



The Vertebrate Fauna of South Western Blue Mountains National Park

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

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THE VERTEBRATE FAUNA OF SOUTH WESTERN BLUE MOUNTAINS NATIONAL PARK

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Cover Photos

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OVERVIEW

South western Blue Mountains National Park (the study area) encompasses 34610 hectares of land within the catchments of the Abercrombie River and Murrain Creek. The study area is located approximately 35 kilometres south of Oberon and is demarcated by the Blue Mountains National Park boundary except to the east where it is marked by Murrain and Shivering Creeks. The area covers a 30 kilometre stretch along the spine of the Great Dividing Range, surrounded to the west by undulating slopes and to the east by a system of steep slopes and deep gullies. Elevation ranges from 400 metres above sea level (asl) in the lower reaches of Murrain Creek to 1285 metres asl along Banshea Road in the far north west corner, with the majority of the area above 800 metres. Vegetation is a diverse mix of communities that reflect geological and altitudinal patterns, including tall sub-alpine forests, undulating grassy tableland woodlands, riverine flats, dry shrub forests, dry rainforest, mallee-heath, and Tea Tree and sedge bogs and swamps. Distinctive landscape features of the area include the basalt capped Mt. Werong and the limestone outcrops and karsts that form part of the band between Jenolan and Wombeyan Caves.

The diverse range of habitats in the study area support a rich assemblage of fauna that includes species typical of montane and sub-alpine environments as well as species more characteristic of coastal hinterlands. This report describes the terrestrial vertebrate fauna of south western Blue Mountains National Park, derived from fauna surveys that have been undertaken by the Department of Environment and Conservation (DEC, formerly NPWS). It documents for the first time the species and habitats of the area and combines data sourced from all systematic surveys undertaken between 1998 and 2004. It concludes that:

- There are 186 vertebrate fauna species known to occur within the reserve. This includes 99 native diurnal birds, six nocturnal birds, fourteen bats, seven arboreal mammals, eleven native ground mammals, 28 reptiles, ten frogs, three introduced birds and eight introduced ground mammals.
- The study area supports habitat for at least nine fauna species that are as listed as threatened on the NSW Threatened Species Conservation Act (1995). Six of these species have been regularly recorded, indicating that good numbers are present within the park. This includes the Stuttering Frog, Powerful Owl, Yellow-bellied Glider, Greater Broad-nosed Bat, Eastern False Pipistrelle and Eastern Bent-wing Bat. Additional threatened fauna species include Masked Owl, Spotted-tailed Quoll and Koala, which have each been recorded once.
- The population of Stuttering Frog within the study area has very high conservation significance. The population is an outlier of the extant known range of the species, constituting the only known location of the species in the greater Sydney Basin above 280 metres asl, and the western-most location in New South Wales. The Stuttering Frog occurs within at least two creek systems, Ruby Creek and Mt. Werong Creek, which flow east and west of the Divide respectively. Numerous tadpoles were found in each location, but no adults were seen or heard calling. Three dead metamorphlings were collected and identified as infected by chytrid fungus. This marks the first time chytrid fungus has been recorded in this species. Management actions for the species in the study area should be considered immediately, in consultation the Central Threatened Species Unit and the species recovery team.
- A further two threatened species have been recently observed within two kilometres of the study area and, given that suitable habitat occurs within the study area, have the potential to occur within its boundaries. These are the Brush-tailed Rock-wallaby and Large-eared Pied Bat.
- Feral animals including the Rabbit, Fox and Pig are present in the reserve. Pig sightings and evidence of their activity are particularly common around Mt. Werong and along drainage lines east of the Dividing Range.
- The composition and distribution of fauna species within the area reflects landscape patterns in elevation, geology and topography, and the influence of both central tableland and coastal hinterland environments on the study area. There are distinctive assemblages of fauna that correspond to the montane and sub-alpine environments in the north, and to the lower altitude valley systems in the far east.

The recent fauna surveys in south western Blue Mountains NP have contributed important information to our understanding of the distribution, range, habitat preference and conservation status of many animals, including threatened and newly described species. Such information will improve our understanding of species conservation status across the region and assist in the updating of effective management strategies.

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1 INTRODUCTION

1.1 PROJECT AIMS

The Central Directorate Parks and Wildlife Division (PWD) of the NSW Department of Environment and Conservation (DEC, formerly NSW National Parks and Wildlife Service (NPWS)) has for the first time established a biodiversity survey priorities program for all DEC managed estate within the Directorate. This program recognised that south western Blue Mountains National Park (NP), which includes the Murruin and Abercrombie catchments, was characterised by very low levels of information on both its flora and fauna values (NPWS 2003b). The decision to sample this area was enhanced by the opportunity of integrating new survey work into a broader study examining the biodiversity values of the Warragamba and Metropolitan Special Areas (DEC in prep.).

The fauna survey program seeks to address the shortfall in information on vertebrate fauna within south western Blue Mountains NP. Improved information will enable park managers to better integrate local information into planning decisions and to become more active in promoting the values of this section of the reserve. It will provide the opportunity to develop more focused strategies on threatened species management, monitoring programs and community education. Importantly it will expand the ability of park managers to understand the role the reserve plays in conserving fauna within the greater Sydney Region.

Specific objectives of this report are to:

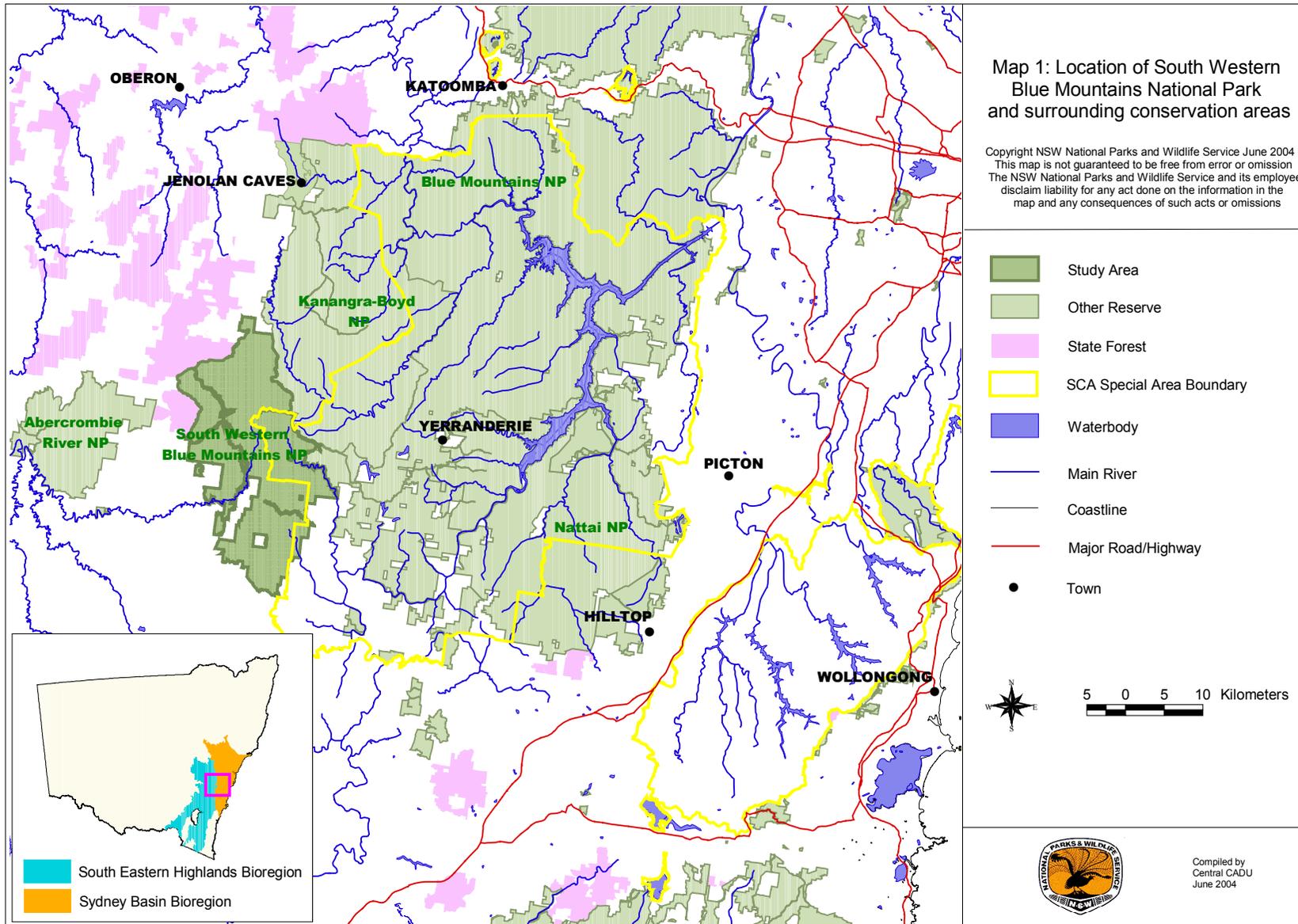
1. Document, review and collate existing fauna data
2. Identify and profile threatened fauna species and other regionally significant fauna that are known or likely to occur
3. Identify broad-scale patterns in fauna occurrence and habitat use across the study area and identify habitats of particular conservation significance.

This report is intended to be read in conjunction with the report on the larger fauna survey program (DEC in prep.).

1.2 BACKGROUND

South western Blue Mountains NP (the study area) encompasses 34 612 hectares of land in the south western most portion of Blue Mountains National Park. The area is demarcated to the north east, north, west and south by the Blue Mountains NP boundary and to the east by Murruin and Shivering Creeks (Map 1). It is located approximately 35 kilometres south of Oberon and 150 kilometres west of outskirts of the Sydney metropolitan area. The study area is bordered to the north and north east by Gurnang State Forest (pine plantations), to the south and south west by partly cleared private land and to the east by the Bindook Highlands and the remainder of Blue Mountains NP.

Sections of the study area were gazetted as part of the Blue Mountains NP in 1978 and the Mt. Werong area was added in 1988. Various small additions to the park have been made since. The study area forms part of the Greater Blue Mountains Area, which was inscribed on the World Heritage List in November 2000. Just under twenty per cent (6300 hectares) of the study area lies within the Warragamba Special Area (drainage flowing east of the Great Dividing Range). A significant portion of the study area falls within the Murruin Creek catchment, which has been nominated for protection under the NSW Wilderness Act 1987 (the Murruin Wilderness). This nomination is currently being assessed (DEC 2004a).



1.3 HISTORY OF LAND USE

There is evidence that Aboriginal occupation of the study area dates back to over 12000 years ago (DEC 2004a). Early European occupation of the area is not well documented, with the first recorded activities based around grazing, stock droving and small-scale mining operations during the mid to late 1800s (DEC 2004a). Cattle and Goats were run in the area from the late 1800s to the 1980s. Logging and mining operations took place from the 1800s up until the gazettal of the Mt. Werong area in 1988 (DEC 2004a). This included at various times: a small mine at Ruby Creek producing lead, silver and zinc; removal of gold and gemstones from the area of Wyndham and Werong; alluvial gold mining from the Abercrombie River; a slate mine in the headwaters of Murrain Creek; and a silver, gold and copper mine on Mt. Werong Creek (DEC 2004a). A small settlement was established at Mt. Werong in the 1930s, but was deserted by the 1940s (Burrarako Archaeological Services in DEC 2004a).

A large portion of the study area was once State Forest, including what were known as Mt. Werong, Banshea and parts of Gurnang State Forests. Evidence of the extensive selective logging that occurred through much of the taller moist forests in the northern half of the study area remains in the form of a high density of stumps, particularly of Brown Barrel (*Eucalyptus fastigata*) and an evenly aged stand of regrowth trees. The western parts of the study area have also been subject to logging and misuse in the past (DEC 2004a). Previous selective logging has affected the age structure of the vegetation, by removal of mature trees, in parts of the north of the study area.

1.4 ENVIRONMENT

Biogeography

The study area lies within the South Eastern Highlands Bioregion (Thackway and Creswell 1995). This Bioregion covers an extensive area of the central tablelands and slopes of New South Wales and Victoria. The Bioregion is dominated by a temperate climate characterised by mild to warm summers and no dry season (NPWS 2003c). Approximately fifteen percent of the Bioregion is reserved for conservation (in National Parks, Nature Reserves, karst conservation reserves and State Conservation Areas) (NPWS 2003c).

The Sydney Basin Bioregion lies eight kilometres to the east of the study area. Landscapes in the far east of the park share some climate, geology and landscape features with the western extremity of this Bioregion.

