with a scattering of salmon-coloured flecks, and an indistinct black stripe passing through the eye and over the tympanum to the shoulder (Gillespie 1999); and by its call. The species was formerly known from the tablelands and slopes of New South Wales, from catchments draining the Northern Tablelands to the Tumut River in the Southern Highlands and other tributaries of the Murrumbidgee River, and has recently been discovered in Victoria (Gillespie 1999). This frog typically inhabits rocky western-flowing creeks and their headwaters, although a small number of animals have also been recorded in eastern-flowing streams (NSW Scientific Committee 1998b). Adults are typically found sheltering under boulders or cobbles near riffles along the stream bank, in both forested areas and open pasture (Gillespie 1999). In spring, eggs are deposited in rock crevices in the stream or in isolated streamside pools and tadpoles metamorphose in January and February (Gillespie 1999).

Threats

Tadpoles of the Booroolong Frog are vulnerable to predation by exotic fish species including Brown Trout, Rainbow Trout (*Oncorhynchus mykiss*) and European Carp (*Cyprinus carpio*) (NSW Scientific Committee 1998b, DEH 2004d). Nearly all streams occupied by the Booroolong Frog are also inhabited by introduced fish, particularly Trout, which may be stocked in very high numbers (DEH 2004d). Land and water degradation, flow modification and weed invasion of riparian areas (particularly by Willow (*Salix* spp.)) each pose a threat to the species across its range (DEH 2004d). Another significant threat is infection by Chytrid fungus (DEH 2004d), listed as a Key Threatening Process on the NSW TSC Act (1995) and the federal EPBC Act (1999). This disease has had a particularly dramatic impact on stream-dwelling species at high altitudes in recent years (NSW Scientific Committee 2003b, DEH 2004d).

Local and Regional Conservation Status

The Booroolong Frog is classified as Endangered under the NSW TSC Act (1995) and is currently under nomination for inclusion as an Endangered species under the EPBC Act (1999). Formerly, the species was present in three main concentrations: the New England Tablelands, the Central Tablelands and the western side of Kosciusko National Park (DEC 2006b, DEH 2004d). Aside from two locations near Tamworth, Booroolong Frog have not been found in the northern part of their range since 1994 (Anstis 2002, DEH 2004d) and it is suspected that the species is virtually extinct in this area (NSW Scientific Committee 1998b, DEH 2004d). The Booroolong Frog has also declined severely across the remainder of its range (DEH 2004d), with only a handful of recent records from the Central Tablelands area. The species is not well represented within conservation reserves, though it is known from Abercrombie River, Turon, Kosciusko and Woomargama National Parks. There are historical records from within Blue Mountains National Park, though populations in these areas appear to have been lost (NSW Scientific Committee 1998b).

The Booroolong Frog has not been recorded within the study area since 1980, when an Australian Museum specimen was collected north of Nullo Mountain (Map 9). This location is in the catchment of the Hunter River, though given the time that it was collected, the spatial accuracy is likely to be low. Specimens were also collected in neighbouring areas, including from the junction of Wollemi Creek, Capertee and Colo River in 1979, and Goulburn River National Park in 1980 (DEC 2006b). The nearest known extant population is located in Turon National Park, west of the Capertee Valley.

Extensive surveys for the Booroolong Frog were not undertaken during 2005-06, due to time and weather limitations. Central Tablelands environments extend some way into the western edge of Wollemi National Park. It is possible that the species persists within one or more of the permanent western-flowing creeks, but has gone undetected. Further survey work is required to ascertain this, in the form of nocturnal surveys in late spring/summer after heavy rain.

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 commonly encountered Lace Monitor though morphologically and taxonomically it is closer to the Sand Monitor (*Varanus gouldii*). 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, and from the Sand Monitor by the lack of a distinctive plain yellow tail tip. This goanna is known to be associated with sandstone environments, 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 1996).

Plate 23: Rosenberg's Goanna © N. Corkish/DEC

Threats

Rosenberg's Goanna is particularly threatened in urban fringes, where the species is subject to pressure from development of the flat sandstone ridgetops that are its preferred habitat. Road mortality is also of concern (NPWS 2002a). Goannas have been identified as taking 1080 baits (Thomson and Kok 2002) and thus may be impacted upon by Dog and Fox control programs. Nests and juveniles of the species may also be vulnerable to predation by Feral Cats and Dogs (DEC 2005i). 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 2003c).

Local and Regional Conservation Status

Rosenberg's Goanna is listed as Vulnerable under the NSW TSC Act (1995). It is a poorly understood species and there is still much to be learnt about its distribution and habitat preferences. Previously the NSW population was thought to be restricted to the Hawkesbury and Narrabeen sandstones, particularly coastal areas such as Ku-ring-gai Chase, Dharug and Morton National Parks and the Woronora Plateau. Survey work conducted by DEC over the last few years has confirmed it to be present elsewhere in the region, with confirmed sightings from Abercrombie River, Turon and northern Wollemi National Parks. In addition, there are 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.).

Rosenberg's Goanna was first recorded within the study area on the Growee Trail in 1997, and detected at five further locations during the BSP surveys (Map 9). While all of these sightings were made on the sandstone plateaux, they are quite widely dispersed, ranging from just above the sandstone escarpment above the Myrtle Creek and Bylong River Valleys, to south of Mount Coricudgy and Tayan Peak. The Goanna has not been recorded by any other park visitors, suggesting that it is likely to have gone undetected in parts of the park where systematic surveys have not been undertaken. Rosenberg's Goanna is highly likely to be patchily distributed across the sandstone plateau, particularly on rocky ridges and upper slopes. However, the density of occurrence is unknown and would only be able to be determined by further survey.

The records of Rosenberg's Goanna in north-western Wollemi National Park constitute the most north-westerly occurrence recorded on the Atlas of NSW Wildlife (DEC 2006b). This suggests that the Hunter and Goulburn Valley escarpments form the northern boundary of the species distribution in central New South Wales, and provides further evidence that in this region it is restricted to sandstone environments. Further survey within potential habitat would be required to determine the status of the species at this far north-western limit of its range. No immediate management actions are currently required for the species.

BROAD-HEADED SNAKE

Species Profile

Plate 24: Broad-headed Snake © A. Dudley

The Broad-headed Snake (*Hoplocephalus bungaroides*) is a semi-arboreal species that spends the cooler part the year under sandstone exfoliations and around rock outcrops, and the summer sheltering in tree hollows in woodland (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 National Park and the Clyde River catchment, south west of Nowra. Within this range it has disappeared from such areas as Port Jackson and Middle Harbour, and on the western edge of its distribution around Bathurst. It is primarily a nocturnal ambush predator (NPWS 1999a) and is known to prey on Lesueur's Velvet Gecko (*Oedura lesueurii*).

Threats

A key threat to the Broad-headed Snake is the collection of bush rock for landscaping (Shine and Fitzgerald 1989, NSW Scientific Committee 1999b). This activity, although now either prohibited or requiring permits in most local government areas, is still widely practiced illegally. Removal of rock not only threatens this species directly, but removes habitat for its main prey species, Lesueur's Velvet Gecko. In addition, the Broad-headed Snake is colourful, rare and venomous, making it prized by snake-collectors and hence collection of specimens from the wild is also a threat (NPWS 1999a). Other potential threats include urbanisation of sandstone ridgetops, altered fire regimes and the impacts of feral animals, through both predation and disturbance (NPWS 1999a). In particular, disturbance of rock outcrops by Feral Goats has been highlighted as a potential threat (Murphy 1996). Webb and Shine (1997) also note that this species may be vulnerable to logging operations due to its reliance on tree hollows for part of the year. Habitat alteration by longwall mining and the removal of dead wood and dead trees are other Key Threatening Processes thought to impact upon this snake (NSW Scientific Committee 2005a, 2003c). It is also postulated that increase in vegetation density due to long term fire suppression has resulted in a reduction in winter habitat (Pringle *et al.* 2003).

Local and Regional Conservation Status

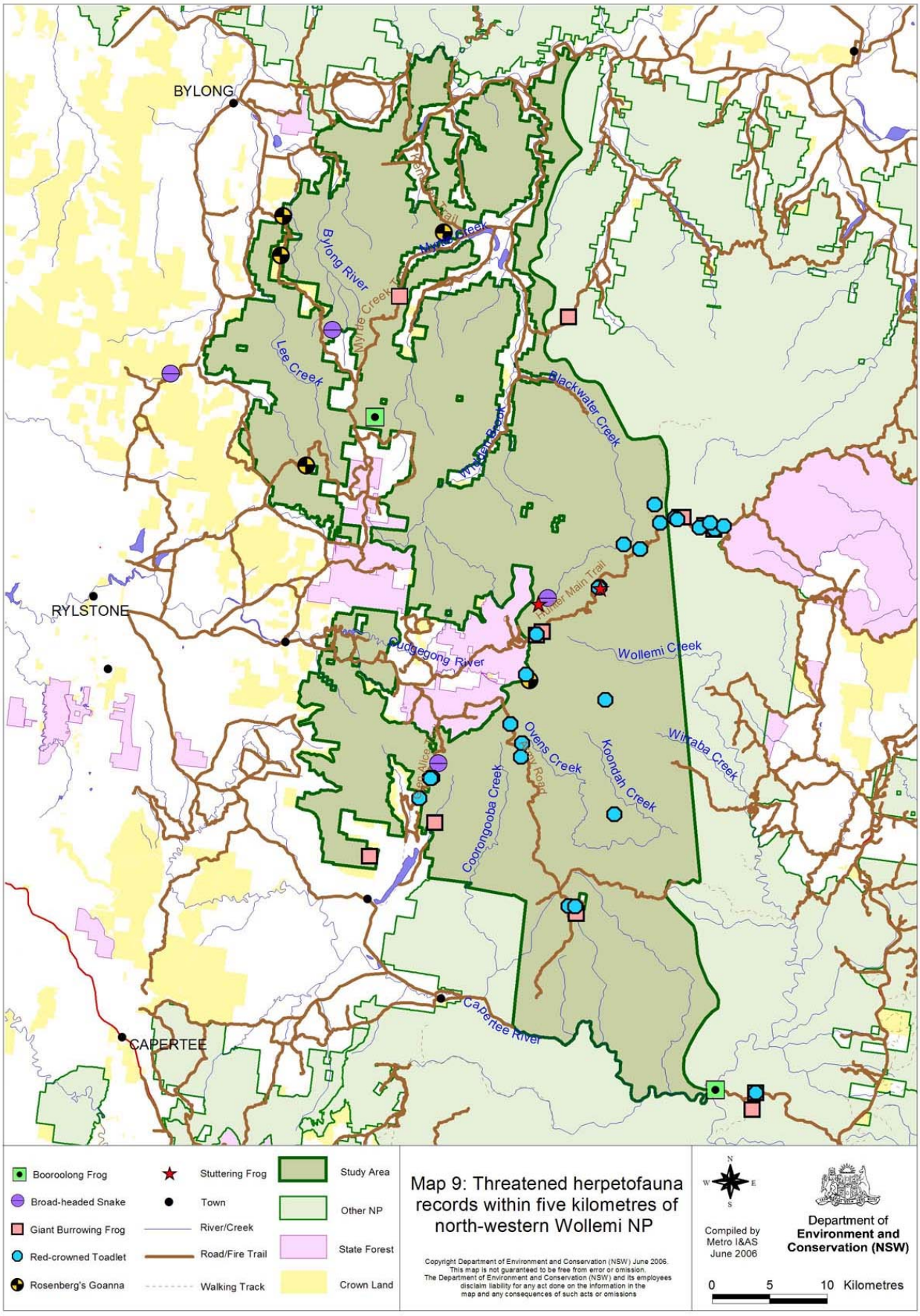
The Broad-headed Snake is listed as Endangered under the NSW TSC Act (1995) and Vulnerable under the Commonwealth EPBC Act (1999). It is restricted to the Hawkesbury and Narrabeen sandstones of the Sydney Basin Bioregion and has disappeared from many locations where it was once well-known to occur. Remaining strongholds appear to be the upper Blue Mountains, southern Wollemi and Royal National Parks extending on to the Woronora Plateau. There is also a population in eastern Morton National Park, west of Nowra, where the species is regularly observed.

The Broad-headed Snake has been observed on three occasions within the study area and reported once during the 1980s from three kilometres to the west (Map 9). One of these study area records is an historical account of the snake in Blackwater Creek from 1963, and the second is of uncertain reliability. The third sighting was made during the BSP surveys, when the snake was positively identified on a rocky sandstone bench north-west of 'Box Ridges' in mid-September. The location of the sighting conforms to known habitat preferences of the species, being exposed rock outcrops in the winter and early spring and more sheltered vegetated areas in the summer. The Broad-headed Snake is likely to also persist in other parts of the Narrabeen sandstone plateaux where such habitat features abound, particularly remote sections located far from roads and access points.

The discovery of the Broad-headed Snake in 2005 was very significant as it confirmed that this rarely recorded species persists in the study area. Furthermore the record constitutes a small north-westerly range extension of the species known distribution. The closest confirmed recent sightings of Broad-headed Snake are located east of Wollemi Creek (just over five kilometres east of the study area), where it was detected at two locations in 1998 (DEC 2006b). Elsewhere in the region, it has been sighted on the Wolgan River in 1999 and at several sites north-east of Blackheath in the late 1990s (DEC 2006b). As far as is known, however, monitoring has not been undertaken at these sites to

ascertain whether the snake remains extant. The scarcity and age of other records in the region highlights the significance of the 2005 sighting, and the importance of the information it provides on the current range of the species.

The greatest threats to the Broad-headed Snake in north-western Wollemi National Park are removal of bush rock, removal of dead wood and disturbance of rock outcrops by Feral Goats. The first two of these threats are only likely to be significant in the vicinity of roads and access points, such as the trail between Bylong River and Myrtle Creek, the Hunter Main Trail and the Army Road. Remote sections of the park are much less subject to such impacts, and are not currently known to be inhabited by Feral Goats. However, it is unknown if or where the species occurs in these parts. Further survey would be required to approximate the status of the Broad-headed Snake in the park. Conservation of the snake at this north-western edge of its range is very important to the species as a whole. The only management actions currently required are Feral Goat control and continued limitation of access to extensive areas of habitat.



Map 9: Threatened herpetofauna records within five kilometres of north-western Wollemi National Park

BLACK-NECKED STORK

Species Profile

The Black-necked Stork (*Ephippiorhynchus asiaticus*) is a large conspicuous black and white bird with an iridescent green and blue sheen on its glossy black head and neck, a large straight black bill and long red legs. It stands at over one metre tall and has a wingspan of around two metres (Marchant and Higgins 1990). The species occurs from Pakistan, India and Sri Lanka to Vietnam, north Malaysia, New Guinea and Australia (Marchant and Higgins 1990), with its core distribution in Australia being the tropical and warm-temperate north. The species also occurs down the east coast, becoming increasingly uncommon further south into NSW, but having been recorded as far south as Victoria and inland to the Macquarie Marshes and Griffith (NSW Scientific Committee 1998c). The range of the Black-necked Stork has contracted to the north and east since European colonisation, while the number of birds recorded at the southern and western limits of its range has declined significantly (NSW Scientific Committee 1998c). Individuals are now only occasionally recorded south of Sydney or west of the Great Dividing Range during favourable conditions, and breeding has not been recorded south of Port Stephens for many years (NSW Scientific Committee 1998c). It inhabits permanent freshwater or occasionally inter-tidal shorelines or estuaries, feeding in shallow still water on fish, frogs, turtles, crustaceans and snakes (Marchant and Higgins 1990). Individuals are largely sedentary, though some birds, particularly immature ones, move long distances outside their normal range. To breed it constructs a very large stick nest in the top of a tall tree, usually laying two to four eggs (Marchant and Higgins 1990).

Threats

The greatest threat apparent to the Black-necked Stork in NSW is clearing and disturbance of river valleys, inhibiting successful breeding and increasing competition with other birds for the limited remaining nesting resources (NSW Scientific Committee 1998c). Loss of dead trees and of nest trees from wetland areas is a significant problem. Wetland destruction, modification and degradation are threats, together with alteration of natural flow regimes, as although artificial water sources provide areas of new habitat, these are often sub-optimal for the species (NSW Scientific Committee 1998c). The species is sensitive to disturbance and so is unlikely to breed in waterbodies adjacent to residential development. Several birds are killed or injured each year as a result of collision with powerlines, comprising a high percentage of the total population within each northern river valley and thereby posing a threat to the ongoing viability of the species in NSW (NSW Scientific Committee 1998c).

Local and Regional Conservation Status

The Black-necked Stork is listed as Endangered under the NSW TSC Act (1995), on the basis of contraction in its range and reduction in numbers and in breeding success at the southern and western extremities of its distribution. In NSW the largest concentration of records is within the NSW North Coast Bioregion, with fewer records in the Sydney Basin Bioregion and scattered records west of the Great Dividing Range (DEC 2006b). Most of the sightings in the Sydney Basin Bioregion have been made in coastal habitats north of Gosford, particularly around the lakes and swamps of the Central Coast (DEC 2006b). Few of these records fall within conservation reserves, though the species has been seen within Hexham Swamp Nature Reserve and Munmorah State Conservation Area.

Black-necked Stork has been observed on one occasion within north-western Wollemi National Park, by a Birds Australia observer just south of the Kandos Weir in May 2001 (Map 10). This is a significant record, as the species has rarely been observed so far west in recent years (DEC 2006b). The species is probably only a rare visitor to the park, and is unlikely to breed within the area. Dunns Swamp provides the largest amount of suitable habitat within the study area, though it is possible that the species also visits the creeks and artificial water bodies within the valleys that intrude into the northern boundary of the park, as well as the Capertee River. North-western Wollemi National Park provides only marginal habitat for the Black-necked Stork and is unlikely to make a significant contribution to the overall conservation of the species in NSW. The habitat is likely be significant on a local scale, however, and may provide an important stop-over site for individuals moving through the region.

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).

Plate 25: Square-tailed Kite © T. Tarrant

Threats

Loss of habitat through land clearance is likely to be a major threat (NPWS 1999b), though it has been suggested that the Square-tailed Kite may also have benefited from partial clearance (Garnett and Crowley 2000). NPWS (1999b) 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 National Parks.

The Square-tailed Kite has only been recorded on one occasion within north-western Wollemi National Park, seen in the vicinity of Lee Creek in January 1985 (Map 10). The species is often sighted in the Capertee Valley (DEC 2006b), is known to breed in Goulburn River National Park (NPWS 2001b) and is occasionally seen flying over agricultural lands west of the park. Given this, the Square-tailed Kite is considered likely to occur elsewhere in the north-west of the study area in summer, particularly the woodlands on Permian geologies below the northern and western escarpments and the fringing valley floors. These areas have significance for the conservation of the species in the locality, but may only be of moderate significance on a regional scale.

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. It is 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, which occurs between October and January (Pizzey and Knight 1999).

Plate 26: Gang-gang Cockatoo © K. Madden/DEC

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). 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 2004e). 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 has recently been listed as a Vulnerable Species under the NSW TSC Act (1995). 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 (in addition to Wollemi) Kanangra-Boyd, Blue Mountains, Nattai and Yengo National Parks.

Within the study area the species has been recorded at over 150 locations between 1977 and 2006 (Map 10). This distinctive bird has been frequently recorded wherever systematic surveys have been undertaken, though the density of sightings decreases at lower elevations in the far north of the reserve. Records have been collected during various times of the year, including spring, summer, autumn and winter, suggesting that the study area provides habitat for the cockatoo all year round. At least one record of breeding was made during the BSP surveys, north of Gospers Mountain. The lower density of records at low elevations is a reflection of the fact the majority of surveys were undertaken in spring and summer, when Gang-gangs move to higher environments. The Box-Ironbark woodlands at lower elevations hold great importance, however, as they provide potential winter habitat for the species. Such habitat has been extensively cleared for agricultural and urban development, while much remaining habitat outside reserves is under ongoing pressure. Importantly, north-western Wollemi National Park lies towards the northern limit of the Gang-gang Cockatoo's range; the species has been recorded in only four reserves further north, including Goulburn River, Mount Royal and Barrington Tops National Parks and Manobalai Nature Reserve (DEC 2006b).

Conservation of the species within the study area is important to the continued conservation of species at the northern edge of its range. The species is widespread across the sandstone reserves of the Sydney Basin, and is currently considered to be relatively secure in the region. No management actions are currently required for the Gang-gang Cockatoo in north-western Wollemi National Park.

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, with yellow patches in the female, and red tail panels. It is usually seen in pairs or trios (with dependant young) in eucalypt woodland or forest, where it nests in 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).

Plate 27: Glossy Black-cocklatoo © N. Williams/DEC

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 (*Eolophus roseicapillus*). 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 2003c), as is competition from feral Honeybees (*Apis mellifora*) (NSW Scientific Committee 2002d). Illegal trapping for aviculture may be a localised, minor threat (Garnett and Crowley 2000). In addition, DEH (2004e) 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 NSW TSC Act (1995). Being a large, conspicuous species 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 1999c). Relatively large areas of the Sydney Basin provide suitable habitat for the species and there are a large number of records throughout the Bioregion (DEC 2006b). Feeding habitat is well protected, occurring in numerous DEC reserves, including Morton, Nattai, Blue Mountains, Ku-ring-gai Chase, Yengo and southern Wollemi National Parks.

The Glossy Black-cockatoo has been recorded at over 80 locations within the study area between 1977 and 2006. Approximately half of these records derive from evidence of the birds activity (as opposed to direct observation) in the form of chewed *Allocasuarina* cones that are left behind after feeding. The locations of sightings are shown in Map 10 and range from the far north of the study area to Army Road. The large majority of the records lie on Narrabeen Sandstone, where Forest Oak (*Allocasuarina torulosa*) or Black She-oak (*Allocasuarina littoralis*) form a component of the small tree layer, particularly in sheltered locations. Of the areas where systematic survey has been undertaken, the number of birds actually observed appears to be lowest along the Hunter Main Trail and at Dunns Swamp, and highest on the Glen Alice Trail, Army Road and Growee Trail, though it is not certain whether this reflects true abundance patterns. In addition to *Allocasuarina* species, the bird was seen in River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) and Cypress (*Callitris* sp.) trees, and appeared to be feeding on seeds of the latter on one occasion. The study area is clearly important to the local protection of the species and contributes significantly to its regional conservation. The species is widespread across the sandstone reserves of the Sydney Basin, and is currently considered to be relatively secure in the region. No management actions are currently required for the Glossy Black-cockatoo in north-western Wollemi National Park.

SWIFT PARROT

Species Profile

The Swift Parrot (*Lathamus discolor*) is a small to medium-sized, green parrot with distinctive red and blue head markings. It favours open eucalypt forest and woodland where it feeds on nectar and lerp. It breeds only in Tasmania, and migrates to the mainland as far north as southern Queensland during autumn and winter. During the non-breeding season it is nomadic, with small to large flocks congregating at suitable food sources. Favoured food trees in NSW include Swamp Mahogany (*Eucalyptus robusta*), Mugga Ironbark (*E. sideroxylon*), White Box (*E. albens*) and Spotted Gum (*Corymbia maculata*) (Higgins 1999).

Plate 28: Swift Parrot © DEC

Threats

The Swift Parrot has a small population of approximately 2000 individuals (Tzaros 2002) which may still be declining (Garnett and Crowley 2000). Outside of the breeding area the main threat is habitat destruction (Garnett and Crowley 2000). Due to the variable nature of the flowering of its favoured feeding trees during the non-breeding season it is nomadic and is sensitive to clearance of areas that it may rely on once every few years. Due to its rapid flight, the species often is killed in collisions with windows, vehicles and fences, though this occurs more regularly in Tasmania (Garnett and Crowley 2000). Psittacine Circoviral (Beak and Feather) Disease has been confirmed in wild Swift Parrots in NSW and has a high potential to adversely impact on the population (NSW Scientific Committee 2002e).

Local and Regional Conservation Status

The Swift Parrot is listed as Endangered under the NSW TSC Act (1995) and as Endangered under the Commonwealth EPBC Act (1999). A national recovery plan has been implemented in order to identify and protect key habitat and reverse population declines (Swift Parrot Recovery Team 2001). The majority of records in NSW occur in the three coastal Bioregions and the NSW South West Slopes Bioregion. Most of the records of Swift Parrots in the Sydney Basin Bioregion are in coastal habitats, particularly the Central Coast. The species has also been regularly recorded in drier areas of the Hunter and Capertee Valleys and the Cumberland Plain. Few records occur within reserves, though important sites include Nattai and Werakata National Parks. Intensive surveys in recent years have greatly increased the understanding of habitat usage by Swift Parrots in their wintering grounds in NSW (D. Saunders pers. comm.).

The Swift Parrot has not been recorded within north-western Wollemi National Park on the Atlas of NSW Wildlife. However, the bird is frequently recorded in the Capertee Valley, where it regularly flocks in the winter months to feed in the grassy Box – Ironbark woodlands (DEC 2006b) (Map 11). It is possible that parts of the study area form a component of the winter feeding habitats within the region, even though it may only be visited on occasion. The species is likely to have gone unnoticed within the study area because very few surveys have been undertaken in the winter months. The study area contains many winter-flowering tree species, most importantly White Box, a favoured food tree for the Swift Parrot. When these trees are in heavy flower, or when other food sources in the region are limited, it is likely that Swift Parrots visit sections of the park where it grows. Such areas are likely to include lower rainfall basalt caps and diatremes, such as that between 'Box Ridges' and Bylong River, and some of the talus slopes and flats on Permian sediments. It is recommended that targeted surveys be undertaken in White Box-dominated areas such as these during flowering times, to determine if, and the extent to which, the habitat is used. Such surveys need to be undertaken by experienced observers familiar with the species call. Any sightings of the Swift Parrot within the reserve should immediately be reported to the species Recovery Team. Such sightings may trigger the need for development of specific management actions in consultation with the Recovery Team, such as annual monitoring or fire management.

The presence of this habitat within the reserve has high conservation significance, as much of the known winter habitat areas for the species are not located on public lands.

TURQUOISE PARROT

Species Profile

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 & Crowley 2000).

Plate 29: Turquoise Parrot © DEC

Threats

Garnett & 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 2003c). 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 2004e). The species may also be threatened by competition for nesting sites with introduced birds, such as the Common Myna, as well as feral Honeybees.

Local and Regional Conservation Status:

The Turquoise Parrot is listed as Vulnerable under the NSW TSC Act (1995). Within NSW the number of records is highest along the western slopes (Nandewar, Brigalow Belt South and NSW South West Slopes Bioregions) and in the Sydney Basin Bioregion (DEC 2006b). In the latter, the species 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 for this species in this Bioregion include, in addition to Wollemi, Yengo and Goulburn River National Parks, Munghorn Gap Nature Reserve and Yerranderie State Conservation Area.

The Turquoise Parrot has been recorded at 40 locations within the study area between 1979 and 2006 (Map 11), with more than two individuals observed at most locations. Most records were collected during the DEC surveys between September 2005 and May 2006, where the parrot was observed in Box – Red Gum – Ironbark – Rough-barked Apple woodlands. Habitat for the species is concentrated below the northern and western escarpments, particularly the alluvial flats and adjacent talus slopes on Permian sediments in the Widden Valley (including lower Blackwater Creek), Lee Creek, Glen Alice and Capertee Valleys. These habitats form part of the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

Large amounts of Turquoise Parrot habitat within the Goulburn, Capertee and Hunter Valleys have been cleared in the past for agriculture or are still under threat from urban development and expansion of mining activities. The preservation of habitat within Wollemi National Park, together with neighbouring reserves such as Yengo and Goulburn River National Parks, is therefore vital to the local and regional conservation of the species.

