South East Timber Association Submission on the NSW Private Native Forestry Code of Practice Review

About SETA

The South East Timber Association (SETA) is made up of a diverse range of people who are a voice for the people directly involved and those who are supportive of the timber industry. SETA seeks to promote the health and wellbeing of the forests and the associated flora and fauna, while maintaining a sustainable and commercially viable resource to support the social and economic base of timber communities.

SETA members are strongly committed to ensuring public forests are available for a range of commercial and recreational activities, while supporting land management practices that maintain environmental values in the long term.

SETA seeks a government commitment that forest policies will strike an appropriate balance between social, environmental and economic outcomes, while minimising adverse impacts on regional communities.

1. General Comments on Forest Management on Public Land.

While SETA is providing specific comments on the Code of Practice for Southern NSW, many of the comments are relevant at the state level.

For more than thirty years, there has been a continual shift of public native forests to formal parks and reserves and informal reserves and harvest exclusion zones on state forest. Along with this transition, a "permanent protection" philosophy and limited budgets have enshrined a management by neglect, rather than active and adaptive management in most of the parks and reserves system.

Permanent protection is underpinned by an assumption that any form of disturbance by fire or machines to soil and vegetation in permanently protected areas is environmentally harmful. This preservationist approach has had perverse outcomes, as the native forest estate has become affected by broadscale decline in forest health and more obviously impacted by environmentally devastating wildfires and megafires.

Science, that in previous decades provided guidance as to how forests could be managed to maintain health and reduce risks of megafires is increasingly undermined by academic activists that promote a terra nullius view of Australia’s forests and selectively report research results to justify a non-disturbance forest management approach across the broader landscape. New generation fire researchers are reinterpreting historical observations of aboriginal fire use to provide a basis for "scientifically" based fire exclusion policies. Human health and ecology are also used to play down the need for the broadscale use of managed fire in Australian native forests.

"High quality wilderness" is actually an artefact of European neglect, rather than maintaining the pre-1750 distribution of each forest type. In most cases, so-called wilderness was actively managed by Aboriginal people. Consequently, much of the conservation reserve system seeks to preserve slabs of land covered by native vegetation, altered in structure, species composition and ecological function.

Private native forests have been increasingly regulated by state and local government to stifle active and adaptive management, but still provide, at times a stark contrast to an increasingly unmanaged public forest estate.
Active management includes grazing, low intensity fuel reduction burning and occasional harvesting operations. The unmanaged public native forest is characterised by die back of the tree crowns and an increasingly scrubbed up understorey, which may be dominated by native or exotic weed species.

**Recommendation 1**

It is recommended that in finalising the Private Native Forestry Codes of Practice, Local Land Services (LLS) ensure that prescriptions do not inhibit ongoing active and adaptive management that delivers a viable commercial outcome and biodiversity outcomes that are superior to large tracts of the NSW conservation reserve system.

2. **Fire Management.**

While the permanent protection/wilderness approach works to limit areas affected by harvesting, ecological damage by wildfires across Australia is a perverse outcome of excluding regular broadscale fuel management from much of the public land base. Activist charities and fire researchers have been key drivers in reducing fuel management burns in recent decades.

The implementation fuel reduction burns (FRBs) has been increasingly regulated over the past 20 years, to manage the perceived environmental impacts of the burning. Minimum return times for FRBs have been specified in the *Guidelines for Sustainable Fire Management 2003*, prepared as part of the NSW *Biodiversity Strategy 2004*.

<table>
<thead>
<tr>
<th>FOREST TYPE</th>
<th>FIRE INTERVAL</th>
</tr>
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<tbody>
<tr>
<td>Wet sclerophyll forest</td>
<td>25 – 60 years.</td>
</tr>
<tr>
<td>Semi-mesic forest</td>
<td>10 – 50 years. Greater than 15 years may be desirable. See photo above</td>
</tr>
<tr>
<td>Swamp sclerophyll forest</td>
<td>7 – 35 years. Greater than 20 years may be desirable</td>
</tr>
<tr>
<td>Sclerophyll grassy woodlands</td>
<td>5 – 40 years. Minimum 10 years on the Southern Tablelands. Greater than 15 years may be desirable.</td>
</tr>
</tbody>
</table>
Dry sclerophyll shrub/grass forest | 5 – 50 years. Greater than 25 years may be desirable.
-- | --
Dry sclerophyll shrub forest | 7 – 30 years. Greater than 25 years may be desirable.

Like much of Australia's biodiversity regulatory framework, the guidelines adopt a terra nullius view of Australian ecology. The terra nullius view effectively denies that Aboriginal fire management had any influence on the development of the Australian biota. Regulatory frameworks are enforcing an exclusion of managed fire, rather than intelligent application of managed fire.

