The Vertebrate fauna of Werakata National Park and Werakata State Conservation Area

Department of **Environment & Climate Change** NSW

THE VERTEBRATE FAUNA OF WERAKATA NATIONAL PARK AND WERAKATA STATE CONSERVATION AREA

Information and Assessment Section
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OVERVIEW

This report examines the fauna present in Werakata NP and Werakata SCA. It builds on the original survey report by the Department on the fauna of Werakata National Park (DEC 2005i). Werakata National Park and State Conservation Area are some of the more significant DECC conservation reserves for the protection of biodiversity in the Sydney Basin. Located within the dry rainshadow of the Hunter Valley, together they comprise approximately 6300 hectares of land located within the catchment of the lower Hunter River adjacent to the towns of Aberdare, Abermain, Abernethy, Bellbird, Cessnock, Kearsley, Kitchener, Kurri Kurri, Neath and Weston. This report compiles Atlas of NSW Wildlife data on the terrestrial vertebrate fauna of these reserves and documents the extensive surveys undertaken by the Department of Environment and Climate Change in 2005 and 2008. A total of 72 DECC systematic survey sites have sampled birds, frogs, reptiles, bats, arboreal and terrestrial mammals. This project has contributed greatly to the knowledge of the current composition and distribution of wildlife across the study area, identified a variety of threatened species, and improved the understanding of conservation management priorities.

Two hundred and thirty-six (236) species of native terrestrial vertebrate fauna are known to inhabit the two reserves. This total is comprised of confirmed records of 15 frogs, 27 reptiles, 149 native diurnal birds, 10 nocturnal birds and 35 native mammals. In addition, 11 feral introduced mammals and five introduced bird species have been detected. The number of fauna species known to occur in Werakata National Park and State Conservation Area is twice that of many similarly sized reserves in Western Sydney or the Central Coast. Numbers compare favourably with less disturbed environments of medium-sized reserves in the region including Manobalai Nature Reserve, Mount Royal National Park and Bouddi National Park. The fact that these levels of fauna diversity are achieved is all the more remarkable given the intensity of modification and exploitation the forests in the Lower Hunter have experienced in the past.

The reasons that lie behind this diversity are likely to be threefold. Firstly, the reserves lie within a corridor of contiguous vegetation that links Cessnock to the surrounding Hunter Ranges. The effects of isolation, so prevalent in Western Sydney reserves, are lessened by the two reserves within the largest patch of remnant vegetation on the Hunter Valley floor. This appears to support species that require large home ranges such as the Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) and the Yellow-bellied Glider (*Petaurus australis*). Secondly, the vegetation of the reserve is dominated by Spotted Gum (*Corymbia maculata*). This distinctive tree is one of only a few eucalypts that occur near the coast that are winter-flowering, and as a result large numbers of animals make use of it as a winter food resource. Nomadic species such as the nationally endangered Regent Honeyeater (*Xanthomyza phrygia*) and Swift Parrot (*Lathamus discolor*) have been observed feeding in the blossoms of this tree on a number of occasions over the last few years, along with other honeyeater and lorikeet species. The Squirrel Glider (*Petaurus norfolcensis*), a threatened arboreal mammal, feeds on the flowering Spotted Gum along with the threatened Grey-headed Flying-fox (*Pteropus poliocephalus*). Thirdly, the Hunter Valley is an important ecological linkage for the movement of many species between the dry western environments and those found along the coast.

Some of the key findings of the surveys are:

- Of the 21 threatened fauna species confirmed to occur in Werakata NP and SCA, the Regent Honeyeater and Swift Parrot are considered to be the highest priority for conservation management. A further nine threatened species are considered a high priority for conservation management being the Square-tailed Kite (*Lophoictinia isura*), Barking Owl (*Ninox connivens*), Masked Owl, Brown Treecreeper (*Climacteris picumnus*), Speckled Warbler (*Pyrrholaemus sagittatus*), Black-chinned Honeyeater (*Melithreptus gularis*), Grey-crowned Babbler (*Pomatostomus temporalis*), Squirrel Glider and the East-coast Freetail-bat (*Mormopterus norfolkensis*). Many of these species rely on habitats that are closely tied to dry grassy woodlands on fertile soils. Historically, these same environments have been preferentially sought for agriculture and, as a result, have been extensively cleared and fragmented. Looming urban and industrial expansion associated with the major urban centres confounds impacts on these habitats across the region.
- A number of threatened species were found to be widespread in Werakata National Park but poorly represented in the adjoining State Conservation Area. These species include the Black-chinned Honeyeater and Squirrel Glider. The Grey-headed Flying-fox was widespread across both reserves.
- The status of a number of threatened species is uncertain with few records, including the Square-tailed Kite, Glossy Black-cockatoo (*Calyptorhynchus lathami*), East-coast Freetail-bat,

Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*M. schreibersii oceanensis*).

- Three threatened species have limited suitable habitat within the reserves; the Black Bittern (*Ixobrychus flavicollis*), Speckled Warbler and Grey-crowned Babbler.
- A number of declining woodland bird species are now rare in the lower and middle Hunter Valley and have only either been recorded once within the reserves or a small number of times in woodland adjacent to the reserves. These species include the Turquoise Parrot (*Neophema pulchella*), Hooded Robin (*Melanodryas cucullata*) and Restless Flycatcher (*Myiagra inquieta*).
- Pest species are widespread across the two reserves, with the Fox (*Vulpes vulpes*) being the most commonly recorded species. Foxes were more frequently recorded in Werakata NP, with only scattered records in Werakata SCA. Feral species, such as the Spotted Turtle-dove (*Streptopelia chinensis*), Common Myna (*Acridotheres tristis*), Common Starling (*Sturnus vulgaris*), Rabbit (*Oryctolagus cuniculus*) and Brown Hare (*Lepus capensis*) are largely restricted to the margins of the reserves. Fallow Deer (*Dama dama*) and the Feral Goat (*Capra hircus*) are currently only limited in extent in the study area, but have the potential to have significant impacts on native fauna in the future if not actively managed.

The biggest challenges facing Werakata National Park and State Conservation Area are associated with the activities that occur around the reserves. For example, grassy woodlands that support a range of threatened fauna within the reserves occur widely in adjoining lands under a variety of tenures. The loss of woodlands in these surrounding areas would have an unknown impact on declining woodland species that occur within the reserves, particularly species that range widely such as the Black-chinned Honeyeater. Further, it needs to be recognised that the current age of most forest types are relatively young in the early to mid stages of regeneration after previous forest harvesting activities. The ability for the reserves to support viable populations of species dependent on such restricted forest types will depend on the maintenance of surrounding habitat. Frequent fire is likely to represent a complex challenge, as the difficulties in managing the duality of asset protection alongside retention of sufficient litter layers and ground cover fundamental for much of the reserves' fauna diversity. Fires that are too hot result in the loss of dead stags and mature or senescent hollow-bearing trees. Such habitat loss is significant given that there are so few of these age classes of trees remaining in the reserves. Clearing and fragmentation are further pressures on surrounding tenures, causing isolation of the reserve, loss of connectivity and reductions in surrounding feeding and nesting resources and collectively leading to increased risk of local extinctions.

Werakata National Park and State Conservation Area are worthy of ongoing monitoring efforts given the rapidity of change in land uses occurring in the Lower Hunter Valley. Already annual monitoring surveys for the Swift Parrot and Regent Honeyeater have been implemented as part of the national recovery plan for these species. Opportunities also exist to implement monitoring surveys on a ten yearly basis, using current baseline data to ensure that levels of species richness are retained across all fauna groups. Other primary species warranting monitoring efforts are Squirrel Gliders and the suite of declining woodland bird species.

Regionally declining woodland species within the Lower Hunter Valley that are patchily distributed within the two reserves; Grey-crowned Babbler (top), Speckled Warbler (lower left) and Swift Parrot (lower right). © M. Schulz

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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 Climate Change (DECC, formerly NSW National Parks and Wildlife Service (NPWS)) has established a biodiversity survey priorities program for DECC managed estate within the Branch. This program recognises that information that documents the range of 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. This program goes some way toward addressing these issues.

Reserves in the Central Branch have highly variable levels in the quantity and quality of information. Typically the largest reserves, which offer significant potential contribution to biodiversity conservation, are the most poorly understood. Other smaller reserves have been overlooked, infrequently visited by naturalists or are only recent acquisitions to the reserve system. Werakata National Park (NP) and Werakata State Conservation Area (SCA) fall within the latter category. To this end the survey program provides a means to address the most poorly known reserves first and combines these 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 of the Central Coast and Lower Hunter as a result of urban expansion. The faunal values of the reserves that occur in the Hunter are fundamental to understanding the conservation priorities for many species in the region.

Werakata NP and SCA are some of only a few reserves that are situated on the Hunter Valley floor itself. New survey work is required to address the gaps is knowledge of fauna species and compositions occurring within DECC managed estate reserve within the region and to build on existing research. The specific objectives of this project are to:

1. Document, review and collate existing fauna data within the two reserves.
2. Carry out systematic field sampling of all terrestrial vertebrate fauna groups to establish baseline data for future conservation assessment and monitoring works within the two reserves.
3. Identify and profile threatened fauna species and other regionally significant fauna that are known or likely to occur within the two reserves.
4. Assess the priority of threatened species for conservation management within the two reserves within a regional context.

1.2 BACKGROUND

Werakata National Park and State Conservation Areas are located near Cessnock in the Lower Hunter Valley within the DECC Hunter Range Area. The reserves are situated approximately 30 kilometres west of Newcastle and 110 kilometres north of Sydney (Map 1). Werakata NP is separated into three distinct but closely located sections (Map 2), which cover an area of approximately 3150 hectares. Werakata, originally called Lower Hunter National Park, was gazetted in 1999 during the NSW Regional Forest Assessments (RFA). During this process, the Spotted Gum-Ironbark vegetation communities found on the Hunter Valley floor were identified as being poorly represented in the regional reserve system. Cessnock and Aberdare State Forests supported substantial areas of these vegetation communities. As a result portions of this public land was set aside as Werakata NP. This reserve is situated within the largest patch of remnant vegetation that remains on the Hunter Valley floor (Bell 2004). Two additions to the NP were made in 2002 when most of the remaining area of Cessnock State Forest (478 hectares) and the Tomalpin section of Aberdare State Forest (531 hectares) were transferred.

Werakata State Conservation Area is separated into three blocks, which cover an area of approximately 2139 hectares (Map 2). This reserve was gazetted in 2007 and formerly comprised the southern sections of Aberdare State Forest. Similar to Werakata NP, the reserve supports substantial areas of Spotted Gum-Ironbark vegetation communities (Bell 2004).

The two reserves lie close to the northern boundary of the Sydney Basin Bioregion. Both areas are comprised of gently undulating forested hills with a network of streams that drain into the sub-catchments of the Hunter River. Swamp and Deadmans Creeks form part of the national park's western boundary in the northern and middle sections and the upper catchments of London and Deep Creek both start within the park. Mount Tomalpin, the highest point in the national park (201 metres above sea level (asl), rises above the valley to form a local landmark. The upper catchments of Bellbird, Black, Bunkerville, Congewai, Swamp and Wallis Creeks arise within Werakata State Conservation Area. The highest points (210 metres asl) within the SCA are along the Broken Back Range forming the southern boundary of the reserve.

The region surrounding the reserves supports an assortment of land uses including agriculture, mining and urban development. Located in close proximity to the town of Cessnock, the reserves abut private rural blocks and denser residential development. Major roads including the Cessnock, Lake, Maitland and Quorrobolong Roads and several high voltage powerline easements pass through sections of the two reserves. The park itself is heavily dissected by access trails, a remnant of its recent logging history.

1.3 HISTORY OF LAND USE

The Hunter region was a resource rich environment inhabited by the Awabakal, Worimi, Wonnarua, Geawegal, Birrpai and Darkinjung Aboriginal tribes (Hunter Valley Research Foundation 2001). Little is known about Aboriginal use of the area in the vicinity of Werakata NP and SCA prior to and post the arrival of settlers. During the Morisset Forestry District Environmental Impact Assessment studies, an archaeological investigation found limited evidence of aboriginal occupation in the Cessnock and Aberdare State Forests (Kinhill Engineers Pty Ltd 1995). Extensive disturbance to the area since the arrival of European settlers is likely to contribute to the apparent lack of physical evidence of early aboriginal use.

Lieutenant John Shortland was the first European documented as discovering the Hunter River and Lower Hunter Valley in 1797 (Hunter Valley Research Foundation 2001). Shortly after European arrival reports of abundant coal and timber resources spread throughout the colony and settlement and further exploration of the surrounding region began. Early exploitation of coal and timber reserves in the area was driven by shortages experienced in Sydney. By 1819 John Howe had blazed a trail north through the mountains from Sydney to the early settlement of Maitland. This route passed through what is now the northern section of Werakata National Park.

In the early 1860s, sawmills were established in or near to the current boundary of the reserves to process harvested timber (Friends of Werakata undated). Much of the timber went to local underground mines for pit-props and building material (State Forests of NSW 1995). Management for the production of mining timber resulted in trees above mining prop size being removed and regrowth being harvested before it grew beyond optimum sizes. Additionally the removal of unmerchantable large trees and a reduction of stump heights following harvesting was undertaken to promote coppice regeneration (State Forests of NSW 1995). Such silvicultural treatment had unknown consequences on the fauna of the forests, but is likely to have resulted in a decrease of hollow-requiring species. The advent of open cut and long wall mining techniques resulted in a substantial decrease in demand for mining timbers.

Cessnock and Aberdare State Forests were initially declared in 1942 (Friends of Werakata undated) and 1963 respectively (EJE Group 1995) and continued to operate until their transfer to NPWS estate in 1999 and 2002 for the NP and 2007 for the SCA. During this time these forests were principally managed for ironbark (mostly Red Ironbark (*Eucalyptus fibrosa*)) and Spotted Gum (*Corymbia maculata*) (Bell 2001).

Other parts of the park have been used for extractive industries in the past. A large clay quarry was established along Old Maitland Road, to supply bricks, ceramic pipes and tiles and a small gravel quarry, in the west near Abermain, was used to supply gravel for roadmaking (Friends of Werakata undated).

Other past land uses in the two reserves includes beekeeping and grazing (State Forests of NSW 1995).

1.4 ENVIRONMENT

1.4.1 Biogeography

The Sydney Basin Bioregion, in which the reserves are situated, extends from just north of Batemans Bay to Nelson Bay on the central coast, and west toward Mudgee (Thackway and Cresswell 1995). It is characterised by a temperate climate with warm summers and no dry season. Approximately 40 percent of the Bioregion is reserved for conservation, largely as National Parks and Nature Reserves (NPWS 2003a). The Hunter Valley, in which the reserves lie, are typical of a number of provinces within the bioregion that are typified by heavily cleared landscapes and poor reservation status for many of the extant vegetation communities. The valley is also a naturally occurring barrier for many biota as the dry woodlands separate the warmer and moister environments of the north coast from the less fertile and drier environments of the Sydney Basin. However, it is also an important conduit between the eastern coastline and the dry western slopes due to the low relief of the Great Dividing Range at the headwaters of the Hunter River.

1.4.2 Geology and Geomorphology

Werakata NP and SCA occur on Permian sediments in the Branxton Formation associated with both the Dalwood and Maitland Group (Kovac and Lawrie 1991). Sediments vary from coarse sandstone and conglomerate layers through to finer grained material associated with siltstone, mudstones and shales.

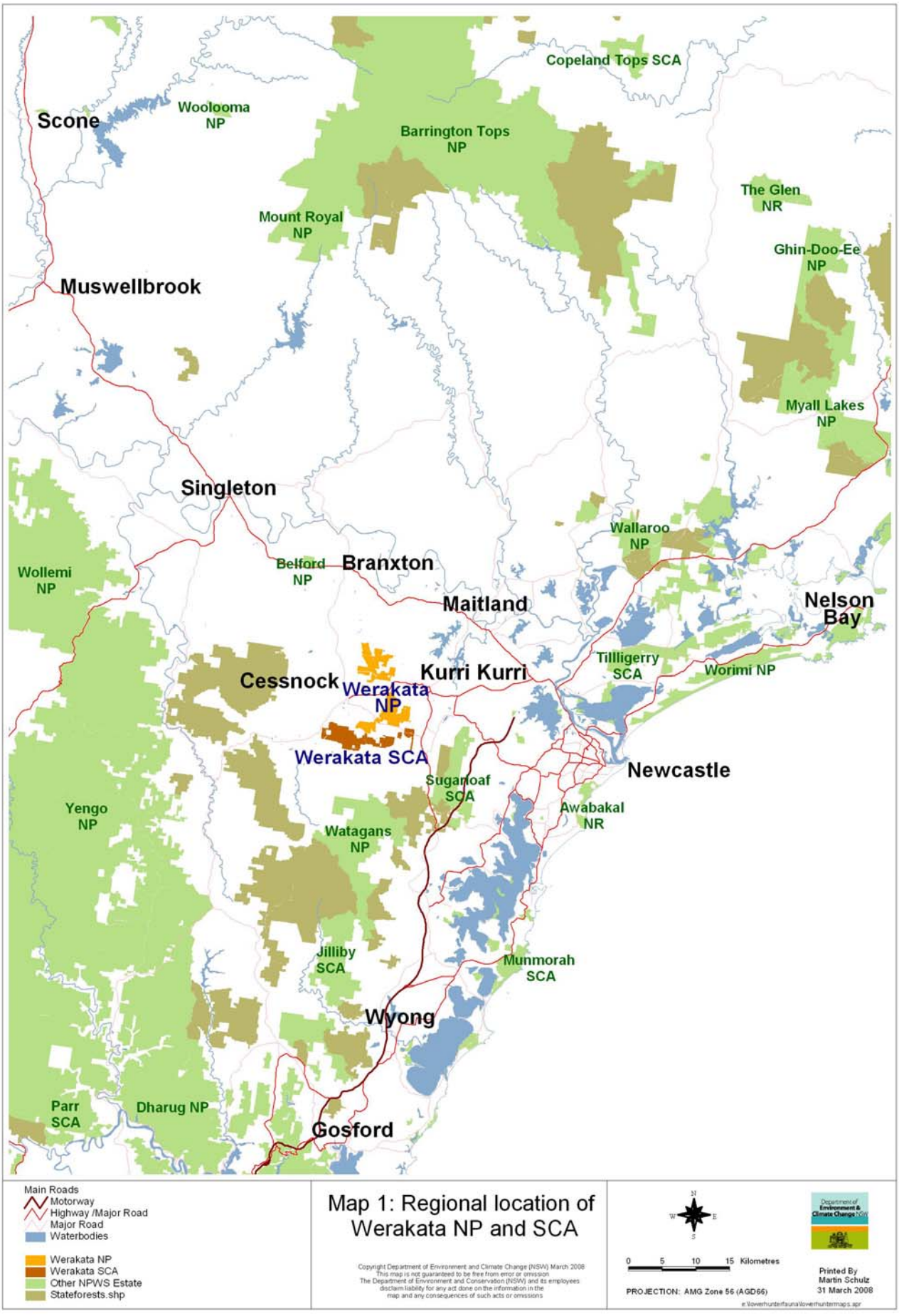
The landscape of the two reserves is characterised by undulating rises and gentle slopes that surround the townships of Cessnock, Kitchener and Kurri Kurri. Small alluvial channels drain a number of creeks, all of which flow into the Hunter River. In the northern parts of the western block of the SCA the terrain is characterised by undulating rises to low hills with a relief of 10 to 40 metres and slopes typically to 5%. This terrain gradually rises in the southern section of this block of the SCA to the higher elevations of the Broken Back Range. This southern section and the two eastern blocks of the SCA are characterised by rolling hills with a relief of 60 to 120 metres and slopes typically of 12 to 15%. Alluvial soils occur in some of the drainage lines.

Powerline easement traversing the western section of © M. Schulz/DECC

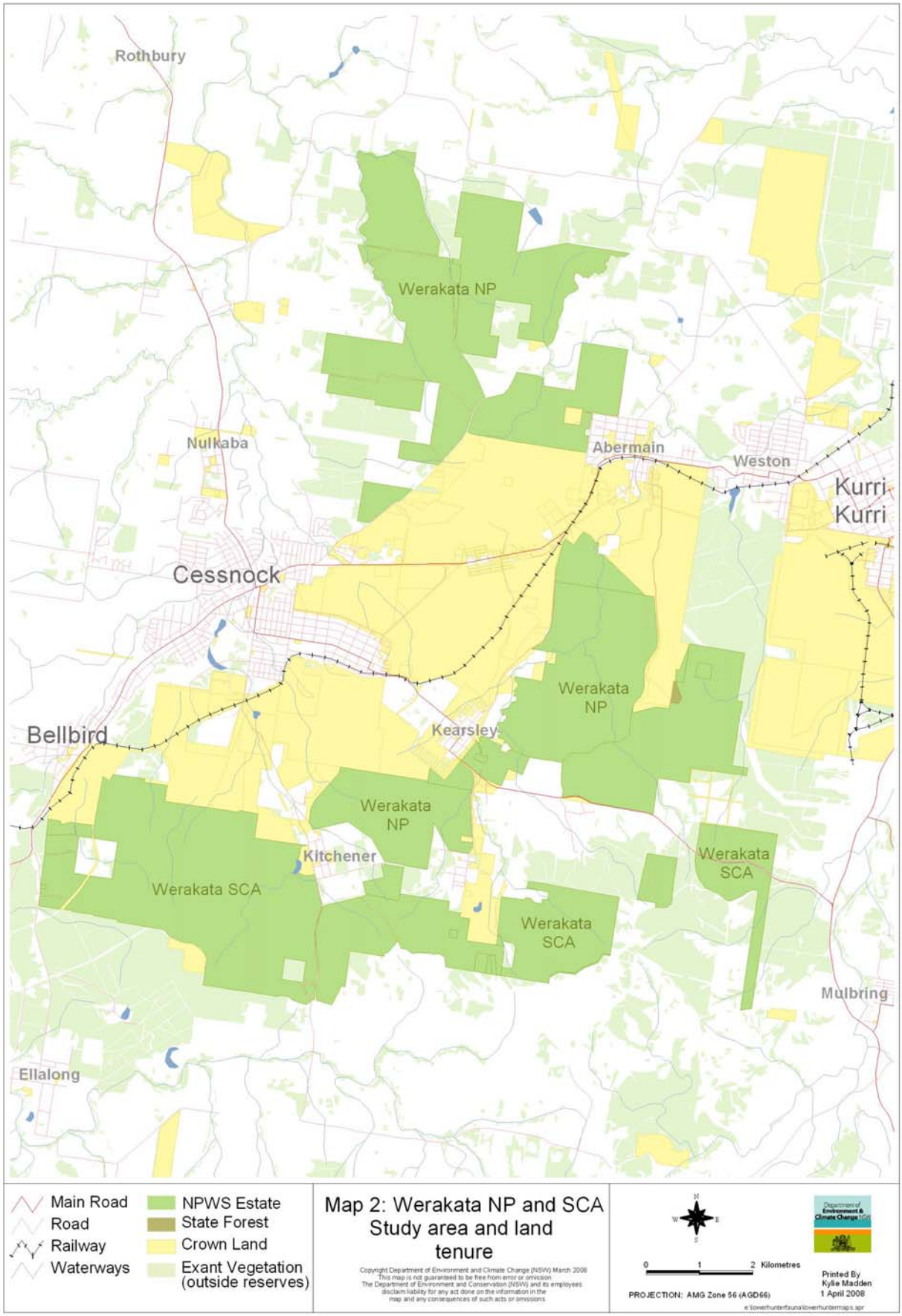
Woodlands are typified by young even-aged eucalypt stands. © M. Schulz/DECC

Common landuse today of the areas is by trail bikes and four wheel drives. © N. Williams/DECC

View across the SCA from the Broken Back Range of the SCA. © M. Schulz/DECC



Map 1: Regional location of Werakata NP and SCA



Map 2: Werakata NP and SCA study area and land tenure

1.4.3 Elevation

Mount Tomalpin is the highest point of Werakata NP and of the surrounding valley. It is reaches 200m above sea level (asl) whereas the lowlands that follow the riparian flats and plains lie between 40 and 60m asl, while the rises are situated between 60m and 140m asl.

The main western block of Werakata SCA is less than 100m asl in the northern section of the reserve west of Kitchener and rises to a maximum of 200m asl along the Broken Back Range that forms the southern boundary of the reserve. The eastern block of the reserve ranges from 140m asl to less than 50m asl.

1.4.4 Climate

The Hunter Valley falls within a warm temperate climatic zone characterised by wet summers and drier winters. Rainfall patterns in the Hunter Valley follow an east to west gradient where mean annual rainfall levels fall from 1200mm per year on the coast to 750 mm per year at Cessnock (Bureau of Meteorology 2001) just 30 kilometres inland. This is typical for rainshadow valleys and plains in NSW. Temperatures are warm to hot during summer months and often humid. Winters are mild to cool, with few frost days. Werakata NP and SCA are likely to experience mean maximum temperatures of 30ºC in summer and 18ºC in winter.

1.5 VEGETATION

The conservation status of the vegetation communities in Werakata NP and SCA underpins the establishment of these reserves. The declaration followed a review of the conservation value of forested public lands through the Regional Forest Agreement process in the late 1990's. The vegetation characteristics of the reserves have been described by Binns (1996), NPWS (1999a, 2000a) and Bell (2004). These forests form a network of dry sclerophyll forests that are present on dry rainshadow valleys of the Hunter-Macleay region (Keith 2004). Each of these studies have recognised that the area represents the largest patch of contiguous native vegetation remaining on the Hunter Valley floor, and that the vegetation communities that occur within the two reserves are poorly reserved and have been heavily cleared. As a result, many of them are now recognised as Endangered Ecological Communities under the NSW Threatened Species Conservation Act, 1995.

Open Spotted Gum-Ironbark Forest showing the impact of fire and dumping. © DECC

The primary vegetation community within Werakata NP is Lower Hunter Spotted Gum-Ironbark Forest (Map 3). This community comprises a moderately tall forest (approximately 25m tall) of Spotted Gum and Red Ironbark. A dense layer of prickly sclerophyllous shrubs such as Gorse Bitter Pea (*Daviesia ulicifolia*), Mountain Holly (*Podolobium ilicifolium*) and Peach Heath (*Lissanthe strigosa*) characterises the understorey. Dense thickets of Ball Honey Myrtle (*Melaleuca nodosa*) are sometimes prominent, particularly in areas that have had soil disturbance in the past. The ground cover is a sparse combination of grasses, herbs and small ferns growing amongst cycads (*Macrozamia* sp.). On deeper less sandy soils, stands include Grey Gums (*E. punctata* X *canaliculata*) as a prominent component of the canopy and less frequently Blue-leaved Stringybark (*E. agglomerata*). These sites tend to be less shrubby and possess a prominent ground cover of Kangaroo Grass (*Themeda australis*).

The low-lying Permian sediments form narrow channels that drain toward the Hunter River. Minor creek flats form as a result of slow moving run-off from the surrounding undulating country. Standing water forms intermittent soaks and swampy soils that underlie a variable forest community of Rough-barked Apple (*Angophora floribunda*), Forest Red Gum (*E. tereticornis*), Grey Box (*E. moluccana*) and Grey Gum. More prominent at times are the dense stands of small trees of Swamp Oak (*Casuarina*

glauca) and Paperbark (*Melaleuca* sp.). The deeper alluvial soils support a dense cover of grasses and herbs.

Hunter Lowlands Redgum Forest. © DECC

One of the unique vegetation features of the NP is the Kurri Sand Swamp Woodland. This recently described (NPWS 2000a) community has been listed as an endangered ecological community under the NSW TSC Acts, 1995. Small deposits of eroded sandstones form a deep sandy soil intermixed with occasional claypans. This soil structure produces a distinctive and variable assemblage of plants. A very low (approximately 10m tall) and open woodland comprised of Narrow-leaved Apple (*Angophora bakeri*), Parramatta Red Gum (*E. parramattensis* subsp. *decadens*), Red Mahogany (*E. resinifera*) and Scribbly Gum (*E. signata*). Shrubs typical of the Sydney sandstone plateau include *Banksia* species, Tea Trees (*Leptospermum* sp.) and Mountain Devil (*Lambertia formosa*). Variations to this community include a scrub-forest that has dense stands of Paperbarks (*Melaleuca nodosa* and *M. decora*) in the small tree layer below a scattering of Eucalypts.

Not surprisingly, the vegetation of the SCA has many similarities with Werakata NP that lies immediately to the north (Map 3). Dominant vegetation communities (as defined by Bell and Driscoll 2007) comprise:

a) *Lower Hunter Spotted Gum-Ironbark Forest*: as described above.

b) *Coastal Foothills Spotted Gum-Ironbark Forest*: Canopy species dominated by Spotted Gum, Ironbark (*E. siderophloia*), Grey Ironbark (*E. paniculata*), Grey Gum (*E. punctata*), White Mahogany (*E. acmenoides*) and some Turpentine (*Syncarpia glomulifera*). The understorey is generally grassy, with a range of herbs.

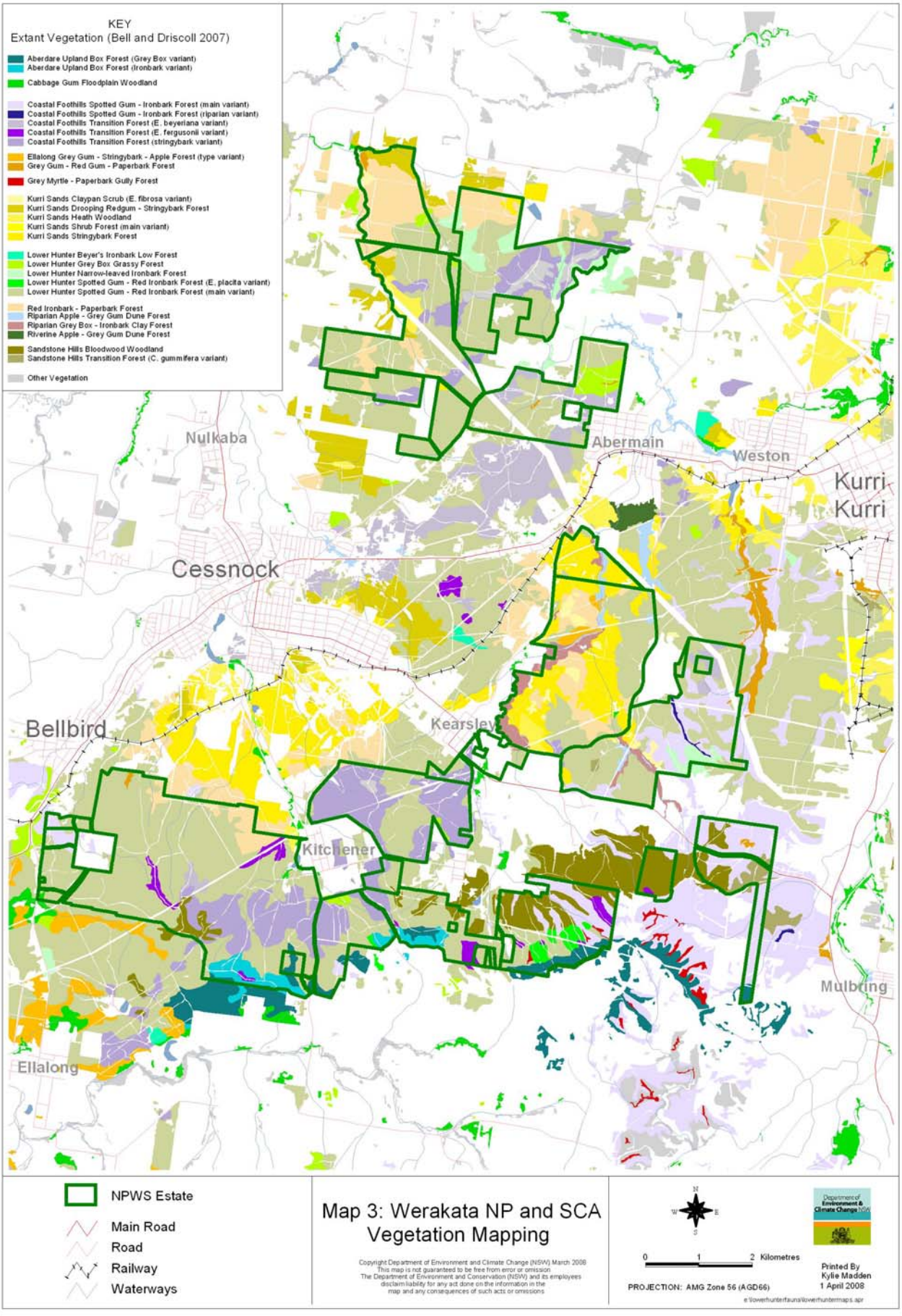
c) *Coastal Foothills Transition Forest*: This community supports a variety of canopy species including Spotted Gum, Red Bloodwood (*Corymbia gummifera*), Ironbark (*E. fergusonii*), Red Ironbark, Brown Stringybark (*E. capitellata*), Grey Gum, Broad-leaved White Mahogany (*E. umbra*) and Turpentine. Understorey vegetation includes Narrow-leaved Geebung (*Persoonia linearis*), Mountain Holly, Grevillea (*Grevillea montana*), Breynia (*Breynia oblongifolia*), Silky Hakea (*Hakea sericea*) and Hairpin Banksia (*Banksia spinulosa*).

d) *Red Ironbark-Paperbark Forest*: Canopy exclusively comprised of Red Ironbark with the subcanopy dominated by Paperbark (*Melaleuca decora*), Ball Honey Myrtle, Blackthorn (*Bursaria spinosa*) and Rusty Velvet-bush (*Lasiopetalum ferrigineum*).

e) *Aberdare Upland Box Forest*: Canopy species dominated by Grey Box with varying amounts of Narrow-leaved Ironbark (*E. crebra*) and Spotted Gum. Sparse shrub layer, dominated by species such as Blackthorn and Cough-bush (*Cassinia quinquefaria*). The understorey supports a well-developed grassy layer dominated by *Aristida* species.

f) *Sandstone Hills Bloodwood Woodland*: Canopy dominated by Yellow Bloodwood (*Corymbia eximia*) with a number of subdominant species such as Red Bloodwood, Brown Stringybark, Smooth-barked Apple (*Angophora costata*) and Scaly Bark (*E. squamosa*). Sparse understorey dominated by a variety of shrub species including Parrot-pea (*Dillwynia retorta*), Broad-leaf Drumsticks (*Isopogon anemonifolius*), Narrow-leaved Geebung, Mountain Holly, Grass Tree (*Xanthorrhoea glauca*) and Pale Mat-rush (*Lomandra glauca*).

