



Rapid Fauna Habitat Assessment of the Sydney Metropolitan Catchment Management Authority Area

Department of Environment and Climate Change (NSW)
June 2008

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OVERVIEW

This study is designed to assist the Sydney Metropolitan Catchment Authority (CMA) address the conservation of native fauna (including threatened species) in their Catchment Action Plan and supporting investment strategies. This study will also assist DECC's own recovery planning program by implementing a number of recovery actions under the Threatened Species Priorities Action Statement (PAS).

Key drivers for the preparation of this study include the Natural Resource Commission (NRC) and State Plan targets, namely:

- By 2015 there is an increase in the recovery of threatened species, populations and ecological communities.
- By 2015 there is an increase in the number of sustainable populations of a range of native fauna species.
- There is an increase in the capacity of natural resource managers to contribute to regionally relevant natural resource management.

A key rationale for the study was that effective implementation of the NRC and State Plan targets is significantly hampered by the absence of a consistent catchment-wide view of native fauna presence, distribution and relative conservation priority. Existing work on fauna values was patchy and inconsistent with no previous work ranking remnant bushland and other habitat based on its overall contribution to native fauna conservation.

Together, these components should provide guidance to the CMA regarding priorities for biodiversity conservation across the CMA area.

In summary this study has:

- Identified all areas of remnant bushland in the CMA area greater than 50 ha (known as sites);¹
- Audited existing information to determine what was already known and which sites required additional survey;
- Involved fauna surveys using a variety of techniques and with the assistance of volunteers;
- Profiled each site describing the habitats present, the threats in operation and comprehensively listing the native fauna species known to occur; and
- Ranked these sites in order of overall conservation priority based on a range of variables including connectivity, condition, presence of key habitat features such as tree hollows, presence of threatened and regionally significant species and the presence of pest species.

The CMA, while small in area and highly urbanised in parts, was found to contain a surprising variety of habitats including rainforests, wet and dry sclerophyll forests and woodlands, grassy woodlands, saltwater and freshwater wetlands and coastal and marine habitats. Utilisation of these habitats by native fauna species is equally complex and includes:

- Endemic species found only in the Sydney Basin Bioregion e.g. Rockwarbler (*Origma solitaria*);
- Freshwater and estuarine wetlands and coastal pelagic species including a number of migratory birds that are subject to international conservation agreements;
- Western fauna including species that come over the range in times of drought e.g. Masked Woodswallow (*Artamus personatus*) and various waterbird species;
- North coast species that are at or close to their southern limit of their range in the CMA area e.g. Logrunner (*Orthonyx temminckii*).
- Temperate species that are close to the northern limit of their range e.g. Pilotbird (*Pycnoptilus floccosus*).
- Summer and winter migrants that move either altitudinally or latitudinally in search of suitable summer or winter habitats.

In total over 550 native fauna species are known to occur in the CMA, including 53 threatened fauna species (excluding vagrants). The significance of a number of existing reserves including Royal National Park, Towra Point Nature Reserve, Dharawal State Conservation Area (SCArea) and Nature Reserve and Prospect SCArea has been confirmed and documented. Other non-reserved lands identified as having significant fauna values include the Botany Wetlands, Holsworthy Military Reserve, Narrabeen Lake, Sydney Olympic Park and the Upper Georges River.

¹ Two sites less than 50ha were also identified, as they were considered likely to contain high fauna values.

This study focuses on native terrestrial vertebrate fauna. This group represents a subset of our overall native fauna (which also includes aquatic fauna) which in turn is a subset of overall biological diversity (which includes fish, invertebrates, plants, bacteria and fungi). This study identifies areas of high terrestrial vertebrate fauna diversity within the CMA area as well as areas that support individual threatened fauna species.

Giving a special focus to native terrestrial vertebrate fauna is considered an important part of overall conservation planning because:

- Fauna species (including aquatic fauna) are disproportionately affected by a range of key threatening processes (habitat clearing, fragmentation, predation and others listed under the *Threatened Species Conservation Act 1995 (TSC Act 1995)* compared to other biota and so represent a significant challenge to conservation managers. Consequently areas supporting threatened fauna species become an important focus of conservation effort.
- The presence of diverse native vertebrate fauna within a habitat is a good sign that basic biological and ecological processes such as pollination, nutrient re-cycling and reproduction, are still in place. Habitats that are still capable of supporting diverse fauna assemblages may be better equipped to maintain their overall species diversity in the face of a range of threatening processes including climate change. Consequently highly diverse native fauna habitats present significant opportunities for long-term, sustainable conservation management.

The study provides the CMA with a catchment-wide assessment of the value of remnant vegetation for native fauna conservation and ranks the larger sites in priority order. As such the CMA can more confidently develop projects that address recognised fauna conservation priorities.

This study also assists DECC in its recovery planning program by:

- Identifying threatened fauna species presence in larger habitat remnants within the CMA. Combined with the PAS, which prioritises recovery actions for every species, this study should assist in the targeting of recovery efforts to species and sites of highest conservation priority;
- Directly implementing 'survey/mapping and habitat assessment' actions listed under the PAS for 25 threatened fauna species and one endangered ecological community while also contributing to the development of threat abatement strategies for a number of fauna related key threatening processes under the TSC Act.

This study is not intended, however, to be the only input to derive biodiversity conservation priorities. It is designed to be part of an overall strategy dealing with the conservation of biological diversity within the CMA area. Other components include:

- Aquatic ecosystems –The CMA is currently funding the mapping of estuarine and freshwater vegetation in key waterways by the Department of Primary Industries. In addition, a recently completed study funded by the CMA in partnership with Wetland Care Australia collated existing freshwater and estuarine wetland mapping for the Sydney Region. This information will be further refined and improved overtime.
- Floristic diversity – the CMA is currently funding vegetation community mapping by DECC that should lead to a better understanding of floristic diversity across the CMA area.

Together, these components should provide guidance to the CMA on priorities for biodiversity conservation across the CMA.

While the focus of this study has been on the largest areas of remnant vegetation, it is also acknowledged that smaller remnants and even scattered original trees and ornamental gardens can have significant value for individual species or groups of species. This study is seen as a first step in the development of an overall program to conserve the native fauna of the CMA area. Future activities include:

- Translation of priority sites into strategies for action. The sites identified by this study range from DECC reserves (which are already managed for conservation) to areas of private and other public land managed for a range of different land-uses. Working with these landholders to determine what can be done to conserve native fauna on their lands should be a key area of investment in the future.
- Further research and survey into smaller remnants and potential habitat links not covered by this study.

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ABBREVIATIONS

ADF	Australian Defence Forces
AMBS	Australian Museum Business Services
ANSTO	Australian Nuclear Science and Technology Organisation
CMA	Sydney Metropolitan Catchment Management Authority
DECC	Department of Environment and Climate Change (NSW)
DoFA	Department of Finance and Administration (Federal Government)
DPI	Department of Primary Industries (NSW)
LGA	Local Government Area
NP	National Park
NPW Act 1974	National Parks and Wildlife Act (1974)
NR	Nature Reserve
PAS	Threatened Species Priority Action Statement (DECC)
RP	Regional Park
RTA	Roads and Traffic Authority
SCArea	State Conservation Area
SF	State Forest
SOPA	Sydney Olympic Park Authority
SRA	State Recreation Area
SCA	Sydney Catchment Authority
TSC Act 1995	Threatened Species Conservation Act (1995)

1 INTRODUCTION

1.1 Project background

Despite its urban context, the Sydney Metropolitan Catchment Management Authority (CMA; <http://www.sydney.cma.nsw.gov.au>) area contains a wide variety of natural environments from estuarine and wetland habitats to rugged sandstone escarpments, open forests and woodlands. These environments are highly valued by many members of the community. This report is designed to assist the CMA address the conservation of native fauna (including threatened species) in their Catchment Action Plan and supporting investment strategies. Additionally, the report has been developed to assist land managers make informed and focused decisions when faced with the difficult task of prioritising the management of sites with biodiversity values. This report will also assist DECC's own recovery planning program by implementing a number of recovery actions under the Threatened Species Priorities Action Statement (PAS; http://www.threatened.species.environment.nsw.gov.au/tsprofile/home_PAS_new.aspx).

Key drivers for the preparation of this report include the Natural Resource Commission (NRC; <http://www.nrc.nsw.gov.au>) and State Plan (<http://www.nsw.gov.au/stateplan>) targets, namely:

- By 2015 there is an increase in the recovery of threatened species, populations and ecological communities.
- By 2015 there is an increase in the number of sustainable populations of a range of native fauna species.
- There is an increase in the capacity of natural resource managers to contribute to regionally relevant natural resource management.

A key rationale for the report is that effective implementation of the NRC and State Plan targets is significantly hampered by the absence of a consistent catchment-wide view of native fauna presence, distribution and relative conservation priority. Existing work on fauna values is patchy and inconsistent with no previous work ranking remnant bushland and other habitat based on its overall contribution to native fauna conservation. This report aims to provide the CMA with a consistent catchment-wide assessment of the fauna values of principle native vegetation remnants, thereby assisting the CMA to develop projects that address recognised fauna conservation priorities.

This report also assists DECC in focusing and prioritising its recovery efforts for threatened species. The survey and assessment work undertaken by this study addresses threatened species recovery and threat abatement planning in three ways:

- by contributing to the implementation of specific strategies and actions such as the requirement for 'survey/mapping and habitat assessment';
- by contributing to the knowledge-base that establishes relative priorities for the implementation of site-specific recovery actions for threat abatement and habitat management priorities; and
- by providing baseline information that will assist with the recovery planning program for threatened species efforts under the *Threatened Species Conservation Act 1995 (TSC Act 1995)*.

1.2 Objectives

The primary objective of this project is to gather and synthesise information to provide a greater understanding of the vertebrate fauna (i.e. birds, mammals, reptiles and frogs) of the CMA area. Specifically, this project aims to:

- Identify larger vegetation remnants (termed sites) within the CMA area.
- Document, review and collate pre-existing data on terrestrial vertebrate fauna.
- Collect information on selected vertebrate fauna groups within the sites using robust, systematic, replicable techniques.
- Identify the relative value of sites as habitat for fauna in the CMA area.
- Interview locals with fauna expertise to gather additional information on fauna present within sites.
- Involve volunteers from the community to assist with the undertaking of field surveys.
- Identify threatened vertebrate fauna species and endangered populations present within the sites.
- Identify additional fauna species occurring in the sites that are considered to be in decline, isolated or regionally under threat (termed 'regionally significant' fauna).
- Contribute all fauna sightings to the Atlas of NSW Wildlife which is accessible to land managers and the broader community for use in conservation planning.

- Prioritise and profile the sites into the five fauna habitat significance categories identified based on explicit assessment criteria.

1.3 Project team

The project was developed by DECC in conjunction with the CMA. The project was completed by Information and Assessment Section, Metropolitan Branch, EPRG, DECC. Martin Schulz was primarily responsible for project design, field work, report writing and data collection. Lucinda Ransom undertook the GIS analysis, data management and community liaison components. Kerry Oakes designed and formatted the report. Erin Dixon organised the volunteers.

The following people (listed in alphabetic order) provided useful comments on an earlier draft that have been incorporated into the report:

- a) Scientific reviewers: Debbie Andrew, Daniel Connolly, James Dawson, Peter Ewin, Tanya Leary, Dan Lunney, George Madani, Kylie Madden and Julie Ravallion.
- b) Local Government, CMA and other organisation reviewers: Robin Anderson (CMA), Richard Bonner (CMA), Diane Campbell (Hornsby Shire Council), Penny Colyer (Ku-ring-gai Council), Kerry Darcovich (Sydney Olympic Park Authority), Geoff Doret (Sutherland Shire Council), Lesley Diver (CMA), Kathy Godfrey (Bankstown City Council), Peter Irish (Baulkham Hills Shire Council), Timothy Matheson (Lane Cove City Council), Jo Ann Moore (CMA), Jeanie Muspratt (Strathfield Council), Jennie Powell (Warringah Council), Adam Smith (Ryde City Council) and Karen Visman (Liverpool City Council).



Map 1: The study area: Sydney Metropolitan Catchment Management Authority boundary, excluding oceanic component.

2 BACKGROUND

2.1 Study area

The study area is the CMA area, excluding the offshore oceanic component extending to the three nautical mile state limit off the coast (Map 1). The CMA area is bounded by the Cumberland Plain and the rolling shale-capped hills behind Campbelltown and Liverpool in the west, rugged Hawkesbury Sandstone ridgelines of Ingleside in the north, sandstone plateaus dotted with upland swamps behind Darkes Forest in the south, and the Pacific Ocean in the east. The CMA is primarily centred on the Hacking, Cooks, Georges, Parramatta and Lane Cove Rivers, Middle Harbour, Eastern and Northern Beaches catchments.

The CMA area is one of the most populated areas in Australia with approximately three million people living within an area of some 203,160 ha. Urban settlement covers a large part of the catchment. Native vegetation is managed by a mix of government (both State and Federal) and private landholders for a range of different purposes.

Native vegetation dominates the southern half of the Catchment with a smaller portion along the northern boundary. A narrow band of rural land occurs along the western section of the CMA area. Despite being one of the most populated CMA areas in NSW and the earliest settled, knowledge of fauna within the catchment is surprisingly patchy with little known about some areas.

2.2 Fauna in the CMA: a surprising diversity

The CMA area supports a surprisingly high fauna biodiversity. For example, over 447 species of birds have been recorded, representing over 70% of the state's total bird species. Such a diversity of fauna is a result of Sydney having some species unique to the Sydney Basin Bioregion as well as representatives of other fauna elements that overlap within the CMA.

Fauna Unique to the Sydney Basin: The Hawkesbury Sandstone dominated vegetation communities of the Sydney Basin Bioregion support a number of unique species. The majority of these species occur within the CMA area including the Red-crowned Toadlet (*Pseudophryne australis*), Broad-headed Snake (*Hoplocephalus bungaroides*) and Rockwarbler (*Origma solitaria*).



Sydney Basin Endemic Fauna:

Top: Red-crowned Toadlet. M. Schulz
Upper Right: Broad-headed Snake. M. Schulz
Right: Rockwarbler. M. Schulz

Centre of Range Fauna Element: The CMA is situated within the main part of the distribution of the majority of species occurring in the region. The large number of species in this category is largely a function of the diversity of habitats present ranging from rainforest to woodland to wetlands to estuaries and coastal waters. Many of these species are residents, while others are regular summer migrants such as the Pacific Koel (*Eudynamis orientalis*) and Sacred Kingfisher (*Todiramphus sanctus*). Some are widespread throughout most habitats, while others are highly restricted to habitats that are now rare within the region, such as grassy woodland. This section also includes feral species, many of which are now a well-established component of Sydney's fauna.



Centre of Range Fauna Element:

Upper Right: Short-beaked Echidna. M. Schulz
Lower Right: Eastern Pygmy-possum. N. Williams
Centre: Eastern Banjo Frog. M. Schulz
Centre Upper: Rabbit and Eurasian Coot. M. Schulz
Above: Superb Fairy-wren. M. Schulz

Northern Fauna Element: A number of species from subtropical north-eastern NSW range as far south as Sydney and the adjacent Illawarra region. Some of these species are restricted to larger patches of subtropical rainforest such as the Logrunner (*Orthonyx temminckii*) and Green Catbird (*Ailuroedus crassirostris*); others to wetlands such as the Wallum Froglet (*Crinia tinnula*); while others are rare or sporadic visitors, such as the Forest Kingfisher (*Todiramphus macleayii*) and Noisy Pitta (*Pitta versicolor*).



Northern Fauna Element:

Left: Australian Brush-turkey. M. Schulz; *Right:* Wallum Froglet. M. Schulz

Southern and Highland Fauna Element: A number of species from southern Australia range as far north as the Sydney region and beyond. Some of these are year-round residents, such as the Pilotbird (*Pycnoptilus floccosus*), while others are primarily winter visitors, such as the Swift Parrot (*Lathamus discolor*). Additionally, during the winter there is an influx of a number of species from higher altitude areas, including the ubiquitous Pied Currawong (*Strepera graculina*) that can be separated from resident birds by their distinctive call dialect (K. Madden, DECC, pers. comm.).



Southern and Highland Fauna Element:

Left: Pilotbird. M. Schulz

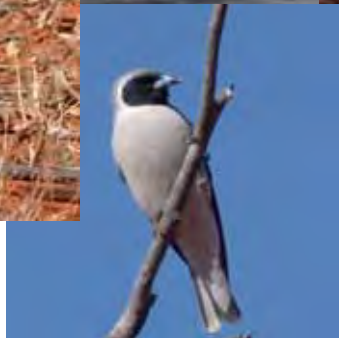
Centre: Pink Robin female. M. Schulz

Bottom Left: Silvereye. M. Schulz

Below: Pied Currawong. M. Schulz



Western Fauna Element: A range of species move into the Sydney region from inland NSW during times of drought. Many of these species are restricted to drier woodland communities on the Cumberland Plain, which fringes the western boundary of the CMA, or use the region's wetlands as a drought refuge.



Western Fauna Element:

Above: Australian Pelican. M. Schulz

Upper Left: Australasian Shoveler. M. Schulz

Far Left: Red-capped Robin male. M. Schulz

Left: Masked Woodswallow. M. Schulz

Marine Fauna Element: A diverse array of marine species occurs off the shores of the CMA. Some of these species regularly or occasionally enter the protected waters of Botany Bay and Sydney Harbour, such as the Bottlenose Dolphin (*Tursiops truncatus*), while other more pelagic species are rarely sighted from land such as various petrels and storm-petrels. Many species are migratory, with perhaps the most well-known examples being the Humpback Whales (*Megaptera novaeangliae*) and Short-tailed Shearwater (*Puffinus tenuirostris*), which pass through the region en route either to breeding or feeding grounds.



Marine Fauna Element:

- Upper Left:* Little Penguin. M. Schulz
- Lower Left:* Australian Fur Seal. M. Schulz
- Centre:* Humpback Whale calf breaching. M. Schulz
- Upper Right:* Bottlenose Dolphin. M. Schulz
- Lower Right:* Black-browed Albatross. M. Schulz

Vagrant Fauna Element: Some species of birds and marine mammals occur within the CMA as vagrants, with only a handful of records documented. Although generally regarded as unimportant in the context of the overall current biodiversity with changing climate conditions and a range of other factors some of these species may become more regular visitors in decades to come.