BROWN TREECREEPER (EASTERN SUBSPECIES)

Species Profile

The Brown Treecreeper (*Climacteris picumnus*) is a medium-sized brown bird that is superficially similar in appearance to the Red-browed (*C. erythrops*) and White-throated (*Cormobates leucophaeus*) Treecreepers. It is distinguished from both by its slightly larger size, distinctive pale supercilium (eyebrow stripe) and distinctive call. It is typically a bird of eucalypt woodlands with a grassy or open shrub understorey and abundant fallen timber and/or dead trees. Unlike most treecreepers, the species 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 tree hollows are utilised for breeding (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 subspecies occurring either further west (*picumnus*) or further north (*melanotus*) (Schodde and Mason 1999).

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). Traill and Duncan (2000) estimated that the population has declined by at least twenty percent in the last fifteen years. Studies have shown that populations cannot persist in habitat fragments smaller than 300 hectares. As with most treecreepers, once extinction occurs in an isolated vegetation remnant, natural recolonisation is unlikely (Garnett and Crowley 2000). The problem is compounded by competition for tree hollows from introduced species like the Common Starling, Common Myna and feral Honeybee (Higgins *et al.* 2001, NSW Scientific Committee 2001b). Stock grazing impacts on the species by decreasing the diversity of ground-dwelling invertebrates, which reduces food availability (NSW Scientific Committee 2001b). The Brown Treecreeper is also listed as a species threatened by the removal of dead wood and dead trees (NSW Scientific Committee 2003c).

Local and Regional Conservation Status

The eastern subspecies of the Brown Treecreeper is listed as Vulnerable under the NSW TSC Act (1995). 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, the species 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 (DEC 2006b). 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, with recent sightings consisting of only a small isolated population in the south (DEC 2006a). Habitat for the species is contained within a limited number of reserves within the Sydney Basin Bioregion, including, in addition to Wollemi, Yerranderie State Conservation Area, Nattai National Park (Burragorang and Nattai Valleys), northern Yengo, Blue Mountains and Goulburn River National Parks and Manobalai Nature Reserve.

The Brown Treecreeper (eastern subspecies) has been recorded at close to 100 locations within north-western Wollemi National Park (Map 11). These records are very restricted in extent, however, with the species almost entirely restricted to lower altitude dry woodlands on higher fertility soils, where Box species (*Eucalyptus albens, E. moluccana, E. dawsonii*) and or Ironbarks (e.g. *E. crebra*) make up a component of the immediate or surrounding canopy. These habitats form part of the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1). Little of the Brown Treecreeper habitat remaining within the Goulburn, Capertee or Hunter Valleys is located within public lands or reserves, so the extent of habitat included within the northern and western edge of Wollemi National Park has high conservation significance and is important to the continued conservation of the subspecies.

The Brown Treecreeper also utilises private lands adjacent to the park, and landowners should therefore be strongly encouraged to retain the integrity of the habitat within this agriculture-bushland interface. Activities that alter the structure of the vegetation or reduce the density of hollow-bearing trees, such as clearing, firewood collecting, burning and over-grazing activities should be discouraged. These areas on private land may play a buffering role for threats to the Brown Treecreeper. A significant portion of occupied habitat bordering cleared land is infested with mistletoe (due to ecosystem stress), which is of concern for the long-term viability of these populations. The retention of healthy Box woodlands on the talus slopes of the reserve and adjoining valleys is paramount to the protection of the subspecies.

SPECKLED WARBLER

Species Profile

Plate 30: Speckled Warbler © N. Williams/DEC

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).

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 2001c). 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 2001c, 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 2003d), 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 in areas supporting dry woodlands, including the Burragorang Valley, lower Hunter Valley and Goulburn River Valley. Its preference for woodlands on higher fertility soils means that it mostly occurs outside the reserve system. Habitat is contained within a limited number of reserves in the Sydney Basin Bioregion including, in addition to Wollemi National Park, Nattai, Yengo and Goulburn River National Parks and Munghorn Gap and Manobalai Nature Reserves (DEC 2005a). The majority of records within these reserves occur near the edges adjacent to more fertile land.

The 64 records of Speckled Warbler are concentrated around the northern and north-western perimeter of the park, near the interface between agricultural land and bushland (Map 11). Scattered records also occur on the lower slopes of the Glen Alice valley, and on fertile soils on and to the north of Mount Towinhingy (Map 11). Habitat for the Speckled Warbler would once have spread across the valleys that border and indent the north, north-west and south-west perimeter of the park. Clearing for agriculture has reduced the available habitat to remnants of Box-Red Gum-Ironbark Woodland on creek flats and lower escarpment slopes, both in the reserve and on adjacent private lands. Much of the habitat for the Speckled Warbler lies within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes, which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

Protection of the species remaining habitat requires close cooperation between reserve managers and adjoining landholders. Landowners should be strongly encouraged to retain the integrity of the habitat on their land and reduce threatening processes such as clearing, shrub thicket removal, burning and grazing activities. The retention of dry woodlands on the northern and north-western creek flats and talus slopes of the reserve and adjoining valleys is primary to the protection of the species. The conservation of Speckled Warbler habitat and the abundance of the species in the study area has high local and regional conservation significance, as the majority of habitat elsewhere in the Goulburn, Capertee and Hunter Valleys remains threatened by agricultural, industrial and urban development.

PAINTED HONEYEATER

Species Profile

The Painted Honeyeater (G*rantiella picta*) is a small to medium sized bird with yellow edging to the flight feathers and a distinctive pink bill. Males exhibit black and white plumage and dark streaks on the flanks, while females are smaller, browner birds with no flank streaks (Simpson and Day 1996). It is a specialist feeder, foraging almost exclusively on the berries and flowers of mistletoes of the genus *Amyema*, although it will also take some nectar and insects (Garnett and Crowley 2000). It inhabits dry forests and woodlands, preferring Boree, Brigalow and Box-Gum woodlands and Box-Ironbark forests (ACT Government 1999, Oliver *et al.* 2003). It is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory, with the greatest concentration and almost all breeding records on the inland slopes of the Great Dividing Range in Victoria, NSW and southern Queensland (Garnett and Crowley 2000, Oliver *et al.* 2003). It is nomadic throughout both breeding and non-breeding seasons, in response to the fruiting of mistletoes and the abundance of rainfall (Keast 1968, Pizzey and Knight 1999).

Threats

The main threats to the Painted Honeyeater are associated with habitat removal, modification and isolation, particularly of the Box-Ironbark and Boree woodlands (Garnett and Crowley 2000). Much of the habitat used during the breeding season has been disturbed, through the clearing of woodlands and open forests, the removal of large trees with heavy mistletoe infestations and inappropriate fire regimes. Non-breeding habitat also continues to be cleared for purposes of agriculture and urban development. The species is negatively impacted by fragmentation of habitat, as it is less likely to be found in remnant strips of vegetation than in wider blocks (Robinson 1994). Heavy grazing and the application of pesticides and fertiliser are also likely to impact on the honeyeater (ACT Government 1999, Garnett and Crowley 2000).

Local and Regional Conservation Status

The Painted Honeyeater is listed as Vulnerable under the NSW TSC Act (1995). Records for the species on the Atlas of NSW Wildlife are sparsely scattered through the centre of NSW, with concentrations in the Cobar Peneplain, Darling Riverine Plain and NSW South West Slopes Bioregions (DEC 2006b). Within the Sydney Basin Bioregion, records are concentrated between Sydney, Newcastle and Mudgee, particularly around the Hunter Valley (DEC 2006b). The species is very poorly represented in reserves in the Bioregion, but has been recorded in Munghorn Gap Nature Reserve, Wollemi National Park and at the boundary of Goulburn River National Park (DEC 2006b).

The Painted Honeyeater was first recorded within the region during the first Birds Australia surveys, in 1977. However, the exact location of the sighting was not recorded. The species was subsequently observed on three occasions during the 2005-06 systematic surveys, each within close vicinity of each other in the Lee Creek Valley (Map 11). The honeyeaters were all seen within Box or Box – Red Gum – Ironbark woodland on flats or lower slopes, and no more than 300 metres within the National Park boundary. The Painted Honeyeater would also be expected to occur in River Oak forest with mistletoe, such as occurs along Widden Brook. These environments form a component of the mosaic of foraging habitat for the species in the Goulburn, Hunter and Capertee Valleys, being visited when mistletoe or eucalypt species are in heavy flower. All of the Painted Honeyeater habitat in the study area lies within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

Painted Honeyeater habitat would once have been extensive across the valleys that border and indent the north, north-west and south-western perimeter of the park. Clearing for agriculture has reduced the available habitat to remnants on creek flats and lower escarpment slopes. North-western Wollemi National Park contains only a small fraction of somewhat marginal habitat, with the greater extent of quality habitat located on private lands. Never-the-less much of the remaining preferred habitat is fragmented and continues to be degraded or under pressure from development, so the preservation of habitat within northern Wollemi National Park has high conservation significance. Even though the species may only visit the park on occasion, such habitats are likely to be vital to the survival of the species east of the Great Dividing Range in NSW. Ongoing conservation will require cooperation between wildlife managers and private landholders. Landowners should be strongly encouraged to retain the integrity of habitat on their land and in particular to retain key tree species. A key management issue is likely to be balancing the dependency of this species on mistletoes of the genus *Amyema*, against the heavy load of mistletoe that appears to be threatening the long term health of woodlands along the northern and north-western perimeters of the park.

BLACK-CHINNED HONEYEATER (EASTERN SUBSPECIES)

Species Profile

Plate 31: Black-chinned Honeyeater © P. Mahoney

The Black-chinned Honeyeater (*Melithreptus gularis*) is a small, rather stocky and short-tailed honeyeater. It is distinguished from other *Melithreptus* honeyeaters by its relatively larger size, bright blue or jade green eye-wattle and distinctive call. The species 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 lerp usually in the upper canopy and outermost flowers and leaves. 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 westward into south-eastern South Australia. The 'Golden-backed Honeyeater' (*laetior*) is widespread across northern Australia (Higgins *et al.* 2001).

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 clearance and fragmentation of woodland habitat and do not appear to use remnants less than 200 hectares in area (NSW Scientific Committee 2001d). The species appears to occur naturally at low densities (NSW Scientific Committee 2001d) and is relatively mobile, so the reason for this absence from small fragments is unknown (Garnett and Crowley 2000). The species is likely to experience high levels of competition from aggressive honeyeater species associated with smaller fragments and may suffer increased nest predation from such species as the Pied Currawongs (*Strepera graculina*) (NSW Scientific Committee 2001d).

Local and Regional Conservation Status

The eastern subspecies of the Black-chinned Honeyeater is listed as Vulnerable under the NSW TSC Act (1995). Scattered records occur in the eastern half of the state, with the highest number in the Nandewar, Sydney Basin and NSW South West Slopes Bioregions (DEC 2006b). 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 DEC reserves, notably Goulburn River and Werakata National Parks and Munghorn Gap Nature Reserve, as well as northern Yengo and north-eastern Wollemi National Parks (DEC 2006b).

The Black-chinned Honeyeater has been recorded at just over 40 locations in the study area (Map 12). Sightings are concentrated on the flats and lower slopes of the Goulburn and Capertee River Valleys, particularly Widden Brook, Lee Creek and Glen Alice valleys. Consistent with records obtained across their range, the species has not been recorded within any sections of the study area that receive more than 700 millimetres of rain (NSW Scientific Committee 2001d), and is restricted to Box – Red Gum – Ironbark – Rough-barked Apple woodlands. The density and distribution of the species within these habitats will vary over time in response to major flowering events. These habitats form part of the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

Habitat for this species would once have been widespread within the valleys of the Capertee, Goulburn and Hunter Rivers. These areas have been extensively cleared for agriculture, industry and settlements and as a result habitat is now largely restricted to remnant vegetation along creeklines and lower escarpment slopes. Many fragments are still under threat from development. The protection of Black-chinned Honeyeater habitat within Wollemi National Park therefore has high local and regional conservation significance and, together within neighbouring National Parks (particularly Goulburn River and Yengo NP) is vital to the ongoing survival of the species east of the Great Dividing Range in central NSW.

REGENT HONEYEATER

Species Profile

The Regent Honeyeater (*Xanthomyza phrygia*) is a medium-sized honeyeater with a 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. The species 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 contraction of range in the other two states (Higgins *et al.* 2001). There is thought to be only a single population of approximately 1500 individuals remaining, with numbers considered to be still decreasing (Garnett and Crowley 2000).

Plate 32: Regent Honeyeater © DEC

Threats

Land clearance for agriculture has removed about three-quarters of habitat suitable for the Regent Honeyeater. 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 1999c). 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 NSW TSC Act (1995) and as Endangered under the Commonwealth EPBC Act (1999). A national recovery plan for the species has been implemented in order to identify and reduce threatening processes and reverse population declines (Menkhorst *et al*. 1999). Within NSW the greatest numbers occur in the Sydney Basin, Nandewar and New England Tableland Bioregions (DEC 2006b). 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 National Parks and Munghorn Gap Nature Reserves (DEC 2006b).

Regent Honeyeater has been recorded in the study area on nine occasions, between 1982 and 2005 (Map 12). All of these sightings are located on or immediately adjacent to the perimeter of the park, with two kilometres the maximum distance inside the boundary that a Regent Honeyeater has been spotted. One of these sightings was made in September 2005 during the DEC surveys, when two individuals were located within Box woodland on the northern side of Blackwater Creek. The Regent Honeyeater favours flowering food trees on the creeks and valley flats that support River Oak with mistletoe, Red Gum and Yellow Box, as well as lower escarpment and dry slopes that are dominated by Box species and Red Ironbark. It is significant that the Regent Honeyeater has been observed within the study area in spring, since this is within the breeding season and suggests that the species may breed within the park or surrounding areas. Much Regent Honeyeater habitat is encompassed within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

Habitat for the Regent Honeyeater would once have spread across the valleys that border the north, north-west and south-west of the park. Clearing has destroyed about 75 percent of the Regent Honeyeater's habitat across its former range (Garnett and Crowley 2000) and has reduced the available habitat in the region to remnants on creek flats and lower escarpment slopes. North-western Wollemi National Park contains only a small fraction of somewhat marginal habitat, with the greater extent of quality habitat located on private lands. Never-the-less much of the remaining high quality habitat within the region is fragmented and continues to be degraded or under pressure from development. Therefore the preservation of habitat within the study area has high conservation significance. Such habitats are vital to the survival of the species as a whole. Targeted surveys during peak flowering periods of favoured food trees are required to ascertain the exact extent to which the species currently depends on these areas. Ongoing conservation will require cooperation between reserve managers and private landholders. The Widden, Goulburn, Myrtle, Growee and Capertee Valleys are considered primary habitat for this rarest of birds. Landuses that remove cover of preferred tree species are likely to constitute a significant impact on the species and warrant impact assessment under relevant legislation. Landowners should be made aware of their responsibilities in this regard and be strongly encouraged to retain the integrity of habitat on their land and in particular to retain key feed tree species, including Mugga Ironbark and Yellow Box.

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. The species utilises dead or fallen timber as perches, from which they pounce to feed mainly on insects and small lizards (Garnett and Crowley 2000). The species 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).

Threats

The south-eastern subspecies of the Hooded Robin has been identified as one of a number of birds that have declined significantly in range and population size in the sheep-wheat belt of central west NSW due to the degradation and fragmentation of woodland habitats. (Reid 1999). Populations do not appear to 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, 2003d). 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. Formerly it was well known from the Cumberland Plain however it has virtually disappeared from this area (DEC 2006b, Keast 1995). Within the Sydney Basin it has been recorded from a limited number of reserves including Wollemi, Nattai and Goulburn River National Parks and Munghorn Gap Nature Reserve, though most records are on the boundary of the reserves where higher fertility soils occur.

The Hooded Robin was recorded in the northern quarter of the study area, in the Goulburn River Valley, during the first Birds Australia Atlas between 1979 and 1981. An individual was also spotted between Bogee and Glen Alice, in the Capertee Valley, in 1997, just within the boundary of the park (Map 12). A total of twelve Hooded Robins were observed at three locations during the BSP surveys in 2005-06, including just inside the park boundary in the Glen Alice Valley, and immediately outside the park boundary in Lee Creek Valley (Map 12). The birds seen at Lee Creek included a male and female pair, suggesting that breeding may occur in the vicinity. The Hooded Robin is more frequently recorded on private lands adjacent to the national park. It remains quite common in the Capertee Valley, but appears to have suffered marked declines in the Hunter Valley (DEC 2005a, 2005b). It has a tendency to dwell at the interface between cleared and wooded land, often perching on fences and dead trees. The Hooded Robin has been described as a winter visitor to some areas of central eastern NSW (Higgins and Peter 2002), a time of year when few surveys have been conducted in the park. Hence the number of Hooded Robin records within the park in spring and summer may be an under representation of the areas actual value to the species. Potential habitat is widespread around the northern, north-western and south-western boundary of the study area, particularly within the Box-Red Gum-Ironbark woodlands. All of the habitat within the study area lies within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

Habitat for the Hooded Robin would once have been widespread across the valleys that border and indent the north, north-west and south-west of the park. 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, both in the reserve and on private lands. Landholders should be encouraged to retain paddock trees (even if they are dead) 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.

GREY-CROWNED BABBLER (EASTERN SUBSPECIES)

Species Profile

Plate 33: Grey-crowned Babbler © N. Williams

The Grey-crowned Babbler (*Pomatostomus temporalis*) is the largest of the four Australian babbler species, and the only one with a light-coloured crown. Other distinctive features are a long, decurved bill and a dark band that passes from the bill through the eye, giving it a "masked" appearance (Higgins and Peter 2002). There are two subspecies in Australia, the nominate being *temporalis*, which occurs in eastern Australia from Cape York to north-east NSW then south and west through central NSW and Victoria to south-eastern South Australia (Higgins and Peter 2002). It is widespread on the inland slopes of the Great Dividing Range in NSW and on the western plains. The Grey-crowned Babbler lives in open forest and woodland, *Acacia* shrubland and adjoining farmland, preferring Box-Gum woodlands on slopes and Box-Cypress and open Box woodlands on alluvial plains (Garnett and Crowley 2000). The species feeds on invertebrates gleaned from vegetation or the ground (Garnett and Crowley 2000). The birds form family parties, consisting of a breeding pair and offspring from prior breeding years, which are thought to be vital for predator avoidance and co-operative feeding of the young (King 1980).

Threats

The Grey-crowned Babbler has been identified as one of a number of birds that have declined significantly in range and population in the sheep-wheat belt of central west NSW due to the degradation and fragmentation of woodland habitats (Reid 1999). Much remaining Babbler habitat occurs in isolated fragments, from which the species has gradually disappeared (Garnett and Crowley 2000). This disappearance has been attributed to the social consequences of habitat fragmentation, including smaller family-group sizes and reduced breeding success, as well as less effective immigration and emigration and higher rates of nest predation (Garnett and Crowley 2000). Once lost from a habitat fragment, natural recolonisation is unlikely (Robinson and Traill 1996). Agricultural practices such as grazing and associated weed invasion also pose a threat (NSW Scientific Committee 2003d), as does increased competitor abundance in disturbed habitats (NSW Scientific Committee 2004d), removal of important feeding sites in the form of dead wood and dead trees and possibly predation by Feral Cats.

Local and Regional Conservation Status

The eastern subspecies of the Grey-crowned Babbler is listed as Vulnerable under the NSW TSC Act (1995). It is most common in the central western Bioregions of NSW, particularly the NSW South Western Slopes and Brigalow Belt South, but also occurs in the NSW North Coast Bioregion in areas such as in the Clarence River Valley (DEC 2006b). Within the Sydney Basin Bioregion the species is largely restricted to the Hunter Valley, with a few records also in the Capertee Valley, where it is closely associated with the drier woodland habitats. Within the Bioregion it is poorly represented in reserves, but has been detected within Wollemi, Goulburn River, Yengo and Werakata National Parks and Munghorn Gap Nature Reserve (DEC 2006b).

The Grey-crowned Babbler was detected within the vicinity of the study area during both the first and second Birds Australia surveys (1978-79 and 2001), though the exact locations of these sightings are unknown. It was recorded once by DEC in September 2005, on a lower slope on the eastern side of Widden Brook, within Box-Red Gum woodland (Map 12). The species has also previously been seen in the Myrtle Creek valley (Bell 1997). The Grey-crowned Babbler is likely to occur at other locations along the northern and south-western boundary of the park, but is more frequently recorded on private lands adjacent to the study area than in the national park itself, particularly within the Capertee Valley. All of the habitat within the study area lies within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

Habitat for this species would once have been widespread within the valleys of the Capertee, Hunter and Goulburn Rivers. These areas have been extensively cleared for agriculture, industry and settlements and as a result habitat is now largely restricted to remnant vegetation along creeklines and lower escarpment slopes. Many fragments in these valleys are still under threat from further development. Thus, even though north-western Wollemi National Park contains only a small fraction of somewhat marginal habitat, it has high local and regional conservation significance and, together with habitat in neighbouring National Parks, is important to the ongoing survival of the species east of the Great Dividing Range in central NSW.

DIAMOND FIRETAIL

Species Profile

The Diamond Firetail (*Stagonopleura guttata*) is an attractive finch, distinguished by its bold black breast band and white-spotted black flanks. The eye, beak and rump are red, with the latter contrasting strongly with the black tail in flight (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).

Threats

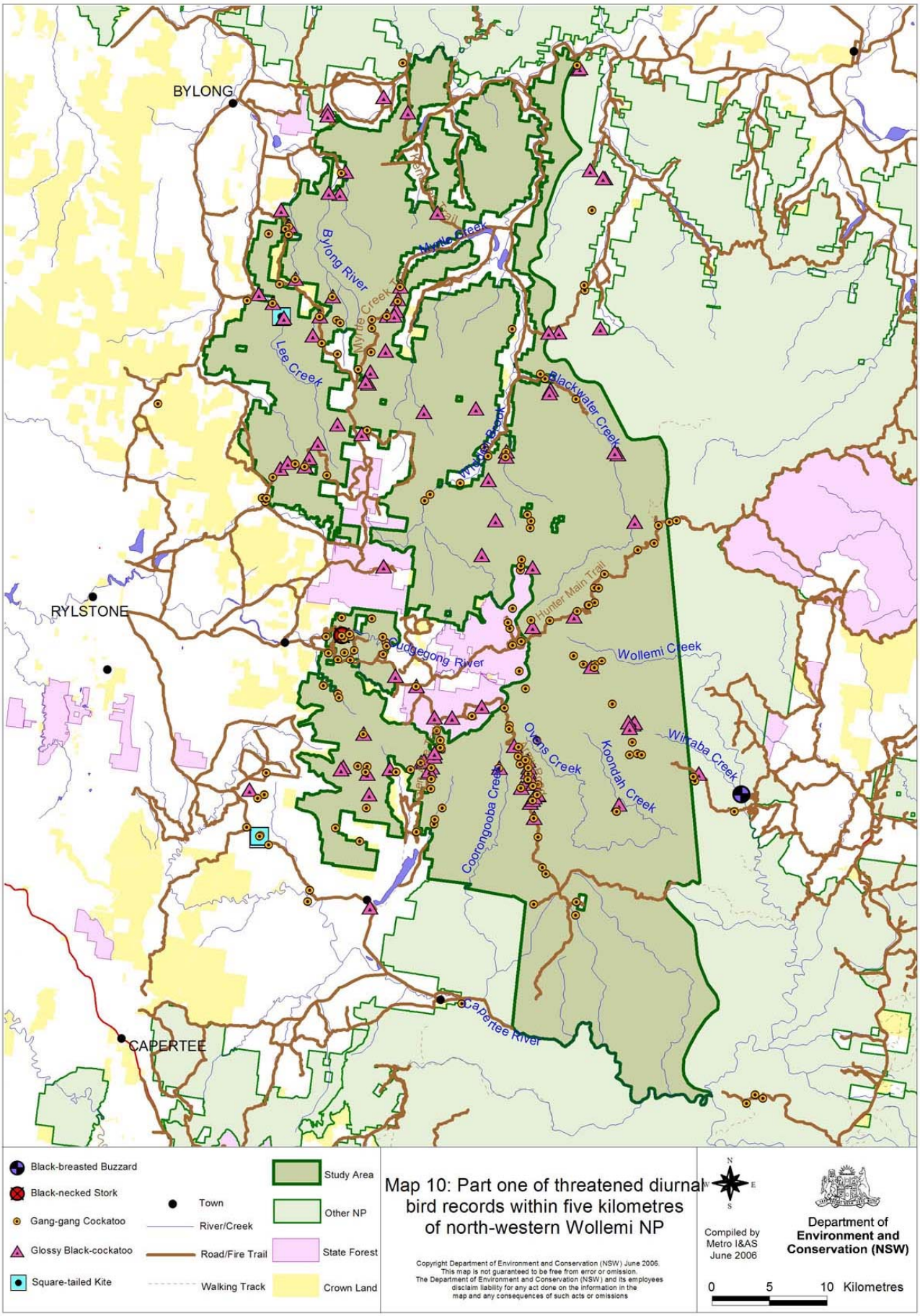
Much habitat suitable for the Diamond Firetail has been cleared and the species is therefore included in the suite of woodland birds that have declined in the sheep-wheat belt of central west NSW (Reid 1999). It appears unable to survive in areas that lack remnants larger than 200 hectares (NSW Scientific Committee 2001f). Much 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 2003d). Predation by Foxes and Feral Cats may be another threat (as the species forages on the ground) (Smith *et al.* 1995). Trapping for the pet trade is believed to have contributed to its rarity on the Cumberland Plain (Hoskin 1991).