Vegetation communities (as defined by Bell and Driscoll 2007) occupying small areas within Werakata SCA include Kurri Sands Heath Woodland, Lower Hunter Grey Box Grassy Forest, Paperbark Depression Forest, Cabbage Gum (*E. amplifolia*) Floodplain Woodland, Grey Gum-Red Gum-Paperbark Riparian Forest and Grey Myrtle (*Backhousia myrtifolia*)-Paperbark Gully Forest (Map 3).



Map 3: Werakata NP and SCA Vegetation Mapping

Widespread vegetation communities within Werakata SCA: Sandstone Hills Bloodwood Woodland (left), Lower Hunter Spotted Gum – Ironbark Forest (centre); Aberdare Upland Box Forest (right). © M. Schulz/DECC

Vegetation communities with restricted distribution within Werakata SCA: Paperbark Depression Forest (left), Cabbage Gum Floodplain Woodland (centre); Grey Myrtle – Paperbark Gully Forest (right). © M. Schulz/DECC

Kurri Sand Melaleuca Scrub-Forest (left); Lower Hunter Spotted Gum-Ironbark Forest on Mount Tomalpin (right). © DECC

1.6 FIRE

Little is known about traditional Aboriginal and early European burning practices in Werakata NP and SCA, but there is no doubt that humans have influenced fire regimes and the resulting vegetation composition throughout the area. Much of both reserves comprise fire-adapted vegetation indicating that fire is an integral component of the ecosystem. In more recent times, high intensity wildfires have burnt through large sections of the reserves. These fires generally occur between late spring and the end of summer when high temperatures and dry north-westerly winds create conditions conducive to the rapid spread of fire. Arson is a recurring problem in both reserves with incidents occurring in most summer seasons (D. van Rensburg pers. comm.). Based on recent fire history records it is likely that at least some portions of the two reserves may experience fire on average once every 2-3 years (Bell 2004). However, overall a fire history across the reserves of between 5-7 years appears the typical fire interval (D. van Rensburg pers. comm.)

A number of wildfires have burnt the reserves since 2000. The whole of the southern section of the NP near Kitchener and adjacent sections of the SCA were devastated by a wildfire that went through the area in October 2002. This was an intense fire with a high degree of canopy burn and complete consumption of the understorey. In October/November 2001, another wildfire burnt the majority of the northern section of the NP, south from Gibsons Road, and the middle section west of Hebburn Road near the town of Kearsley. The vegetation cover still displays impacts from this fire. In the summer of 2003/04 a small wildfire burnt around the Mount Tomalpin area. Recent fire has affected the Mount Tomalpin area in the 2005/6 season and other parts of the northern and central sections of the NP in the 2006/07 season (DEC 2006b; D. van Rensberg pers. comm.).

Fire management is a major issue in the two reserves. © D. van Rensberg/DECC

1.7 DISTURBANCE

Prior to the declaration of both Werakata NP and SCA, the forests experienced a long history of disturbance in addition to fire. The Spotted Gum and Ironbark trees were specifically managed to provide timber props for the surrounding coal mines. This management technique sought to promote smaller, narrow diameter trees that fit easily into underground mining shafts. Forests were thinned of old, overmature and defective trees. This practice left the forest dominated by a young regrowth stand of even-aged trees, with many less than 40cm diameter at breast height. Hollow-bearing trees are sparse as a result. Mapping of the age class of Aberdare and Cessnock State Forests for the Broad Old Growth Mapping Project (NPWS 1996) indicated that 90% of the reserve is dominated by regrowth stands with only small areas including mature age trees in the canopy. A major challenge to increase biodiversity within the reserves is to alter the predominantly even-aged forests as a result of past silvicultural practices to a more multi-aged, less dense forest.

Trail bikes occur throughout both reserves. © P. O'Neill/DECC

Extensive road and trail networks cover the area as a result of past logging and mining activities. Current activities such as trail bike riding and four-wheel driving continue to disturb soil and ground cover layers throughout many parts of the reserve. Rubbish dumping is prevalent in and around access trails

Both reserves are traversed by wide easements associated with high-voltage powerlines. Roads along many sections of these easements are heavily used by motorbikes and other off-road vehicles. Some western sections of the SCA may be subject to impacts from coal mining, such as access to vent shafts and ground subsidence and headwater stream alteration as a result of longwall coal mining. The impact of longwall mining has been listed as a key threatening process under the NSW

TSC Act (1995) (NSW Scientific Committee 2005b) but little information is available on the impacts of this type of mining within the reserves.

Disturbance within Werakata SCA ranges from potential ground subsidence as a result of longwall coal mining (left) to dumped rubbish and fires as a result of arson, such as the firing of dumped vehicles (right). © M. Schulz/DECC

A major management issues impacting on the presence of threatened species are the largely even-aged stands of forest as a result of past silvicultural practices. The challenge for the future is to create a more multi-aged forest structure within the reserve. © M. Schulz/DECC

Other management issues include firewood poaching (left); rubbish dumping (right). © J. Schejnin /DECC

1.8 PROJECT TEAM

Werakata NP: Helen Achurch was primarily responsible for the project design, management, field survey planning, logistics and map production of the 2005 fauna survey of the NP. Field surveys were undertaken by Helen Achurch, Narawan Williams, Martin Schulz and Kylie Madden. Deon van Rensburg assisted with providing information on management, such as fire history. Peter Ewin assisted with the map production and fauna data extraction. Survey data was entered by Rebecca Allport and Helen Achurch. The report was written by Helen Achurch and Daniel Connolly. Kerry Oakes designed the report cover and formatted the report.

Werakata SCA: Martin Schulz was primarily responsible for the project design, management, field survey planning and logistics of the 2008 fauna survey of the SCA; wrote the report and assisted with map production. Field surveys were undertaken by Martin Schulz, with assistance from George Madani. Deon van Rensburg assisted with providing access to parts of the SCA and information on management, such as fire history. Kylie Madden produced the maps and figures for the report and undertook the fauna data extraction. Barbara Triggs analysed the few predator scats collected. Valuable comments on earlier drafts of this report were provided by Daniel Connolly, Kylie Madden Deon van Rensberg and Steve Wright. Luke McLaren entered all fauna records of the current survey into the Atlas of NSW Wildlife. Kerry Oakes designed the report cover and formatted the report.

The Brown-striped Frog is a widespread species in wetlands across the two reserves. © M. Schulz

2 METHODS

2.1 EXISTING FAUNA DATA

The changing face of the Lower Hunter Valley from an agricultural to a rural-urban landscape has necessitated a significant amount of ecological study in recent years in order to address impacts of development. These studies have helped to provide important contextual information on the fauna habitats of the Lower Hunter floor. Other nearby State Forests, with similar habitat, were the subject of extensive fauna survey work as part of the environmental impact studies for forestry operations in the Morisset Forestry District (Ecotone Ecological Consultants 1995; Hoye 1995; Webster 1995; Wellington and Wells 1995). The Comprehensive Regional Assessment (CRA) program used systematic survey methods in the study area as a means to provide a broad overview of the fauna conservation values of public land in eastern NSW (NPWS 2000b). In September 1998, a number of systematic fauna sites were located throughout the then Aberdare State Forest aiming to sample a range of broad environmental strata. This work resulted in two nocturnal playback sites situated within the area now known as Werakata NP and six sites in Werakata SCA (comprising diurnal bird surveys at four sites and nocturnal playback at three sites). The Lower Hunter and Central Coast Regional Environmental Management Strategy undertook fauna surveys across the Cessnock, Maitland, Newcastle, Lake Macquarie, Port Stephens, Wyong and Gosford Local Government Areas (LHCCREMS 2001). The work targeted a suite of threatened species considered most at risk in the region. The data has subsequently been used to create maps of predicted habitat for these species and define areas of habitat conservation priority (Wintle *et al.* 2004). Two sites were located within Werakata NP and were sampled in March 2001 and two sites in Werakata SCA and were also sampled in March 2001 (Appendices A and B).

Also in 2001 the University of Newcastle (Grenadier *et al.* 2001) was commissioned by National Parks and Wildlife Service to conduct a survey of vertebrate fauna in parts of the reserve. This survey aimed to provide baseline fauna data for use in fire management planning. It recorded a range of species across the reserves using a variety of techniques. Although site based, some survey methods used during this survey differed from those during the CRA and recent DECC systematic surveys.

Since then a substantial amount of new survey work has been completed in forested lands that adjoin the NP known as the Hunter Economic Zone (also referred to as the Hunter Employment Zone). As part of these studies a significant amount of data was generated on lands which are now incorporated within the reserve. These studies have been carried out over numerous seasons and have addressed most fauna groups (Grenadier *et al.* 2002; HSO Ecology 2004).

The Atlas of NSW Wildlife stores a number of records associated with incidental observations, Australian Museum specimen registers and licensed data from Birds Australia. The licensed data from Birds Australia includes site-based bird records collected during the 1998-2002 period for the second Atlas of Australian Birds published by the Birds Australia (Barrett *et al.* 2003). The Australian Museum data derives from specimens submitted to the museum by members of the public, as well as from field trips undertaken by Museum staff specifically to collect fauna specimens. Records collected soon after European settlement have been entered into the Museum database with a low level of spatial and temporal reliability. For this reason, records from the Australian Museum prior to 1950 have been excluded from discussion in this report.

Remaining records within the Atlas come from observations made by park rangers and field officers, fauna consultants, bird watchers and naturalists, scientific researchers 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 identification experience of the observer.

2.2 SURVEY STRATIFICATION AND SITE SELECTION

New survey effort was targeted to areas and habitats that had not previously been sampled by previous studies. To do this, all existing survey sites were plotted against the vegetation mapping of Werakata NP and SCA (Bell 2001; Bell and Driscoll 2007). New survey work was proportionally allocated to each of the vegetation communities based on their extent within the two reserves. This allocation was modified to ensure that smaller vegetation communities received a minimum level of replication.

Sites were also allocated across all three sections of the NP and all three sections of the SCA. However, in the NP survey effort in the northern section was prioritised due to the paucity of species data in this area. Similarly, in the SCA survey effort was prioritised in the main western section and

larger eastern block, with only a single site in the smaller eastern block. Potential sample sites were initially selected using GIS data layers describing vegetation type and fire history. Recently burnt vegetation was avoided where possible. Attention was given to the allocation of sites across the geographic spread of the vegetation communities and at different aspects and positions on the slope. Survey sites, each two hectares in area, were spaced approximately one kilometre from each other to ensure spatial independence (two kilometres for nocturnal call playback surveys). The majority of sites were placed in close proximity to access trails to allow for night spotlighting and harp trapping surveys and to maximise the number of sites that could be accessed during the short three-day survey effort for the NP and the five-day survey effort for the SCA. The numerous trails bisecting the reserves provided good access during dry weather conditions enabling survey sites to be located in most areas. Some sites were located off roads to avoid disturbance of nearby neighbouring residents or to access particular vegetation communities, such as the gully with rainforest elements on the southern boundary of the SCA east of Southams Road. Rain prior to the survey and at the beginning of the survey period prohibited vehicle access along some trails during the NP survey and the preliminary visit to the SCA.

All sites were ground-truthed to ensure they were accessible, representative of mapped vegetation communities, and comprised a single vegetation community. If these criteria were not met a similar alternative site was selected.

Map 4 shows the location of fauna survey sites within the study area. Appendices A and B provide site details including vegetation community type for all systematic surveys that have been undertaken in the NP and the SCA respectively.

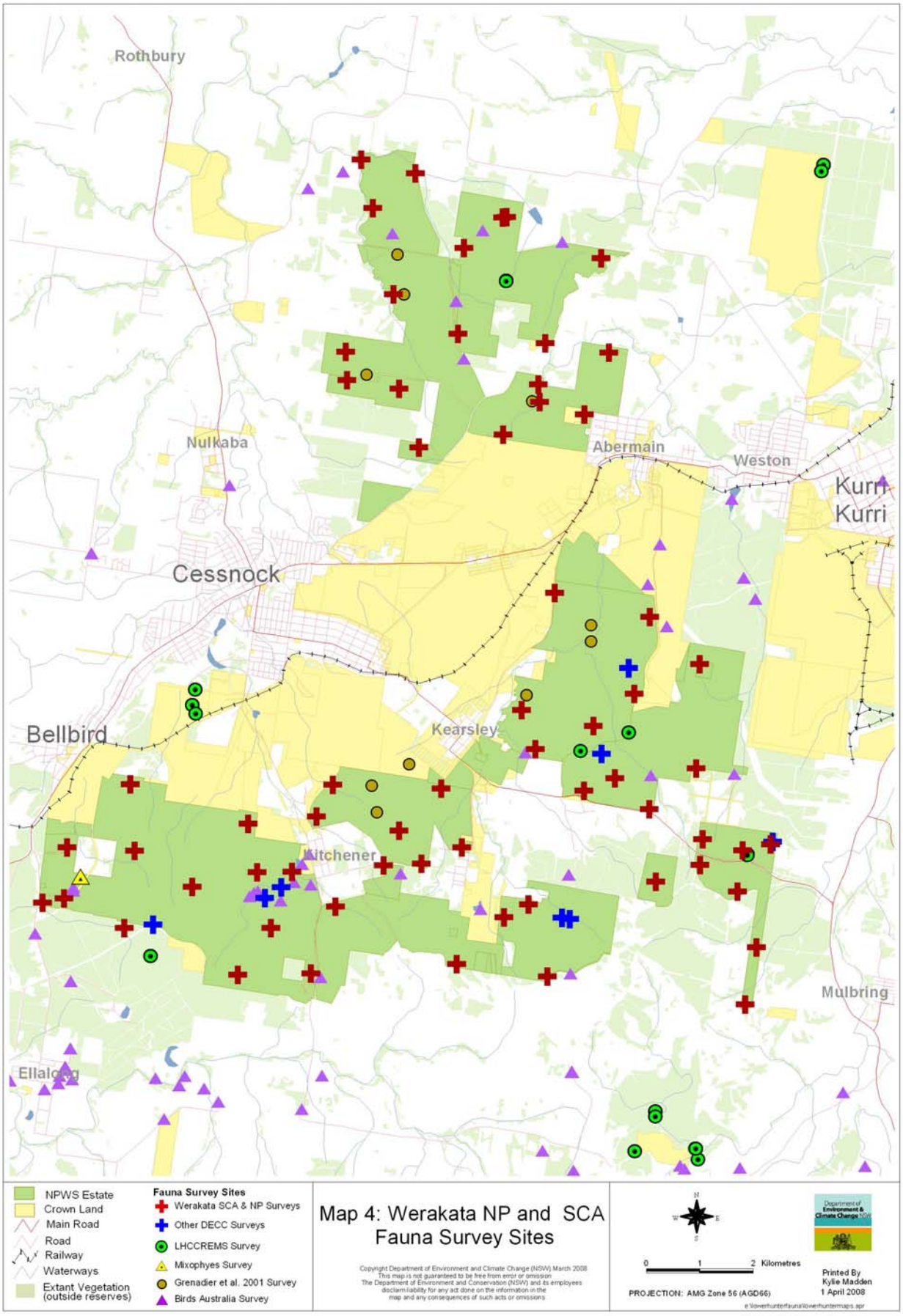
2.3 SURVEY METHODS

The systematic fauna survey methods used in the 2005 NP and 2008 SCA surveys by the Bioregional Data Unit of DECC were based on those developed by the NPWS Biodiversity Survey Coordination Unit (NPWS 1997a). The systematic techniques described below were used to sample the following vertebrate fauna groups: diurnal and nocturnal birds, amphibians, diurnal and nocturnal reptiles, bats, arboreal mammals 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 future comparisons with consistent surveys of environments elsewhere, such as other surveyed reserves within the Sydney Basin Bioregion.

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 DECC Biodiversity Subsystem (BSS) of the NSW Wildlife Atlas computer database. The names of observers and recorders were noted on every data sheet to aid data verification and entry.

Table 1: The number of systematic survey techniques conducted in the two reserves.

Reserve	Diurnal Bird Surveys	Diurnal Reptile Surveys	Spotlight Surveys	Harp Trap Sites	Anabat Sites	Streamside Searches	Owl Call Playback	Elliott Trapping
Werakata NP	39	26	25	9	7	1	10	10
Werakata SCA	24	22	15	15	4	3	7	3



Map 4: Werakata NP and SCA Fauna Survey Sites

2.3.1 Systematic site-based methods

A total of 63 systematic sites were surveyed in Werakata NP and 54 in Werakata SCA (Appendices A and B). Table 1 shows the number of each systematic survey technique undertaken in the two reserves, including the projects listed in Table 2. Map 4 shows the location of systematic survey sites and point locality-based targeted survey sites. Appendices A and B provide the specific AMG, vegetation type and survey techniques completed at each of these sites.

2.3.2 Systematic site-based methods

Site Attributes

A site attribute form, aiming to characterise fauna habitat, was filled out at every systematic site where one or more survey techniques were conducted. A 20m x 20m quadrat typical of the overall 100m x 200m 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 for each site. Standard codes provided by the Australian Soil and Land Survey Handbook (McDonald *et al.* 1990), particularly for vegetation (i.e. Walker and Hopkins 1990) were used wherever possible.

Diurnal Bird Survey

Diurnal bird censuses comprised a twenty minute observation and listening search within a two hectare (100m x 200m) area, conducted by an experienced bird surveyor. Censuses were conducted only during periods of relatively high bird activity (in the early morning) and reasonable detectability (e.g. low wind and cicada activity). 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 area (100m x 50m) was searched for one person-hour at each site (standardised regardless of the number of persons searching). Censuses were restricted to the period between mid-morning and late afternoon, when temperature and insolation are sufficient to ensure maximum reptile activity. Surveying was not conducted on overcast, rainy or extremely windy days.

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, dumped rubbish, rock outcrops and other likely shelter sites. Species identified by shed skin, found during the search, were also recorded on the census sheet. Incidental observations of other fauna were recorded on opportunistic forms.

Harp Trapping

While ultrasonic recorders are used principally to detect high flying bat species, collapsible bat traps, known as harp traps (Tidemann and Woodside 1978) capture low flying species. Two nights of trapping were conducted at each bat trap site in the Werakata NP survey and between one and three nights in the Werakata SCA survey. Sites were selected for their perceived potential to interrupt bats along their flight paths, and were usually placed along tracks, over watercourses, next to dams or in gaps between trees where adjacent vegetation might force bats to fly.

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

Bat Ultrasonic ('Anabat') Call Recording

Ultrasonic recorders (Corben 1989) are particularly useful for the detection of high-flying species, which often comprise more than one third of an area's bat species (Parnaby 1992b), yet are undersampled by harp trapping (Richards 1992). Additionally, ultrasonic detectors also record low-flying species in open situations not suited for the placement of harp traps. This method records the principally ultrasonic echolocation 'calls' made by bats (i.e. most species emit signals that are inaudible to the human ear).

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 in locations where

bats were expected to fly within a site, such as over waterbodies, in forest openings or along tracks. The Anabat was set to commence at dusk and turn off at dawn. During the night, a delay switch operated to turn on the recording device when bat activity was detected and then de-activate the device while no bat activity was occurring. The equipment was left in each location for one night only and then moved elsewhere. A 40 kilohertz calibration tone was recorded for a few seconds at the start and end of each recording session.

Ultrasonic calls recorded during the DECC surveys were analysed and identified by Narawan Williams. Identifications were divided into three reliability categories: definite, probable and possible.

Nocturnal Site Spotlighting Survey

This census technique comprised searching for arboreal mammals along a 200m transect within a site for half a person hour. Fifty-watt spotlights were used to scan the vegetation and ground for animals, including searching for reflected eye shine. Surveyors also listened, identified and recorded all fauna calls during the survey period. The ground and rock overhangs were also searched for nocturnal reptiles. All fauna observed within the census period were recorded, noting whether they were on or off site.

Nocturnal Streamside Search

Streamside searches for frogs were undertaken for half a person hour in one of two ways: a) in stream or gully habitats a 200m stretch was searched; while b) at standing water bodies a half-hectare (50m x 100m) area was surveyed. The searches were only conducted on warm, dark, humid and wet 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 territorial 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. 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. Prior to call broadcasts, on arrival at the site, the surrounding area was searched by spotlight for 15 minutes to detect any fauna in the immediate vicinity and then a ten-minute period of listening was undertaken. 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. Windy and rainy periods were avoided where possible.

In the Werakata SCA survey a variant of the above technique was used due to the limited time and the single team undertaking nocturnal fauna sampling. In this technique there were no pre- or post-listening periods and the playing of the four owl calls interspersed with five-minute listening periods was conducted simultaneously with spotlighting or streamside searches.

Elliott trapping

In the Werakata NP fauna survey this technique involved setting ten Elliott B traps at 20m intervals along a 200m 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.

In the Werakata SCA survey two lines of 25 Elliott A traps were set at approximately 10m intervals across a site. These traps were baited with walnut pieces and were left out for three consecutive nights. Similar to the NP survey, traps were checked soon after dawn and any animals captured were identified, sexed and released at the point of capture.

2.3.3 Opportunistic methods

Predator and herbivore scat and owl pellet collection

The large numbers of hairs, and occasionally skeletal remains, in predator scats and pellets results in a high level of confidence in identifications of prey species 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*), Feral Dog (*C. lupus familiaris*) and Feral Pig (*Sus scrofa*). 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 present within a general area. However, Lunney *et al.* (2002) demonstrated that predators defecate an average of 2km from the point of prey ingestion.

Predator scats collected during the DECC surveys were 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. Unfortunately, due to the very wet conditions preceding the Werakata SCA survey, very few predator scats were located for analysis.

The location of non-predator mammal scats during the DECC surveys was also noted on an opportunistic basis. If there was any doubt in the identification of these scats in the field, samples were brought back for identification by Barbara Triggs.

No owl pellets were located during the fauna surveys of Werakata NP and SCA.

Incidental records

Surveyors driving or walking through the study area recorded the location of notable fauna. Particular species targeted by this technique were those undersampled by systematic surveys, including large ground mammals, non-vocalising birds, and secretive, shy and/or rarely encountered animals. The date, time, location, grid reference (usually obtained from a GPS) and microhabitat of the animal were recorded on opportunistic data sheets.

2.3.4 Additional methods used during LHCCREMS and Newcastle University surveys

Koala surveys

Targeted searches for the signs of the Koala (*Phascolarctos cinereus*) were conducted at standard surveys sites during LHCCREMS and University of Newcastle surveys. Three samples of 20 trees were searched for signs of Koala activity at each site. Three trees were selected at each site (Koala food trees if present or other random trees) and then 19 trees surrounding them with a girth greater than 10cm were visually scanned for Koalas and any potential scratch marks on the trunk were noted. At each tree an area of 1m from the base of the tree was searched for Koala scats.

Hair tube sampling

Lengths of PVC pipe or specially designed hair tube funnels (Faunatech, Bairnsdale, Victoria) were baited with either meat or a mixture of rolled oats, peanut butter and honey. Double-sided tape or a sticky wafer inside the tube collects samples of the hair of any mammal investigating the bait. Tubes are left on site for up to ten nights. Collected hair samples are identified, by a recognised expert in the field, using the techniques described by Brunner and Coman (1974). Similar to predator scat analysis, identifications were divided into three levels of reliability levels: definite, probable and possible.

Harp trap set on creek adjacent to North Basin Road, Werakata SCA. © M. Schulz

2.4 SURVEY TIMING

DECC systematic field surveys were undertaken within Werakata NP during the CRA process and the recent 2004/05 season and in Werakata SCA during the CRA process and between 7 February and 6 March 2008. Table 2 summarises the timing of these and other surveys along with the techniques that were undertaken.

Table 2: Timing and techniques of the various fauna surveys within Werakata NP and SCA

Survey program	Timing	Techniques employed
Comprehensive Regional Assessment (CRA)	September - November 1998	*Werakata NP:* Nocturnal call playback, opportunistic techniques. *Werakata SCA:* Nocturnal call playback, diurnal bird census.
Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS 2001)	22 – 30 March 2001	*Werakata NP:* Nocturnal call playback, site spotlighting, diurnal bird census, Koala surveys, harp trapping, nocturnal streamside search, Elliott trapping, hair tube analysis, opportunistic methods, bat call analysis. *Werakata SCA:*, Site spotlighting, diurnal bird census, harp trapping, nocturnal streamside search, Elliott trapping, hair-tube analysis, opportunistic methods.
University of Newcastle survey of Lower Hunter National Park (Grenadier *et al.* 2001)	31 March –22 May 2001	*Werakata NP:* Incidental birds, nocturnal call playback, site spotlighting, reptile search, nocturnal streamside search, Elliott trapping, hair-tube analysis, opportunistic methods, bat call analysis.
Hunter Economic Zone (HSO Ecology 2004)	September 2002, April 2003	*Werakata NP:* Assorted methods sampling birds, reptiles, frogs and mammals.
Biodiversity Survey Priorities Program (DEC 2005i)	29 March – 1 April 2005	*Werakata NP:* Nocturnal call playback, site spotlighting, diurnal bird census, reptile search, harp trapping, nocturnal streamside search, Elliott trapping, opportunistic methods.
Werakata/Sugarloaf SCA Reserve Additions Fauna Survey (current survey)	January – March 2008	*Werakata SCA:* Nocturnal call playback, site spotlighting, diurnal bird census, reptile search, harp trapping, bat call analysis, nocturnal streamside search, Elliott trapping, opportunistic methods.

3 RESULTS AND DISCUSSION

3.1 OVERVIEW

A total of 236 native vertebrate species are currently confirmed to occur within Werakata NP and SCA. This total is comprised of 15 frogs, 27 reptiles, 149 native diurnal birds, 10 nocturnal birds and 35 native mammals. In addition, 11 feral mammals and five introduced bird species were recorded. Table 3 presents the total numbers of native, threatened and introduced fauna known to occur within Werakata NP and SCA. A complete list for all terrestrial vertebrate fauna groups is provided in Appendix C.

Table 3: Number of vertebrate fauna known to occur within Werakata NP and SCA

Total number of native fauna species known to occur	236
Number of species listed as threatened under the TSC Act (1995)	21
Number of species listed as threatened under the EPBC Act (1999)	3
Number of introduced mammals	11
Number of introduced birds	5

Systematic fauna surveys in the reserve have contributed a considerable number of species records to the NSW Wildlife Atlas. The Biodiversity Survey Priorities program over 2005 and 2008 has been responsible for many of these records (Figure 1). The 2005 Werakata NP survey contributed 29 species previously unrecorded in Werakata NP and added over 1020 new records and 43 new locations for threatened species. While the Werakata SCA survey in 2008 contributed 86 species previously unrecorded from the reserve and added 991 new records and 35 new locations for threatened species. Twenty-eight species and 34 species were only recorded from Werakata NP and SCA respectively, with all records from the various surveys combined (Appendix C).

The Red-bellied Black Snake was the most frequently encountered snake in the two reserves. © N. Williams

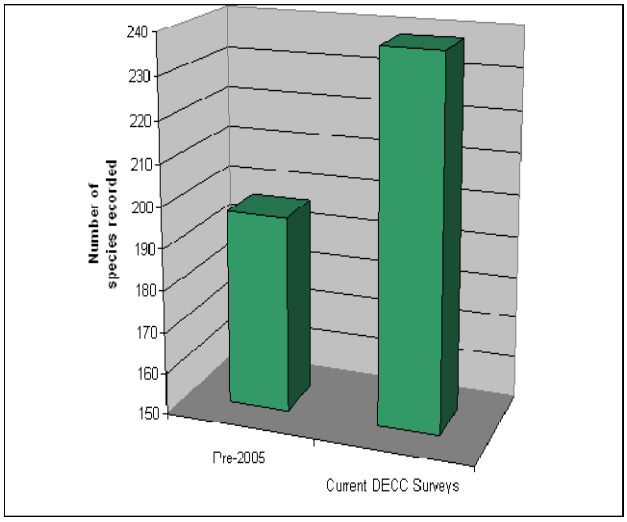


Figure 1: Dramatic increase in the number of terrestrial vertebrate fauna species recorded in the two reserves following DECC systematic fauna surveys in 2005 and 2008.

3.2 NATIVE DIURNAL BIRDS

The most diverse fauna group within the two reserves are the diurnal birds, comprising 149 species (Appendix C). The DECC systematic fauna surveys recorded 22 species which that had not previously been recorded, including four waterbird species, four raptors, four dry forest species, three wet forest species and two threatened species i.e. the Black Bittern (*Ixobrychus flavicollis*) and Square-tailed Kite (*Lophoictinia isura*). Twenty additional species were recorded in other surveys but not in the DECC systematic surveys; dominated by waterbirds (nine species) and raptors (five species). Other birds not recorded were either winter migrants e.g. Swift Parrot (*Lathamus discolor*), species that have significantly declined in the Lower Hunter region e.g. Hooded Robin (*Melanodryas cucullata*) or nectarivorous or inland species that periodically occur in the dry forests of the lower Hunter (e.g. White-browed Woodswallow (*Artamus superciliosus*).

Hooded Robin © M. Schulz

The most significant element of the diurnal bird group present was species associated with the grassy open forests/woodlands. The reserves provide very important foraging habitat for the endangered Regent Honeyeater (*Xanthomyza phrygia*) and Swift Parrot. Both species occur sporadically depending on both flowering events within the region and elsewhere within the species' distribution. For example, late spring/early summer 2007 had a significant Red Ironbark flowering event that had not been seen in the previous 17 years (A. Zoneff, pers. comm.). This event resulted in a 'large' number of Regent Honeyeaters occurring in forests bordering the NP and extending northwards towards the outskirts of Kurri Kurri. Significantly this flowering event resulted in the nesting of at least 10 pairs of this endangered bird (A. Zoneff, pers. comm.). Unfortunately no systematic surveys were conducted during this time to investigate the extent of occurrence within the reserves at this time. However, soon after one bird was observed in a stand of flowering Grey Gums adjacent to Pelton Road in the southwest corner of the SCA.

The prevalence of key flowering trees such as Spotted Gum, Red Ironbark and Grey Gum across much of the area results in the two reserves being highly significant for a large variety of other nectarivorous species. For example, the area supports a relatively large population of the threatened Black-chinned Honeyeater (*Melithreptus gularis*) and regionally declining nectarivores such as the Fuscous Honeyeater (*Lichenostomus fuscus*) and regionally patchily distributed species such as the Striped Honeyeater (*Plectorhyncha lanceolata*).

The reserves also support other birds typical of the grassy open forest/woodlands, including threatened species, such as the Brown Treecreeper (*Climacteris picumnus victoriae*), Speckled Warbler (*Pyrrholaemus sagittatus*) and Grey-crowned Babbler (*Pomatostomus temporalis temporalis*). However, all of these species are very patchily distributed and only small total populations are present. Other members of this bird community appear to be no longer resident and only occur as vagrants, such as the Hooded Robin and Diamond Firetail (*Stagonopleura guttata*). Other species typical of grassy woodlands are regionally declining but are still well represented with the two reserves, such as the Weebill *Smicrornis brevirostris* and Fuscous Honeyeater.

Associated with the grassy open forest/woodlands situated within the rain shadow of the Hunter Valley are a number of inland species that range eastwards into this dry forest corridor. Birds within this category include the Cockatiel (*Nymphicus hollandicus*), White-browed Babbler (*Pomatostomus superciliosus*) and the White-browed Woodswallow. It is likely that other inland species occur within the reserves, particularly during drought times or in late summer/autumn when juvenile birds are dispersing, such as the Black-eared Cuckoo (*Chrysococcyx osculans*), Red-capped Robin (*Petroica goodenovii*), Western Gerygone (*Gerygone fusca*) and the Masked Woodswallow (*Artamus personatus*) (after Bourke 1969; Morris 1975).

Grassy woodland bird species present in the two reserves: Brown Treecreeper, very patchily distributed (left); Weebill, a declining species now patchily distributed across the reserves (centre); Jacky Winter, primarily occurring on the edges of the reserves (right). © M. Schulz

The avifauna is not only characterised by the appearance of species dispersing from more western areas of the state or from following the flowering of key eucalypts but also by a range of species that are either summer, winter or passage migrants. Common summer migrants include various cuckoo species, the Rainbow Bee-eater (*Merops ornatus*), White-throated Needletail (*Hirundapus caudacutus*), Leaden Flycatcher (*Myiagra rubecula*) and the Cicadabird (*Coracina tenuirostris*). While in the winter months some species increase their presence in the drier forests of the Hunter Valley such as the Gang-gang Cockatoo (*Callocephalon fimbriatum*), Crimson Rosella (*Platycercus elegans*), Rose Robin (*Petroica rosea*) and the Pied Currawong (*Strepera graculina*). Other species primarily occur as passage migrants, such as the Rufous Fantail (*Rhipidura rufifrons*).

Widespread birds: Brown Thornbill (left); Noisy Miner (centre); Superb Fairy-wren (right). © M. Schulz

In contrast to the typical open forest/woodland vegetation communities with a grassy understorey, small sections of open forest with a closed forest subcanopy occur in deeper gullies coming off the north side of the Broken Back Range. These gullies supported small populations of a number of wet forest birds not seen elsewhere within the reserves, such as the Brown Cuckoo-Dove (*Macropygia*

amboinensis), Brown Gerygone (*Gerygone mouki*) and the Black-faced Monarch (*Monarcha melanopsis*). It is likely that sporadic visits by other as yet unrecorded wet forest bird species occur in these gullies, particularly when particular trees are in flower or fruit. For example, this may include wet forest species that occur to the south at the nearby Bow Wow Gorge, such as the Topknot Pigeon (*Lopholaimus antarcticus*) (Waterhouse 1975) and the White-headed Pigeon (*Columba leucomela*) (D. Connolly, DECC, pers. comm.).

Although the area supports a range of creeks and temporary wetland environments, the waterbird diversity is low compared to dams and other water storage facilities in surrounding cleared land. For example, species such as the Comb-crested Jacana (*Irediparra gallinacea*) and Black-necked Stork (*Ephippiorhynchus asiaticus*) have not been recorded. The majority of waterbirds present are in low numbers and occur sporadically, with the most common species being the Pacific Black Duck (*Anas superciliosa*), Australian Wood Duck (*Chenonetta jubata*) and the Masked Lapwing (*Vanellus miles*).

The diversity of shrub layer birds is generally patchy across much of the area due the typically open grassy nature of the vegetation, with regionally common species, such as the Variegated Fairy-wren (*Malurus lamberti*), Superb Fairy-wren (*M. cyaneus*) and the White-browed Scrubwren (*Sericornis frontalis*) being overall uncommon in the reserves. However, surprisingly the regionally uncommon Chestnut-rumped Heathwren (*Calamanthus pyrrhopygia*) was encountered at several locations in Sandstone Hills Bloodwood Woodland with a scattered shrub layer in the SCA in the 2008 DECC survey.

