2 METHODS

2.1 EXISTING FAUNA DATA

The Atlas of NSW Wildlife (DEC 2004a) was the primary resource used to acquire existing data on the fauna of the park. Systematic fauna survey effort has been limited within the Nattai and Bargo reserves. Mount King Ecological Surveys (1989, 1994) carried out some sampling around the shores of Lake Burragorang as part of the Warragamba Dam flood restoration works, though much of the data in these reports is difficult to incorporate into the Atlas. The majority of records within the Atlas prior to the summer of 2003-04 derive from DEC systematic surveys of the park, undertaken as part of the Comprehensive Regional Assessment fauna surveys (1997-99) and the Warragamba Special Area fauna surveys (2002-03), which are each described below. The former carried out sampling in the Burragorang and Nattai Valleys, and the sandstone plateau on Wattle Ridge Trail, while the latter surveyed the northern portions of Nattai National Park. Belik and Close (1997) summarised the available biodiversity data for the Bargo River area immediately adjoining Bargo SCA for the Nepean Catchment Committee and undertook limited survey in October 1996. The National Parks Association (NPA) completed a community biodiversity survey in the same area in June 1997 as part of a proposal for the establishment of a Bargo River National Park. The records from these surveys have been included within the report, but many of the survey techniques undertaken do not allow direct comparison with surveys undertaken by DEC.

The bulk of the remaining records derive from the licensed data sets of Birds Australia (Blakers *et al.* 1984 and Barrett *et al*. 2003) and the specimen register of the Australian Museum. Blakers *et al.* (1984) sightings involve 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. This process was also used by some observers included in Barrett *et al.* (2003), although others provided information at a finer 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. Early specimens in the register often have 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. Catchment rangers have collected opportunistic records of fauna for many years prior to the transfer of lands to the NPWS in 1991. Observations by landowners, bushwalkers and naturalists have also contributed to the Atlas of NSW Wildlife, although these records are sparse.

2.2 SURVEY STRATIFICATION AND SITE SELECTION

Vegetation mapping was used to identify the range of fauna habitats present in the study area. There are 37 different communities described and mapped (DEC 2004b) which have varying distributions ranging from highly restricted to extensive. Each specific vegetation community within the park was placed into a broader flora group; vegetation communities that 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.

The preferable sampling strategy would have aimed to sample the mapped vegetation communities proportionately according to the mapped area of each community within the reserve *and* have included enough repeat sampling within each vegetation community to provide reasonable reliability that potential variations within widespread stratum were captured. Such replication of sites serves to strengthen the reliability of patterns derived from collected data. The pre-trip site selection process aimed to fulfil this goal as much as possible. Survey work that was completed in 1997 and more recently in 2002 was overlaid on the vegetation mapping in order to examine sampling adequacy An analysis identified the previous systematic fauna survey effort undertaken within each vegetation community and broad flora group within the park. Vegetation communities that had not previously been sampled or had been under-sampled (where the amount of previous survey effort was less than that estimated by the proportional size of the community) were prioritised for sampling. Small and isolated communities were not targeted, while extensive communities have been afforded replicated sampling.

New sites were 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 affected 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 metres by 200 metres in area, and spaced a minimum of one kilometre from each other (two kilometres apart for nocturnal call playback surveys). Given the extent of the 2001-2002 wildfires sampling of some burnt vegetation was unavoidable.

Selection of survey sites was extremely limited, at both stages of the process, by the steep and dramatic terrain of the park, the location of access trails, and the large amount of travelling time between areas. Given the nature of the terrain, many sites involved extensive walking to access sheltered forest, gully forest and rainforest.

Table 1 presents the area of each broad flora group within the reserves and the corresponding survey effort for each fauna survey technique. Map 4 shows the location of fauna survey sites and the vegetation within the reserves. Appendix A provides the specific AMG, vegetation type and survey techniques of each survey site. The tables and figures include all systematic surveys undertaken within the reserves by DEC between 1997 and 2004.