Local and Regional Conservation Status

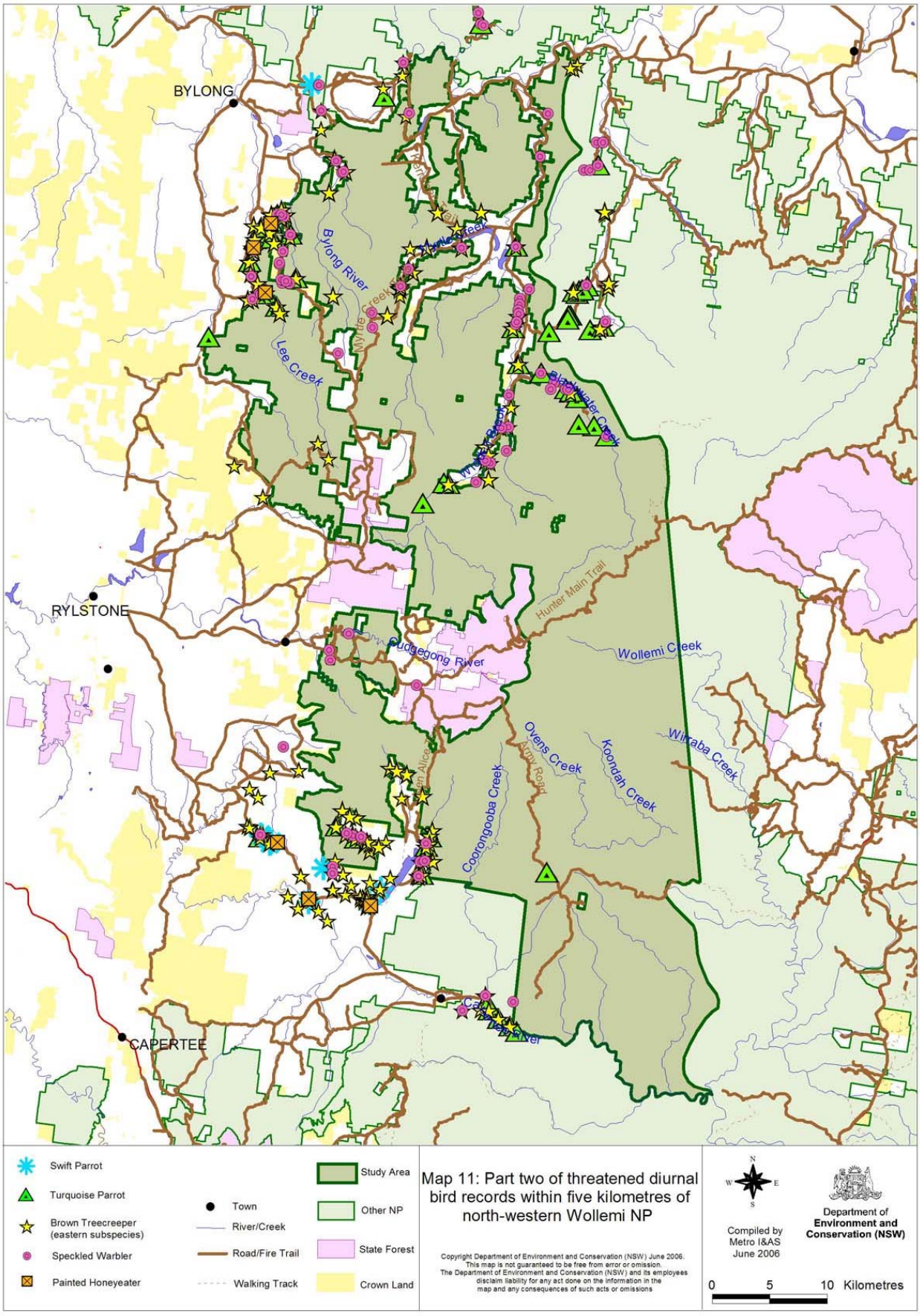
The Diamond Firetail is listed as Vulnerable under the NSW TSC Act (1995). It is widely recorded in the eastern two thirds of the state, although it is less frequently seen in the three coastal Bioregions and in the high country of the Australian Alps. Within the Sydney Basin Bioregion the species is 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 National Park, near the northern boundary of north-eastern Wollemi National Park, as well as in Goulburn River National Park and Munghorn Gap Nature Reserve (DEC 2006b).

The Diamond Firetail has been recorded at 30 localities, concentrated around the northern and north-western perimeter of the park, near the interface between agricultural land and bushland (Map 12). Scattered records also occur on the lower slopes of the Glen Alice valley, and on fertile soils north of Mount Towinhingy (Map 12). Habitat for the Diamond Firetail would once have spread across the wider valleys that border and indent the north, north-west and south-western perimeter of the park. Clearing for agriculture has reduced the available habitat to remnants of Box-Red Gum-Rough-barked Apple Woodland or riparian River Oak forest with a grassy understorey on creek flats and lower escarpment slopes, both in the reserve and on adjacent private lands. All of the habitat within the study area lies within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

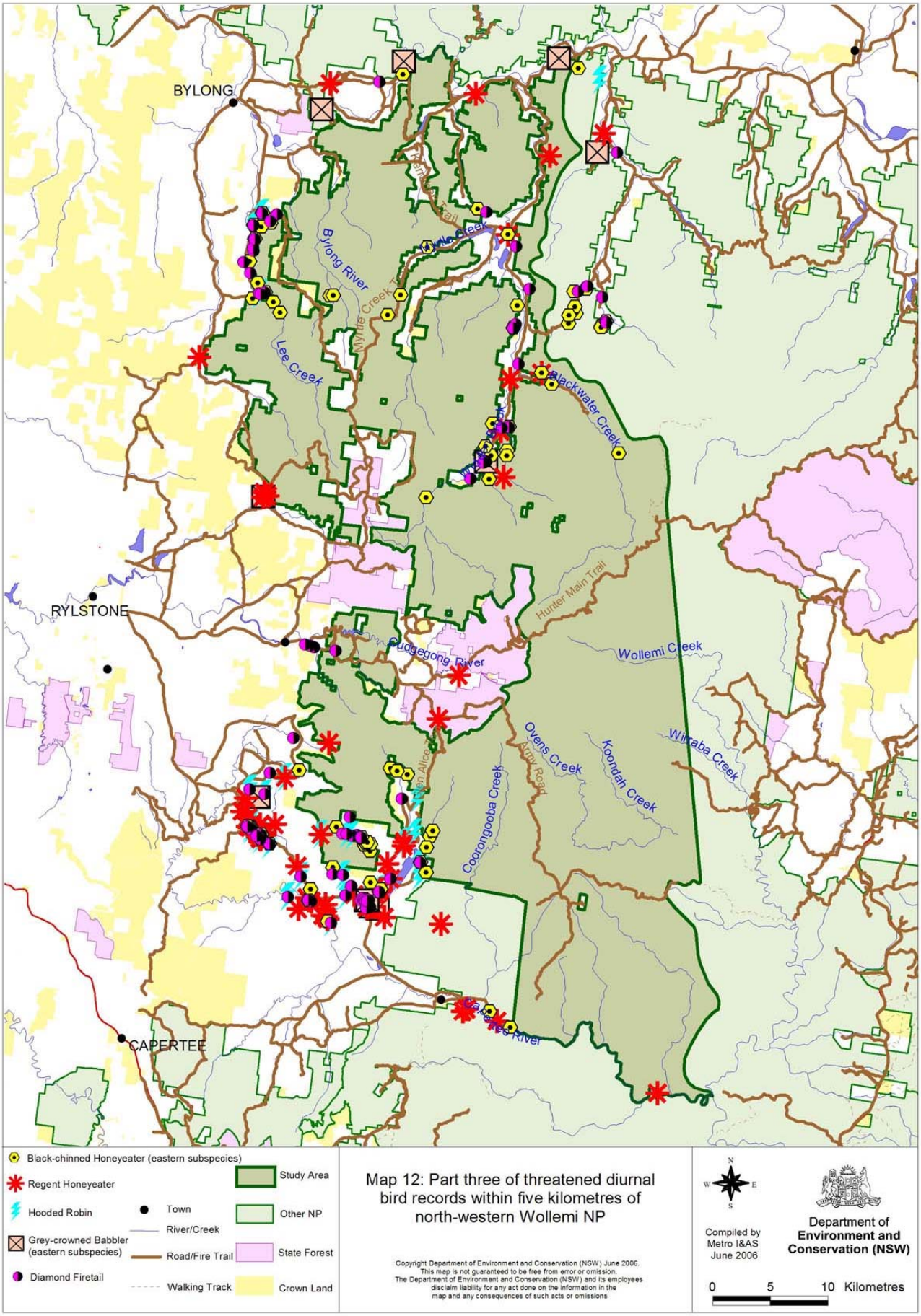
Protection of the species remaining habitat requires close cooperation between reserve managers and adjoining landholders. Landowners should be strongly encouraged to retain the integrity of the habitat on their land and reduce threatening processes such as further clearing, grazing and invasion of exotic grasses. The retention of dry woodlands on the northern, north-western and south-western creek flats and talus slopes of the reserve and adjoining valleys is essential to the protection of the species in the region. The conservation of Diamond Firetail habitat in the study area has high local and regional conservation significance, as the majority of habitat elsewhere in the Goulburn, Capertee and Hunter Valleys remains threatened by agricultural, industrial and urban development.



Map 10: Part 1 of threatened diurnal bird records within five kilometres of north-western Wollemi National Park



Map 11: Part 2 of threatened diurnal bird records within five kilometres of north-western Wollemi National Park



Map 12: Part 3 of threatened diurnal bird records within five kilometres of north-western Wollemi National Park

BARKING OWL

Species Profile

The Barking Owl (*Ninox connivens*) is of intermediate size between the larger Powerful Owl (*N. strenua*) and the Southern Boobook (*N. boobook*). It has dark brown upper-parts and a white underbody with coarse brown streaking (Higgins 1999). It is often identified by its call, which is a distinctive, dog-like barking that can be confused with Fox (*Vulpes vulpes*) or Dog (*Canis lupus familiaris*) barks. It 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).

Plate 34: Barking Owl © S. Cottrell/DEC

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 and competition from feral Honeybees (Garnet & Crowley 2000, NSW Scientific Committee 2003c). The long generation time of this species (ten years) is a further issue, as it compromises the ability to recover after suffering population declines (NSW Scientific Committee 1998d).

Local and Regional Conservation Status

The Barking Owl is listed as Vulnerable under the NSW TSC Act (1995). Records occur throughout NSW, though it is more rare in the far west and at higher altitudes in the south-east (DEC 2006b). 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 on conservation reserves, with most being on private lands (DEC 2006b). However, recent DEC surveys have obtained a small number of records from the dry woodlands on the periphery of northern Yengo and Wollemi National Parks (DEC 2005c, 2005a) as well as Manobalai Nature Reserve and Crown Lands (DEC 2005b).

The Barking Owl has been recorded in the study area on only one occasion on the Atlas of NSW Wildlife, during the first Birds Australia Atlas (1979). Neither the CRA or BSP systematic surveys detected the species, despite the undertaking of 84 nocturnal call playback surveys, of which 15 were located within potential Barking Owl habitat. This result was somewhat surprising, given that the species was located in similar habitat in north-eastern Wollemi and northern Yengo National Parks in 2004-05. There is, however, some evidence that the species occurs in the study area, as it has been reported on private lands at Lee Creek (P. Lonrigan pers. comm.), on the Glen Alice Trail (Washington & Mullins Imrie 1998) and near Wilsons Clearing (Goldney & Cardale 1993). Potential habitat for the owl is widespread in the woodlands on creek flats and lower slopes near the dry northern, north-western and south-western boundaries of the park, particularly the creeks that drain into the Goulburn River. The majority of the suitable habitat within the study area lies within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1). The absence of recent records from the study area or immediately adjacent lands is very concerning, and suggests that even if the species does persist, it only does so at low abundance. The owl was recorded on numerous occasions in the Capertee Valley in the 1990s, but has not been recorded on the Atlas of NSW Wildlife in that area since 2000 (DEC 2006b).

The preferred habitat of the Barking Owl in the Capertee, Goulburn and Hunter Valleys has been widely depleted by clearing for agriculture, industry and settlements and much remaining habitat is under continued pressure from these threats. This species is now rare in the Sydney Basin Bioregion and known localities that occur on reserve have very high conservation significance. It is recommended that further targeted nocturnal call playback surveys be undertaken to confidently ascertain the species' current distribution and status across northern Wollemi National Park. Management of the owl in the park and the region should be undertaken in accordance with the state-wide recovery plan (currently in draft form, NPWS 2003c).

POWERFUL OWL

Species Profile

The Powerful Owl (*Ninox strenua*) is the largest owl in Australia and is distinguished by its relatively small, round head and long tail. It is dark brown above with prominent off-white barring, and paler underneath with diagnostic dark chevrons. 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 (*Pseudocheirus peregrinus*) and Greater Gliders (*Petauroides volans*) (Kavanagh 2002a). This species usually nests in a hollow in a eucalypt within or below the canopy, 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).

Plate 35: Powerful Owl © N. Williams

Threats

Past land clearance for agriculture has reduced the area of 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 areas of Brisbane, Sydney and Melbourne (Garnett and Crowley 2000, DEC 2004f). Two of the determining factors for the species persistence in disturbed areas are the presence and suitable abundance of prey species (Chafer 1992) and suitable nesting/roosting sites (Debus and Chafer 1994). Other factors that may affect this species include predation of fledglings by Foxes and secondary poisoning, though neither is thought to be a significant cause of mortality (DEC 2005e). In addition, the foliage roosts of the Powerful Owl are vulnerable to regular hazard reduction burning (DEC 2005e).

Local and Regional Conservation Status

The Powerful Owl is listed as Vulnerable under the NSW TSC Act (1995). Within NSW, the majority of records occur within the three coastal Bioregions, but occasional sightings have also been made further west, particularly in the South Eastern Highlands Bioregion. 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 (DEC 2006a). Most reserves within the Sydney Basin Bioregion support known territories of this species, though they are at lower densities in the drier environments of the north-west (NPWS 2001b, DEC 2005a, b, c).

The Powerful Owl has been recorded at 20 locations in north-western Wollemi National Park between 1994 and 2006 (Map 13). These records are widely dispersed across the study area, but each within the vicinity of moister habitat types, either along creeklines and lower slopes in the north and west, in gullies that incise the sandstone plateaux or in higher elevation areas, including some of the basalt caps. Relative to other localities in the Sydney Basin, the habitat along the northern and north-western boundaries of the study area is not thought to be of particularly high quality for the Powerful Owl. The owls are likely to reach greater density at moderate to high elevations, where preferred prey items such as Greater Glider and Common Ringtail Possum are more abundant. The Powerful Owl has been recorded in few locations within five kilometres of the study area, as it does not occur in the agricultural lands that dominate the Capertee and Goulburn River Valleys.

The Powerful Owl is considered to be relatively secure when located in protected areas and no management actions are currently required for this species in the study area. However, known locations near the boundaries of the park should be considered during fire management planning. Management of the owl should be undertaken in accordance with the state-wide recovery plan (currently in draft form, DEC 2005e).

MASKED OWL

Species Profile

Plate 36: Masked Owl © M. Todd

The Masked Owl (*Tyto novaehollandiae*) is a large owl that is distinguished from the similar Barn Owl by its larger size, more thickset and hunchbacked appearance, fully feathered legs and larger 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 diurnal 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 2005e). The owl has a home range of 800 to 1200 hectares (Kavanagh 2002b). It nests in hollow trees, usually eucalypts, where two to three eggs are the normal clutch (Higgins 1999). The nominate subspecies *novaehollandiae* was formerly found around the southern coast of Australia between Fraser Island (Queensland) and Carnarvon (Western Australia), though its range has contracted, particularly in Western Australia (Garnett and Crowley 2000). Other subspecies occur in Tasmania, northern Australia and in New Guinea and adjoining islands, some of which are sometimes considered separate species (Higgins 1999).

Threats

Clearance of native forest for agriculture and urban development, and the resulting fragmentation of habitat, has negatively affected the abundance of Masked Owls (Kavanagh 2002b, Garnett and Crowley 2000). The species does not persist within fragments of forest less than 200 hectares (Kavanagh 2002b). The owl may be affected by logging, through removal of hollows or reduction in foraging habitat due to vigorous regrowth (Garnett and Crowley 2000). However 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 is considered to be a Key Threatening Process affecting this species (NSW Scientific Committee 2003c). The core areas of the species distribution in NSW are located on the Central Coast and Lower Hunter Valley and much habitat in these areas is not reserved and is under continued pressure from habitat fragmentation and clearance due to urban and industrial development.

Local and Regional Conservation Status

The Masked Owl is listed as Vulnerable under the NSW TSC Act (1995). Most records for the species in NSW are located within the three coastal bioregions (NSW North Coast, Sydney Basin and South East Corner), with a few scattered records west of the Divide (DEC 2006b). Within the Sydney Basin Bioregion, the woodlands of the coastal plains between Wyong and Port Stephens support high numbers of this species, with concentrations of records also occurring in the south and to a lesser extent across the southern Blue Mountains. Records of the Masked Owl are scattered within a number of DEC reserves, including, in addition to Wollemi NP, Royal, Blue Mountains, Nattai, Kanangra-Boyd, Brisbane Water and Dharug National Parks and Berowra Valley Regional Park (DEC 2006b).

The Masked Owl has been detected at just one location in the study area, where it responded to an owl call playback survey in March 2006 (Map 13). The species is not expected to occur on the rugged sandstone plateaux. However, its apparent scarcity in the dry woodlands along the northern talus slopes and creeklines was somewhat surprising, given its occurrence in similar habitats in north-eastern Wollemi National Park (DEC 2005a; one record shown on Map 13). The species may be present in the dry woodlands along the northern talus slopes and creeklines, but only at low abundance and hence has evaded detection. These data suggest that compared to the Lower Hunter Valley, the Upper Hunter, Goulburn and Capertee Valleys hold lesser importance for the Masked Owl.

Further targeted nocturnal call playback surveys would be necessary to confidently ascertain the distribution and status of the Masked Owl within northern Wollemi National Park and the contribution the area makes to conservation of the species in the region and on the western side of the Great Dividing Range. In the mean time, management of the owl in the region should be undertaken in accordance with the state-wide recovery plan (currently in draft form, DEC 2005e).

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 2005e). 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).

Threats

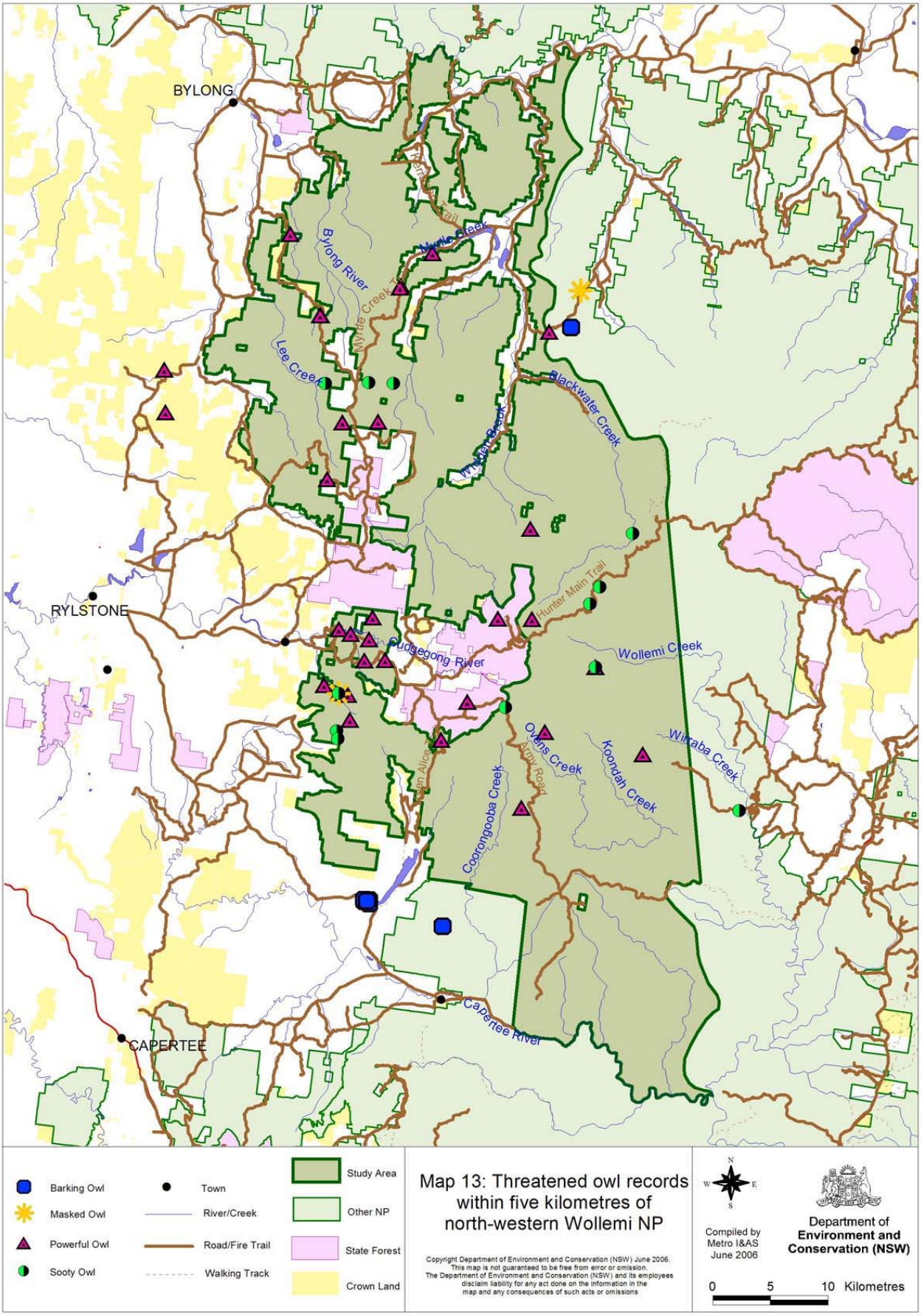
Garnett and Crowley (2000) list the main threat as habitat clearance for agriculture and urban development, along with additional fragmentation or degradation caused by logging, burning and dieback. The exact impacts of logging remain unclear (Higgins 1999). Where the species is at the margins of its 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).

Local and Regional Conservation Status

The Sooty Owl is listed as Vulnerable under the NSW TSC Act (1995). 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 State Conservation Areas, with other records in Royal, Blue Mountains and Bouddi National Parks (DEC 2006b).

The Sooty Owl has been recorded on eleven occasions within the study area, each located in or near gully lines that incise the central sandstone plateaux (Map 13). These animals were heard calling spontaneously or in response to call playback, or were directly observed in their roosting habitat. Three individuals were located in deep sandstone overhangs. These results correspond to known habitat preferences of the Sooty Owl, specifically areas with a high percentage of rainforest or moist forest with a mesic understorey and low levels of annual radiation, mostly on south-facing slopes (DEC 2006a). The owl is expected to be widespread within such habitats, particularly in the southern two-thirds of the study area within gully lines that contain an abundance of tree hollows or caves for roosting and preferred prey items such as Common Ringtail Possum and Sugar Glider (Kavanagh 2002a). The Sooty Owl has been recorded at just one other location within five kilometres of the study area, as it does not inhabit the agricultural lands that dominate the Capertee and Goulburn River Valleys. It is also absent from the dry lower slopes and gullies below the northern and western escarpments.

The observation made in north-western Wollemi National Park are the furthest west that the species has been recorded in central NSW (DEC 2006b), as the western sandstone escarpment forms the western boundary of the species distribution. Habitats within the park therefore play a significant role in the conservation of the species at the limit of its distribution, and in ensuring that the species persists across its current known distribution. The owl appears to currently be secure in the park, and to not require any immediate management actions. However, management of the owl in the region should be undertaken in accordance with the state-wide recovery plan (currently in draft form, DEC 2005e).



Map 13: Threatened nocturnal bird records within five kilometres of north-western Wollemi National Park

SPOTTED-TAILED QUOLL

Species Profile

Plate 37: Spotted-tailed Quoll © N. Fenton/DEC

The Spotted-tailed or Tiger Quoll (*Dasyurus maculatus*) is a medium-sized marsupial carnivore that is identifiable by its rufous to dark brown fur and white spots which are present on the body and tail. It is essentially terrestrial, but is also an agile climber. It feeds on a wide variety of birds, reptiles, mammals and invertebrates and will also take carrion and domestic poultry (NPWS 1999d). Two subspecies of Spotted-tailed Quolls have been recognised: *D. maculatus gracilis* from north Queensland and *D. m. maculatus* from south-eastern Queensland, New South Wales, Victoria and Tasmania (Edgar and Belcher 1995). However, genetic work has shown that the true genetic split occurs between Tasmania and the rest of the mainland (Firestone *et al*. 1999). Within NSW the species utilises a variety of habitats on both sides of the Great Dividing Range, including sclerophyll forest and woodlands, coastal heath and rainforest (NPWS 1999d). Habitat requirements include suitable den sites, an abundance of food and large areas of intact vegetation (NPWS 1999d).

Threats

The main problems confronting the Spotted-tailed Quoll are believed to be habitat loss, degradation and fragmentation (Belcher 2004). Other threats include: predation and competition by introduced predators such as Feral Cat, Fox and Wild Dog; disease such as toxoplasmosis; road mortality; and direct mortality at the hands of humans (Mansergh 1984). Quolls were heavily persecuted as killers of domestic fowl, and have been hunted and trapped to extinction in many parts of eastern Australia. In more recent years evidence has been collected to suggest that aerial, ground and mound baiting using 1080 (sodium monoflouroacetate) has significant negative impacts on Quoll populations (Belcher 2004, Murray and Poore 2004). Wild Dog/Dingo control also has the potential to indirectly impact on Quolls as it can result in greater numbers of Foxes and/or Feral Cats (Glen & Dickman 2005). The Spotted-tailed Quoll has been listed as a species affected by the following Key Threatening Processes: removal of dead wood and dead trees (NSW Scientific Committee 2003c); high frequency fire (NSW Scientific Committee 2000b); and removal of bushrock (NSW Scientific Committee 1999b).

Local and Regional Conservation Status

The Spotted-tailed Quoll is listed as Vulnerable under the NSW TSC Act (1995) and as Endangered under the Commonwealth EPBC Act (1999). 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 (DEC 2006b). 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 upper Blue Mountains and to a lesser extent in the Kangaroo Valley (DEC 2006b). It may have recently become extinct in other areas. The species has been recorded in a number of conservation reserves in the Sydney Basin Bioregion, most recently within Blue Mountains, Brisbane Water, Popran and Wollemi National Parks (DEC 2006b).

The Spotted-tailed Quoll is a very cryptic species. Where it occurs in low density, it is difficult to trap and can require an immense effort to detect using standard survey techniques (Lunney and Matthews 2001). The majority of recent records for the species in the Sydney Basin come from traces left by the animals (such as tracks, remains or scats), road kills and opportunistic sightings. This behaviour is reflected in the low number of Spotted-tailed Quoll records within north-western Wollemi National Park, where it has been definitely recorded on the Atlas of NSW Wildlife on just three occasions between 1992 and 2006. In addition to these records, however, there is much anecdotal evidence of the species occurrence. Many landholders adjacent to the park occasionally sight Quolls, including in Widden Valley (D. Alley pers. comm.), in Lee Creek Valley (S. Thorn pers. comm.), in Bylong River Valley (B. Kerney pers. comm.) and along Towinhingy Creek (M. Kirk pers. comm.). Furthermore, scats considered to 'probably' have come from the Spotted-tailed Quoll have been recorded on Myrtle

Creek and Kerry Mountain during 2005-06 DEC surveys, as well as by bushwalkers in diatremes south of the Hunter Range (Macqueen 2005). Spotted-tailed Quoll have been recorded on the Atlas of NSW Wildlife at five additional locations within five kilometres of the study area, including to the east of Mount Monundilla and to the west of the park (Map 15).

It is very important to note that some landholders that have lived in the area for decades have noticed a decline in Quoll numbers in recent times. Fifty years ago Spotted-tailed Quolls were a common sight on the boundary between cleared and forested land, where now they are rarely seen (M. Kirk pers. comm.). Like elsewhere in the Sydney Basin, Quolls have clearly declined in numbers within the region. The positive identification in March 2006 of Quoll hair from a hair tube located just off the Army Road was very exciting as it confirms that the species persists within the park. However, the current distribution, abundance and status of the species within the body of the park remain unknown. Potential habitat for the Spotted-tailed Quoll is widespread across the sandstone plateaux, particularly within moister vegetation types on gully lines and sheltered lower slopes. The paucity of records suggests that the study area supports only a low density of Spotted-tailed Quolls, though this pattern is typical of Sydney sandstone environments. Numbers may be underestimated due to the absence of targeted surveys and the remoteness of much of the study area. Further survey work, including extensive cage trapping and hair tubing over an extended time period, is required to confirm the species status and to determine the role that north-western Wollemi National Park plays in the regional conservation of the species.