While this document is titled "guidelines," the return times are usually interpreted as prescriptions. Consequently, with the guidelines and a minimal commitment to FRBs by most public land managers, modern day fuel reduction burns often have higher than desirable intensity, as agencies try to apply fire in historically high forest fuel loads, to a high percentage of the planned area, as the specified return times generally preclude "top up" burns in following years, if the actual area burnt is significantly less than planned.

The historical record as detailed in the Bill Gammage book *The Biggest Estate on Earth* and *Firestick Ecology* by Vic Jurskis highlight the adaptation of much of the Australian ecology to the broadscale use of relatively low intensity fire, with very occasional major wildfires. The loss of regular, managed fire across the landscape, is leading to an escalation in the frequency of wildfires across Australia.

When fires inevitably start due to lightning or human causes, heavy fuel loads across the forested landscape increases the risk of fire overwhelming initial attack efforts and burning at a higher intensity than would be the case in forests where there is regular fuel management.

The scan below, from the wildfire near Rosedale in Victoria, which ignited on 4 January 2019, highlights the value of FRBs in breaking up wildfire fronts. The grey and black shows areas with no or very low fire intensity and the red is high intensity fire. The grey wedge between the two areas of red corresponds to a 2017 FRB. This area provides refuge for some wildlife and reduces the overall area impacted by intense wildfire.

Bushfire Heat Scan Near Rosedale Victoria 5 January 2019
The Private Native Forestry Code of Practice for Southern NSW (the Code) largely references fire or burning in relation to fire exclusion from harvest exclusion zones. This general exclusion ensures that any plants and fungi that respond to low intensity burns will decline in number in the exclusion zones and may not give the best environmental outcome, particularly if the area is impacted by wildfire. The perversity of fire exclusion is that when a wildfire is inevitable, the most environmentally sensitive areas, with high fuel loads, will burn most intensely.

**Recommendation 2**

If private native forest owners can demonstrate that low intensity burning can be used to reduce wildfire risk and deliver improved biodiversity outcomes, the code should not enforce a total managed fire exclusion from harvest exclusion zones.

3. **Penalty Regimes Under Section 60ZZA of the Local Land Services Act 2013 (LLS Act) - Offence of Contravening Requirements of Plan or Code of Practice.**

This section of the LLS Act has penalties that are supposed to align with penalties contained in the Protection of the Environment Operations Act 1997 (POEO Act). SETA has great concerns that the alignment of penalties is not what the agencies responsible for this legislation purport it to be.

The maximum penalties of $5 million applying under Sections 115, 116 and 117 of the POEO Act relate to disposal of waste (such as the ABC 4 Corners story on illegal waste dumping, now subject to ICAC investigation), leaks, spillages and other escapes and emission of ozone depleting substances. None of these offences would be expected to occur during native forest harvesting operations.

Section 123 of the POEO Act states that the maximum penalties for water pollution offences are $1 million for corporations and $250,000 for individuals, with additional penalties for continuing offences.

Section 13.1 of the Biodiversity Conservation Act 2016 states the maximum penalty for a Tier 1 offence is $1,650,000 for a corporation and $330,000 for individuals, with additional penalties for continuing offences.
Section 220ZA of the Fisheries Management Act 1994 (FM Act) sets maximum penalties for harming threatened species or ecological communities at 2,000 penalty units or $220,000.

The maximum penalties in the LSS Act 2013 are greatly in excess of the penalty provisions for comparable offences (water pollution and harm to biodiversity) in the POEO Act, BC Act and FM Act. The penalty regime does not differentiate between deliberate clearing of native vegetation without approvals and breaches of a harvest operation approval.

Penalty Notice offences have been increased from to $15,000 for corporations and to $5,000 for individuals. This means potential breaches under the approved plans will be treated with the same severity as operations conducted illegally.

Penalties applying to Part 5A offences under the LLS Act, are included in Schedule 1 of the BC regulations. In relation to Clause 139 (Offence of contravening certain requirements of approvals or certificates), maximum penalties for corporations are $2,200 and $440 for individuals, compared to $15,000 and $5,000.

There is a clear intent to establish the harshest penalty regimes, whether operations are conducted with or without approvals. Those responsible for revising the LLS private forestry penalty regimes have:

- Relied on comparison to irrelevant sections of the POEO Act to justify the maximum penalties for court-imposed penalties;
- Chosen to impose the same penalty for breaches of approved plan conditions (usually at the low end of the environmental impact scale) for penalty notice offences, as would be applied to illegally conducted operations; and
- The size of the fines would not be an issue for the SETA membership, many of whom will be affected by this Bill, if they were confident that the regulating authority could deliver regulatory oversight in a fair and equitable manner.

Recommendations 3

3.1 It is recommended that penalties applying to breaches of approved private native forestry plan conditions be set at the level applying to offences under the relevant provisions of the POEO Act, BC Act and FM Act).