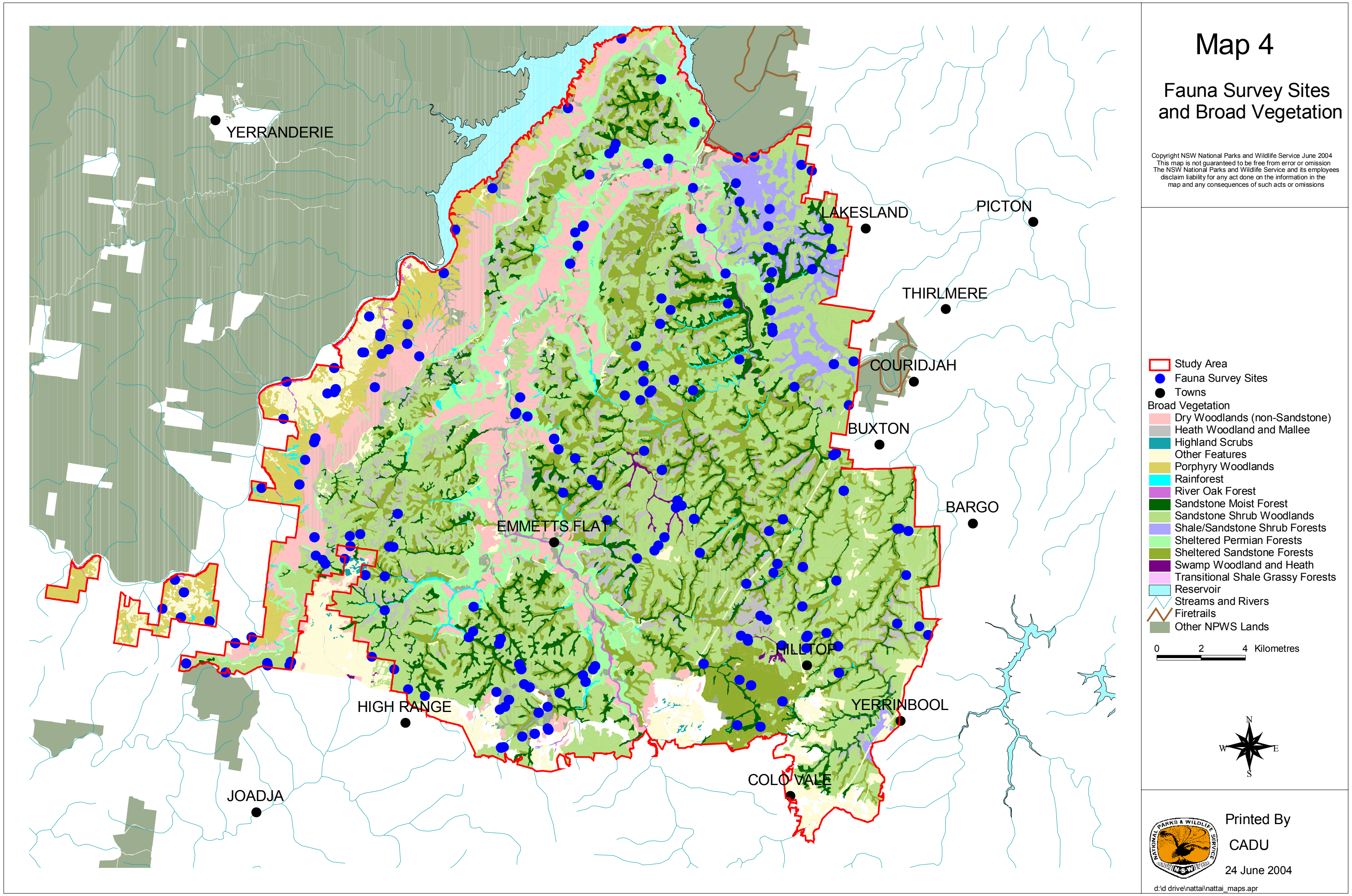
Table 1: Area of each broad flora group within the Nattai and Bargo Reserves and corresponding allocation of systematic survey methods (includes systematic survey sites from CRA, SCA and Biodiversity Survey Priorities projects).

Broad Vegetation	**Mapped area of vegetation community Reserves (ha)**	**Relative mapped area of vegetation community (%)**	**No. of ultrasonic bat detector sites**	**No. of diurnal bird sites**	**No. of diurnal reptile sites**	**No. of Elliott trap sites**	**No. of hair tube Sites**	**No. of harp trapping bat sites**	**No. of nocturnal call playback sites**	**No. of nocturnal streamside search sites**	**No. of site spotlights for arboreal mammals**	**No. of spotlight transects for arboreal mammals**
Rainforest	614	0.9	0	3	0	0	0	0	2	0	2	1
Tall Forest	12616	17.9	5	10	11	6	0	6	7	0	11	0
Woodland	30020	42.6	3	27	27	5	1	8	32	5	22	4
Open Forest	21875	31.0	2	23	18	7	0	13	20	4	24	1
Heaths and Swamps	1163	1.6	1	1	3	0	0	1	0	1	1	0
Other	4197	6.0	0	5	7	0	2	4	6	0	8	2
Total	**70485**	**100**	**11**	**69**	**66**	**18**	**3**	**32**	**67**	**10**	**68**	**8**

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, reptiles, amphibians, bats, and arboreal and terrestrial mammals. Consistency in the use of these techniques allows comparison between fauna species detected across different vegetation types and environments within the park. 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 Sub-system (BSS) of the Atlas of NSW Wildlife computer database. The names of observers and recorders were noted on every data sheet to aid data verification and entry.