Many processes threatening the Spotted-tailed Quoll operate across all tenures and protection of habitat alone does not guarantee the conservation of the species. The impact of Fox and Wild Dog predation and competition is still being researched, but likely to be significant on already stressed Quoll populations. Ironically, Fox and Wild Dog control programs also have the potential to negatively impact Quolls. The extent of this impact is widely debated, with different research programs arriving at conflicting conclusions (e.g. Belcher 2003 versus Kortner *et al.* 2003). As the Spotted-tailed Quoll population in Wollemi National Park appears to already be stressed, it is recommended that a cautionary approach to 1080 baiting be taken and that use of 1080 baiting in areas where Quolls are known be very carefully considered. Aerial baiting in particular is likely to negatively affect Quoll populations. Much research is currently being undertaken into this issue, and park managers should be sure to keep up to date with the latest findings as they relate to on-ground actions. In the mean time, burying baits deeper than seven centimetres below the ground surface (rather than burying them in raised mounds) will decrease the number of baits removed by Quolls (Glen & Dickman 2003).

Priority should be given to increasing public awareness of this species, its identification and conservation status, and to encouraging neighbours and park visitors to report any sightings, together with accurate location information.

KOALA

Species Profile

Plate 38: Koala © P. Madden

The Koala (*Phascolarctos cinereus*) is a distinctive arboreal mammal of eucalypt forest and woodland. 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 (DEC 2006a) suggest that Koalas generally have a preference for higher fertility soils. Individuals spend most of the day resting in the forks of trees, and are most active following sunset (NPWS 1999e). They generally move within a home range, the size of which varies on the density of food trees and population size, but ranges between 15 and 100 hectares (Lunney pers. comm.). Three subspecies occur between north Queensland and the Eyre Peninsula in South Australia. However, the distribution is now fragmented and introductions, such as to Phillip Island in Victoria, have possibly altered the genetic diversity of many of the populations (Martin and Handasyde 1995). Reed *et al*. (1990) reported that a survey in 1986-87 found 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 its distribution.

Threats

Threats to the Koala across its range include: destruction of habitat by clearing for urban development, agriculture and mining; degradation of habitat through fragmentation and disturbance such as fire or weed invasion; direct mortality from Wild Dogs and motor vehicles; and infection by *Chlamydia* which causes keratoconjunctivitis (an infection of the eyes) and infertility (NPWS 1999e, NPWS 2003d). In NSW, *Chlamydia* mostly afflicts animals that are already stressed and is not considered to be a major problem (Menkhorst 1995a, NPWS 2003d). Throughout its entire range loss, fragmentation and degradation of habitat is the species greatest threat (NPWS 2003d).

Local and Regional Conservation Status

The Koala is listed as Vulnerable under the NSW TSC Act (1995). The species is widespread across the eastern third of the state and, being an easily recognisable species, there are 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 (DEC 2006b). Records from reserves within the Sydney Basin are uncommon, though sightings have been made in Morton, Dharug, Nattai, Blue Mountains, Brisbane Water, Wollemi and Yengo National Parks (DEC 2006b).

The Koala has not positively been recorded within north-western Wollemi National Park, though a scat possibly deposited by this species was seen on lower Blackwater Creek during BSP surveys in 2005. This lack of records is somewhat surprising, as the Koala is known from similar habitats in north-eastern and southern Wollemi National Park (DEC 2006b). There is a historic record of the species near Nullo Mountain, and it was recorded east of the study area on Boorai Creek Track in 1997 (Map 14). Potential habitat for the Koala occurs on higher fertility soils along the creek flats and lower slopes on the perimeter of agricultural country, particularly the 'Upper Goulburn Valleys and Escarpment' where favoured feed trees such as Red Gums (*Eucalyptus tereticornis*/*E. blakelyi*) and Grey Gum (*E. punctata*) occur. Potential habitat is also present where Grey Gum occurs on sheltered sandstone slopes and gullies that incise the sandstone plateaux. It is possible that the species still persists in these areas, but has evaded detection due to low density. This would be ascertained only by further targeted survey. Such survey is recommended in the vicinity of the possible scat and elsewhere along the lower reaches of Blackwater Creek.

The Koala would once have been more abundant and widespread in the upper Hunter and Goulburn Valleys, particularly in the fertile valley floors and plains that have now been cleared for agriculture and settlements. The protection of habitat within northern Wollemi National Park therefore has high conservation significance, and gaining an understanding of the distribution of the Koala in the park is likely to be important to managing the regional conservation of the species in the future. Koalas, particularly males, can be wide ranging and it is likely that this species roams across the northern escarpment and east into northern Yengo National Park and Pokolbin State Forest. This stretch of contiguous habitat is highly important to the regional conservation of the species.

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 (Turner and Ward 1995). 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 1995b). It is very difficult to detect without the use of pitfall trapping (Tulloch 2001) and hence its distribution and abundance may often be underestimated.

Plate 39: Eastern Pygmy-possum
© K Gillett/DEC

Threats

The NSW Scientific Committee (2001g) listed the following potential threats to the Eastern Pygmy-possum: isolated sub-populations with little dispersal potential which increase the risk of local extinction; habitat loss and fragmentation caused by clearing; inappropriate fire regimes that may effect 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 NSW TSC Act (1995). 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 (DEC 2006b). Within the Sydney Basin Bioregion records are concentrated within the Blue Mountains, Central Coast and the Woronora Plateau (DEC 2006b). The species has been recorded in a number of reserves including Morton, Royal, Blue Mountains, Ku-ring-gai Chase and Brisbane Water National Parks (DEC 2006b).

The Eastern Pygmy-possum was recorded for the first time in north-western Wollemi National Park during the 2005-06 systematic surveys. Bones and hair of the species were collected at two remote locations south of the Hunter Main Trail, while remains were identified from a Fox scat near Stack Ridge, above the Glen Alice valley (Map 14). The tiny possum has not been directly observed either within or five kilometres surrounding the study area. It is, however, a highly cryptic animal, and some survey techniques that target the species, particularly pitfall trapping, have not been undertaken. The Eastern Pygmy-possum is therefore highly likely to be more widespread than records indicate. Potential habitat is relatively widespread and food sources abound. Based on records elsewhere, the species is most likely to occur within woodlands that have a dense shrub layer and an abundance of flowers, or else within areas that contain Cypress (*Callitris* spp.) with very little understorey (Bladen *et al.* 2002, Shelley 1998).

An intensive targeted trapping program would be required in order to assess the abundance, distribution and conservation status of the Eastern Pygmy-possum within the locality and region. Trapping would need to include use of pitfall traps with drift fences, Elliott traps and nest boxes positioned against flowering shrubs and trees, as these techniques have been found to be the most effective capture method for the species in other areas (Bladen *et al.* 2002, Shelley 1998, M. Schulz pers. comm.). The largest threat to Eastern Pygmy-possum within the study area is likely to be predation by Foxes, and as such known locations of the species should be included in any Fox control programs.

YELLOW-BELLIED GLIDER

Species Profile

Plate 40: Yellow-bellied Glider © J. Winter/DEC

The Yellow-bellied Glider (*Petaurus australis*) is a medium-sized nocturnal mammal found in tall open sclerophyll forests and woodlands 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 underneath 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. It feeds on eucalypt nectar, sap, manna and invertebrates found under shedding bark. Its feeding habits to extract sap can leave deep V-notched incisions in the bark of eucalypts, with individuals and families demonstrating preference for repeated use of individual trees for many seasons (Mackowski 1988). Yellow-bellied Gliders are known to utilise a home range of between 30 and 65 hectares (Goldingay and Kavanagh 1991). The southern, nominate subspecies ranges between south-eastern South Australia and central coastal Queensland with a separate subspecies isolated in the wet tropics of north Queensland (Russell 1995).

Threats

Yellow bellied Gliders are known to be greatly affected by the reduction of nesting resources when the availability of hollow-bearing trees are lost through clearing, fragmentation or timber extraction (NPWS 1999f). 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, 2003e). The Yellow-bellied Glider is also listed as potentially negatively affected by the Key Threatening Process of competition from feral Honeybees (NSW Scientific Committee 2002d).

Local and Regional Conservation Status

The Yellow-bellied Glider is listed as Vulnerable under the NSW TSC Act (1995). 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 (DEC 2006b). The species appears to have a patchy distribution within the Sydney Basin Bioregion (DEC 2006b), though recent surveys have significantly expanded the knowledge on its distribution and habitat preferences. 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 (DEC 2006a). Here the species has been found to strongly associate with habitats that have a high cover of Grey Gum (*Eucalyptus punctata*) and Forest Red Gum (*E. tereticornis*), with large numbers located in the Blue Mountains escarpments and gullies (DEC 2006a). Population strongholds elsewhere in the Sydney Basin include the tall forests of the Central Coast and Watagan Ranges (DEC 2006b). Numerous records are known from a large number of reserves including Jervis Bay, Morton, Nattai, Blue Mountains, Yengo, Watagans and Wollemi National Parks amongst others (DEC 2006b). 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).

The importance of dedicated survey for the detection of the Yellow-bellied Glider is highlighted by the fact that the species was not detected prior to DEC surveys, but since has been found to be widespread and relatively abundant in the park (Map 14). The species has been seen or heard calling at 60 locations, and detected by the distinctive 'V'-shaped incisions that it leaves in feed trees at a further 40 sites. Within the study area these feeding notches (used to extract sap from eucalypts) have most commonly been recorded on Grey Gum (*E. punctata*), but also on Mountain Blue Gum (*E. deanii*) and Manna Gum (*E. viminalis*). Yellow-bellied Gliders have also been observed in flowering Box trees, as well as catching and consuming grubs. The glider is expected to inhabit the majority of tall gully forests and adjacent forests/woodlands across the sandstone plateaux. They are also widespread in the drier forests and woodlands located on the northern, north-western and south-western alluvial gullies and sheltered lower slopes, so long as preferred food resources, such as Grey Gum, and suitable shelter are present.

The recent surveys of northern Wollemi (including the north-east and north-west) and northern Yengo National Parks have revealed the Yellow-bellied Glider to be widespread in the sandstone reserves that border the southern escarpment of the upper Hunter Valley. This result concurs with recent findings in the greater southern Sydney region (DEC 2006a) 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.

SQUIRREL GLIDER

Species Profile

The Squirrel Glider (*Petaurus norfolcensis*) is a small to medium-sized nocturnal mammal 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 (*P. breviceps*). However, the Squirrel Glider is larger, has a longer more pointed face, longer and narrower ears and a bushier tail, particularly at the base. It also lacks the persistent yapping call of the Sugar Glider, instead infrequently emitting a deeper call. It has a varied diet comprised of insects, nectar, pollen, seeds, *Acacia* gum and sap from eucalypts (Suckling 1995b). The Squirrel Glider usually occurs in family groups of up to ten, consisting of one male, one or more females and their dependant young. Home ranges vary between 0.65 and 8.55 hectares and individuals have been known to move up to 500 metres in one night. It is patchily distributed along the east coast and inland slopes between north Queensland and northern Victoria (NPWS 1999g) in habitats that comprise sufficient numbers of hollow-bearing trees for shelter and winter flowering plant species for food (Quin 1995).

Plate 41: Squirrel Glider © N. Williams

Threats

The greatest threat to the Squirrel Glider is loss of habitat by broadscale clearing for agriculture (Kavanagh 2004). Most clearing in NSW has fallen on open forests and woodlands growing on relatively fertile soils on gentle topography, especially in river valleys (Lunney & Leary 1988), which comprises the prime habitat of the Squirrel Glider. Clearing of land for mining has also resulted in habitat loss in the Hunter Valley (N. Williams pers. comm.). 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 2003c); ecological consequences of high frequency fire (NSW Scientific Committee 2000b); and competition for tree hollows with feral Honeybees (NSW Scientific Committee 2002d).

Local and Regional Conservation Status

The Squirrel Glider is listed as Vulnerable under the NSW TSC Act (1995). It occurs patchily throughout the eastern Bioregions of NSW, and is only recorded regularly in the NSW North Coast, Nandewar and Sydney Basin Bioregions (DEC 2006b). Across its range, habitat for the Squirrel Glider appears to occur primarily outside of public lands (Kavanagh 2004). In the Sydney Basin Bioregion the dry woodlands of the Central Coast provide very high quality habitat and the area has been well documented as 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 National Parks (DEC 2006b).

The Squirrel Glider was definitively recorded within the study area for the first time during the 2005-06 surveys, with sightings made at six locations (Map 14). A seventh record from the CRA exists on the road leading to Mount Monundilla, however due to identification uncertainties and the fact that suitable habitat is not present in this area, the species is considered unlikely to occur here. This latter record has therefore not been included on Map 14. It is well recognised that the Squirrel Glider prefers dry woodlands, generally below 300 metres asl, and is not found in tall forest or closed forest (e.g. Goldingay and Jackson 2004). Although four of the records collected in the study area lie at slightly higher elevation than expected (between 400 and 500 metres asl), all of the sightings were made in low rainfall woodlands on alluvial creeklines or lower slopes, as is normal for the species. The Squirrel Glider is expected to be moderately widespread in such habitats across the northern and north-western perimeters of the reserve, and may also occur in the Glen Alice valley. They are likely to inhabit areas with Box, Red Gum or Rough-barked Apple in the canopy, wherever hollow-bearing trees and at least one winter-flowering tree or shrub species occur. However, the sparsity of records suggests the species only persists at moderately low abundance. There is anecdotal evidence of the glider in paddock trees in the Widden Valley. Habitat of the Squirrel Glider in the study area is located

almost entirely within the ‘Upper Goulburn Valley and Escarpment’ and the ‘Sydney Basin Western Escarpment’ Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

The Squirrel Glider would once have been abundant and widespread throughout the valleys of the Hunter and Goulburn Rivers. However, large amounts of primary habitat have been lost through clearing for agriculture, urban and industrial development, while remaining habitat is under ongoing pressure. Squirrel Glider populations in and adjoining the reserve (together with those in the adjoining north-east Wollemi, Yengo and Goulburn River National Parks) will increase in importance as remaining coastal strongholds are cleared or fragmented for urban and industrial expansion. These reserves will become vital to the survival of the species in the region. Predation by Foxes and possibly by Feral Cats are likely to be the major threats to the Squirrel Glider in north-western Wollemi National Park and adjacent reserves, and should be actively managed accordingly. 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

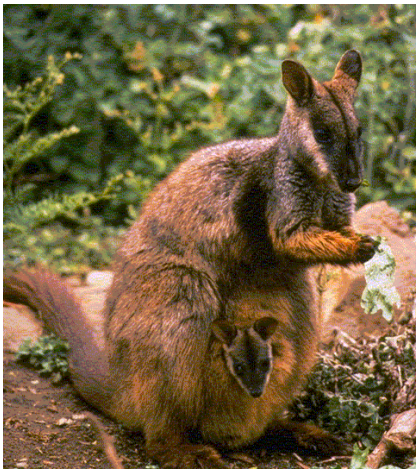


Plate 42: Brush-tailed Rock-wallaby © E. Holland/DEC

The Brush-tailed Rock-wallaby (*Petrogale penicillata*) is a medium-sized macropod, characterised by its distinctive facial markings, black paws, and long thickly furred tail which has a distinctive brush-like appearance near the tip (NSW Scientific Committee 2003a, NPWS 2002b). Habitats occupied by this species tend to take one of three forms: loose piles of large boulders containing a maze of subterranean holes and passageways; cliffs (usually over fifteen metres high) with many mid level ledges covered by overhangs; or isolated rock stacks, usually sheer sided and often girdled with fallen boulders (NPWS 2002b). Vegetation forms a vital component of the habitat, especially as refugia near major rock outcrops. 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 significantly in the west and south of its former range, and populations have become more fragmented throughout (NSW Scientific Committee 2003a). It was thought to be extinct in Victoria until small populations were rediscovered in the Grampians and near the Snowy River (Eldridge and Close 1995).

Threats

The historical decline of the Brush-tailed Rock-wallaby is attributed to three factors: hunting for bounty and fur; predation by introduced predators; and competition with introduced herbivores (especially Feral Goat (*Capra hircus*), Rabbit (*Oryctolagus cuniculus*) and domestic stock) (NSW Scientific Committee 2003a). The major threats continuing to impact on the species include ongoing predation and competition with feral species such as Goats (*Capra hircus*), Foxes (*Vulpes vulpes*) and Wild Dogs (*Canis lupus familiaris*), habitat modification by fire, vegetation clearing, disease transmission (toxoplasmosis and hydatosis) by feral carnivores (NSW Scientific Committee 2003a) and inbreeding (Environment ACT 1999). The species typically exhibits low migration rates between colonies, impeding persistence and recovery of populations affected by these threatening processes.

Local and Regional Conservation Status

The Brush-tailed Rock-wallaby is listed as Endangered under the NSW TSC Act (1995) and as Vulnerable under the Commonwealth EPBC Act (1999). In the Sydney Basin Bioregion the species forms part of one of the three Evolutionary Significant Units (ESU) that summarise genetically distinctive groups on the basis of DNA. The nominate ESU encompasses closely related populations in central NSW including Kangaroo Valley, Jenolan Caves, the Hunter Valley and the Warrambungles. This central ESU is one of the most fragile in NSW and all sites within it are of very high conservation significance (NSW Scientific Committee 2003a). Recent records from reserves within the Sydney Basin are mostly confined to Yengo, Wollemi, the Watagans and Morton NPs and Parr SCA (DEC 2006b) as well as a recently discovered colony in Nattai National Park (DEC 2004c).

Plate 43: Habtiat in the vicinity of Brush-tailed Rock-wallaby sighting on Myrtle Creek in March and May 2006 © N. Williams/DEC

The Brush-tailed Rock-wallaby is well known in the northern end of Wollemi National Park. Rock-wallabies were noted by explorers to the Doyles Creek Valley in the early 1800s (Macqueen 2005), by landholders in the 1960s (e.g. B. Tindale of 'Myrtle Grove') and by researchers visiting the Colo, Capertee and Wollemi Gorges in the 1970s (Australian Museum 1979). A report produced in 1994 summarised the known distribution of the species in the area at the time (Wong 1994). This distribution included three colonies in the Widden Valley, one colony in Kings Creek Valley, and one colony on the eastern side of Martindale Valley (Wong 1994) (the latter two being to the east of the current study area). Since the mid-1990s, the Wallaby has been recorded at six further widely spaced locations in north-western Wollemi, including rocky escarpments on the central sandstone plateau, north of Glen Alice, and on the south-west slope of

Mount Barker (Map 15). BSP surveys in 2004-05 detected evidence of the species on the ridgeline between the Baerami and Widden Valleys (as well as further east in the Appletree Creek, Turnbull Creek, Doyles Creek and Martindale Valleys) (DEC 2005a).

The DEC 2005-06 surveys detected fresh evidence of the Brush-tailed Rock-wallaby at two locations, and undertook searches in a wide range of potential habitats. A summary of the 2005-06 findings follows.

- Myrtle Creek. The most significant sighting of Brush-tailed Rock-wallaby made during the DEC surveys was in the vicinity if Myrtle Creek approximately two kilometres south of 'Myrtle Grove'. Two animals were directly observed in March 2006, in dry rainforest vegetation dominated by Grey Myrtle (*Backhousia myrtifolia*) and Rusty Fig (*Ficus rubiginosa*). On returning to the area to undertake more extensive targeted searches in May 2006, two further individuals were seen at the base of a cliff line approximately 300 metres east of the first sighting (Map 15). Brush-tailed Rock-wallaby scats were identified from twelve locations in the vicinity of the sightings, including up to one kilometre to the east of west of the creek (Map 15). At least five individuals currently appear to be using this section of Myrtle Creek and the surrounding escarpment, where there is a network of crevices and overhangs for shelter, ledges for sunning, and connecting habitat corridors such as lines of boulders. One of the individuals observed was a sub-adult, indicating that breeding has occurred in the area recently. Twenty-two Wild Dog and five Fox scats were collected from the vicinity of the sightings, but Brush-tailed Rock-wallaby remains were not identified from within any of them.
- Box Hole Clearing. Fresh scats were collected from the north-western corner of the clearing, west of the Army Road. The scats were located on ledges and overhangs in rock faces. Brush-tailed Rock-wallaby tracks were also seen, but the density of the tracks and scats suggests that only a few animals are currently using the site.
- Red Creek. In May 2006 Brush-tailed Rock-wallaby scats were identified from three locations on Red Creek, between one and a half and two kilometres upstream of Widden Brook. One of these sets of scats was quite fresh, while those further upstream were reasonably old. The areas where the scats were located consist of large boulders alongside the creekline, surrounded by wet sclerophyll forest with a dense mesic understorey and scattered Rusty Fig. Red Creek is spring fed, providing a permanent source of water for many fauna, including the Brush-tailed Rock-wallaby.
- Bylong River. In March and May 2006 Brush-tailed Rock-wallaby scats were identified from two locations near the ford, including around rock outcrops and overhangs and near the river itself. However these scats were quite old, and there is no evidence of recent Brush-tailed Rock-wallaby activity. Feral Goat droppings and prints were found near the old Brush-tailed Rock-wallaby scats.
- Lovers Leap. In May 2006 searches were undertaken around Lovers Leap, the sight of historic Brush-tailed Rock-wallaby records (Wong 1994). Sadly, only old Brush-tailed Rock-wallaby scats were located between 'Myrtle Grove' homestead and Lovers Leap, suggesting that the species does not currently utilise the area.

The findings of the 2006 surveys are both encouraging and alarming. While the confirmation that a breeding colony of Brush-tailed Rock-wallabies persists around Myrtle Creek is very exciting, the low density and distribution of fresh scats elsewhere in north-western Wollemi National Park suggests that only a few small colonies are extant and that distribution is very patchy. Potential habitat for the Brush-tailed Rock-wallaby remains widespread across the northern and western escarpment of the study area and it is possible that more colonies exist in remote escarpments and rocky areas that have not been visited or surveyed. Never-the-less, the 2006 surveys, together with experiences elsewhere in the state, suggest that the long term survival of the known Brush-tailed Rock-wallaby colonies in the park will depend in careful targeted management.

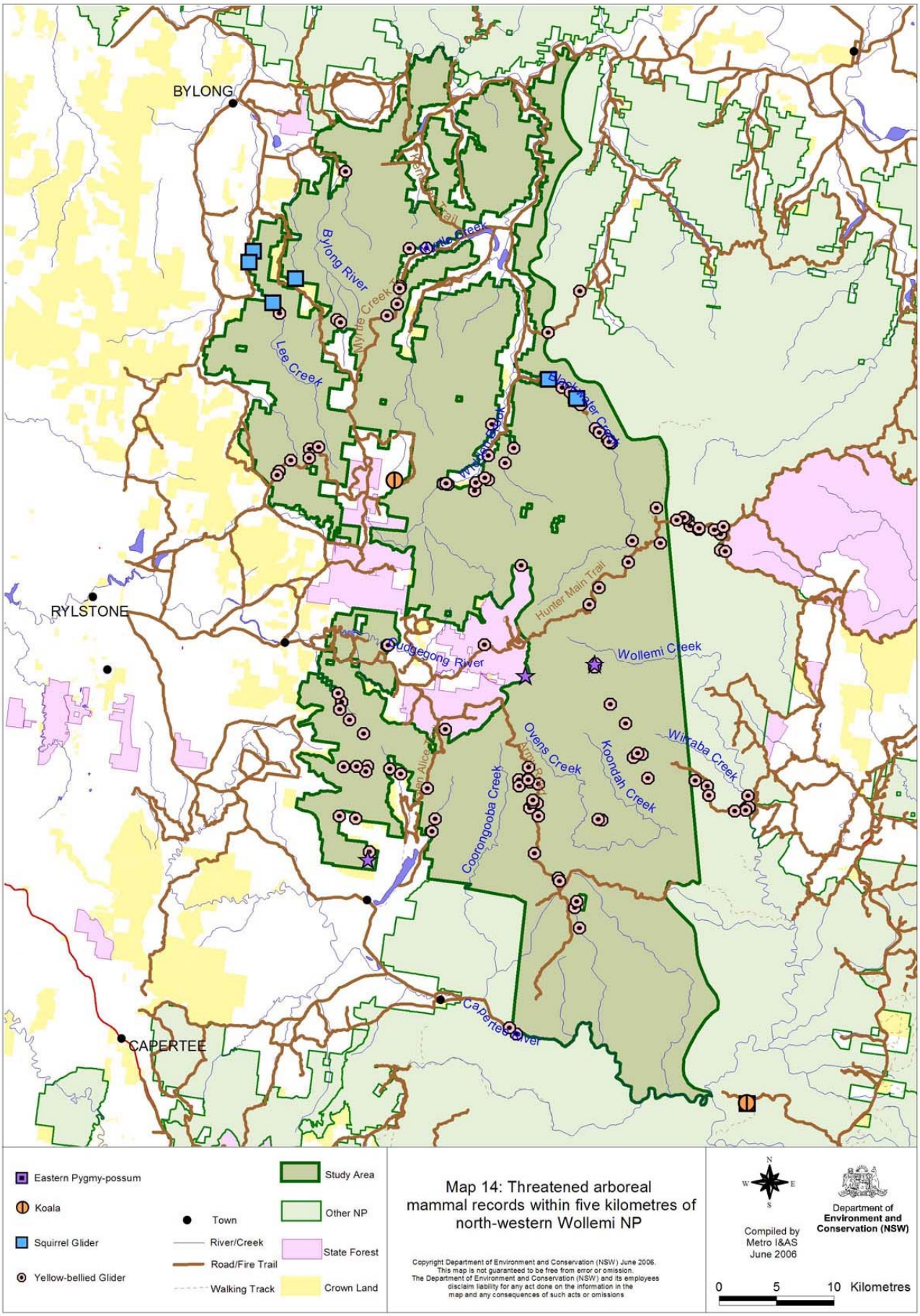
Plate 44: Crevice site in use by Brush-tailed Rock-wallaby on the eastern side of Myrtle Creek © N. Williams/DEC

Colonies of the Brush-tailed Rock-wallaby within northern Wollemi National Park, together with those in northern Yengo National Park, are highly significant as the area encompasses one of the few remaining strongholds for the species, not only within the region but also within the central ESU. These colonies are important to the conservation of the species across the state. These Rock-wallabies can be linked to populations in the south of Wollemi and southern Yengo by contiguous rocky terrain. A significant population also

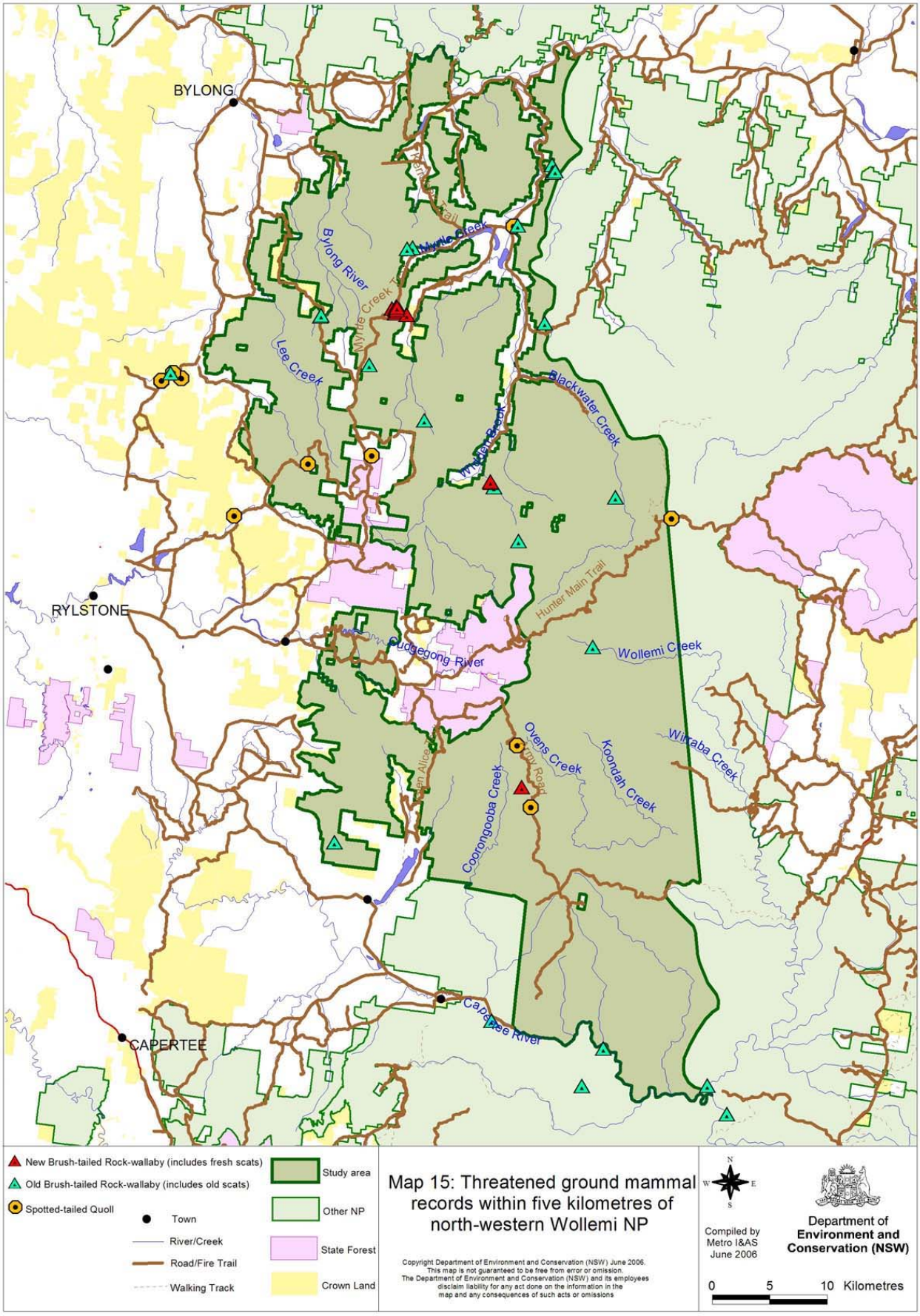
occurs not far to the south-east, in Watagans National Park. However, to the north the Wollemi-Yengo population(s) is the last known significant population within the central ESU. Another healthy population of the species does not occur until the Apsley and Macleay River gorges over 160 kilometres to the north (Wong 1994), where the animals are of a different ESU.