Vagrant Fauna Element:

- Upper Right:* Subantarctic Fur Seal juvenile. M. Schulz
- Centre:* Green Turtle. M. Schulz
- Upper Left:* Banded Stilt. M. Schulz
- Centre Left:* Black Kite. M. Schulz
- Lower Left:* Comb-crested Jacana. M. Schulz

2.3 Fauna in the CMA landscape

A *fauna habitat* is a broad environment utilised by a suite of fauna with similar environmental requirements. Eleven broad vegetation types have been identified occurring within the CMA (adapted from Keith 2004; DECC 2007a) and these vegetation types have been used to broadly define 'fauna habitats' in this study. The distribution of these habitats is shown in Map 2, excluding marine habitats. Each of the identified habitats supports varying fauna assemblages, thereby contributing to the high fauna biodiversity value of the region. This section outlines for each identified habitat: a) the importance to fauna in a regional context; b) distribution within the CMA; c) reservation status within the region; and d) whether a habitat has been listed as a priority habitat. A *priority fauna habitat* is identified as a fauna habitat that is of exceptional importance for the conservation of vertebrate fauna, particularly threatened and regionally significant species and has restricted occurrence within the CMA. A more detail description of what constitutes a priority fauna habitat and a brief description of these habitats is provided in Appendix 1. The broad distribution of priority fauna habitats with the CMA area is shown in Map 3. Given limited resources, protection and enhancement of priority fauna habitat will generate the maximum benefit to threatened species conservation and to vertebrate diversity in the region.

1) Rainforest (RF)



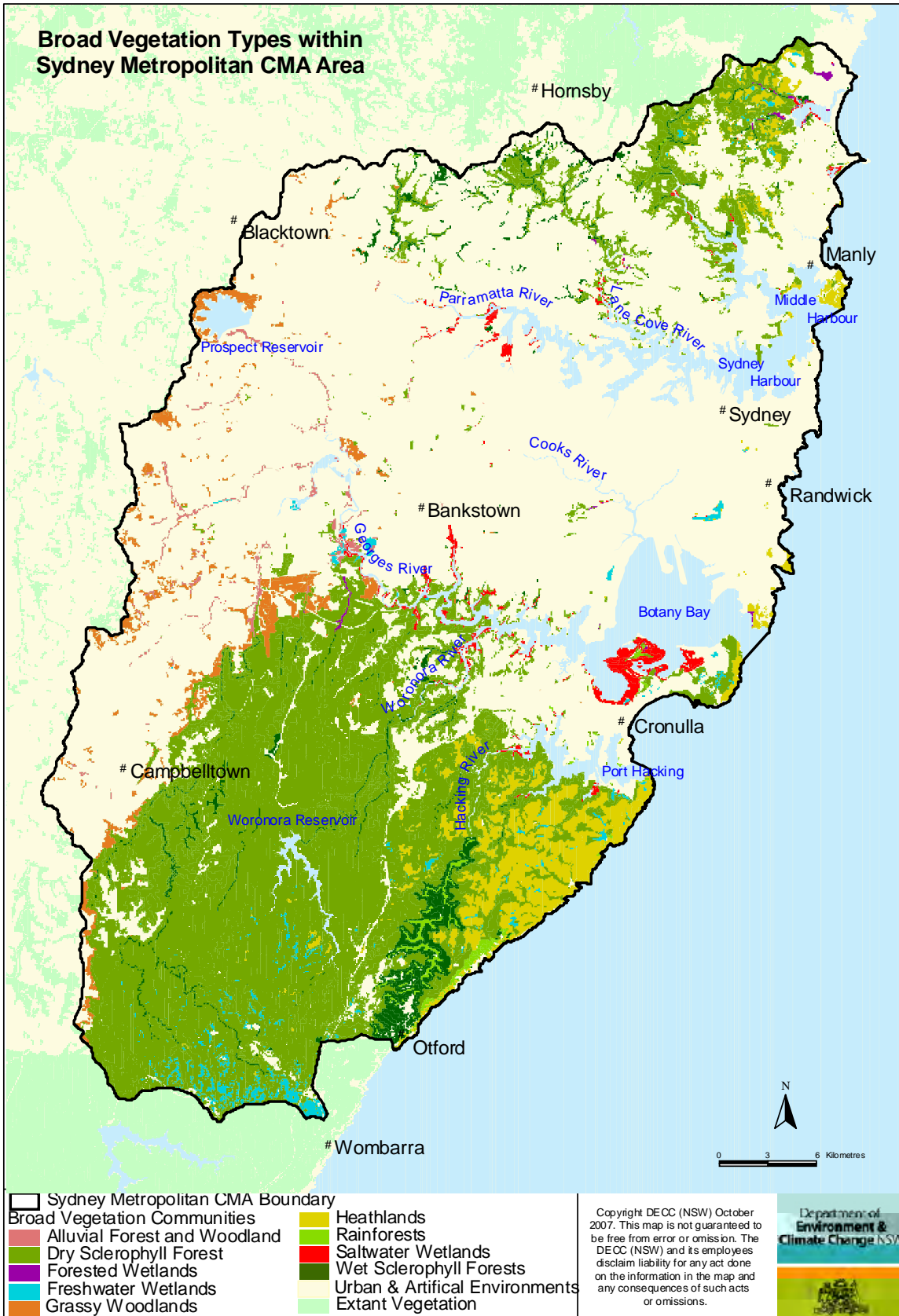
Importance to Fauna:

- Supports a number of subtropical species at their southern range limit, such as the Logrunner and Green Catbird.
- Supports species that are rare in other vegetation communities within the CMA, such as the Mountain Brushtail Possum (*Trichosurus caninus*) and Sooty Owl (*Tyto tenebricosa*).
- In the past supported a number of threatened frugivorous pigeons listed under the TSC Act 1995, such as the Wompoo Fruit-Dove (*Ptilinopus magnificus*), Superb Fruit-Dove (*P. superbus*) and Rose-crowned Fruit-Dove (*P. regina*). Today these species are only vagrants to the region.
- In the past supported the Stuttering Frog (*Mixophyes balbus*), a species listed under the TSC Act 1995 that appears no longer to be present within the CMA.
- Provides potential habitat for some species that have not yet been recorded within the CMA but may occur e.g. Golden-tipped Bat (*Kerivoula papuensis*).

Distribution in CMA: Highly Restricted

Reservation Status: Some of the best patches are situated on unreserved land, such as in the Upper Hacking River catchment linking Royal NP to the Illawarra Escarpment rainforests. Endangered Ecological Communities (under TSC Act 1995) include Littoral Rainforest, Western Sydney Dry Rainforest and Sydney Blue Gum High Forest (with a rainforest subcanopy).

Priority Fauna Habitat: Yes



Map 2: The distribution of broad vegetation types (adapted from Keith 2004) within the Sydney Metropolitan CMA area (excluding some coastal and all subtidal habitats) boundary (taken from Tozer *et al.* 2006).

2) Wet Sclerophyll Forest (WSF)



Importance to Fauna:

- Supports a wide range of wet forest species that are patchily distributed across the CMA.
- Supports a number of species that are uncommon in other vegetation communities, such as the Pilotbird, Superb Lyrebird (*Menura novaehollandiae*) and the Greater Glider (*Petauroides volans*).
- Typically supports important hollow-bearing trees that provide roosting and nesting habitat for a variety of species that range into adjacent vegetation communities to feed. This group includes tree-hole roosting bats and a number of bird species.

Distribution in CMA: Patchily Distributed

Reservation Status: Relatively well protected in DECC, DPI (Forests) and local government reserves. Endangered Ecological Communities (under TSC Act 1995) include Blue Gum High Forest (Critically Endangered Community), Sydney Turpentine Ironbark Forest (wetter parts) and Moist Shale Woodland.

Priority Fauna Habitat: No

3) Dry Sclerophyll Forest and Woodland (DSF)



Importance to Fauna:

- The primary habitat that supports the Sydney Basin Bioregion's endemic fauna: the Red-crowned Toadlet, Broad-headed Snake and Rockwarbler. Habitat supporting these species are well reserved in expansive national parks ringing the Sydney Basin.
- Important habitat for a number of threatened species, including the Giant Burrowing Frog (*Heleioporus australiacus*), Rosenberg's Goanna (*Varanus rosenbergi*), Glossy Black-Cockatoo (*Calyptorhynchus lathamii*) and Gang-gang Cockatoo (*Callocephalon fimbriatum*).
- Important habitat for a number of regionally significant species, such as the Chestnut-rumped Heathwren (*Calamanthus pyrrhopygius*) and Lace Monitor (*Varanus varius*).
- Overhangs in some localities provide important roosting habitat for a number of threatened species, including the Eastern Bentwing-bat (*Miniopterus schreibersii*) and Large-eared Pied Bat (*Chalinolobus dwyeri*).
- Cracks and crevices provide important habitat for a variety of reptiles, such as the Broad-tailed Gecko (*Phyllurus platurus*) and Cunningham's Skink (*Egernia cunninghami*).

Distribution in CMA: Widespread.

Reservation Status: Well protected in DECC, military and local government reserves. Endangered Ecological Communities (under TSC Act 1995) include Duffys Forest and Sydney Turpentine Ironbark Forest (drier sections).

Priority Fauna Habitat: No

4) Grassy Woodland (GW)



Importance to Fauna:

- This vegetation type was formerly widespread in the western parts of the CMA but today remnants are predominantly small, isolated, weed infested and disturbed. Consequently, the fauna occurring within this habitat has either disappeared, is in the process of disappearing or is rare and restricted in distribution within the CMA.
- Species that have recently disappeared include the endangered Bush Stone-curlew (*Burhinus grallarius*) and vulnerable Speckled Warbler (*Pyrrholaemus sagittatus*).
- Species that are in the process of disappearing include a range of threatened species such as the Squirrel Glider (*Petaurus norfolcensis*), Brown Treecreeper (*Climacteris picumnus*) and Diamond Firetail (*Stagonopleura guttata*).
- Species that are rare and restricted include the Brown Toadlet (*Pseudophryne bibronii*), Tree-base Litter-skink (*Carlia foliorum*), Jacky Winter (*Microeca fascinans*) and White-winged Chough (*Corcorax melanorhamphos*).
- This habitat is important for nectarivorous species, such as the threatened Swift Parrot, Grey-headed Flying-fox (*Pteropus poliocephalus*) and Black-chinned Honeyeater (*Melithreptus gularis*).
- Most remnant patches have few tree hollows present resulting in a depauperate hollow fauna. Patches that support tree hollows are of critical importance.

Distribution in CMA: Very Patchily Distributed with few relatively undisturbed patches remaining.

Reservation Status: Poorly protected and most reserved patches are isolated from adjacent patches. Endangered Ecological Communities (under TSC Act 1995) include Castlereagh Swamp Woodland, Cooks River/Castlereagh Ironbark Forest, Cumberland Plain Woodland and Shale Gravel Transition Forest.

Priority Fauna Habitat: Yes

5) Alluvial Forest and Woodland (AW)



Importance to Fauna:

- Similar to the grassy woodlands this vegetation type was formerly widespread along watercourses and low-lying swampy ground predominantly in the western parts of the CMA. But today much of this habitat has been reclaimed into playing fields, urban areas and industrial estates. Therefore similar to the grassy woodlands much of the fauna is now restricted to narrow bands with a high edge effect resulting in a number of species that have disappeared, are in the process of disappearing or are rare and restricted in distribution within the CMA.
- Species that have recently disappeared include the endangered Bush Stone-curlew and vulnerable Speckled Warbler.
- Species that are in the process of disappearing include a range of threatened species such as the Squirrel Glider, Brown Treecreeper and Diamond Firetail.
- Species that are rare and restricted include the Brown Toadlet, Tree-base Litter-skink, Jacky Winter and White-winged Chough.
- This habitat is important for nectarivorous species, such as the threatened Swift Parrot, Grey-headed Flying-fox and Black-chinned Honeyeater.
- Important habitat for a variety of bats including the Greater Broad-nosed Bat (*Scoteanax rueppellii*).
- Associated temporary wetlands are important for a variety of declining waterbird species such as Latham's Snipe (*Gallinago hardwickii*) and frogs such as Tyler's Tree Frog (*Litoria tyleri*).

Distribution in CMA: Patchily Distributed with most remaining vegetation present as narrow bands with a high 'edge effect' and heavily disturbed by surrounding land uses.

Reservation Status: Poorly protected and most reserved patches are isolated from adjacent patches and still impacted by adverse management from adjacent lands or upstream pollution sources. Endangered Ecological Communities (under TSC Act 1995) includes River-Flat Eucalypt Forest on Coastal Floodplains.

Priority Fauna Habitat: Yes

6) Heathland (HE)



Importance to Fauna:

- Much of this habitat has been subject to an increased level of disturbance such as the increased incidence of wildfire, often a result of arson. This increased fire frequency and intensity has resulted in the loss of several threatened species in the last few decades, including the Eastern Bristlebird (*Dasyornis brachypterus*) and Ground Parrot (*Pezoporus wallicus*).
- Much of the fauna present within this habitat is uncommon in other vegetation communities.
- Threatened species present include the Giant Burrowing Frog, Red-crowned Toadlet, Littlejohn's Tree Frog (*Litoria littlejohni*), Rosenberg's Goanna, Southern Brown Bandicoot (*Isoodon obesulus*) and Eastern Pygmy-possum (*Cercartetus nanus*).
- Regionally significant species present include Freycinet's Frog (*Litoria freycineti*), Bold-striped Cool-skink (*Acritoscincus duperreyi*), Southern Emu-wren (*Stipiturus malachurus*), Chestnut-rumped Heathwren, Beautiful Firetail (*Stagonopleura bella*) and New Holland Mouse (*Pseudomys novaehollandiae*).
- This habitat is important for nectarivorous species, such as the threatened Grey-headed Flying-fox and regionally significant Tawny-crowned Honeyeater (*Gliciphila melanops*).

Distribution in CMA: Patchily Distributed.

Reservation Status: Moderately protected. However some heathlands display disturbance features attributable to poorly managed longwall mining operations. Impacts include ground subsidence, streambed cracking, wetland loss and the input of pollutants into headwater streams. Endangered Ecological Communities (under TSC Act 1995) include Eastern Suburbs Banksia Scrub and Kurnell Dune Forest (heathier components) and Themeda Grassland on Seacliffs and Coastal Headlands

Priority Fauna Habitat: Yes

7) Forested Wetland (FOW)



Importance to Fauna:

- Similar to alluvial woodland much of this habitat has been lost or substantially modified in the past due to land reclamation activities. Much of the remaining patches are either regenerating after past clearing and/or have a high 'edge effect'.
- This habitat represents an intergrade between treeless wetlands (freshwater and saltwater) and backing dryland vegetation. Therefore it provides an important buffer to fauna using either adjacent wetlands or forested habitats.
- Stands that include scattered Swamp Mahogany (*Eucalyptus robusta*) provide important feeding habitat for the endangered Swift Parrot and occasionally the endangered Regent Honeyeater (*Xanthomyza phrygia*).
- Other threatened species that utilise this vegetation type include the Black Bittern (*Ixobrychus flavicollis*).
- Regionally significant species present include Tyler's Tree Frog and a range of waterbirds, such as the Nankeen Night Heron (*Nycticorax caledonicus*). A variety of insectivorous bats occur including the Eastern Bentwing-bat and East-coast Freetail-bat (*Mormopterus norfolcensis*).
- Forested wetlands provide important winter habitat for a number of bird species e.g. Rose Robin (*Petroica rosea*) and Brown Gerygone (*Gerygone mouki*).

Distribution in CMA: Patchily Distributed with most remaining vegetation present as narrow bands with a high 'edge effect' and heavily disturbed by surrounding land uses.

Reservation Status: Poorly protected and most reserved patches are still impacted by adverse management from adjacent lands or upstream/coastal pollution sources. Endangered Ecological Communities (under TSC Act 1995) include Swamp Oak Floodplain Forest and Swamp Sclerophyll Forest.

Priority Fauna Habitat: Yes

8) Freshwater Wetland (FRW)



Importance to Fauna:

- Similar to alluvial woodland and forested wetlands, much of this habitat has been lost or substantially modified in the past due to land reclamation activities. Much of the remaining patches are either heavily modified or artificially created. Few untouched natural wetlands remain in the CMA
- Freshwater wetlands encompass a number of types with associated distinctive fauna.
- Hanging swamps associated with open treeless plains, particularly on the Woronora Plateau provide important habitat for a number of threatened frogs, such as the Littlejohn's Tree Frog which is only known from a small number of locations within the region. Other threatened frogs include the Giant Burrowing Frog and Red-crowned Toadlet.
- Freshwater wetlands elsewhere range in size and type from extensive reedbeds to open expanses of water. A range of threatened species occur such as the Australasian Bittern (*Botaurus poiciloptilus*) and Green and Golden Bell Frog (*Litoria aurea*).
- These wetlands support an extensive range of species that are considered regionally significant, such as various crane and rail species.
- These wetlands are important as drought refuges for a variety of waterbirds, including the threatened Freckled Duck (*Stictonetta naevosa*) and regionally significant Australasian Shoveler (*Anas rhynchotis*) and Red-kneed Dotterel (*Erythronyx cinctus*).
- Some wetlands support colonial waterbird nesting sites, particularly of the Australian White Ibis (*Threskiornis molucca*). Although deemed as a pest by many during times of drought Sydney's wetlands support some of the only active colonies in the state.
- Many wetlands are important as nesting sites for non-colonial waterbirds but their importance on a state-wide scale is poorly understood e.g. crakes.
- Coastal wetlands are frequently important to species utilising adjacent saltwater wetlands. For example, Dee Why Lagoon is used as an alternative shelter site to Long Reef by migratory shorebirds during strong onshore winds.
- Freshwater wetlands provide important habitat for a number of species listed under international migratory bird agreements e.g. Latham's Snipe.
- A number of declining and regionally significant passerine bird species occur, such as the Little Grassbird (*Megalurus gramineus*).

Distribution in CMA: Patchily Distributed.

Reservation Status: Poorly protected and most reserved patches are still impacted by adverse management from adjacent lands or upstream/coastal pollution sources. Endangered Ecological Communities (under TSC Act 1995) include Freshwater Wetlands on Coastal Floodplains and Sydney Freshwater Wetlands.

Priority Fauna Habitat: Yes

9) Saltwater Wetland and Coastal Shoreline (SW)



Importance to Fauna:

- Similar to freshwater wetlands, much of this habitat has been lost or substantially modified in the past due to land reclamation activities, in particular areas of saltmarsh and intertidal flats used by a wide variety of shorebirds. Few untouched natural saltwater wetlands remain in the CMA.
- Saltwater wetlands encompass a number of types with associated distinctive fauna ranging from saltmarsh to mangrove forest, intertidal flats to rocky coastline and islets.
- Extensive areas of saltmarsh are now rare in the region. This habitat supports the only two remaining populations of the regionally significant White-fronted Chat (*Epthianura albifrons*). Extensive saltmarsh and adjacent sedgeland at Towra Point also provide important habitat for a number of other regionally significant species, such as the Southern Emu-wren and Lewin's Rail.
- The expanses of mangroves present have increased often at the expense of saltmarsh and intertidal flats. Mangroves support the regionally rare Mangrove Gerygone (*Gerygone levigaster*) and a wide range of waterbirds. Some migratory shorebirds, particularly the Whimbrel (*Numenius phaeopus*) roost in mangroves at high tide.
- Intertidal flats, particularly in parts of Botany Bay support a number of threatened (such as the Great Knot (*Calidris tenuirostris*) and Terek Sandpiper (*Xenus cinereus*) and regionally significant migratory shorebirds, many of which are listed under international migratory bird agreements.
- Recognition of the importance of migratory shorebirds within Botany Bay is demonstrated by the listing of 'The Endangered Shorebird Community occurring on the Relict Tidal Delta Sands at Taren Point'.
- Intertidal flats are also important for a range of other waterbirds, such as waterfowl and egrets.
- Migratory shorebird roosts occur at a number of localities in Botany Bay and at Long Reef. These important areas provide resting habitat for these species during high tide.
- Predominantly secluded sections of shoreline provide important nesting habitat for the endangered Little Tern (*Sterna albifrons*), vulnerable Pied Oystercatcher (*Haematopus longirostris*) and the regionally significant Red-capped Plover (*Charadrius ruficapillus*).
- Reef platforms provide foraging habitat for the threatened Sooty Oystercatcher (*Haematopus fuliginosus*) and regionally significant Eastern Reef Egret (*Egretta sacra*).