3.3 NOCTURNAL BIRDS

Ten nocturnal bird species have been recorded within the two reserves, including two waterbirds, the Black Bittern (*Ixobrychus flavicollis*) and the Nankeen Night Heron (*Nycticorax caledonicus*) (Appendix C). Both of these waterbird species were uncommon in the study area, with only a single record of the former species from the edge of Saltwater Creek in Werakata NP.

Three species were widespread and regularly recorded during the DECC surveys; the Southern Boobook (*Ninox boobook*), Tawny Frogmouth (*Podargus strigoides*) and the Australian Owlet-nightjar (*Aegotheles cristatus*). The White-throated Nightjar (*Eurostopodus mystacalis*) appeared widespread in the SCA on ridges and spurlines, particularly in Sandstone Hills Bloodwood Woodland. It has not been recorded from the NP but is likely to occur on ridges and spurlines such as around Mount Tomalpin. Three other species appeared uncommon and limited in distribution within the study area; the Barking Owl, Powerful Owl and the Masked Owl. Further work is required to determine the population size, habitat preferences and whether these species breed within the reserves. An additional species not recorded in the DECC surveys; the Barn Owl (*Tyto alba*) has been recorded on the interface between cleared and forested country on the edge of the NP. It is also likely to occur sporadically on the edges of the SCA.

Nocturnal birds present within the reserves: Tawny Frogmouth. © M. Schulz (left); Masked Owl. © R. Jackson (centre); White-throated Nightjar chick. © M. Schulz/DECC (right)

3.4 ARBOREAL MAMMALS

Seven arboreal mammal species have been recorded from the two reserves (Appendix C). Systematic DECC survey results indicated that larger possums were primarily in low densities across the area. The low densities of the Common Brushtail Possum (*Trichosurus vulpecula*) and the apparent restricted distribution of the Yellow-bellied Glider (*Petaurus australis*) to the Mount Tomalpin area in the NP and the northern section of the eastern block of the SCA is likely to be associated with the paucity of hollows as a result of past silvicultural practices. While the Common Ringtail Possum (*Pseudocheirus peregrinus*) was patchily distributed in small numbers possibly as a result of repeated fires that may be repressing populations of the species or alternatively the habitat present is only of secondary quality.

Most notable of the arboreal mammals are the relative abundance of the Feathertail Glider (*Acrobates pygmaeus*) and the Squirrel Glider (*Petaurus norfolcensis*). The former species is typically difficult to detect during spotlighting surveys, but within the two reserves was observed on a number of occasions. The Spotted Gum-Red Ironbark Forests of the reserves provides an extensive area of suitable habitat for the latter species. The Squirrel Glider was the most frequently recorded arboreal species in the NP (22% of survey sites); while surprisingly it was only recorded from a single site in the SCA. In contrast in the SCA, the Sugar Glider (*Petaurus breviceps*) was the most commonly recorded species. The reason for the apparent difference in dominant medium-sized glider species between the two reserves is unknown.

Evidence of habitat use by Koalas is sparse and limited to a small number of historical records. Our surveys were unable to confirm the presence of the species, although we concur with other documented conclusions that suggest suitable habitat may support a limited population in the area (Grenadier *et al*. 2001; HSO Ecology 2004).

Two species were noticeably absent from the reserves. The Greater Glider (*Petauroides volans*) is common in the Hunter Region in tall moist forests of the Watagan Ranges. However, the dry Spotted Gum-Ironbark dominated forests of the valley floor with a low density of large hollows within the reserves appeared to support unsuitable habitat. The Brush-tailed Phascogale (*Phascogale tapoatafa*) is known to prefer dry Spotted Gum-Ironbark forests found on coastal foothills and ranges. This threatened species is well known in such forests between Raymond Terrace and Dungog, with other records from the Singleton area (DECC 2008a). No evidence of the species has been found despite considerable survey effort in the Lower Hunter Valley over the last few years. Further targeted survey work within the reserves is required to confirm that this species is not present in the area. It may be that the shrubby forests of Werakata NP and SCA are unsuitable, when compared with the grassy Spotted Gum communities of the Barrington Foothills and the Central Hunter Valley.

3.5 BATS

East-coast Freetail-bat © N. Williams/ DECC

Fourteen species of bat have been recorded in the two reserves (Appendix C). An additional three species have been recorded adjacent to the reserves and may occur: the Large-footed Myotis (*Myotis adversus*), Greater Broad-nosed Bat (*Scoteanax rueppellii*) and the Inland Broad-nosed Bat (*Scotorepens balstoni*). Two species recorded within the reserves in the Atlas of NSW Wildlife but not located in the current surveys require confirmation: the Eastern Forest Bat (*Vespadelus pumilus*) in the SCA and the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) in the NP. The latter species was identified by analysis of ultrasonic calls at two locations within the middle section of the NP. Fauna surveys undertaken since 1998 have been unable to confirm the presence of this species. All confirmed records in the Lower Hunter and Central Coast are from moderate to higher elevations in the Watagan and associated ranges (HSO Ecology 2004). The calls of this species are similar to a number of microbat species, which also occur in the area (Pennay *et al.* 2004). Given the dry sclerophyll habitat surrounding the area where these records were recorded, it is likely they have been mis-identified (Glenn Hoye pers. comm., in Grenadier *et al.* 2001). An additional unconfirmed species was recorded from forest adjacent to the NP, the Greater Long-eared Bat (*Nyctophilus timoriensis*). There are few confirmed records of this species in the Lower Hunter region (N. Williams, pers. comm.) and the presence of this species in the area requires confirmation.

Similar to nectarivorous birds, flowering eucalypts within the reserves provide important foraging habitat for the Grey-headed Flying-fox (*Pteropus poliocephalus*). A related species, the Little Red Flying-fox *Pteropus scapulatus* is an irregular visitor, with numbers feeding in flowering Grey Gum in the SCA in February 2008. No flying-fox camps have been recorded within either reserve.

Two species of cave-dwelling bats occur within the reserves; the Little Bentwing-bat (*Miniopterus australis*) and the Eastern Bentwing-bat (*M. schreibersii oceanensis*). No roosts of these species have been recorded within either reserve.

The remaining bats comprise species that roost in trees, primarily utilising a variety of tree hollows. It is likely that the densities of many of these species is reduced due to past forestry practices resulting in a relative paucity of tree hollows in even-aged timber stands across the landscape. The most commonly recorded species across a range of vegetation communities was the Little Forest Bat (*Vespadelus vulturnus*). The distribution, abundance and habitat preferences of many of these tree-hole roosting bats is poorly known within the two reserves with either no or few records during the DECC surveys. Species in this category include the East-coast Freetail-bat (*Mormopterus norfolkensis*), Eastern Freetail-bat (*Mormopterus* sp. 2), Eastern Broad-nosed Bat (*Scotorepens orion*) and the Large Forest Bat (*Vespadelus darlingtoni*).

Examples of the diversity of bats occurring within the two reserves: Chocolate Wattled Bat (left); Grey-headed Flying-foxes flying into the SCA at dusk to feed on flowering eucalypts (centre); Gould's Long-eared Bat (right). © M. Schulz

3.6 NATIVE GROUND MAMMALS

The native ground mammals are probably the least understood group of native species within the two reserves since no broadscale trapping and hair tubing have been conducted. Instead records are the result of very limited Elliott trapping, predator scat analysis and hair tube sampling; with the majority of sightings the result of incidental observations. The diversity of native ground mammals was relatively low, with a total of 13 species recorded (Appendix C). Of these three species were not recorded in the DECC systematic surveys: Brown Antechinus (*Antechinus stuartii*), New Holland Mouse (*Pseudomys novaehollandiae*) and the Swamp Rat (*Rattus lutreolus*). In addition, one species that is very rare and poorly understood on the floor of the Hunter valley, the Spotted-tailed Quoll (*Dasyurus maculatus*) has been recorded adjacent to the SCA at Bellbird and Kitchener. It may occur as a rare visitor to the reserves.

The most obvious native ground mammals were the macropods; with the Swamp Wallaby (*Wallabia bicolor*) being the most commonly sighted species across the reserves. The Common Wallaroo (*Macropus robustus*) was primarily restricted to ridges, spurlines and slopes within the area, particularly in sections of the SCA on the slopes of the Broken Back Range and in the Mount Tomalpin area of the NP. The other two macropods were patchily distributed. The Eastern Grey Kangaroo (*M. giganteus*) tended to be restricted to the boundaries of the reserves adjacent to cleared pastureland areas, while few Red-necked Wallabies (*M. rufogriseus*) were observed with the majority of sightings in the Pelton Road section of the SCA.

Other larger ground mammals present include the Short-beaked Echidna (*Tachyglossus aculeatus*) and the Common Wombat (*Vombatus ursinus*). The former species was widespread but occurred in small numbers, with the majority of records based on distinctive tracks and diggings in colonial ant nests. While the Common Wombat appeared primarily restricted to the higher elevation areas of the Broken Back Range, particularly in higher-quality forests in the two eastern blocks of the SCA.

Two medium-sized ground mammals comprising the bandicoots appeared to be rare within the reserves. The Long-nosed Bandicoot (*Perameles nasuta*) was sparsely distributed, with most evidence of this species located during the DECC surveys from along a gully west of North Basin Road in the SCA. While the Northern Brown Bandicoot (*Isoodon macrourus*) was detected from fur collected in hair tubes on the edge of the Cessnock Racecourse in the SCA.

Examples of ground-dwelling mammals occurring within the reserves: Short-beaked Echidna (left); Common Wombat (centre); Yellow-footed Antechinus (right). © M. Schulz

The most commonly recorded small ground mammal species was the Yellow-footed Antechinus (*Antechinus flavipes*), which was trapped in a variety of forest types across the two reserves, including open forest with a riparian band of Grey Myrtle-dominated closed forest in the eastern block of the SCA. The Common Dunnart (*Sminthopsis murina*) was present in surprisingly large densities in the NP, with individuals found sheltering under dumped tin, under bark on the ground and inside a hollow log. This species, known to occur in heathy dry sclerophyll forest and mallee heath across its range, was found exclusively in Spotted Gum-Ironbark Forest within the NP. It is thought to benefit from periodic burning of its habitat and generally reaches highest densities two to four years following fire (Fox 1995). Surprisingly this species was far less frequently recorded during the systematic DECC surveys of the SCA. In contrast native rodents appeared uncommon within the reserves, with no individuals recorded during the current surveys. The New Holland Mouse (*Pseudomys novaehollandiae*) was trapped in two localities in the NP in open forest in close proximity to Kurri Sand *Melaleuca* Scrub Forest (Grenadier *et. al* 2001). It is thought that this species prefers dry heathland or open forest habitats regenerating from fire, and avoids areas that are completely protected from fire or burnt too frequently (Watts and Aslin 1981). The occurrence of this species in the reserve is significant given the nearest records are 20km to the south. The Water-rat (*Hydromys chrysogaster*) and the Swamp Rat (*Rattus lutreolus*) were recorded at only one location each within the northern

section of the NP. The Swamp Rat was trapped on several occasions in typical riparian vegetation habitat (Grenadier *et al.* 2001). The Water Rat was noted from tracks left at the water edge along Swamp Creek during the recent DECC surveys. It is often found around pools of water where it feeds on fish, yabbies, snails and frogs (Watts and Aslin 1981). Surprisingly, the Bush Rat (*Rattus fuscipes*) was notably absent from the species list for the reserves, even though suitable habitat exists. This rodent has been recorded within 5km of the reserves and its apparent absence may be an artefact of the limited amount of trapping conducted.

3.7 REPTILES

Twenty-seven species of reptile are known to occur in the two reserves, none of which are listed under the NSW TSC Act (1995) (Appendix C). Additionally, the Stephens' Banded Snake (*Hoplocephalus stephensii*) listed as vulnerable under the NSW TSC Act (1995) was recorded from an Australian Museum specimen, collected in 1989, which is noted to have a spatial accuracy of within 10km of the given grid reference. Although the grid reference locates this specimen in the southern section of the NP, it is unlikely to have actually been collected there. This species is typically found in wetter sclerophyll or rainforests (Cogger 1996), which are not substantially represented in the study area. The nearest records are located some 10km to the south east in Sugarloaf SCA (DECC 2008b) and over 10km to the south in the Watagans National Park and Olney State Forest (DECC 2008a).

The list of reptiles for Werakata NP and SCA is comprised of one species each of turtle, legless lizard and goanna, two geckoes, three dragons, 13 skinks and six species of snake (Appendix C). The diverse mix of species reflects the location of the reserves at the confluence of drier inland e.g. South-eastern Morethia Skink (*Morethia boulengeri*), northern e.g. Tussock Rainbow-skink (*Carlia vivax*) and moister coastal environments e.g. Bar-sided Skink *Eulamprus tenuis*).

These surveys detected 10 species which that had not previously been recorded in the two reserves. These species were the Eastern Stone Gecko (*Diplodactylus vittatus*), Thick-tailed Gecko (*Underwoodisaurus milii*), Burton's Snake-lizard (*Lialis burtonis*), Eastern Water Dragon (*Physignathus lesueurii*), Bearded Dragon (*Pogona barbata*), Cream-striped Skinning Skink (*Cryptoblepharus virgatus*), Tree Skink (*Egernia striolata*), Bar-sided Skink, Brown Tree Snake (*Boiga irregularis*) and Eastern Brown Snake (*Pseudonaja textilis*). While one species was not recorded during the DECC surveys of the two reserves but had been recorded previously. This species was the White's Rock-skink (*Egernia whitii*).

Three species of reptiles were found patchily distributed within the two reserves in association with waterbodies. The most frequently encountered species was the Eastern Water-skink (*Eulamprus quoyii*) which was regularly seen basking at the water's edge and in associated riparian vegetation. The two other species, the Eastern Water Dragon and the Eastern Snake-necked Turtle (*Chelodina longicollis*), were uncommon and observed much less frequently. All these species are common throughout the region and the latter is often seen on roads when moving between farm dams and watercourses.

Examples of reptiles occurring within the reserves: Eastern Stone Gecko (left); Common Tree Snake (centre); Tree Skink (right). © M. Schulz

The most diverse group of reptiles were the skinks, with the most frequently detected species across the reserves being the Copper-tailed Ctenotus (*Ctenotus taeniolatus*). The Southern Rainbow-skink (*Carlia tetradactyla*), also frequently recorded, appears to be restricted to the southern section of the NP and across much of the SCA. This surface-active skink is found commonly west of the Great Divide and frequently throughout the Hunter Valley, preferring dry forests and woodland habitats (Swan *et al.* 2004). The Tussock Rainbow-skink was found at three locations in the NP. The records obtained during recent DECC surveys in Werakata and Northern Yengo NP (DEC 2005d) constitute the most southerly locations known. The nearest known populations occur in the Taree and Gunnedah

areas (DECC 2008a). This disjunct population may vary genetically from the northern populations and should be further investigated. The two *Carlia* species demonstrated signs of habitat partitioning in Northern Yengo NP (DEC 2005d), but in Werakata NP both were found on the same site.

Less frequently encountered litter dwelling skinks included the Robust Ctenotus (*Ctenotus robustus*), Dark-flecked Garden Sunskink (*Lampropholis delicata*), Pale-flecked Garden Sunskink (*L. Guichenoti*), South-eastern Morethia Skink and the Eastern Blue-tongue (*Tiliqua scincoides*). The South-eastern Morethia Skink is often found in dry environments west of the Great Divide and throughout the Hunter Valley. This skink was found at two locations within the NP and one location in the SCA during the recent DECC surveys.

Tussock Rainbow-skink © N. Williams/ DECC

Three species of largely tree-dwelling skinks were also recorded. The Bar-sided Skink was only recorded in the SCA in a range of habitats, primarily at the entrance of or adjacent to tree hollows and crevices. The Tree Skink, a species typical of western NSW is found throughout the Hunter Valley associated with dry forest and open woodlands. It has been recorded in both reserves, primarily in grassy woodland/open forest habitat, such as in Lower Hunter Spotted Gum-Ironbark Forest. The Cream-striped Shinning-skink, often seen on stags or old logs, was infrequently encountered during the surveys.

The second-most diverse group of lizards were the dragons, with the Jacky Lashtail (*Amphibolurus muricatus*) the most commonly recorded. In contrast, the Eastern Bearded Dragon (*Pogona barbata*) was found along the edge of the two reserves adjoining cleared land. This species is typically seen on stumps and fence posts in or on the edge of open paddocks.

All species within the remaining lizard groups were uncommon in the two reserves. For example, there was only a single record of Burton's Snake-lizard from the SCA and less than five records of the Eastern Stone Gecko, Thick-tailed Gecko and Lace Monitor (*Varanus varius*). The last species is a habitat generalist that forages across a large home range and requires large rock crevices or hollow trees and logs as sheltering sites. The low abundance of goannas throughout the study area was notable and is likely to be a reflection of the lack of suitable shelter. The young age of the forest means that few large hollows have had time to develop. Frequent fires through the area have also reduced the number of available logs on the ground.

Six species of snake were detected in the two reserves, with two species only recorded from the SCA (the Brown Tree Snake and Eastern Brown Snake). The former species appeared common in the roofs of houses and around outbuildings on private land adjacent to the eastern section of the SCA. The most frequently encountered species during the DECC surveys was the Red-bellied Black Snake (*Pseudechis porphyriacus*). Interestingly no blind snakes were encountered during the DECC surveys, despite extensive rain prior to surveys of the two reserves. These harmless snakes are most often encountered under surface debris following heavy and/or prolonged rain events.

During the recent DECC surveys it was noted that a large number of reptiles were found sheltering under an assortment of rubbish dumped throughout the park. In the absence of any natural ground shelter these species are making use of the alternative resource (also noted by Grenadier *et al.* 2001). Often flat pieces of corrugated iron and section of dumped car bodies are used preferentially by reptiles' even when natural shelter is available. Removal of extensive amounts of suitable supplementary habitat, in the absence of any natural alternative, is likely to have important implications for the survival of a number of these species.

3.8 FROGS

The two reserves support a diverse and abundant frog fauna, particularly in lower lying swampy areas. In all, 15 species are known to occur (Appendix C), none of which are listed under the NSW TSC Act (1995). All of the species present in the reserves are typically associated with slower moving waterways, occurring on flat land with chain-of-ponds hydrology. The abundance of frogs was highlighted in an inundated area where several hundred individuals comprising 10 species were recorded in the western block of Werakata SCA on a rainy night in February 2008.

These surveys located one species, Tyler's Tree Frog (*Litoria tyleri*), which that had not previously been recorded in the two reserves. While four species were not detected during the DECC surveys of the two reserves but had been recorded previously. These species were the Ornate Burrowing Frog (*Limnodynastes ornatus*), Bibron's Toadlet (*Pseudophryne bibronii*), Red-backed Toadlet (*P. coriacea*) and Verreaux's Frog (*Litoria verreauxii*). The Ornate Burrowing Frog was recorded in low numbers in the NP, primarily in a range of habitats with a typically sandy substrate present. Being a burrowing species, it is most often detected after rain or on hot humid nights. It was only recorded in the middle section of Werakata NP with no records from the SCA.

Bibron's Toadlet © M. Schulz

The Bibron's Toadlet is considered to be declining in the Sydney Basin and is a species of conservation concern (DECC 2007b). It has been recorded twice in Werakata NP close to gully lines in the northern and middle sections. Of interest is that both subspecies of the Eastern Banjo Frog (*Limnodynastes dumerilii dumerilii* and *L. d. grayi*) have been recorded calling from the same inundated areas in the two reserves. It is uncommon to record both subspecies sympatrically in the same wetlands within the Sydney Basin Bioregion.

Other species of frog recorded within 5km of the study area, include the Green-thighed Frog (*Litoria brevipalmata*), which is listed as vulnerable under the NSW TSC Act (1995). This frog has been recorded twice within 2km of the park boundary along two unnamed creeklines east of Mount Tomalpin during surveys in the Hunter Economic Zone in March 2002 (Grenadier *et al.* 2002). Marginal habitat for this species, moist creeklines and riparian vegetation, is present within the middle section of the NP and in the eastern blocks of the SCA. Recent systematic DECC surveys were unable to verify its presence. However, this species is notoriously difficult to detect, as it is primarily located during or immediately after prolonged and/or heavy rainfall events in the summer months.

Examples of frogs occurring within the reserves: Broad-palmed frog (left); Ornate Burrowing Frog (centre); Dusky Toadlet (right). © M. Schulz

3.9 INTRODUCED SPECIES

The Hunter Valley in the Cessnock LGA has long been a rural landscape. As a result, introduced species have occurred in the area for a considerable time, proliferating from urban and rural settlements and expanding as native landscapes change into cleared and fragmented vegetation cover. The two reserves form part of the current landscape that mixes contiguous vegetation cover with cleared land. Feral animals use these habitats widely, although some have more specialised habitat requirements than others.

Sixteen introduced species, comprising 11 mammal and five bird species were recorded in the two reserves (DECC 2008a; Appendix C; Maps 5, 6 and 7). Introduced predators are of particular concern because of the impact they have on native wildlife. Additionally, due to the reserves being located in close proximity to houses and adjacent to major towns such as Cessnock wide-ranging domestic cats and dogs are also likely to pose a major threat to wildlife. Domestic dogs were commonly encountered being exercised off-leash within the SCA during the 2008 survey.

The most common feral mammals detected were the Rabbit (*Oryctolagus cuniculus*), Wild/Domestic Dog (*Canis lupus*) and Fox (*Vulpes vulpes*). Rabbits were prevalent in well grassed habitats adjacent to farming lands and alluvial soils where food sources are plentiful and soils are deep enough for

burrowing (Map 6). Feral Rabbits impact negatively on indigenous species via competition for resources, alteration of the structure and composition of vegetation, and land degradation (NSW Scientific Committee 2002a). Competition and land degradation by feral rabbits is listed as a Key Threatening Process on the Commonwealth EPBC Act (1999). The last two species were recorded in a wide range of vegetation communities found in the reserve and are known from adjoining cleared environments where they are more easily seen (Map 5). Predation by the Fox is listed as a Key Threatening Process under the NSW TSC Act (1995) and as a result a Threat Abatement Plan (TAP) has been prepared (NPWS 2001a). 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. Fox predation has been implicated in limiting the habitat choice and population size of a number of medium-sized marsupials (NSW Scientific Committee 1998a). As a result of heavy rainfall prior to the surveys of the two reserves few Feral Dog and Fox scats were located. Therefore, only a limited number of scats were investigated to determine the range of mammalian species being targeted by these introduced predators. For example, two Fox scats collected in the SCA contained hair of the Swamp Wallaby and insect remains respectively.

Other introduced predators occurring within the two reserves were the Feral Cat (*Felis catus*), Brown Rat (*Rattus norvegicus*) and Black Rat (*R. rattus) (*Map 5). The impact of the last two species on biodiversity values in the reserves is unknown. Feral Cats are extremely cryptic and are likely to be widespread across both reserves (Map 5). Feral Cats threaten native fauna by direct predation, particularly targeting ground and shrub-dwelling species. This species is recognised as a Key Threatening Process under the NSW TSC Act (1995) as it is carnivorous and capable of killing vertebrates up to three kilograms. Preference is shown for mammals weighing less than 220 grams and birds less than 200 grams, but reptiles and amphibians are also eaten (NSW Scientific Committee 2000a).

Other introduced mammals present included the House Mouse (*Mus musculus*), Brown Hare (*Lepus capensis*), Feral Horse (*Equus caballus*), Feral Goat (*Capra hircus*) and Fallow Deer (*Dama dama*) (Map 6). Additionally, evidence of an unidentified deer species was recorded on the northern boundary of the western block of the SCA west of Bellbird. All of these species appear to be either uncommon or restricted in distribution within the two reserves.

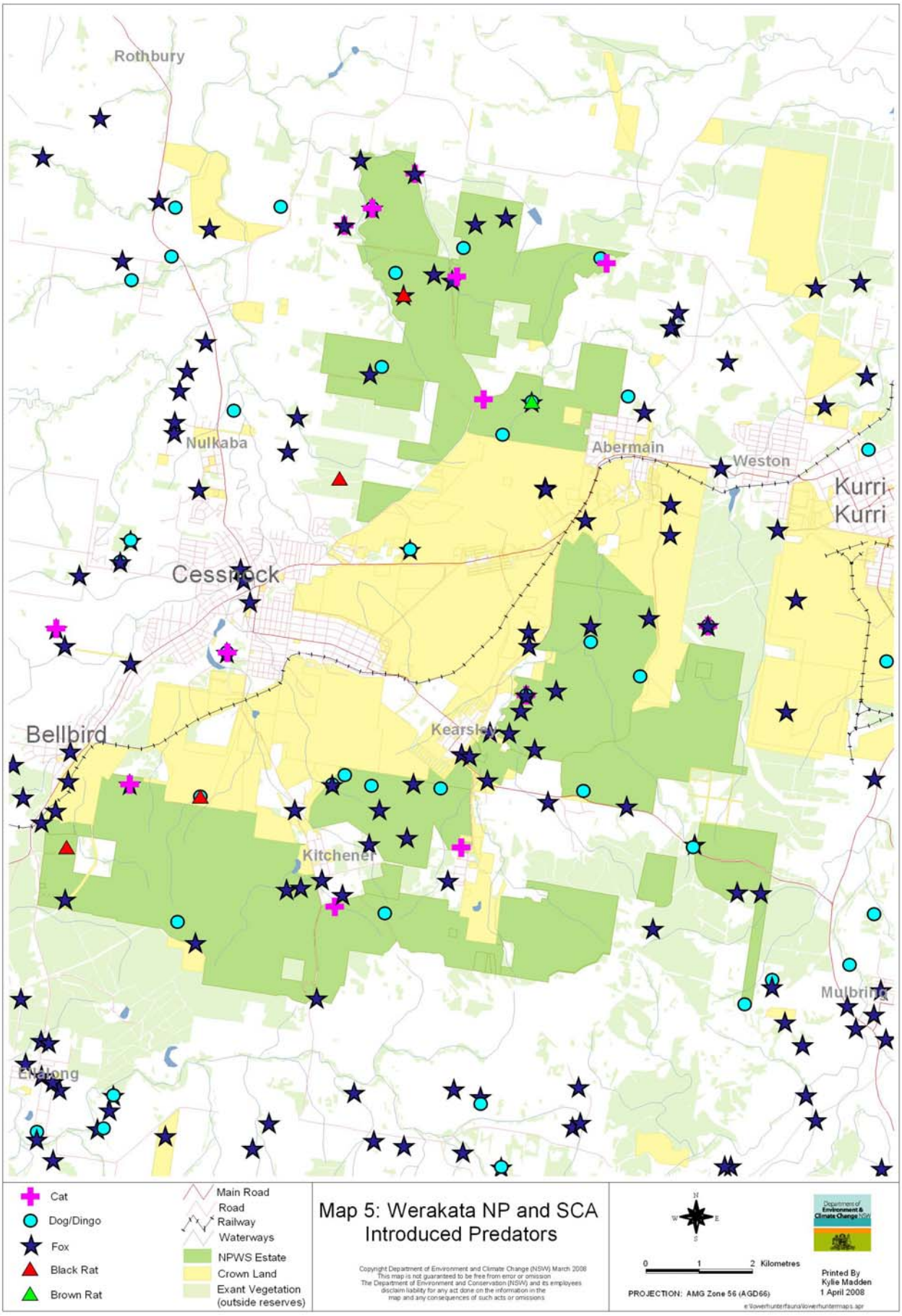
Introduced bird species were uncommon and confined to the edges of the reserves (Map 7). Expansion of aggressive introduced species, particularly the Common Myna (*Acridotheres tristis*) and Common Starling (*Sturnus vulgaris*) may potentially compete with native hollow-nesting bird and mammal species. The other three introduced species, the Mallard (*Anas platyrhynchos*), Spotted Turtle-Dove (*Streptopelia chinensis*) and the House Sparrow (*Passer domesticus*) were extremely limited in occurrence and are unlikely to significantly impact on biodiversity values.

Examples of feral species occurring within the reserves: Common Myna © M. Schulz (left); Fox © N. Williams (centre); Brown Hare © M. Schulz (right).

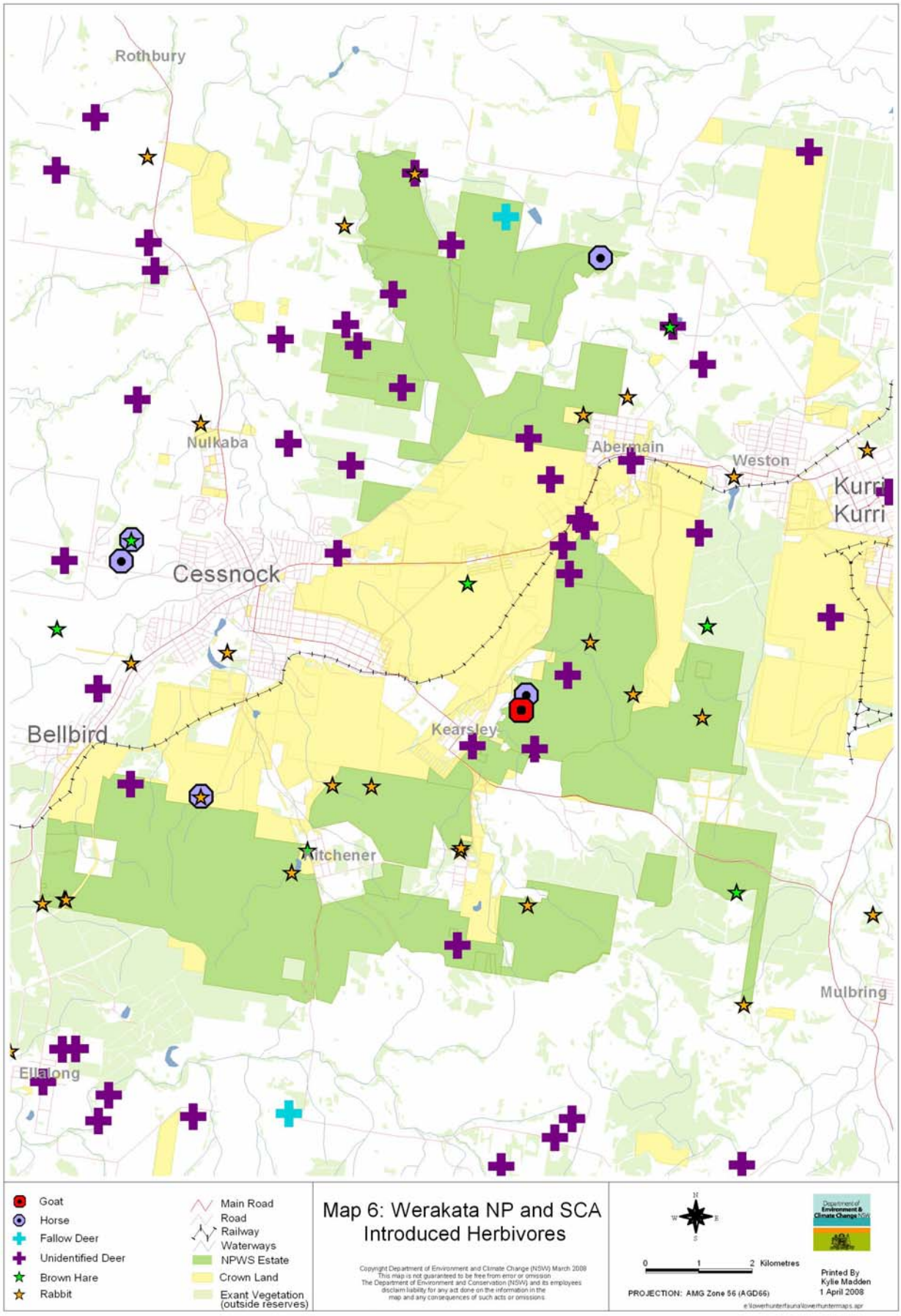
Two other feral species that are likely to impact on the native fauna values in the two reserves are the Feral Honeybee (*Apis mellifera*) and Plague Minnow (*Gambusia holbrooki*). Both species are listed as key threatening processes under the NSW Threatened Species Act (1995) (DECC 2005). Feral Honeybees were encountered occupying a number of hollows in Red Ironbark and Grey Gum on the edge of the SCA. These bees are likely to occur across both reserves and compete with native hollow-dwelling fauna, such as various bat and glider species. Additionally, they have an unknown impact through competition for floral resources such as nectar and pollen with threatened species, such as the endangered Regent Honeyeater and Swift Parrot. While the Plague Minnow was recorded at the lake on the southwest edge of Kitchener on the northern edge of the SCA (Map 7). These fish predate on the eggs and tadpoles of a variety of frog species and have been attributed to

the decline of various species in the Sydney Basin Bioregion, such as the now endangered Green and Golden Bell Frog (*Litoria aurea*). This frog may have formerly occurred in the two reserves as they are located between the main component of the Middle Hunter Green and Golden Bell Frog Key Population in the Wentworth Swamp area between Maitland and Kurri Kurri and an outlying population in the Ellalong area (DECC 2007c).