The primary threat to the persistence of Brush-tailed Rock-wallabies in north-western Wollemi National Park is likely to be predation by Foxes and Wild Dogs. Competition with Feral Goats poses a threat in the Bylong River, and could become highly significant if the species spreads to, or increases in numbers in, the Widden Valley. The proximity of the Myrtle Creek colony to agricultural land makes it susceptibility to disease transmission from feral carnivores. The small size and apparently scattered nature of the colonies also makes them susceptible to fire.

The long-term survival of the wallabies within northern Wollemi National Park will require park managers to gain an understanding of the most significant threats to remaining colonies as soon as possible. This should be followed by a threat abatement program(s) and associated monitoring of the known Brush-tailed Rock-wallaby colonies. If, as suspected, Foxes pose a threat to the Myrtle Creek colony, the site should be included in the Fox TAP and its associated outcomes and recommendations. At least until further information is gained, high intensity wildfire should be excluded from the rocky refugia of known colonies. At a minimum, an annual survey should be undertaken of the Myrtle Creek colony to determine whether the colony size remains stable, increases or decreases in response to management actions and threat abatement programs. An assessment of the colony's health and size using DNA analysis of fresh scats could also be considered. See Section 4.6.1 of this report for further detail of recommended monitoring and further survey.



Map 14: Threatened arboreal mammal records within five kilometres of north-western Wollemi National Park



Map 15: Threatened ground mammal records within five kilometres of north-western Wollemi National Park

GREY-HEADED FLYING-FOX

Species Profile

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is a large fruit bat that has dark grey body fur, a slightly paler grey head and a russet collar. It is the largest bat in the study area, with a wingspan of up to one metre. It is a highly mobile species and numbers roosting at specific camps may vary depending on season and food availability. It feeds on nectar and pollen of various trees including *Eucalyptus, Melaleuca* and *Banksia* as well as fruits, originally of rainforest species, but now including commercial and garden crops. The species can travel up to twenty kilometres to a food source, and is an important pollinator and disperser of native plants. The Grey-headed Flying-fox is endemic to eastern Australia, between Melbourne, Victoria and Bundaberg, Queensland (NPWS 2001g). The species range has contracted, previously occurring as far north as Rockhampton (NPWS 2001g). It primarily occurs along the eastern coastal plain, east slopes and tablelands, although regular movements occur over the Great Dividing Range to the western slopes in northern NSW (NPWS 2001g). A number of studies have noted the annual southerly movement of animals in spring and summer and their return to north-east NSW and south-east Queensland in winter (NPWS 2001g).

Plate 45: Grey-headed Fliying-fox
© N. Williams

Threats

The main threats to the Grey-headed Flying-fox are: destruction of habitat, particularly of foraging habitat, by clearing for urban development and agriculture; disturbance at roosting sites, particularly of pregnant females; unregulated shooting, particularly when feeding on commercial crops or close to residential developments; electrocution on power lines, particularly in urban areas; and accumulation of pollutants and pesticides (NPWS 2001g, Duncan *et al.* 1999).

Local and Regional Conservation Status

The Grey-headed Flying-fox is listed as Vulnerable under the NSW TSC Act (1995) and is also listed as Vulnerable under the Commonwealth EPBC Act (1999). The species is regularly recorded in all three coastal bioregions (DEC 2006b). Eby *et al.* (1999) estimated there to be approximately sixteen camps within the Sydney Basin Bioregion. Current locality data suggests the species to be primarily distributed across the coastal and hinterland environments of the Sydney Basin, although this may reflect reporting bias in the data. The species has been recorded foraging in numerous conservation reserves, including Royal, Lane Cove, Dharug, Blue Mountains, Wyrrabalong, Yengo and Werakata National Parks (DEC 2006b), as well as southern and eastern Wollemi National Park. However, a greater number of records occur off reserve, including within parks and gardens in metropolitan areas between Sydney and Newcastle. The majority of known camps are not within national parks.

The Grey-headed Flying-fox was recorded for the first time within north-western Wollemi National Park during DEC surveys in November 2005 (Map 16). Only one individual was encountered, flying high over the canopy south of Koondah Creek. Four animals were recorded approximately four kilometres east of the study area in 1998 during CRA surveys near Wollemi Creek (Map 16). Further east, the bat has been recorded more frequently, including in eastern Wollemi and northern Yengo National Parks (DEC 2006b). These results indicate that the Grey-headed Flying-fox roams widely over at least the southern half of the study area, but suggest they are only infrequent visitors. North-western Wollemi National Park would form a component of the foraging habitats on which Grey-headed Flying-foxes in the Hunter Valley depend. Such as was observed in north-eastern Wollemi National Park in 2005 (DEC 2005a), large numbers are likely to congregate in the study area only when an abundance of eucalypts are in heavy flower, or when food resources are limited elsewhere. There is no indication of a Grey-headed Flying-fox camp in the study area.

Wollemi National Park contributes significantly to the system of reserves (also including Yengo and Werakata National Parks) that provide a natural foraging area for Grey-headed Flying-foxes in the Hunter Valley in spring and summer, and therefore holds conservation significance to the species. The area may also play an important role during southward/northward population movements.

YELLOW-BELLIED SHEATHTAIL-BAT

Species Profile

Plate 46: Yellow-bellied Sheathtail-bat © J. Little/DEC

The Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) is readily distinguished from other insectivorous bat species in south-eastern Australia by its large size, characteristic tail and distinct coloration, with bright white or yellow fur on the belly and contrasting rich, black, shiny fur on the back (Churchill 1998). Males possess a prominent throat pouch, which is represented by an undeveloped skin fold in the female (Richards 1995). Endemic to Australia, it is the only species of Sheathtail-bat to extend so far into temperate, cool areas (Churchill 1998). It is widely distributed across northern and eastern Australia, but is uncommonly captured in harp traps due to its rapid, high-flying behaviour. However it is fairly easily identified by its ultrasonic call, which is audible to humans (Pennay *et al.* 2004). It forages for airborne insects (mainly beetles and moths) above the tree canopy, although in more open habitats also feeds closer to the ground (Churchill 1998, Shelley 2004). It usually roosts in tree hollows (Churchill 1998). It is thought to undertake a winter migration from the south to warmer areas, with reports from southern Australia existing only between January and June (Richards 1995, Shelley 2004). Habitat preferences of this species are fairly broad, with roost sites located in cleared grazing areas, open woodland, and unmodified forests (Shelley 2004).

Threats

The ecology of the Yellow-bellied Sheathtail-bat remains poorly understood, making the elucidation of threats difficult. The most pertinent threat is likely to be the clearing of forest and woodland for settlements and agriculture, resulting in the loss of hollow-bearing trees for roost sites and reduction of foraging habitat (DEC 2005f, Shelley 2004). Foraging activities are also likely to be impacted by the use of pesticides that cause a reduction in the availability of food and possibly a build up of toxins within the bats' tissues (DEC 2005f).

Local and Regional Conservation Status

The Yellow-bellied Sheathtail-bat is listed as Vulnerable under the NSW TSC Act (1995). Most records for the species in NSW come from the Brigalow Belt South, Nandewar and Darling Riverine Plains as well as the NSW North Coast and Sydney Basin Bioregions (DEC 2006b). Within the Sydney Basin, most records are outside of reserves. However, it has been detected in the southern Blue Mountains and Ku-ring-gai National Parks and Manobalai Nature Reserve (DEC 2006b). There are a number of records in the coastal plain between Wollongong and Cessnock.

The Yellow-bellied Sheathtail-bat has only been recorded once within the study area, detected by ultrasonic call in January 2006. This individual was utilising alluvial Box – Red Gum – Rough-barked Apple woodland on a small tributary of Lee Creek (Map 16). The species is probably more widespread than records indicate. It is likely to utilise alluvial flats and lower talus slopes along the northern, north-western and south-western boundaries of the reserve.

Records of the Yellow-bellied Sheathtail-bat in the study area hold significance as very little is known about the species in the region. Within a 40 kilometre radius of the study area boundary, the species has been detected at just four other locations (Manobalai Nature Reserve, Turon River, Walerawang and Mount Arthur). The record collected in north-western Wollemi thus contributes important information about the species distribution, habitat preferences and status. Additionally, as few confirmed records for the species have been collected on reserves in the Sydney Basin, their protection within the National Park holds conservation importance.

Fertile low-elevation forests and woodlands of plains and valleys are the likely to be the preferred habitat of the Yellow-bellied Sheathtail-bat in the region. Within the study area and adjacent lands, these habitat types are located within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

EAST-COAST FREETAIL-BAT

Species Profile

Plate 47: East-coast Freetail-bat © N. Williams/DEC

The East-coast Freetail-bat (*Mormopterus norfolkensis*) is a member of a group of bats that remain in a state of taxonomic uncertainty (Churchill 1998). The species can be distinguished from other members of the group by its long forearm, upright ears and robust build (Allison and Hoye 1995, Parnaby 1992a). Reinhold *et al.* (2001) describes the ultrasonic call as "a pattern of alternating pulses", making it unique among *Mormopterus*, though it can also call without this pattern. This is a poorly known species, but it appears to be restricted to the east of the Great Dividing Range between approximately Brisbane (Queensland) and Picton (New South Wales) (Duncan *et al.* 1999, Parnaby 1992a). The species appears to favour dry eucalypt forest and woodland, though it has also been captured in rainforest and wet sclerophyll forest (Churchill 1998). 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 1998).

Threats

The threats to this species are poorly known, though it is suspected that clearing for agriculture, development and logging have serious impacts (Duncan *et al.* 1999). These threats are of heightened significance because the species' entire known distribution lies within an area of concentrated human population density and increasing urban development. The East-coast Freetail-bat is listed as threatened by the Key Threatening Process removal of dead wood and trees (NSW Scientific Committee 2003c) and it has been suggested that pesticide use may also be a problem (NPWS 2002c).

Local and Regional Conservation Status

The East-coast Freetail-bat is listed as Vulnerable under the NSW TSC Act (1995). Most records for the species in NSW occur within the NSW North Coast, South East Corner and Sydney Basin Bioregions. Within these bioregions it appears to prefer 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 (DEC 2006b). 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 National Parks and Western Sydney Regional Park (DEC 2006b).

The East-coast Freetail-bat has only been recorded on the immediate perimeter of north-western Wollemi National Park, on the southern edge of the Glen Alice Valley (Map 16). At this location it was detected by its ultrasonic call, flying over a farm dam. The species has also been detected on Wollemi Creek and the Capertee River, to the east and west of the study area, again by it's distinctive ultrasonic call (Map 16). It is significant that the bat has not been captured in harp traps within the area, as this highlights the species habit of flying high and ranging widely through more open habitats where it is difficult to capture. Current records are therefore likely to be an underestimate of the status and distribution of the bat in the region. However, as this species primarily occurs east of the Great Dividing Range, it is considered unlikely to be present in the drier western-influenced environments in the north and north-west of the study area. Interestingly, all of the records obtained to date have been in the vicinity of permanent water, which suggests the species may be dependent on water availability and more moist environments near this western limit of its range. A better understanding of habitat requirements is required to make an accurate assessment of the species distribution and abundance within the study area. Recent surveys of the species across the southern Sydney region have suggested an association with more fertile country (DEC 2006a), a pattern which may be replicated in this region.

LARGE-EARED PIED BAT

Species Profile

Plate 48: Large-eared Pied Bat © N. Williams/DEC

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is readily distinguished from other members of its genus by the combination of large ears and overall black colour, with bands of white fur along the undersides of the body, that typically join to form a V-shape (Parnaby 1992a, Churchill 1998). The call (undetectable by the human ear) is an alternate pattern made at a low frequency, which is readily distinguishable from all other species (Reinhold *et al.* 2001). It has been recorded from a number of scattered locations on either side of the Great Dividing Range between Rockhampton (Queensland) and Bungonia (New South Wales) (Hoye & Dwyer 1995). It occurs in a wide range of habitats, including wet and dry eucalypt forest, rainforest, Cypress (*Callitris*) forest and sub-alpine woodland (Duncan *et al.* 1999). It is a cave-roosting species, though it has also been detected roosting in disused mine shafts and overhangs (Churchill 1998) as well as abandoned Fairy Martin (*Petrochelidon ariel*) nests (Schulz 1998). It seems to prefer the 'twilight' areas of caves, and may be dependent on sandstone outcrops (Duncan *et al.* 1999, Hoye & Dwyer 1995).

Threats

Threats to this species are poorly understood but thought to include: clearing, isolation and alteration of forest and woodland foraging habitat near cliffs, caves and old mines; damage to roosting and maternity sites from mining operations and recreational caving activities; and use of pesticides (DEC 2005j). Predation by feral animals is also thought to be a threat (Duncan *et al.* 1999), as is disturbance of roost sites by Feral Goats (M. Schulz pers. comm.).

Local and Regional Conservation Status

The Large-eared Pied Bat is listed as Vulnerable under the NSW TSC Act (1995) and also as Vulnerable under the Commonwealth EPBC Act (1999). The Sydney Basin is extremely important to the species, holding a large proportion of overall records. Only scattered records occur to the north, south and west of the Bioregion (DEC 2006b). There is a concentration of records across the Blue Mountains plateau, particularly within Nattai and Blue Mountains National Parks, as well as in the upper Hunter Valley in Yengo, Wollemi and Goulburn River National Parks (DEC 2006b). However these concentrations are likely to reflect the locations of recent DEC survey effort. Records are scattered throughout the Bioregion, including southern Wollemi, Kanangra-Boyd, Royal, Gardens of Stone and Morton National Parks (DEC 2006b). However, despite this wide distribution the species is infrequently detected, suggesting that it only occurs at low abundance.

The Large-eared Pied Bat is widespread within north-western Wollemi National Park, as was found to be the case in the north-eastern section (DEC 2005a). A total of 35 individuals have been captured at 26 harp locations, and it has been recorded from a further 13 locations by its ultrasonic call (Map 16). These sites are located in a wide range of environments, including Box – Red Gum – Rough-barked Apple woodland in the northern alluvial valleys and lower slopes, dry rainforest along Myrtle Creek, Scribbly Gum woodland north of Tayan Peak, Stringybark – Peppermint woodland on sandstone ridges and rainforest on basalt-influenced soils. No roost sites have been located within the study area, but are sure to occur in deep sandstone overhangs and holes in cliff faces, including along sandstone gully lines and the northern and western escarpments. Maternity roost requirements for the species are poorly understood, but are located within deeper cave systems, which are comparatively rare. It is however likely that a maternity roost site(s) occurs within the reserve.

The recent systematic surveys in north-west and north-east Wollemi, northern Yengo and Goulburn River National Parks have shown the upper Hunter Valley and Goulburn Valley region to be a stronghold for the species. The records continue to provide evidence that the bat is more common in sandstone reserves in the Sydney Basin Bioregion than previously thought, and is likely to be relatively well protected. The primary threat at this stage is likely to be predation by feral animals, wildfires that scorch roost and maternity caves, and disturbance of roost sites by Feral Goats.

EASTERN FALSE PIPISTRELLE

Species Profile

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) is a relatively large (up to 70 millimetres) bat that is 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 1998). 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 in northern parts of its range (Phillips 1995), though it has been recorded between sea level and 1500 metres in Victoria (Menkhorst & Lumsden 1995) and Tasmania (M. Schulz pers. comm.). It usually roosts in hollows in *Eucalyptus*, though it has been recorded in caves (Churchill 1998). It may hibernate over winter and has been known to travel at least twelve kilometres from its roost site (Churchill 1998).

Plate 49: Eastern False Pipistrelle © L. Broome/DEC

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 2005k). Urban expansion in areas such as the Cumberland Plain continues to threaten the species (DEC 2006a). The Eastern False Pipistrelle is listed as impacted by the Key Threatening Process removal of dead wood and trees (NSW Scientific Committee 2003c).

Local and Regional Conservation Status

The Eastern False Pipistrelle is listed as Vulnerable under the NSW TSC Act (1995). The species is known from the Sydney Basin Bioregion and the South Eastern Highlands Bioregion (DEC 2006b). The species has been relatively well reported from a number of reserves in the Sydney Basin, including, in addition to Wollemi, Nattai, Blue Mountains, Kanangra-Boyd and Gardens of Stone National Parks (DEC 2006b).

A total of nine Eastern False Pipistrelle have been captured at seven locations in north-western Wollemi National Park, additional to the seven times it has been positively detected by its ultrasonic call (Map 16). Unless a long sequence is recorded, the ultrasonic call of this species is easily confused with those of the Eastern Broad-nosed Bat (*Scotorepens orion*) and Greater Broad-nosed Bat (*Scoteanax ruepellii*) (Pennay *et al.* 2004). This has led to the 'possible' identification of Eastern False Pipistrelle at a number of further locations (due to low reliability these have not been included on Map 16). Though the species has been detected once at moderately low elevation in the Lee Creek catchment, the distribution of records suggest it occurs much more frequently at higher elevations, mostly above 600 metres above sea level, which is consistent with previous research on the species. At these higher elevations the bat has most frequently been detected within tall wet sclerophyll forests along sandstone gully lines or enriched ridges. Similar to the south of Sydney (DEC 2006a), it has only rarely been located in sandstone dry sclerophyll woodland.

The northern Wollemi region is important to the conservation of the Eastern False Pipistrelle as it lies towards the western edge of the species' known range. As with many other bat species, a better understanding of habitat requirements and further harp trapping surveys are required in order to accurately assess its distribution and conservation status in the study area and the surrounding region.

EASTERN BENTWING-BAT

Species Profile

The Common Bentwing-bat (*Miniopterus schreibersii*) is the most widely distributed bat in the world, occurring through Europe, Africa and Australasia (Churchill 1998). However, recent research suggests there to be three taxa in Australia (Duncan *et al.* 1999). The subspecies *oceanensis* occurs in eastern Australia and extends from central Victoria to Cape York Peninsula, Queensland (Duncan *et al.* 1999). This subspecies is commonly called the Eastern Bentwing-bat. This species is distinguished from most other bats by the long last bone in the third wing digit and from the Little Bentwing-bat (*M. australis*) by the longer forearm (greater than 44 mm) (Parnaby 1992a). The ultrasonic call can be distinctive, although it is often inseparable from *Vespadelus darlingtoni* and *V. regulus* (Reinhold *et al.* 2001). The species utilises a wide variety of habitats where it usually roosts in caves, though it has been known to use mines and road culverts (Churchill 1998). It is a fast flying bat that usually feeds above the canopy or in canopy gaps (Churchill 1998) and has been known to travel up to 65 kilometres in a night (Dwyer 1966). Though individuals often use numerous roosts, they congregate en masse at a small number of sites to breed and hibernate (Churchill 1998).

Plate 50: Eastern Bentwing-bat © S. Eberhard

Threats

Damage and disturbance to hibernating and maternity roosting sites is the greatest known threat to this species. Because only relatively few nursery caves are used, significant population changes can occur if these sites are damaged (Dwyer 1995) or inappropriately gated (e.g. Hoye 2001). Disturbance of hibernating colonies can lead to starvation due to loss of energy reserves (Gilmore and Parnaby 1994). Alteration of drainage patterns in or near roost sites may also be a threat, by leading to changes in roost site microclimate (N. Williams pers. comm.). Disturbance of smaller diurnal roosts by recreational caving and tourism may also be significant. Other potential threats include modification to feeding habitat by agriculture and urban development (Gilmore and Parnaby 1994), application of pesticides in or adjacent to foraging areas (DEC 2005l) and predation by Feral Cats and (less often) Foxes (Dwyer 1995).

Local and Regional Conservation Status

The Eastern Bentwing-bat is listed as Vulnerable under the NSW TSC Act (1995). The species is widely distributed in the eastern third of NSW, with the number of records decreasing with distance from the coast (DEC 2006b). Records are widespread within the Sydney Basin Bioregion, but strong clusters are present in the Lower Hunter and Central Coast, Cumberland Plain, Woronora Plateau and across the southern Blue Mountains. Individuals have been recorded flying through a diverse range of habitat in a number of reserves including Royal, Nattai, Kanangra-Boyd, Blue Mountains and Wollemi National Parks (DEC 2005a). However, roost sites for the species, particularly maternity roosts, are much less frequently recorded and poorly reserved.

Though the Eastern Bentwing-bat is widespread in north-western Wollemi National Park, only five individuals have been captured at four harp trap locations. This stands in stark contrast to the density of records in north-eastern Wollemi, where almost 100 individuals have been captured at six locations (DEC 2005a). The majority of records in north-western Wollemi derive from ultrasonic call identification, by which the species was detected at 17 locations (Map 17). Though the species may be more widespread within the study area than records indicate, it is clearly less common here than in other parts of the region. This is likely to be due to a lower abundance of deep caves suitable for roosting. One possible roost site was located along Myrtle Creek, but as no bats were present at the time this could not be confirmed. No maternity roost sites have been located in the study area. However, one of the bats captured in December 2005 was pregnant, indicating that breeding does occur somewhere in the region (most likely in the Baerami Valley oil shale mines). As urban and industrial expansion continues to place pressure on off-reserve roost sites, any roost sites that are located in reserves will take on increasing conservation importance. If any roosts, particularly maternity or hibernation sites, are confirmed they should be managed to minimise disruption from visitation and fire. Gating of any occupied roost sites should be avoided, or if necessary designed/modified in consultation with an expert on the species in order to minimise impacts.

LARGE-FOOTED MYOTIS

Species Profile

Plate 51: Large-footed Myotis © R. Williams

The Large-footed Myotis (*Myotis adversus*) is another bat species for which the taxonomy has recently been reviewed. Australian Myotis are now considered to belong to two 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 Myotis (*M. moluccarum*) occurs in Queensland and across the Top End (Duncan *et al.* 1999, Churchill 1998). Even though Myotis can be recorded from up to 20 metres using Anabat, it can be difficult to distinguish from *Nyctophilus* species (Reinhold *et al.* 2001). In the hand it is easily distinguished from other species by its disproportionately large feet, which it uses to rake its prey of insects and small fish from the surface of water (Churchill 1998). It occurs in a wide variety of habitats as long as water is nearby. It roosts in caves, tree hollows and man-made structures such as bridges, road culverts and mines (Churchill 1998).

Threats

The primary threats to the Large-footed Myotis are thought to be: changes in water quality due to sedimentation (from vegetation clearing and logging), eutrophication (sewage and fertiliser run-off), pollution and altered flow regimes (Duncan *et al.* 1999); loss or disturbance of roosting sites by activities such as recreational caving or roadworks (Duncan *et al.* 1999, Gilmore and Parnaby 1994); and clearing or application of pesticides adjacent to foraging areas (DEC 2005m). Land subsidence due to longwall mining may also impact on habitat for this species (NSW Scientific Committee 2005a).

Local and Regional Conservation Status

The Large-footed Myotis is listed as Vulnerable on the NSW TSC Act (1995). Throughout its range, it is primarily a coastal species. In the Sydney Basin Bioregion it is strongly associated with the coastal plains and hinterland environments of the Central Coast, Cumberland Plain and Illawarra. Records are highly scattered in the South Eastern Highlands Bioregion, though this may reflect the difficulty in capturing this species. Representation in DEC reserves is relatively poor, however records occur in Nattai, Royal and Popran National Parks (DEC 2006b).

The Large-footed Myotis has not been recorded within the study area, but was observed foraging over a large pool in the Capertee River, just over two kilometres east of the area boundary, during DEC surveys in November 2005. This sighting was confirmed by identification of the species' ultrasonic call from above another large pool, 500 metres further east (Map 17). The species is likely to utilise other large pools along the Capertee River within the study area, as well as other permanent waterbodies such as the Cudgegong River and potential Blackwater or Wollemi Creeks.

Elsewhere in the region, the Large-footed Myotis has been recorded on the Hunter Valley floor, but remains an infrequently encountered species. The preservation of habitat within north-western Wollemi National Park, though only small in extent, may thus have importance for the regional conservation of the species. The value of reserve to this species will only come to light when a greater understanding of the species ecology and habitat preferences in the region is gained through further survey and research.

GREATER LONG-EARED BAT (SOUTH-EASTERN FORM)

Species Profile

Plate 52: Greater Long-eared Bat © N. Williams/DEC

Immediately recognised as a long-eared bat by its prominent ears, the Greater Long-eared Bat (*Nyctophilus timoriensis*) has fairly uniformly dark grey-brown fur and is distinguished by its thickset body, a low ridge above a broad snout and a inter-canine width greater than 5.6 mm (Parnaby 1995, Churchill 1998). This species utilises tree hollows, crevices and loose bark as roost sites. It is known to be an agile yet slow-flying bat, making use of the understorey and ground to capture non-flying prey (Churchill 1998, DEC 2005g). Ultrasound recordings are of little use in identifying this species, as its call characteristics and frequencies overlap almost completely with other *Nyctophilus* species using Anabat call analysis (Pennay *et al.* 2004). Recent taxonomic revision has shown the mainland form of the Greater Long-eared Bat to be comprised of three distinct species with allopatric (non-overlapping) distributions, in addition to a Tasmanian subspecies (Parnaby 1995, Duncan *et al.*1999). The nominate south-eastern form occurs across much of inland southern Australia, from south central Queensland, central western NSW, north-western Victoria to south eastern South Australia. It is generally associated with dry woodlands, and semi-arid mallee and savannah (Churchill 1998).