Geomorphology

The south west of the southern Blue Mountains NP straddles the Great Dividing Range, with this range separating catchments of east (Hawkesbury-Nepean) and west (Murray-Darling) flowing streams. The geology of the study area is perhaps the most complex of the entire Blue Mountains reserve network. Other than the alluvial deposits and the basalt caps at Mts. Shivering and Jerrong, the rocks are the oldest found within this series of reserves.

The north of the study area contains subalpine environments that lie on the hard weather-resistant granite knolls around the former Mt. Werong and Banshea State Forests. These lie above 1000 metres in elevation and are a similar landscape feature to the larger Boyd Plateau found to the north within Kanangra-Boyd NP. The rocks in these areas erode to produce a soil of moderate fertility.

To the west the granite knolls are surrounded by an undulating landscape that gradually falls in elevation with distance from the Great Dividing Range. These landscapes form the eastern arm of the south and central tablelands, a region that extends from the Brindabella Ranges near Canberra in the south to Mudgee in the north. The underlying rocks are the oldest in the study area, having been formed during the Ordovician period (Hird 1991). These include silty sandstones, micaceous siltstone, phyllite shale, and slate quartzite (Brunker and Offenbergl 1968). Such rocks are found at the headwaters of Burnt Hole Creek, and on Mts. Jerrong and Armstrong. The ridge and gully systems in this area are shallower than the landscapes to the east.

The eastern fall of the Great Dividing Range covers several north-south running bands of different geological age. This combination of rocks is derived from sandstones, slates and quartzite from the Upper Devonian and Ordovician periods (Henderson 2003), leading to soils that are shallow, rocky and infertile. The Chalkers Ridge fire trail traces the line of these geological changes. The landscape

forms a network of narrow ridges and deep gullies that range between 700 and 1000 metres in elevation. These landscapes retain cool temperate influences typical of higher elevations of the Blue Mountains reserves.

Murruin, Jocks and Little Wombeyan Creeks descend into the massive Porphyritic intrusion that spans the Wollondilly Valley. These rocks, formed during the upper Devonian period (Henderson 2003), are easily eroded, meaning that the rivers cut and incise massive gorges into the bedrock. The soils derived from these rocks are moderately fertile and similar in structure to other coarse grained igneous rocks such as granite. These landscapes occupy elevations between 400 and 650 metres in the south eastern part of the study area. A number of limestone outcrops, formed during the Silurian period, are present in the Little Wombeyan and Murruin Creek valleys. These outcrops are part of the distinctive karst systems that extend between Wombeyan and Jenolan Caves.

Small patches of alluvium have developed on bends of some of the larger streams such as Abercrombie River, Mount Werong, Little Wombeyan and Murruin Creeks. These form small flats that have been sought for grazing pursuits, and many are cleared or disturbed.

Elevation

The entire study area lies higher than 600 metres above sea level (asl), with the exception of the lower reaches of Ruby Creek in the north east, which falls to 460 metres asl, and Murruin Creek in the south east, at 400 metres asl. The eastern section of the study area, including the catchments of Little Wombeyan and Jocks Creeks, ranges between 600 and 800 metres asl. The majority of the centre of the area, bounded roughly to the east by Limeburners Flat and the west by Parliament Hill, lies between 800 and 1000 metres asl, with sections along the Range Firetrail and Trailers Mountain above the latter height. The north western corner of the study area, from Parliament Hill north west to Gurnang State Forest, lies above 1000 metres in height, rising from 1088 metres asl at Parliament Hill to 1215 metres at Mt. Werong and 1285 metres asl along Banshea Road in the far north west corner.

Climate

The study area has a cool to mild sub-alpine climate, in which snow can be expected on some days in winter (DEC 2004a). Long term climate patterns across the study area are directly related to topography. The lands higher than 1000 metres asl in the north of the park, have a mean annual temperature of nine degrees, with a maximum of 20 to 25 degrees and a minimum of minus two degrees Celsius. The southern two thirds of the study area experience a mean annual temperate of between ten and twelve degrees, with a minimum of around zero degrees and maximum of 23 to 26 degrees Celsius. The large creeks that drain eastwards, including Ruby, Murruin, Jocks and Middle Creeks, maintain a more moderate average annual temperature of between twelve and fifteen degrees Celsius, with a summer maximum of 28 degrees and a winter minimum of one degree Celsius.

The annual rainfall data for the study area follows a similar pattern. Areas at high elevation, along the Great Dividing Range, at Mt. Werong and along the Banshea Ridge, experience an average of approximately 1000 millimetres of rain per year, while the remainder of the study area receives an average of between 700 and 900 millimetres per year.

1.5 VEGETATION

Vegetation across south western Blue Mountains NP was mapped on a broad scale in 2000 as part of the CRA program (NPWS 2000a). In 2001 DEC was commissioned by the SCA to undertake a comprehensive flora survey of the entire Warragamba Special Area. Fine scale vegetation mapping was undertaken in the far eastern section of the study area as part of this program (NPWS 2003a). The following description of vegetation is based on information contained in NPWS (2000a) and NPWS (2003a).

Such a landscape as described above greatly influences the trend in vegetation patterns across the study area. Overall the vegetation patterns correspond to sub-alpine, montane and eastern tablelands environments that have low to moderate fertility and moderate rainfall. Small areas in the Murruin Creek are characterised by the drier climate of the Wollondilly Valley. The following synopsis of vegetation in the area is drawn from NPWS (2003a) and NPWS (2000a).

In the north of the study area, around the former Banshea and Mt. Werong State Forests, the country is dominated by moderately fertile soil that, in combination with good rainfall and high elevation, supports a sub-alpine tall forest of Narrow-leaved Peppermint (*Eucalyptus radiata*), Mountain Gum (*E. dalrympleana* subsp. *dalrympleana*) and Brown Barrel on ridges and gentle slopes (Plate 1). These forests are shrubby with a herbaceous and grassy ground cover. This community is extensive and has been repeatedly logged for Brown Barrel. Drainage lines and depressions on these granites form a cold air sink and mark a transition into a shorter open forest and woodland dominated by Snow Gum (*Eucalyptus pauciflora*), Mountain Gum and Candlebark (*E. rubida*). Silver Wattle (*Acacia dealbata*) is a common shrub and the ground cover includes dense clumping of Tussock and Snow Grass (*Poa* spp.).



