

4 MANAGEMENT RECOMMENDATIONS

4.1 AREAS OF HIGH CONSERVATION SIGNIFICANCE

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

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

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

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

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

4.1.2 Known localities of the Stuttering Frog

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

4.1.3 Known Brush-tailed Rock-wallaby colonies

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

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

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

4.1.4 Known localities of the Broad-headed Snake

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

4.2 SUMMARY OF RELEVANT RECOVERY PLAN ACTIONS

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

4.2.1 Stuttering Frog

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

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

4.2.2 Brush-tailed Rock-wallaby

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

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

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

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

4.2.3 Large Forest Owls

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

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

4.2.4 Barking Owl

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

4.2.5 Koala

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

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

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

4.2.6 Yellow-bellied Glider

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

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

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

4.3 FIRE AND BIODIVERSITY

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

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

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

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

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

4.3.2 Recommendations for fire management

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

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

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

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

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

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

4.4 PEST SPECIES AND BIODIVERSITY

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

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

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

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

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

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

4.5 OFF-RESERVE CONSERVATION AND LAND ACQUISITIONS

4.5.1 Additions to Wollemi National Park

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

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

4.5.2 Conservation on private lands in the high priority Landscapes

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

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

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

4.5.3 Co-operative pest management

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

4.6 FURTHER SURVEY AND MONITORING

4.6.1 Specific threatened species projects

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

Brush-tailed Rock-wallaby

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

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

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

Stuttering Frog

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

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

Swift Parrot

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

Barking Owl

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

Booroolong Frog

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

Eastern Quoll

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

Regent Honeyeater

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

Spotted-tailed Quoll

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

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

4.6.2 Other future work

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

Fire intensity and detailed vegetation mapping

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

Further frog and small terrestrial mammal surveys

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

Further feral animal surveys

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

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

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

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

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

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

Fauna survey of remote sections of the park

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