3.2 It is recommended the fines for penalty notice offences be included in the POEO regulations, BC regulation and the FM regulations, rather than all being grouped under the BC Regulations.

3.3 It is recommended the penalty notice regime be set at lower levels (as applies to Part 5A offences under the Local Land Services Act 2013) for breaches of approved private native forest plan conditions, than those that would apply to operations conducted illegally or without the necessary approvals.

4. Private Native Forestry Code of Practice for Southern NSW.

(a) Definition of Clearing

Harvesting, regeneration and thinning is not permanent clearing. The current clearing definition results in an overstatement of the amount of permanent clearing undertaken in NSW each year. The original authors of the definition of clearing were either totally ignorant of the outcomes of native forest harvesting or else have sought to deliberately overstate and so, mislead the Australian public on the amount of permanent clearing undertaken each year.
Recommendations 4

4.1 It is recommended that the definition of "clearing" be amended to only include those activities that result in permanent clearing of native vegetation.

4.2 It is recommended that harvesting, regeneration, thinning and related operations be fully covered by the definition of "forestry operations" contained in the LLS Act, Section 60QZ: Part 5 Definitions.

4.3 It is recommended that all other regulatory instruments that contain the definition of clearing be amended to conform with recommendations 4.1 and 4.2.

(b) Introduction

The introduction to the Code states in part: "...while at the same time maintaining non-wood values at or above target levels considered necessary by society for the prevention of environmental harm and the provision of environmental services for the common good."

What does this actually mean? Are managers of the NSW national parks and reserve system maintaining non-wood values at or above target levels considered necessary by society? If so, how is it monitored and measured? "Target values" is not defined.

Clauses like this can be used by activist bureaucrats to impose currently undefined public good on private land at private cost. Potentially a tool to impose de facto national park status on private land.

Recommendation 5

It is recommended that the quoted section be amended to read: while at the same time maintaining non-wood values at current levels and where desired by the landowner, allowing them to take actions that are reasonably practical, to improve these values.

(c) Repealed Acts

Note: Replacing repealed Acts with the current Acts, should not be overlooked.

(d) Property Vegetation Plans

SETA notes that the EPA will provide digital information of landscape features.

Recommendation 6

If the administrative transfer has not occurred already, it is recommended that this responsibility be undertaken by LLS staff, to streamline administrative processes.

(e) Table A: Minimum Stand Basal Areas

The current table requires the retention of 18 square meters of basal area (BA) in ash/stringybark stands and 16 in tablelands ash, which typically grows on more fertile soils, with higher rainfall than ash/stringybark.

Retained BAs of 16 and 18m² are too high to allow for reasonable volume growth and health of any regeneration resulting from the harvest or thinning operation, particularly on sites of low to medium site quality.

Recommendation 7

It is recommended that the table be simplified and minimum retained BA on all sites be reduced to 10m² per hectare, regardless of site quality. If the intention of the harvest operation is to create a significant regeneration event, it recommended the minimum basal be set at 6m² per hectare.
(f) **Australian Group Selection**

Canopy openings of double the tree length create significant competition for the regenerating stand with impacts on growth rate and health of regeneration within half a tree length of the edge of the circle or about half the gap area.

**Recommendation 8**

It is recommended that Clause 3.2(1) (b) be amended to allow the gap size be increased to four times the stand height. It is recommended that hollow bearing trees be retained with in the opening.

(g) **Regeneration and Stocking**

Clause 3.3(2) defines a regeneration event as a harvesting or thinning operation. As thinning occurs in regrowth stands, with the aim of creating space for the retained regrowth trees to grow to larger diameters and larger crowns. Any regeneration is incidental and not critical to maintaining forest structure.

For operational efficiency, responsibility for specifying regeneration standards should be transferred to LSS and Clause 3.3(5) be amended to reflect the administrative change.

**Recommendation 9**

It is recommended that thinning be removed from the definition of a regeneration event and no regeneration assessment be required after thinning and Clause 3.3(5) be amended as set out above.

(h) **Protection of Landscape Features – Old Growth Identification**

Private and public forest practitioners in NSW have been aware for many years that old growth mapping across the state is riddled with errors. Sample verification by the Natural Resources Commission has highlighted gross inaccuracies, that would appear to confirm the mapping was undertaken by people who, if not less than competent were incompetent in the task of distinguishing old growth from other forest classes.

Forest managers and conservation agencies should not continue to rely on existing mapping and should confirm existence of old growth from on ground inspections and new mapping as it becomes available. If old-growth is so ecologically precious, it must be managed and to do this requires land managers to know where it is.

**Recommendation 10**

It is recommended that the government fund the Natural Resources Commission to remap all NSW native forest to establish the actual location and area of old growth. If possible, this remapping should be extended over time to rainforest and endangered ecological communities and populations.