Plate 1: Montane Sheltered Forest in the former Banshea State Forest © DEC

West of the divide, the landscape and climate slips from a sub-alpine to a cool tableland environment. Rainfall decreases and a low open woodland becomes the distinctive feature of the ridgelines and slopes (Plate 2). This forest is floristically simple, dominated by tree species typical of poor soils in tableland environments. These include Red Stringybark (*Eucalyptus*

macrorhyncha), Brittle Gum (*E. mannifera* subsp. *mannifera*), Tablelands Scribbly Gum (*E. rossii*) and Broad-leaved Peppermint (*E. dives*). Again, a sparse understorey and ground cover is present with *Daviesia leptophylla* growing above Snow Grass and Silver-top Wallaby Grass (*Joycea pallida*). The tall montane gully forests that feature Brown Barrel have less mesic understoreys and are restricted to only the most protected sites. Within this area there are also a number of broad valleys and riverine flats, particularly along the Abercrombie River, which are primarily private land holdings. These form frost hollows in which Black Sally (*Eucalyptus stellulata*) and Snow Gum dominate. Much of this riverine flat community has been heavily cleared, although small patches remain at Limeburners Flat, which is the only example of this community east of the Divide.

South of Mt. Werong the deeply dissected Silurian and Ordovician metasediments support a dry shrub forest on ridgelines and exposed slopes. These forests are dominated by dense stands of Silver-top Ash (*Eucalyptus sieberi*) in combination with species such as Narrow-leaved Peppermint and Brown Stringybark (*E. blaxlandii*). The sclerophyllous shrub layer is generally very open with low Narrow-leaved Geebung (*Persoonia linearis*) and Native Holly (*Podolobium ilicifolium*) scattered amongst Snow Grasses (*Poa* spp.) and Bracken (*Pteridium esculentum*). The forest floor tends to support very little vegetation over the bare rocks and soil. Slopes are similar in floristic composition, however as shelter increases Brown Stringybark and Narrow-leaved Peppermint gain dominance in the canopy with taller shrubs and small trees of Broad-leaved Hickory (*Acacia falciformis*) and *Leucopogon lanceolatus* becoming more prominent. Slopes descend into gullies that feature tall Brown Barrel, Narrow-leaved Peppermint, Ribbon Gum (*Eucalyptus viminalis*) and Mountain Gum in the most protected aspects. The understorey is characterised by a dense carpet of ferns and twiners, below a taller though sparse mid strata of Blackwood (*Acacia melanoxylon*) and River Lomatia (*Lomatia myricoides*).

The creeks that flow east into the Wollondilly via the Murrumbidgee system gradually cut downwards to expose more erosion-prone rocks. Very steep gorges develop and dry forests of Grey Gum (*Eucalyptus punctata*) and Blue-leaved Stringybark (*E. agglomerata*) are common. The understorey is



Plate 2: Tablelands Exposed Silvertop Ash-Brittle Gum Woodland on Range Fire Trail © DEC

particularly sparse with Daisy Bush (*Olearia viscidula*) and Nodding Blue Lily (*Stypandra glauca*) forming clumps over exposed soil. In the gullies, a tall sheltered forest forms that differs from the Brown Barrel Forests that dominate many of the sheltered aspects at higher elevations. At these scattered locations on Little Wombeyan and Jocks Creeks, River Peppermint (*Eucalyptus elata*) forms a dense forest, sometimes with Ribbon Gum on narrow alluvial flats and lower slopes. The Murruin Creek gorge below the Bindook Highlands exposes large areas of the granite-like porphyry bedrock that is common throughout the

Wollondilly Valley. Elevation drops rapidly in the gorge dry slopes, which are covered in Forest Red Gum (*Eucalyptus tereticornis*), Yellow Box (*E. melliodora*) and Stringybarks (*E. eugenioides/globoidea*). This open shrubby woodland generally occurs below 700 metres elevation. The precipitous nature of the Murruin Creek Gorge means slopes and rock falls are common. These scree slopes provide ideal habitat for a low growing dry rainforest to develop wherever there is sufficient protection from the sun and dry westerly winds. Large Port Jackson Fig (*Ficus rubiginosa*), Grey Myrtle (*Backhousia myrtifolia*) and occasionally Giant Stinging Tree (*Dendrocnide excelsa*) may dominate.

There are a number of interesting vegetation communities in the study area that are restricted in distribution. The first of these is a mallee-heath community that occurs on the Loombah Plateau. A thick shrub layer of Silver Banksia (*Banksia marginata*) has taller Mallee Ash (*Eucalyptus stricta*), Snow Gum and Mountain Gum sparsely scattered above. Vegetation growing on Mts. Shivering and Werong are influenced the basalt soils. These soils are fertile and undulating ridges support a forest of Brown Barrel and Ribbon Gum. While Mt. Werong has been heavily logged in the past and is primarily regrowth, Mt. Shivering is largely untouched and provides a example of what these majestic tall forests once were. The floristic assemblages of these forests are very closely aligned with those that are found throughout the gully systems of the area.

A small and contrasting community is the bogs and swamps that form in depressions, drainage lines and soaks of the montane and tableland environments. These form a dense shrub and sedge layer often featuring Tea Trees (*Leptospermum continentale*, *L. myrtifolium*) and sedges from the Restionaceae family that include *Empodisma minus* and *Lepyrodia anarthria*.

1.6 FIRE

Little is known about traditional Aboriginal burning practices in the area. Since European settlement, fire events have predominantly been caused by lightning strikes during dry thunderstorms between December and March, with occasional wildfires being caused by burn-offs (DEC 2004a). The most recent wildfire within the study area occurred in the summer of 2001-2002 and effected the area bounded by Mt. Werong to the north, Abercrombie River and Maneveland fire trail to the south and Bindook Ridge to the east. The intensity of the fire was highly variable, reaching extreme (total vegetation consumption) at a number of locations along the ridgelines between Millamein Creek and Mt. Werong. Small areas near the Range Firetrail burnt between 1989 and 1991 and near the Little River fire trail in 1987 and 1997 (DEC 2004a). The remaining areas of the study area have not burnt since the 1980s, when small patchy fires burnt around the upper reaches of Mount Werong Creek, and the upper reaches of Tuglow Hole Creek.