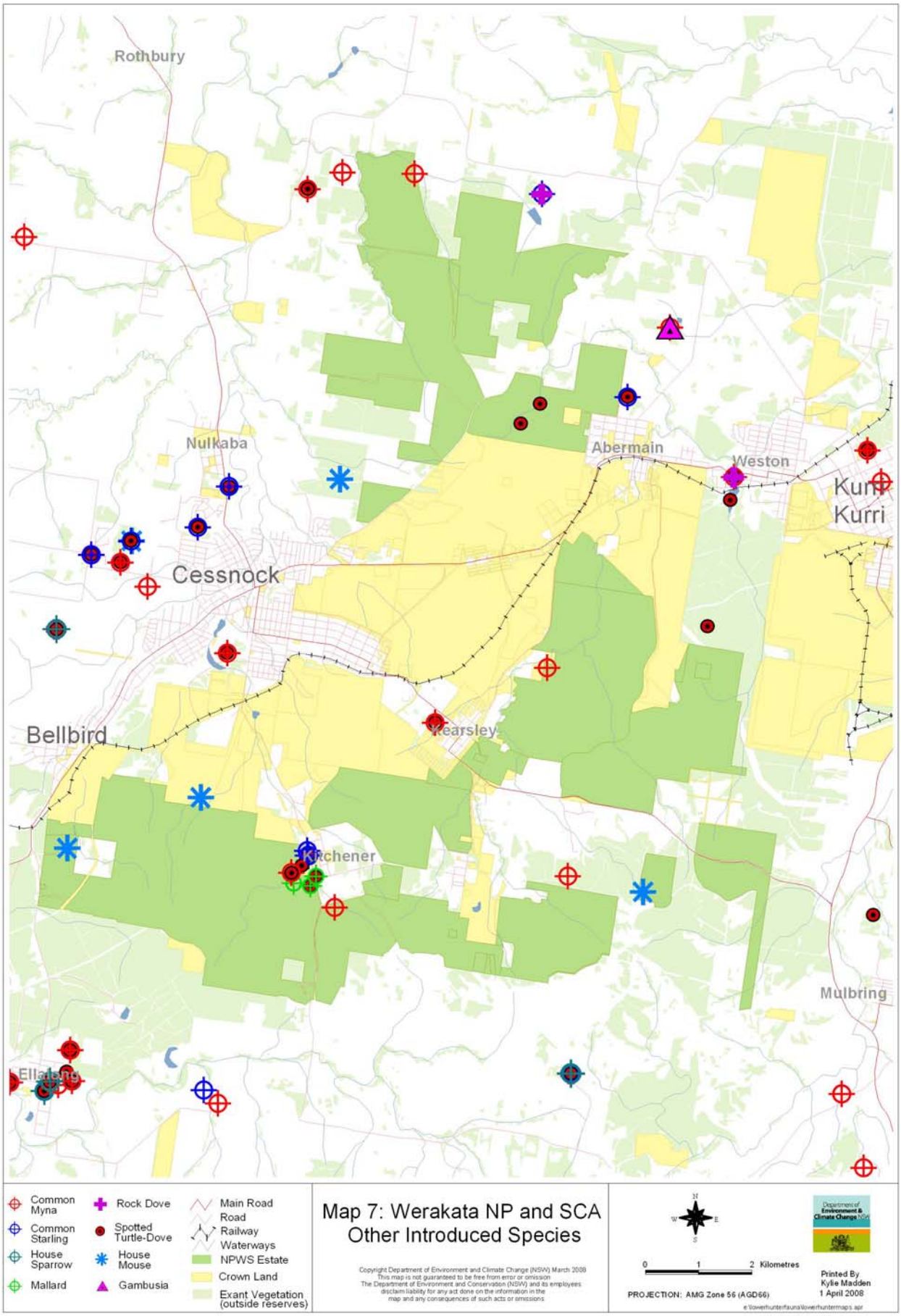
The Green and Golden Bell Frog may formerly have occurred in swamps within the reserves. © M. Schulz



Map 5: Werakata NP and SCA Introduced Predators



Map 6: Werakata NP and SCA Introduced Herbivores



Map 7: Werakata NP and SCA Other Introduced Species

4 PRIORITIES FOR FAUNA CONSERVATION AND MANAGEMENT

4.1 THREATENED SPECIES CONSERVATION MANAGEMENT PRIORITIES

Land managers are faced with an ominous list of threatened fauna species. However, not all threatened species warrant equivalent management efforts in the Werakata NP and SCA. There are a number of threatened species within these reserves which at this stage do not require any targeted management, and others that require specific management, further survey and/or monitoring to be undertaken in order to increase their chances of long term survival.

Table 4 lists all of the threatened species currently known to occur in the two reserves, with a rating of their priority for conservation management. These ratings are derived from expert knowledge rather than quantitative assessment, and will require review and revision in the future when comprehensive information on the regional conservation status of each species becomes available. The ratings are defined as follows.

Highest: Species that are likely to become extinct from the reserves in the short to medium term without action, and/or for which the study area plays a crucial role in the regional conservation of the species. These species require management at site by site level.

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

Moderate: Species for which the study area does not support a significant amount of habitat to that reserved elsewhere in the region. Specific management actions are not currently required for these species within the reserves. However, pressures on the species elsewhere in the region, or the emergence of threats within the reserve may require more active management in the future.

Lower: Species for which habitat is widespread within the reserves and are EITHER well-represented in the regional reserve system OR species that are present: a) in low numbers; b) utilise the reserves for foraging but are not known to roost within it (i.e. Grey-headed Flying-fox); c) occur as irregular visitors in varying numbers (such as following flowering events of key eucalypt species) or d) only occur as vagrants. All these species are better represented elsewhere in the regional reserve system. These species do not require any specific management in the reserves at this stage, other than ongoing protection of important habitat features such as mature hollow-bearing trees.

Table 4: Threatened fauna species confidently recorded within Werakata NP and SCA, their relative management priority, key locations and potential threats

Priority for Management in the Reserves	Species	Number of Confirmed Records in the Reserves	Key Locations in the Reserves	Potential Key Threats in the Reserves	Significance of the Reserves to Regional Conservation of the Species
Highest Management Priority					
Require targeted management at a reserve level	Regent Honeyeater	5	Large sections of both reserves supporting flowering eucalypts, particularly ironbark species, Spotted Gum and Grey Gum. May potentially nest in the reserves but such locations are difficult to predict and are dependent on flowering events.	Fires (including hazard reduction burns) impacting foraging habitat: areas of flowering eucalypts (particularly ironbarks, Spotted Gum and Grey Gum) and potential nesting habitat; competition of nectar/pollen from the Feral Honeybees.	High (sporadic visitor depending on flowering events within reserves compared to elsewhere within the species' distribution)
	Swift Parrot	8	Large sections of both reserves supporting late autumn, winter and early spring flowering eucalypts, particularly ironbark species, Spotted Gum and Grey Gum.	As for the Regent Honeyeater but not nesting in the area.	High (sporadic visitor depending on flowering events within reserves compared to elsewhere within the species' winter distribution)
High Management Priority					
Require further survey and/or management of key habitats and key threats	Square-tailed Kite	1	Unknown; further targeted surveys are required to identify key locations and habitats within the two reserves in late spring/early summer.	Unknown; potentially disturbance of nest trees; fire intensity and frequency impacting on nest trees.	Unknown
	Barking Owl	2	Poorly understood due to paucity of records, with single records from the far southwest corner of the SCA and the northern edge of the NP.	Low density of hollow-bearing trees due to historical forestry practices and current collection of dead trees for firewood; fire intensity and frequency impacting on current and future hollow availability; collisions with vehicles and barbwire fences; competition of hollows with introduced birds and Feral Honeybee.	Moderate

Priority for Management in the Reserves	Species	Number of Confirmed Records in the Reserves	Key Locations in the Reserves	Potential Key Threats in the Reserves	Significance of the Reserves to Regional Conservation of the Species
	Masked Owl	2	Not well understood but likely to occur sporadically in a variety of habitats across much of the two reserves.	As for Barking Owl; additionally fire regimes that promote a dense shrubby understorey.	Unknown
	Brown Treecreeper	5	Patchily distributed, with birds absent from large sections of both reserves supporting potentially suitable habitat (i.e. vegetation communities comprising grassy woodland/open forest).	Frequent burning resulting in the loss understorey, leaf litter, fallen timber and dead trees; low density of hollow-bearing trees due to historical forestry practices and current collection of dead trees and fallen timber for firewood; potential competition for hollows from the Common Starling, Common Myna or Feral Honeybee; grazing by introduced herbivores.	High
	Speckled Warbler	4	As for Brown Treecreeper.	Frequent burning resulting in the loss understorey, leaf litter, fallen timber; predation by Foxes and cats; grazing by livestock and feral herbivores; exotic perennial grass invasion.	Moderate
	Black-chinned Honeyeater	19	Large sections of both reserves supporting flowering eucalypts, particularly ironbark species, Spotted Gum and Grey Gum.	Fires (including hazard reduction burns) impacting foraging habitat: areas of flowering eucalypts (particularly ironbarks, Spotted Gum and Grey Gum); competition of nectar/pollen from the Feral Honeybee.	High
	Grey-crowned Babbler	5	Edges of reserves supporting complex of fallen timber and scattered shrubs in grassy woodland/open forest.	As for Speckled Warbler.	Moderate

Priority for Management in the Reserves	Species	Number of Confirmed Records in the Reserves	Key Locations in the Reserves	Potential Key Threats in the Reserves	Significance of the Reserves to Regional Conservation of the Species
	Squirrel Glider	9	Open forest/woodland dominated by ironbarks and Spotted Gum; potentially occurring throughout much of both reserves.	Low density of hollow-bearing trees due to historical forestry practices and current collection of dead trees for firewood; fire intensity and frequency impacting on current and future hollow availability; entanglement in barbwire fences; competition of hollows with introduced birds and feral Honeybees; ; competition of nectar/pollen from the Feral Honeybees; predation by Foxes and cats.	High
	East-coast Freetail-bat	1	Unknown; further targeted surveys are required to identify key locations and habitats within the two reserves in late spring and summer.	Unknown; potentially low density of hollow-bearing trees due to historical forestry practices and current collection of dead trees for firewood; fire intensity and frequency impacting on current and future hollow availability; competition of hollows with introduced birds and Feral Honeybee.	Unknown
Moderate Management Priority					
Require management of key habitats and key threats	Black Bittern	1	Only recorded from riparian vegetation along Saltwater creek in Werakata NP.	Unknown, potentially water quality, predation by Foxes; and watercourses impacted by subsidence as a result of longwall mining.	Low
	Yellow-bellied Glider	15	Confined to taller open forests particularly in areas of higher fertility, such as in the Mount Tomalpin area and north of Lake Road in the eastern block of the SCA.	As for Squirrel Glider.	Moderate

Priority for Management in the Reserves	Species	Number of Confirmed Records in the Reserves	Key Locations in the Reserves	Potential Key Threats in the Reserves	Significance of the Reserves to Regional Conservation of the Species
Lower Management Priority					
Do not currently require management actions	Gang-gang Cockatoo	4	Occasional visitor in a variety of vegetation communities; predominantly during the non-breeding season.	None identified.	Low
	Glossy Black-cockatoo	4	Uncommon, restricted to vegetation communities supporting stands of *Allocasuarina*, particularly in the eastern blocks of the SCA.	Low density of hollow-bearing trees due to historical forestry practices; loss of foraging habitat as a result of fire (i.e. stands of *Allocasuarina*).	Low
	Powerful Owl	3	Sparsely distributed; mainly in areas with a relative abundance of hollows and high arboreal possum density.	As for Barking Owl.	Low
	Hooded Robin	1	Currently a vagrant species to the local area.	None identified.	Low
	Koala	3	Few records; status uncertain. Likely to occur in vegetation communities with Grey Gums or Forest Red Gums present.	Unknown, potentially disturbance by fire, predation by dogs; collisions with cars.	Low
	Grey-headed Flying-fox	23	Both reserves provide extensive areas of prime feeding habitat, including forests and woodlands with Spotted Gum, ironbark species, Grey Gum and Forest Red Gum.	Fires (including hazard reduction burns) impacting foraging habitat: areas of flowering eucalypts (particularly ironbarks, Spotted Gum and Grey Gum); entanglement in barbwire fences; competition of nectar/pollen from the Feral Honeybee.	High (foraging habitat, no roosts present)
	Little Bentwing-bat	4	Poorly known, probably widespread in variety of vegetation communities across the reserves.	None identified, as no roosts occur within the two reserves.	Moderate (foraging habitat, no roosts present)
	Eastern Bentwing-bat	2	Poorly known, possibly widespread in variety of vegetation communities across the reserves.	None identified, as no roosts occur within the two reserves.	Low (foraging habitat, no roosts present)

4.2 THREATENING PROCESSES

A number of Key Threatening Processes (KTPs), as identified under state and federal legislation, act within the study area. Table 5 summarises the KTPs that are considered to occur within the study area, including threats that are currently likely to be having a significant impact on native fauna (shaded red), threats that are restricted in extent or which are not well understood in the study area (shaded pink) and threats that may arise in the future (shaded orange). Also listed are the threatened fauna species that still occur in the study area and that are likely to be impacted upon by these processes. At present, probably the most significant threat key threatening processes are the loss of hollow-bearing trees, the removal of dead trees and fallen timber for firewood and the ecological consequences of high fire frequencies. The consequences of the loss of hollow-bearing trees and the removal of dead wood and dead trees have already impacted on the study area due to past forestry operations, and potentially contributed to the current absence or rarity of some species such as the Turquoise Parrot (*Neophema pulchella*) and Hooded Robin. The impacts of other key threatening processes are not well known, such as the infection of frogs by Chytrid fungus, competition for hollows by the Feral Honeybee and the presence of beak and feather disease affecting parrot species.

Additional threatening processes identified as potentially impacting on threatened species within the two reserves are outlined in Table 6.

The Bearded Dragon is primarily restricted to the edges of the reserve where the forest abuts cleared farmland. © M. Schulz/DECC

Table 5: Key Threatening Processes acting within Werakata NP and SCA and the threatened fauna species affected by each.

Threatened Species	Loss of hollow-bearing trees	Removal of dead wood and dead trees	Ecological consequences of high-frequency fires	Predation by the European Red Fox	Predation by Feral Cats	Predation by the Plague Minnow (*Gambusia holbrooki*)	Invasion of native plant communities by exotic perennial grasses	Invasion, establishment and spread of *Lantana camara*	Herbivory and environmental degradation caused by Feral Deer	Competition from Feral Honeybees	Competition and grazing by the feral European Rabbit	Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations	Infection of frogs by amphibian Chytrid causing the disease chytridiomycosis	Alteration to habitat following subsidence due to longwall mining
Key current locations of threat and areas to target for abatement/management	Occurrence is widespread. This threatening process will reduce over time due to the cessation of the loss of tree hollows due to forest harvesting activities.	Occurrence is widespread. This threatening process will reduce over time due to the cessation of forest harvesting activities and curtailment of firewood collecting.	Entire NP and SCA at risk.	Occurrence is widespread but at comparatively low densities. Successful abatement will require a reserve-wide approach with cooperation from neighbouring landholders as this species is widespread and common in surrounding areas (Map 5).	Distribution is poorly known but probably widespread.	Extent unknown, but may potentially impact on regionally declining frog species.	The invasion of perennial grasses from adjacent agricultural lands and powerline easements has an unknown impact on ground fauna in the reserves.	Small occurrences are confined predominantly to gullies and lower slopes in the eastern section of the SCA.	Predominantly in sections of Werakata NP.	Extent unknown. Several hives present in tree hollows in the western section of Werakata SCA bordering cleared land.	Generally edges of the reserve on deeper more fertile soils.	Extent unknown, but threatened species such as the Swift Parrot may potentially be impacted.	Extent unknown.	Impact unknown, but wetland and riparian species may be adversely impacted.
Black Bittern				X	X									X
Square-tailed Kite			X											X
Glossy Black-cockatoo	X	X	X							X		X		
Gang-gang Cockatoo	X	X	X							X		X		
Swift Parrot			X							X		X		

Threatened Species	Loss of hollow-bearing trees	Removal of dead wood and dead trees	Ecological consequences of high-frequency fires	Predation by the European Red Fox	Predation by Feral Cats	Predation by the Plague Minnow (*Gambusia holbrooki*)	Invasion of native plant communities by exotic perennial grasses	Invasion, establishment and spread of *Lantana camara*	Herbivory and environmental degradation caused by Feral Deer	Competition from Feral Honeybees	Competition and grazing by the feral European Rabbit	Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations	Infection of frogs by amphibian Chytrid causing the disease chytridiomycosis	Alteration to habitat following subsidence due to longwall mining
Brown Treecreeper	X	X	X	X	X		X	X	X	X	X			
Speckled Warbler		X	X	X	X		X	X	X		X			
Regent Honeyeater			X								X			
Black-chinned Honeyeater			X								X			
Grey-crowned Babbler		X	X	X	X			X	X		X			
Hooded Robin		X	X	X	X		X	X	X		X			
Barking Owl	X	X	X					X		X				
Powerful Owl	X	X	X	X						X				
Masked Owl	X	X	X					X		X				
Koala			X	X										
Yellow-bellied Glider	X	X	X	X	X					X				
Squirrel Glider	X	X	X	X	X					X				
Grey-headed Flying-fox (*no camps present)*			X											X
East-coast Freetail-bat	X	X	X							X				
Little Bentwing-bat (*no camps present)*														
Eastern Bentwing-bat (*no camps present)*														

Table 6: Other threatening processes acting in Werakata NP and SCA

Process	Threatened species potentially affected	Key locations of threat to native fauna
Motorbikes and 4WD vehicles	All species	Throughout the two reserves, leading to erosion, rubbish dumping, collection of firewood, vandalism, acts of vandalism, exercising dogs, and road mortality.
Commercial Honeybees	Regent Honeyeater, Swift Parrot, Black-chinned Honeyeater, Yellow-bellied Glider, Squirrel Glider, Grey-headed Flying-fox	In addition to Feral Honeybees being a problem, bees from commercial hives located within or adjacent to the reserves may result in competition for flower resources across the two reserves.
Hollow competition from introduced birds	Hollow-dependent species	Primarily restricted to the edges of parts of the two reserves where the Common Myna and Common Starling occur.
Predation by wide-ranging domestic cats	Most species	Sections of the reserves adjacent to settlements.
Predation by domestic and feral dogs	Koala	Widespread. There appears to be few wild dogs within the reserves. However, these areas are commonly used to exercise dogs off-leash; in addition to free-ranging domestic dogs that range into the reserves.
Reduction in water quality	Black Bittern	Various watercourses.
Entanglement in barbed wire fences	Barking Owl, Powerful Owl, Yellow-bellied Glider, Squirrel Glider, Grey-headed Flying-fox	Barbed wire fences exist along the perimeter of much of both reserves, with some old fence lines within the reserves.
Entanglement in powerlines	Grey-headed Flying-fox	Roads fringing the reserves, such as in Kitchener.
Road mortality	Barking Owl, Powerful Owl, Masked Owl, Koala	Larger roads that traverse or adjoin the two reserves, such as Lake Road.
Very high intensity fire/canopy fire	All species	Anywhere in the two reserves.
The disease *Chlamydia*	Koala	The incidence of this disease in individuals frequenting the reserves is unknown. However, it is likely that only old or sick individuals would succumb.
Livestock grazing	Brown Treecreeper, Speckled Warbler, Grey-crowned Babbler	Some grazing of the thin band of the eastern block of Werakata SCA is currently occurring. Such grazing is resulting in an opening up and thinning of the ground and shrub layer vegetation in this area.
Pacific Black Duck hybridisation	Wetland areas	Wetlands where Mallards occur may result in the hybridisation with the native Pacific Black Duck e.g. wetland on southwest edge of Kitchener.

Remains of a Grey-headed Flying-fox entangled on a barbwire fence. © M. Schulz

4.3 KEY THREATENING PROCESS MANAGEMENT

4.3.1 Key Threatening Processes Significantly Impacting Fauna Values

Three key threatening processes were identified in Section 4.2 as having a significant impact on native fauna within the reserves: 1) loss of hollow-bearing trees, 2) removal of dead wood and dead trees, and 3) ecological consequences of high-frequency fires.

Loss of Hollow-bearing Trees

Strategies to reduce the impacts on fauna values of the loss of hollow-bearing trees include:

- Site any potential infrastructure, such as picnic areas and toilet facilities away from hollow-bearing trees.
- Identify strategic road and track closures to protect stands of hollow-bearing trees from potential acts of arson and vandalism.

Removal of Dead Wood and Dead Trees

Strategies to reduce the impacts on fauna values of the removal of dead wood and dead trees include:

- Identify strategic road and track closures to reduce and restrict the incidence of the taking of dead trees and fallen timber for firewood.

Ecological Consequences of High-frequency Fires

Fire, both as a result of wildfires and prescribed burns, is a major factor associated with all three key threatening processes identified as having a significant impact on fauna in the reserves. Some wildfires within the reserves are the result of arson, including the setting alight of dumped vehicles. A systematic review of road and track closure to the general public is likely to reduce the frequency and ignition points of these fires.

Strategies to reduce the impacts of prescribed burns on fauna values include:

- Avoid burning forest with key canopy trees in flower as this may impact on feeding resources of endangered species, such as the Regent Honeyeater and Swift Parrot. Key canopy trees in the reserves are Spotted Gum, ironbarks, Grey Box, Grey Gum and Forest Red Gum (after Higgins 1999; Higgins *et al*. 2001).
- During heavy-flowering events between the months of July and January, assess the potential presence of nesting Regent Honeyeaters before undertaking a prescribed burn.
- Avoid burning areas known to support other declining woodland bird species (i.e. Brown Treecreeper, Speckled Warbler, Regent Honeyeater, Black-chinned Honeyeater and Grey-

crowned Babbler) during the nesting season (for all species this is primarily between the months of July and January; Higgins *et al.* 2001; Higgins and Peter 2002).

- Investigate implementation techniques for fire regimes that will not result in the replacement of a grassy ground cover with a shrubby ground cover.
- Ensure vehicle and staff movements associated with fire operations do not encourage the establishment and spread of aggressive noxious grasses.
- In areas supporting Brown Treecreeper populations undertake small patch burns to ensure that significant sections of these bird's territories (territory size varies in NSW depending on locality between 1.5 and 50ha; Higgins *et al.* 2001) still support important habitat, such as fallen timber and leaf litter. Where larger burns are unavoidable due to terrain or control line issues make every effort NOT to have a scorched earth burn across the entire burn area encompassing all or most of a pair's territory.
- Avoid burning in forest areas supporting active raptor nests, such as the Square-tailed Kite.
- Avoid burning under conditions which may result in flare-ups resulting in the loss of large hollow-bearing trees.
- In areas supporting Speckled Warbler and Grey-crowned Babbler populations conduct small patch burning to ensure the retention of Acacias, Blackthorn and other shrubs in at least half of the bird's home range. Territory size is 2 to 9ha for the Speckled Warbler and 10 to 53ha for the Grey-crowned Babbler (Higgins and Peter 2002). Where larger burns are unavoidable due to terrain or control line issues make every effort NOT to have a scorched earth burn across the entire burn area encompassing all or most a pair's territory.
- Do not undertake prescribed burns at night where nests of the Grey-crowned Babbler are present as this species roosts in these structures (Higgins and Peter 2002). The nests are distinctive structures often as low as one or two metres above the ground in shrubs or saplings. The nest itself is a large domed stick structure with a spout-like entrance and is lined with a variety of soft material. There are likely to be a number of such nests scattered across a group's territory, but not all will be used at the one time.
- Protect known Yellow-bellied Glider habitat from wildfire, such as feed trees, particularly in the Mount Tomalpin 'arboreal zone' area.

Distinctive domed nest of the Grey-crowned Babbler. © M. Schulz

4.3.2 Management Actions to Address Other Key Threatening Processes

Eight key threatening processes were identified as being restricted or poorly understood within the two reserves (see Section 4.2). Management actions to ameliorate the impact of these key threatening processes include:

a) Fox

- Atlas records show that this introduced predator is widespread in surrounding lands (Map 5). Therefore, it will be impossible to exterminate this species from the two reserves. Instead conduct strategic periodic Fox baiting programs targeting areas supporting: i) declining woodland bird species that predominantly dwell on the ground or in shrubs i.e. Brown Treecreeper, Speckled Warbler, Grey-crowned Babbler (Map 9); ii) areas supporting the Squirrel Glider (refer to Map 12); and iii) the Mount Tomalpin area, specifically centring on areas supporting Yellow-bellied Gliders (refer to Map 12).

b) Feral Cat

- Conduct trapping in areas where high densities of sightings or indirect signs are evident.
- Encourage adjacent landholders to shoot Feral Cats on surrounding land.

c) Exotic Grasses

- Monitor the presence of exotic grasses, particularly in areas occupied by declining woodland bird species, and undertake appropriate control programs.

d) Lantana

- Map the extent of Lantana across the two reserves.
- Undertake strategic removal, concentrating on areas supporting known populations of threatened species potentially impacted by this weed e.g. declining woodland bird species, Barking and Masked Owls (see Section 4.2).

e) Feral Deer

- Control numbers in conjunction with surrounding landholders to reduce potential impacts.

f) Feral Honeybee

- Destroy or remove all feral bee hives encountered.
- Encourage reserve users to report the location of wild hives to maximise the number of hives removed from the reserves.
- Encourage adjacent landholders to destroy feral hives on surrounding land.

g) Rabbit

- Undertake control programs in areas where populations occur, particularly away from the reserve boundaries.
- Control programs to be undertaken in conjunction with Fox control programs to avoid population increases resulting in potential further spread across the reserves.

4.4 OTHER HABITAT MANAGEMENT

4.4.1 Even-aged Forest Structure

The current largely even-aged forest structure through much of the two reserves has resulted in reduced populations of some members of particular fauna groups, such as species requiring hollows. A major challenge to managers will be the creation of a more multi-aged forest structure that will enhance the reserves for a number of threatened species and other fauna.

Coupled with the rarity of hollows is the dense regeneration of young canopy trees in many parts of the reserves. This dense regrowth has resulted in the exclusion or very low densities and patchy distribution of most woodland bird species that are a feature of these reserves, such as the Brown Treecreeper. Another challenge facing managers will be to reduce the stem densities in parts of the reserves to encourage increases in some woodland bird species, particularly the Speckled Warbler and Grey-crowned Babbler that currently occur only on the margins (Map 9).

4.4.2 Artificial habitat

Studies within fragmented and disturbed environments, including recent DECC surveys, have shown that artificial ground cover associated with dumped rubbish provides important habitat in areas that have highly simplified and modified natural ground cover layers (Grenadier *et al.* 2001; Wellington and Wells 1995). Species recorded amongst artificial ground cover during these surveys include the Common Dunnart and a number of lizards and snake species. These habitats present a paradox for land managers. It is recommended that artificial habitat such as wood, corrugated iron and other heavier refuse should be kept *in situ* in environments where recent fire has removed ground layer vegetation and consumed ground logs and litter. Until such time as the vegetation cover is re-established larger artificial habitat should be retained. Such an approach does not warrant keeping all forms of rubbish. Rubbish that is easily dispersed by wind or water is unsuitable for retention of habitat for a period of months or years. There is also a need to remove rubbish that is easily visible from tracks and roads to discourage further dumping.

Good reptile habitat: dumped corrugated iron. © M. Schulz/DECC

4.4.3 Trail closure

An extensive network of trails traverses Werakata NP and SCA. At present these facilitate extensive use of the park by trail bikes and off-road vehicles, facilitate arson, rubbish dumping and promote weed growth and feral animal access (see Section 4.3). A trail management strategy should be developed to close trails and regenerate habitats for those that are not required for essential management purposes.

4.4.4 Barbed Wire Fences

Barbed wire fences result in the entanglement of a variety of species ranging from button-quail to the Powerful Owl to bats to various glider species. In the Cessnock area both the Squirrel and Yellow-bellied Gliders have been recorded as having died as a result of entanglement (DECC 2008a). It is recommended that the following approaches be adopted:

- Any new fences in the reserve to not use barbed wire, instead high tensile plain wire.
- Monitoring of fences by DECC staff to record any entanglement incidences on existing boundary fences. Additionally, reports from other reserve users to be encouraged. All entanglement incidences to be incorporated into a database to identify entanglement 'hotspots'.

- At identified 'hotspots' undertake the following actions dependent on the circumstances (e.g. length of fence, relations with neighbouring landholders, presence of stock, etc): a) replace the barbed wire fence or at least the top barbed wire strand, b) cover the top barbed wire strand with tubing (i.e. split poly pipe) or c) improve fence visibility by adding visible markers, such as tape, plastic flags and metal tags (note: that some of these visible markers may be removed by cattle if on a boundary fence).

4.5 OFF-RESERVE CONSERVATION AND LAND ACQUISITIONS

4.5.1 Cooperative land management

Werakata NP and SCA are located within the largest remnant of native vegetation on the Hunter Valley floor. Long-term maintenance of the fauna values in the reserves demands a cooperative approach to the management of adjacent lands across multiple tenures. Management authorities include the Hunter Economic Zone, Department of Lands, Department of Natural Resources, local government as well as private holdings. The purpose of such an approach is to recognise that the impacts that occur adjoining or nearby the reserve impact the fauna values occurring within it and hence manage the threats accordingly. Cooperation between these authorities should cover habitat loss, fire and pest management strategies, monitoring efforts, rubbish removal and access and trail management.

4.5.2 Additions to Werakata National Park and State Conservation Area

Werakata NP and SCA are located within the largest remnant of native vegetation on the Hunter Valley floor. Management of this remnant currently spans multiple land tenures. Shared management objectives are one approach to assisting the protection of fauna values. Adding additional land areas to the reserve is another. Additions should be prioritised towards lands that contain one of more of the following attributes:

- Support recent breeding records of the endangered Regent Honeyeater.
- Support regularly used feeding habitat of the Regent Honeyeater and Swift Parrot.
- Support resident populations of declining woodland species, such as the Squirrel Glider, Diamond Firetail, Grey-crowned Babbler, Black-chinned Honeyeater, Brown Treecreeper, Speckled Warbler, Hooded Robin and Masked or Barking Owl.
- Support high numbers of older hollow bearing examples of Spotted Gum, Forest Red Gum, Grey Gum or Grey Box.
- Support roosts of the Eastern and Little Bentwing-bats or Large-footed Myotis.
- Support an understorey that maintains a good ground cover of native flora species.
- Areas that do not require frequent burning for asset protection along the rural-urban fringe.

These habitat features and species can also be used to highlight areas of high conservation value on adjoining lands to assist with fauna protection strategies in the local area.

4.6 FURTHER SURVEY AND MONITORING

4.6.1 Further survey

Every effort was made during the recent systematic fauna surveys to sample the full variety of habitat types and fauna groups within Werakata NP and SCA, and hence obtain a comprehensive picture of terrestrial vertebrate fauna within the area. However, the surveys were subject to a number of constraints, including weather, season and time. Recommendations for further work to be undertaken within the area in coming years include:

- Systematic frog surveys using the nocturnal streamside search method described in Section 2.3.2. The surveys should be undertaken under appropriate weather conditions on warm, humid nights in spring or early summer after an extended period of rain. This program should specifically endeavour to ascertain whether the Green-thighed Frog persists adjacent to and extends within to within the reserves. Surveys should focus on moist creeklines and riparian vegetation in the vicinity of Mount Tomalpin during late spring and summer when males are likely to be calling. Some surveys should also be undertaken in winter to target winter-breeding species.

- Additional bat surveys using harp traps may resolve the uncertainty associated with some of the results of the ultrasonic call analysis. Harp trapping in combination with ultrasonic detection provides more reliable results than Anabat analysis alone as trapped animals can be identified with a high level of confidence. When trapped animals are released, reliable call files for that species can be collected. This improves the accuracy of subsequent call analysis. Call signals from bats surveyed during the 2004-5 season in the region are shown in Appendix D. Trapping should be carried out during spring/summer on warm humid nights following warm-hot daytime temperatures.
- Barking Owl records in the north of the reserve should be confirmed using systematic playback techniques. If present, the territory should be searched to identify potential nest or roost sites along gully lines and riparian zones. Fire protection strategies should be subsequently employed at the site(s) to minimise potential disturbance.
- The disjunct populations of Tussock Rainbow-skink found in Werakata NP and Yengo NPs should be investigated further to ascertain whether they are genetically distinct from the nearest northern populations found in Dorrigo NP and Plagyan State Forest on the North Coast.

4.6.2 Monitoring

a. Regent Honeyeater and Swift Parrot

- Survey suitable habitat in the two reserves biannually as part of the Regent Honeyeater/Swift Parrot monitoring program.
- Conduct targeted surveys during heavy flowering events, and where these occur in spring and early summer (e.g. for the Red Ironbark) conduct systematic searches for nesting activity of the Regent Honeyeater.
- Check all Regent Honeyeaters encountered for colour bands to provide important movement information to assist in understanding the regional movements of this declining species.

b. Declining Woodland Species

We recommend that an annual monitoring project be implemented to assess changes in woodland fauna abundance over time, particularly in relation to fire, management actions undertaken in Section 4.4 and through progressive changes to the forest structure following cessation of forest harvesting and silvicultural practices. However, monitoring all vertebrate fauna is a complex task. This is because it requires high level of fauna survey skills, and a large survey effort to make results meaningful and to address limitations imposed by survey technique and site variability.

Therefore a two-pronged approach is recommended:

a) *Declining Woodland Birds:* In association with the statewide biannual Regent Honeyeater and Swift Parrot monitoring program establish an associated monitoring program across the two reserves for declining woodland bird species based on previous sighting locations (Map 9). This monitoring program would be valuable in assessing population changes of declining woodland birds and assess population trends in other woodland bird species that may be listed under the TSC Act (1995) in the future. Local bird watchers or bird groups (including Birds Australia) could be encouraged to partake in this monitoring program.

b) Other changes to the fauna values in the reserve are likely to occur slowly as the surrounding area becomes increasingly urbanised. These landscape scale changes are likely to come about from the gradual increase in the intensity of the threatening processes that force localised extinctions, enhance habitat for some species and restrict it for others. A full vertebrate fauna survey every 10 years is likely to be achievable given the small size of the reserves. While results may prove less informative to reserve management, they are likely to be highly informative on the effects of landscape changes. These results could then be used to guide ongoing environmental planning initiatives in the Hunter Valley.

5 THREATENED SPECIES PROFILES

Twenty-one threatened fauna species are known to occur in Werakata NP and SCA. This section contains profiles for most of these species. These profiles 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 reserves and adjacent areas; and an appraisal of the distribution and status of the species in the two reserves.

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 DECC Atlas of NSW Wildlife as occurring within the area. Only species that have been directly and reliably observed within the study area since 1950, or have been recorded on the Atlas of NSW Wildlife within two kilometres and considered likely to occur within the study area, have been afforded a species profile. Table 7 lists all the threatened species recorded on the Atlas of NSW Wildlife in the study area as well as those occurring within five kilometres of the boundary. This list details their current status, together with an annotation for each species regarding the latest record, reliability of identification and a rationale for the generation of a species profile.

Common Dunnart © M. Schulz

Table 7: Threatened fauna species recorded within and around Werakata National Park and State Conservation Area.