Distribution in CMA: Patchily Distributed.

Reservation Status: Poorly protected and most reserved patches are still impacted by adverse management from adjacent lands, disturbance or coastal pollution sources. Endangered Ecological Communities (under TSC Act 1995) includes Coastal Saltmarsh.

Priority Fauna Habitat: Yes

10) Coastal Waters (CW)



Importance to Fauna:

- A wide range of birds and marine mammals occur in subtidal waters ranging from waters in protected bays to exposed continental shelf waters.
- Marine mammals are characterised by the Common Dolphin (*Delphinus delphis*) and Bottlenose Dolphin in protected waters and the Humpback Whale and Minke Whale (*Balaenoptera acutorostrata*) in more pelagic waters. Seals are occasional visitors with the most common species being the Australian Fur Seal (*Arctocephalus pusillus*).
- A variety of seabirds occur ranging from tiny storm-petrels to the majestic Wandering Albatross (*Diomedea exulans*).
- Marine reptiles are infrequent; the most frequently recorded being the Green Turtle (*Chelonia mydas*), Leatherback Turtle (*Dermochelys coriacea*) and Yellow-bellied Sea Snake (*Pelamis platurus*).
- Most threatened species occurring within these habitats are non-breeding visitors, such as the Humpback Whale, Gibson's Albatross (*Diomedea gibsoni*) and the Southern Giant-petrel (*Macronectes giganteus*).
- An exception is the Little Penguin (*Eudyptula minor*), with an endangered population nesting on the shoreline of North Head. Other colonies formerly occurred elsewhere, such as at Cape Banks.
- Inshore waters also provide important feeding habitat for the endangered Little Tern and regionally significant species such as the White-fronted Tern (*Sterna striata*).

Note: This group of fauna was beyond the scope of the current study.

Distribution in CMA: Extensive

Reservation Status: Poorly protected.

Priority Fauna Habitat: No

11) Urban, Rural and Artificial Environments (UE)



Importance to Fauna:

- Urban, rural and artificial environments include residential and industrial lands, urban-rural landscapes, playing fields and ornamental parks, cleared ground with rank grassland, and extensive artificial environments such as Sydney Airport.
- Although alienated environments, many areas retain a scattering of original trees or plantings of a variety of native species. The greater the representation of these in an area, in addition to proximity to remnant habitat, the higher the species diversity present.
- Not surprisingly these environments are the home of a range of feral species, such as the House Mouse (*Mus musculus*), Black Rat (*Rattus rattus*), House Sparrow (*Passer domesticus*), Common Mynah (*Acridotheres tristis*) and Common Starling (*Sturnus vulgaris*).
- More surprisingly is the diversity of threatened and regionally significant species that also occur. The Swift Parrot is sometimes recorded foraging in flowering streetscape and parkland trees. Both original and some planted trees are an important food source for the threatened Grey-headed Flying-fox. The Eastern Bentwing-bat, Little Bentwing-bat and Southern Myotis roost in a variety of artificial structures such as under bridges, in stormwater drains and disused gunnery emplacements.
- In artificial environments such as Sydney Airport other threatened and regionally significant species occur, such as the Pied Oystercatcher, Double-banded Plover (*Charadrius bicinctus*) and Australian Pipit (*Anthus australis*).
- In disused plots of cleared land or rural pastures typified by long grass and weeds species such as the regionally significant Brown Quail (*Coturnix ypilophora*), King Quail (*C. chinensis*), Brown Songlark (*Cinclorhamphus cruralis*) and Golden-headed Cisticola (*Cisticola exilis*) may occur.
- Perhaps it is not surprising that a range of birds and bats occur in these alienated landscapes. Of greater surprise is the range of non-flying mammals and even reptiles. For example, recently a population of Long-nosed Bandicoots (*Perameles nasuta*) was discovered in Dulwich Hill, hardly pristine bushland. Similarly the Water-rat (*Hydromys chrysogaster*) occurs around the built-up shoreline of Sydney Harbour.
- Reptiles present range from the Broad-tailed Gecko that not only has adapted to living in some people's letterboxes but also ventures indoors to the ubiquitous Cream-striped Shinning Skink (*Cryptoblepharus virgatus*). Snakes also occur in some areas, particularly the Red-bellied Black Snake (*Pseudechis porphyriacus*).
- Houses and other buildings are not only utilised by some geckoes but also as roosts by some insectivorous bats, such as the Gould's Wattled Bat (*Chalinolobus gouldii*) and White-striped Mastiff-bat (*Tadarida australis*).

Distribution in CMA: Extensive

Reservation Status: Not Applicable

2.4 Fauna in relation to priority fauna habitats

Seven of the 11 broad fauna habitats outlined in the previous section were identified as priority fauna habitats due to their restricted occurrence (see Map 3) and/or poorly reserved status within the CMA area. Many of these priority habitats support a suite of species that are listed under the TSC Act 1995 or are regarded as regionally significant within the region based on restricted distribution or known/suspected declines in populations.

Threatened species of the CMA area are shown in relation to priority fauna habitats in Table 1. The priority fauna habitats occupied by the largest number of threatened species are grassy woodlands (16 species), alluvial forest and woodlands (14 species) and saltwater wetlands (13 species). In comparison, non-priority habitats also provide habitat for a number of threatened species; dry sclerophyll forest (17 species) and wet sclerophyll forest (14 species). Even urban and other alienated environments provide habitat for a number of threatened species (seven species).

When this list is reduced to threatened species that are primarily restricted to a single habitat in the CMA area, the highest number occur in saltwater wetlands (11 species), followed by grassy woodland (four species) and freshwater wetlands (three species) (Table 1). In contrast, the non-priority habitats are the primary habitat for only a negligible number of threatened species.

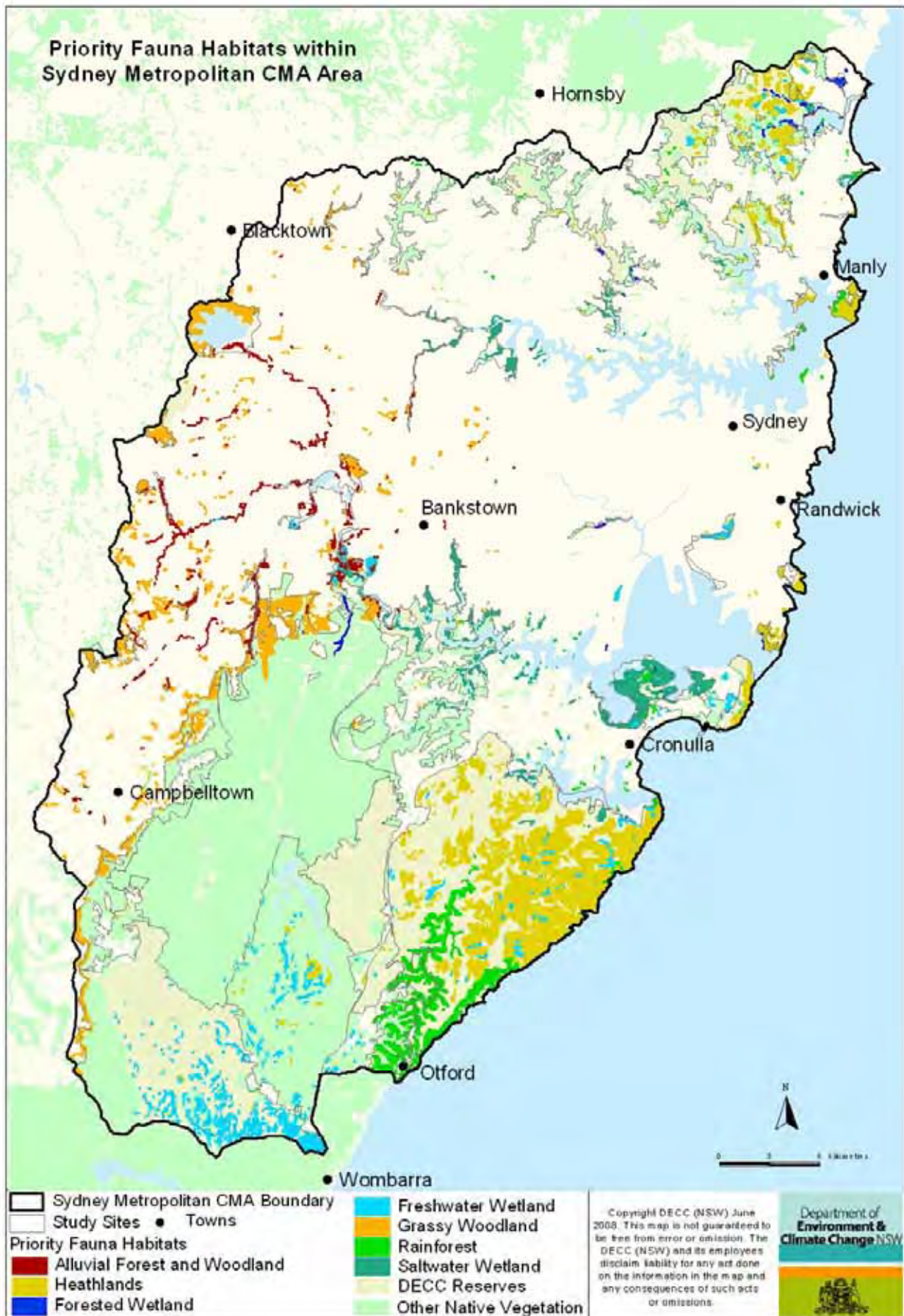
Regionally significant species in the CMA area are defined as:

- a) species listed previously as regionally significant in the CMA by NSW National Parks and Wildlife Service (1997); DEC (2006); and DECC (2007a);
- b) species listed as nationally near threatened (Garnett & Crowley 2000); and
- c) regionally uncommon or restricted species that are suspected to have declined across the region (identified through discussions with relevant experts).

Regionally significant species are shown in relation to priority fauna habitats in Table 2. The priority fauna habitats occupied by the largest number of regionally significant species are: freshwater wetlands (46 species), grassy woodlands (42 species), heathlands (39 species) and alluvial forests and woodlands (37 species). Similarly, non-priority habitats also support a high number of regionally significant species; wet sclerophyll forest (40 species) and dry sclerophyll forest (38 species).

However, when identifying regionally significant species that are primarily restricted to a single habitat; the highest numbers occur in saltwater wetlands (14 species), freshwater wetlands (11 species) and heathlands (six species). Similar to threatened species, the non-priority habitats provide sole primary habitat for only relatively small numbers of regionally significant species with dry sclerophyll forest supporting the highest number (six species).

When threatened and regionally significant species (Tables 1 and 2) are combined, the priority habitats that provide the sole habitat for the largest numbers of species are saltwater wetlands (25 species) and freshwater wetlands (14 species). Non-wetland habitats provide sole primary habitat for a smaller number of these species; the highest being heathland (seven species), grassy woodland (six species) and rainforest (six species). The comparatively low number of species supported by some of these latter priority habitats is in part the result of recent local extinctions that occurred within the last three decades (Table 1). For example, heathland provided the primary habitat for the Ground Parrot and Eastern Bristlebird and grassy woodland the primary habitat for the Bush Stone-curlew and Speckled Warbler. Non-priority habitats provide sole primary habitat for a small number of species, with dry sclerophyll forest supporting the highest number of species (six species). No recent local extinctions have occurred in these habitats.



Map 3: Priority fauna habitats within the Sydney Metropolitan CMA area.

Table 1. Priority fauna habitats and threatened species recorded within that last 10 years in the CMA area (not including subtidal habitats).

Note: This table does not include vagrant and unconfirmed species; V –Vulnerable, E – Endangered; * - habitat abbreviations (see previous section).

Species	Status	Priority Fauna Habitats*							Other Habitats*		
		GW	AW	SW	HE	RF	FRW	FOW	DSF	WSF	UE
<i>Frogs:</i>											
Wallum Froglet (<i>Crinia tinnula</i>)	V	-	-	-	-	-	+	-	-	-	-
Giant Burrowing Frog (<i>Heleioporus australiacus</i>)	V	-	-	-	+	-	+	-	+	-	-
Stuttering Frog (<i>Mixophyes balbus</i>)	E	-	-	-	-	+	-	-	-	-	-
Red-crowned Toadlet (<i>Pseudophryne australis</i>)	V	-	-	-	+	-	-	-	+	+	-
Green and Golden Bell Frog (<i>Litoria aurea</i>)	E	-	-	-	-	-	+	-	-	-	+
Littlejohn's Tree Frog (<i>Litoria littlejohni</i>)	V	-	-	-	+	-	+	-	-	-	-
<i>Reptiles:</i>											
Rosenberg's Goanna (<i>Varanus rosenbergi</i>)	V	-	-	-	+	-	-	-	+	-	-
Broad-headed Snake (<i>Hoplocephalus bungaroides</i>)	E	-	-	-	+	-	-	-	+	-	-
<i>Birds:</i>											
Freckled Duck (<i>Stictonetta naevosa</i>)	V	-	-	-	-	-	+	-	-	-	-
Australasian Bittern (<i>Botaurus poiciloptilus</i>)	V	-	-	-	-	-	+	-	-	-	-
Black Bittern (<i>Ixobrychus flavicollis</i>)	V	-	-	-	-	-	+	+	-	-	-
Osprey (<i>Pandion haliaetus</i>)	V	-	-	+	-	-	-	-	-	-	-
Square-tailed Kite (<i>Lophoictinia isura</i>)	V	+	+	-	-	-	-	-	-	-	-
Black-tailed Godwit (<i>Limosa limosa</i>)	V	-	-	+	-	-	-	-	-	-	-
Terek Sandpiper (<i>Xenus cinereus</i>)	V	-	-	+	-	-	-	-	-	-	-
Great Knot (<i>Calidris tenuirostris</i>)	V	-	-	+	-	-	-	-	-	-	-
Sanderling (<i>C. alba</i>)	V	-	-	+	-	-	-	-	-	-	-
Broad-billed Sandpiper (<i>Limicola falcinellus</i>)	V	-	-	+	-	-	-	-	-	-	-
Bush Stone-curlew (<i>Burhinus grallarius</i>)	E	Extinct in CMA, occasional vagrants									
Pied Oystercatcher (<i>Haematopus longirostris</i>)	V	-	-	+	-	-	-	-	-	-	-
Sooty Oystercatcher (<i>H. fuliginosus</i>)	V	-	-	+	-	-	-	-	-	-	-
Lesser Sand-Plover (<i>Charadrius mongolus</i>)	V	-	-	+	-	-	-	-	-	-	-
Greater Sand-Plover (<i>C. leschenaultii</i>)	V	-	-	+	-	-	-	-	-	-	-
Little Tern (<i>Sterna albifrons</i>)	E	-	-	+	-	-	-	-	-	-	-
Glossy Black-Cockatoo (<i>Calyptorhynchus latham</i>)	V	-	-	-	-	-	-	-	+	-	-
Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>)	V	-	-	-	-	-	-	-	+	+	-
Swift Parrot (<i>Lathamus discolor</i>)	E	+	+	-	-	-	-	+	+	-	+
Turquoise Parrot (<i>Neophema pulchella</i>)	V	+	-	-	+	-	-	-	-	-	-
Ground Parrot (<i>Pezoporus wallicus</i>)	V	Extinct in CMA, one recent vagrant									
Powerful Owl (<i>Ninox strenua</i>)	V	-	-	-	-	+	-	-	+	+	-
Barking Owl (<i>Ninox connivens</i>)	V	+	+	-	-	-	-	-	-	-	-
Masked Owl (<i>Tyto novaehollandiae</i>)	V	+	+	-	-	-	-	-	-	+	-
Sooty Owl (<i>T. tenebricosa</i>)	V	-	-	-	-	+	-	-	-	+	-
Eastern Bristlebird (<i>Dasyornis brachypterus</i>)	V	Extinct in CMA									
Speckled Warbler (<i>Pyrholaemus sagittatus</i>)	V	Suspected to be Extinct in CMA									
Brown Treecreeper (<i>Climacteris picumnus</i>)	V	+	-	-	-	-	-	-	-	-	-
Regent Honeyeater (<i>Xanthomyza phrygia</i>)	E	+	+	-	-	-	-	+	-	-	+

Species	Status	Priority Fauna Habitats*							Other Habitats*			
		GW	AW	SW	HE	RF	FRW	FOW	DSF	WSF	UE	
Black-chinned Honeyeater (<i>Meliphreptus gularis</i>)	V	+	+	-	-	-	-	-	-	-	-	-
Hooded Robin (<i>Melanodryas cucullata</i>)	V	+	-	-	-	-	-	-	-	-	-	-
Diamond Firetail (<i>Stagonopleura guttata</i>)	V	+	-	-	-	-	-	-	-	-	-	-
Mammals:												
Spotted-tailed Quoll (<i>Dasyurus maculatus</i>)	V	-	+	-	+	+	-	-	+	+	-	-
Southern Brown Bandicoot (<i>Isodon obesulus</i>)	E	-	-	-	+	-	-	-	+	+	-	-
Koala (<i>Phascolarctos cinereus</i>)	V	+	+	-	-	-	-	-	+	-	-	-
Eastern Pygmy-possum (<i>Cercartetus nanus</i>)	V	-	-	-	+	-	-	-	+	-	-	-
Squirrel Glider (<i>Petaurus norfolcensis</i>)	V	+	-	-	-	-	-	-	-	-	-	-
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	V	+	+	-	+	+	-	+	+	+	+	+
Black Flying-fox (<i>P. alecto</i>)	V	-	-	-	-	-	-	-	-	-	-	+
East-coast Freetail-bat (<i>Mormopterus norfolcensis</i>)	V	+	+	-	-	-	-	+	+	+	-	-
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	V	-	-	-	-	+	-	-	+	+	-	-
Eastern Bentwing-bat (<i>Miniopterus schreibersii</i>)	V	+	+	+	+	+	+	+	+	+	+	+
Little Bentwing-bat (<i>M. australis</i>)	V	-	+	-	-	-	-	+	-	+	+	+
Southern Myotis (<i>Myotis macropus</i>)	V	-	+	+	-	+	+	+	-	+	-	-
Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>)	V	+	+	-	-	+	-	-	+	+	-	-
Total Species:		16	14	13	11	9	9	8	17	14	7	

Table 2. Priority fauna habitats of regionally significant species of amphibians, reptiles, birds and mammals within the CMA area (not including subtidal habitats).