Threats

The main threat facing this species is extensive loss of habitat through clearing (Duncan *et al.*1999). In uncleared areas the species is threatened by loss of hollow-bearing trees due to timber harvesting and grazing (Duncan *et al.*1999). An altered fire regime is also likely to impact on the species, with a long absence of fire causing a lack of hollow regeneration, while fires of too high intensity can destroy hollow-bearing trees altogether and remove the shrub layer which is commonly used for foraging. Application of pesticides near foraging areas is also likely to impact, through reduction of invertebrate populations and accumulation of toxins within the bats' tissues (DEC 2005g).

Local and Regional Conservation Status

The Greater Long-eared Bat (south-eastern form) is listed as Vulnerable under the NSW TSC Act (1995) and Vulnerable under the Commonwealth EPBC Act (1999). Records for the species are sparsely distributed across the western three quarters of the state, with concentrations in the Brigalow Belt South and Murray Darling Depression Bioregions (DEC 2006b). The species only occurs in the far north-west of the Sydney Basin Bioregion, where western influenced environments occur in the Goulburn and Hunter River Valleys (DEC 2005a). Representation in reserves in the Bioregion is poor, with key areas being Goulburn River National Park, Manobalai Nature Reserve and north-eastern Wollemi National Park.

The Greater Long-eared Bat was detected for the first and only time in the study area when captured in a harp trap on the Kerrabee Trail, west of Myrtle Creek, in September 2005 (Map 17). Like all Long-eared Bats, however, the abundance and distribution of records of the Greater Long-eared Bat is likely to be an underestimation of true status, because it cannot be readily distinguished using ultrasonic call analysis. Elsewhere within a five kilometre radius of the study area, the species has been detected in north-eastern Wollemi (on Ruebens Creek) and Goulburn River (on the Merriwa River) National Parks (Map 17). Further afield, recent surveys indicated the species to be quite common in alluvial Red Gum – Ironbark – Rough-barked Apple woodlands in the crown lands south of Manobalai Nature Reserve (DEC 2005b). Based on these records, the Greater Long-eared Bat is expected to be present at further locations in the far north of the study area, particularly along alluvial creeklines such as the lower reaches of Blackwater Creek. These habitats are largely encompassed within the 'Upper Goulburn Valley and Escarpment' and the 'Sydney Basin Western Escarpment' Mitchell Landscapes which remain subject to several threatening processes and are a high management priority (see Section 4.1.1).

The presence of Greater Long-eared Bat within northern Wollemi National Park has high conservation significance as the species reaches the eastern limit of its range in this area and is very scarce and poorly conserved within the Sydney Basin Bioregion. Further harp trapping is required to ascertain the conservation status of the species within the region. The habitat preferences of this species in the Hunter and Goulburn River Valleys differ markedly from those in south-west NSW, Victoria and South

Australia where it occurs in mallee woodland (M. Schulz pers. comm.). Habitat is comparable to the Pilliga, where it occurs in Box – Ironbark woodland. The collection of records of the species in the Hunter region over the last five years has contributed important information regarding the ecology of the species at the eastern limit of its range. The alluvial woodland habitats on both sides of the perimeter of northern Wollemi National Park are key to the regional survival of the Greater Long-eared Bat and hence should take high priority in park management planning. Land holders should be encouraged to maintain the structural integrity of woodland habitats near the boundary of the park, retain dead timber and hollow-bearing trees and avoid over-use of pesticides near the woodland-agriculture interface.

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 east New South Wales and north-eastern Queensland. The species can 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 ultrasonic call overlaps in frequency and may be confused with Eastern False Pipistrelle, Eastern Broad-nosed Bat and Inland Broad-nosed Bat, though they can be distinguished if a good call sequence is recorded (Pennay *et al.* 1994). The Greater Broad-nosed Bat utilises creeks and clearings for hunting (Churchill 1998, Hoye and Richards 1995). In southern New South Wales the species appears to be restricted to lower altitude forests (McKean 1966), while in the centre of its range it occurs at a wide range of altitudes from near sea level to upland areas (Calaby 1966 in Duncan *et al.*1999). It usually roosts in tree hollows, in cracks and fissures in trunks or under exfoliating bark, and in old buildings (Churchill 1998).

Plate 53: Greater Broad-nosed Bat © N. Williams/DEC

Threats

The threats to this species are poorly known, but 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 (DEC 2005n). Logging may remove suitable hollows and alter the availability of prey (Duncan *et al.* 1999), while urban expansion continues to pose a threat to the species in the Sydney Basin (DEC 2006a).

Local and Regional Conservation Status

The Greater Broad-nosed Bat is listed as Vulnerable under the NSW TSC Act (1995). The majority of records for the species in NSW occur in the NSW North Coast, South East Corner and Sydney Basin, with some records in the New England Tableland Bioregion and South-eastern Highlands Bioregion (DEC 2006b). 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 DEC reserves within the Sydney Basin, including Nattai, Kanangra-Boyd, Blue Mountains and Wollemi National Parks (DEC 2006b).

The Greater Broad-nosed Bat has been detected at three harp trap locations (resulting in the capture of nine individuals) (Map 17). As mentioned above, unless a long sequence is recorded, the ultrasonic call of this species is easily confused with those of the Eastern Broad-nosed Bat and Eastern False Pipistrelle (Pennay *et al.* 2004). This has led to the 'possible' identification of Greater Broad-nosed Bat at a number of further locations (however due to low reliability these have not been included on Map 17).

The habitat at the harp trap locations includes sheltered dry sclerophyll forest, exposed rocky woodland and riparian Box – Rough-barked Apple woodland with River Oak. The Greater Broad-nosed Bat has also been recorded on the Capertee River and Wollemi Creek, to the west and east of the study area (Map 17). Given its propensity to occupy a wide range of habitat types, the Greater Broad-nosed Bat is considered likely to be widespread across the study area, though probably only at low density. The species is thought to be sparse across its range (Parnaby 1992b). This suggestion is supported by the results of the recent surveys and by data obtained in the neighbouring north-eastern Wollemi National Park (DEC 2005a).

North-western Wollemi National Park is located towards the western limit of the known distribution of the Greater Broad-nosed Bat. The records collected during the current surveys (and those in north-eastern Wollemi) contribute important information about the distribution and ecological tolerances of this poorly understood species. Continued scientific survey and research of the species is crucial to guiding its conservation management. The protection of the Greater Broad-nosed Bat within the study area has high significance and is important to the ongoing conservation of the species at the edges of its range.

EASTERN CAVE BAT

Species Profile

Plate 54: Eastern Cave Bat © N. Williams/DEC

The Eastern Cave Bat (*Vespadelus troughtoni*) is a small mustard yellow-brown bat with dark wings. It has a patchy distribution through much of eastern Australia and remains one of the least known and understood members of its genus. It is very similar in size to the Large Forest Bat (*V. darlingtoni*), the most reliable distinguishing feature between the two species being the shape and size of the penis (Parnaby 1992a). The species is very difficult to distinguish from ultrasonic call recordings, as the frequency and call pattern overlaps with that of the Little Forest Bat (*Vespadelus vulturnus*) (Pennay *et al.* 2004). The Eastern Cave Bat displays a predominantly tropical distribution that ranges down the east coast from Cape York in Queensland to Kempsey in NSW, with smaller numbers recorded south to at least 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 2005h). Although little is known about the biology and ecology of this species, 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 1998, DEC 2005h). 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 1998). It has also been discovered roosting in disused Fairy Martin (*Hirundo ariel*) mud nests (Schulz 1998).

Threats

Threats to the species 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 2005h). This type of disturbance results from clearing and isolation of habitat as a result of increasing development, both residential and agricultural, as well as altered fire regimes and consequential habitat modification and from practices such as timber harvesting and grazing (DEC 2005h). Direct damage or disturbance to roosting sites can result from mining operations or recreational activities such as caving (DEC 2005h). Application of pesticides near foraging areas is also likely to impact, through reduction of invertebrate populations and accumulation of toxins within the bats' tissues (DEC 2005h). Predation by Feral Cats and Foxes also poses a threat to the species (DEC 2005h).

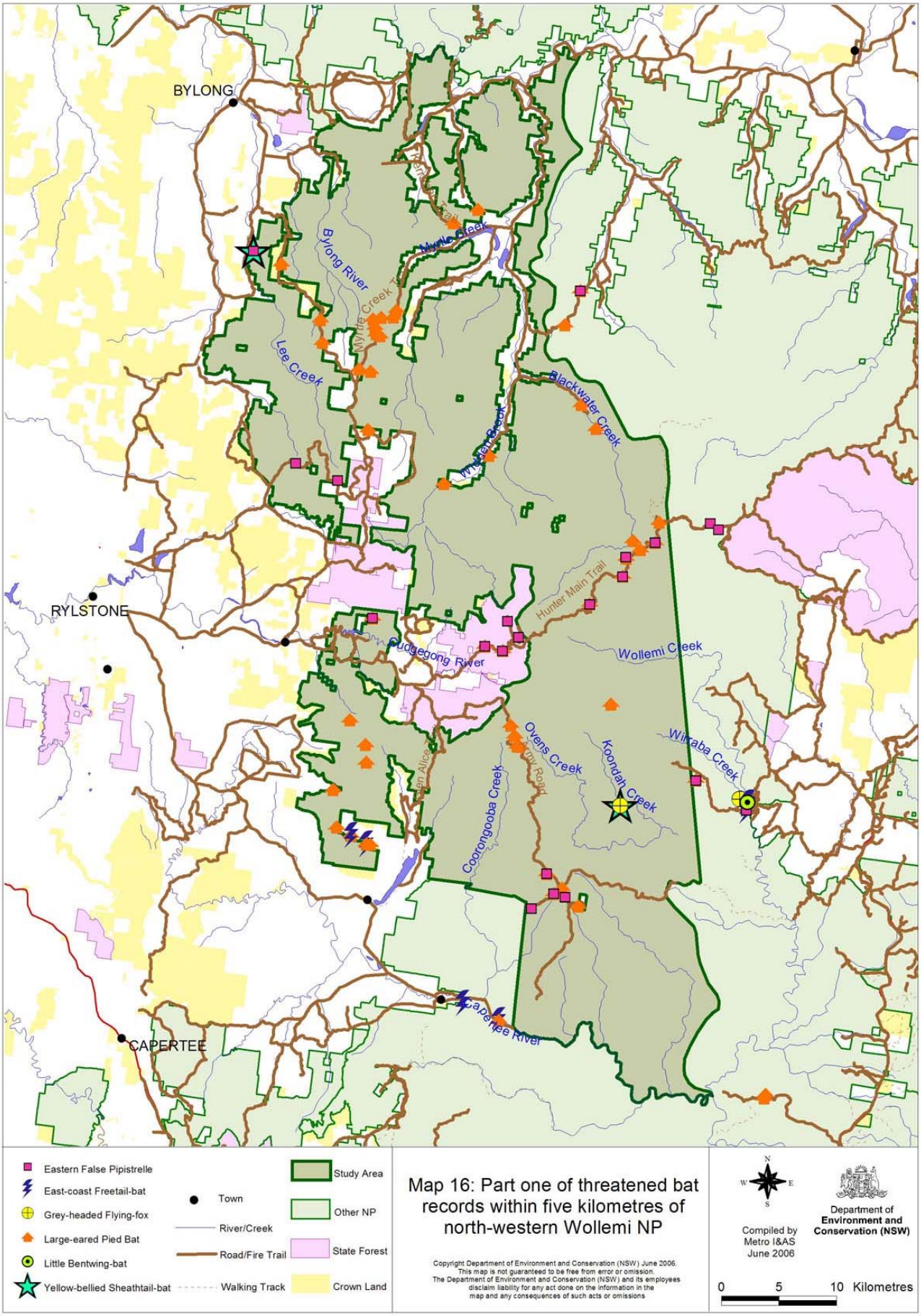
Local and Regional Conservation Status

The Eastern Cave Bat is listed as Vulnerable under the NSW TSC Act (1995). This poorly understood species has only been recorded 34 times on the Atlas of NSW Wildlife between 1980 and the current surveys. 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 (DEC 2006b). The species is reported in low numbers from DEC reserves including, in addition to Wollemi, Yengo, Goulbourn River and Warrumbungle National Parks and Arakoola and Manobalai Nature Reserves (DEC 2006b). Extensive DEC surveys in various reserves and Sydney Catchment Authority Special Areas in the central area of the Sydney Basin Bioregion have failed to locate this species in that area (DEC 2006a), although targeted searches of overhangs and caves was not undertaken.

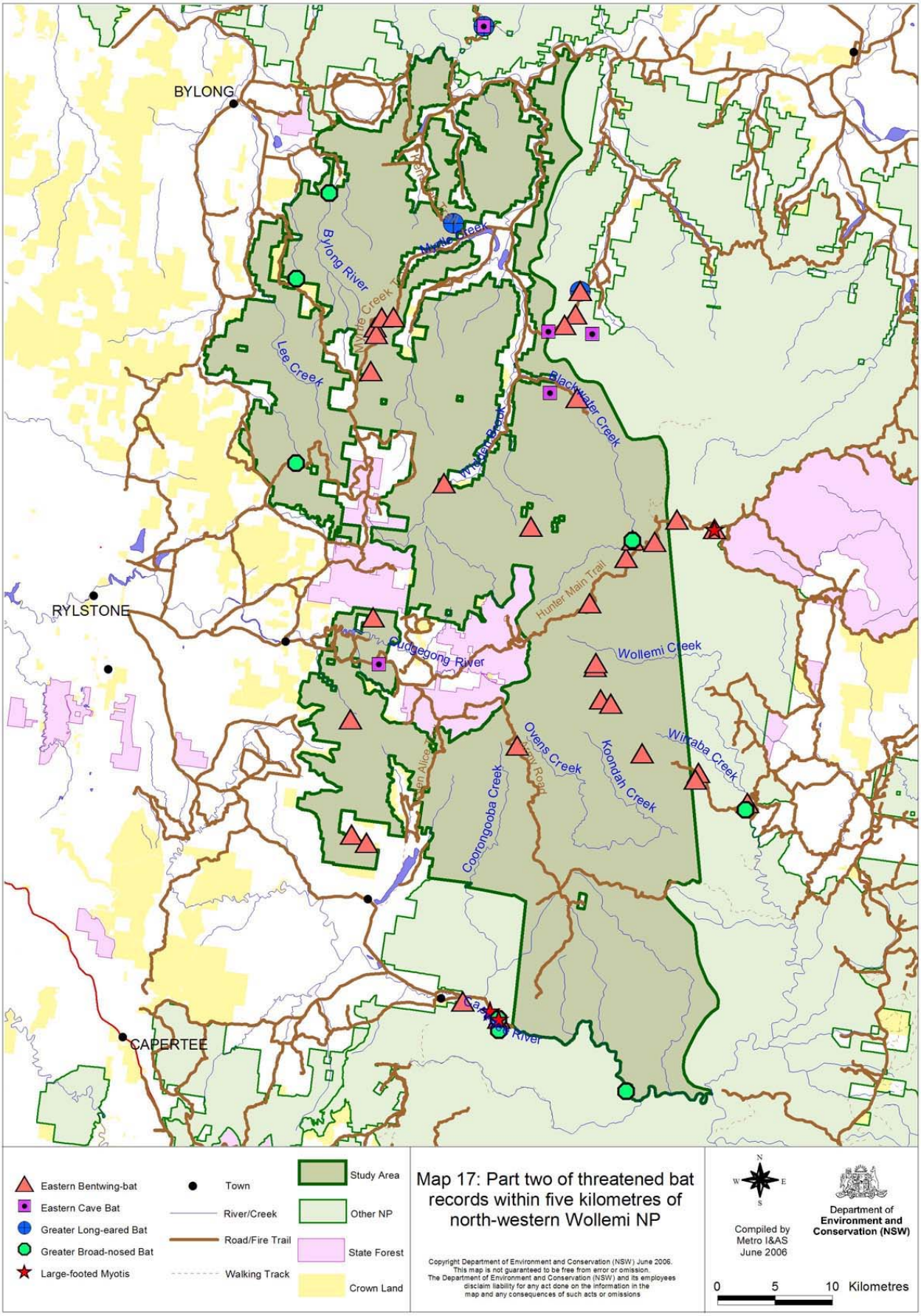
The Eastern Cave Bat had been confirmed from just three locations in the study area, including two bats captured in a harp trap on the ridgeline east of Widden Brook, two adult males found roosting in an overhang south of Dunns Swamp, and three individuals located in an overhang at the base of the escarpment south of Blackwater Creek (Map 17). Due to the difficulty in identifying the Eastern Cave Bat using Anabat call analysis, the species abundance and distribution in the study area is likely to be underestimated in relation to bats that can be detected by this method. The northern escarpment is likely to provide extensive roosting opportunities for this species, with potential foraging habitat also widespread. To date there is no evidence of maternity roosts within the study area.

Recent DEC surveys of reserves in the upper Hunter and Goulburn River Valleys have found the Eastern Cave Bat to be widespread in north-eastern Wollemi (where one roost was located and

several individuals captured), northern Yengo (where two roost sites (one with five bats and one with 20 bats) were located) and Goulburn River National Parks, as well as Manobalai Nature Reserve and Crown Lands (where a maternity roost was located). The region thus appears to be a stronghold for the Eastern Cave Bat in the Sydney area and is likely to play a pivotal role in its conservation within the Sydney Basin. As with many of the bats, further research into the ecology of the species in the southern part of its range is required to obtain a better understanding of distribution and habitat requirements, in order to accurately assess conservation status in the study area and the surrounding region. It is possible that the Eastern Cave Bat is more widespread than previously thought, but due to difficulties in identification has been overlooked or mis-identified in other locations. Given the paucity of information on the Eastern Cave Bat, these records make an exciting contribution to the overall understanding of the species' ecology and distribution.



Map 16: Part one of threatened bat records within five kilometres of north-western Wollemi National Park



Map 17: Part two of threatened bat records within five kilometres of north-western Wollemi National Park

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APPENDIX A – LOCATION OF SURVEY SITES

Tabulated below is the location of systematic fauna survey sites in north-western Wollemi National Park and the techniques undertaken at each site. In addition to this, 24 further harp trap sites were erected on an opportunistic basis. All sites are located in Zone 56, using Australian Geodatum 66.

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	BGE01O	239856	6349213	1	1								
BSP	BGE02O	239842	6348354	1	1								
BSP	BGE03O	239620	6350655	1	1								
BSP	BGE04O	237358	6358238	1	1	1	1		2				
BSP	BGE05O	237497	6356842	1	1	1							
BSP	BGE06O	239556	6354740	1	1	1							
BSP	BGE07O	239923	6351935	1	1	1			1				
BSP	BGE08W	237235	6351353	1	1								
BSP	BGE09W	239068	6351414		1								
BSP	BGE10C	239471	6356014	1	1								
BSP	BGE11O	236100	6358957	1	1	1							
BSP	BGE12M	239631	6348646		1								
BSP	BGE13O	237450	6356750				1					1	
BSP	BGE14O	239252	6354760				1						
BSP	BGE15W	239714	6353788				1		1				
BSP	BGE16O	239777	6352263				1						
BSP	BGE17W	238353	6355928					1	1				
BSP	BGE18W	237992	6345925	1	1	1							
BSP	BGE19O	237178	6346622	1	1	1	1						
BSP	BGE20O	237704	6348015	1	1	1	1						
BSP	BGE21W	238900	6347386	1	1								
BSP	BGE22W	239248	6345477				1						
BSP	BGE24O	237473	6347592	1									
BSP	BGE25W	241841	6351696		1								
BSP	BYL01W	237998	6403535	1	1	1							
BSP	BYL02W	237893	6402306	1	1								
BSP	BYL03W	237036	6404622	1	1								
BSP	BYL04O	238020	6401309		1								
BSP	BYL05O	238000	6402650			1	1		1	1			

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	BYL06O	236546	6401690	1		1	1		1	1			
BSP	CRC01C	253580	6359797		1								
BSP	CRC03M	259849	6360886		1								
BSP	CRC04H	259600	6360500	1		1			1		1		
BSP	CRC05O	260180	6360950	1	1								
BSP	CRC06O	259672	6360835	1	1	1	1	1	1		1		
BSP	CRC07O	258164	6361334	1	1								
BSP	CRC08O	258635	6360826	1									
BSP	CRC09W	258160	6366350	1	1								
BSP	CRC10O	259124	6366009	1	1	1		1	1				
BSP	CRC11W	258106	6365446	1	1	1					1		
BSP	CRC12C	254113	6364675	1	1								
BSP	CRC13C	254275	6365750	1	1								
BSP	CRC14C	255025	6366335	1	1								
BSP	CRC15M	255332	6363935	1	1	1					1		
BSP	CRC16W	254322	6363543		1				1				
BSP	CRC17H	264109	6370946	1									
BSP	CRC18C	262858	6371503	1		1		1	1	1			
BSP	CRC19O	262050	6371159	1	1								
BSP	CRC20O	260926	6371037		1								
BSP	CRC21O	262501	6369639		1				1				
BSP	CRC22W	259582	6367471	1	1	1							
BSP	CRC23O	262215	6368465		1								
BSP	CRC24O	253236	6369381	1		1							
BSP	CRC25O	253416	6370337	1	1	1							
BSP	CRC26O	253620	6371725	1	1								
BSP	CRC27O	254034	6372677	1	1	1		1	1				
BSP	CRC28O	254449	6371703	1									
BSP	CRC29O	255608	6372220	1	1								
BSP	CRC30C	256560	6372271		1								
BSP	CRC31O	255727	6364649	1	1	1							
BSP	CRC32O	261249	6368417		1								
BSP	CRC33C	263050	6373165	1									
BSP	CRC34C	262799	6372080	1						1			
BSP	CRC35M	255452	6364330								1		

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	CRC36O	256717	6372722		1								
BSP	CRC37C	259977	6367436	1		1							
BSP	CRC38O	258604	6365545									1	
BSP	CRC39O	254271	6363345	1	1	1	1				1	1	
BSP	CRC40O	254901	6363384				1						
BSP	CRC41W	256371	6364661				1						
BSP	CRC42O	258055	6365151				1						
BSP	CRC43C	258926	6365672				1						
BSP	CRC44W	259520	6367493				1						
BSP	CRC45W	262271	6369980				1						
BSP	CRC46W	263472	6370727				1						
BSP	CRC47O	264771	6371346	1	1	1	1						
BSP	CRC48O	261977	6368414				1						
BSP	CRC50O	257812	6364120						1				
BSP	CRC52O	265277	6371301						1				
BSP	CRN01C	251952	6349756	1	1								
BSP	CRN02O	251815	6357025	1	1			1	1			1	
BSP	CRN03H	251978	6353893	1	1								
BSP	CRN04W	253880	6351831	1	1	1							
BSP	CRN05O	252897	6349675	1	1								
BSP	CRN06O	253987	6349754	1	1								
BSP	CRN07O	254699	6350387	1	1	1							
BSP	CRN08O	253160	6352663	1	1	1							
BSP	CRN09C	253750	6354059	1									
BSP	CRN10O	254595	6354203	1	1								
BSP	CRN11C	255225	6354896	1	1								
BSP	CRN12O	252238	6355495	1	1	1							
BSP	CRN13O	254209	6349027		1								
BSP	CRN14O	253826	6350735	1		1							
BSP	CRN15H	252824	6353651	1	1			1	1			1	
BSP	CRN16C	251968	6350932		1								
BSP	CRN20W	251867	6356552				1						
BSP	CRN21W	252279	6355447				1						
BSP	CRN22W	252608	6354523				1						
BSP	CRN23W	253034	6353614				1						

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	CRN24W	253167	6352778				1						
BSP	CRN25O	253834	6351710				1						
BSP	CRN26O	254651	6349498	1			1						
BSP	CRN27O	254338	6347470	1			1						
BSP	CRN28O	254726	6345826	1			1						
BSP	CRN29H	253628	6358671	1		1	1				1		
BSP	CRN30W	253898	6359310	1	1								
BSP	CRN31O	253430	6358035	1		1		1	1	1			
BSP	CRN32C	252971	6357385	1	1								
BSP	CRN33C	252710	6356920		1								
BSP	CRN34W	260962	6357283	1	1	1		1			1		
BSP	CRN35W	261500	6358396		1								
BSP	CRN36C	260058	6357649	1		1		1					
BSP	CRN37O	260425	6358475	1	1								
BSP	CRN38M	261143	6357360						1				
BSP	CRN39C	261517	6348041		1	1							
BSP	CRN40C	261490	6348090	1		1		1			1		
BSP	CRN41O	261769	6348497	1	1	1	1		1				
BSP	CRN42O	261221	6347601		1								
BSP	CRN43W	259989	6347360		1								
BSP	CRN44C	261239	6347668	1	1	1		1					
BSP	CRN45C	262125	6348400	1									
BSP	CRN46C	262455	6348520	1									
BSP	CRN47O	263679	6352967	1	1	1	1	1	1		1		
BSP	CRN48C	264200	6350900	1	1	1				1			
BSP	CRN49O	263304	6353061	1									
BSP	CRN50O	262886	6354028	1	1								
BSP	CRN51O	262617	6355254		1								
BSP	CRN52C	263000	6355720		1								
BSP	CRN53O	262625	6352960	1	1								
BSP	CRN54C	261780	6352230	1	1								
BSP	CRN55O	261500	6348150						1		1		
BSP	CRN56C	245715	6353084	1	1	1							
BSP	CRN57O	245456	6351826	1		1							
BSP	CRN58O	245468	6350845	1		1							

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	CRN59O	245413	6350015	1		1							
BSP	CRN60H	244322	6349645	1	1								
BSP	CRN61W	245234	6351520				1						
BSP	CRN62O	245132	6350117				1						
BSP	CRN63W	244660	6349255				1						
BSP	CRN64O	244414	6348732	1		1	1						
BSP	CRN65O	243670	6351652	1									
BSP	CRN66C	244539	6352275	1									
BSP	CRN67W	246439	6353117	1									
BSP	CRN68W	245482	6346283	1	1								
BSP	CRN69W	245766	6347352	1	1								
BSP	CRN70C	246411	6348338	1	1								
BSP	CRN71W	246881	6354709	1									
BSP	CRN72O	244750	6349700			1							
BSP	CRN73O	246300	6353636				1						
BSP	CRN74C	246250	6354200				1		1				
BSP	CRN76O	245952	6355056	1	1	1		1					
BSP	CRN77O	244346	6349035						1				
BSP	CRN78C	246141	6354406									1	
BSP	GLC01W	239589	6345066	1	1	1			1				
BSP	GLC02W	240078	6344515	1									
BSP	GLC03O	238797	6344250		1								
BSP	GLC04W	237764	6344706		1								
BSP	GLC05O	240043	6344048	1									
BSP	GLC06O	239859	6343905		1								
BSP	GLC07O	239407	6343743	1									
BSP	GLC08W	240106	6345131				1						
BSP	GRW01W	239274	6384589	1	1								
BSP	GRW02C	239324	6384407	1	1								
BSP	GRW03C	239967	6385186		1	1			1	1			
BSP	GRW04C	240130	6386189	1		1		1	1	1			
BSP	GRW05W	236771	6386791	1	1	1			1				
BSP	GSP01O	258263	6337892	1									
BSP	GSP02O	255524	6340358		1	1							
BSP	GSP03O	258549	6337315		1								