Map 4
Fauna Survey Sites and Broad Vegetation
Copyright NSW National Parks and Wildlife Service June 2004
This map is not guaranteed to be free from error or omission
The NSW National Parks and Wildlife Service and its employees disclaim liability for any act done on the information in the map and any consequences of such acts or omissions
YERRANDERIE
LAKESLAND
PICTON
THIRLMERE
COURIDJAH
BUXTON
BARGO
EMMETTS FLAT
HILLTOP
YERRINBOOL
HIGH RANGE
COLO VALE
JOADJA
Study Area
Fauna Survey Sites
Towns
Broad Vegetation
Dry Woodlands (non-Sandstone)
Heath Woodland and Mallee
Highland Scrubs
Other Features
Porphyry Woodlands
Rainforest
River Oak Forest
Sandstone Moist Forest
Sandstone Shrub Woodlands
Shale/Sandstone Shrub Forests
Sheltered Permian Forests
Sheltered Sandstone Forests
Swamp Woodland and Heath
Transitional Shale Grassy Forests
Reservoir
Streams and Rivers
Firetrails
Other NPWS Lands
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Systematic site-based methods

Diurnal bird survey

Diurnal bird censuses comprised a twenty minute observation and listening search within a two hectare (50 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 (eg. low wind and cicada activity). All bird species and abundance of individuals seen or heard were recorded. Individuals were scored as on-site if they were detected within the two hectare plot. Individuals recorded outside the plot, in adjacent vegetation types or flying overhead were recorded as off-site.

Diurnal herpetofauna search

A standard half-hectare area subplot (50 by 100 metres) within a two hectare standard site was searched for one person-hour (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, echolocation "calls" made by bats, which, except for one or two species, are ultrasonic, that is, inaudible to humans.

<u>1997-2002 surveys</u>

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

<u>Current surveys</u>

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). Calls that proved difficult to identify were also assessed by Michael Pennay (DEC Western Regional Assessments Unit) using the techniques described in 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 (*Ninox strenua*), Masked (*Tyto novaehollandiae*), Sooty (*T. tenebricosa*) and Barking (*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 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.

Hair-sampling tubes

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

Transect-based methods

Transect spotlighting survey

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

Opportunistic methods

Predator and herbivore scat 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 (*Canis lupus familiaris*) and Pig (*Sus scrofa*). Due to the unknown time delay between prey ingestion and defecation, the location in which the prey animals lived cannot be accurately known, so this technique is useful only for detecting the species presence within a general area. However, Lunney *et al.* (2002) showed that on average Dogs and Foxes defecate within a two kilometre radius of the site of prey ingestion.

Predator scats were collected, placed in paper envelopes, labelled and sent to specialist Barbara Triggs for analysis, using the methods described previously for hair tube samples.

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 park 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 the study area 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 the Nattai and Bargo Reserves.

Survey program	Timing	Techniques employed
Fauna Survey of the Lake Burragorang area (Mt King Ecological Surveys)	1989 – 1994	Elliott trapping, cage trapping, spotlight transects, opportunistic bird and reptile records
National Parks Association Community Survey Bargo River crown lands	October 1996 and July 1997	Bird census, spotlighting, Elliott trapping, reptile search
Comprehensive Regional Assessment (CRA)	April – May 1997	Bird census, reptile search, transect spotlighting, harp trapping, 30 minute bat call detection, streamside search, hair tubes, nocturnal call playback, opportunistic methods
	September 1998	Nocturnal call playback and site spotlight
Warragamba Special Area Surveys – Year 1	December 2002 – March 2003	Bird census, reptile search, site spotlighting, opportunistic methods
	April – June 2003	Nocturnal call playback and site spotlighting
Biodiversity Survey Priorities Surveys	December 2003 – January 2004	Bird census, reptile search, site spotlighting, harp trapping, overnight bat call detection, streamside search, Elliott trapping, opportunistic methods
	June 2004	Elliott trapping, nocturnal call playback and site spotlighting
Warragamba Special Area Surveys – Year 2	January-March 2004	Bird census, reptile search, site spotlighting, harp trapping, overnight bat call detection, streamside search, Elliott trapping, opportunistic methods