Source: 1- NSW National Parks and Wildlife Service 1997, DEC 2006; DECC 2007a; 2 – Garnett & Crowley 2000; 3 – expert opinion; * - habitat abbreviations (see previous section).

Species	Source	Priority Fauna Habitats							Other Habitats			
		FRW	GW	AW	HE	SW	FOW	RF	WSF	DSF	UE	
Frogs:												
Haswell's Froglet (<i>Paracrinia haswelli</i>)	1	+	-	-	+	-	+	-	-	-	-	-
Bibron's Toadlet (<i>Pseudophryne bibronii</i>)	3	-	+	+	-	-	-	-	+	-	-	-
Green Tree Frog (<i>Litoria caerulea</i>)	1	+	+	+	-	-	+	-	-	-	+	+
Freycinet's Frog (<i>Litoria freycineti</i>)	3	+	-	-	+	-	-	-	-	-	-	-
Reptiles:												
Eastern Snake-necked Turtle (<i>Chelodina longicollis</i>)	1	+	-	-	-	-	+	-	-	-	-	-
Short-necked Turtle (<i>Emydura</i> sp.)	1	+	-	-	-	-	-	-	-	-	-	-
Eastern Stone Gecko (<i>Diplodactylus vittatus</i>)	1	-	+	-	+	-	-	-	-	+	-	-
Lesueur's Velvet Gecko (<i>Oedura lesueurii</i>)	1	-	-	-	-	-	-	-	-	+	-	-
Thick-tailed Gecko (<i>Underwoodisaurus milii</i>)	1	-	+	-	-	-	-	-	-	+	-	-
Burton's Legless Lizard (<i>Lialis burtonis</i>)	1	-	+	-	+	-	-	-	-	+	-	-
Southern Scaly-foot (<i>Pygopus lepidopus</i>)	1	-	-	-	+	-	-	-	-	+	-	-
Eastern Bearded Dragon (<i>Pogona barbata</i>)	1	-	+	+	-	-	-	-	-	-	-	-
Lace Monitor (<i>Varanus varius</i>)	1	-	+	+	-	-	-	-	+	+	-	-
Bold-striped Cool-skink (<i>Acritoscincus duperreyi</i>)	3	-	-	-	+	-	-	-	-	-	-	-
Tree-base Litter-skink (<i>Carlia foliorum</i>)	1	-	+	-	-	-	-	-	-	-	-	-
Sheoak Skink (<i>Cyclodomorphus michaeli</i>)	3	-	-	-	+	-	-	-	-	-	-	-
Gully Skink (<i>Saproscincus spectabilis</i>)	3	-	-	-	-	-	-	+	+	-	-	-
Diamond Python (<i>Morelia spilota spilota</i>)	1	-	-	-	-	-	-	+	+	+	-	-
Eastern Brown Tree Snake (<i>Boiga irregularis</i>)	1	-	-	-	-	-	-	-	-	+	-	-

Species	Source	Priority Fauna Habitats							Other Habitats		
		FRW	GW	AW	HE	SW	FOW	RF	WSF	DSF	UE
Green Tree Snake (<i>Dendrelaphis punctulata</i>)	1	-	-	-	+	-	+	-	-	+	-
Southern Death Adder (<i>Acanthophis antarcticus</i>)	1	-	-	-	-	-	-	-	-	+	-
Golden-crowned Snake (<i>Cacophis squamulosus</i>)	1	-	-	-	+	-	+	+	+	-	-
Mustard-bellied Snake (<i>Drysdalia rhodogaster</i>)	1	-	-	-	+	-	-	-	-	-	-
Red-naped Snake (<i>Furina diadema</i>)	1	-	-	-	+	-	-	-	+	+	-
Marsh Snake (<i>Hemiaspis signata</i>)	1	+	-	-	+	-	+	-	+	-	-
Mainland Tiger Snake (<i>Notechis scutatus</i>)	1	+	+	+	+	-	+	-	-	-	-
Eastern Bandy-bandy (<i>Vermicella annulata</i>)	1	-	-	-	+	-	-	-	-	+	-
Birds:											
Australian Brush-turkey (<i>Alectura latham</i>)	1	-	-	-	-	-	-	+	+	-	+
Stubble Quail (<i>Coturnix pectoralis</i>)	1	+	-	-	+	-	-	-	-	-	+
Brown Quail (<i>C. ypsilophora</i>)	1	+	-	-	+	-	-	-	-	-	+
King Quail (<i>C. chinensis</i>)	1	-	-	-	+	-	-	-	-	-	+
Musk Duck (<i>Biziura lobata</i>)	1	+	-	-	-	-	-	-	-	-	-
Australasian Shoveler (<i>Anas rhynchotis</i>)	3	+	-	-	-	-	-	-	-	-	-
Great Crested Grebe (<i>Podiceps cristatus</i>)	1	+	-	-	-	-	-	-	-	-	-
Eastern Reef Egret (<i>Egretta sacra</i>)	3	-	-	-	-	+	-	-	-	-	-
Great Egret (<i>Ardea alba</i>)	1	+	-	-	-	+	+	-	-	-	-
Nankeen Night Heron (<i>Nycticorax caledonicus</i>)	1	+	-	-	-	+	+	-	-	-	-
Little Bittern (<i>Ixobrychus minutus</i>)	2	+	-	-	-	-	-	-	-	-	-
Glossy Ibis (<i>Plegadis falcinellus</i>)	1	+	-	-	-	-	-	-	-	-	-
Pacific Baza (<i>Aviceda subcristata</i>)	1	-	+	+	-	-	-	-	+	-	-
Whistling Kite (<i>Haliastur sphenurus</i>)	1	+	+	+	+	+	+	-	-	-	-
White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>)	1	+	-	+	-	+	+	-	-	+	-
Swamp Harrier (<i>Circus approximans</i>)	3	+	-	-	+	-	-	-	-	-	-
Grey Goshawk (<i>Accipiter novaehollandiae</i>)	1	-	+	+	-	-	-	+	+	-	-
Wedge-tailed Eagle (<i>Aquila audax</i>)	1	-	+	+	-	-	-	-	+	+	-
Little Eagle (<i>Hieraaetus morphnoides</i>)	1	-	+	+	-	-	-	-	-	-	-
Peregrine Falcon (<i>Falco peregrinus</i>)	1	+	+	+	+	+	+	-	+	+	+
Buff-banded Rail (<i>Gallirallus philippensis</i>)	3	+	-	-	-	-	+	-	-	-	+
Lewin's Rail (<i>Rallus pectoralis</i>)	2	+	-	-	+	+	+	-	-	-	-
Baillon's Crake (<i>Porzana pusilla</i>)	3	+	-	-	-	-	-	-	-	-	-
Australian Spotted Crake (<i>P. fluminea</i>)	3	+	-	-	-	-	-	-	-	-	-
Spotless Crake (<i>P. tabuensis</i>)	3	+	-	-	-	-	-	-	-	-	-
Painted Button-quail (<i>Turnix varia</i>)	1	-	+	+	-	-	-	-	-	+	-
Latham's Snipe (<i>Gallinago hardwickii</i>)	1	+	-	-	-	-	-	-	-	-	+
Bar-tailed Godwit (<i>Limosa lapponica</i>)	1	-	-	-	-	+	-	-	-	-	-
Whimbrel (<i>Numenius phaeopus</i>)	1	-	-	-	-	+	-	-	-	-	-
Eastern Curlew (<i>N. madagascariensis</i>)	1	-	-	-	-	+	-	-	-	-	-
Marsh Sandpiper (<i>Tringa stagnatilis</i>)	1	+	-	-	-	+	-	-	-	-	-
Common Greenshank (<i>T. nebularia</i>)	1	+	-	-	-	+	-	-	-	-	-
Wood Sandpiper (<i>T. glareola</i>)	1	+	-	-	-	-	-	-	-	-	-
Common Sandpiper (<i>Actitis hypoleucos</i>)	1	-	-	-	-	+	-	-	-	-	-
Grey-tailed Tattler (<i>Heteroscelus brevipes</i>)	3	-	-	-	-	+	-	-	-	-	-
Wandering Tattler (<i>H. incanus</i>)	3	-	-	-	-	+	-	-	-	-	-
Ruddy Turnstone (<i>Arenaria interpres</i>)	1	-	-	-	-	+	-	-	-	-	-
Red Knot (<i>Calidris canutus</i>)	3	-	-	-	-	+	-	-	-	-	-

Species	Source	Priority Fauna Habitats							Other Habitats		
		FRW	GW	AW	HE	SW	FOW	RF	WSF	DSF	UE
Sharp-tailed Sandpiper (<i>C. acuminata</i>)	1	+	-	-	-	+	-	-	-	-	-
Red-necked Stint (<i>C. ruficollis</i>)	1	+	-	-	-	+	-	-	-	-	-
Curlew Sandpiper (<i>C. ferruginea</i>)	1	+	-	-	-	+	-	-	-	-	-
Pacific Golden Plover (<i>Pluvialis fulva</i>)	1	-	-	-	-	+	-	-	-	-	+
Grey Plover (<i>P. squatarola</i>)	1	-	-	-	-	+	-	-	-	-	-
Red-capped Plover (<i>Charadrius ruficapillus</i>)	1	-	-	-	-	+	-	-	-	-	-
Double-banded Plover (<i>C. bicinctus</i>)	3	-	-	-	-	+	-	-	-	-	+
Common Tern (<i>Sterna hirundo</i>)	1	-	-	-	-	+	-	-	-	-	-
Whiskered Tern (<i>Chlidonias hybrida</i>)	3	+	-	-	-	+	-	-	-	-	-
White-winged Black Tern (<i>C. leucopterus</i>)	1	+	-	-	-	+	-	-	-	-	-
Brown Cuckoo-Dove (<i>Macropygia amboinensis</i>)	1	-	-	-	-	-	-	+	+	-	-
Emerald Dove (<i>Chalcophaps indica</i>)	1	-	-	-	-	-	-	+	-	-	-
Common Bronzewing (<i>Phaps chalcoptera</i>)	1	-	+	+	-	-	-	-	+	+	-
Brush Bronzewing (<i>P. elegans</i>)	3	-	-	-	+	-	-	-	+	+	-
Peaceful Dove (<i>Geopelia placida</i>)	1	-	+	+	-	-	+	-	-	-	-
Bar-shouldered Dove (<i>G. humeralis</i>)	1	-	+	+	-	-	-	-	-	-	-
Wonga Pigeon (<i>Leucosarcia melanoleuca</i>)	3	-	-	-	-	-	-	+	+	-	-
Topknot Pigeon (<i>Lopholaimus antarcticus</i>)	3	-	-	-	-	-	-	+	+	-	-
Oriental Cuckoo (<i>Cuculus saturatus</i>)	1	-	-	+	-	-	-	-	+	-	-
Pheasant Coucal (<i>Centropus phasianinus</i>)	1	+	-	-	+	-	+	-	-	-	-
White-throated Nightjar (<i>Eurostopodus mystacalis</i>)	3	-	-	-	-	-	-	-	-	+	-
Noisy Pitta (<i>Pitta versicolor</i>)	3	-	-	-	-	-	-	+	-	-	-
Superb Lyrebird (<i>Menura novaehollandiae</i>)	3	-	-	-	-	-	-	+	+	-	-
Red-browed Treecreeper (<i>Climacteris erythroptera</i>)	1	-	-	-	-	-	-	-	+	-	-
Southern Emu-wren (<i>Stipiturus malachurus</i>)	1	-	-	-	+	+	-	-	-	-	-
Pilotbird (<i>Pycnoptilus floccosus</i>)	3	-	-	-	-	-	-	-	+	+	-
Rockwarbler (<i>Origma solitaria</i>)	1	-	-	-	+	-	-	-	-	+	-
Yellow-throated Scrubwren (<i>Sericornis citreogularis</i>)	3	-	-	-	-	-	-	+	+	-	-
Large-billed Scrubwren (<i>S. magnirostris</i>)	3	-	-	-	-	-	-	+	+	-	-
Chestnut-rumped Heathwren (<i>Hylacola pyrrhopygia</i>)	1	-	-	-	+	-	-	-	-	+	-
Weebill (<i>Smicromis brevirostris</i>)	3	-	+	+	-	-	-	-	-	-	-
Mangrove Gerygone (<i>Gerygone levigaster</i>)	1	-	-	-	-	+	-	-	-	-	-
Buff-rumped Thornbill (<i>Acanthiza reguloides</i>)	1	-	+	+	-	-	-	-	-	+	-
Yellow-rumped Thornbill (<i>A. chrysorrhoa</i>)	1	-	+	+	-	-	+	-	-	-	+
Fuscous Honeyeater (<i>Lichenostomus fuscus</i>)	1	-	+	+	-	-	-	-	-	-	-
Brown Honeyeater (<i>Lichmera indistincta</i>)	1	-	-	-	+	-	+	-	-	-	-
Tawny-crowned Honeyeater (<i>Phylidonyris melanops</i>)	3	-	-	-	+	-	-	-	-	-	-
White-fronted Chat (<i>Epthianura albigrons</i>)	1	-	-	-	-	+	-	-	-	-	-
Jacky Winter (<i>Microeca fascinans</i>)	1	-	+	+	-	-	-	-	-	-	-
Scarlet Robin (<i>Petroica boodang</i>)	1	-	+	-	-	-	-	-	-	+	-
Red-capped Robin (<i>P. goodenovii</i>)	1	-	+	-	-	-	-	-	-	+	-
Flame Robin (<i>P. phoenicea</i>)	1	-	+	-	-	-	-	-	-	-	-
Logrunner (<i>Orthonyx temminckii</i>)	1	-	-	-	-	-	-	+	-	-	-
Spotted Quail-thrush (<i>Cinlosoma punctatum</i>)	1	-	+	-	-	-	-	-	-	+	-
Varied Sittella (<i>Daphoenositta chrysoptera</i>)	3	-	+	+	-	-	-	-	+	+	-

Species	Source	Priority Fauna Habitats							Other Habitats		
		FRW	GW	AW	HE	SW	FOW	RF	WSF	DSF	UE
Crested Shrike-tit (<i>Falcunculus frontatus</i>)	1	-	+	+	-	-	-	-	+	-	-
Restless Flycatcher (<i>Myiagra inquieta</i>)	1	-	+	+	-	-	+	-	-	-	-
White-bellied Cuckoo-shrike (<i>Coracina papuensis</i>)	1	-	+	+	-	-	-	-	+	-	-
White-winged Triller (<i>Lalage sueurii</i>)	1	-	+	+	-	-	-	-	-	-	-
Grey Currawong (<i>Strepera versicolor</i>)	1	-	-	-	-	-	-	-	-	+	-
White-winged Chough (<i>Corcorax melanorhamphos</i>)	1	-	+	+	-	-	-	-	-	-	-
Green Catbird (<i>Ailuroedus crassirostris</i>)	1	-	-	-	-	-	-	+	-	-	-
Singing Bushlark (<i>Mirafra javanica</i>)	1	+	-	-	-	-	-	-	-	-	+
Australian Pipit (<i>Anthus australis</i>)	3	+	-	-	-	+	-	-	-	-	+
Zebra Finch (<i>Taeniopygia guttata</i>)	1	+	+	+	-	-	-	-	-	-	+
Beautiful Firetail (<i>Stagonopleura bella</i>)	1	-	-	-	+	-	-	-	-	-	-
Chestnut-breasted Mannikin (<i>Lonchura castaneothorax</i>)	1	+	-	-	-	-	-	-	-	-	-
Tawny Grassbird (<i>Megalurus timoriensis</i>)	3	+	-	-	-	-	-	-	-	-	+
Little Grassbird (<i>M. gramineus</i>)	3	+	-	-	-	+	-	-	-	-	-
Rufous Songlark (<i>Cincloramphus mathews</i>)	1	-	+	+	+	-	-	-	-	-	-
Brown Songlark (<i>C. cruralis</i>)	1	+	-	-	-	-	-	-	-	-	+
Golden-headed Cisticola (<i>Cisticola exilis</i>)	1	+	-	-	-	-	-	-	-	-	+
Bassian Thrush (<i>Zoothera lunulata</i>)	1	-	-	-	-	-	-	+	+	-	-
Mammals:											
Short-beaked Echidna (<i>Tachyglossus aculeatus</i>)	1	-	+	+	+	-	-	-	+	+	-
Platypus (<i>Ornithorhynchus anatinus</i>)	1	+	-	-	-	-	-	-	-	-	-
Brown Antechinus (<i>Antechinus stuartii</i>)	1	-	+	+	+	-	+	+	+	+	-
Dusky Antechinus (<i>A. swainsonii</i>)	1	-	-	-	+	-	-	+	-	-	-
Common Dunnart (<i>Sminthopsis murina</i>)	1	-	+	+	+	-	-	-	-	-	-
Long-nosed Bandicoot (<i>Perameles nasuta</i>)	1	-	-	+	+	-	+	+	+	+	+
Common Wombat (<i>Vombatus ursinus</i>)	1	-	-	-	-	-	-	-	+	+	-
Greater Glider (<i>Petauroides volans</i>)	1	-	-	-	-	-	-	-	+	+	-
Mountain Brushtail Possum (<i>Trichosurus caninus</i>)	1	-	-	-	-	-	-	+	+	-	-
Feathertail Glider (<i>Acrobates pygmaeus</i>)	1	-	-	-	-	-	-	-	+	-	-
Red-necked Wallaby (<i>Macropus rufogriseus</i>)	1	-	-	-	-	-	+	-	+	+	-
Common Wallaroo (<i>M. robustus</i>)	1	-	-	-	-	-	-	-	+	+	-
Eastern Grey Kangaroo (<i>M. giganteus</i>)	1	-	+	+	-	-	-	-	-	-	-
Swamp Wallaby (<i>Wallabia bicolor</i>)	1	-	+	+	+	-	+	+	+	+	-
Red-necked Pademelon (<i>Thylogale thetis</i>)	1	-	-	-	-	-	-	+	-	-	-
Water-rat (<i>Hydromys chrysogaster</i>)	1	+	-	-	-	+	-	-	-	-	-
New Holland Mouse (<i>Pseudomys novaehollandiae</i>)	1	-	-	-	+	-	-	-	-	-	-
Bush Rat (<i>Rattus fuscipes</i>)	3				+			+	+	+	
Swamp Rat (<i>Rattus lutreolus</i>)	1	+	-	-	+	-	+	-	-	-	-
Eastern Horseshoe-bat (<i>Rhinolophus megaphyllus</i>)	3	-	-	-	-	-	-	+	+	-	-
Eastern Broad-nosed Bat (<i>Scotorepens orion</i>)	3	-	+	+	-	-	+	+	+	+	-
Total Species:		46	42	37	39	33	25	25	40	38	18

2.5 Threats to fauna in the CMA area

Key threatening processes as listed under the TSC Act 1995 impacting on fauna within the CMA area include:

Key threatening processes related to habitat alteration:

- Clearing of native vegetation.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.
- Alteration of habitat following subsidence due to longwall mining.
- Ecological consequences of altered fire regimes (e.g. less or more frequent and/or intense fires).
- Loss of hollow-bearing trees.
- Removal of dead wood and dead trees.
- Bushrock removal and disturbance.
- Infection of native plants by Cinnamon Fungus (*Phytophthora cinnamomi*).
- Invasion, establishment and spread of Lantana (*Lantana camara*).
- Invasion of native plant communities by Bitou Bush and Boneseed (*Chrysanthemoides monilifera*).
- Invasion and establishment of exotic vines and scramblers.
- Invasion of native plant communities by exotic perennial grasses.