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	GSP04O	259427	6336638		1								
BSP	GSP05W	256445	6341754			1							
BSP	GSP06W	257731	6342868			1							
BSP	GSP07O	254382	6344367			1							
BSP	GSP08C	257975	6339069	1		1							
BSP	GSP09W	258017	6340220	1	1	1							
BSP	GSP10O	256446	6342229	1	1								
BSP	GSP11C	256351	6342958	1									
BSP	GSP12C	256331	6343877		1								
BSP	GSP13W	256379	6341484		1								
BSP	GSP14O	259931	6337635		1								
BSP	GSP15W	256571	6341385	1									
BSP	GSP16O	257133	6341858			1							
BSP	GSP17O	258036	6339069							1			
BSP	GSP18W	255403	6342637	1			1						
BSP	GSP19W	256578	6340777	1			1						
BSP	GSP20W	258050	6339950				1						
BSP	GSP22W	245343	6345121	1									
BSP	GSP23W	244953	6344268	1									
BSP	GSP24O	245545	6343750	1	1								
BSP	MMR03W	252208	6329275	1		1							
BSP	MMR04O	252809	6328720			1							
BSP	MPM01W	244927	6375282	1	1								
BSP	MPM02O	245720	6375945	1	1								
BSP	MPM03W	246900	6376387	1	1	1							
BSP	MPM04O	244816	6374245		1								
BSP	MPM05W	254902	6386028	1		1							
BSP	MPM06W	255673	6384323	1	1								
BSP	MPM07W	257835	6383645	1		1							
BSP	MPM08W	259669	6381245	1	1	1	1						
BSP	MPM09O	261009	6379974	1		1							
BSP	MPM10O	261587	6379045	1									
BSP	MPM11W	249292	6376564	1	1	1							
BSP	MPM12W	250727	6377835	1	1								
BSP	MPM13O	251849	6378269	1	1	1							

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	MPM14W	251941	6379261	1									
BSP	MPM15W	252763	6384794	1									
BSP	MPM16W	252949	6386806	1	1	1							
BSP	MPM18O	250365	6376796	1									
BSP	MPM19C	251532	6375374	1									
BSP	MPM20W	250074	6379656	1									
BSP	MPM21W	250681	6381613	1									
BSP	MPM22O	251704	6377805	1									
BSP	MPM23O	250962	6375974	1									
BSP	MPM25W	250529	6378853			1					1		
BSP	MPM27O	258947	6382234			1							
BSP	MPM28O	258015	6383863					1	1				
BSP	MPM29O	255476	6385549				1						
BSP	MPM30W	256782	6384787				1						
BSP	MPM31O	257866	6384050				1						
BSP	MPM32W	258371	6383307				1						
BSP	MPM33W	250362	6378901	1	1		1		1				
BSP	MPM34O	249888	6378244				1						
BSP	MPM35C	249778	6377521	1			1						
BSP	MPM36C	248777	6376868	1			1						
BSP	MPM37W	246469	6376451				1	1					
BSP	MPM38O	257293	6384589	1	1	1				1			
BSP	MPM40O	259983	6380899						1				
BSP	MPM41G	253786	6373816	1	1								
BSP	MPM42W	251906	6378844						1				
BSP	MPM43W	250065	6376959						1				
BSP	MPM44W	251351	6384526						1				
BSP	MPM45W	252502	6382699						1				
BSP	MPM46W	256100	6385125						1				
BSP	MPM47O	246705	6376515						1				
BSP	OLN01W	236658	6361089	1									
BSP	OLN02W	237361	6361245	1	1	1			1				
BSP	OLN03W	237971	6361199	1		1							
BSP	OLN04M	238798	6362057	1	1	1							
BSP	OLN05M	239604	6361066	1	1	1							

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	OLN06O	240826	6360769	1	1								
BSP	OLN07W	241286	6361720	1	1	1		1					
BSP	OLN08W	240006	6362914	1	1	1			1				
BSP	OLN09W	238919	6363127	1	1	1							
BSP	OLN10O	242309	6359750	1	1	1							
BSP	OLN11W	241259	6363225	1	1	1							
BSP	OLN12W	241026	6364029	1	1	1							
BSP	OLN13O	240322	6364810	1	1	1	1	1	1			1	
BSP	OLN14H	238383	6361164		1								
BSP	OLN15S	238921	6364294	1									
BSP	OLN16W	238232	6362849		1								
BSP	OLN17W	241162	6364094				1						
BSP	OLN18W	241644	6362078				1						
BSP	OLN19O	241386	6361101				1		1				
BSP	OLN21W	241320	6363411									1	
BSP	PTT13O	268074	6351610	1	1								
BSP	PTT15O	268149	6351041	1		1		1					
BSP	PTT16O	266640	6352002	1	1								
BSP	PTT17W	267805	6351246		1								
BSP	S-F-LNE-75-002-B	237600	6364200						1				
BSP	TLB01W	235794	6389865	1	1	1	1						
BSP	TLB02O	235980	6388701	1	1	1	1				1		
BSP	TLB03O	235855	6390994	1	1	1	1		1	1	1	1	
BSP	TLB04C	235211	6390349	1		1				1			
BSP	TLB05O	235149	6389334		1								
BSP	TLB06O	236716	6391738	1									
BSP	TLB07W	236879	6392732		1								
BSP	TLB08O	236824	6389786	1	1								
BSP	TLB09W	235995	6392357		1								
BSP	TLB10O	237573	6390468		1								
BSP	TLB11W	241067	6390857	1	1			1					
BSP	TLB12C	241490	6387390	1	1								
BSP	TLB13O	241603	6391023	1	1	1							
BSP	TLB15W	235804	6390675				1						
BSP	TLB16W	235858	6389076						1				

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	TLB18O	231720	6392168	1	1	1	1					1	
BSP	TLB19W	232276	6391228	1	1								
BSP	TLB20O	232899	6390605		1								
BSP	TLB21W	230013	6396608	1	1	1		1					
BSP	TLB22W	229627	6395665	1	1	1							
BSP	TLB23W	231011	6392982	1	1								
BSP	TLB24W	231709	6398784			1							
BSP	TLB25O	232279	6391403			1				1			
BSP	TLB26O	230803	6392960				1						
BSP	TLB27W	230364	6393811	1									
BSP	TLB28W	232434	6399470	1	1								
BSP	TLB29W	232627	6400283	1	1	1			1				
BSP	TLB30W	231454	6398999	1	1				1				
BSP	TLB31W	231366	6398188	1	1								
BSP	TLB32O	233093	6397915	1	1	1			1				
BSP	TLB33W	233122	6398823	1	1	1							
BSP	TLB34O	232399	6395505	1	1	1		1					
BSP	TLB35O	232313	6393817	1	1	1							
BSP	TLB36W	234012	6393137	1	1	1							
BSP	TLB37O	233688	6394254	1	1	1	1				1		
BSP	TLB38W	232566	6396604								1		
BSP	TLB39O	230104	6397624	1	1								
BSP	TLB40W	230252	6392382	1		1							
BSP	TLB41W	229519	6392402	1									
BSP	TLB42W	230661	6398653		1								
BSP	TLB43O	231786	6397304		1								
BSP	TLB44O	231567	6397708		1								
BSP	TLB45W	230514	6392933						1				
BSP	TLB46W	229748	6394701	1	1								
BSP	TLB47W	232411	6400205				1						
BSP	TLB48W	233085	6398099				1						
BSP	TLB49O	234097	6393155				1						
BSP	WDD03W	255595	6389365	1	1	1							
BSP	WDD05W	255229	6390311	1	1								
BSP	WDD32W	255553	6389683				1						

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
BSP	WDD36O	255600	6389572						1				
BSP	WDD37W	253916	6393305	1	1				1				
BSP	WDD38W	252802	6391847	1	1								
BSP	WDD39W	252487	6389920	1	1								
BSP	WDD40W	252735	6396989	1	1								
BSP	WDD41W	243836	6394773	1									
BSP	WDD42W	249735	6399998		1								
BSP	WDD43W	242490	6392019	1	1	1							
BSP	WDD44W	248025	6396894	1	1								
BSP	WDD45O	247627	6398600	1		1							
BSP	WDD46H	246998	6398846	1									
BSP	WDD47W	245034	6396911	1	1								
BSP	WDD48H	248749	6399988	1	1								
BSP	WDD49W	242683	6393402	1	1	1			1				
BSP	WDD50W	246468	6398258		1								
BSP	WDD51W	248250	6399503	1	1								
BSP	WDD52W	249102	6400079			1							
BSP	WDD53O	247275	6399065				1		1				
BSP	WDD54W	249409	6400227				1						
BSP	WDD55O	242090	6390886					1					
BSP	WDD56C	242388	6391474		1		1		1				
Central CRA	LJMP98020900	236408	6376803										1
Central CRA	LJMP98021008	254342	6344406										1
Central CRA	LJMP98021100	254235	6348998										1
Central CRA	LJMP98021107	257275	6339610										1
Central CRA	LKAB97080408	254110	6339670								1		
Central CRA	LKEM97082004	255350	6364000								1		
Central CRA	LKEM97082801	231406	6376249										1
Central CRA	LKEM9708280E	234507	6377993										1
Central CRA	LKEM97082908	235486	6380004										1
Central CRA	LKEM9708290J	239580	6387142										1
Central CRA	LKEM9708290R	240430	6390760										1
Central CRA	LKEM9708290W	238800	6383530										1
Central CRA	LKEM97090118	255350	6364000										1
Central CRA	S-F-SYD-42-002-R-A	256010	6340880	1	1			1	1			1	

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
Central CRA	S-F-SYD-42-002-R-B	256010	6340880					1					
Central CRA	S-F-SYD-42-003-M	256980	6340580	1	1			1	1				
Central CRA	S-F-SYD-42-004-G	257300	6339700	1	1		1	1	1	1		1	
Central CRA	S-F-SYD-42-006-R-A	255400	6342620	1	1				1				
Central CRA	S-F-SYD-42-006-R-B	255400	6342620					2					
Central CRA	S-F-SYD-42-007-M-A	254600	6343650	1	1			2	1				
Central CRA	S-F-SYD-42-007-M-B	254600	6343650					1					
Central CRA	S-F-SYD-42-010-R-A	253970	6348320	1	1			1	1				
Central CRA	S-F-SYD-42-010-R-B	253970	6348320					2					
Central CRA	S-F-SYD-42-011-M-A	254250	6348780	1	1		1		1		1	1	
Central CRA	S-F-SYD-42-014-R	234875	6378700	1	1			1	1				
Central CRA	S-F-SYD-42-015-M	232075	6377225	1	1			1	1				
Central CRA	S-F-SYD-42-016-G	235675	6379650	1	1		1	1	1	1			
Central CRA	S-F-SYD-42-018-R	234500	6377975	1	1			1	1			1	
Central CRA	S-F-SYD-42-019-M	233000	6378300	1	1			1	1			1	
Central CRA	S-F-SYD-42-020-G	233675	6378225	1	1		1	1	1	1	1	1	
Central CRA	S-F-SYD-42-022-R	236425	6377725	1	1			1	1			1	
Central CRA	S-F-SYD-42-023-M	236300	6378400	1	1			1	1				1
Central CRA	S-F-SYD-42-024-G	237300	6376725	1	1		1	1	1	1		1	
Central CRA	S-F-SYD-42-026-R	240610	6389440	1			1	1	1			1	
Central CRA	S-F-SYD-42-027-M	240330	6390720	1	1		1	1	1				
Central CRA	S-F-SYD-42-028-G	240550	6389925	1	1			1	1	1		1	
Central CRA	S-F-SYD-42-030-R	240275	6388475	1	1		1	1	1				
Central CRA	S-F-SYD-42-031-M	239685	6387800	1	1		1	1	1			1	
Central CRA	S-F-SYD-42-032-G	239900	6381130	1			1	1	1				
Central CRA	S-F-SYD-42-034-R	239130	6386400	1	1	1	1	1	1			1	
Central CRA	S-F-SYD-42-035-M	239000	6383750	1	1	1		1	1				
Central CRA	S-F-SYD-42-036-G	238500	6382600	1	1	1		1	1	1			
Central CRA	S-F-SYD-42-042-M	253013	6363890	1	1			1	1				
Central CRA	S-F-SYD-42-044-G	252570	6364920	1	1		1	1	1	1		1	
Central CRA	T-F-SYD-42-043	234820	6378800								1		
Central CRA	T-F-SYD-42-044	234950	6378500								1		
Central CRA	T-F-SYD-42-045	235120	6379601								1		
Central CRA	T-F-SYD-42-046	240500	6390010					1			1		
Central CRA	T-F-SYD-42-131	235797	6379878				1						

Survey program	Site number	Easting	Northing	Diurnal bird census	Diurnal reptile census	Site spotlight census	Harp trap	Bat ultrasound detection	Nocturnal call playback	Nocturnal streamside search	Elliott trap	Hair tubes	Transect spotlight survey
Central CRA	T-F-SYD-42-132	232448	6377814				1						
Central CRA	T-F-SYD-42-133	235450	6380100				1	1					
Central CRA	T-F-SYD-42-134	235750	6380070				1						
Lower North East CRA	LJKL97082107	264950	6374350										1
Lower North East CRA	LPBB9708060M	265150	6372900										1
Lower North East CRA	LPBB9708060S	265125	6373050										1
Lower North East CRA	S-F-LNE-41-002-R	266100	6373175	1	1		1	2	1				
Lower North East CRA	S-F-LNE-41-003-M	265200	6373000	1	1			1	1				
Lower North East CRA	S-F-LNE-41-035-M	264050	6374350		1				1				
Lower North East CRA	S-F-LNE-41-036-G	264750	6374600		1				1	1			
Lower North East CRA	S-F-LNE-75-001-B	237700	6364900	1									
Lower North East CRA	S-F-LNE-75-002-B	237600	6364200	1									
Lower North East CRA	T-F-SYD-41-016	265250	6372600		1								
Lower North East CRA	T-F-SYD-41-017	264200	6370900		1								
Lower North East CRA	T-F-SYD-41-020	265150	6372900								1		
Grand Total				234	211	109	88	61	85	21	25	23	15

APPENDIX B – SUMMARY OF EXPLORATORY DATA ANALYSES

Following is an overview of the exploratory statistical analyses that were undertaken to identify major associations between bird and reptile species and broad vegetation classes. It should be noted that these analyses were used to guide discussion only. The systematic data collected during the CRA and BSP surveys will be incorporated into more detailed modelling of habitat preferences across the greater northern Sydney region in coming years.

The software package *Primer 5 for Windows* (version 5.2.9) was used for the analyses.

Data used in the analyses

The analysis was performed on the following data set.

- A subset of systematic survey sites that had both diurnal bird and diurnal herpetofauna censuses undertaken at them. The results of bird and reptile censuses were analysed together.
- Presence-absence data was used as this is not sensitive to fluctuations in abundance or differences in count estimation by observers.
- For the diurnal birds, all records that were noted as flying 'Above Canopy' were excluded because it is not known if they were actually using the site or not. Both 'on-site' and 'off-site' bird records were included.
- Species that were only recorded from a single site were excluded, so single occurrences of rare species did not overly influence the data.

Step One

Similarity matrices are useful for identifying groups of sites that contain similar suites of species. Bray-Curtis similarity matrices were created for diurnal birds and reptiles to examine differences in species composition between groups of sites. This method creates pairwise comparisons for every site using the Bray-Curtis coefficient. Sites that are perfectly similar will have a coefficient of 1, and perfectly dissimilar will have a coefficient of 0. Matrices were the basis of further techniques performed, including ANOSIM and MDS.

Step Two

Non-metric multi-dimensional scaling (MDS) uses the similarity matrix to graphically present the pattern of similarity between sites. A three-dimensional MDS plot for sites coded by major vegetation class is presented in Figure 3.

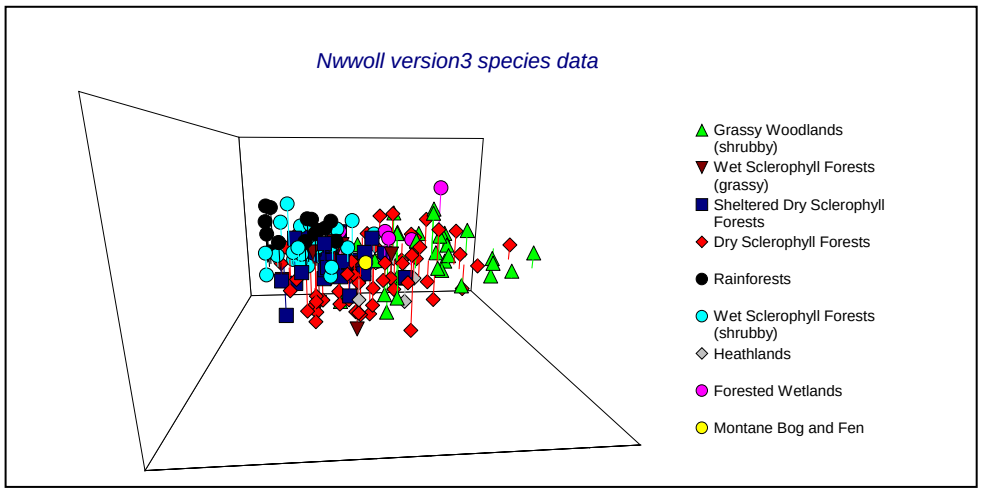

Figure 3: Three-dimension MDS plot of sites coded by major vegetation class

Step Three

Analysis of Similarities (ANOSIM) was used to test for differences between the fauna assemblage of the major habitat types of the study area. It is an extremely robust procedure that requires few replicates or assumptions. For this reason it is ideal for application to data collected by many observers over an extended period of time. This statistical test is similar to Analysis of Variance (ANOVA), however it allows for the use of multivariate rather than univariate data. ANOSIM ascertains if there is a greater degree of similarity between replicates (sites) within a grouping than there is between sites from a different grouping. The output is an R statistic and a significance value for each assemblage pairing.

This test can only be applied to groups that were determined *apriori*. Nine major vegetation classes were tested in this analysis. These were Heathland, Dry Sclerophyll Forest, Grassy Woodland, Sheltered Dry Sclerophyll Forest, Wet Sclerophyll Forest (grassy), Wet Sclerophyll Forest (shrubby), Rainforest, and Forested Wetland. This technique helped identify differences in the fauna assemblage of these vegetation classes by determining whether or not the reptile and bird species located within a certain vegetation class was or was not significantly different from other vegetation classes. Table 7 presents a summary of these significance tests.

	Grassy Woodlands	Wet Sclerophyll Forests (Grassy)	Sheltered Dry Sclerophyll Forests	Dry Sclerophyll Forests	Rainforest	Wet Sclerophyll Forests (Shrubby)	Heathlands	Forested Wetlands
Wet Sclerophyll Forests (Grassy)	NS							
Sheltered Dry Sclerophyll Forests	NS	NS						
Dry Sclerophyll Forests	NS	NS	NS					
Rainforest	S	S	S	NS				
Wet Sclerophyll Forests (Shrubby)	S	NS	NS	NS	NS			
Heathlands	NS	NS	S	NS	S	S		
Forested Wetlands	NS	_	NS	NS	NS	NS	_	

S = significant difference; NS = no significant difference

Table 7: Results of ANOSIM between sites grouped into major vegetation classes

Step Four

SIMPER is a technique that isolates fauna species that characterise site-groupings identified in the similarity matrix and MDS analysis. It is an exploratory tool that allows examination of the species that contribute to the similarity or dissimilarity between groups of sites. This technique was used to derive the principal species characteristic of each vegetation class, as detailed in Section 3.3 (reptiles) and Section 3.4 (birds) of this report.

APPENDIX C – FAUNA SPECIES RECORDED IN NORTH-WESTERN WOLLEMI NATIONAL PARK

Below is a list of the fauna species recorded within north-western Wollemi National Park on the Atlas of NSW Wildlife (as at 19th June 2006). Taxonomical nomenclature follows that used on the Atlas of NSW Wildlife, with more updated scientific names noted where relevant. Records are derived from DEC systematic surveys (Biodiversity Survey Priorities and Comprehensive Regional Assessment), licensed data sets (Birds Australia and the Australian Museum) and incidental observations submitted by individuals, including park rangers and field officers; catchment officers; bushwalkers and naturalists; scientific researchers working in the area; and other visitors to the park.

The list contains records of various levels of reliability and spatial accuracy. Species where there is doubt about their occurrence within the study area due to possible identification inaccuracy have been marked with an asterisk ***** and due to spatial inaccuracy have been marked with an ^. Introduced species are indicated with the addition of an **!**.

Family	Scientific name	Common name	NSW Legal Status	National Legal Status	BSP	CRA	Birds Australia	Australian Museum	Other Sources
Frogs									
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet	P		✓	✓			✓
Myobatrachidae	*Heleioporus australiacus*	Giant Burrowing Frog	V	V	✓	✓			
Myobatrachidae	*Limnodynastes dumerilii*	Bullfrog	P		✓	✓			✓
Myobatrachidae	*Limnodynastes ornatus*	Ornate Burrowing Frog	P			✓			
Myobatrachidae	*Limnodynastes peronii*	Striped Marsh Frog	P		✓				
Myobatrachidae	*Limnodynastes tasmaniensis*	Spotted Marsh Frog	P		✓	✓			
Myobatrachidae	*Mixophyes balbus*	Stuttering Frog	E	V	✓				
Myobatrachidae	*Pseudophryne australis*	Red-crowned Toadlet	V		✓	✓			
Myobatrachidae	*Pseudophryne bibronii*	Bibron's Toadlet	P		✓	✓			
Hylidae	*Litoria booroolongensis* *	Booroolong Frog *	E					✓	
Hylidae	*Litoria caerulea*	Green Tree Frog	P		✓	✓		✓	✓
Hylidae	*Litoria citropa*	Blue Mountains Tree Frog	P		✓				
Hylidae	*Litoria dentata*	Keferstein's Tree Frog	P		✓				
Hylidae	*Litoria jervisiensis* *	Jervis Bay Tree Frog *	P						✓
Hylidae	*Litoria latopalmata*	Broad-palmed Frog	P						✓
Hylidae	*Litoria lesueuri*	Lesueur's Frog	P		✓				
Hylidae	*Litoria peronii*	Peron's Tree Frog	P		✓	✓			
Hylidae	*Litoria phyllochroa*	Green Stream Frog	P		✓			✓	
Hylidae	*Litoria verreauxii*	Verreaux's Tree Frog	P		✓				✓
Hylidae	*Litoria wilcoxii*	Stoney Creek Frog	P		✓				
Reptiles									
Chelidae	*Chelodina longicollis*	Eastern Snake-necked Turtle	P		✓			✓	
Gekkonidae	*Diplodactylus vittatus*	Eastern Stone Gecko	P		✓	✓		✓	✓
Gekkonidae	*Oedura lesueurii*	Lesueur's Velvet Gecko	P		✓	✓			✓
Gekkonidae	*Oedura robusta*	Robust Velvet Gecko	P		✓				
Gekkonidae	*Phyllurus platurus*	Broad-tailed Gecko	P		✓	✓			✓
Gekkonidae	*Underwoodisaurus milii*	Thick-tailed Gecko	P		✓				
Pygopodidae	*Delma plebeia*	Leaden Delma	P		✓				
Pygopodidae	*Lialis burtonis*	Burton's Snake-lizard	P		✓				
Pygopodidae	*Pygopus lepidopodus*	Southern Scaly-foot	P		✓				

Family	Scientific name	Common name	NSW Legal Status	National Legal Status	BSP	CRA	Birds Australia	Australian Museum	Other Sources
Agamidae	*Amphibolurus muricatus*	Jacky Lashtail	P		✓	✓			✓
Agamidae	*Amphibolurus nobbi*	Nobbi Lashtail	P		✓				
Agamidae	*Physignathus lesueurii lesueurii*	Eastern Water Dragon	P		✓	✓			
Agamidae	*Pogona barbata*	Eastern Bearded Dragon	P		✓	✓			
Agamidae	*Tympanocryptis* (revised to *Rankinia*) *diemensis*	Mountain Heath Dragon	P		✓	✓		✓	✓
Varanidae	*Varanus rosenbergi*	Rosenberg's Goanna	V		✓	✓			
Varanidae	*Varanus varius*	Lace Monitor	P		✓	✓			
Scincidae	*Anomalopus leuckartii*	Two-clawed Worm-skink	P		✓				
Scincidae	*Anomalopus swansoni*	Punctate Worm-skink	P		✓				
Scincidae	*Bassiana platynota* (taxonomy revised to *Acritoscincus platynotum*)	Red-throated Cool-skink	P		✓	✓			✓
Scincidae	*Carlia tetradactyla*	Southern Rainbow-skink	P		✓				
Scincidae	*Cryptoblepharus virgatus*	Cream-striped Shinning-skink	P		✓	✓		✓	✓
Scincidae	*Ctenotus robustus*	Robust Ctenotus	P		✓				
Scincidae	*Ctenotus taeniolatus*	Copper-tailed Ctenotus	P		✓	✓		✓	✓
Scincidae	*Egernia cunninghami*	Cunningham's Spiny-tailed Skink	P		✓	✓			✓
Scincidae	*Egernia striolata*	Tree-crevice Skink	P		✓				
Scincidae	*Egernia whitii*	White's Rock-skink	P		✓	✓		✓	✓
Scincidae	*Eulamprus heatwolei*	Warm-temperate Water-skink	P		✓	✓			
Scincidae	*Eulamprus quoyii*	Eastern Water-skink	P		✓	✓			✓
Scincidae	*Eulamprus tenuis*	Bar-sided Forest-skink	P		✓				
Scincidae	*Eulamprus tympanum*	Cool-temperate Water-skink	P		✓				
Scincidae	*Hemiergis decresiensis*	Three-toed Earless Skink	P						✓
Scincidae	*Lampropholis delicata*	Dark-flecked Garden Sunskink	P		✓	✓			✓
Scincidae	*Lampropholis guichenoti*	Pale-flecked Garden Sunskink	P		✓	✓		✓	
Scincidae	*Lerista bougainvillii*	South-eastern Slider	P		✓	✓			✓
Scincidae	*Lygisaurus foliorum* (taxonomy revised to *Carlia foliorum*)	Tree-base Litter-skink	P		✓			✓	
Scincidae	*Morethia boulengeri*	South-eastern Morethia Skink	P		✓	✓			
Scincidae	*Saiphos equalis*	Yellow-bellied Three-toed Skink	P		✓	✓		✓	
Scincidae	*Saproscincus mustelinus*	Weasel Shadeskink	P		✓	✓			✓
Scincidae	*Tiliqua nigrolutea*	Blotched Bluetongue	P		✓				
Scincidae	*Tiliqua scincoides*	Common Bluetongue	P			✓			
Typhlopidae	*Ramphotyphlops nigrescens*	Blackish Blind Snake	P		✓	✓		✓	✓
Boidae	*Morelia spilota spilota*	Diamond Python	P		✓	✓			
Boidae	*Morelia spilota variegata* *	Carpet Python*	P						✓
Elapidae	*Acanthophis antarcticus*	Southern Death Adder	P			✓			✓
Elapidae	*Cacophis squamulosus*	Golden Crowned Snake	P		✓				✓
Elapidae	*Demansia psammophis*	Yellow-faced Whipsnake	P		✓				
Elapidae	*Hoplocephalus bungaroides*	Broad-headed Snake	E	V	✓				✓
Elapidae	*Hoplocephalus stephensii* *	Stephens' Banded Snake*	V						✓
Elapidae	*Notechis scutatus*	Mainland Tiger Snake	P		✓	✓			✓
Elapidae	*Pseudechis porphyriacus*	Red-bellied Black Snake	P		✓	✓			✓
Elapidae	*Pseudonaja textilis*	Eastern Brown Snake	P						✓
Elapidae	*Rhinoplocephalus nigrescens*	Small-eyed Snake	P		✓	✓			✓
Elapidae	*Suta spectabilis dwyeri*	Variable Black-naped Snake	P			✓			✓
Elapidae	*Vermicella annulata*	Eastern Bandy-bandy	P		✓				