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within Werakata NP/SCA		No. of locations within a five kilometre radius of Werakata NP/SCA[1]	Notes on reliability and date of last record	Species profile generated?
				DECC[2]	Other[3]			
Litoria aurea	Green and Golden Bell Frog	E	V	0	0	2	There are a number of records from the Ellalong area to the south west of Werakata SCA (DECC 2007c). Not recorded in Werakata NP and SCA, with little suitable habitat available.	N
Litoria brevipalmata	Green-thighed Frog	V	-	0	0	4	The status of this species is poorly known within the Lower Hunter Valley. This frog has been observed in gullies east of Mount Tomalpin during the Hunter Economic Zone surveys, March 2002. Not recorded in Werakata NP and SCA.	N
Hoplocephalus stephensii	Stephens' Banded Snake	V	E	0	1	0	The only record is from the Australia Museum collection from 1989. This specimen had associated inaccurate location details. It is unlikely to occur in the dry forests and woodlands characteristic of Werakata NP and SCA.	N
Stictonetta naevosa	Freckled Duck	V	-	0	0	1	There is an old record (1983) from Ellalong Lagoon to the south west of Werakata SCA. Not recorded in Werakata NP and SCA, with little suitable habitat available.	N
Ixobrychus flavicollis	Black Bittern	V	-	1	0	1	Rare visitor to the Lower Hunter Valley (A. Zoneff, pers. comm.). One individual was observed near a creek in the Bishops Hill area during the DECC survey of Werakata NP. Not recorded from Werakata SCA.	Y
Ephippiorhynchus asiaticus	Black-necked Stork	E1	-	0	0	2	A vagrant to the Lower Hunter Valley (A. Zoneff, pers. comm.). Not recorded in Werakata NP and SCA, with little suitable habitat available. Recorded from two wetlands near Kurri Kurri, with the most recent sighting in 1991.	N
Erythrotriorchis radiatus	Red Goshawk	E1	V	0	0	1	The presence of this species in the Lower Hunter Valley requires confirmation given that Debus (1991) indicated its distribution in NSW was confined to north of 30^0S (e.g. Glen Innes and Upper Orara). One record near Cessnock in 1987.	N

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within Werakata NP/SCA		No. of locations within a five kilometre radius of Werakata NP/SCA[1]	Notes on reliability and date of last record	Species profile generated?
				DECC[2]	Other[3]			
Hamirostra melanosternon	Black-breasted Buzzard	V	-	0	0	3	A vagrant to the Lower Hunter Valley and the coastal/near-coastal regions of NSW in general (Marchant & Higgins 1993). Several records from adjacent to Neath, last recorded in 1999. May potentially occur as a vagrant to Werakata NP and SCA.	N
Lophoictinia isura	Square-tailed Kite	V	-	1	0	3	A regular principally spring/early summer visitor to the Lower Hunter Valley (A. Zoneff, pers. comm.). One recorded from Werakata SCA in the 2008 DECC survey. Two records to the north of Mount Tomalpin in the Hunter Economic Zone, last seen in 1998.	Y
Irediparra gallinacea	Comb-crested Jacana	V	-	0	0	8	All recent records from wetlands located to the east of Mount Tomalpin, John Brown's Lagoon near Colliery Dam and in the Mulbring area; last recorded in 2000. Not recorded in Werakata NP and SCA, with little suitable habitat present.	N
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	1	3	3	Uncommon visitor to the Lower Hunter Valley (A. Zoneff, pers. comm.). Last recorded in Werakata NP in September 2003 south of Mount Tomalpin. Several birds recorded from the eastern section of Werakata SCA during the 2008 DECC survey.	Y
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	1	3	4	Uncommon visitor to the Lower Hunter Valley (A. Zoneff, pers. comm.). Single records from Werakata NP and the extreme SW corner of Werakata SCA in the 2008 DECC survey.	Y
Lathamus discolor	Swift Parrot	E1	E	0	8	20	Regular winter visitor to the Lower Hunter Valley in variable numbers (A. Zoneff, pers. comm.). Recorded from Werakata NP during recent Swift Parrot surveys (May 2005) and from various localities in the western section of Werakata SCA.	Y
Neophema pulchella	Turquoise Parrot	V	-	0	0	2	This species has severely declined in the Lower Hunter Valley; with a resident population no longer present (A.	Y

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within Werakata NP/SCA		No. of locations within a five kilometre radius of Werakata NP/SCA[1]	Notes on reliability and date of last record	Species profile generated?
				DECC[2]	Other[3]			
							Zoneff, pers. comm.). Last seen in 1998 off park south-west of Kurri Kurri and in bushland that now is situated within the Hunter Economic Zone in 2003 (A. Zoneff, pers. comm.).	
Ninox connivens	Barking Owl	V	-	2	0	1	A rare species in the Lower Hunter Valley. Recently detected on the northern edge of Werakata NP by a neighbouring landholder in March 2005 (J. Goswell, pers. comm.). One bird responded to playback in the far SW of Werakata SCA during the 2008 DECC survey.	Y
Ninox strenua	Powerful Owl	V	-	2	1	4	An uncommon species on the floor of the Lower Hunter Valley. A single record from Werakata NP in 1998 from the southern side of Mount Tomalpin. Recorded from the western boundary of Werakata SCA during the 2008 DECC survey.	Y
Tyto novaehollandiae	Masked Owl	V	-	1	1	4	An uncommon species on the floor of the Lower Hunter Valley, with higher numbers reported from coastal forests in the Wyong area. One bird heard adjacent to Missing Link Road on the eastern edge of Werakata SCA during the 2008 DECC survey. Occasionally heard calling in bushland adjacent to the SCA (R. Suwald, pers. comm.). This owl has not been recorded in the Werakata NP but is likely to occur. For example, apart from the above records, one was observed close to the NP boundary east of Mount Tomalpin in 1998.	Y
Tyto tenebricosa	Sooty Owl	V	-	0	0	2	Generally confined to wet sclerophyll forest and rainforest in the Lower Hunter Valley. Therefore unlikely to occur within Werakata NP and SCA. Recorded within 5km of the NP from the edge of Weston in 2000.	N
Climacteris picumnus victoriae	Brown Treecreeper (eastern subsp.)	V	-	2	3	15	Uncommon, patchily distributed species that is declining within the Lower Hunter Valley (A. Zoneff, pers. comm.). Two individuals were recorded in the middle section of Werakata NP in 2002. Also recorded from Werakata NP/SCA on both sides of Abernethy Road in 2008 during	Y

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within Werakata NP/SCA		No. of locations within a five kilometre radius of Werakata NP/SCA[1]	Notes on reliability and date of last record	Species profile generated?
				DECC[2]	Other[3]			
							the DECC survey.	
Pyrrholaemus sagittatus	Speckled Warbler	V	-	3	1	9	Uncommon, patchily distributed species that is declining within the Lower Hunter Valley (A. Zoneff, pers. comm.). Pairs or small groups recorded from several localities on the edge of Werakata SCA south of Kitchener and east of the Ellalong Road in the DECC survey. Observed in the middle section of Werakata NP in 2001.	Y
Grantiella picta	Painted Honeyeater	V	-	0	0	1	Extremely rare visitor to the Lower Hunter Valley (A. Zoneff, pers. comm.). One record to the south of Werakata NP in 1977.	N
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subsp.)	V	-	14	5	36	Uncommon, patchily distributed species that is declining within the Lower Hunter Valley (A. Zoneff, pers. comm.). Recorded at a number of locations in the two reserves during recent DECC surveys	Y
Xanthomyza phrygia	Regent Honeyeater	E1	E	1	4	9	Rare, irregular breeding visitor to the Lower Hunter Valley, particularly during times of prolific flowering of key tree species, such as the Red Ironbark (A. Zonefff, pers. comm.). In the summer of 2007/08 approximately 10 pairs nested in bushland adjacent to the northern boundary of Werakata NP (A. Zoneff, pers. comm.).	Y
Melanodryas cucullata	Hooded Robin	V	-	0	1	1	An extremely rare and declining visitor to the Lower Hunter Valley (A. Zoneff, pers. comm.). Likely to be a vagrant to Werakata NP and SCA, with only a single record from the former reserve in 1986.	N
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subsp.)	V	-	2	3	33	A patchily distributed and declining species within the Lower Hunter Valley (A. Zoneff, pers. comm.). Recorded during recent DECC surveys in the northern section of Werakata NP and on the northern edge of Werakata SCA adjacent to Kitchener.	Y
Stagonopleura guttata	Diamond Firetail	V	-	0	0	1	A rare and declining visitor to the Lower Hunter Valley (A. Zoneff, pers. comm.). Likely to be a vagrant to Werakata NP and SCA. The only record is from the edge of	N

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within Werakata NP/SCA		No. of locations within a five kilometre radius of Werakata NP/SCA[1]	Notes on reliability and date of last record	Species profile generated?
				DECC[2]	Other[3]			
							Kitchener just outside the SCA in 2004.	
Dasyurus maculatus	Spotted-tailed Quoll	V	E	0	0	2	The only records are from adjacent to the SCA at Bellbird and Kitchener. The species is may occur as a vagrant in the two reserves.	N
Phascolarctos cinereus	Koala	V	-	0	3	1	A patchily distributed species in the Lower Hunter Valley. Not recorded from Werakata SCA, although a small population formerly occurred on private land on the east side of Pinnacle Link Road (R. Suwald, pers. comm.). The only records from Werakata NP based on scratch marks and observations of a local resident are from a single location in the middle section of the reserve.	Y
Petaurus australis	Yellow-bellied Glider	V	-	3	12	16	A patchily distributed species on the Lower Hunter Valley floor. Records concentrated in the Mount Tomalpin area of the NP and north of Lake Road in the eastern block of the SCA.	Y
Petaurus norfolcensis	Squirrel Glider	V	-	7	2	13	A patchily distributed species in the Lower Hunter Valley, with the two reserves providing core habitat. A number of individuals were spotlighted in the northern section of Werakata NP during recent DECC surveys. This species appeared to be less common in the SCA with all records restricted to the western block.	Y
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	20	3	6	Widespread throughout the Lower Hunter Valley, with the closest camps located at Milfield (P. Eby and N. Williams, pers. comm.). Widespread throughout Werakata SCA foraging on flowering Grey Gum during the 2008 DECC survey. Similarly widespread in Werakata NP, feeding predominantly on flowering Spotted Gum *Corymbia maculata* in northern and middle sections of the reserve during the 2005 DECC survey. Likely to occur throughout both reserves following the flowering of key eucalypt species, such as various ironbarks, Grey Gum and Spotted Gum.	Y
Mormopterus norfolkensis	East-coast Freetail-	V	-	0	1	8	A patchily distributed species in the Lower Hunter Valley.	Y

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				DECC[2]	Other[3]			
	bat						It has been recorded close to the boundary of Werakata NP in 2001 and during recent DECC surveys. There are no records of this species from Werakata SCA, although it is likely to be present in small numbers.	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	0	2	2	No confirmed trapping records. A poorly understood species with all records identified from Anabat analysis. However, its ultrasonic signals are readily confused with those of the Greater Broad-nosed Bat and the much more common Gould's Wattled Bat (Pennay *et al.* 2004; H. Parnaby DECC, pers. comm.). An unconfirmed Anabat record from the middle section of Werakata NP in 1998. Not recorded from Werakata SCA.	N
Miniopterus australis	Little Bentwing-bat	V	-	2	2	1	A patchily distributed species in the Lower Hunter Valley, with few roosts documented from the Cessnock-Kurri Kurri area. The ultrasonic signals of this bat were identified from Anabat recordings from two localities in Werakata NP. Three individuals were captured in harp traps from two localities in the eastern section of Werakata SCA in the 2008 DECC survey.	Y
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	1	1	7	Similar to the previous species, patchily distributed in the Lower Hunter Valley, with few roosts documented from the Cessnock-Kurri Kurri area. Several records from within Werakata NP.	Y
Myotis adversus	Large-footed Myotis	V	-	0	0	4	Similar to the previous species, patchily distributed in the Lower Hunter Valley. Not recorded from within Werakata NP and SCA. However, it is may occur within the latter area given that it was found roosting in the Kitchener sewer line in 2004 and in a culvert on Sandy Creek Road, near Ellalong in 2005. It has also been identified based on ultrasonic signals recorded from the western edge of the SCA. However, little suitable foraging habitat is present within either reserve (i.e. open permanent surface water).	N

Scientific name	Common name	Status in NSW (TSC Act 1995)	Status in Australia (EPBC Act 1999)	No. of locations within Werakata NP/SCA		No. of locations within a five kilometre radius of Werakata NP/SCA[1]	Notes on reliability and date of last record	Species profile generated?
				DECC[2]	Other[3]			
Nyctophilus timoriensis	Greater Long-eared Bat	V	V	0	0	1	The presence of this species in the Lower Hunter Valley is unconfirmed, with no trapped individuals recorded (e.g. DECC surveys; N. Williams, pers. comm.). Not recorded from within Werakata NP and SCA. The only record was identified from Anabat recordings near the Kurri smelter to the north of the NP in 2001. However, this record must be regarded as unconfirmed since the echolocation calls of this species cannot be reliably separated from other sympatric long-eared bat species with commonly used ultrasonic bat detectors (e.g. Anabat detectors) (Reinhold *et al*. 2001; Pennay *et al*. 2004; Richards *et al*. 2004).	N
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	0	0	4	The distribution of the species is poorly known within the Lower Hunter Valley. Not recorded from within Werakata NP and SCA. The only adjacent records are ultrasonic calls recorded by Anabat from Weston in 2003, southern edge of Cessnock in 2000 and on the western edge of Kitchener in 2004.	N

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 DECC systematic surveys.

BLACK BITTERN

Species Profile

The Black Bittern (*Ixobrychus flavicollis*) is a medium-sized, dark grey-black heron, with a distinctive yellow stripe on the head and neck. It is usually found singly or in pairs in thick vegetation at the margins of freshwater and estuarine wetlands, with breeding occurring in thick leafy trees overhanging water (Marchant and Higgins 1990). In the Sydney Basin region it is usually recorded on the edges of watercourses with either Swamp (*Casuarina glauca*) or River Oak (*C. cunninghamiana* subsp. *cunninghamiana*) (Chafer *et al*. 1999). Within Australia, it is widespread coastally between the Kimberleys, Western Australia and extreme north-eastern Victoria. This species is rare in the lower Hunter Valley (Morris 1975).

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Threats

Habitat alteration is the greatest threat to the Black Bittern with practices that are known to have severely affected the species in Western Australia likely to have similar impacts in New South Wales. Identified threats include clearing of riparian vegetation for agriculture and urbanisation, and the resultant increase in salinity and sedimentation (Marchant and Higgins 1990; Garnett and Crowley 2000). Other threats that are likely to be important are additional factors impacting on water quality, weeds and introduced predators, especially Foxes. The NSW Scientific Committee (2004a) listed this species as one that is likely to have habitat affected by subsidence due to longwall mining.

Local and Regional Conservation Status

The Black Bittern is listed as Vulnerable on the NSW TSC Act (1995) due to a retraction in range and a decrease in abundance in NSW. The majority of records in NSW come from the three coastal Bioregions, with the occasional historic record west of the Divide (DECC 2008a). In the Sydney Basin Bioregion, most records are along coastal waterways or the major rivers, such as the Hawkesbury, which are often poorly reserved. Nevertheless, a number of records occur in Dharug and Scheyville NPs.

Within the Lower Hunter, much of the floodplain habitats have been destroyed and modified with only small areas of suitable habitat now remaining. The species has been recorded a number of times in the Kooragang Island area near Newcastle. The only record of this species from Werakata NP is of a single individual flushed from the edge of Saltwater Creek in the Bishops Hill portion of Werakata NP during the 2005 DECC survey (see Map 10). This is the first record of the species from the reserve. This low-lying creek traverses Casuarina forests and open Melaleuca scrubs on slightly raised ground. This is the first record in the Lower Hunter for some years, and indicates that the species will utilise mosaics of riparian forests and wetlands away from typical estuarine habitat. Habitat within Werakata NP is restricted to small riparian zones that drain into larger wetland and creek systems with permanent water. While Black Bitterns are likely to be an intermittent visitor to the reserve, the area forms part of a network of suitable habitat that are important for the species in the region. However given the prevalence of carnivores such as Foxes and Cats, it remains vulnerable to predation.

It has not been recorded from Werakata SCA, with little suitable habitat present within the reserve.

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).

© T. Tarrant

Threats

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

Local and Regional Conservation Status

The Square-tailed Kite is listed as Vulnerable on the NSW TSC Act (1995) due to a decline in abundance across this state. Within NSW, this species has been detected across all Bioregions. 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 Cumberland Plain; with breeding recorded from all of these locations except the last. Records exist for a number of reserves, including Jervis Bay and Goulburn River NPs, though its preferred habitat often exists outside of the reserve system.

Within the Lower Hunter, this species is an uncommon predominantly spring/early summer visitor. It has not been recorded from Werakata NP. However, it is likely to be an occasional visitor given that it has been recorded in bushland to the north of the reserve (DECC 2008a; A. Zoneff, pers. comm). The 2005 DECC fauna survey was undertaken in March. This time of the year is situated outside the spring/early summer period when the species is most likely to be present (Debus *et al*. 1992, 1993; Marchant & Higgins 1993).

The only record of this species from Werakata SCA is of a single individual observed flying through the forest canopy adjacent to South Basin Road in the eastern block of Werakata SCA during 2008 DECC survey (Map 10). As with Werakata NP it is likely to be an occasional visitor and may potentially breed within the reserve in spring/early summer.

GLOSSY BLACK-COCKATOO

Species Profile

The Glossy Black-Cockatoo (*Calyptorhynchus lathami*) is a medium-sized black cockatoo, which has a diagnostic black-brown head, with yellow patches in the female and orange-red tail panels. It is usually seen in pairs or trios (with dependant young) in eucalypt woodland or forest, where it nests in large hollows. This species feeds almost exclusively on Sheoaks (*Allocasuarina* species including *A. verticillata, A. torulosa* and *A. littoralis*) (Higgins 1999). Chewed cones scattered underneath these trees are a distinctive indication of the presence of this bird.

© N. Williams/ DECC

Threats

The major threat is habitat destruction for agriculture or residential development due to the removal of nesting and feeding sites, and also from hollow competition with more open habitat species such as the Galah (*Eolophus roseicapillus*) (NPWS 1999b; NSW Scientific Committee 2000b). Fire may be a threat as many *Allocasuarina* species are fire sensitive. Therefore, inappropriate burning regimes may affect food supplies (NSW Scientific Committee 2000c). In addition, the removal of dead wood and dead trees is a key threatening process that may impact on this species (NSW Scientific Committee 2003a). Illegal trapping for aviculture may be a localised, minor threat (Garnett and Crowley 2000). DEH (2004) and NSW Scientific Committee (2002b) lists the Glossy Black-Cockatoo as a species that has exhibited symptoms of Psittacine Circoviral (beak and feather) Disease.

Chewed Forest Oak cones are telltale evidence of this species.
© M. Schulz

Local and Regional Conservation Status

The Glossy Black-Cockatoo is listed as Vulnerable on the NSW TSC Act (1995) due to a reduction in range and decrease in abundance across its range. It is a well known species and there are many records across 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 (NPWS 1999b; NSW Scientific Committee 1999a). Relatively large areas of the Sydney Basin provide suitable habitat for the species and there are a large number of records throughout the Bioregion (DECC 2008a). The species occurs in many conservation reserves, including Morton, Nattai, Blue Mountains, Ku-ring-gai Chase, Yengo and Wollemi National Parks. How4ever, little information is available on preferred nesting areas, including in conservation reserves.

Glossy Black-Cockatoos are not commonly recorded in the forests of the Hunter Valley although it was formerly more widespread (Morris 1975). This is not surprising because *Allocasuarina* species are not a prominent component of the vegetation communities of the Hunter Valley (NPWS 2000a). It is a rare visitor to Werakata NP, with no individuals recorded in the 2005 DECC survey. Many of the past observations of the Glossy Black-Cockatoo in the reserve were made near Mount Tomalpin (Map 10). The rarity of this bird is likely to be related to the few stands of Forest Oak (*Allocasuarina torulosa*) and other Sheoak species present within the reserve.

In Werakata SCA the only record was of three individuals feeding in Forest Oak west of North Basin Road (Map 10). This species is likely to be most prevalent in the most eastern block of the reserve where stands of Forest Oak are relatively common in sheltered forests.

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 1997). Both sexes have a wispy crest that is curved forward and twisted. The male's crest and head is a distinctive 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-gang Cockatoos are seasonally nomadic, inhabiting tall mountain forests and woodlands in the summer and moving to lower altitude 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 upper understorey (Higgins 1999). The Gang-gang Cockatoo requires hollows in large trees for breeding which occurs between October and January (Pizzey and Knight 1997).

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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 2001e, 2005a). 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 2001e, 2005a), with observations of nest displacement by the Sulphur-crested Cockatoo (*Cacatua galerita*) noted from the Sydney region (T. Saunders, pers. comm.). Psittacine Circoviral (Beak and Feather) Disease may threaten small populations that are already stressed (DEH 2004; NSW Scientific Committee 2002b). Climate change may alter the extent and nature of the cool temperate vegetation that the species utilises, particularly during the summer period (Olsen *et al.* 2003).

Local and Regional Conservation Status

The Gang-gang Cockatoo has recently been listed as a Vulnerable Species on the NSW TSC Act (1995) (NSW Scientific Committee 2005a) 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 widespread south of the Hunter River with numerous records from many National Parks and other reserves.

The Hunter Valley represents the northern coastal limit of the species' range, with only infrequent observations made within the valley itself (A. Zoneff, pers. comm.). This species is predominantly a winter visitor between April and September in the lower Hunter Valley (Morris 1975). There are two records of this species within Werakata NP and there are a number of records within adjacent forested land to the east towards the Sugarloaf Range and in bushland north of Abermain (Map 10).

The only two records from Werakata SCA are from the extreme southwest corner, including two individuals in Cabbage Gum dominated woodland adjacent to Ellalong Road in the 2008 DECC survey (Map 10). It is likely that this species ranges more widely across the reserve during the late autumn/winter months, particularly in the eastern sections of the area. There are also records from adjacent areas, such as at Mulbring.

SWIFT PARROT

Species Profile

The Swift Parrot (*Lathamus discolor*) is a 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 (Higgins 1999).

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Threats

The Swift Parrot has a total population of approximately 2000 individuals (Tzaros 2002) which may still be declining (Garnett and Crowley 2000). Outside the breeding area the main threat is habitat destruction (Garnett and Crowley 2000). During the non-breeding season it is nomadic due to the variable nature of the flowering of its favoured feeding trees. Therefore, it is sensitive to clearance of areas that it may rely on once every few years. In some areas it may be threatened by competition with the Feral Honeybee (NSW Scientific Committee 2002c). Due to its rapid flight, the species 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 from wild Swift Parrots in NSW and has the potential to adversely affect the population (NSW Scientific Committee 2002b).

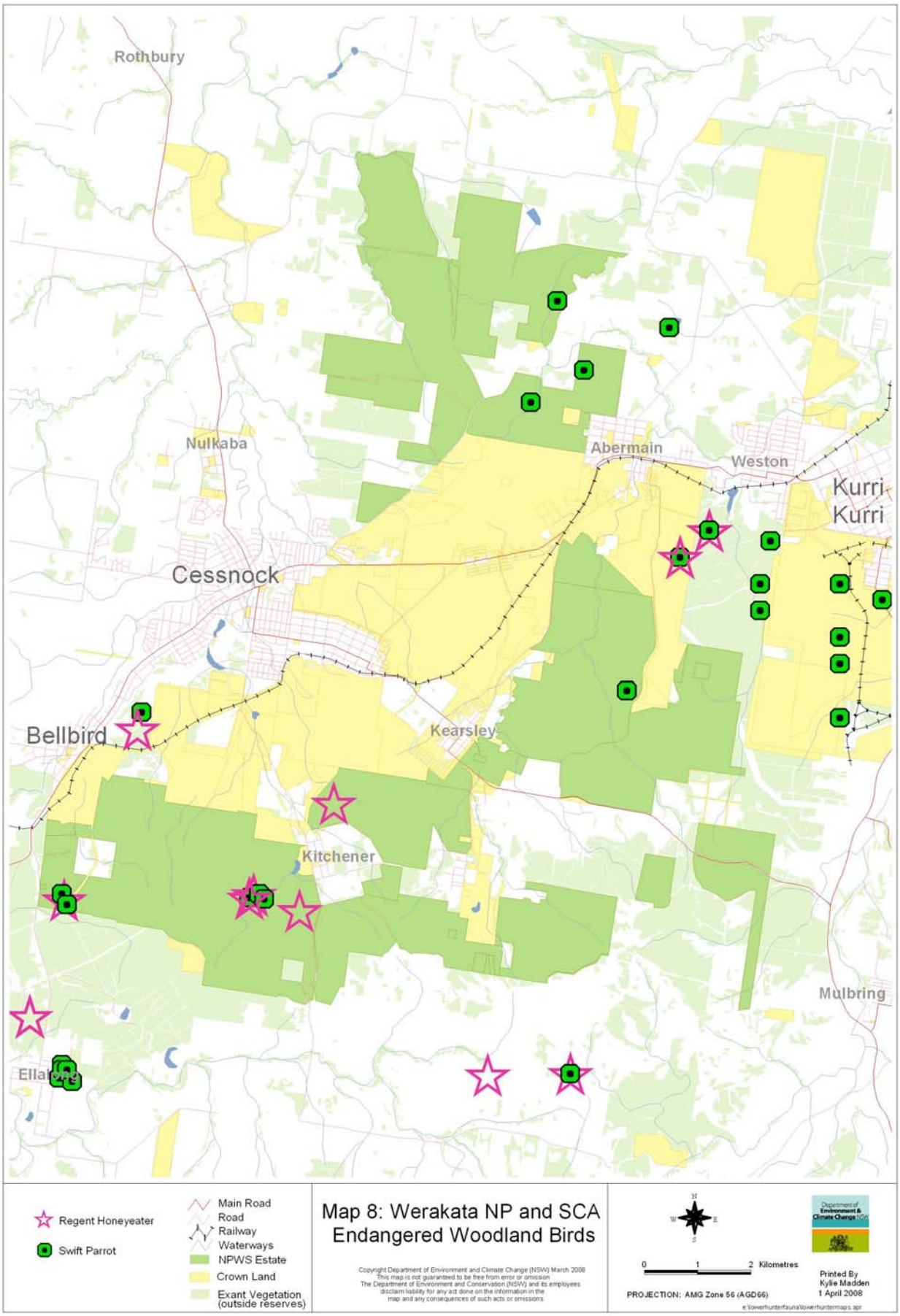
Local and Regional Conservation Status

The Swift Parrot is listed as Endangered on the NSW TSC Act (1995) and on the Commonwealth EPBC Act (1999) and 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 occur in the three coastal Bioregions and the NSW South West Slopes Bioregion (DECC 2008a). In the Sydney Basin Bioregion, most Swift Parrot records are from coastal habitats, particularly the Central Coast. It has also been regularly recorded in drier areas of the Hunter and Capertee Valleys and the Cumberland Plain. Few records occur within reserves, though Nattai NP and Werakata NP and SCA are exceptions. Annual surveys across the range of the Swift Parrot have greatly emphasised the importance of its winter feeding grounds in NSW (D. Saunders, pers. comm.).

The Swift Parrot is well known from the Spotted Gum-Ironbark Forests of the Lower Hunter Valley. These forests are recognised by the Swift Parrot Recovery Team as being significant to the national population of the species (Swift Parrot Recovery Team 2001). Large numbers of the Swift Parrot have been recorded feeding in flowering Spotted Gum within the Abermain portion of Werakata NP in June 2000. The birds have recently been observed in the same area in May - June 2005. The birds were observed feeding on nectar, blossom and lerps in Spotted Gums and also on lerps in Grey Box (D. Saunders pers. comm.).

There are also a number of records from Werakata SCA, particularly south west of Kitchener (e.g. Sawpit Road) and east of Ellalong Road in the western section of the reserve (Map 8). Additionally there are records from adjacent areas, such as Mulbring to the east, Wollong Road and Ellalong to the south and Bellbird Heights to the north.

Spotted Gum is widespread in the two reserves along with another winter flowering eucalypt, the Forest Red Gum (*Eucalyptus tereticornis*) which is prevalent along drainage flats within the NP. Werakata NP and SCA remain some of the few protected areas supporting Swift Parrot habitat on the valley floor (Map 8). There are a number of other recent records of this species from adjoining crown and private lands, and a cooperative approach to the management of these lands is warranted.



Map 8: Werakata NP and SCA Endangered Woodland Birds

TURQUOISE PARROT

Species Profile

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

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Threats

Key threats include: ongoing 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 (Garnett and Crowley 2000). Fire can impact on the breeding of this species through the destruction of dead stumps, but can positively affect feeding habitats (Quin and Baker-Gabb 1993). Further threats include removal of dead wood and dead trees (NSW Scientific Committee 2003a), Psittacine Circoviral (beak and feather) Disease (DEH 2004); habitat alteration by the invasion of exotic perennial grasses such as Serrated Tussock (*Nassella trichotoma*) (NSW Scientific Committee 2003b); and land subsidence due to longwall mining (NSW Scientific Committee 2005b). In Western Sydney the invasion of habitat by the African Olive (*Olea europaea* subspecies *cuspidata*) has resulted in a loss of foraging habitat. The species may also be threatened by competition for nesting sites with introduced birds, such as the Common Myna (*Acridotheres tristis*).

Local and Regional Conservation Status

The Turquoise Parrot is listed as Vulnerable on the NSW TSC Act (1995) and is listed by Garnett and Crowley (2000) as Near Threatened. Within NSW, the number of records is highest in the Sydney Basin Bioregion and along the western slopes (Nandewar, Brigalow Belt South and NSW South West Slopes Bioregions) (DECC 2008a). In the Sydney Basin Bioregion, it is most commonly found within dry grassy box woodland environments that are prominent in the Hunter and Capertee Valleys and to a lesser extent the Cumberland Plain. Important conservation reserves for this species in this Bioregion include Yengo and Goulburn River NPs, Munghorn Gap NR and Yerranderie SCA.

The Turquoise Parrot has severely declined in the lower Hunter region, with a resident population no longer present in the Cessnock – Kurri Kurri area (A. Zoneff, pers. comm.). There is one recent record adjacent to Werakata NP of two individuals in the Weston area in June 2006 (DECC 2008a). There are also several sightings recorded at two locations during the mid to late 1990's north of Mount Tomalpin area outside the NP (Map 9). Recent DECC surveys did not record this species. Suitable habitat appears restricted to small grassy riparian areas and taller forests with an open understorey on the southern slopes of Mount Tomalpin. Elsewhere the forests and woodlands contain a dense shrub layer and sparse grass cover, which is not typical habitat for the species. Much of the preferred habitat containing grassy Box-Red Gum-Ironbark woodlands in the lower Hunter has been cleared.

There are no documented records from Werakata SCA, although this species may potentially occur within the reserve as a rare visitor.

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 these species by its slightly larger size, distinctive pale supercilium (eyebrow stripe) and by 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, this species spends approximately half of the time on the ground where it feeds 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 (Schodde and Mason 1999).

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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) predicted that the population in NSW had declined by at least twenty percent over the last fifteen years. Studies have shown that populations cannot persist in habitat fragments smaller than 300 hectares, mostly because females either disperse or suffer from preferential mortality. As with most treecreepers, once extinction occurs in a remnant, natural recolonisation is unlikely (Garnett and Crowley 2000). Competition for tree hollows from introduced species such as the Common Starling and European Honeybee is also problematic (Higgins *et al.* 2001; NSW Scientific Committee 2001a). Further Key threatening Processes that are considered to impact on this species are the removal of dead wood and dead trees (NSW Scientific Committee 2003a) and grazing, which reduces the diversity of ground-dwelling invertebrates and hence food availability (NSW Scientific Committee 2001a).

Local and Regional Conservation Status

The eastern subspecies of the Brown Treecreeper is listed as Vulnerable on the NSW TSC Act (1995) due to a severe reduction in range and decrease in abundance across NSW and because of the continued threat faced by the species. It is found through all the eastern Bioregions in NSW, though it is least common in the south, and has declined significantly within the Sydney Basin and NSW North Coast Bioregion. 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 Cumberland Plain and Hunter Valley (DECC 2008a).

The Brown Treecreeper has declined in the lower Hunter region, with small resident populations only present in some of the larger and less disturbed forest remnants (A. Zoneff, pers. comm.). The species is rare within Werakata NP. There are three records of the species within the NP, although 2005 DECC surveys did not record the species (Map 9). A few individuals in the 2008 DECC survey were observed ranging into the NP on the north side of Abernethy Road from Werakata SCA. Extensive survey work carried out in the adjoining HEZ lands revealed breeding activity was evident at a number of locations within Spotted Gum Forest and the open grassy riparian forests (HSO Ecology 2004). In Werakata NP the species is unlikely to inhabit areas where a dense shrub understorey occurs particularly in thickets of Ball Honey Myrtle in the Spotted Gum-Ironbark Forests and amongst the Kurri Sand Swamp Woodland. It is more likely to be found in the open riparian areas or in taller grassier variations of the Spotted Gum forests that are found in the southern portions of the reserve.

Within Werakata SCA, this bird was only recorded on the south side of Abernethy Road adjacent to Werakata NP in the 2008 DECC survey (Map 9). The rarity of the species within the reserve may be attributed to the predominance of relatively dense even-aged stands of woodland across the area.

SPECKLED WARBLER

Species Profile

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The Speckled Warbler (*Pyrrholaemus sagittata*) is a small, ground-dwelling scrubwren-like bird. It is similar in size and shape to the Buff-rumped Thornbill (*Acanthiza reguloides*) but can be identified by its boldly streaked underbody, distinctive facial pattern and noticeably longer tail. The female differs from the male by having a chestnut, rather than black, streak in the eyebrow. It usually occurs in the grassy understorey of dry sclerophyll forests and woodlands dominated by eucalypts, often with scattered shrubs. The Speckled Warbler 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. Two to four (usually three) eggs are laid, though breeding success can be low. The Speckled Warbler is endemic to south-eastern Australia, being found between Maryborough (Queensland) and the Grampians (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). Local populations in small isolated patches readily become extinct due to natural population fluctuations (Garnett and Crowley 2000); particularly in landscapes where there are no patches over 100 hectares in area (NSW Scientific Committee 2001c). Other threats include invasion of exotic perennial grasses such as Serrated Tussock (NSW Scientific Committee 2003b); nest predation by Cats, Foxes and Black Rats; and loss of ground cover due to grazing by stock, kangaroos and Rabbits (Garnett and Crowley 2000; NSW Scientific Committee 2001c) In the Cumberland Plain and lower Hunter further threats include inappropriate fire regimes that result in a decreased cover of forbs and grasses (T. Saunders, pers. comm.); collection of dead timber; loss of habitat due to infestation by African Olive and removal of the important native shrub Blackthorn, which residents widely consider to be a weed.

Local and Regional Conservation Status

The Speckled Warbler is listed as Vulnerable on the NSW TSC Act (1995) and as Near Threatened by Garnett and Crowley (2000) due to declines in abundance across its range. It is widespread in the eastern Bioregions of NSW, 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 drier woodlands, including the Burragorang, lower Hunter and Goulburn River Valleys. Its preference for woodlands on higher fertility soils means that it mostly occurs outside the reserve system, although notable exceptions include Nattai and Munghorn Gap NPs, Barton and Girralang NRs and the fringes of Wollemi NP.