2 METHODS

2.1 EXISTING FAUNA DATA

Prior to the current study, knowledge of the terrestrial vertebrate fauna of the south western Blue Mountains NP was markedly depauperate. The study area was subject to limited investigation during the NSW Comprehensive Regional Assessment (CRA) program, which sought to provide a broad overview of the conservation value of public lands in eastern NSW. Limited bird and mammal surveys were undertaken in the north of the study area in 1998 and the vegetation across the area was mapped on a broad scale in 2000 (NPWS 2000a). In 2001 a small biodiversity survey was undertaken at Mt. Werong, employing various techniques, including pitfall and Elliott trapping, spotlighting and bird surveys. This data was originally entered into the Atlas of NSW Wildlife as incidental records at a single location, and this is reflected in the maps within this report. Efforts are being made with GIS Group to alter this data to more accurate locations although unless the original datasheets are used, it will be impossible to transfer this data into systematic data that can be used for further analysis. Also in 2001, DEC was commissioned by the SCA to undertake a comprehensive flora and fauna survey of the entire Warragamba Special Area, which overlaps the east of the study area. Ten systematic fauna survey sites were established and surveyed in 2003 as part of this program (NPWS 2003a, DEC in prep.).

The Atlas of NSW Wildlife was the primary resource used to access existing data on the fauna of the study area. The majority of records within the Atlas prior to the summer of 2003-04 derive from the previous DEC systematic surveys of the park described above. The bulk of the remaining records derive from the licensed data sets of Birds Australia (Blakers *et al.* 1984 and Barret *et al.* 2003) and the specimen register of the Australian Museum. The method used by Birds Australia to record sightings involves designating a ten-minute spatial grid, based on easting and northing lines. All birds recorded from within this grid are then assigned to AMG coordinates at the centre of the grid, such that the data is not spatially accurate on a fine scale. The Australian Museum data derives from specimens submitted to the museum by members of the public, as well as from field trips undertaken by Museum staff specifically to collect fauna specimens. Records collected soon after European settlement have been entered into the Museum database with a low level of spatial and temporal reliability. For this reason, records from the Australian Museum prior to 1950 have been excluded from discussion in this report.

Remaining records within the Atlas derive from observations made by: park rangers and field officers; catchment officers; bushwalkers and naturalists; scientific researchers working in the area; and other visitors to the park. These records have various levels of reliability depending on the type of observation, as well as the certainty and identification experience of the observer.

2.2 SURVEY STRATIFICATION AND SITE SELECTION

Prior to the commencement of the program of fauna surveys in 2004, 27 systematic fauna survey sites had been established within the study area, seventeen as part of the CRA program in 1998 and ten as part of the SCA fauna survey program in 2003. Gap analyses undertaken as part of the survey stratification and site selection for the 2004 survey season incorporated these systematic surveys, to ensure that the data collected would complement, rather than replicate, work that has previously been undertaken within the study area.

The primary stratum used for site selection was vegetation type. The study area is covered by a number of vegetation maps, of which two were used in the selection of fauna survey sites. For the area of park within the SCA Special Area boundary (eastern side of the study area) the vegetation map and descriptions produced by the Central Conservation Assessment and Data Unit (NPWS 2003a) were used; for the remainder of the study area, the vegetation map and descriptions produced by Southern Directorate CRA (NPWS 2000a). Each specific vegetation community within the study area was placed into a broader flora group; vegetation communities which shared significant similarities in floristic composition, structure, topographic position and substrata were grouped together. Fauna survey site stratification was based on these broad flora groups, while aiming to sample the full variation of vegetation communities within each group as much as possible.

A gap analysis identified the previous systematic fauna survey effort undertaken within each vegetation community and broad flora group across the whole of the Kanangra and Highlands area of Blue Mountains NP. Vegetation communities that had not previously been sampled or had been under-sampled (where the amount of previous survey effort was less than that predicted by the proportional size of the community), and were present within the study area, were prioritised for sampling. This ensured that the sites surveyed as part of the current study completed the broader program of systematic fauna survey being undertaken across the greater Blue Mountains region. Due to time and budgetary constraints, vegetation communities that occupied less than 100 hectares of land within the study area were not targeted for systematic replicated sampling, though some techniques were undertaken in some of these communities where possible.

Sites were initially selected using Arcview, with information gained from topographic maps, vegetation maps, access trails, and location of previous survey effort. Sites were positioned primarily on or close to access trails to facilitate conduct of spotlighting and harp trapping surveys and to maximise the number of sites that could be accessed during the limited survey period. In the field, the proposed site locations were ground-truthed to ensure that they were representative of the mapped vegetation community, had not been significantly effected by recent burning or other habitat modification, and comprised a single vegetation community. If these criteria were not met, an alternative location was selected for the site. Systematic survey sites were 100 by 200 metres in area, and spaced a minimum of one kilometre from each other (two kilometres for nocturnal call playback surveys).

Selection of survey sites was limited, at both stages of the process by the location of access trails and the large amount of travelling time between areas. Consequently, considerable difficulties were met in locating survey sites that sampled the range of vegetation communities, maintained sufficient distance between sites to ensure they were independent from one another and could be accessed with a reasonable degree of efficiency. For these reasons, and because fauna survey is very labour intensive, not all communities within the study area could be sampled to the desired extent. Vegetation communities that were restricted in extent and/or difficult to access received comparatively fewer sites in proportion to their area. In particular, problems were encountered in surveying Montane Sandstone Dry Shrub Forests. Table 1 presents the area of mapped vegetation communities (greater than 100 hectares in area) categorised into broad flora groups and the corresponding survey effort for each fauna survey technique. Map 2 shows the location of fauna survey sites and the distribution of broad flora groups within the study area. Appendix A provides the specific AMG, vegetation type and survey techniques undertaken at each survey site. The tables and figures include all systematic surveys undertaken within the study area by DEC between 1998 and 2004.

2.3 SURVEY METHODS

The systematic fauna survey methods used were based on those developed by the NPWS Biodiversity Survey Coordination Unit (NPWS 1997). The systematic techniques described below were used to sample the following vertebrate fauna groups: diurnal and nocturnal birds, diurnal and nocturnal reptiles, bats, arboreal mammals, amphibians, and terrestrial mammals. Consistency in the use of these techniques allows comparison between fauna species detected across different vegetation types and environments within the study area. Furthermore, it will allow future comparisons with consistent surveys of environments elsewhere.