Key threatening processes related to the impacts of feral species:

- Predation by the European Red Fox (*Vulpes vulpes*).
- Predation by Feral Cats (*Felis catus*).
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*).
- Predation by the Plague Minnow (*Gambusia holbrooki*).
- Competition from feral Honeybees (*Apis mellifera*).
- Herbivory and environmental degradation caused by feral deer.
- Competition and habitat degradation by Feral Goats (*Capra hircus*).
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*).

Other key threatening processes:

- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis.
- Infection by Psittacine circoviral (beak & feather) disease affecting endangered psittacine species and populations.
- Exclusion as a result of aggressive interactions with overabundant native fauna, such as the Noisy Miner (*Manorina melanocephala*), Galah (*Cacatua roseicapilla*), Little Corella (*C. sanguinea*) and Rainbow Lorikeet (*Trichoglossus haematodus*).
- Human-induced climate change.
- Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments.

There are a range of other impacts that are not currently listed as key threatening processes in NSW but are thought to be having localised impacts in the CMA area. These are described below.

Coastal environment: Water quality and associated impacts such as gross pollution, sedimentation and dredging impacts; alteration to coastal processes; disturbance by watercraft, particularly hovercrafts and jet skis; invasion of saltmarsh and intertidal flats by the Grey Mangrove (*Avicennia marina*); birdstrike as a result of powerlines traversing estuaries; and disturbance by uncontrolled dogs.

Wetland and non-tidal watercourses: Water quality and associated impacts such as gross pollution, sedimentation; disturbance by the public; birdstrike as a result of powerlines traversing wetlands and rivers; infestation by a variety of weeds; predation by wide-ranging domestic cats; disturbance by uncontrolled dogs; and the impacts of introduced rodents.

2.6 Feral species

European colonisation introduced many exotic species to the region, including plants, fish, birds, mammals, invertebrates and even fungus. Some introduced species are predominantly confined to urban areas and probably have little impact on native environments, for example the House Sparrow. With others, the impact has been disastrous, with well-known examples including the Rabbit and Fox. Other feral species have a more subtle effect, such as the Mallard (*Anas platyrhynchos*) which hybridises with our native Pacific Black Duck (*A. superciliosa*). A summary of regularly observed feral vertebrate species present within the CMA is provided in Table 3.

Introduced vertebrates can impact on the environment in a number of ways. The action of hoofed animals such as the Feral Goat and Rusa Deer (*Cervus timorensis*) can lead to soil erosion and reduce the germination rates of some native plants species. While the Fox and Feral Cat prey on native fauna. The impact of introduced rats as predators is virtually unknown. Some species of introduced vertebrates are able to penetrate deep into otherwise undisturbed country (Table 3). Rabbits, Rusa Deer, Feral Pigs, Feral Cats and Foxes are all identified as contributing significantly to the continued decline of some threatened species and are listed as key threatening processes under the TSC Act 1995 (see Section 2.5).

Within the CMA the impact of feral predators is further magnified by the impact of wide-ranging domestic cats and uncontrolled domestic dogs.

Table 3: Common feral species present within the CMA area.

Species	Impact on Native Fauna and/or Habitat	Widespread in Habitat Remnants	Restricted largely to edges of Habitat Remnants	Limited in Distribution and/or rarely in Habitat Remnants
Birds				
Mallard (<i>Anas platyrhynchos</i>)	Moderate	+		
Muscovy Duck (<i>Cairina moschata</i>)	Limited			+
Rock Dove (<i>Columba livia</i>)	Limited	+		
Spotted Turtle-Dove (<i>Streptopelia chinensis</i>)	Limited	+		
Eurasian Skylark (<i>Alauda arvensis</i>)	Limited			+
Red-whiskered Bulbul (<i>Pycnonotus jocosus</i>)	Moderate	+		
House Sparrow (<i>Passer domesticus</i>)	Limited		+	
Nutmeg Mannikin (<i>Lonchura punctulata</i>)	Limited			+
European Goldfinch (<i>Carduelis carduelis</i>)	Limited			+
European Greenfinch (<i>C. chloris</i>)	Limited			+
Eurasian Blackbird (<i>Turdus merula</i>)	Moderate	+		
Common Starling (<i>Sturnus vulgaris</i>)	Significant	+		
Common Myna (<i>Acridotheres tristis</i>)	Significant		+	
Mammals				
House Mouse (<i>Mus musculus</i>)	Significant	+		
Black Rat (<i>Rattus rattus</i>)	Significant	+		
Brown Rat (<i>R. norvegicus</i>)	Moderate			+
Fox (<i>Vulpes vulpes</i>)	Significant	+		
Feral Dog (<i>Canis lupus familiaris</i>)	Significant	+		
Feral Cat (<i>Felis catus</i>)	Significant	+		
Rabbit (<i>Oryctolagus cuniculus</i>)	Significant	+		
Brown Hare (<i>Lepus capensis</i>)	Limited			+
Fallow Deer (<i>Dama dama</i>)	Limited			+
Red Deer (<i>Cervus elaphus</i>)	Limited			+

Species	Impact on Native Fauna and/or Habitat	Widespread in Habitat Remnants	Restricted largely to edges of Habitat Remnants	Limited in Distribution and/or rarely in Habitat Remnants
Rusa Deer (<i>C. timorensis</i>)	Significant	+		
Feral Goat (<i>Capra hircus</i>)	Significant			+
Feral Pig (<i>Sus scrofa</i>)	Significant			+

Examples of Feral Species with a Significant Impact on Native Fauna



Upper Left: Feral Cat: present in most bushland remnants within the CMA. M. Schulz

Lower Left: Rabbit: patchily distributed within the CMA. M. Schulz

Upper Right: Feral Dog: surprisingly common even within inner Sydney bushland remnants. G. Steenbeeke

Lower Right: Fox: widespread and present in all habitat remnants within the CMA. N. Williams

Examples of Feral Species with a Moderate Impact on Native Fauna



Left: Rusa Deer: restricted distribution within the CMA but causing major localised damage in parts of Royal NP and adjoining bushland areas. D. Andrew

Lower Left: Mallard: present in many wetlands within the CMA. M. Schulz

Examples of Feral Species with Limited Impact on Native Fauna



Upper Left: Brown Hare: present in low densities, primarily in the west of the CMA M. Schulz

Lower Left: Red Junglefowl: a rare and localised species within the CMA. M. Schulz

Upper Right: House Sparrow: primarily restricted to urban areas M. Schulz

Lower Right: Rock Dove: widespread in primarily urban areas M. Schulz

3 METHODS

3.1 What is a site?

For the purposes of this study a site was defined as a patch of continuous native vegetation that was greater than 50 hectares (ha) in area. These larger areas are likely to support the greatest diversity of any habitat remnants within the CMA and were the first priority for survey and assessment. While vertebrate fauna represents a small fraction of overall biological diversity, it is also accepted that areas supporting high vertebrate fauna diversity are also likely to be complex, diverse, functioning environments that have, at least in part, escaped the myriad of threatening processes acting on natural ecosystems. This is largely due to the sensitivity of many vertebrate fauna species to local extinctions arising from a range of threatening processes.

Sites included not only bushland remnants but also wetlands, native grassland and coastal shoreline vegetation. Two smaller sites that contained endangered ecological communities were also surveyed and assessed.

The approach of the study aimed to investigate areas of remnant vegetation that had not been significantly modified and consequently did not include:

- a) Parkland greater than 50 ha in area where there is no remnant vegetation.
- b) Areas greater than 50 ha where remnant vegetation elements have been significantly modified, such as only scattered original trees or treed habitat with the shrub and ground layer vegetation largely removed.
- c) Artificial habitats, such as ornamental gardens.

While this study focussed on larger remnants it is acknowledged that small and degraded remnants and even stands of original trees and ornamental gardens can have significant value for individual species or groups of species. Prominent examples include:

- The extensive mowed grasslands of Sydney Airport provides habitat for regionally significant shorebirds such as the Double-banded Plover and nesting habitat for the threatened Pied Oystercatcher;
- The ornamental lakes of Centennial Park at times support numbers of regionally significant shorebirds and other waterbirds;
- The Royal Botanic Gardens supports a permanent Grey-headed Flying-fox camp.
- Many Council reserves across the CMA area support scattered remnant eucalypts in parklands dominated by mowed grass. In some years these trees can provide important feeding habitat for nectarivorous species such as the endangered Swift Parrot and Regent Honeyeater or provide hollows suitable for some birds and a variety of bats, including threatened species such as the East-coast Freetail-bat.

3.2 Definition of sites

Aerial photographs from 2001 and SPOT 5 and Landsat satellite imagery were used to identify habitat remnants greater than 50 ha in area. These sites were digitised at 1:25,000 scale and overlaid onto tenure, landuse and existing vegetation mapping. Some sites supported similar landform and vegetation and were isolated by urban, agricultural uses from other vegetated lands. These areas naturally fell out as a single study site. Other areas were further broken down if:

- they were divided by modified vegetation (e.g. scattered canopy trees set amongst houses or mowed grass); or
- they supported different land tenure and hence land management practices. For example, Woronora Special Area managed by the Sydney Catchment Authority was identified separately from Heathcote NP managed by DECC; or
- they supported significantly different landforms within the landscape of a local region within the CMA, such as Narrabeen Lake from the Hawkesbury Sandstone gullies, slopes and plateaus of the Garigal – Oxford Falls area.

From this analysis 50 sites were identified across the CMA area.

3.3 Preliminary review of existing fauna information

In order to profile the fauna values of all sites and to target survey effort, these 50 sites were then assessed to determine the extent of current survey effort.

Information on previously recorded fauna species was extracted from:

- the Atlas of NSW Wildlife (including licensed datasets from Birds Australia, Department of Primary Industries (Forests) and the Australian Museum);
- DECC reports;
- local councils;
- relevant internet sites: Birding-Aus (<http://www.shc.melb.catholic.edu.au/home/birding/index.html>), Birdline NSW (<http://www.ereamaea.com>) and BioNet (<http://www.bionet.nsw.gov.au>);
- fauna consultancies and other written reports and published records; and
- unpublished records by interviewing selected observers.

Records were divided into species considered to be currently present (i.e. recorded within the last 10 years) and species with only historical records (i.e. only recorded more than 10 years ago).

Sites were then divided:

a) Well Surveyed Sites: Sites with at least 11 systematic fauna survey sites or at least 300 incidental fauna records (excluding seawatch records, bird banding results and large numbers of records of a single species at one location; see Map 4)

b) Poorly Surveyed Sites: Sites with 10 or fewer systematic fauna survey sites or less than 300 incidental fauna records (excluding seawatch records, bird banding results and large numbers of records of a single species at one location; see Map 4).

3.4 Survey techniques used in poorly surveyed sites

As part of the study, each of the poorly surveyed sites was subjected to field survey. This involved sampling all major vegetation communities for a period of two to nine days (depending on the site area and the time constraints) between February and September 2007. The survey involved a combination of systematic fauna survey techniques, opportunistic techniques and incidental sightings. Note that due to time and resource constraints time-consuming techniques such as small mammal and pitfall trapping were not used. These techniques are outlined in Appendix 2.

Systematic Rapid Fauna Assessment

The field-based survey methods employed the current DECC standard developed for use in the state-wide Comprehensive Regional Assessments (Appendix 2; NSW National Parks and Wildlife Service 1997). These techniques have been used widely by DECC in and adjacent to the Greater Sydney region (e.g. DEC 2006; DECC 2007a, b, d). Standardising these systematic techniques between vegetation types, surveys, regions, years and government agencies allows for comparison of results. When analysing the results collected using standard systematic techniques, accurate conclusions may be drawn about the differences in fauna sightings between different vegetation types, reserves, environments, disturbance levels or between other factors of interest. Such an approach has the benefit of direct comparison with large-scale regional fauna surveys, such as the Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region (DECC 2007a, b). Additionally, the techniques outlined in Appendix 2 are similar to those used in the Western Sydney Rapid Assessment fauna survey (DEC 2006).

Systematic sites sampled all major vegetation communities and a range of topography, including ridgetops, midslopes and creeklines. Systematic sites were two hectares in area and located either one kilometre apart when in similar broad vegetation types or greater than 500 m apart when in distinctly different vegetation communities (e.g. woodland versus saltmarsh). The number of systematic sites sampled was dependent on the size of the area and the diversity of vegetation communities.

Survey effort

At each systematic site a range of techniques was used depending on time constraints. Some techniques were not used in situations that might draw attention from members of the public, such as spotlighting close to residential areas or the siting of harp traps in high public use situations. Additionally, where perceived danger to field surveyors was judged unacceptable survey activities were ceased and the personnel left the area.

Of the 50 sites identified for assessment 25 were field surveyed (see Map 5). The field survey component of the study established 488 systematic survey sites (comprising one or more field

survey techniques), representing 10% of the total systematic survey sites undertaken in the region and documented in the Atlas of NSW Wildlife. The remaining 25 sites had no field survey component due to the documentation of previous systematic and/or incidental fauna records but had a varying number of incidental sightings recorded whilst undertaking site inspections. These site inspections were undertaken to evaluate various factors that were an integral component of the site scoring system (refer to Appendix 3). In total this study added 7630 records to the Atlas of NSW Wildlife. This total accounted for 5% (or 12% for all sightings post 1996) of the total records for the CMA in the Atlas.

Storage of data

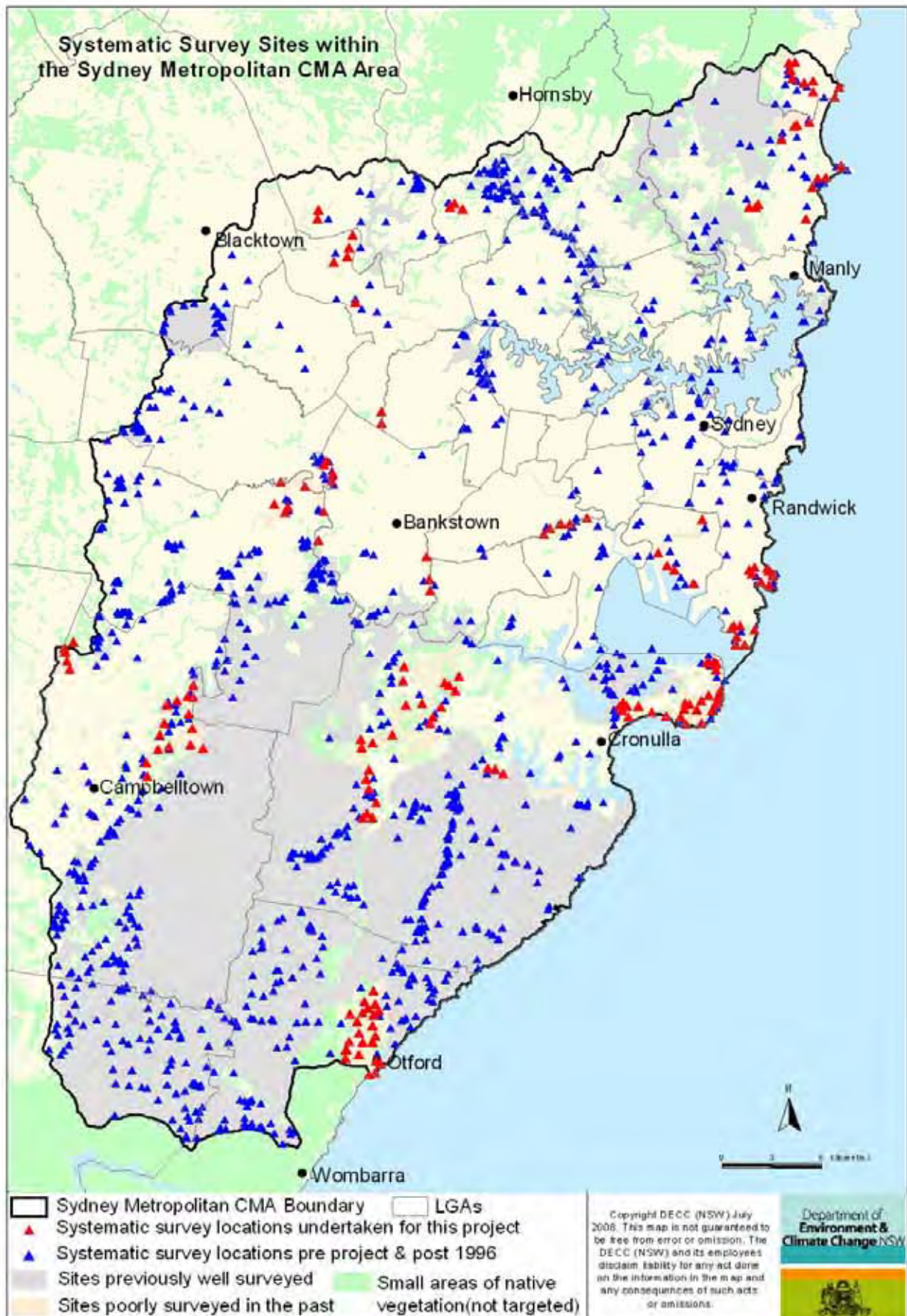
All field survey results and incidental records collected during the study have been entered into the Atlas of NSW Wildlife. This information is now publicly available.

Volunteer Involvement

An essential part of the field surveys was the involvement of around 40 volunteers. The majority of the nocturnal survey component of the field surveys was only made possible by the assistance of volunteers as it was judged essential for a sole DECC field surveyor to be accompanied by one or more additional personnel as a matter of safety.



Map 4: Sites previously well surveyed and poorly surveyed using DECC systematic survey techniques within the Sydney Metropolitan CMA area.



Map 5. Location of systematic survey sites using DECC systematic survey techniques both prior to this study and sampled during the Current study within the Sydney Metropolitan CMA area.