The Speckled Warbler is infrequently recorded in the lower Hunter Valley and has declined with only scattered pairs or small groups remaining (A. Zoneff, pers. comm.). This bird was not recorded in the 2005 Werakata NP DECC fauna survey. However, there are two records of this bird within or adjoining the NP (Map 9) and several pairs are known to occur in woodland bordering the northern boundaries of the NP and in the Kearsley area (J. Goswell and A. Zoneff, pers. comm.). Within the reserve suitable habitat is restricted to small areas of open woodland associated with grassy creek flats, grassy open forests near Mount Tomalpin and at the interface of cleared environments.

In Werakata SCA, the Speckled Warbler was recorded at three localities on the edge of cleared land on the reserve boundary south of Kitchener and east of the Ellalong Road in the 2008 DECC survey (Map 9). It is likely that other groups are scattered elsewhere within the reserve, particularly adjacent to the park boundary.

REGENT HONEYEATER

Species Profile

© DECC

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 woodlands supporting Swamp Mahogany and Spotted Gum. The population seems to undertake complex movements, generally dependent on where flowering food trees are available. It feeds mainly on nectar, and nests in eucalypts where it usually lays two or three eggs. It is endemic to south-eastern Australia, formerly between Rockhampton (Queensland) and Adelaide, though it is now extremely rare in Queensland and probably extinct in South Australia, with a contraction of range in the other two states (Higgins *et al.* 2001).

Threats

Land clearance for agriculture has removed about three-quarters of the suitable habitat of the Regent Honeyeater. The remaining vegetation is fragmented, and continues to be degraded by the removal of larger trees. Habitat alteration may also advantage more aggressive honeyeaters, such as Miners (*Manorina* sp.) and Friarbirds (*Philemon* sp.) which may displace the Regent Honeyeater. The remaining population is estimated to be between 800 and 2000 individuals (Department of the Environment, Water, Heritage and the Arts 2007).

Local and Regional Conservation Status

The Regent Honeyeater is listed as Endangered on the NSW TSC Act (1995) and as Endangered on the Commonwealth EPBC Act (1999) due to a massive decrease in abundance and reduction in range. 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. Important areas in the Sydney Basin are the Capertee and lower Hunter Valleys, the northern Cumberland Plain, Burragorang Valley and the Central Coast. The majority of records are outside reserves, but important exceptions include Goulburn River, Wollemi and Nattai NPs, Cockle Bay and Munghorn Gap NRs and Werakata SCA.

The Regent Honeyeater is a sporadic visitor to the lower Hunter valley depending on the concentration of flowering of key tree species, and the absence of flowering elsewhere within its range. For example spring/summer 2007 attracted extraordinary numbers of the species to the region due to a one in 17 year (or more) mass flowering of the Red Ironbark (A. Zoneff, pers. comm.). At this time it was estimated that at least 16 pairs nested in woodland between Werakata NP and Kurri Kurri fledging approximately 18 young (Morris 2008; A. Zoneff, pers. comm.). Within Werakata NP, Grenadier *et al.* (2001) reported that five birds were observed by members of the Hunter Bird Observers Club feeding in Spotted Gum blossoms in June 2000 (Map 8).

There are several records from Werakata SCA: one bird was observed feeding in flowering Grey Gum adjacent to Pelton Road in the 2008 DECC survey, 20 individuals were observed adjacent to Black Creek south west of Kitchener in 2000, and eight individuals adjacent to Sand Pit Road southwest of Kitchener in 2000 (Map 8). This species has also been recorded from adjacent areas, such as Cony Creek, Bellbird Heights and Ellalong areas.

Due to the number of sightings and recent breeding records adjacent to the NP the area ranks alongside a small number of sites that are frequently visited by this declining bird in the Sydney Basin. As a result woodlands within the region are considered critical for the ongoing survival of this endangered bird.

BLACK-CHINNED HONEYEATER

Species Profile

The eastern subspecies of the Black-chinned Honeyeater (*Melithreptus gularis gularis*) is a medium-sized, 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 between dry eucalypt woodlands that feature ironbark and/or box species with low to moderate rainfall levels, where they are usually found in pairs or small groups of up to twelve (Higgins *et al*. 2001). They feed on insects, nectar and lerp usually in the upper canopy and outermost flowers and leaves.

© T. Shimba

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 the fragmentation of woodland habitat and do not appear to survive in remnants less than 200 hectares (NSW Scientific Committee 2001b). The species appears to occur naturally at low densities (NSW Scientific Committee 2001b) and is relatively mobile, so the reason for this absence in small fragments is unknown (Garnett and Crowley 2000). They are also 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 Currawong (NSW Scientific Committee 2001b).

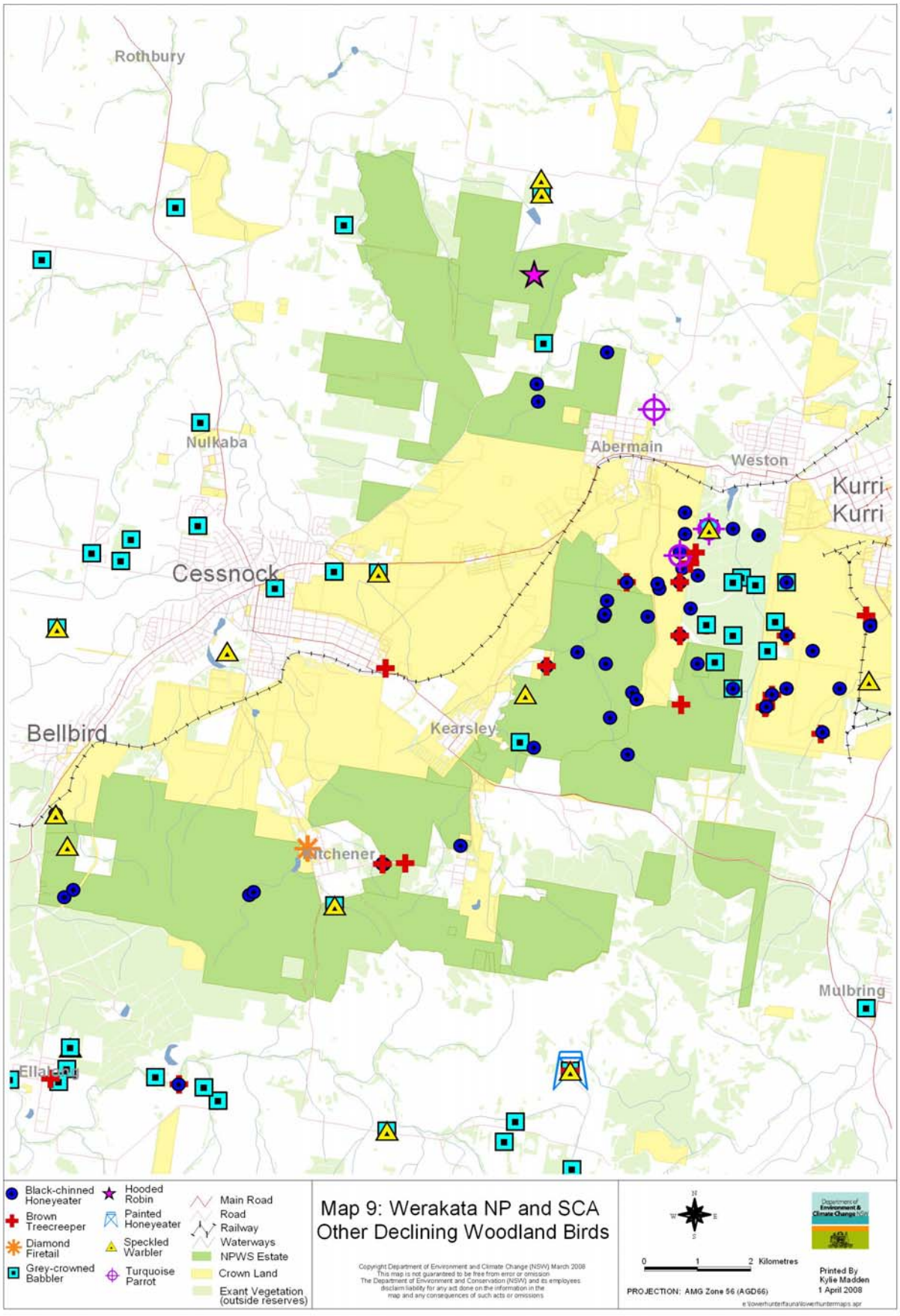
Local and Regional Conservation Status

The eastern subspecies of the Black-chinned Honeyeater is listed as Vulnerable on the NSW TSC Act (1995) due to severe declines in range and abundance across NSW and due to the serious threats facing this species. 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 and few in the South Eastern Highlands (DECC 2008a). In the Sydney Basin region most records come from drier areas with more fertile soils, such as Western Sydney, the Capertee and Hunter Valleys, where it is often associated with winter-flowering species, such as White Box and Spotted Gum. All these areas have been heavily cleared in the past and remain subject to ongoing degradation and fragmentation.

The Black-chinned Honeyeater is a declining species, predominantly confined to the larger woodland tracts within the lower Hunter region (A. Zoneff, pers. comm.). Within Werakata NP, this bird was recorded at nine locations (Map 9) during the 2005 DECC surveys (DECC 2008). Observations were concentrated in the northern and middle sections of the reserve, where flowering Spotted Gums and ironbarks were profuse. These findings concur with those of HSO Ecology (2004) that the species occurs widely within the adjoining Hunter Economic Zone. Werakata NP provides high quality habitat for this species in the Hunter region. Recent surveys in larger reserves in Wollemi, Yengo NP's and Manobalai NR found only a handful of records of Black-chinned Honeyeaters associated with ironbark woodlands on the escarpment boundaries (DEC 2005b, 2005c, 2005d).

This species was found to be less common in Werakata SCA during the 2008 DECC survey, with records from adjacent to Abernethy Road, along Pelton Road and south-east of Bellbird (Map 9). The smaller number of records may have been due to the timing of the survey, with little Spotted Gum in blossom.

Preferred habitat for this species is not well protected in reserves and remains under threat from clearing across the Sydney Basin Bioregion. Consequently, since the lower Hunter Valley has been identified as important to the species, cooperative management of the adjoining crown and private lands in association with the DECC reserves is warranted.



Map 9: Werakata NP and SCA Other Declining Woodland Birds

GREY-CROWNED BABBLER (EASTERN SUBSPECIES)

Species Profile

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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). It is widespread on the inland slopes of the Great Dividing Range and on the western plains in NSW. 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 (DEC 2005f; Garnett and Crowley 2000). The species feeds on invertebrates gleaned from vegetation or the ground (DEC 2005f; Garnett and Crowley 2000). The birds form family parties, consisting of a breeding pair and offspring from prior breeding years. These family units are thought to be vital for predator avoidance and cooperative feeding of the young (King 1980).

Threats

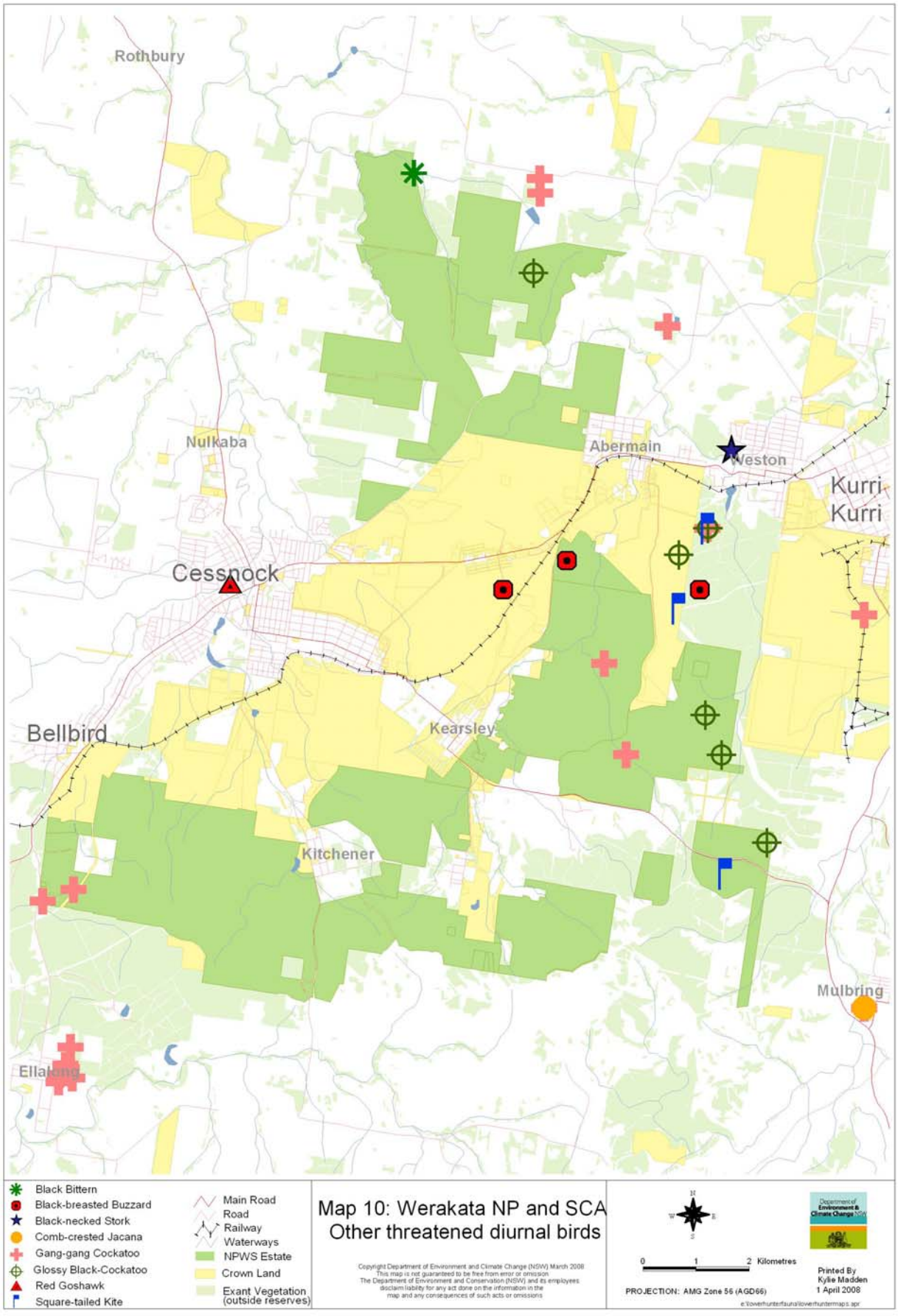
The Grey-crowned Babbler is one of a suite of woodland birds that have declined throughout their range due to habitat clearance (Reid 1999). Much of the remaining habitat for this species occurs in a mosaic of remnants, many of which are often inadequate to sustain long term populations resulting in the gradual disappearance of this bird from many areas (Garnett and Crowley 2000). This gradual disappearance has been attributed to the consequences of habitat fragmentation on the birds' behaviour, namely smaller family-group sizes and the resulting reduction in breeding success and higher rates of nest predation (DEC 2005f; Garnett and Crowley 2000; NSW Scientific Committee 2004b). Once lost from a habitat fragment, natural recolonisation is unlikely (Robinson and Traill 1996). Other threats include agricultural practices, such as grazing and associated weed invasion (NSW Scientific Committee 2003b); increased competitor abundance in disturbed habitats (NSW Scientific Committee 2004a); removal of important feeding sites in the form of dead wood and dead trees (NSW Scientific Committee 2003a); and predation by the Feral and domestic Cat and Black Rat.

Local and Regional Conservation Status

The eastern subspecies of the Grey-crowned Babbler is listed as Vulnerable on the NSW TSC Act (1995) due to severe declines in range and abundance across NSW and due to the serious threats facing this species. It is most common in the central western regions 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 the Clarence River Valley (DECC 2008a). Within the Sydney Basin Bioregion the species is virtually restricted to the Hunter Valley, with a few records also in the Capertee Valley, where it is closely associated with the drier grassy woodland habitats. Within the Bioregion it is poorly represented in reserves, having been recorded in only small areas within Wollemi NP, Goulburn River, Yengo and Werakata NPs and Munghorn Gap NR (DECC 2007a, 2008a).

The Grey-crowned Babbler has been widely recorded across the Hunter Valley floor but has declined in recent years (A. Zoneff, pers. comm.). It is commonly found near the edges of disturbed environments with a tall shrub or small tree layer present that is utilised for nesting purposes. A number of nesting sites for this species have been recorded in the Lower Hunter (HSO Ecology 2004). In Werakata NP this species appears confined to the Park boundary (Map 9). For example, it was recorded in Spotted Gum - Ironbark Forest on the northern boundary of the reserve in the 2005 DECC survey. Additionally, it has been recorded in adjacent areas, particularly between the NP and Kurri Kurri.

In Werakata SCA the only record of this species was from the reserve boundary south of Kitchener in Lower Hunter Grey Box Grassy Forest during the 2008 DECC survey (Map 9). This bird is likely to occur elsewhere along the boundary of the SCA. Additionally, there are also records from adjacent areas, such as at Mulbring to the east, Sandy Creek Road and Paxton to the south, and Bellbird Heights and Cessnock to the north.



Map 10: Werakata NP and SCA Other Threatened Diurnal Birds

BARKING OWL

Species Profile

The Barking Owl (*Ninox connivens*) is an owl of intermediate size between the larger Powerful Owl and the smaller Southern 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 or Dog/dingo barks. It usually inhabits dry open eucalypt forests and woodlands, where it is often associated with hydrological features such as rivers and swamps (Taylor *et al.* 2002a). The owl is often located at the edge of forest blocks adjacent to cleared land, possibly due to increased prey availability at such locations (Taylor *et al*. 2002b). It nests in the hollows of live trees, often on the edge of cleared country, where it lays one to three eggs (Taylor *et al.* 2002b; NPWS 2003b). 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 (Higgins 1999).

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Threats

The main identified threat to the species is habitat destruction; particularly the clear-felling for agriculture of woodlands and forests from low-lying fertile areas (Taylor *et al.* 2002b). Remaining habitat is often subjected to further degradation through grazing, collection of firewood or forestry operations that fell old-growth and over-mature trees, thus reducing available nesting sites (Kavanagh *et al*. 1995; NPWS 2003b). Other threats include predation, particularly of fledglings, mortality from collisions with fences and vehicles, and secondary poisoning from rodenticides (NPWS 2003b). The owl may also be adversely impacted by competition from Feral Honeybees (Garnett and Crowley 2000). The long generation time (ten years) of this species is a further issue, as it does not have the ability to recover quickly following population declines (NSW Scientific Committee 1998b).

Local and Regional Conservation Status

The Barking Owl is listed as Vulnerable on the NSW TSC Act (1995) due to a severe reduction in range and a decrease in abundance within NSW. For this reason, a recovery plan has been prepared outlining the key management actions required to ensure the long-term survival of the species across NSW (NPWS 2003b). Records occur throughout the state, though it is rarer in the far west and at higher altitudes (DECC 2008a). Within the Sydney Basin Bioregion, important localities include the Capertee Valley and western Hunter Valley. Within this Bioregion, few records occur within conservation reserves, though surveys have recently obtained a number of records from Grassy Box Woodlands on the peripheries of Yengo, and Wollemi NP and Manobalai NR (DEC 2005b, 2005c, 2006a; DECC 2007a).

The Barking Owl is not commonly recorded in the lower Hunter Valley despite extensive survey effort in the region (LHCCREMS 2001; NPWS 2001b; DECC 2008a). However, in the drier western Hunter Valley, fewer surveys have been undertaken although the grassy woodlands are likely to provide better habitat. Recent surveys (DEC 2005b, 2005c, 2006a) in dry ironbark woodlands in northern Wollemi and Yengo NPs and Manobalai NR confirm the bird's preference for drier environments in this region. In Werakata NP this species is known from only a single on the edge of the northern section of the park. The bird was heard calling by a landowner adjoining the reserve (Map 11).

The only record for Werakata SCA was a single individual attracted by call playback in Cabbage Gum woodland in the extreme south-west corner of the reserve adjacent to Ellalong Road in the 2008 DECC survey (Map 11). It is likely that most of the home range of this individual occurs on adjoining private land.

These records are significant for the lower Hunter Valley as so few records exist in this part of the valley and even fewer within protected areas. Follow-up surveys are worthwhile to confirm the species' presence in Werakata NP and assess the importance of Werakata SCA to the species. Territories of this owl are worthy of special management actions that seek to protect roost and nest sites.

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 a variety of forest habitats, though it usually breeds and roosts in rainforest or wet sclerophyll forest. It hunts in more open forests, where it feeds mainly on arboreal mammals, particularly the Common Ringtail Possum and Greater Glider. This species usually nests in eucalypt hollows within or below the canopy, and generally has a clutch size of two eggs. They usually maintain 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). The Powerful Owl is tolerant of some level of disturbance, and is found in the suburban areas of Brisbane, Sydney and Melbourne (Garnett and Crowley 2000).

© M. Schulz

Threats

Land clearance for agriculture has reduced the area of habitat available for the Powerful Owl (Garnett and Crowley 2000), particularly the availability of roost sites. However, this species will survive in areas with some levels of disturbance, such as in selectively logged forests (Kavanagh 1997) with the abundance of prey and availability of nesting/roosting sites determining its persistence (Chafer 1992; Debus and Chafer 1994). Other factors that may affect this species are: predation of fledglings by Foxes, collisions with vehicles and poisoning, though none of these are considered to be significant causes of mortality.

Local and Regional Conservation Status

The Powerful Owl is listed as Vulnerable on the NSW TSC Act (1995), and a recovery plan has been prepared outlining key actions that ensure the long-term persistence of this species and the other large forest owls across NSW (DEC 2006c). 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 Great Dividing Range onto the Central Tablelands. Most reserves within the Sydney Basin support territories of the Powerful Owl, though they are at lower densities in Yengo and Wollemi NPs (DEC 2005c, 2005d, 2006a; DECC 2007a).

Powerful Owls are widespread and relatively common in the Lower Hunter and Central Coast regions. While primarily known from tall open forests on the coastal ranges and sandstone gullies they are recorded in a range of habitats including urban interface areas. Playback surveys in the 2005 DECC fauna survey in Werakata NP failed to detect the species. However, it is known from the Mount Tomalpin area (Map 11) with a number of roost sites located in densely vegetated gullies in the Hunter Economic Zone (HSO Ecology 2004). Taller forests on the south side of Mount Tomalpin and adjacent gully habitats are likely to represent key habitat areas within the park.

In Werakata SCA the only records are of several individuals that either responded to playback or were heard calling east of Ellalong Road in the far west of the reserve during the 2008 DECC survey (Map 11). This species has also been heard calling in woodland on private land adjacent to the eastern section of the reserve in the Pinnacle Link Road area (R. Suwald, pers. comm.).

In a region-wide perspective, the forests and woodlands of Werakata NP and SCA do not fall within priority conservation areas for the Powerful Owl (Wintle *et al*. 2004).

MASKED OWL

Species Profile

The Masked Owl (*Tyto novaehollandiae*) is a large 'barn' owl, which has three colour morphs (with intermediates). It 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 woodland habitats with large hollows for roosting and open areas for hunting. It feeds mostly on ground-dwelling mammals and occasionally on diurnal birds, Sugar Gliders and insects. The owl has a home range of 800 to 1200 hectares (Kavanagh 2002). It nests in hollow trees, usually eucalypts, where two to three eggs are the normal clutch size (Higgins 1999).

© R. Jackson

Threats

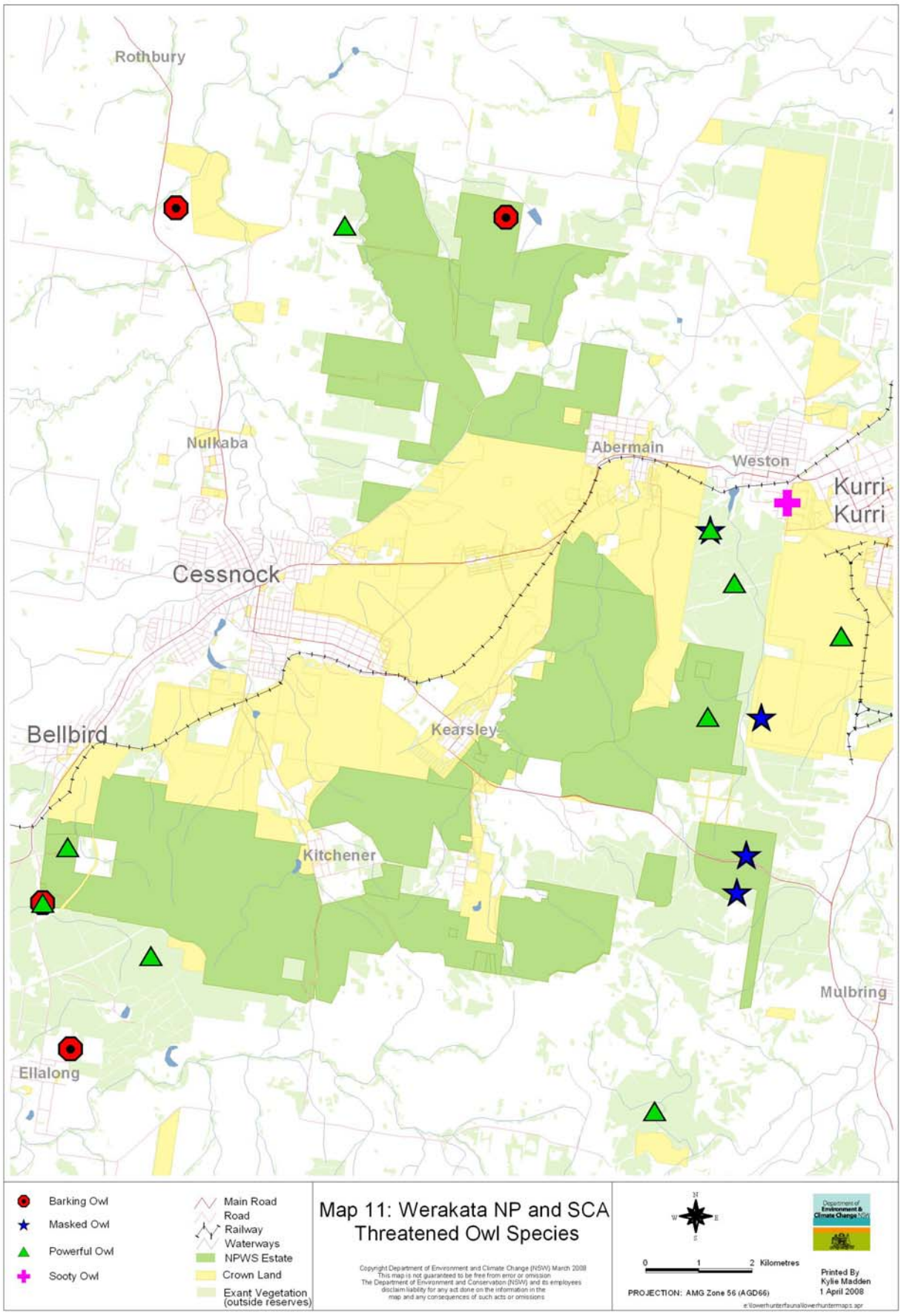
Clearance of native forest for agriculture and urban development, and fragmentation of habitat has decreased the abundance of this species (Kavanagh 2002; Garnett and Crowley 2000). Some forestry practices affect the species through the removal of hollows or reduction in foraging habitat due to vigorous regrowth (Garnett and Crowley 2000); though modern mosaic logging operations may be less problematic (Kavanagh 2002). The removal of dead wood and dead trees is considered to be a key threatening process affecting this species (NSW Scientific Committee 2003a). Fire intensity and frequency may also indirectly affect the species due to its impact on hollows and prey species, although generally a more open understorey may preferentially suit the species by providing more foraging opportunities (DEC 2004a).

Local and Regional Conservation Status

The Masked Owl is listed as Vulnerable on the NSW TSC Act (1995) due to a reduction in range and a decrease in abundance across NSW. For this reason, a recovery plan for the species has been prepared outlining the actions required to ensure the long-term survival of this and other large forest owls (DEC 2006c). The majority of records for the species in NSW are located within the three coastal bioregions, with fewer records in the South Eastern Highlands Bioregion (DECC 2008a). Within the Sydney Basin, the open woodlands of the coastal plains between Wyong and Port Stephens support the highest numbers of this species; though this area is currently under considerable threat from development. Important reserves in the Sydney Basin are Brisbane Waters and Jervis Bay NPs and Berowra Valley Regional Park.

The Spotted Gum forests of the Cessnock-Kurri Kurri area have yielded few records of Masked Owl despite a significant amount of survey work in the last few years. This is surprising given that the coastal plains, less than 10 kilometres to the east, contain a significant number of records, and delineate the area as a population stronghold (DECC 2008a). The 2005 DECC survey failed to record this species in Werakata NP. Two records exist just outside of the reserve adjacent to the south-eastern boundary and south of Weston (Map 11).

There are two records of this owl from the eastern section of Werakata SCA, with one individual heard adjacent to Missing Links Road in the 2008 DECC survey (Map 11). This owl is occasionally heard calling in woodland on private land between the two eastern sections of the reserve adjacent to Pinnacle Link Road (R. Suwald, pers. comm.).



Map 11: Werakata NP and SCA Threatened Owl Species

KOALA

Species Profile

The Koala (*Phascolarctos cinereus*) is a distinctive, iconic arboreal mammal of eucalypt forests and woodlands. It feeds on a wide range of eucalypts, though the species preferred diet varies throughout its range. Individuals spend most of the day resting in dense foliage or the forks of trees, and are most active following sunset (NPWS 1999c). Home range varies depending on the density of food trees and population size. In coastal areas of NSW home ranges vary between 15 and 100 hectares, with individuals, particularly dispersing juveniles, known to travel up to 50 kilometres (Martin and Handasyde 1995; NPWS 1999c).

© P. Madden

Threats

Throughout its entire range, loss, fragmentation and degradation of habitat for urban development, agriculture and mining are its greatest threat (NPWS 2003c). Reed *et al.* (1990) reported on a survey in 1986-87 that found that the Koala had disappeared from 50 to 75 percent of its known range in NSW and populations had been lost from many localities, particularly on the southern and western edges of their distribution. Other threats to the Koala across its range include: disturbance by fire; mortality from Dogs and motor vehicles; and infection by *Chlamydia* which causes *keratoconjunctivitis* (an infection of the eyes) and infertility (NPWS 1999c; 2003c). In NSW, *Chlamydia* mostly afflicts animals that are already stressed and it is not considered to be a major problem (Menkhorst 1995; NPWS 2003c).

Local and Regional Conservation Status

The Koala is listed as Vulnerable on the NSW TSC Act (1995) due to a reduction in range and a decrease in abundance across the state. The species is widespread across the eastern third of the state, with records scattered throughout the South Eastern Highlands Bioregion (DECC 2008a). It is less common further west with only sparse records in parts of the Brigalow Belt South and Darling Riverine Plains Bioregions. The recovery plan for this species (NPWS 2003c) indicates that much of the Sydney Basin Bioregion comprises secondary habitat that supports populations that are patchy and at low abundance. Within the Sydney Basin Bioregion, Koalas have recently been discovered in Nattai NP and Wollondilly River NR (DEC 2004c) and are known from Lower Blue Mountains and Wollemi NPs (DEC 2005c). Prominent populations occur around Campbelltown and the Avon Catchment (DECC 2007b, 2008a). In the Hunter Region, the species is known from Yengo and Wollemi NPs as well as the Pokolbin, Corrabare and Watagan Ranges State Forests.

This species was not recorded in Werakata NP in the 2005 DECC survey. Scratch marks on several Grey Gums, attributed to Koalas were located in the middle section of the reserve (Grenadier *et al.* 2001; Map 12). A local resident who had seen and heard Koalas in the area (Grenadier *et al.* 2001) confirmed this general location. A small number of other records have been made in close proximity to the reserve (Map 12).

This species has been recorded in the SCA adjacent to the Quorrobolong Road, with several other sightings on the northern edge of the reserve at Kitchener and Bellbird (Map 12). No individuals were recorded during the 2008 DECC survey. A small population was formerly present on private land east of Pinnacle Link Road east of the reserve (R. Suwald, pers. comm.). This species has not been seen for some time on wooded private land between the two eastern sections of the reserve (R. Suwald pers. comm.). The absence of recent sightings suggests that this population has disappeared. Other landowners, motorbikers and other reserve users questioned had not encountered the species within the area.

Surveys carried out in the region (Ecotone Ecological Consultants 1995; HSO Ecology 2004) as well as recent DECC surveys have failed to find evidence of the species. This would suggest that individuals are sparsely distributed across the Cessnock area and that currently the region is primarily used by browsing and wandering males. Preferred feed trees in the region include Forest Red Gum and the Grey Gum.

YELLOW-BELLIED GLIDER

Species Profile

The Yellow-bellied Glider (*Petaurus australis*) is a nocturnal marsupial found in the tall open sclerophyll forests of eastern Australia. It is an arboreal species that requires mature hollow-bearing trees in which to den during the day (NPWS 1999d). 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 shriek, 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 family groups demonstrating a marked preference for individual trees within their territory (Mackowski 1988). The Yellow-bellied Glider utilise a home range of between 30 and 65 hectares (Goldingay and Kavanagh 1991).

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Threats

Yellow bellied Gliders are known to be greatly affected by the reduction of denning resources when the availability of hollow-bearing trees are lost through clearing, fragmentation or timber extraction (NPWS 1999d). In particular, logging of high-productivity forests is thought to be the major threat to the species across its range (NPWS 2003d). Predation by cats and foxes is also thought to contribute to the species' vulnerability. Impacts of fire regimes are poorly understood, although high-intensity fire has been considered to reduce populations and the availability of food resources (NPWS 1999d, 2003d). This species is occasionally entangled on barbwire fences, including a record in 2000 in forest north of Werakata SCA (DECC 2008a).

Local and Regional Conservation Status

The Yellow-bellied Glider is listed as Vulnerable on the NSW TSC Act (1995) as it is believed to have undergone population declines and a reduction in range (NPWS 2003d). It was also thought to be subject to serious threatening processes, whilst being an ecological specialist with poor recovery potential. For these reasons, in 2003, a recovery plan for the species was approved for NSW that outlines key actions required to ensure the long-term viability of the species (NPWS 2003d). Within the Sydney Basin Bioregion it is patchily distributed with the majority of records being located in reserves such as Nattai, Blue Mountains, Yengo, Watagans and Wollemi NPs (DECC 2008a). Recent DECC surveys have discovered the species to be more abundant than previously thought in the escarpments and gullies in the Blue Mountains, Wollemi, Yengo and Nattai NPs and within the Warragamba Special Area (DEC 2005c, 2005d, 2006a; DECC 2007b). Across the Sydney Basin Bioregion there appears to be a distinct preference for Grey Gum as a preferred sap feed tree (Mackowski 1988).