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

2.3.1 Systematic site-based methods

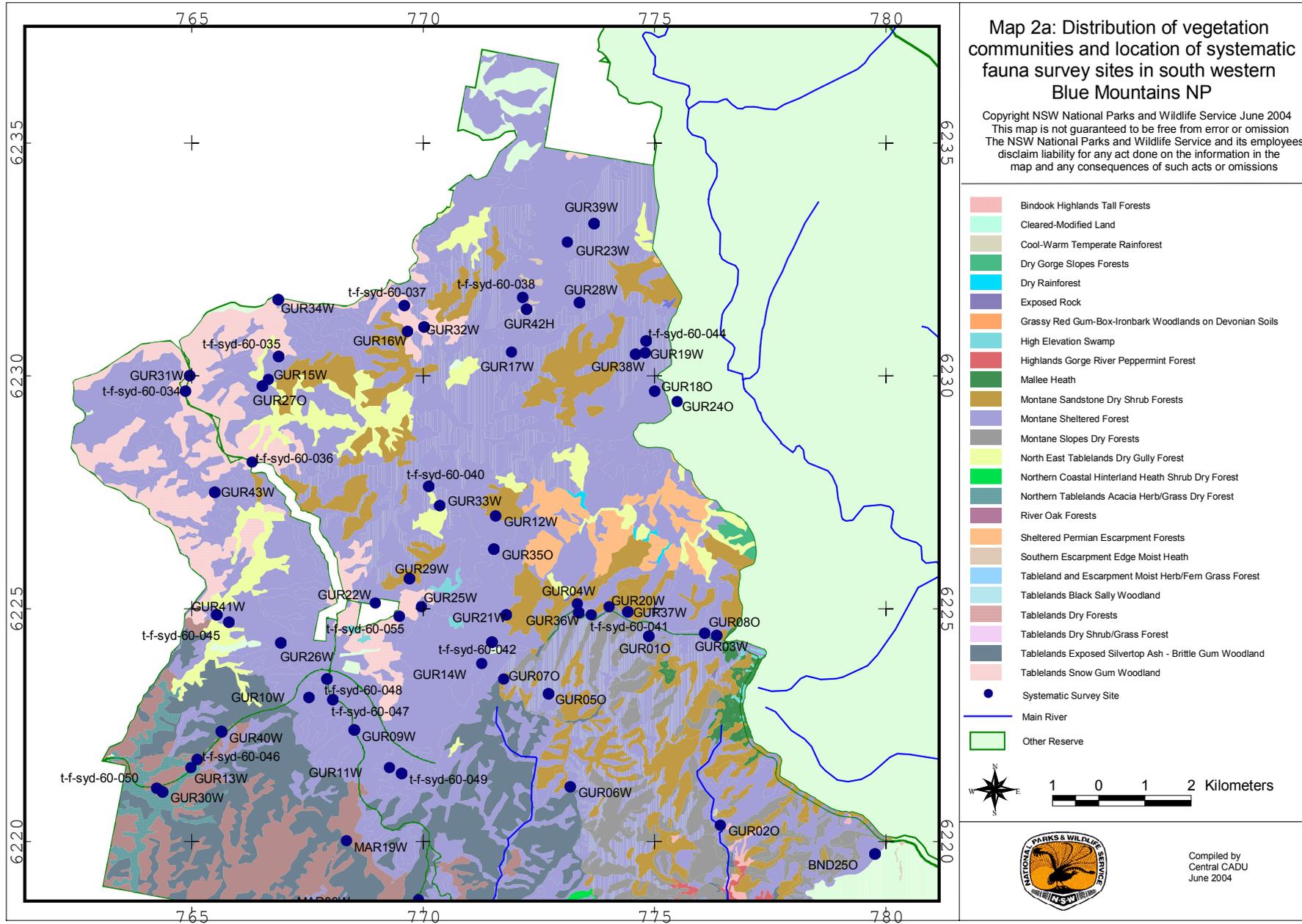
Diurnal bird survey

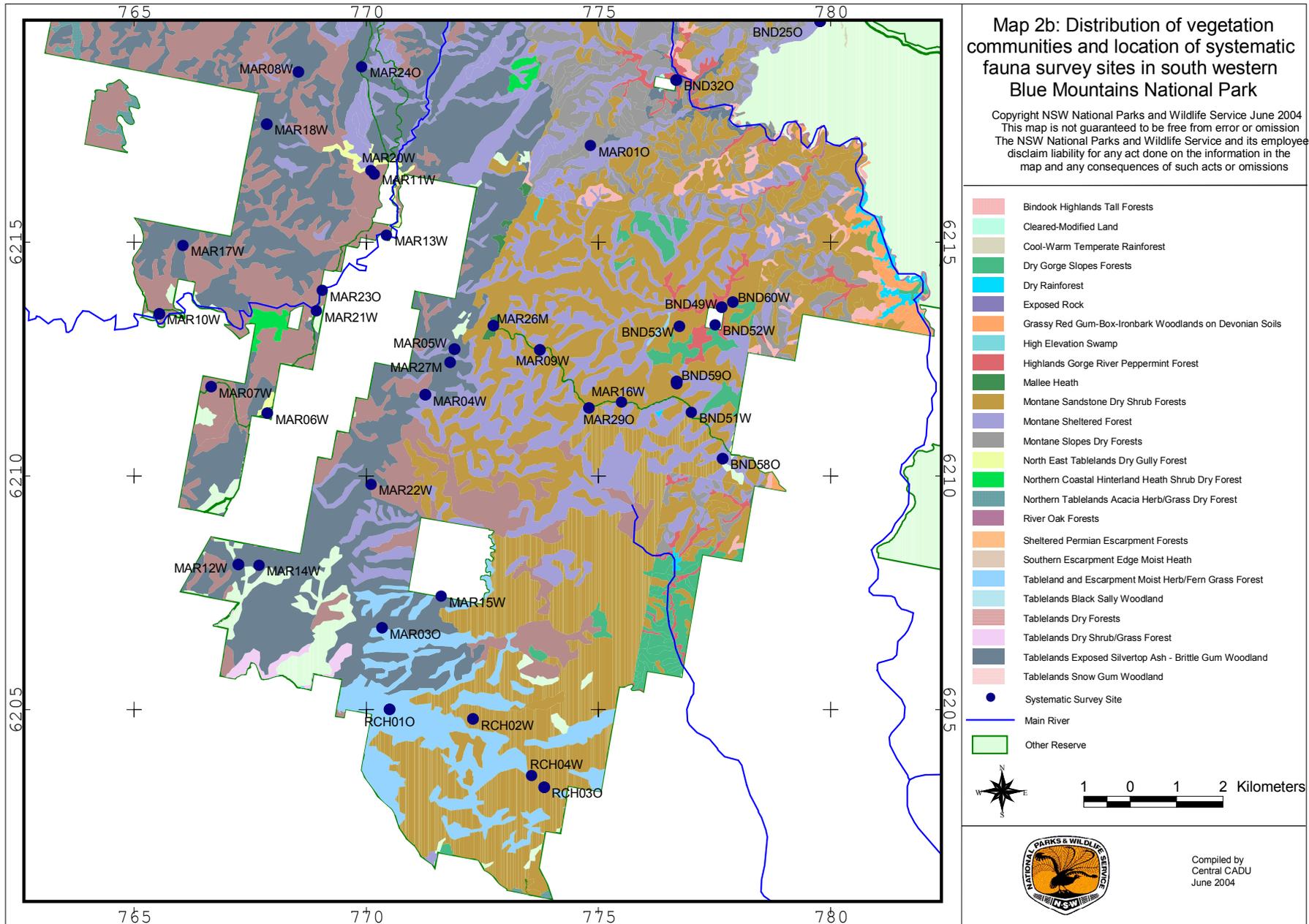
Diurnal bird censuses comprised a twenty minute observation and listening search within a two hectare (100 by 200 metre) area, conducted by an experienced bird surveyor. Censuses were conducted only during periods of relatively high bird activity (in the early morning) and reasonable detectability (e.g.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