4 FAUNA SIGNIFICANCE OF SITES

4.1 Assessment and profiling of sites

The fauna significance of each site was assessed by scoring each site against a range of features known to be important fauna habitat components. These features include:

- Habitat connectivity
- Habitat state (or condition)
- Presence of tree hollows
- Below canopy structural attributes
- Habitat present considered to comprise priority fauna habitat
- Future prospects
- Presence of threatened species and regionally significant species
- Potential presence of further significant fauna
- Presence of feral bird species
- Presence of additional fauna attributes

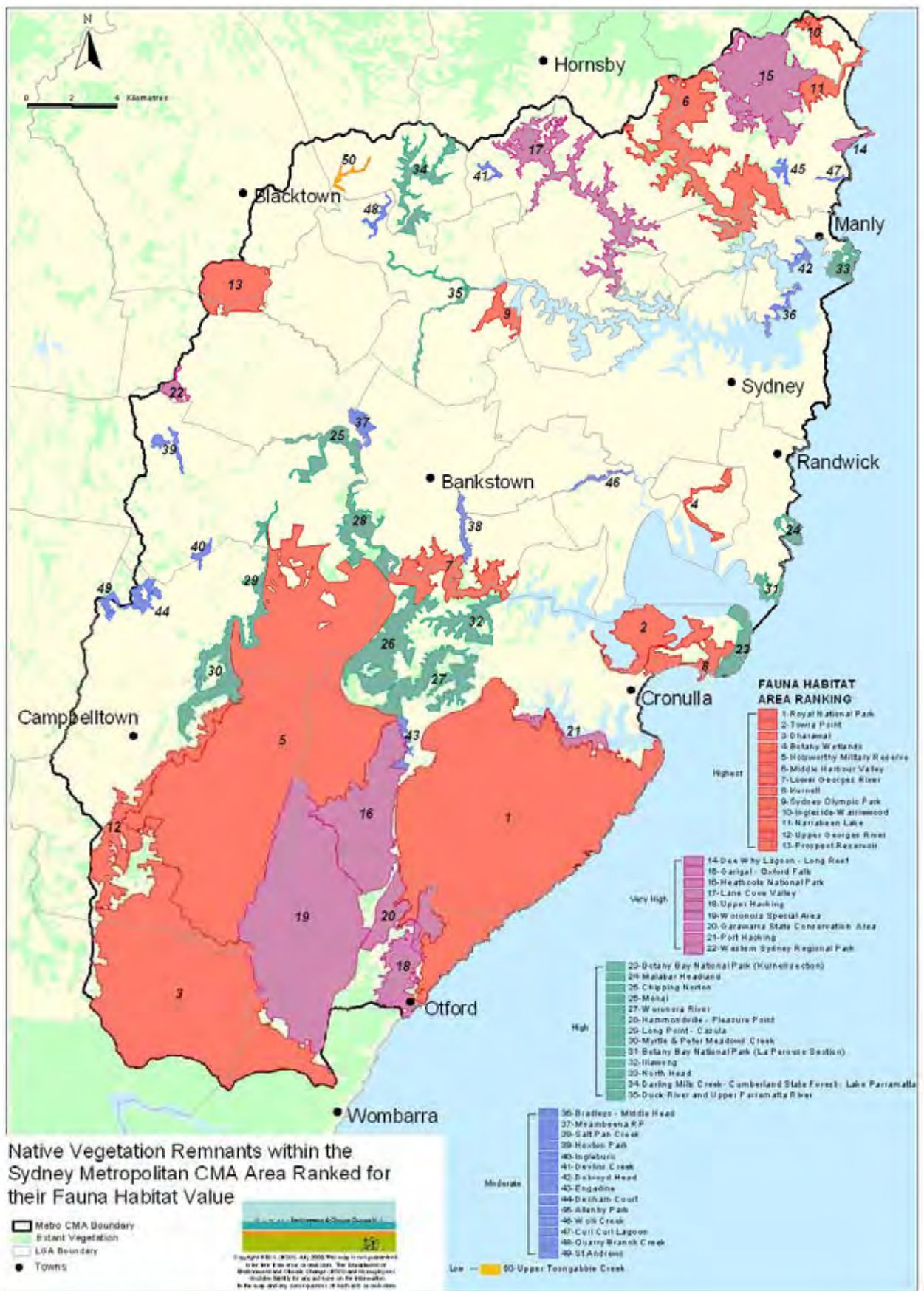
Appendix 3 details these features and how they were applied to rank the fauna significance of each site. A summary of the fauna values of these sites using the ranking system outlined in Appendix 3, key biodiversity values and LGA location is shown in Table 4.

A profile has been prepared of all 50 sites that:

- Describes the location and tenure of the site and its environmental and land management setting
- Describes the habitat features present
- Presents an overview of the fauna present
- Reviews the threatened fauna present and other important fauna values
- Describes the threats likely to be in operation on identified fauna values
- Includes relevant references for each site
- Provides an annotated list of all vertebrate fauna (excluding fish and marine species, where relevant) known to occur within each site including threatened and regionally significant species

These profiles are included in Appendix 4 or in the accompanying CD on the back sleeve of the report. Note that for speedy access to a particular site click on the hyperlink at the start of Appendix 4 on the CD.

A small-scale map detailing all the identified sites and their assigned fauna values are outlined in Map 6. Larger resolution maps are located in Appendix 5.



Map 6: The fauna value ranking of identified sites within the Sydney Metropolitan CMA area.

Table 4: Summary of identified fauna sites including ranking category, key biodiversity value and relevant LGAs.

Ranking	Site No.	Site	Fauna Diversity Values	Local Government Area	Land Management
Highest	1	Royal National Park	Extremely high fauna diversity: coastal, wetland, heath, bushland, rainforest, wetlands	Sutherland, Wollongong	DECC
	2	Towra Point	Very high fauna diversity: coastal, wetland, bushland; migratory waders, seabird/shorebird nesting	Sutherland	Mostly DECC, DPI
	3	Dharawal	Very high fauna diversity: heath, bushland; upland swamps, threatened frogs	Campbelltown, Wollondilly, Wollongong	Mostly DECC, Crown Reserve
	4	Botany Wetlands	High fauna diversity: coastal, wetland; drought refuge; seabird nesting; migratory waders	Botany Bay	Various
	5	Holsworthy Military Reserve	Very high fauna diversity: heath; very large bushland area; little restricted public access; Cumberland Plain species	Campbelltown, Liverpool, Sutherland	Dept of Defence
	6	Middle Harbour Valley	High fauna diversity: heath, bushland; flying-fox camp; Southern Brown Bandicoot	Ku-ring-gai, Manly, Warringah, Willoughby	Complex; including DECC
	7	Lower Georges River	High fauna diversity: estuarine, wetland, bushland; migratory waders	Bankstown, Hurstville, Sutherland	Complex; including DECC
	8	Kurnell	High fauna diversity: coastal, wetland, bushland; migratory waders; Grey-headed Flying-fox camp; threatened frogs	Sutherland	Various
	9	Sydney Olympic Park	High fauna diversity: estuarine, wetland, bushland; waders; drought refuge; threatened frogs	Auburn, Canada Bay	Sydney Olympic Park Authority
	10	Ingleside-Warriewood	Very high fauna diversity: wetland, heath, bushland; threatened frogs	Pittwater	Various
	11	Narrabeen Lake	High fauna diversity: coastal, wetland, heath, bushland	Pittwater, Warringah	Mostly Crown; Council
	12	Upper Georges River	Very high fauna diversity: bushland; important Koala habitat; Cumberland Plain species	Campbelltown	Various
	13	Prospect Reservoir	High fauna diversity: wetland, bushland; drought refuge; waterfowl; Cumberland Plain species	Blacktown, Fairfield, Holroyd	Mostly DECC, SC Authority

Ranking	Site No.	Site	Fauna Diversity Values	Local Government Area	Land Management
Very High	14	Dee Why Lagoon-Long Reef Point	High fauna diversity: coastal, wetland; migratory waders; drought refuge	Warringah	Mostly Council, Crown
	15	Garigal-Oxford Falls	High fauna diversity: heath, bushland; Southern Brown Bandicoot; threatened frogs	Pittwater, Warringah	Various, including DECC
	16	Heathcote NP	High fauna diversity: heath, bushland; Eastern Horseshoe-bat roost; threatened frogs; Eastern Pygmy-possum	Sutherland, Wollongong	Mostly DECC
	17	Lane Cove Valley	High fauna diversity: estuarine, bushland	Hornsby, Hunters Hill, Ku-ring-gai, Lane Cove, Ryde, Willoughby	Various, including DECC
	18	Upper Hacking	High fauna diversity; rainforest species; cave-dwelling bats; Stuttering Frog	Wollongong	Mostly private
	19	Woronora Special Area	High fauna diversity: heath, bushland; threatened frogs; little public access	Campbelltown, Sutherland, Wollondilly, Wollongong	SC Authority
	20	Garawarra SCArea	High fauna diversity: heath, bushland; rainforest species	Sutherland, Wollongong	Mostly DECC
	21	Port Hacking	Moderate fauna diversity: coastal; migratory waders	Sutherland	Various
	22	Western Sydney RP	Moderate fauna diversity: Cumberland Plain species	Fairfield	DECC, Council
High	23	Botany Bay NP (Kurnell section)	Moderate fauna diversity: coastal, wetland, heath, bushland; threatened frogs	Sutherland	Mostly DECC
	24	Malabar Headland	Moderate fauna diversity: coastal, wetland, heath, bushland; cave-dwelling bats	Randwick	Mostly Commonwealth
	25	Chipping Norton	Moderate fauna diversity: wetland, heath, bushland; Grey-headed Flying-fox camp; Cumberland Plain species	Bankstown, Fairfield, Liverpool	Mostly Council, Crown
	26	Menai	Moderate fauna diversity: heath, bushland; threatened frogs	Sutherland	Various
	27	Woronora River	Moderate fauna diversity: heath, bushland; cave-dwelling bats; threatened owls, migratory waders	Sutherland	Various
	28	Hammondville-Pleasure Point	Moderate fauna diversity: wetland, heath, bushland; threatened frogs; Cumberland Plain species, Koala	Bankstown, Liverpool	Various
F	29	Long Point-Casula	Moderate fauna diversity: wetland, bushland;	Campbelltown, Liverpool	Various, including

Ranking	Site No.	Site	Fauna Diversity Values	Local Government Area	Land Management
			threatened frogs; Cumberland Plain species		DECC
	30	Myrtle and Peter Meadows Creeks	Moderate fauna diversity: bushland; Cumberland Plain species, Koala	Campbelltown	Mostly Dept of Planning
	31	Botany Bay NP (La Perouse section)	Moderate fauna diversity: coastal, wetland, heath, bushland; cave-dwelling bats; threatened frogs	Randwick	Mostly DECC
	32	Illawong	Moderate fauna diversity: estuarine, wetland, bushland; migratory waders	Sutherland	Various
	33	North Head	Moderate fauna diversity: coastal, heath, bushland; Little Penguin and Long-nosed Bandicoot endangered populations	Manly	Mostly DECC
	34	Darling Mills Creek-Cumberland SF-Lake Parramatta	Moderate fauna diversity: bushland	Baulkham Hills, Parramatta	Various
	35	Duck River-Upper Parramatta River	Moderate fauna diversity: estuarine, wetland, bushland; two Grey-headed Flying-fox camps; threatened frogs; migratory waders; Cumberland Plain species	Auburn, Parramatta	Mostly Council
Moderate	36	Bradleys Head-Middle Head	Low to moderate fauna diversity: coastal, heath, bushland; cave-dwelling bats	Mosman	Mostly DECC
	37	Mirambeena	Low to moderate fauna diversity: wetland, bushland; White Ibis colony; Cumberland Plain species	Bankstown, Fairfield	Mostly Council
	38	Salt Pan Creek	Low to moderate fauna diversity: estuarine, bushland	Bankstown, Canterbury, Hurstville	Mostly Council
	39	Hoxton Park	Low to moderate fauna diversity: wetland, bushland; cave-dwelling bats; Cumberland Plain species	Liverpool	Various
	40	Ingleburn	Low to moderate fauna diversity: wetland, bushland; little public access; Cumberland Plain species	Campbelltown, Liverpool	Mostly Commonwealth
	41	Devlins Creek	Low to moderate fauna diversity: bushland; cave-dwelling bats	Hornsby	Mostly Council
	42	Dobroyd Head	Low to moderate fauna diversity: coastal, heath, bushland; potential Little Penguin habitat	Manly	Mostly DECC
N	43	Engadine	Low to moderate fauna diversity: bushland	Sutherland	Mostly Crown

Ranking	Site No.	Site	Fauna Diversity Values	Local Government Area	Land Management
	44	Denham Court	Low to moderate fauna diversity: bushland; Cumberland Plain species	Campbelltown	Mostly private
	45	Allenby Park	Low to moderate fauna diversity: heath, bushland; cave-dwelling bats	Warringah	Mostly Council
	46	Wolli Creek	Low to moderate fauna diversity: heath, bushland; Grey-headed Flying-fox camp	Canterbury, Rockdale	Mostly Council, DECC, Crown
	47	Curl Curl Lagoon	Low to moderate fauna diversity: coastal lagoon	Warringah	Mostly Council
	48	Quarry Branch Creek	Moderate fauna diversity: bushland	Parramatta	Mostly Council
	49	St Andrews	Low to moderate fauna diversity: bushland; Cumberland Plain species	Campbelltown	Mostly private
LOW	50	Upper Toongabbie Creek	Low fauna diversity: bushland	Baulkham Hills	Mostly Council

4.2 Ranking scores of fauna sites identified within the CMA area

In this section information is presented in Table 5 that details the overall scores of each category within the site-based ranking system for all identified sites (refer to Appendix 3 for a detailed description of the scoring system used).

Table 5: Results of Site-based Ranking System for all larger habitat remnants identified within the CMA area.

#	Site	Rating	Habitat Connectivity	Habitat State	Tree Hollows	Below Canopy Attributes	Priority Fauna Habitat	Future Prospects	Further Significant Fauna	Threatened Species	Regionally Significant Species	Feral Bird Species	Additional Fauna Values	TOTAL
	Score Range (Highest to Lowest)		0-20	0-15	0-20	0-15	0-30	-10 to 10	0-30	10 per Vulnerable sp 30 per Endangered sp	5 per species	0-5	Various	
1	Royal National Park	Highest	20	15	20	15	15	0	0	360	385	5	40	875
2	Towra Point	Highest	5	10	5	5	30	-10	10	180	195	5	140	575
3	Dharawal	Highest	20	15	15	15	15	-10	10	200	230	5	40	545
4	Botany Wetlands	Highest	0	0	5	5	30	-10	10	190	230	0	80	540
5	Holsworthy Military Reserve	Highest	20	15	15	15	15	0	10	220	180	5	5	500
6	Middle Harbour Valley	Highest	5	10	15	10	15	-10	10	230	170	2	30	487
7	Lower Georges River	Highest	10	5	20	10	15	0	20	170	180	2	35	467
8	Kurnell	Highest	5	5	5	5	15	-10	0	180	185	0	45	435
9	Sydney Olympic Park	Highest	5	5	5	5	30	0	10	80	275	0	50	435
10	Ingleside-Warriewood	Highest	5	20	15	15	15	-10	10	150	205	2	5	432
11	Narrabeen Lake	Highest	20	10	20	5	30	0	10	160	170	0	5	430
12	Upper Georges River	Highest	20	15	20	15	15	-10	30	170	145	5	0	425
13	Prospect Reservoir	Highest	5	10	10	10	30	0	20	90	200	2	35	412
14	Dee Why Lagoon–Long Reef Point	Very High	0	5	5	5	30	0	20	140	170	0	20	395

#	Site	Rating	Habitat Connectivity	Habitat State	Tree Hollows	Below Canopy Attributes	Priority Fauna Habitat	Future Prospects	Further Significant Fauna	Threatened Species	Regionally Significant Species	Feral Bird Species	Additional Fauna Values	TOTAL
	Score Range (Highest to Lowest)		0-20	0-15	0-20	0-15	0-30	-10 to 10	0-30	10 per Vulnerable sp 30 per Endangered sp	5 per species	0-5	Various	
15	Garigal-Oxford Falls	Very High	10	10	10	15	15	-10	30	170	140	5	0	395
16	Heathcote NP	Very High	20	15	20	15	15	0	10	150	125	5	20	395
17	Lane Cove valley	Very High	0	10	15	10	15	0	10	150	160	2	20	392
18	Upper Hacking	Very High	20	10	5	10	15	-10	10	110	125	5	65	365
19	Woronora Special Area	Very High	20	15	20	15	15	-10	20	140	100	5	0	340
20	Garawarra SCArea	Very High	20	15	20	15	15	0	30	70	120	5	0	310
21	Port Hacking	Very High	20	15	15	10	30	-10	20	110	75	2	15	302
22	Western Sydney Regional Park	Very High	5	10	15	0	30	10	30	70	130	2	0	302
23	Botany Bay NP (Kurnell Section)	High	5	15	15	15	30	0	10	120	80	2	5	297
24	Malabar Headland	High	0	0	0	10	30	-10	10	80	145	0	25	290
25	Chipping Norton	High	5	5	10	0	30	0	10	70	105	0	55	290
26	Menai	High	10	10	20	10	15	-10	30	90	80	5	0	260
27	Woronora River	High	10	10	10	15	15	0	10	90	75	2	20	257
28	Hammondville–Pleasure Point	High	10	5	5	5	30	-10	20	90	95	0	5	255
29	Long Point–Casula	High	20	5	5	5	15	0	30	110	60	0	5	255
30	Myrtle and Peter	High	20	10	15	15	15	-10	20	70	90	2	0	247

#	Site	Rating	Habitat Connectivity	Habitat State	Tree Hollows	Below Canopy Attributes	Priority Fauna Habitat	Future Prospects	Further Significant Fauna	Threatened Species	Regionally Significant Species	Feral Bird Species	Additional Fauna Values	TOTAL
	Score Range (Highest to Lowest)		0-20	0-15	0-20	0-15	0-30	-10 to 10	0-30	10 per Vulnerable sp 30 per Endangered sp	5 per species	0-5	Various	
	Meadows Creeks													
31	Botany Bay NP (La Perouse Section)	High	0	5	5	10	30	0	10	50	70	0	45	225
32	Illawong	High	5	5	10	10	15	0	30	70	60	2	15	222
33	North Head	High	5	5	10	5	15	0	10	100	65	2	0	217
34	Darling Mills Creek-Cumberland State Forest-Lake Parramatta	High	0	5	10	5	5	0	20	70	90	0	0	210
35	Duck River & Upper Parramatta River	High	5	0	5	0	15	0	30	40	50	0	65	210
36	Bradleys-Middle Heads	Moderate	5	0	15	5	15	0	30	60	10	5	40	185
37	Mirambeena Regional Park	Moderate	5	5	10	5	30	0	30	10	70	0	20	185
38	Salt Pan Creek	Moderate	10	10	5	5	30	0	30	60	25	0	5	180
39	Hoxton Park	Moderate	0	0	10	5	30	-10	30	40	50	0	20	175
40	Ingleburn	Moderate	0	10	5	15	30	0	30	40	35	5	0	170
41	Devlins Creek	Moderate	5	0	10	10	0	0	30	60	5	2	40	162
42	Dobroyd Head	Moderate	5	0	10	15	15	0	30	60	20	5	0	160
43	Engadine	Moderate	20	15	20	15	0	0	30	30	25	5	0	160
44	Denham Court	Moderate	0	15	5	5	30	-10	30	50	25	2	0	152
45	Allenby Park	Moderate	0	0	10	15	15	0	20	50	15	5	20	150
46	Wolli Creek	Moderate	0	0	5	5	15	0	10	20	60	0	35	150
47	Curl Curl Lagoon	Moderate	0	0	5	0	30	0	30	20	40	0	5	130

#	Site	Rating	Habitat Connectivity	Habitat State	Tree Hollows	Below Canopy Attributes	Priority Fauna Habitat	Future Prospects	Further Significant Fauna	Threatened Species	Regionally Significant Species	Feral Bird Species	Additional Fauna Values	TOTAL
	Score Range (Highest to Lowest)		0-20	0-15	0-20	0-15	0-30	-10 to 10	0-30	10 per Vulnerable sp 30 per Endangered sp	5 per species	0-5	Various	
48	Quarry Branch Creek	Moderate	5	10	10	10	0	0	20	40	10	0	20	125
49	St Andrews	Moderate	0	10	5	0	30	-10	30	20	30	2	0	117
50	Upper Toongabbie Creek	Low	0	0	10	5	0	0	20	20	0	0	0	55

5 CONCLUSIONS AND NEXT STEPS

This study was designed to assist the CMA and DECC target its efforts to conserve the native fauna in and around Sydney. One of the most obvious outcomes of the study is the high levels of reservation and protection already provided to many habitats around Sydney. In fact 50% of our highest and very high priority sites are already wholly or partially reserved and managed for conservation. These sites include Australia's first conservation reserve, Royal NP; the internationally recognised Towra Point wetlands, the Cumberland Plain Woodlands at Prospect Reservoir and the heaths, forests and bushland of Dharawal SCArea and NR. In addition, effective conservation arrangements are also in place over all remnant native vegetation communities at Sydney Olympic Park.