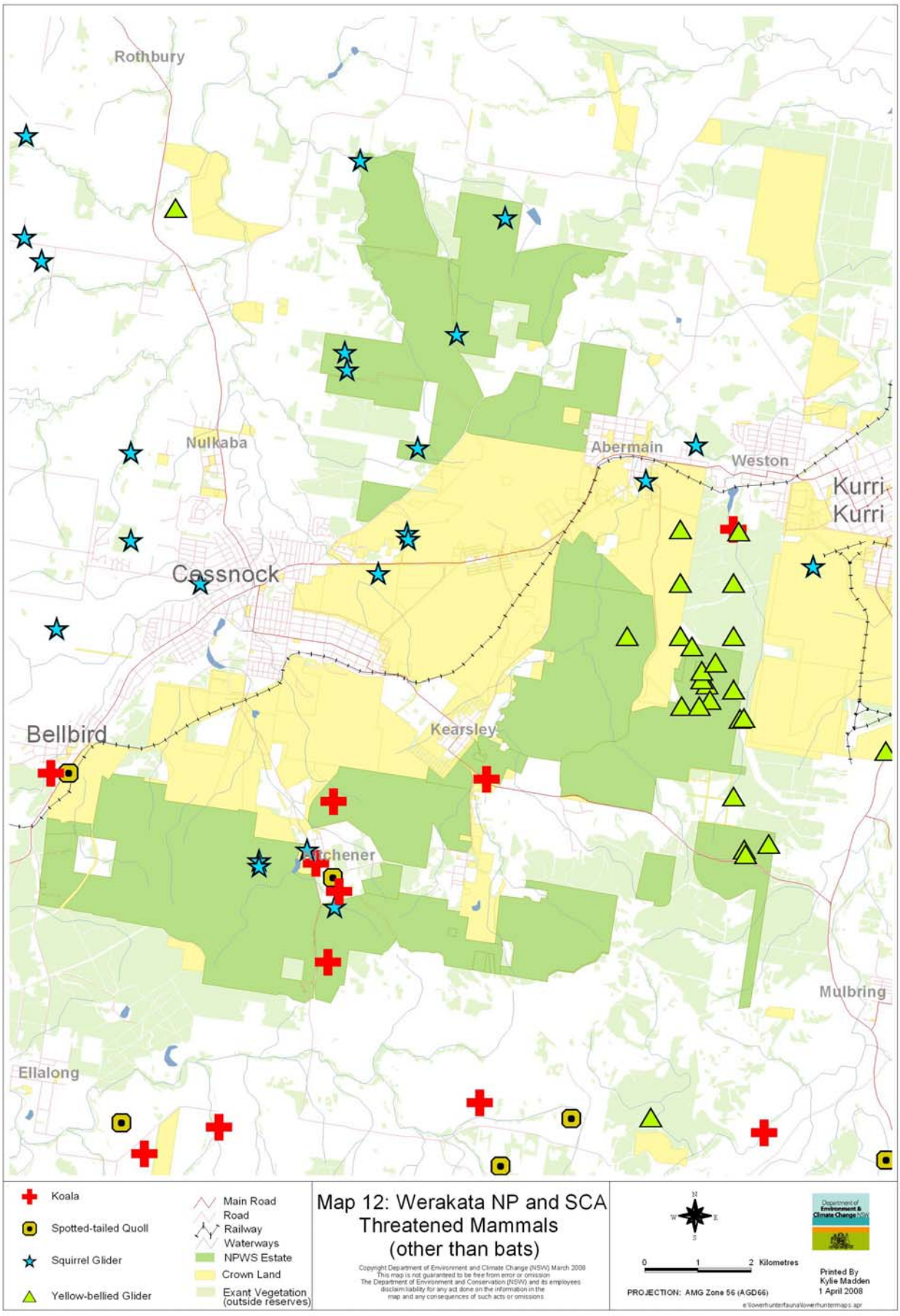
The Yellow-bellied Glider is patchily distributed in the lower Hunter region, primarily restricted to areas of tall moist forests. The species has been observed in the south-east portion of Werakata NP near Mount Tomalpin. The 2005 DECC survey confirmed that habitat for the species is being used with distinct feed tree markings found on Grey Gums on the northern side of Mount Tomalpin (Map 12). Records found within the Mount Tomalpin area and Chinamans Hollow in the Hunter Economic Zone (HEZ) represents the most significant occurrence on the floor of the Lower Hunter Valley (HSO Ecology 2004; Map 12). In the latter area in late 2007 a Yellow-bellied Glider was observed denning in the same Grey Gum as a nesting Regent Honeyeater to the north of the NP (J. Goswell, pers. comm.).

Within the Werakata SCA this species appears confined to north of Lake Road in the eastern block of the reserve and possibly represents the southern edge of the Mount Tomalpin population (Map 12). In the 2008 DECC survey no individuals were located within the SCA. However, a feed tree with old feed marks was located in a Grey Gum on the western side of North Basin Road in the most eastern section of the reserve. Additionally, there is a 1994 record of an individual down a mine shaft at the

Ellalong Colliery south of the reserve (DECC 2008). Records from the Ellalong area suggest that the species could potentially occur in the drier woodlands of the western block of the SCA.

While habitats within Werakata NP and SCA are not considered areas of conservation priority for the species in the region (Wintle *et al*. 2004) they do represent the only areas that conserve the species on the valley floor. Fire is likely to present the greatest long-term threat to the species within the reserves, particularly if mature stands of Grey Gum are damaged on the slopes of Mount Tomalpin. Preventing repeated high-intensity fires within gullies between the Quorrobolong Road, and the eastern section of Werakata SCA will also assist in ensuring viable populations within the reserves. A cooperative approach to fire management between land managers of the adjoining private land, Crown land and the Rural Fire Service is likely to assist the persistence of the species.

Yellow-bellied Glider feed marks on a Grey Gum trunk, Mount Tomalpin, Werakata NP.
© M. Schulz/DECC



Map 12: Werakata NP AND SCA Threatened Mammals (other than bats)

SQUIRREL GLIDER

Species Profile

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

© N. Williams

Threats

The Squirrel Glider may be affected by the following threats: the loss of hollow-bearing trees through clearing, fragmentation or timber extraction; predation by Cats and Foxes; inappropriate fire regimes and the removal of dead trees and wood (NPWS 1999e; NSW Scientific Committee 2003a). Individuals have also been rescued by the Wildlife Information and Rescue Emergency Service (WIRES) from barbwire fences, including one individual at Cypress Lakes Golf Course west of Bellbird and one on the southern edge of Cessnock (DECC 2008a).

Local and Regional Conservation Status

The Squirrel Glider is listed as a Vulnerable species on the NSW TSC Act (1995) as it is considered to have undergone population declines and a reduction in range. It occurs patchily throughout the eastern Bioregions of NSW, and is only recorded with regularity in the NSW North Coast, Nandewar and the Sydney Basin Bioregions. In the Sydney Basin Bioregion, the dry woodlands of the Central Coast and lower Hunter Valley provide very high-quality habitat for the species. This area has been well documented as a stronghold for the species, though few records are from within conservation reserves (Smith and Murray 2003).

The Squirrel Glider is under considerable pressure arising from the loss of habitat due to land clearing and fragmentation throughout the Hunter Valley and Central Coast. As urban development pressures permeate the Hunter Valley, Squirrel Glider populations on reserves in the region will assume increased conservation significance. Recent DECC surveys within Werakata NP recorded seven individuals from six sites; with an additional record from near Abermain in October 2005 (DECC 2008a; Map 12). These results were unexpected as significant survey effort in the reserve and areas adjoining the reserve (HSO Ecology 2004) failed to record the species. All observations except one were made in the Spotted Gum-Ironbark forests and the other in alluvial forest dominated by Forest Red Gum. Survey results suggest that Squirrel Gliders occur at low densities, with approximately one individual observed per five hectares of Spotted Gum forest. These densities do not equate to higher quality habitat found in Wyong and Lake Macquarie LGAs (between 0.5-0.9 per hectare) (Smith and Murray 2003). However, Werakata NP protects the largest area of habitat for the species on the Hunter Valley floor.

In contrast, in the 2008 DECC survey of Werakata SCA, only a single individual was detected (south of Kitchener) in 15 sites spotlighted across the reserve (Map 12). Two other records from this reserve are from individuals spotlighted in Red Ironbark dominated woodland near the Powerline Track west of Kitchener in 1993 (DECC 2008a).

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 a highly mobile species and numbers roosting at specific camps may vary depending on season and food availability. They feed 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. They can travel over twenty kilometres to a food source, and are an important pollinator and disperser of native plants. It is endemic to the east of Australia between Melbourne, Victoria and Bundaberg in Queensland, though it formerly ranged as far north as Rockhampton (NPWS 2001c).

Roosting Grey-headed Flying-foxes. © M. Schulz

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; and electrocution on power lines, particularly in urban areas (NPWS 2001c; DEC 2005h). This species is also commonly entangled on barbwire fences and in nets draped over fruit trees in backyards.

Local and Regional Conservation Status

The Grey-headed Flying-fox is listed as Vulnerable on the NSW TSC Act (1995) and is also listed as Vulnerable on the Commonwealth EPBC Act (1999) due to declines that have been recorded across its range. Eby *et al.* (1999) estimated that there are approximately sixteen camps within the Sydney Basin Bioregion. Camps are generally located based on roost suitability and proximity to food sources and may move when conditions change. Current locality data suggests that the species is primarily distributed across the coastal and hinterland environments although this may reflect reporting bias in the data. They have been recorded in a number of reserves across the region including records from Royal, Wyrrabalong, Blue Mountains, Wollemi and Yengo NPs (DECC 2007b, 2008a). However, few camps are located on conservation reserves within the region. They have also been recorded at numerous locations off reserve in farming and urban environments including the Botanic Gardens in the centre of Sydney. The Hunter Valley and Newcastle area presently contain a large percentage of the total population with average numbers around 440,000 (N. Williams pers. comm.).

No camps have been located within Werakata NP or SCA. Both reserves lie within range of a number of camps within the lower Hunter Valley. The closest camp, near Milfield, is approximately 3.5 to 10km away (from Werakata SCA and NP respectively) and other camps include Black Hill, Martinsville and Singleton. The 2005 DECC survey recorded the species within the NP at a number of locations feeding on flowering Spotted Gum and Ironbark (Map 13). Spotted Gums are one of the primary feed trees for the species in the region (Eby and Law, in prep.). The tree is common in the lower Hunter region and a dominant canopy species throughout the reserve. In late 2007, the species was present in the NP and adjacent forested areas in large numbers feeding on flowering Red Ironbark (J. Goswell, pers. comm.).

The species was also widespread across Werakata SCA during the 2008 DECC survey (Map 13). At this time, the Grey-headed Flying-fox was primarily encountered feeding on the blossoms of the Grey Gum. During this survey, it was observed foraging in the same areas as the smaller Little Red Flying-fox. It is likely that similar to Werakata NP, other important food trees include the Red Ironbark and Spotted Gum.

EAST-COAST FREETAIL-BAT

Species Profile

The East-coast (or Eastern) Freetail-bat (*Mormopterus norfolkensis*) is a member of a genus of bats that remains in a state of considerable taxonomic uncertainty. Within this group the species can be distinguished by its long forearm, upright ears and robust build (Allison and Hoye 1995; Parnaby 1992a; Churchill 1998). Reinhold *et al.* (2001) describes the ultrasonic call as "a pattern of alternating pulses", making it unique among Freetail-bats (*Mormopterus* sp.) though it can also call without this pattern. This is a poorly known species that appears to be restricted to east of the Great Dividing Range between approximately Brisbane (Queensland) and Pambula (south coast of NSW) (Parnaby 1992a; Duncan *et al.* 1999). Habitat preferences are not well understood, but the species appears to favour dry eucalypt forest and woodland. However, it has also been captured in rainforest and wet sclerophyll forest (Churchill 1998; DECC 2007b, 2008a). It usually roosts in tree hollows (Gilmore and Parnaby 1994; Churchill 1998), though it has also been recorded in the roof of a hut and under the metal caps of telegraph poles (Churchill 1998).

© N. Williams

Threats

The threats to this species are poorly known, though it is suspected that urbanisation and clearing for agriculture, and forest harvesting have serious impacts (NPWS 2002b). It has also been suggested that pesticide use may be a problem for this species (NPWS 2002b). Threats may be heightened because the species' entire known distribution lies within an area of concentrated population density. The core habitat for this species is the Grassy Box Woodlands of the coastal plains, such as the Cumberland Plain and lower Hunter Valley, which continue to face pressure from development (DECC 2007b). The impact of Feral Honeybees and introduced hollow-nesting birds, particularly the Common Starling are further potential threats to this bat.

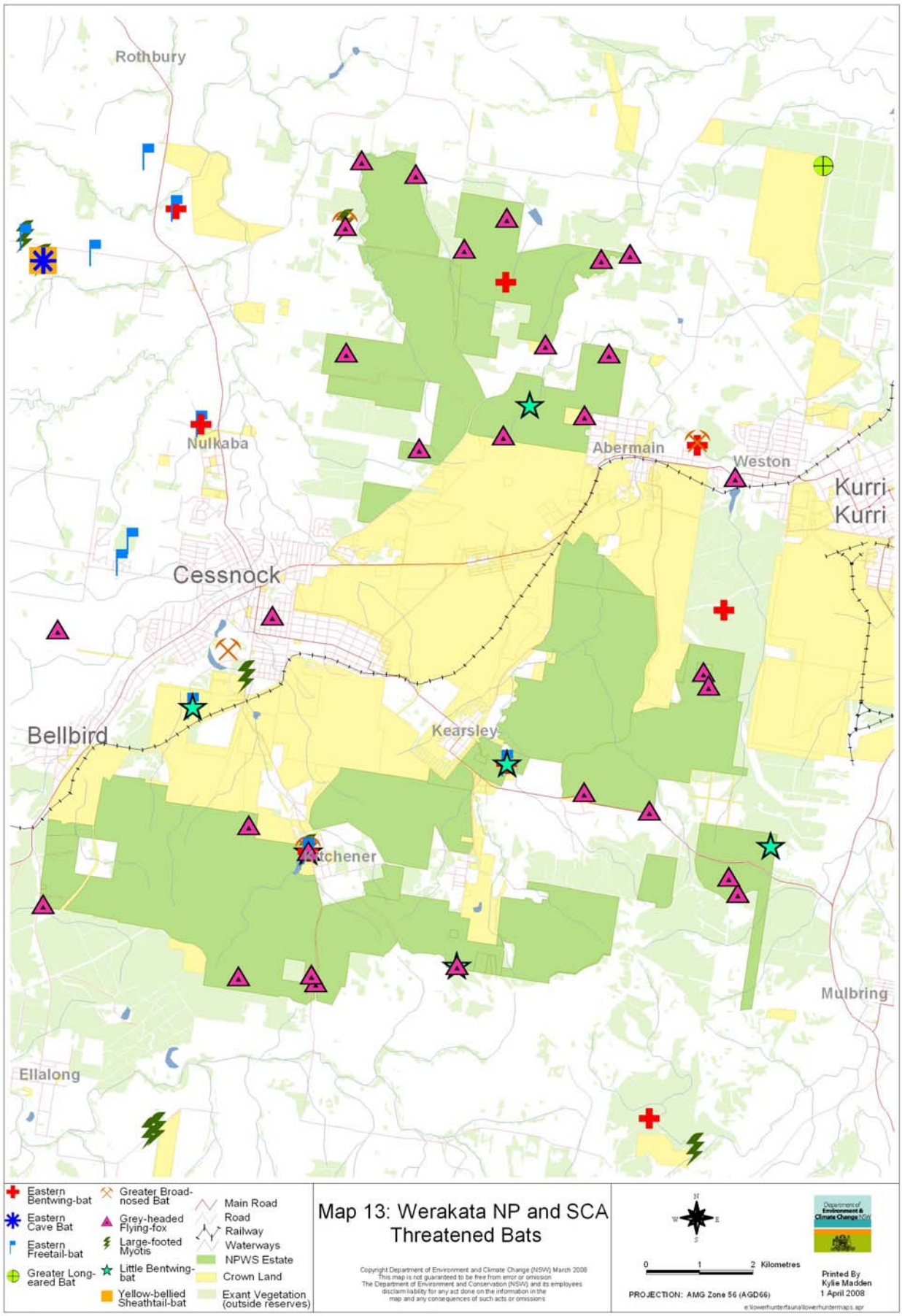
Local and Regional Conservation Status

The East-coast Freetail-bat is listed as Vulnerable on the NSW TSC Act (1995) due to suspected population declines and a decrease in abundance across its range. Most records for the species in NSW are contained within the NSW North Coast, South East Corner and Sydney Basin Bioregions (DECC 2008a). Within these Bioregions, it appears that the species favours the coastal plains and larger incised valleys of the Great Dividing Range, with large numbers of records from the Cumberland Plain, Central Coast, Hunter and Kangaroo Valleys. The majority of records for the species within the Sydney Basin Bioregion occur off park. However, it has been detected within the Blue Mountains, Wollemi and Marramarra NPs and Western Sydney Regional Park (DECC 2007b).

The East-coast Freetail-bat has frequently been identified within the Lower Hunter Valley, particularly along the southern and coastal edges using ultrasound call analysis although few individuals have been trapped (N. Williams, pers. comm.; DECC 2008a). These results would indicate that this bat is likely to make widespread use of the dry forests and woodlands of the area, including those within Werakata NP. However, to date within the NP there has been only one recorded location for this species east of Kearsley (Map 13; Grenadier *et al.* 2001). The 2005 DECC surveys failed to trap this species or identify it using ultrasound call analysis within Werakata NP.

Similar to Werakata NP, there have been no records of this species within Werakata SCA. The ultrasonic signals of this bat were recorded by Anabat on the western edge of Kitchener, immediately adjacent to the SCA (Map 13). Given the immediately adjacent record, the suitability of habitat and the presence of roosting hollows it is likely that this species is present within the reserve.

As a tree-roosting species, the abundance and prevalence of hollows are likely to greatly influence habitat suitability. Further survey work is required to confirm the status of this species within both Werakata NP and SCA.



Map 13: Werakata NP and SCA Threatened Bats

LITTLE BENTWING-BAT

Species profile

© M. Schulz

The Little Bentwing-bat (*Miniopterus australis*) is a small, insectivorous bat, which is chocolate-brown above and lighter below. This species, like other Bentwing-bats, gains its common name from a bend in its wing that folds back when the bat is at rest, due to a very long third finger and a narrow wingtip (Dwyer 1995a). Its coastal distribution ranges from the northern half of NSW through all of eastern Queensland, and is also found outside Australia in New Caledonia, New Guinea, Malaysia and the Philippines (Dwyer 1995a). The Little Bentwing-bat forages for small, mostly flying insects within well-vegetated habitat, including rainforest, tall moist forest, swamps and dry sclerophyll forest, requiring agile flying capabilities and manoeuvrability (Australian Museum 1999; Dwyer 1995a; Churchill 1998). It is predominantly a cave-dwelling species, although they are also known to roost in tree hollows during the day. This bat commonly shares roosting sites with the Eastern Bentwing-bat, often forming mixed clusters of the two species during winter (Australian Museum 1999; Dwyer 2005a; Churchill 1998). The Little Bentwing-bat relies on a very restricted number of nursery sites. Only a small number of nursery sites are known in Australia, with a few located in areas of limestone mining (Dwyer 1995a).

Threats

With colonies reaching large sizes, disturbance of the limited number of nursery or over-wintering sites from mining or caving activities could prove catastrophic. Modification of habitat, especially that surrounding maternity sites is likely to impact on foraging activities and hence breeding success (Australian Museum 1999; Churchill 1998). Increased pesticide use may result in decreased prey availability and possibly toxic build-up within the bats' tissues (DEC 2005g). There is also some suggestion that around maternity colonies and hibernation sites the species may be susceptible to predation by Foxes and Feral Cats (DEC 2005g).

Local and Regional Conservation Status

The Little Bentwing-bat is listed as Vulnerable on the NSW TSC Act (1995). The species is widely recorded throughout the coast and ranges in the northern half of NSW, with the number of records decreasing with distance from the coast (DECC 2007b). Records of the species within the Sydney Basin Bioregion are restricted to the coast with the most southerly record being of a small roost in a disused railway tunnel in the Stanwell Park area (DECC 2008c). Relatively large numbers have been recorded throughout the North Coast Bioregion (DECC 2007b). Individuals have been recorded in a number of coastal reserves such as Bouddi, Myall Lakes, and Wallingat NPs.

Within the Hunter Valley this species is widespread in coastal areas and inland towards Maitland. The species appears to be absent from drier environments in the central and western Hunter Valley. The Little Bentwing-bat has been recorded at several locations in Werakata NP using ultrasound call analysis techniques (Grenadier *et al.* 2001) (Map 13). This bat is primarily a cave roosting species and populations may be foraging widely from roosts nearby old mine shafts.

In Werakata SCA this species was captured in harp traps at two sites: one along a creek west of North Basin Road in the eastern section of the reserve and two from a gully line with rainforest elements in the subcanopy east of Southams Road (Map 13). It was also identified based on ultrasonic calls from the western edge of Kitchener in 2004 (DECC 2008a). It is likely that this species ranges widely across at least the eastern section of the reserve.

Based on currently available data these records are likely to approach the western limit of the species in the region. No known roosts have been located either within Werakata NP or SCA. The discovery of a roost site within either reserve would be highly significant and trigger immediate targeted management. In absence of this, no specific management actions are currently required in the reserves for this species.

EASTERN BENTWING-BAT

Species Profile

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Miniopterus schreibersii is the most widely distributed bat in the world, occurring through Europe, Africa and Australasia (Churchill 1998). However, recent research suggests that there may be three taxa in Australia (Duncan *et al.* 1999). The subspecies *oceanensis* is the relevant taxa for New South Wales and extends at least between central Victoria and Cape York Peninsula, Queensland (Duncan *et al.* 1999) and is commonly referred to as the Eastern Bentwing-bat. This species is distinguished from other similar-sized bats by the long last bone in the third wing digit and from the Little Bentwing-bat by the longer forearm (greater than 44mm) (Parnaby 1992a). The ultrasonic call can be distinctive. However, it is often inseparable from the Large Forest Bat and Southern Forest Bat (*Vespadelus regulus*) (Reinhold *et al.* 2001). It utilises a wide variety of habitats where it usually roosts in caves, disused mines and road culverts (Churchill 1998). It is a fast flying species that usually feeds above the canopy (Churchill 1998) and has been known to travel up to 65 kilometres away from roosts in a night (Dwyer 1966). Though individuals often use numerous roosts, they congregate en masse at a small number of caves to breed and hibernate (Dwyer 1995b; Churchill 1998).

Threats

Damage and disturbance to roosting sites are the greatest threats to this species. Only relatively few nursery caves are used, hence significant population changes can occur if these sites are damaged (Dwyer 1995b). Disturbance of hibernating colonies can lead to starvation due to loss of energy reserves (Gilmore and Parnaby 1994). Disturbance of roosts by recreational caving and tourism may also be significant, as may modification to feeding habitat by agriculture and urban development (Gilmore and Parnaby 1994). Some individuals are preyed upon by Feral Cats and, less often, Foxes (Dwyer 1995b).

Local and Regional Conservation Status

The Eastern Bentwing-bat is listed as Vulnerable on the NSW TSC Act (1995). The species is widely recorded in the eastern third of NSW, with the number of records decreasing with distance from the coast (DECC 2008a). Sightings are widespread within the Sydney Basin Bioregion, though clusters of records are present in the lower Hunter valley and Central Coast, Cumberland Plain, Woronora Plateau and across the southern Blue Mountains. Many of these records are from reserves, including Royal, Botany Bay, Blue Mountains, Nattai, Kanangra-Boyd, Yengo and Wollemi NPs and Bargo and Nattai SCAs. The species is known to roost in old shale mine shafts in Wollemi NP (DEC 2005c) and has been recorded roosting in a wide array of human-made structures in the Sydney Metropolitan area, including disused gunnery emplacements (DECC 2008c).

Records of the Eastern Bentwing-bat occur widely throughout the Hunter Valley. Within Werakata NP the species has been detected at two locations using ultrasound call analysis techniques (see Map 13). There are also numerous records of the species within a five kilometre radius of the reserve, most detected by ultrasound call analysis. Werakata NP is likely to provide foraging habitat for this wide ranging species despite roost sites being a considerable distance away.

This bat has not been recorded in Werakata SCA, such as in the 2008 DECC survey. However, it was identified based on ultrasonic calls from the western edge of Kitchener in 2004 and from Bow Wow Gorge to the south and Millfield to the west (DECC 2008a) (Map 13).

No known roosts have been located either within Werakata NP or SCA. The discovery of a roost site within either reserve would be highly significant and trigger immediate targeted management. In absence of this, no specific management actions are currently required in the reserves for this species.

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Wedge-tailed Eagle. © M. Schulz

APPENDIX A – LOCATION OF SURVEY SITES, WERAKATA NATIONAL PARK

This appendix details the location, vegetation type and survey techniques undertaken for each systematic survey site in the Werakata National Park.

Site number	Easting	Northing	Vegetation community (Bell 2001)	Diurnal bird census	Diurnal reptile census	Elliott traps	Harp traps	Nocturnal call playback	Nocturnal streamside search	Spotlight census	Bat ultrasound detection	Hair tubes
Birds Australia sites												
BA-RF-184437	351074	6362813	Central Hunter Riparian Forest	✷								
BA-RF-54447	353421	6362394	Central Hunter Riparian Forest	✷								
BA-RF-75942	349776	6371273	Lower Hunter Spotted Gum-Ironbark Forest	✷								
BA-RF-75943	350276	6372605	Lower Hunter Spotted Gum-Ironbark Forest	✷								
BA-RF-75945	349923	6370197	Lower Hunter Spotted Gum-Ironbark Forest	✷								
BA-RF-75946	348586	6372549	Lower Hunter Spotted Gum-Ironbark Forest	✷								
BA-RF-83989	349776	6371273	Lower Hunter Spotted Gum-Ironbark Forest	✷								
DECC Surveys												
CSN01H	348984	6373681	Kurri Sand Melaleuca Scrub-Forest	✷	✷	✷	✷			✷		
CSN02O	348001	6373935	Hunter Lowlands Redgum Forest	✷	✷					✷		
CSN03W	348600	6371412	Kurri Sand Swamp Woodland	✷						✷		
CSN04O	350717	6372857	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷					✷		
CSN05O	347709	6370334	Lower Hunter Spotted Gum-Ironbark Forest	✷						✷		
CSN06W	348705	6369643	Lower Hunter Spotted Gum-Ironbark Forest	✷						✷		
CSN07O	350652	6368780	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷					✷		
CSN08O	351443	6370490	Central Hunter Riparian Forest	✷						✷		

Site number	Easting	Northing	Vegetation community (Bell 2001)	Diurnal bird census	Diurnal reptile census	Elliott traps	Harp traps	Nocturnal call playback	Nocturnal streamside search	Spotlight census	Bat ultrasound detection	Hair tubes
CSN09O	352490	6372085	Lower Hunter Spotted Gum-Ironbark Forest					✷		✷		
CSN10O	352175	6369159	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷					✷		
CSN11H	347459	6362212	Hunter Lowlands Redgum Forest	✷								
CSN12O	352633	6370316	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷					✷		
CSN13W	351265	6362875	Kurri Sand Swamp Woodland	✷	✷							
CSN14W	351621	6365808	Kurri Sand Melaleuca Scrub-Forest	✷	✷							
CSN15O	353108	6363929	Lower Hunter Spotted Gum-Ironbark Forest	✷								
CSN16W	353395	6365357	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷							
CSN17O	354330	6364474	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷							
CSN18W	349498	6362150	Kurri Sand Swamp Woodland	✷								
CSN19W	351000	6363621	Kurri Sand Melaleuca Scrub-Forest	✷	✷							
CSN20O	349812	6370671	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷		✷			✷		
CSN21O	349918	6372280	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷					✷		
CSN22W	348215	6373027	Lower Hunter Spotted Gum-Ironbark Forest	✷						✷		
CSN23W	349075	6368537	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷					✷		
CSN24O	352168	6362109	Lower Hunter Spotted Gum-Ironbark Forest		✷					✷		
CSN25W	353390	6361759	Lower Hunter Spotted Gum-Ironbark Forest							✷		
CSN26W	347162	6361625	Lower Hunter Spotted Gum-Ironbark Forest		✷							
CSN27O	350644	6372852	Lower Hunter Spotted Gum-Ironbark Forest				✷					
CSN28O	347732	6369798	Lower Hunter Spotted Gum-Ironbark Forest				✷					
CSN29W	351314	6369723	Lower Hunter Spotted Gum-Ironbark Forest				✷					
CSN30O	352739	6362345	Lower Hunter Spotted Gum-Ironbark Forest				✷					

Site number	Easting	Northing	Vegetation community (Bell 2001)	Diurnal bird census	Diurnal reptile census	Elliott traps	Harp traps	Nocturnal call playback	Nocturnal streamside search	Spotlight census	Bat ultrasound detection	Hair tubes
CSN31W	352352	6363295	Kurri Sand Melaleuca Scrub-Forest				✷					
CSN32O	354270	6362540	Lower Hunter Spotted Gum-Ironbark Forest				✷					
CSN33W	351333	6369401	Central Hunter Riparian Forest						✷			
QRB01O	348707	6361362	Lower Hunter Spotted Gum-Ironbark Forest	✷								
QRB02O	349878	6361050	Lower Hunter Spotted Gum-Ironbark Forest		✷							
QRB03W	349125	6360743	Lower Hunter Spotted Gum-Ironbark Forest		✷							
T-F-LNE-61-040	353000	6364400	Lower Hunter Spotted Gum-Ironbark Forest					✷				
T-F-LNE-61-041	352500	6362800	Lower Hunter Spotted Gum-Ironbark Forest					✷				
Grenadier *et al.* 2001 survey												
SURVEY SITE 1	348800	6371400	Kurri Sand Swamp Woodland	✷	✷	✷		✷		✷		
SURVEY SITE 2	348680	6372150	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷	✷		✷		✷		
SURVEY SITE 3	351200	6369400	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷	✷						
SURVEY SITE 4	352300	6365200	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷	✷				✷		
SURVEY SITE 5	352300	6364900	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷	✷		✷		✷		
SURVEY SITE 6	351100	6363900	Kurri Sand Melaleuca Scrub-Forest	✷	✷	✷		✷		✷		
SURVEY SITE OWL 7	348300	6361700	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷	✷		✷				
SURVEY SITE 8	348200	6362200	Lower Hunter Spotted Gum-Ironbark Forest	✷	✷	✷				✷		
ANABAT 1	347780	6369800	Lower Hunter Spotted Gum-Ironbark Forest								✷	
ANABAT 2	351155	6369362	Lower Hunter Spotted Gum-Ironbark Forest								✷	
ANABAT 3	351000	6362900	Kurri Sand Melaleuca Scrub-Forest								✷	
ANABAT 4	350730	6362650	Kurri Sand Swamp Woodland								✷	
ANABAT 5	348204	6362188	Lower Hunter Spotted Gum-Ironbark Forest								✷	

Site number	Easting	Northing	Vegetation community (Bell 2001)	Diurnal bird census	Diurnal reptile census	Elliott traps	Harp traps	Nocturnal call playback	Nocturnal streamside search	Spotlight census	Bat ultrasound detection	Hair tubes
HAIRTUBE 1	348650	6371810	Kurri Sand Melaleuca Scrub-Forest									✷
HAIRTUBE 2	352700	6364900	Lower Hunter Spotted Gum-Ironbark Forest									✷
HAIRTUBE 3	347700	6362400	Lower Hunter Spotted Gum-Ironbark Forest									✷
LHCCREMS Survey												
CF2 DR*	350713	6371658	Lower Hunter Spotted Gum-Ironbark Forest	✷		✷	✷	✷		✷	✷	✷
COP1 DR*	353000	6363200	Kurri Sand Melaleuca Scrub-Forest					✷		✷	✷	

* Systematic koala surveys also conducted at these sites.

APPENDIX B – LOCATION OF SURVEY SITES, WERAKATA STATE CONSERVATION AREA

This appendix details the location, vegetation type and survey techniques undertaken for each systematic survey site in the Werakata State Conservation Area.