Table 1: Areas of mapped vegetation communities (broad flora groups) within south western Blue Mountains NP and allocation of systematic survey methods (includes systematic survey sites from CRA, SCA and Data Priorities projects). Vegetation communities derived from NPWS (2003a) and NPWS (2000a).

Broad Flora Group	Mapped area of vegetation community in study area ¹	Proportion of study area occupied by vegetation community (%)	No. of diurnal bird surveys	No. of diurnal reptile surveys	No. of site spotlight surveys	No. of harp trapping bat sites	No. of ultrasonic bat detector sites	No. of nocturnal streamside searches for frogs	No. of owl call broadcast sites	No. of Elliott trap sites
Montane Sheltered Forest	12375	35.8	18	14	22	10	4	3	13	3
Montane Sandstone Dry Shrub Forests	7195	20.8	5	6	5	5	3	0	0	1
Tablelands Exposed Silvertop Ash-Brittle Gum Woodland	5119	14.8	5	4	5	3	1	0	2	1
Tablelands Dry Forests	2787	8.1	3	3	5	4	1	0	3	0
Montane Slopes Dry Forests	1665	4.8	1	1	1	0	0	0	1	0
Tablelands Snow Gum Woodland	1214	3.5	5	2	5	1	1	0	4	0
Tableland and Escarpment Moist Herb/Fern Grass Forest	872	2.5	2	2	1	0	0	0	0	0
North East Tablelands Dry Gully Forest	797	2.3	3	2	2	1	0	1	0	0
Dry Gorge Slopes Forests	456	1.3	0	0	0	0	0	0	0	0
Sheltered Permian Escarpment Forests	349	1.0	0	0	0	0	0	0	0	0
Highlands Gorge River Peppermint Forest	230	0.7	1	2	2	0	1	1	1	0
Northern Tablelands Acacia Herb/Grass Dry Forest	227	0.7	0	0	0	0	0	0	0	0
Bindook Highlands Tall Forests	208	0.6	0	0	0	0	0	0	0	0
Grassy Red Gum-Box-Ironbark Woodlands on Devonian Soils	132	0.4	0	0	0	0	0	0	0	0
Mallee Heath	115	0.3	0	0	0	0	0	0	0	1
Southern Escarpment Edge Moist Heath	13	0.0	1	1	0	0	0	0	0	0
Other vegetation communities with < 100 hectares in study area	857	2.5	0	0	0	0	0	0	0	0
Total	34612	100	44	37	48	24	11	5	24	6

¹ area based on GIS data layers does not equal gazetted area of reserve





Diurnal herpetofauna search

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

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

Nocturnal site spotlighting survey

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

Harp trapping

While ultrasonic recorders were used principally to detect high flying bat species, collapsible bat traps, known as harp traps (Tidemann and Woodside 1978), captured low flying species. Two nights of trapping were conducted at each bat trap site. Sites were selected for their perceived potential to interrupt bats along their flight paths, and were usually along tracks or in gaps between trees where adjacent vegetation might force bats to fly.

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

Bat ultrasonic ('Anabat') call recording

Ultrasonic recorders (Corben 1989) are particularly useful for detection of high-flying species, which often comprise more than one third of an area's bat species (Parnaby 1992b), yet are under sampled by harp trapping (Richards 1992). The method requires the recording and identification of high frequency, echo-location "calls" made by bats, which, except for one or two species, are ultrasonic, that is, inaudible to humans.

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

Anabat recordings were transferred onto computer and analysed by Narawan Williams, a recognised expert in this field. Identification was designated as either definite, probable or possible, following the methodology of Parnaby (1992b) and Pennay *et al.* (2004).

Nocturnal streamside search

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

Nocturnal call playback

Nocturnal birds and mammals are often detected only when they vocalise for territory or social contact, behaviour which can be elicited by broadcasting specific calls. A standard survey census involved broadcasting the calls of each of the four large forest owls - Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) Sooty Owl (*T. tenebricosa*) and Barking Owl (*N. connivens*) - from the centre of a site. Prior to call broadcasts, on arrival at the site, the surrounding area was searched by spotlight for five minutes to detect any fauna in the immediate vicinity and then a ten minute period of listening was undertaken.

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

Elliott trapping

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

2.3.2 Targeted survey for Stuttering Frog

In February 2004 targeted surveys were undertaken for the Stuttering Frog (*Mixophyes balbus*) around Mt. Werong. The aim of the surveys was twofold: to re-visit the site where the frog had previously been recorded in order to ascertain the extent, distribution and status of the population; to search for new locations and potential habitats of the species in the area. Surveys were undertaken along sections of: Ruby Creek (from above mine site to two kilometres north east of Ruby Creek Falls); Mount Werong Creek (one kilometre upstream and downstream of Middle Werong Creek Trail and five hundred metres upstream and downstream of Upper Werong Creek Trail); Tuglow Hole Creek (500 metres up and down stream of Bouchers fire trail crossing and near Dingo Dell); Burnt Hole Creek (one kilometre downstream and 500 metres upstream of Burnt Hole Creek fire trail). Diurnal searches were undertaken at all locations, involving dip netting for tadpoles and habitat assessment. Ruby Creek and Mount Werong creek were also surveyed at night, when spotlighting and call playback were used to ascertain the presence of adult frogs. All species of tadpoles and adult frogs seen or heard calling were recorded and entered onto a data sheet.