Future management of lands of significant value

The study found, however, that some important sites were not necessarily managed for their conservation values. The fact that native fauna continue to live at these sites is largely an accidental by-product of other land management objectives. The most obvious example of this is the Defence lands at Holsworthy, Malabar and Ingleburn. The ongoing management of these sites and any decision by Department of Defence to dispose of these lands obviously has significant implications for the conservation of native fauna in Sydney.

The study also found that the ownership of some very important sites is fractured across a number of different managers and, depending on the site, includes conservation reserve managed by DECC, crown land managed by the Department of Lands, Council reserves managed by Local Government, public lands managed by a range of different State Government Departments and private lands. Such sites include Botany Wetlands, Middle Harbour Valley, Lower Georges River, Kurnell Peninsula, Ingleside-Warriewood and Narrabeen Lake and the Upper Georges River. Ensuring management activities are co-ordinated across these sites and the high fauna values are recognised is a highly desirable outcome. It was outside the scope of this study however, to evaluate the effectiveness of management arrangements in place at these sites. Further work could be undertaken to contact the relevant managers and determine what management activities are needed and the extent to which greater co-ordination between land managers could improve and maintain the habitat value of these sites for native fauna.

Additionally it was outside the scope of this study to investigate the fauna values of small patches of remnant habitat less than 50 hectares in area. However, it is acknowledged that such patches play an important role in fauna conservation within the CMA, both in terms of the fauna that utilise these patches and by providing 'stepping stone' habitat links between larger remnants. It is likely that some of these smaller remnants which were not included in the current study would score higher in fauna habitat values than some of the lower-scoring larger remnants included in this report. Therefore, it is recommended that as part of regional planning for fauna conservation an audit of small habitat remnants (i.e. less than 50 hectares in size) be undertaken within the CMA taking into account both their fauna values and their potential importance as habitat links to larger habitat remnants. As part of such a small remnant audit it would be important to undertake an investigation of species that are entirely or primarily limited to small habitat remnants (such as the Gully Skink; see photo below) to ensure their long-term persistence within the CMA.

Overlap between terrestrial fauna sites and areas of value for water quality and riparian values

Another outcome of the study is the large degree of overlap between priority sites and riverine and estuarine systems. Nine out of 13 highest priority sites are associated with rivers or wetlands. These systems are also well known to be highly vulnerable to degradation through upstream and other impacts and are among the most sensitive of all our fauna habitat types.

Separate processes are currently underway within the CMA focusing on river health and the prioritisation of significant river reaches. Work should be done to overlay the outcomes of this study with the river health work to determine whether any synergies could be developed between these programs.

Relevance of work to local biodiversity assessments

Local Government plays an important role in addressing many actions that can affect fauna conservation, such as bushland restoration, feral animal control programs, water quality assessment and monitoring, stream remediation, fire management, noxious weed programs and fauna friendly community programs. Many Local Governments within the CMA are embarking on biodiversity strategies and undertaking LGA scale conservation significance assessments. Typically these studies involve an assessment of a range of criteria including floristic diversity (e.g. endangered ecological communities and rare plants), riparian and water quality criteria as well as terrestrial vertebrate fauna (threatened fauna habitat and native fauna corridors).

This study should provide input to Councils planning to identify fauna habitats of significant regional value. Many sites examined in this study could be considered 'regional fauna corridors' while others are islands of core habitat nested within the urban fabric. This study does not provide input on other biodiversity values or areas of local terrestrial fauna significance and further work will need to be done to establish these values.

This study does highlight a real need for Councils to work together in identifying areas of biodiversity value and to work towards consistency in the conservation criteria applied. Many of the most significant sites within the CMA straddle LGA boundaries and so it is important for Councils to work together on adopting consistent mapping and assessment criteria.

Further it is important that regional strategies be devised as a planning tool between local councils, the Sydney Metropolitan CMA and where relevant other adjoining CMA's to address regional and local habitat links, such as between Lane Cove Valley and Berowra Regional Park.

Further work could be undertaken by the CMAs and DECC to work with Councils to determine a 'model' mapping and assessment approach. A key challenge for this work to address will be the consistent mapping and assessment of 'corridors'. Many different scales of corridors analyses exist serving a range of different ecological functions. Further work should be undertaken to ensure a hierarchy of regional and local corridors can be identified across the CMA.

Input to threatened species recovery programs

This study provides additional information to support DECC's recovery planning program for threatened vertebrate fauna species. This includes:

- Directly implementing 'survey/mapping and habitat assessment' actions listed under the PAS for 25 threatened fauna species and one endangered ecological community while also contributing to the development of threat abatement strategies for a number of fauna related key threatening processes under the TSC Act 1995.
- Detailed assessment of all sites important for the conservation of threatened migratory and other shorebirds in the CMA area. DECC should consider a recovery approach to improve the management and profile of these sites.

During the course of undertaking this study it became apparent that while the nature conservation values of national parks and reserves were generally understood by the community, the value of some of the other sites was poorly known and promoted. While it is recognised that many of these sites are not

designed to accommodate visitation, the values of these sites should still be recognised as an important component of the natural history of Sydney. In undertaking this study, a significant volume of information has been prepared that profiles the habitat values of the different sites (see Appendix 4). This information, along with this report, could be used as the basis to develop further educational resources and so encourage increased community appreciation and involvement in the management of these sites.



The Gully Skink is a poorly known species restricted to a handful of small remnant gully forests in suburban eastern Sydney. M. Schulz

6 REFERENCES

Note: This section includes all references cited in the Site Profiles in Appendix 4.

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APPENDIX 1. PRIORITY FAUNA HABITAT CLASSIFICATION

A comprehensive vegetation layer mapped at the same scale covering the entire Sydney Metropolitan CMA area was not available for this project. A project funded by the CMA (titled 'Native Vegetation Mapping of the Sydney Metropolitan Catchment Authority Area) is however currently underway that will produce a high resolution, consistent and comprehensive native vegetation map of the Catchment. As a result priority fauna habitats identified in the 'Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region' report (DECC 2007a) that occupy the CMA area, were adapted to select priority fauna habitats for this project. Priority fauna habitats are those that have exceptional importance for the conservation of vertebrate fauna, particularly threatened species. Selection of priority fauna habitats involved:

a) adopting the priority habitats that were identified in DECC (2007a) for the Greater Southern Sydney region, which encompasses a significant component of the CMA. Habitats identified using this criteria were Grassy Woodland, Freshwater Wetland, Alluvial Forest and Woodland, Forested Wetland, and Saltwater Wetland.

b) including coastal heathland as a priority habitat since a distinct fauna occurs within this community, including several species that have become extinct within the CMA in recent decades such as the Eastern Bristlebird and Ground Parrot (DECC 2007a) or are now uncommon and patchily distributed such as the Southern Emu-wren and the Eastern Pygmy-possum.

c) including rainforest as a priority habitat as this habitat supports a distinctive fauna, some of which are severely restricted within the CMA (e.g. Logrunner and Green Catbird) or support species that have declined since settlement and now only occur as vagrants (e.g. Rose-crowned fruit-Dove and Wompoo Fruit-Dove).

Rainforest

Rainforests are characterised by having a closed or closely spaced canopy (ies) comprising mostly non-sclerophyllous vegetation. Where more than one canopy is present and there is an even proportion of sclerophyllous and translucent / moist / glossy / large leaved plants (i.e. typical rainforest species) then the community is classified as mixed (McDonald *et al.* 1984). They are found in moist humid areas, generally gullies or dark environments, mostly free from fire and with moderate to high fertility soils (Keith 2004; DECC 2007a). Both, the presence of lianas, epiphytes, exposed root and stem structures, and the absence of annual herbs on the forest floor identifies these communities as rainforest (McDonald *et al.* 1984).

Alluvial Forest and Woodland

This habitat occupies river edges, beds, flats and other alluvial deposits that are periodically inundated with water. As a result of the low lying and flat depositional environments they inhabit, these communities are generally underlain by fertile soils. Within the CMA remnants of this community are found on more elevated terraces with an upperstorey dominated by Angophoras and Eucalypts (DECC 2007a).

Grassy Woodland

Grassy Woodlands has an open tree canopy of sclerophyllous vegetation (Eucalypts) rarely taller than 35m and usually branching at less than half of their height (Keith 2004). The understorey has a rich diversity of grasses and herbs that are present at different times of the year depending upon rainfall. These communities require rainfall within the 500-1000 mm range with the typical rainfall on the east coast of New South Wales being from 700-1000 mm (Keith 2004). For the most part of the year a continuous pasture of perennial tussock grasses dominate the community. Shrubs if present, are clearly separated, typically drought resistant and of sclerophyllous vegetation. Soils characteristic of this community are fertile loams to clay loams and are found on flat to undulating topography (DECC 2007a). Due to the fertile soils these communities occupy they have been extensively cleared in the past for grazing and more recently development.

Coastal Heathland (includes Coastal Headlands Heath, Wallum Sand Heath and Sydney Coastal Heath)

Coastal Heathland grows in exposed coastal environments on shallow, nutrient poor soils. They are characterised by a closed, dense shrub layer varying in height from 1-5 m with few or no emergent trees. Hard-leaved sedges, grasses, shrubs and herbs representative of the Gondwanan era with principal families such as the Proteaceae, Fabaceae, Myrtaceae, Casuarinaceae, Xanthorrhoeaceae, Restionaceae and Cyperaceae dominate the community. Three types of Coastal Heathlands (i.e. Coastal Headlands Heath, Wallum Sand Heath and Sydney Coastal Heath) are present in the CMA. The landscape location and species composition distinguish between the different communities of Coastal Heathlands:

a) Coastal Headland Heath occupy headlands exposed to sea salt spray. This community is structurally diverse within the herb to shrubland layer but are floristically simple. Soils of these communities are dark loams and clays that have developed as a result of salt weathering (Keith 2004).

b) Wallum Sand Heath occupies ancient sand dunes that are located behind the coastal shoreline. Vegetation of this community is stunted at 2 m for shrubs and 4 m for mallee Eucalypts, Bloodwoods and Banksias due to the impoverished soils that are enriched only from rain and sea spray (Keith 2004). This community is frequently swampy and at times grades into freshwater wetlands.

c) Sydney Coastal Heath is influenced by soil depth, drainage and fire history. This community is restricted to the Sydney Basin Bioregion and is typically found on the sandstone plateaux that are characteristic of this area (Keith 2004).

Forested Wetland

Forested Wetland comprise freshwater wetlands dominated by sclerophyllous trees (Keith 2004). They are typically found along riverine corridors and floodplains below 800 m that are periodically inundated with water. Generally restricted to low altitudes these flat depositional environments contain fertile alluvial soils varying from peaty semi-humic loams to sandy clays (Keith 2004). Coastal Swamp Forest is a type of forested wetland found within the CMA. These forests are dominated by Swamp Oak (*Casuarina glauca*) and Paperbarks (*Melaleuca* sp.) with an understorey dominated by a range of sedge, reed and rush species (DECC 2007a). Small patches of Coastal Floodplain Wetland are also present, although stands of Swamp Mahogany (*Eucalyptus robusta*) were once far more extensive on the alluviums of the Cumberland Plains and elsewhere within the CMA (DECC 2007a).

Freshwater Wetland (includes Upland Swamp, Hanging Swamp and Coastal Wetland)

Freshwater wetlands are those areas of land that are either periodically or permanently inundated with water. These environments range from being sparse to densely vegetated, depending on their location, substrate, altitude, drainage and aspect. Vegetation most commonly found are those that can tolerate water logged soils such as sedges, reeds, rushes, grasses, succulent herbs and emergent shrubs. They are found below 600 m typically in poorly drained depressions on sandstone, coastal sand sheets, in swales and at the headwaters of creeks (Keith 2004). Soils vary from deep, dark, rich, humic peats to shallow sands found in weathered sandstone depressions.

Saltwater Wetland (includes Mangrove Swamp and Saltmarsh)

Mangrove Swamps and Saltmarshes are classified as saltwater wetlands (Keith 2004) with both environments being subject to tidal inundation by saline or brackish water.

Mangrove Swamps are distinguished by their lack of understorey and their closed tree canopy dominated by mangroves, typically the one species. In contrast Saltmarshes characteristically support few or no emergent shrubs and trees. The vegetation structure is a closed mosaic of sedgeland, grasslands and open herbfields. Saltmarshes are typically more saline than Mangrove Swamps as inundation is intermittent which can leave the saltmarsh dry for extended periods of time.

APPENDIX 2: DESCRIPTION OF TECHNIQUES USED DURING SURVEY

Diurnal bird survey

Diurnal bird censuses consisted of a twenty-minute observation and listening search within a two hectare site. Censuses were conducted by an experienced bird surveyor (M. Schulz) and only undertaken in the early to mid morning or late afternoon during periods of high bird activity and reasonable detectability (e.g. not during high wind and loud cicada activity). All bird species and the number of individuals seen or heard were recorded. Individuals were scored as on-site if they were detected within the two hectare plot and those outside the plot were recorded as off-site. When a species was only detected flying overhead and not actually using the site, it was noted as such so it could be excluded from later analyses (e.g. a flock of Australian Pelicans flying over a bushland site).

Diurnal herpetofauna search

Diurnal searches for reptiles and frogs were conducted in a half hectare area subplot (50 by 100 metres) situated around the centre-point of a standard two hectare site. Standard searches were conducted for one person-hour by a single observer (M. Schulz). Censuses were restricted to the period of maximum reptile activity which is generally between mid morning and late afternoon or when the temperature range was between 18 and 33 °C. Therefore, no systematic reptile searches were undertaken in sites surveyed during winter. Additionally, searches were not conducted when it was very windy, overcast or during rain or in periods of extreme heat.

Diurnal herpetofauna searches entailed active searching of potential reptile and frog microhabitats within the half hectare area. Herpetofauna was detected by listening and watching for basking and active individuals. Sheltering or cryptic species were detected by searching under rocks, logs, litter, decorticating and fallen bark, rock outcrops and other likely shelter sites. Identification was aided by using field guides, such as Cogger (1996), Wilson & Swan (2003), Swan *et al.* (2004) and Griffiths (2006).

Site spotlighting survey

This technique comprised searching for arboreal mammals along a 200-metre transect within a site for a half person hour. Generally, one experienced surveyor and a volunteer searched for 30 minutes using 50-watt spotlights to scan the vegetation for reflected eye shine and active or vocalising animals. All fauna observed or heard within the census period were recorded, noting whether they were within or outside the 2 ha area. Spotlighting was not conducted where groups of youths were loitering or during heavy rain, strong winds or other extreme weather conditions.

Harp trapping

Collapsible bat traps, known as harp traps were used to capture low flying bat species. Typically one night of trapping was undertaken at each bat trap site. Sites were selected for their perceived potential to capture bats along their flight paths, and were usually located along tracks or in gaps between trees where adjacent vegetation might force bats to fly.

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

Nocturnal streamside search

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

Nocturnal call playback

Nocturnal birds and mammals are often detected only when they vocalise for territory or social contact; behaviour which can be elicited by broadcasting specific calls. For this study standard survey census was undertaken which involved broadcasting the calls of each of the four large threatened forest owls - Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*T. tenebricosa*) and Barking Owl (*N. connivens*) - from the centre of each site. Prior to call broadcasts, on arrival at the site, the surrounding area was searched by spotlight for five minutes to detect any fauna in the immediate vicinity and then a ten minute period of listening was undertaken. A pre-recorded compact disc of each species' call series was played, amplified through a megaphone. Calls of each species were played for five minutes, followed by a five minute listening period. The surrounding area was again searched by spotlight after a final ten minute listening period. After the census, the response or presence of any fauna, date and time the response occurred, and weather details such as amount of cloud cover was recorded. Very windy and rainy conditions were avoided where possible.

Indirect mammal signs

During the one-hour herpetofauna search, all mammal species located by indirect signs such as characteristic scats, diggings and burrows were recorded. If there were any doubts in the identification of these signs in the field, samples or photographs were sent to Barbara Triggs (author of Triggs 1996) for identification.

Fauna habitat characteristics

A site attribute form, aiming to characterise fauna habitat was completed at all sites where systematic survey techniques were conducted. A 20 by 20 metre quadrat typical of the overall 100 by 200 metre site was used for the assessment. The site attribute procedure located and described the site in a format that was comparable to other DECC survey sites described elsewhere within the Greater Sydney Region (DECC 2007a). Data relating to physio-geographic, disturbance, structural and floristic, microhabitat and stream/wetland categories were recorded and entered on to the Atlas of NSW Wildlife. Additionally, photos were taken at each site and these have been labelled and stored digitally.

As a whole each site was assessed in terms of fauna habitat quality (refer to Appendix 3) and threats to fauna within the area.

Predator scat collection

All predator scats/pellets were collected, placed in paper envelopes, labelled and sent for specialist analysis to Barbara Triggs. In addition, potential owl roosts in overhangs were searched for the presence of regurgitated pellets. Known roosts, where time allowed, were revisited to confirm current usage and collect recent pellet deposits

The large numbers of hairs, and occasionally skeletal remains collected in predator scats and pellets provided a high level of confidence in the identification of prey species. Occasionally, this includes species such as the Eastern Pygmy-possum that are rarely recorded using other systematic survey techniques. Due to the unknown time delay between prey ingestion and defecation, the location in which the prey animals live cannot be accurately determined, so this technique is only useful for detecting the species presence in the general area.

Waterbirds and shorebird counts

Open waterbodies, shorebird roosts and foraging areas were assessed by scanning over a varying time period (depending on area size) and recording the total number of birds sighted.