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Birds									
Megapodiidae	*Alectura lathami*	Australian Brush-turkey	P		✓	✓			✓
Phasianidae	*Coturnix pectoralis*	Stubble Quail	P		✓		✓		
Phasianidae	*Coturnix ypsilophora*	Brown Quail	P		✓		✓		
Anatidae	*Anas gracilis*	Grey Teal	P		✓		✓		
Anatidae	*Anas superciliosa*	Pacific Black Duck	P		✓		✓		✓
Anatidae	*Aythya australis*	Hardhead	P		✓		✓		
Anatidae	*Biziura lobata*	Musk Duck	P		✓		✓		
Anatidae	*Chenonetta jubata*	Australian Wood Duck	P		✓	✓	✓		✓
Anatidae	*Cygnus atratus*	Black Swan	P				✓		
Podicipedidae	*Poliocephalus poliocephalus*	Hoary-headed Grebe	P				✓		
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	P		✓		✓		✓
Anhingidae	*Anhinga melanogaster*	Darter	P		✓		✓		✓
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant	P		✓		✓		
Phalacrocoracidae	*Phalacrocorax melanoleucos*	Little Pied Cormorant	P		✓		✓		✓
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant	P		✓		✓		✓
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant	P				✓		✓
Ardeidae	*Ardea alba*	Great Egret	P				✓		
Ardeidae	*Ardea pacifica*	White-necked Heron	P		✓		✓		
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	P		✓		✓		
Ardeidae	*Nycticorax caledonicus*	Nankeen Night Heron	P		✓		✓		
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill	P				✓		
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	P				✓		
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	E				✓		
Accipitridae	*Accipiter cirrocephalus*	Collared Sparrowhawk	P		✓		✓		
Accipitridae	*Accipiter fasciatus*	Brown Goshawk	P		✓	✓	✓		
Accipitridae	*Accipiter novaehollandiae*	Grey Goshawk	P				✓		
Accipitridae	*Aquila audax*	Wedge-tailed Eagle	P		✓	✓	✓		✓
Accipitridae	*Elanus axillaris*	Black-shouldered Kite	P		✓		✓		
Accipitridae	*Elanus scriptus*	Letter-winged Kite	P				✓		
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-eagle	P				✓		
Accipitridae	*Haliastur sphenurus*	Whistling Kite	P				✓		
Accipitridae	*Hieraaetus morphnoides*	Little Eagle	P		✓		✓		
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V						✓
Falconidae	*Falco berigora*	Brown Falcon	P		✓		✓		
Falconidae	*Falco cenchroides*	Nankeen Kestrel	P		✓		✓		
Falconidae	*Falco longipennis*	Australian Hobby	P		✓		✓		
Falconidae	*Falco peregrinus*	Peregrine Falcon	P		✓		✓		
Rallidae	*Fulica atra*	Eurasian Coot	P		✓		✓		✓
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen	P		✓		✓		✓
Rallidae	*Porphyrio porphyrio*	Purple Swamphen	P		✓		✓		✓
Rallidae	*Porzana tabuensis*	Spotless Crake	P		✓				
Turnicidae	*Turnix varia*	Painted Button-quail	P		✓	✓	✓		
Turnicidae	*Turnix velox*	Little Button-quail	P		✓				
Scolopacidae	*Gallinago hardwickii*	Latham's Snipe	P				✓		
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel	P				✓		
Charadriidae	*Vanellus miles*	Masked Lapwing	P		✓		✓		✓
Columbidae	*Chalcophaps indica*	Emerald Dove	P		✓				

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Columbidae	*Geopelia cuneata*	Diamond Dove	P		✓				
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove	P		✓		✓		
Columbidae	*Geopelia placida*	Peaceful Dove	P		✓		✓		✓
Columbidae	*Leucosarcia melanoleuca*	Wonga Pigeon	P		✓	✓	✓		✓
Columbidae	*Macropygia amboinensis*	Brown Cuckoo-dove	P		✓				
Columbidae	*Ocyphaps lophotes*	Crested Pigeon	P		✓		✓		✓
Columbidae	*Phaps chalcoptera*	Common Bronzewing	P		✓	✓	✓		✓
Columbidae	*Phaps elegans*	Brush Bronzewing	P		✓				
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	P		✓	✓	✓		✓
Cacatuidae	*Cacatua sanguinea*	Little Corella	P		✓				
Cacatuidae	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V		✓	✓	✓		✓
Cacatuidae	*Calyptorhynchus funereus*	Yellow-tailed Black-cockatoo	P		✓	✓	✓		✓
Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-cockatoo	V		✓	✓	✓		✓
Cacatuidae	*Eolophus roseicapillus*	Galah	P		✓		✓		✓
Psittacidae	*Alisterus scapularis*	Australian King-parrot	P		✓	✓	✓		✓
Psittacidae	*Glossopsitta concinna*	Musk Lorikeet	P		✓		✓		
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	P		✓	✓	✓		✓
Psittacidae	*Neophema pulchella*	Turquoise Parrot	V		✓	✓	✓		
Psittacidae	*Platycercus adscitus eximius*	Eastern Rosella	P		✓	✓	✓		✓
Psittacidae	*Platycercus elegans*	Crimson Rosella	P		✓	✓	✓		✓
Psittacidae	*Psephotus haematonotus*	Red-rumped Parrot	P		✓		✓		
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet	P			✓			
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	P		✓	✓	✓		✓
Cuculidae	*Cacomantis variolosus*	Brush Cuckoo	P		✓		✓		✓
Cuculidae	*Chalcites basalis*	Horsfield's Bronze-cuckoo	P		✓		✓		✓
Cuculidae	*Chalcites lucidus*	Shining Bronze-cuckoo	P		✓		✓		
Cuculidae	*Chalcites osculans*	Black-eared Cuckoo	P		✓				✓
Cuculidae	*Cuculus pallidus*	Pallid Cuckoo	P		✓		✓		
Cuculidae	*Eudynamys orientalis*	Pacific Koel	P		✓		✓		
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo	P		✓		✓		
Strigidae	*Ninox boobook*	Southern Boobook	P		✓	✓	✓		
Strigidae	*Ninox connivens*	Barking Owl	V				✓		
Strigidae	*Ninox strenua*	Powerful Owl	V		✓	✓			✓
Tytonidae	*Tyto alba*	Barn Owl	P		✓				
Tytonidae	*Tyto novaehollandiae*	Masked Owl	V		✓				
Tytonidae	*Tyto tenebricosa*	Sooty Owl	V		✓				✓
Podargidae	*Podargus strigoides*	Tawny Frogmouth	P		✓	✓	✓		✓
Caprimulgidae	*Eurostopodus mystacalis*	White-throated Nightjar	P		✓	✓	✓		
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar	P		✓	✓	✓		✓
Apodidae	*Apus pacificus*	Fork-tailed Swift	P		✓				
Apodidae	*Hirundapus caudacutus*	White-throated Needletail	P		✓	✓	✓		
Alcedinidae	*Alcedo azurea*	Azure Kingfisher	P		✓		✓		
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	P		✓	✓	✓		✓
Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher	P		✓	✓	✓		✓
Meropidae	*Merops ornatus*	Rainbow Bee-eater	P		✓		✓		
Coraciidae	*Eurystomus orientalis*	Dollarbird	P		✓		✓		
Menuridae	*Menura novaehollandiae*	Superb Lyrebird	P		✓	✓	✓		✓
Climacteridae	*Climacteris erythrops*	Red-browed Treecreeper	P		✓	✓	✓		✓

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Climacteridae	*Climacteris picumnus picumnus*	Brown Treecreeper (eastern subsp.)	V		✓	✓	✓		✓
Climacteridae	*Cormobates leucophaeus*	White-throated Treecreeper	P		✓	✓	✓		✓
Maluridae	*Malurus cyaneus*	Superb Fairy-wren	P		✓	✓	✓		✓
Maluridae	*Malurus lamberti*	Variegated Fairy-wren	P		✓	✓	✓		✓
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	P		✓	✓	✓		✓
Pardalotidae	*Pardalotus striatus*	Striated Pardalote	P		✓	✓	✓		✓
Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	P		✓		✓		
Acanthizidae	*Acanthiza lineata*	Striated Thornbill	P		✓	✓	✓		✓
Acanthizidae	*Acanthiza nana*	Yellow Thornbill	P		✓		✓		✓
Acanthizidae	*Acanthiza pusilla*	Brown Thornbill	P		✓	✓	✓		✓
Acanthizidae	*Acanthiza reguloides*	Buff-rumped Thornbill	P		✓	✓	✓		✓
Acanthizidae	*Calamanthus pyrrhopygius*	Chestnut-rumped Heathwren	P		✓	✓			
Acanthizidae	*Gerygone fusca*	Western Gerygone	P		✓		✓		
Acanthizidae	*Gerygone mouki*	Brown Gerygone	P		✓	✓	✓		✓
Acanthizidae	*Gerygone olivacea*	White-throated Gerygone	P		✓	✓	✓		
Acanthizidae	*Origma solitaria*	Rockwarbler	P		✓	✓	✓		✓
Acanthizidae	*Pycnoptilus floccosus*	Pilotbird	P		✓	✓			✓
Acanthizidae	*Pyrrholaemus sagittatus*	Speckled Warbler	V		✓	✓	✓		✓
Acanthizidae	*Sericornis citreogularis*	Yellow-throated Scrubwren	P		✓	✓	✓		
Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren	P		✓	✓	✓		✓
Acanthizidae	*Sericornis magnirostris*	Large-billed Scrubwren	P		✓	✓	✓		
Acanthizidae	*Smicrornis brevirostris*	Weebill	P		✓		✓		✓
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill	P		✓	✓	✓		✓
Meliphagidae	*Anthochaera carunculata*	Red Wattlebird	P		✓	✓	✓		✓
Meliphagidae	*Anthochaera chrysoptera*	Little Wattlebird	P			✓	✓		
Meliphagidae	*Entomyzon cyanotis*	Blue-faced Honeyeater	P		✓		✓		
Meliphagidae	*Grantiella picta*	Painted Honeyeater	V		✓		✓		
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater	P		✓	✓	✓		✓
Meliphagidae	*Lichenostomus fuscus*	Fuscous Honeyeater	P		✓		✓		
Meliphagidae	*Lichenostomus leucotis*	White-eared Honeyeater	P		✓	✓	✓		✓
Meliphagidae	*Lichenostomus melanops*	Yellow-tufted Honeyeater	P		✓	✓	✓		✓
Meliphagidae	*Lichenostomus penicillatus*	White-plumed Honeyeater	P		✓		✓		✓
Meliphagidae	*Manorina melanocephala*	Noisy Miner	P		✓		✓		✓
Meliphagidae	*Manorina melanophrys*	Bell Miner	P		✓	✓	✓		✓
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater	P		✓	✓	✓		✓
Meliphagidae	*Melithreptus brevirostris*	Brown-headed Honeyeater	P		✓	✓	✓		
Meliphagidae	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subsp.)	V		✓		✓		
Meliphagidae	*Melithreptus lunatus*	White-naped Honeyeater	P		✓	✓	✓		✓
Meliphagidae	*Myzomela sanguinolenta*	Scarlet Honeyeater	P		✓		✓		
Meliphagidae	*Philemon citreogularis*	Little Friarbird	P		✓		✓		
Meliphagidae	*Philemon corniculatus*	Noisy Friarbird	P		✓	✓	✓		✓
Meliphagidae	*Phylidonyris novaehollandiae*	New Holland Honeyeater	P		✓	✓	✓		
Meliphagidae	*Phylidonyris pyrrhoptera*	Crescent Honeyeater	P		✓	✓			
Meliphagidae	*Plectorhyncha lanceolata*	Striped Honeyeater	P		✓		✓		✓
Meliphagidae	*Xanthomyza phrygia*	Regent Honeyeater	E	E	✓		✓		✓
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	P		✓	✓	✓		✓

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Petroicidae	*Melanodryas cucullata cucullata*	Hooded Robin (eastern subsp.)	V		✓		✓		✓
Petroicidae	*Microeca fascinans*	Jacky Winter	P		✓		✓		✓
Petroicidae	*Petroica boodang*	Scarlet Robin	P		✓	✓	✓		
Petroicidae	*Petroica goodenovii*	Red-capped Robin	P		✓		✓		
Petroicidae	*Petroica phoenicea*	Flame Robin	P		✓	✓	✓		
Petroicidae	*Petroica rosea*	Rose Robin	P		✓	✓	✓		✓
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler	P		✓		✓		
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subsp.)	V		✓		✓		
Eupetidae	*Cinclosoma punctatum*	Spotted Quail-thrush	P		✓	✓	✓		✓
Eupetidae	*Psophodes olivaceus*	Eastern Whipbird	P		✓	✓	✓		✓
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	P		✓	✓	✓		
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	P		✓	✓	✓		✓
Pachycephalidae	*Falcunculus frontatus*	Eastern Shrike-tit	P		✓	✓	✓		✓
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler	P		✓	✓	✓		✓
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	P		✓	✓	✓		✓
Dicruridae	*Dicrurus bracteatus*	Spangled Drongo	P			✓			
Dicruridae	*Grallina cyanoleuca*	Magpie-lark	P		✓		✓		
Dicruridae	*Monarcha melanopsis*	Black-faced Monarch	P		✓	✓	✓		
Dicruridae	*Monarcha trivirgatus* *	Spectacled Monarch *	P			✓			
Dicruridae	*Myiagra cyanoleuca*	Satin Flycatcher	P		✓				
Dicruridae	*Myiagra inquieta*	Restless Flycatcher	P		✓		✓		
Dicruridae	*Myiagra rubecula*	Leaden Flycatcher	P		✓	✓	✓		✓
Dicruridae	*Rhipidura albiscapa*	Grey Fantail	P		✓	✓	✓		✓
Dicruridae	*Rhipidura leucophrys*	Willie Wagtail	P		✓	✓	✓		✓
Dicruridae	*Rhipidura rufifrons*	Rufous Fantail	P		✓	✓	✓		
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	P		✓	✓	✓		✓
Campephagidae	*Coracina papuensis*	White-bellied Cuckoo-shrike	P		✓	✓	✓		
Campephagidae	*Coracina tenuirostris*	Cicadabird	P		✓	✓	✓		✓
Campephagidae	*Lalage tricolor*	White-winged Triller	P		✓		✓		
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole	P		✓	✓	✓		✓
Artamidae	*Artamus cyanopterus*	Dusky Woodswallow	P		✓	✓	✓		
Artamidae	*Artamus superciliosus*	White-browed Woodswallow	P		✓		✓		
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	P		✓		✓		✓
Artamidae	*Cracticus torquatus*	Grey Butcherbird	P		✓	✓	✓		
Artamidae	*Gymnorhina tibicen*	Australian Magpie	P		✓	✓	✓		✓
Artamidae	*Strepera graculina*	Pied Currawong	P		✓	✓	✓		✓
Artamidae	*Strepera versicolor*	Grey Currawong	P		✓	✓	✓		✓
Corvidae	*Corvus coronoides*	Australian Raven	P		✓	✓	✓		✓
Corvidae	*Corvus mellori*	Little Raven	P		✓		✓		
Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough	P		✓	✓	✓		✓
Ptilonorhynchidae	*Ailuroedus crassirostris* *	Green Catbird *	P						✓
Ptilonorhynchidae	*Ptilonorhynchus violaceus*	Satin Bowerbird	P		✓	✓	✓		
Alaudidae	*Mirafra javanica*	Horsfield's Bushlark ^	P				✓		
Motacillidae	*Anthus australis*	Australian Pipit	P		✓		✓		
Estrildidae	*Neochmia modesta*	Plum-headed Finch	P				✓		✓
Estrildidae	*Neochmia temporalis*	Red-browed Finch	P		✓	✓	✓		✓
Estrildidae	*Stagonopleura bella*	Beautiful Firetail	P				✓		✓

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Estrildidae	*Stagonopleura guttata*	Diamond Firetail	V		✓		✓		
Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch	P		✓		✓		✓
Estrildidae	*Taeniopygia guttata*	Zebra Finch ^	P				✓		
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	P		✓	✓	✓		✓
Hirundinidae	*Cheramoeca leucosternus*	White-backed Swallow	P				✓		
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	P		✓	✓	✓		✓
Hirundinidae	*Petrochelidon ariel*	Fairy Martin	P				✓		
Hirundinidae	*Petrochelidon nigricans*	Tree Martin	P		✓		✓		
Sylviidae	*Acrocephalus australis*	Australian Reed-warbler	P				✓		✓
Sylviidae	*Cincloramphus cruralis*	Brown Songlark	P				✓		
Sylviidae	*Cincloramphus mathewsi*	Rufous Songlark	P		✓		✓		
Sylviidae	*Cisticola exilis*	Golden-headed Cisticola	P				✓		
Zosteropidae	*Zosterops lateralis*	Silvereye	P		✓	✓	✓		✓
Muscicapidae	*Turdus merula* [I]	Eurasian Blackbird [I]	U	U			✓		
Muscicapidae	*Zoothera lunulata*	Bassian Thrush	P		✓	✓	✓		
Sturnidae	*Acridotheres tristis* [I]	Common Myna [I]	U	U	✓		✓		
Sturnidae	*Sturnus vulgaris* [I]	Common Starling [I]	U	U	✓		✓		✓
Mammals									
Ornithorhynchidae	*Ornithorhynchus anatinus*	Platypus	P						✓
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	P		✓	✓			
Dasyuridae	*Antechinus flavipes*	Yellow-footed Antechinus	P		✓	✓		✓	✓
Dasyuridae	*Antechinus stuartii*	Brown Antechinus	P		✓	✓			
Dasyuridae	*Antechinus swainsonii*	Dusky Antechinus	P		✓				
Dasyuridae	*Dasyurus maculatus*	Spotted-tailed Quoll	V	E	✓				✓
Dasyuridae	*Sminthopsis murina*	Common Dunnart	P		✓				
Peramelidae	*Perameles nasuta*	Long-nosed Bandicoot	P		✓				
Phascolarctidae	*Phascolarctos cinereus* *	Koala – 'probable' scat identification only *	V		✓				
Vombatidae	*Vombatus ursinus*	Common Wombat	P		✓	✓			✓
Burramyidae	*Cercartetus nanus*	Eastern Pygmy-possum	V		✓				
Petauridae	*Petaurus australis*	Yellow-bellied Glider	V		✓	✓			
Petauridae	*Petaurus breviceps*	Sugar Glider	P		✓	✓			✓
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V		✓	✓			
Pseudocheiridae	*Petauroides volans*	Greater Glider	P		✓	✓			✓
Pseudocheiridae	*Pseudocheirus peregrinus*	Common Ringtail Possum	P		✓	✓			
Acrobatidae	*Acrobates pygmaeus*	Feathertail Glider	P		✓				
Phalangeridae	*Trichosurus caninus*	Mountain Brushtail Possum	P		✓	✓			
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum	P		✓	✓			✓
Potoroidae	*Potorous* sp. *	Potoroo *	P			✓			
Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo	P		✓	✓			✓
Macropodidae	*Macropus robustus*	Common Wallaroo	P		✓	✓			✓
Macropodidae	*Macropus rufogriseus*	Red-necked Wallaby	P		✓	✓			✓
Macropodidae	*Petrogale penicillata*	Brush-tailed Rock-wallaby	E	V	✓				✓
Macropodidae	*Wallabia bicolor*	Swamp Wallaby	P		✓	✓			✓
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	✓				
Rhinolophidae	*Rhinolophus megaphyllus*	Eastern Horseshoe-bat	P		✓	✓			
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	V		✓				
Molossidae	*Mormopterus planiceps* *	Little Mastiff-bat *	P			✓			

Family	Scientific name	Common name	NSW Legal Status	National Legal Status	BSP	CRA	Birds Australia	Australian Museum	Other Sources
Molossidae	*Mormopterus norfolkensis*	East-coast Freetail-bat	V		✓				
Molossidae	*Mormopterus* species 2 (Adams *et al.* 1988)	Eastern Freetail-bat	P		✓	✓			
Molossidae	*Mormopterus* species 4 (long penis form) (Adams *et al.* 1988)	Southern Freetail-bat (long penis)	P		✓				
Molossidae	*Tadarida australis*	White-striped Freetail-bat	P		✓	✓			
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	✓	✓			✓
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	P		✓	✓			✓
Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat	P		✓	✓			
Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V		✓	✓			
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V		✓	✓			
Vespertilionidae	*Nyctophilus geoffroyi*	Lesser Long-eared Bat	P		✓	✓			
Vespertilionidae	*Nyctophilus gouldi*	Gould's Long-eared Bat	P		✓	✓			
Vespertilionidae	*Nyctophilus timoriensis*	Greater Long-eared Bat	V	V	✓				
Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V		✓	✓			
Vespertilionidae	*Scotorepens balstoni*	Inland Broad-nosed Bat	P		✓				✓
Vespertilionidae	*Scotorepens orion*	Eastern Broad-nosed Bat	P		✓	✓			
Vespertilionidae	*Vespadelus darlingtoni*	Large Forest Bat	P		✓	✓		✓	
Vespertilionidae	*Vespadelus regulus* *	Southern Forest Bat *	P			✓			
Vespertilionidae	*Vespadelus troughtoni*	Eastern Cave Bat	V		✓	✓			
Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat	P		✓	✓		✓	✓
Muridae	*Hydromys chrysogaster*	Water-rat	P		✓				
Muridae	*Mus musculus*	House Mouse [I]	U	U	✓	✓			
Muridae	*Rattus fuscipes*	Bush Rat	P		✓	✓			✓
Muridae	*Rattus rattus*	Black Rat [I]	U	U	✓				
Muridae	*Rattus lutreolus*	Swamp Rat	P						✓
Leporidae	*Lepus capensis*	Brown Hare [I]	U	U	✓				
Leporidae	*Oryctolagus cuniculus*	Rabbit [I]	U	U	✓	✓			✓
Canidae	*Canis lupus*	Dingo/Wild Dog [I]	U	U	✓	✓			✓
Canidae	*Vulpes vulpes*	Fox [I]	U	U	✓	✓			
Felidae	*Felis catus*	Feral Cat [I]	U	U	✓	✓			
Equidae	*Equus caballus*	Horse [I]	U	U	✓				
Suidae	*Sus scrofa*	Feral Pig [I]	U	U	✓				
Bovidae	*Bos taurus*	European Cattle [I]	U	U	✓	✓			
Bovidae	*Capra hircus*	Feral Goat [I]	U	U	✓				
Bovidae	*Ovis aries*	Sheep [I]	U	U	✓				
Cervidae	*Cervus/Dama* sp.	Unidentified Deer [I]	U	U	✓				

APPENDIX D – FAUNA SPECIES RECORDED AROUND (BUT NOT WITHIN) NORTH-WESTERN WOLLEMI NATIONAL PARK

Below is a list of fauna species recorded on the Atlas of NSW Wildlife within a five kilometre radius of the study area boundary, but not recorded from within the study area (as at 2nd May 2006).

Family	Scientific name	Common name	NSW Legal Status	National Legal Status
Frogs				
Myobatrachidae	*Adelotus brevis*	Tusked Frog	P	
Myobatrachidae	*Lechriodus fletcheri*	Fletcher's Frog	P	
Myobatrachidae	*Limnodynastes fletcheri*	Long-thumbed Frog	P	
Myobatrachidae	*Mixophyes fasciolatus*	Great Barred Frog	P	
Myobatrachidae	*Neobatrachus sudelli*	Painted Burrowing Frog	P	
Myobatrachidae	*Uperoleia laevigata*	Smooth Toadlet	P	
Hylidae	*Litoria chloris*	Red-eyed Tree Frog	P	
Reptiles				
Chelidae	*Emydura macquarii signata*	Short-necked Turtle	P	
Varanidae	*Varanus gouldii*	Sand Monitor	P	
Scincidae	*Egernia modesta*	Eastern Ranges Rock-skink	P	
Scincidae	*Pseudemoia entrecasteauxii*	Tussock Cool-skink	P	
Scincidae	*Pseudemoia pagenstecheri*	Tussock Skink	P	
Typhlopidae	*Ramphotyphlops proximus*	Proximus Blind Snake	P	
Colubridae	*Boiga irregularis*	Eastern Brown Tree Snake	P	
Elapidae	*Drysdalia rhodogaster*	Mustard-bellied Snake	P	
Elapidae	*Pseudechis guttatus*	Spotted Black Snake	P	
Birds				
Casuariidae	*Dromaius novaehollandiae*	Emu	P	
Phaethontidae	*Phaethon lepturus*	White-tailed Tropicbird	P	
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican	P	
Ardeidae	*Ardea ibis*	Cattle Egret	P	
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis	P	
Accipitridae	*Aviceda subcristata*	Pacific Baza	P	
Accipitridae	*Hamirostra melanosternon*	Black-breasted Buzzard	V	
Accipitridae	*Milvus migrans*	Black Kite	P	
Falconidae	*Falco subniger*	Black Falcon	P	
Columbidae	*Lopholaimus antarcticus*	Topknot Pigeon	P	
Columbidae	*Streptopelia chinensis*	Spotted Turtle-dove [I]	U	
Cacatuidae	*Calyptorhynchus banksii*	Red-tailed Black-cockatoo *	V	
Psittacidae	*Lathamus discolor*	Swift Parrot	E	E
Psittacidae	*Platycercus icterotis* *	Western Rosella * (probable escapee)	P	
Acanthizidae	*Aphelocephala leucopsis*	Southern Whiteface	P	
Meliphagidae	*Epthianura albifrons*	White-fronted Chat	P	
Meliphagidae	*Lichenostomus ornatus*	Yellow-plumed Honeyeater	P	
Meliphagidae	*Lichenostomus virescens*	Singing Honeyeater	P	

Family	Scientific name	Common name	NSW Legal Status	National Legal Status
Meliphagidae	*Phylidonyris nigra*	White-cheeked Honeyeater	P	
Oriolidae	*Sphecotheres vieilloti*	Australasian Figbird	P	
Artamidae	*Artamus cinereus*	Black-faced Woodswallow	P	
Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow	P	
Artamidae	*Artamus personatus*	Masked Woodswallow	P	
Corvidae	*Corvus orru*	Torresian Crow	P	
Alaudidae	*Alauda arvensis*	Eurasian Skylark [I]	U	U
Passeridae	*Passer domesticus*	House Sparrow [I]	U	U
Fringillidae	*Carduelis carduelis*	European Goldfinch [I]	U	U
Sylviidae	*Megalurus gramineus*	Little Grassbird	P	
Mammals				
Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot	P	
Potoroidae	*Potorous tridactylus*	Long-nosed Potoroo	V	
Macropodidae	*Macropus parma*	Parma Wallaby	V	
Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V	
Vespertilionidae	*Myotis adversus* (taxonomy revised to *Myotis macropus*)	Large-footed Myotis	V	
Vespertilionidae	*Vespadelus pumilus*	Eastern Forest Bat	P	
Muridae	*Pseudomys novaehollandiae*	New Holland Mouse	P	




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