Site Number	Easting	Northing	Vegetation Community (Bell and Driscoll 2007)	Diurnal bird census	Diurnal reptile census	Elliott traps	Harp traps	Nocturnal call playback	Nocturnal streamside search	Spotlight census	Bat ultrasound detection
Birds Australia sites											
BA-RF-105893	342614	6360225	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							
BA-RF-146807	348742	6360546	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							
BA-RF-146809	347055	6360335	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							
BA-RF-147332	351917	6358675	Cleared/Unmapped	✷							
BA-RF-147334	347240	6358603	Cleared/Unmapped	✷							
BA-RF-150597	347022	6360911	Cleared/Unmapped	✷							
BA-RF-174247	346071	6360218	Coastal Foothills Transition Forest (Stringybark variant)	✷							
BA-RF-184438	346202	6360128	Coastal Foothills Transition Forest (Stringybark variant)	✷							
BA-RF-185194	350235	6359882	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							
BA-RF-185195	346895	6360724	Cleared/Unmapped	✷							
BA-RF-192583	351889	6360523	Sandstone Hills Bloodwood Woodland	✷							
BA-RF-81989	345917	6360123	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							
BA-RF-81990	346490	6360040	Coastal Foothills Transition Forest (Stringybark variant)	✷							
BA-RF-81991	346744	6360383	Cleared/Unmapped	✷							
BA-RF-83970	345994	6360186	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							
BA-RF-83992	345917	6360123	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							

Site Number	Easting	Northing	Vegetation Community (Bell and Driscoll 2007)	Diurnal bird census	Diurnal reptile census	Elliott traps	Harp traps	Nocturnal call playback	Nocturnal streamside search	Spotlight census	Bat ultrasound detection
BA-RF-81989	345994	6360186	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							
BA-RF-96104	342613	6360287	Cleared/Unmapped	✷							
DECC Survey											
QRB004W	342034	6360007	Cabbage Gum Floodplain Woodland	✷	✷			✷	✷	✷	✷
QRB005W	342495	6361050	Coastal Foothills Spotted Gum-Red Ironbark Forest (main variant)	✷	✷					✷	
CSN034W	343678	6362232	Grey Gum-Red Gum-Paperbark Forest	✷	✷		✷	✷		✷	
QRB0060	344839	6360308	Coastal Foothills Transition Forest (*E. beyeriana* variant)	✷	✷		✷				
QRB007R	346707	6360588	Paperbark Depression Forest	✷	✷		✷				
QRB0080	347056	6358685	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷	✷					✷	
QRB009W	345692	6358657	Aberdare Upland Box Forest (Ironbark variant)	✷	✷			✷		✷	
QRB010R	349785	6358861	Grey Myrtle – Paperbark Gully Forest	✷	✷		✷			✷	
QRB0110	355668	6361064	Coastal Foothills Spotted Gum-Ironbark Forest (main variant)	✷	✷	✷	✷	✷	✷	✷	✷
CSN035W	345880	6361488	Red Ironbark Paperbark Forest	✷	✷		✷	✷		✷	
QRB012W	343758	6360983	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷	✷		✷				
QRB0130	343562	6359955	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷	✷					✷	
QRB014W	346310	6359534	Coastal Foothills Transition Forest (Stringybark variant)	✷	✷			✷		✷	✷
QRB015W	348507	6360610	Coastal Foothills Transition Forest (Stringybark variant)	✷	✷					✷	
QRB016W	347516	6359936	Lower Hunter Grey Box Grassy Forest	✷	✷		✷	✷		✷	
QRB0170	351321	6358974	Lower Hunter Spotted Gum-Red Ironbark Forest (*E. placita* variant)	✷	✷						
QRB0180	351125	6359974	Sandstone Hills Bloodwood Woodland	✷	✷		✷				
QRB019W	353509	6360404	Sandstone Hills Bloodwood Woodland	✷	✷		✷	✷		✷	✷

Site Number	Easting	Northing	Vegetation Community (Bell and Driscoll 2007)	Diurnal bird census	Diurnal reptile census	Elliott traps	Harp traps	Nocturnal call playback	Nocturnal streamside search	Spotlight census	Bat ultrasound detection
QRB0200	355397	6359170	Coastal Foothills Spotted Gum-Ironbark Forest (main variant)		✷						
QRB021W	355182	6358104	Aberdare Upland Box Forest (Grey Box variant)		✷						
QRB022W	355042	6360217	Sandstone Hills Transition Forest (*Corymbia gummifera* variant)	✷	✷	✷				✷	
QRB0230	354387	6361198	Coastal Foothills Spotted Gum-Ironbark Forest (main variant)	✷	✷						
QRB024W	346048	6360584	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)				✷			✷	
QRB0250	355135	6360993	Grey Gum-Red Gum-Paperbark Forest				✷				
QRB0260	354340	6360716	Sandstone Hills Bloodwood Woodland				✷				
QRB027W	350668	6359734	Sandstone Hills Bloodwood Woodland				✷				
QRB028W	342441	6360089	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)				✷				
LHCCREMS Survey											
CF5 HVF*[1]	355223	6360911	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷		✷	✷		✷		✷
CF5 HVF START*[2]	355223	6360900	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)				✷				
Mixophyes Survey											
F-MIX-22	342750	6360500	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)						✷		
Central CRA Fauna Survey											
S-F-SYD-53-023	355700	6361150	Coastal Foothills Spotted Gum-Ironbark Forest (main variant)	✷							
S-F-SYD-53-024	351900	6359700	Sandstone Hills Bloodwood Woodland	✷							
S-F-SYD-53-025	346500	6360300	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)	✷							
Lower North East CRA Fauna Survey											

Site Number	Easting	Northing	Vegetation Community (Bell and Driscoll 2007)	Diurnal bird census	Diurnal reptile census	Elliott traps	Harp traps	Nocturnal call playback	Nocturnal streamside search	Spotlight census	Bat ultrasound detection
T-F-LNE-61-042	346200	6360100	Coastal Foothills Transition Forest (Stringybark variant)					✷			
T-F-LNE-61-043	344100	6359600	Lower Hunter Spotted Gum-Red Ironbark Forest (main variant)					✷			
T-F-LNE-81-001	351760	6359730	Coastal Foothills Spotted Gum-Ironbark Forest (main variant)	✷				✷			

*1 = *Additional technique*: hair tube sampling.

*2 = *Additional technique*: transect spotlighting.

APPENDIX C – FAUNA SPECIES RECORDED IN WERAKATA NATIONAL PARK AND WERAKATA STATE CONSERVATION AREA

This appendix details the list of fauna species currently known to occur within Werakata NP and Werakata SCA. The list is based on records from the DECC Atlas of NSW Wildlife to within 200 metres of the reserve boundaries. The data was extracted from the Atlas on 25 March 2008. Records have been included from DECC systematic surveys (both reserves), licensed data sets (Birds Australia), and six other surveys (Hunter Employment Zone, REMS, Newcastle University Survey, CRA surveys and *Mixophyes* survey, as well as incidental observations submitted by individuals, including park rangers and field officers; wildlife consultants, bird watchers and naturalists; scientific researchers working in the area; and other visitors to the park. Following a review of records conducted for this project, a number of species have been designated as * to indicate species that require confirmation based on the current level of knowledge. The list does not include records collected during the first Birds Australia survey due to their low spatial accuracy, records collected prior to 1950 or records in areas immediately adjacent to the reserves since in many locations the vegetation and degree of disturbance is significantly different to that within the reserves.

Key:

Common Name: [I] = Introduced species; * = Species requiring confirmation (not included in species' totals).

Conservation Status: E – Endangered (under TSC Act 1995); V – Vulnerable (under TSC Act 1995); P – Protected (under NPWS Act 1974); U – Unprotected, introduced species.

DECC Surveys, Birds Australia, Hunter Employment Zone, REMS, Lower Hunter Survey and Other: NP – Only recorded from Werakata NP; SC – Only recorded from Werakata SCA; B – Recorded from both Werakata National Park and State Conservation Area.

Other: Within the SCA includes records from the CRA surveys, the *Mixophyes* survey, in addition to observations by various individuals.

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone	REMS	Lower Hunter Survey	Other
Frogs									
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet	P	B			SC	NP	B
Myobatrachidae	*Limnodynastes dumerilii dumerilii*	Eastern Banjo Frog	P	B				NP	
Myobatrachidae	*Limnodynastes dumerilii grayi*	Eastern Banjo Frog	P	B				NP	
Myobatrachidae	*Limnodynastes ornatus*	Ornate Burrowing Frog	P				NP	NP	
Myobatrachidae	*Limnodynastes peronii*	Striped Marsh Frog	P	B				NP	
Myobatrachidae	*Limnodynastes tasmaniensis*	Spotted Marsh Frog	P	B				NP	
Myobatrachidae	*Pseudophryne bibronii*	Bibron's Toadlet	P					NP	
Myobatrachidae	*Pseudophryne coriacea*	Red-backed Toadlet	P					NP	
Myobatrachidae	*Uperoleia fusca*	Dusky Toadlet	P	B				NP	
Myobatrachidae	*Uperoleia laevigata*	Smooth Toadlet	P	SC				NP	

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone	REMS	Lower Hunter Survey	Other
Hylidae	*Litoria dentata*	Keferstein's Tree Frog	P	B					NP
Hylidae	*Litoria fallax*	Eastern Dwarf Tree Frog	P	B		NP		NP	B
Hylidae	*Litoria latopalmata*	Broad-palmed Frog	P	B				NP	SC
Hylidae	*Litoria peronii*	Peron's Tree Frog	P	B					B
Hylidae	*Litoria tyleri*	Tyler’s Tree Frog	P	SC					
Hylidae	*Litoria verreauxii*	Verreaux's Tree Frog	P			NP		NP	
Reptiles									
Chelidae	*Chelodina longicollis*	Eastern Snake-necked Turtle	P	B				NP	
Gekkonidae	*Diplodactylus vittatus*	Eastern Stone Gecko	P	SC					
Gekkonidae	*Underwoodisaurus milii*	Thick-tailed Gecko	P	B					
Pygopodidae	*Lialis burtonis*	Burton’s Legless-lizard	P	SC					
Agamidae	*Amphibolurus muricatus*	Jacky Lashtail	P	B			NP		SC
Agamidae	*Physignathus lesueurii*	Eastern Water Dragon	P	B					
Agamidae	*Pogona barbata*	Eastern Bearded Dragon	P	B					
Varanidae	*Varanus varius*	Lace Monitor	P	B					SC
Scincidae	*Carlia tetradactyla*	Southern Rainbow-skink	P	B		NP	NP		SC
Scincidae	*Carlia vivax*	Tussock Rainbow-skink	P	NP			SC		
Scincidae	*Cryptoblepharus virgatus*	Cream-striped Shinning-skink	P	B					
Scincidae	*Ctenotus robustus*	Robust Ctenotus	P	B			SC	NP	
Scincidae	*Ctenotus taeniolatus*	Copper-tailed Ctenotus	P	B		NP			
Scincidae	*Egernia striolata*	Tree-crevice Skink	P	B					
Scincidae	*Egernia whitii*	White's Rock-skink	P					NP	
Scincidae	*Eulamprus quoyii*	Eastern Water-skink	P	B				NP	
Scincidae	*Eulamprus tenuis*	Bar-sided Forest-skink	P	SC					
Scincidae	*Lampropholis delicata*	Dark-flecked Garden Sunskink	P	B				NP	NP
Scincidae	*Lampropholis guichenoti*	Pale-flecked Garden Sunskink	P	NP				NP	SC A
Scincidae	*Morethia boulengeri*	South-eastern Morethia Skink	P	B					SC
Scincidae	*Tiliqua scincoides*	Eastern Bluetongue	P	SC					B
Colubridae	*Boiga irregularis*	Eastern Brown Tree Snake	P	SC					
Colubridae	*Dendrelaphis punctulata*	Green Tree Snake	P	SC				NP	
Elapidae	*Demansia psammophis*	Yellow-faced Whipsnake	P	SC			SC	NP	NP
Elapidae	*Hoplocephalus stephensii*	Stephens' Banded Snake*	V						NP
Elapidae	*Pseudechis porphyriacus*	Red-bellied Black Snake	P	SC				NP	NP
Elapidae	*Pseudonaja textilis*	Eastern Brown Snake	P	SC					
Elapidae	*Rhinoplocephalus*	Eastern Small-eyed Snake	P	SC				NP	

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone REMS		Lower Hunter Survey	Other
	nigrescens								
Birds									
Phasianidae	*Coturnix pectoralis*	Stubble Quail	P		SC				
Phasianidae	*Coturnix ypsilophora*	Brown Quail	P		SC			NP	
Anatidae	*Anas castanea*	Chestnut Teal	P		NP				
Anatidae	*Anas gracilis*	Grey Teal	P	SC	NP				SC
Anatidae	*Anas platyrhynchos*	Mallard[I]	U	B					SC
Anatidae	*Anas superciliosa*	Pacific Black Duck	P	B	NP				B
Anatidae	*Aythya australis*	Hardhead	P		B				
Anatidae	*Chenonetta jubata*	Australian Wood Duck	P	B	NP	NP			B
Anatidae	*Cygnus atratus*	Black Swan	P						B
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	P	SC					B
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant	P						B
Phalacrocoracidae	*Phalacrocorax melanoleucos*	Little Pied Cormorant	P	SC					SC
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant	P		SC				NP
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant	P						B
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican	P					NP	
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	P	SC					SC
Ardeidae	*Ixobrychus flavicollis*	Black Bittern	V	NP					
Ardeidae	*Nycticorax caledonicus*	Nankeen Night Heron	P	B					
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	P		SC				NP
Accipitridae	*Accipiter cirrocephalus*	Collared Sparrowhawk	P	NP	SC				
Accipitridae	*Accipiter fasciatus*	Brown Goshawk	P	B	NP	NP			
Accipitridae	*Aquila audax*	Wedge-tailed Eagle	P	B	NP	NP		NP	SC
Accipitridae	*Aviceda subcristata*	Pacific Baza	P	SC					
Accipitridae	*Elanus axillaris*	Black-shouldered Kite	P					NP	
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	P	NP					
Accipitridae	*Haliastur sphenurus*	Whistling Kite	P	SC				NP	
Accipitridae	*Hieraaetus morphnoides*	Little Eagle	P	SC					
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V	SC					
Falconidae	*Falco berigora*	Brown Falcon	P					NP	
Falconidae	*Falco cenchroides*	Nankeen Kestrel	P	NP	SC			NP	
Falconidae	*Falco longipennis*	Australian Hobby	P						SC
Falconidae	*Falco peregrinus*	Peregrine Falcon	P					NP	

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone	REMS	Lower Hunter Survey	Other
Falconidae	*Falco subniger*	Black Falcon	P						B
Rallidae	*Fulica atra*	Eurasian Coot	P		NP				B
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen	P	B	NP				B
Rallidae	*Gallirallus philippensis*	Buff-banded Rail	P	NP					
Rallidae	*Porphyrio porphyrio*	Purple Swamphen	P	NP	NP				B
Turnicidae	*Turnix varia*	Painted Button-quail	P	SC					
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel	P	B					
Charadriidae	*Vanellus miles*	Masked Lapwing	P	B		NP			SC
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove	P	B	NP	NP		NP	NP
Columbidae	*Geopelia placida*	Peaceful Dove	P	B	NP	NP		NP	NP
Columbidae	*Leucosarcia melanoleuca*	Wonga Pigeon	P	SC				NP	
Columbidae	*Macropygia amboinensis*	Brown Cuckoo-Dove	P	SC					
Columbidae	*Ocyphaps lophotes*	Crested Pigeon	P	SC					B
Columbidae	*Phaps chalcoptera*	Common Bronzewing	P	B	NP		NP	NP	B
Columbidae	*Streptopelia chinensis*	Spotted Turtle-Dove[I]	U	B					B
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	P	B				NP	
Cacatuidae	*Cacatua pastinator*	Little Corella	P	SC					
Cacatuidae	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V	SC		NP			NP
Cacatuidae	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo	P	SC					B
Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V	SC					NP
Cacatuidae	*Eolophus roseicapillus*	Galah	P	B				NP	B
Cacatuidae	*Nymphicus hollandicus*	Cockatiel	P	SC					
Psittacidae	*Alisterus scapularis*	Australian King-Parrot	P	B		NP		NP	B
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet	P	SC					
Psittacidae	*Glossopsitta concinna*	Musk Lorikeet	P	B					
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	P	B	NP	NP		NP	B
Psittacidae	*Lathamus discolor*	Swift Parrot	E		SC				B
Psittacidae	*Platycercus adscitus eximius*	Eastern Rosella	P	B	NP	NP		NP	B
Psittacidae	*Platycercus elegans*	Crimson Rosella	P		NP	NP		NP	B
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	P	B	NP	NP		NP	B
Cuculidae	*Chalcites basalis*	Horsfield's Bronze-Cuckoo	P	SC		NP		NP	
Cuculidae	*Chalcites lucidus*	Shining Bronze-Cuckoo	P	B				NP	
Cuculidae	*Cuculus pallidus*	Pallid Cuckoo	P	SC					B
Cuculidae	*Eudynamys orientalis*	Pacific Koel	P	SC					B
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo	P	SC	NP				B

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone REMS		Lower Hunter Survey	Other
Centropodidae	*Centropus phasianinus*	Pheasant Coucal	P	SC	NP				SC
Strigidae	*Ninox boobook*	Southern Boobook	P	B		NP			B
Strigidae	*Ninox connivens*	Barking Owl	V	B					
Strigidae	*Ninox strenua*	Powerful Owl	V	SC					NP
Tytonidae	*Tyto alba*	Barn Owl	P			NP			
Tytonidae	*Tyto novaehollandiae*	Masked Owl	V	SC					
Podargidae	*Podargus strigoides*	Tawny Frogmouth	P	B		NP		NP	B
Caprimulgidae	*Eurostopodus mystacalis*	White-throated Nightjar	P	SC					SC
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar	P	B		NP	B		B
Apodidae	*Hirundapus caudacutus*	White-throated Needletail	P	B	NP				SC
Alcedinidae	*Alcedo azurea*	Azure Kingfisher	P	SC					
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	P	B	NP	NP	NP	NP	B
Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher	P	B		NP		NP	SC
Meropidae	*Merops ornatus*	Rainbow Bee-eater	P	B	NP	NP			NP
Coraciidae	*Eurystomus orientalis*	Dollarbird	P	B					SC
Climacteridae	*Climacteris picumnus*	Brown Treecreeper	V	SC		NP			B
Climacteridae	*Cormobates leucophaeus*	White-throated Treecreeper	P	B	NP	NP	B	NP	B
Maluridae	*Malurus cyaneus*	Superb Fairy-wren	P	B	NP	NP	SC	NP	B
Maluridae	*Malurus lamberti*	Variegated Fairy-wren	P	B	NP	NP	SC	NP	
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	P	B	NP	NP	B	NP	B
Pardalotidae	*Pardalotus striatus*	Striated Pardalote	P	B		NP			
Pardalotidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	P	B		NP			SC
Pardalotidae	*Acanthiza lineata*	Striated Thornbill	P	B	NP	NP	B	NP	B
Pardalotidae	*Acanthiza nana*	Yellow Thornbill	P	B	NP	NP	SC	NP	B
Pardalotidae	*Acanthiza pusilla*	Brown Thornbill	P	B	NP	NP	SC	NP	B
Pardalotidae	*Acanthiza reguloides*	Buff-rumped Thornbill	P	B		SC	NP		B
Pardalotidae	*Calamanthus pyrrhopygius*	Chestnut-rumped Heathwren	P	SC		NP			
Pardalotidae	*Gerygone mouki*	Brown Gerygone	P	SC					
Pardalotidae	*Gerygone olivacea*	White-throated Gerygone	P	B	NP	NP		NP	SC
Pardalotidae	*Pyrrholaemus sagittatus*	Speckled Warbler	V	SC				NP	
Pardalotidae	*Sericornis frontalis*	White-browed Scrubwren	P	B	NP	NP	SC	NP	B
Pardalotidae	*Smicrornis brevirostris*	Weebill	P	B	NP	NP			
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill	P	B	NP	NP	SC	NP	B
Meliphagidae	*Anthochaera carunculata*	Red Wattlebird	P	B					NP
Meliphagidae	*Entomyzon cyanotis*	Blue-faced Honeyeater	P	SC					

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone	REMS	Lower Hunter Survey	Other
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater	P	B	NP	NP	SC	NP	B
Meliphagidae	*Lichenostomus fuscus*	Fuscous Honeyeater	P	B	NP			NP	B
Meliphagidae	*Lichenostomus leucotis*	White-eared Honeyeater	P	B		NP		NP	NP
Meliphagidae	*Lichenostomus melanops*	Yellow-tufted Honeyeater	P	B	NP	NP		NP	B
Meliphagidae	*Lichenostomus penicillatus*	White-plumed Honeyeater	P	NP	B				
Meliphagidae	*Manorina melanocephala*	Noisy Miner	P	B	NP	NP			B
Meliphagidae	*Manorina melanophrys*	Bell Miner	P	B	NP	NP	NP	NP	B
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater	P	SC	NP			NP	SC
Meliphagidae	*Melithreptus brevirostris*	Brown-headed Honeyeater	P	B	NP	NP		NP	NP
Meliphagidae	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subsp.)	V	B		NP			NP
Meliphagidae	*Melithreptus lunatus*	White-naped Honeyeater	P	B	NP	NP	SC		B
Meliphagidae	*Myzomela sanguinolenta*	Scarlet Honeyeater	P	B	NP				SC
Meliphagidae	*Philemon corniculatus*	Noisy Friarbird	P	B	NP	NP	B	NP	B
Meliphagidae	*Philemon citreogularis*	Little Friarbird	P						NP
Meliphagidae	*Phylidonyris nigra*	White-cheeked Honeyeater	P	B	NP			NP	SC
Meliphagidae	*Phylidonyris novaehollandiae*	New Holland Honeyeater	P	NP					
Meliphagidae	*Plectorhyncha lanceolata*	Striped Honeyeater	P	B		NP		NP	
Meliphagidae	*Xanthomyza phrygia*	Regent Honeyeater	E	SC	SC			NP	SC
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	P	B	NP	B	NP	NP	SC
Petroicidae	*Melanodryas cucullata*	Hooded Robin	V						NP
Petroicidae	*Microeca fascinans*	Jacky Winter	P	B	NP	NP		NP	SC
Petroicidae	*Petroica boodang*	Scarlet Robin	P						NP
Petroicidae	*Petroica rosea*	Rose Robin	P	NP	NP	NP	SC	NP	B
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler	P	SC					
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subsp.)	V	B		NP		NP	NP
Cinclosomatidae	*Cinclosoma punctatum*	Spotted Quail-thrush	P	SC				NP	B
Cinclosomatidae	*Psophodes olivaceus*	Eastern Whipbird	P	B	NP	NP		NP	B
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	P	B	NP	NP		NP	SC
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	P	B	NP	NP	NP	NP	B
Pachycephalidae	*Falcunculus frontatus*	Eastern Shrike-tit	P	B				NP	
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler	P	B	NP	NP	SC	NP	B
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	P	B	NP	NP	B	NP	B
Dicruridae	*Grallina cyanoleuca*	Magpie-lark	P	B		NP			B

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone	REMS	Lower Hunter Survey	Other
Dicruridae	*Monarcha melanopsis*	Black-faced Monarch	P	SC					
Dicruridae	*Myiagra rubecula*	Leaden Flycatcher	P	SC	NP				
Dicruridae	*Rhipidura albiscapa*	Grey Fantail	P	B	NP	NP	B	NP	B
Dicruridae	*Rhipidura leucophrys*	Willie Wagtail	P	B	NP	NP		NP	B
Dicruridae	*Rhipidura rufifrons*	Rufous Fantail	P	SC	NP		SC		
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	P	B	NP	NP	NP	NP	B
Campephagidae	*Coracina papuensis*	White-bellied Cuckoo-shrike	P	SC	NP	NP		NP	
Campephagidae	*Coracina tenuirostris*	Cicadabird	P	SC					
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole	P	B		NP			SC
Artamidae	*Artamus cyanopterus*	Dusky Woodswallow	P	B	NP	NP		NP	B
Artamidae	*Artamus superciliosus*	White-browed Woodswallow	P	SC					
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	P	B	NP	NP		NP	B
Artamidae	*Cracticus torquatus*	Grey Butcherbird	P	B	NP	NP		NP	B
Artamidae	*Gymnorhina tibicen*	Australian Magpie	P	B	NP	NP		NP	B
Artamidae	*Strepera graculina*	Pied Currawong	P	B	NP	NP	B	NP	B
Corvidae	*Corvus coronoides*	Australian Raven	P	B	NP	NP	NP	NP	B
Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough	P	B		NP	B	NP	
Ptilonorhynchidae	*Ptilonorhynchus violaceus*	Satin Bowerbird	P	B	NP	NP		NP	SC
Passeridae	*Neochmia temporalis*	Red-browed Finch	P	B	NP	NP	SC	NP	B
Passeridae	*Passer domesticus*	House Sparrow[I]	U		SC				
Passeridae	*Taeniopygia bichenovii*	Double-barred Finch	P	B				NP	
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	P	B	NP	NP	NP	NP	SC
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	P	B	NP	NP	SC	NP	B
Hirundinidae	*Petrochelidon nigricans*	Tree Martin	P	B	NP			NP	SC
Sylviidae	*Acrocephalus stentoreus*	Clamorous Reed-Warbler	P		SC				
Zosteropidae	*Zosterops lateralis*	Silvereye	P	B	NP	NP	B	NP	B
Sturnidae	*Acridotheres tristis*	Common Myna[I]	U	B		NP			NP
Sturnidae	*Sturnus vulgaris*	Common Starling[I]	U		SC				NP
Mammals									
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	P	B			NP		SC
Dasyuridae	*Antechinus flavipes*	Yellow-footed Antechinus	P	B				NP	
Dasyuridae	*Antechinus stuartii*	Brown Antechinus	P				SC		
Dasyuridae	*Sminthopsis murina*	Common Dunnart	P	B				NP	NP
Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot	P						SC
Peramelidae	*Perameles nasuta*	Long-nosed Bandicoot	P	SC			NP		

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone REMS	Lower Hunter Survey	Other
Phascolarctidae	*Phascolarctos cinereus*	Koala	V				NP	SC
Vombatidae	*Vombatus ursinus*	Common Wombat	P	SC				SC
Petauridae	*Petaurus australis*	Yellow-bellied Glider	V	B		NP	SC	NP
Petauridae	*Petaurus breviceps*	Sugar Glider	P	B		NP	B	NP	B
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V	B				B
Pseudocheiridae	*Pseudocheirus peregrinus*	Common Ringtail Possum	P	B		NP		NP	NP
Acrobatidae	*Acrobates pygmaeus*	Feathertail Glider	P	B				NP
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum	P	B		NP	SC	NP	B
Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo	P	B		NP		NP	B
Macropodidae	*Macropus robustus*	Common Wallaroo	P	B					NP
Macropodidae	*Macropus rufogriseus*	Red-necked Wallaby	P	B					NP
Macropodidae	*Wallabia bicolor*	Swamp Wallaby	P	B		NP		NP	B
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	B					B
Pteropodidae	*Pteropus scapulatus*	Little Red Flying-fox	P	SC					
Molossidae	*Mormopterus norfolkensis*	East-coast Freetail-bat	V					NP	
Molossidae	*Mormopterus* sp. 2	Eastern Freetail-bat	P					NP	SC
Molossidae	*Tadarida australis*	White-striped Freetail-bat	P	B		NP	B	NP	
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	P	SC			NP	NP	
Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat	P	SC				NP	
Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle*****	V						NP
Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V	SC				NP	NP
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V				NP		
Vespertilionidae	*Nyctophilus geoffroyi*	Lesser Long-eared Bat	P	B			SC		NP
Vespertilionidae	*Nyctophilus gouldi*	Gould's Long-eared Bat	P	B			SC		SC
Vespertilionidae	*Scotorepens orion*	Eastern Broad-nosed Bat	P					NP	
Vespertilionidae	*Vespadelus darlingtoni*	Large Forest Bat	P				SC		NP
Vespertilionidae	*Vespadelus pumilus*	Eastern Forest Bat*	P						SC
Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat	P	B			NP	NP	
Muridae	*Hydromys chrysogaster*	Water-rat	P	NP					
Muridae	*Mus musculus*	House Mouse[I]	U	SC					
Muridae	*Pseudomys novaehollandiae*	New Holland Mouse	P					NP	
Muridae	*Rattus lutreolus*	Swamp Rat	P					NP	
Muridae	*Rattus norvegicus*	Brown Rat[I]	U					NP	
Muridae	*Rattus rattus*	Black Rat[I]	U	SC				NP	

Family	Scientific name	Common name	Conservation	DECC Surveys	Birds Australia	Hunter Employment Zone REMS		Lower Hunter Survey	Other
Leporidae	*Oryctolagus cuniculus*	Rabbit[I]	U	B				NP	B
Leporidae	*Lepus capensis*	Brown Hare[I]	U	SC					B
Canidae	*Canis lupus*	Dingo/Dog[I]	U	B				NP	B
Canidae	*Vulpes vulpes*	Fox[I]	U	B		NP		NP	B
Felidae	*Felis catus*	Cat[I]	U	B				NP	NP
Equidae	*Equus caballus*	Feral Horse[I]	U					NP	SC
Bovidae	*Capra hircus*	Feral Goat[I]	U	NP					
Cervidae	*Dama dama*	Fallow Deer[I]	U	NP					
Cervidae		Deer (Unidentified)[I]	U	SC					

APPENDIX D – FREQUENCY RANGE OF INSECTIVOROUS BAT CALLS RECORDED IN THE HUNTER RANGE AREA

This table has been compiled by Narawan Williams, based on the analysis of ultrasonic calls recorded during the 2004-05 DECC surveys of the Hunter Range Area.

Key:

The first row for each species shows the frequency range (in kilohertz) of reference calls, recorded during release of bats captured in harp traps.

The second row for each species shows the frequency range (in kilohertz) of calls recorded at Anabat various sites. These only include sequences for which a 'definite' identification was obtained, unless stated otherwise in the notes. The number in brackets next to each frequency range is the total number of call sequences referred to for frequency range sample.

There are notes under each species.

Bat species	**Northern Yengo National Park**		**Eastern Wollemi National Park (California and Commission Roads)**		**Northern Wollemi (Baerami, Hungerford, Martindale & Doyles Creek areas)**		**Manobalai Nature Reserve and Crown Lands**		**Werakata National Park**
Reference call samples followed by analysis result samples.	**Valley floors to lower slopes (6 sites)**	**Mid slopes to ridgelines (7 sites)**	**Valley floors to lower slopes (0 sites)**	**Mid slopes to ridgelines (5 sites)**	**Valley floors to lower slopes (9 sites)**	**Mid slopes to ridgelines (1 site)**	**Valley floors to lower slopes (5 sites)**	**Mid slopes to ridgelines (1 site)**	
Chalinolobus dwyeri				22–25 (1)					
		23-28(2)		21-27 (12)	22-27 (10)		22-27 (5)	22-24 (4)	
Stepped call in good sequence usually between 22- 27 kHz – easy to determine with good sequence.									
Chalinolobus gouldii		28-32 (3) 31-34(3)		29-33(2) 31-33(2)			30-34 (2)		
	29-33(1)	28-33(11)		31-34(2) 29-32 (2)	29-32 (10)	31-34 (2)	28-31(5) 26-30 (2)	28-30 (1)	
Stepped call – one of the easier species to determine.									

Bat species	Northern Yengo National Park		Eastern Wollemi National Park (California and Commission Roads)		Northern Wollemi (Baerami, Hungerford, Martindale & Doyles Creek areas)		Manobalai Nature Reserve and Crown Lands		Werakata National Park
Chalinolobus morio		49-51(2) 50-52 (4)		50-53(3)			49-50(2)		
	48-55(7)	47-56 (24)		48-53 (14)	47-57 (25)	49-53 (4)	45-53 (19)	49-54 (4)	49-54 (4)
Call frequencies are variable between call sequences and within call sequence.									
Falsistrellus tasmaniensis		See notes below		35-41(7)	34-38 (1)				
		35-39 (1) 36-39(1)							
Note: All these frequencies are from only probable *Falsistrellus tasmaniensis* results – no definite. This species' calls are generally hard to define against variation in *Scotorepens orion* calls and also *Scoteanax rueppellii.*									
Miniopterus schreibersii oceanensis									
		43-46 (5)		44-46 (12)	43-47 (30)		44-47 (3)		43-44 (3)
Fairly consistent in frequency – the higher numbers in Northern Wollemi are due to this species using mine shafts in Baerami Creek.									
Mormopterus norfolkensis									
		29.5-32 (2)							28-33(1) 30-32(1) 30-34 (1)
Stepped call usually between 31 – 34 kHz. A couple of the calls are below this however there was regular stepping.									
***Mormopterus* sp. 4 (long penis form)** (Adams *et al.*1988)							27-29 (10)		
		24-25 (2)			24-26 (2)		25-29 (9)	25-27 (5)	

Bat species	Northern Yengo National Park		Eastern Wollemi National Park (California and Commission Roads)		Northern Wollemi (Baerami, Hungerford, Martindale & Doyles Creek areas)		Manobalai Nature Reserve and Crown Lands		Werakata National Park
The higher frequency range of this species overlaps with other *Mormopterus* species.									
***Mormopterus* sp. 3 (short penis form)** (Adams *et al.*1988)				See notes					
				30-36 (4)					
Notes: This one call was only 'probable'. Other possible calls were not able to be defined as there is known overlap with other *Mormopterus* species.									
***Mormopterus* sp. 2** (Adams *et al.* 1988)		29-32 (1) 28-29 (1)					32-34 (1)		
		27-32 (6)		29-30 (3)	29-32 (8)		28-31(3)		28-32 (15)
Most pulses flat and at the lower frequency with occasional step (the higher frequency). There is overlap in frequency with other *Mormopterus* species.									
Nyctophilus geoffroyi		30-34 (1)					38-43 (1) 43-46 (2)		
Could not define between other *Nyctophilus* species.									
Nyctophilus gouldi		38-45 (5)		28-39 (1) 36-43 (5)					
Could not define between other *Nyctophilus* species.									
Nyctophilus timoriensis									
No reference calls. Could not define between other *Nyctophilus* species.									
***Nyctophilus* species**	40 (1)	40-45 (2)		38-43 (6)	41-48 (11)		39-44 (8)	43-46 (3)	
Rhinolophus megaphyllus									

Bat species	Northern Yengo National Park		Eastern Wollemi National Park (California and Commission Roads)		Northern Wollemi (Baerami, Hungerford, Martindale & Doyles Creek areas)		Manobalai Nature Reserve and Crown Lands		Werakata National Park
	65-67.5 (3)	66.5 – 67 (5)		66-68 (2)	64-68 (14)			66 (1)	
A very distinctive call at fairly consistent frequency.									
Saccolaimus flaviventris									
							17.5 (1) 21 (1)		
Call frequency and characteristics within normal range for this species.									
Scoteanax rueppellii				37-40 (2)					
					32-34 (2)				
Call often hard to define against *Scotorepens orion* and *S. balstoni* unless a good call sequence is recorded.									
Scotorepens balstoni							32-35 (5)		
	31-32 (1)	32 (1) Probable		32-34 (2)	31-35 (10)		32-35 (11)		
Most often call frequency was around 31- 33 kHz. The higher frequency of this species overlaps with *Scotorepens orion*.									
Scotorepens orion				35-36 (3)					
		34-39 (12)		34-36 (2) 35 – 38(4)	34-38 (7)				
Calls can overlap with *Scoteanax rueppellii* and *Falsistrellus tasmaniensis*.									
Tadarida australis									
	11-12 (2)	11 (2)		11-20 (3)	10-15.5 (9)		10-15 (7)		9.5-12.5 (3)

Bat species	Northern Yengo National Park		Eastern Wollemi National Park (California and Commission Roads)		Northern Wollemi (Baerami, Hungerford, Martindale & Doyles Creek areas)		Manobalai Nature Reserve and Crown Lands		Werakata National Park
Standard frequency around 10 –12 kHz.									
Vespadelus darlingtoni				41-45 (6)					
		42-45 (9)		41-44 (9)	42-45 (6)				
Calls were at expected frequency range and characteristics.									
Vespadelus troughtoni	See notes								
No Reference calls from area. Overlaps with *Vespadelus vulturnus*.									
Vespadelus vulturnus		49-52 (12) 52-55 (7)		49-52 (4) 51-54 (8)			45-48 (1) 47-50 (15) 49-52 (7)		
	48-50 (2)	51-54(1) 49-53 (11)		48-53 (7)	47-53(23)		46-50 (3) 47-52 (2)	46-51 (4)	
It appears that the call frequency is generally lower in the Valley floors and Manobalai NR which fits the general expected trend for this species.									

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