Diurnal herpetofauna search

Since much of the field survey was conducted outside the period of maximum reptile activity; an abbreviated reptile search was conducted to provide incidental records of species from all systematic survey sites where the full one hour active search was not undertaken. In these abbreviated searches the same techniques were employed for a 15-minute period.

Bat ultrasonic ('Anabat') call recording

Anabat recordings using AnabatII® detector and digital flash card were made at each site during spotlighting and nocturnal playback sessions under fine weather conditions. They were then transferred onto computer and analysed by Narawan Williams, a recognised expert in this field. Identification of recordings was designated as definite, probably or possible following the method of Parnaby (1992a).

Cave/overhang/artificial structure search

Caves, overhangs, bridges, culverts and abandoned structures were searched for the presence of roosting bats, owls, geckoes and indirect animal signs, where they were present in an area and could be accessed safely.

Non-standard call playback

In some locations only one or two species of threatened owl species were played in order to induce a response. At others, additional species were played such as the Grass Owl (*Tyto capensis*) and Australasian Bittern. Additionally, due to the limited time available in some sites nocturnal playback of all four owl species was undertaken at the same time as spotlighting or nocturnal streamside searches.

Incidental Records

Incidental records were made at point localities of fauna encountered opportunistically during the survey period. These records augmented species records that were not well sampled by standard systematic techniques, such as large ground mammals, non-vocalising birds and secretive and rare animals.

APPENDIX 3: SCORING SYSTEM USED TO RANK FAUNA SITES

This Appendix outlines the factors considered and scoring system used in ranking the fauna sites during this study.

Habitat Connectivity

Note: Determined from aerial photographs and on-site inspection.

- a. Not directly connected with adjacent reserves or other sites that are likely to be reserved = **0** (*Not Connected*)
- b. Marginally connected (i.e. narrow band of habitat that has been modified e.g. road reserve or narrow riparian strip) to adjacent reserves or other sites that are likely to be reserved OR continuous with adjacent reserve or proposed reserve but separated by a major road/railway line = **5** (*Little Connected*)
- c. Continuous with adjacent reserve or proposed reserve on one side of the site, forming a complete habitat link with good quality habitat linking the two areas OR where more than one habitat link all such links form narrow corridors such as <50 m either side of watercourses with cleared land backing all of these habitat links = **10** (*Moderately Connected*)
- d. Continuous with adjacent reserve or proposed reserve on more than one side, forming a complete habitat link with good quality habitat linking the two areas = **20** (*Highly Connected*)

Habitat State (or Condition)

Note: Determined from aerial photographs and on-site inspection.

- a. Small isolated site = **0** (*Highly Bisected*)
- b. Site bisected by small acreage properties or different land uses with differing levels of habitat modification OR site with varying size patches of habitat remnants but totalling <50% of overall area = **5** (*Moderately Bisected*)
- c. Relatively continuous site with similar level of habitat modification throughout but typically numerous roads, tracks and cleared easements bisecting the area OR patches of heavily modified habitat totalling <50% of overall area = **10** (*Little Bisected*)
- d. Relatively continuous forest or other habitats within the site with similar level of habitat modification throughout and few road, tracks and cleared easements bisecting the area = **15** (*Continuous*)

Tree Hollows

Note: Determined from on-site inspection.

- a. All trees in a site forming young even-aged stands with no hollow formation discernible or where there are no trees within a site e.g. wetland area = **0** (*Nil*)
- b. The majority of trees young with no hollow formation discernible and widely scattered large trees/stags with some small and/or large hollow (<15 cm diameter) development = **5** (*Few*)
- c. The majority of trees young with no hollow formation discernible and scattered large trees with both small and large hollow development, primarily concentrated along roadsides, watercourses or other discrete areas = **10** (*Some*)
- d. Some stands of trees with small and large hollow development (e.g. along watercourses), with >50% of the site comprising forest with hollow formation rare in typically even-aged stands = **15** (*Moderate*)
- e. Trees with both small and large hollow development plentiful across the landscape, with >50% of the site comprising forest with hollow formation = **20** (*High*)

Below Canopy Structural Attributes

Note: Determined from on-site inspection.

- a. Predominantly heavily modified shrub and ground layers with few logs present e.g. heavily weed infested such as with African Olive (*Olea europaea* subspecies *africana*), Lantana (*Lantana camara*) or Bitou Bush (*Chrysanthemoides monilifera* subspecies *rotundata*), heavily grazed, frequent fires and/or largely slashed/mowed = **0** (*Highly Modified*)
- b. Sections of the site without greatly modified shrub and ground layers and (where relevant) some fallen timber present but limited to discrete areas (e.g. along watercourses) = **5** (*Mostly Modified*)
- c. The majority (>50%) of the site or within remnant vegetation patches within the site without greatly modified shrub and ground layers and (where relevant) fallen timber widespread = **10** (*Moderately Modified*)
- d. All of the site (away from roads) without greatly modified shrub and ground layers and (where relevant) fallen timber present widespread = **15** (*Little Modified*)

Priority Fauna Habitat

Note: Priority fauna habitats are described in Appendix 1. The presence of these habitats within site was determined from broad-scale vegetation mapping (e.g. Tozer *et al.* 2006) and by on-site inspection.

- a. Site supporting no priority fauna habitat (i.e. forested wetland, rainforest, alluvial forest and woodland, grassy woodland, coastal heathland, freshwater and saline wetlands; refer to Appendix 1) = **0** (*Nil*)
- b. Site supporting negligible amounts (<5%) of priority fauna habitat = **5** (*Little*)
- c. Site supporting moderate amounts (5 to 50%) of priority fauna habitat = **15** (*Moderate*)
- d. Site supporting large amounts (>50%) of priority fauna habitat = **30** (*High*)

Future Prospects

Note: Determined from discussions with local land managers and on-site inspection.

- a. Fauna values within the site may potentially decline in the next decade due to perceived factors such as continued or increased fragmentation, continuing or increased habitat modification, increased infestation by aggressive weed species such as African Olive, confirmed housing developments to occur along additional site boundaries, increasing public usage levels including activities that impact on fauna (e.g. jet skis, trail bikes) and/or fragmentation or loss of habitat links to adjoining habitat areas = **-10** (*Decrease*)
- b. Fauna values within the site to potentially remain relatively constant due to the perceived maintenance of current land management practices OR potential future management of the site is unknown = **0** (*Little Change*)
- c. Fauna values within the site to potentially increase due to management actions aimed at improving the biodiversity values of the area = **10** (*Increase*)

Further Significant Fauna

Note: The scoring in this category was based on the completeness of systematic fauna surveys within a site, with a low score where systematic surveys had been conducted widely across the site covering birds, mammals, frogs and reptiles while conversely a high score was where there had either been little systematic fauna survey work conducted or where some groups had been omitted from the surveys such as bats where the likelihood of additional threatened or regionally significant species occurring was high.

- a. Little possibility of additional threatened/regionally significant species (other than vagrants or occasional visitors) occurring = **0** (*Low*)
- b. Moderate possibility of additional threatened/regionally significant species (other than vagrants or occasional visitors) occurring = **10** (*Moderate*)

- c. High possibility of additional threatened/regionally significant species (other than vagrants or occasional visitors) occurring = **20 (High)**
- d. Very high possibility of additional threatened species (other than vagrants or occasional visitors) occurring = **30 (Very High)**

Threatened Species

Note: This listing does not include fish or invertebrate species. Additionally it does not include species that are vagrants to the Sydney Basin Bioregion (e.g. Hoskin *et al.* 1991; DECC 2007a, b), such as the Beach Stone-curlew (*Esacus neglectus*) and Orange-bellied Parrot (*Neophema chrysogaster*).

- a. No threatened species recorded in the last 10 years = **0**
- b. Vulnerable species (listed under the TSC Act 1995) that have been recorded within the site in the last 10 years. This category does not include vagrant species in the CMA or unconfirmed sightings of a species within the site = **10 (per species)**
- c. Endangered species or Endangered Ecological Fauna Communities or Endangered Populations (listed under the TSC Act 1995) that have been recorded within the site in the last 10 years. This category does not include vagrant species in the CMA or unconfirmed sightings of a species within the site = **30 (per species)**

Regionally Significant Species

Note: Regionally significant species have been identified as taxa that: a) listed previously as regionally significant in the CMA (adapted from NSW National Parks and Wildlife Service 1997; DEC 2006; DECC 2007a); b) species listed as nationally near threatened (Garnett & Crowley 2000); or c) regionally uncommon or restricted species that are suspected to have declined across the region. For a full list of regionally significant species refer to Table 3.

The aim of this section was to reflect the site's current status (i.e. within the last 10 years) in supporting regionally significant fauna relative to other sites in the CMA. Therefore, this section only includes species in fauna groups that can readily be encountered in visit to a site, without conducting trapping or other more labour intensive survey activities:

- a. Diurnal birds
- b. Nocturnal birds
- c. Arboreal mammals
- d. Large terrestrial mammal species:

Species that required trapping, Anabat, nocturnal playback, nocturnal streamside searches and active herpetofauna searches were not included as all these techniques were conducted at varying levels of intensity in each site both in the current study and previous studies. Therefore other fauna groups were not included for the following reasons:

- a. *Small mammals:* Systematic surveys for small mammals were not conducted in the current study (e.g. pitfall and small mammal trapping). Therefore, all records obtained were on an opportunistic basis making it difficult to compare individual sites.
- b. *Aquatic Mammals:* Not included due to the difficulty of sampling all potential habitat consistently.
- c. *Bats:* Not included due to the difficulty of sampling all sites consistently i.e. limited funds for Anabat analysis, difficulty of sampling some areas due to the high risk of vandalism of equipment and timing of the study (i.e. reduced bat activity, particularly in late autumn and winter).
- d. *Frogs:* Not included as the majority of regionally significant species do not vocalise during the time of the current study, and for late summer-autumn/early spring breeders it is likely that activity was low due the dry conditions.
- e. *Reptiles:* Not included due to lower activity levels during the late autumn and winter parts of the study period and the difficulty of sampling all sites consistently.

Score = 5 (per species).

Feral Bird Species

Note: Determined from previous records and current survey.

- a. Greater than two feral bird species scattered throughout the site, not confined to the edges = **0** (*Widespread*)
- b. One to two feral bird species scattered throughout the site, not confined to the habitat edges = **2** (*Moderate*)
- c. No feral bird species recorded away from the habitat edges (not including above canopy records) = **5** (*Few*)

Additional Fauna Values

- a. Little Tern (*Sterna albifrons*) nesting site within a site = **30**
Justification: Most formerly used nesting sites of this endangered ground-nesting bird have not been used for decades e.g. Long Reef area, Merries Reef area (e.g. Ross & Jarman 2001).
- b. Regularly occupied Grey-headed Flying-fox camp in a site = **30**
Justification: This colonial roosting bat only occupies a limited number of permanent camps across the CMA. It is particularly vulnerable to disturbance at roosts, including breeding failure and roost abandonment (P. Eby, flying-fox consultant, pers. comm.).
- c. Occasionally occupied Grey-headed Flying-fox camp in a site = **15**
Justification: Comments as for b) but less likely to breed in these camps and only occupied seasonally usually in proximity to flowering or fruiting trees.
- d. Known cave-dwelling bat roost (i.e. Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing-bat, Little Bentwing-bat (*Miniopterus australis*), Southern Myotis (*Myotis macropus*) and Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) in a site = **20** (*per roost*)
Justification: Cave-dwelling bats in the CMA are typically colonial and vulnerable to disturbance by human visitation. Many of the sites occupied by these bats are also attractive 'hang-out' locales for teenagers, thereby greatly increasing the frequency of disturbance at many sites.
- e. Major migratory wader roost or feeding area (regularly > 500 individuals at times, including species listed under international migratory bird agreements) in a site = **30**
Justification: Many migratory waders are listed under international migratory bird agreements. Therefore sites frequented by large numbers of these shorebirds are of key importance for the international conservation of these species. Many formerly important sites in the region have been lost due to land reclamation works. There are very few sites within this category within the CMA.
- f. Minor migratory wader roost or feeding (regularly <500 individuals at times, including species listed under international migratory bird agreements) in a site = **15**
Justification: Comments as for f) but of potentially slightly lower importance due to lower densities of birds frequenting these sites.
- g. Occasionally used by small numbers of migratory waders, including species listed under international migratory bird agreements) in a site = **5**
Justification: Comments as for f) but of lower importance due to low numbers of individuals that typically irregularly frequent these sites. Most sites used by migratory waders within the CMA fall within this category.
- h. Regularly used colonial waterbird nesting site (e.g. cormorants, herons, ibis, egrets and spoonbills) in a site = **20** (*per colony within a site*)
Justification: The wetlands of the CMA are important in a statewide perspective in that they serve as important refuges during periods of drought. At this time many colonial waterbirds are not able to breed in regularly used sites in the drought-affected inland regions. Therefore wetlands that support colonial nesting waterbirds, particularly during these drought times are of great importance.

- i. Shorebird nesting within a site; excluding Black-winged Stilt (*Himantopus himantopus*), Black-fronted Dotterel (*Elseyaornis melanops*) and Masked Lapwing (*Vanellus miles*) = **10** (for each location within a site)

Justification: Few ground-nesting shorebirds nest any longer in former haunts within the CMA. The increasing vulnerability of these birds to nesting failure is reflected in the Pied and Sooty Oystercatchers being listed as vulnerable across the state under the TSC Act 1995. Species such as the Pied Oystercatcher and Red-capped Plover formerly nested in a number of localities along the coast, but have not been recorded to do so in recent years, e.g. Boat Harbour and Long Reef areas.

- j. Other regionally significant waterbirds (not covered in i & h) that regularly nest within a site = **10** (for each species)

Justification: The remaining wetlands in the CMA form important nesting habitat for a number of non-colonial waterbird species, such as various waterfowl, crakes and rails. Anecdotally the majority of these species have declined within the CMA as a result of land reclamation, loss in water quality, beautification of some wetlands, predation and disturbance.

- k. Site listed on the register of wetlands of international importance under the Ramsar convention = **50**

Justification: There are only three wetlands listed on the register of wetlands of international importance under the Ramsar convention in coastal NSW, including one within the CMA (Department of the Environment, Water, Heritage and the Arts 2008)

Site scores were divided into the following categories based on the total number of points:

- *Highest* fauna significance = Score >401 points
- *Very high* fauna significance = Score 301 to 400 points
- *High* fauna significance = Score 201 to 300 points
- *Moderate* fauna significance = Score 101 to 200 points.
- *Low* fauna significance = Score <100 points.

Details of how identified sites were ranked using this system can be found in Appendix 4.

APPENDIX 4: SITE PROFILES

A CD of the 50 site profiles prepared as part of this study can be found at the back of this report or in the document. Due to the large number of site profiles it was decided not to include a hard copy of every profile in each copy of the final hard copy versions of this report.

This appendix explains the content of each profile.

Site profile order

The sites are arranged in descending order of fauna significance with all sites within each of the five significance rankings grouped together. For quick reference the ranking of a particular site is highlighted on the side of each page, with each ranking category given a different colour identifier code. At the beginning of each section a location map is provided for easy location reference.

The order of sites within each significance ranking was determined by their total score in the ranking classification with sites identified in descending order of overall fauna rating going from the highest fauna rating to the lowest in each of the significance categories. Details of how each ranking was derived using the categories are outlined in Appendix 3.

Site profile explanation

Each site profile has been divided into a number of sections:

Site Number: Each site is identified in descending order of overall fauna rating going from the highest fauna rating (i.e. Site 1) to the lowest faunal rating (i.e. Site 50).

Site Name: A brief site descriptor name is provided to assist in the identification of a site.

Location: A site description is provided with reference to the relevant map to assist in the identification of the site's location and boundaries. Note that all sites are outlined in greater detail in the electronic map on this CD.

Relative Area Size in CMA: Three broad categories are identified: a) *Large* = >1000 ha; b) *Medium* = 201 – 1000 ha; and c) *Small* = <200 ha.

Sub-catchment: The sub-catchment within the CMA is provided.

Local Government Area: Relevant Local Government Areas are listed.

Tenure: Five broad tenure areas are identified and the total area and % of the site comprising each category is provided: a) *DECC Reserves* = Land owned by the Department of Environment and Climate Change; b) *Crown land* = Land owned by the Department of Lands; c) *Commonwealth land* = Land owned by a Commonwealth body such as Department of Defence, Scientific Reserves and Airports; d) *Remaining public land* = Land that is managed by State government bodies such as local councils, DPI (Forests) and the Sydney Catchment Authority; and *Other* = Land held as freehold including land managed by the Department of Planning.

Note: These estimates were constructed from data obtained from Department of Lands collated in 2005 and DECC data from 2007 and should only be used as a rough guide. It is likely that for some areas there have been changes with respect to the area occupied by the different tenure categories. The rapidly changing tenure of Sydney land made it difficult to present an up-to-date tenure layer for mid-2007 and thus was beyond the scope of this project.

Environmental Setting: A brief description of the site is provided, including the identification of the priority fauna habitats present.

Habitat Assessment Criteria: Habitat assessment criteria identified and described in detail in Section 3.7 are outlined in this section to provide a summary of the habitat values of a site. Actual scores for all assessment criteria for each site are detailed in Section 4.2.

Fauna Overview: A brief summary of the overall fauna values of a site are outlined.

Priority Fauna Species Review: This section is divided into three parts:

- a) A brief summary that details the number of species recorded in the last 10 years, including the number of threatened (as listed under the TSC Act 1995) and regionally significant species occurring within a site.

Note: Species considered do not include pelagic species, vagrants, escapees or unconfirmed records of some species that are considered rare in the Sydney Basin Bioregion (e.g. Hoskin *et al.* 1991; DECC 2007a, b).

- b) *Threatened Species Known to Occur:* This section identifies all threatened species (including endangered populations and endangered ecological communities) recorded within the last 10 years. Species only known from a site prior to 10 years ago are denoted by **.

For each species the following information is given: threat category (as listed under the TSC Act 1995), the most recent documented record, land tenure within a site in which a species has been recorded and additional relevant information.

- c) *Additional Faunal Values:* Identifies additional faunal values that were used in the overall rating of the site. This section also notes, where the information was readily available, any threatened terrestrial invertebrates that occur within the site and past faunal values that are no longer present, such as the presence of a former nesting colony of the Little Penguin at Cape Banks in Botany Bay NP.

Identified Threats to Fauna Values: This section is divided into high and moderate threats either known or suspected to be impacting on faunal values within a site.

Land Management: Summarises in broad terms key land managers and where relevant, management strategies that may be desirable with adjacent areas to maintain or even increase long-term biodiversity values.

References and Further Reading: Cites references that were either referred to within the site account or would be useful in obtaining further information in relation to fauna values in a site.

Area Species List: Provides a full list of amphibians, reptiles, birds and mammals identified in each site, including whether the species currently is present (i.e. it has been recorded within the last 10 years), the source of the record, and the rating of the species in terms of listing under the TSC Act (1995) or as a regionally significant species.