2.3.3 Opportunistic methods

Predator and herbivore scat and pellet collection

The large numbers of hairs, and occasionally skeletal remains, in predator scats and pellets results in a high level of confidence in identifications of prey species and is hence an efficient sampling technique for prey animals. In addition, the recording of predator or non-predator scats constitutes records for the species that deposits the scat, providing locality records for species such as the Spotted-tailed Quoll (*Dasyurus maculatus*), Fox (*Vulpes vulpes*), Dingo (*Canis lupus dingo*), Dog (*C. lupus familiaris*) and Pig (*Sus scrofa*). Due to the unmeasurable time delay between prey ingestion and defecation, the location in which the prey animals lived cannot be accurately known, so this technique is useful only for detecting the species presence within a general area. Lunney *et al.* (2002) have shown, however, that predators defecate an average of two kilometres from the point of prey ingestion.

Predator scats were collected, placed in paper envelopes, labelled and sent to specialist Barbara Triggs for analysis. Hair samples were identified using the techniques described by Brunner and Coman (1974). Identifications were classified into three levels of reliability: definite, probable and possible.

The location of herbivore scats was also noted on an opportunistic basis to indicate the presence of an animal. If there was any doubt in herbivore scat identification in the field, samples were brought back for identification by an expert.

Incidental records

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

2.4 SURVEY TIMING

As indicated above, systematic field surveys have been undertaken within south western Blue Mountains NP over a number of years. Table 2 summarises the timing of these surveys and the techniques that were undertaken in each season.

Table 2: Timing of DEC systematic fauna surveys within south western Blue Mountains NP

Survey program	Timing	Techniques employed
Comprehensive Regional Assessment (CRA)	August – September 1998	Diurnal bird census, site spotlighting, nocturnal call playback, opportunistic methods
Warragamba Special Area Surveys – Year 1	March 2003	Diurnal bird census, reptile search, harp trapping, opportunistic methods
	April – May 2003	Nocturnal call playback, site spotlighting
Biodiversity Survey Priorities Program	January – February 2004	Diurnal bird census, reptile search, site spotlighting, harp trapping, bat call detection, nocturnal streamside search, elliott trapping, opportunistic methods
	May 2004	Nocturnal call playback, elliott trapping, site spotlighting, opportunistic methods

3 RESULTS AND DISCUSSION

3.1 OVERVIEW

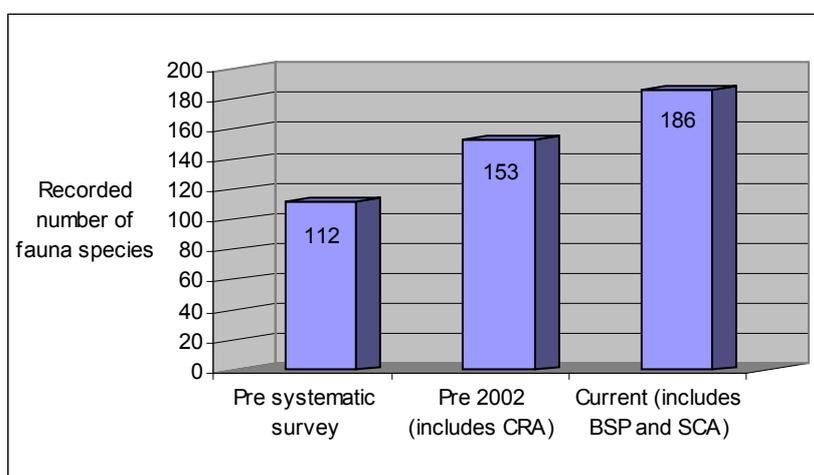
DEC has established and surveyed a total of 100 systematic fauna survey sites within south western Blue Mountains NP, 73 of which were surveyed in 2004 as part of the Biodiversity Survey Priorities fauna survey program. These sites cover the range of dominant habitats and landscapes present within the study area, and have been surveyed during spring, summer and autumn. In addition to these surveys, members of Birds Australia have contributed significantly to the number of fauna records for the study area, as have numerous DEC staff, scientific researchers, and dedicated members of the public.

One hundred and eighty six species of vertebrate fauna have been recorded on the Atlas of NSW Wildlife within the south western Blue Mountains NP. This includes ten species listed as threatened on the NSW Threatened Species Conservation Act (1995) (TSC Act), of which two are also listed on the commonwealth Environmental Protection and Biodiversity Conservation Act (1999) (EPBC Act). Eleven introduced fauna species have been recorded within the study area to date, including eight ground mammals and three birds. A complete species list for all fauna groups is provided in Appendix A.

In addition to the above fauna, 33 species have been recorded within a five kilometre radius of the study area boundary (see Appendix A). This includes six additional threatened species, which will be discussed further below.

The value of systematic fauna survey is apparent in the contribution it has made to the knowledge of fauna within the study area and the building of a species inventory. The CRA surveys, undertaken in 1998, added 41 species to the list of known fauna within south western Blue Mountains NP, and the Biodiversity Survey Priorities (BSP) program, undertaken in 2004, has added a further 33 species to the study area database. Figure 1 indicates the increase in the known number of fauna species within the study area over time, primarily as a result of dedicated systematic fauna survey.

Figure 1: Number of species recorded within south western Blue Mountains National Park following systematic fauna survey.



3.2 NATIVE DIURNAL BIRDS

A total of 108 bird species have been recorded within the study area. Of these 99 are native diurnal species, six are nocturnal species (Section 3.3) and three are introduced (Section 3.9). These records have been accumulated in three stages. Table 3 shows the accumulated species counts and number of records for each of these periods of time. This table includes nocturnal species within the counts of species and records.

The first period was prior to 1998, where a large number of records were gathered as part of the Bird Atlas published by the Royal Australasian Ornithologists Union (RAOU) (Blakers *et al.* 1984). A few incidental records are also included within the Atlas of NSW Wildlife for these period, but the vast majority of records are located at the centre of two ten-minute grid squares that happen to fall within Blue Mountains NP. There