(i) **Table C: Requirements for Protecting Landscape Features.**

This table locks in terra nullius view that the landscape was not actively managed by Aboriginal people and overlooks those species that require managed fire to perpetuate their food resources or to assist with regeneration of threatened plant species.

Rocky outcrops is one landscape feature, has become a proxy for threatened species protection. However, regulatory creep over the past 15 years has increased rock protection to the extent that only a small proportion of rocky outcrops contain or have potential to contain threatened species. Rocky outcrops now contain more trees and understorey and ground fuels than historic records reveal.
Rocky outcrops should be ideal habitat for a range of species, including reptiles. With too much continuous shade, many reptile species no longer have access to sufficient sunshine to meet their thermo regulatory needs and so fade away. In the case of the broad headed snake, it appears that with much of its' habitat "permanently protected" in the reserve system, the species is being managed, or more accurately, neglected to extinction. Major fire events would likely be adding to population loss and the continued "scrubbing up" of rocky terrain.

Recommendation 11

It is recommended that the code is worded so that management burns are not totally excluded from landscape features of environmental significance and active fire management is used to support the maintenance of ecological values and manage the risk of wildfire damage to ecological values.

(j) Southern Brown Bandicoot (Eastern) (Isoodon obesulus)

Since 2014, Forests NSW, in cooperation with Parks Australia and the Taronga Conservation Society began to transfer Long-nosed Potoroos and later Southern Brown Bandicoots (SBB) to repopulate the Booderee National Park.

This transfer was made possible through the implementation of permanent predator bait stations laid across about 100,000ha of state forest. This methodology was implemented by Victorian public land managers in 2000, after adopting the coordinated baiting program from the Western Australian Department of Conservation and Land Management.

In 2016, the Threatened Species Scientific Committee (TSSC) estimated there were less than 1,000 SBBs in northern NSW, less than 2,000 in southern NSW, less than 10,000 in Victoria and more than 10,000 in SA.

Relevant population information included in the TSSC report, for the southern NSW Code is:

<table>
<thead>
<tr>
<th>Population</th>
<th>State</th>
<th>Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ben Boyd National Park</td>
<td>NSW</td>
<td>44% 1999 to 2008</td>
</tr>
<tr>
<td>Nadgee Nature Reserve</td>
<td>NSW</td>
<td>47% 1999 to 2008</td>
</tr>
</tbody>
</table>

These population declines occurred despite a substantial decline in fox activity due to 1080 baiting in Ben Boyd National Park (Claridge et al., 2010).

Following assessment of this and other information, the Committee advised the Minister that the southern brown bandicoot (eastern) is continuing to decline across its range. The Committee determined that the SBB should retain it's Endangered listing.

The Code protection prescription for Southern Brown Bandicoots (SBB) requires an exclusion zone of about 12.5 hectares be established. The need for this level of protection is an example of a higher burden of protection being required on private property, to make up for the parks and reserves system failing to adequately protect this listed species.

It would appear that any private native forest owner, who has effectively controlled predators and wildfire, which are the major threats to SBBs, will be financially punished, if they have SSBs on their property. The apparent underperformance of the agency that has conservation of threatened and other species at the core of it’s business needs to be addressed.

Recommendation 12

It is recommended that an independent predator control expert be commissioned to undertake a state wide review of NP&WS predator control programs in all parks and reserves to see if the current programs meet best practice standards.
SSB in Forest Subject to Harvesting & Thinning

An Early Indicator That Permanent Baiting Programs Increases SBB Numbers

(k) Threatened Flora 20 and 50 Metre Exclusion Zones

These exclusion zones are an example of blind regulation implemented under the terra nullius ecological "protection" regime. Given many threatened species require disturbance, particularly fire, to flower/seed/regenerate, if the growing threatened species list is to be reduced, these blanket exclusions must be modified to allow active and adaptive management to be undertaken in exclusion zones.

Recommendation 13

It is recommended that the use of fire and other management actions be allowed in threatened flora exclusions zones where it has the potential to provide more sustainable ecological outcomes than management by neglect.

Fire Excluded Foreground and LHS – Ecological Burning RHS

Peter Rutherford
SETA Secretary
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Change in the diet of sooty owls (Tyto tenebricosa) since European settlement: from terrestrial to arboreal prey and increased overlap with powerful owls

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Abstract. The current diet of the sooty owl (Tyto tenebricosa) was determined by analysing freshly regurgitated pellets collected beneath their roosting sites in East Gippsland, Victoria. Comparisons were then made to: i) prehistoric and historic diet from bone deposits found in cave roosts, and ii) diet of a sympatric owl species the powerful owl (Ninox strenua). Sooty owls consumed a large array of terrestrial mammal species prior to European settlement, however, only three terrestrial species were detected in their current diet, a reduction of at least eight species since European settlement. To compensate, sooty owls have increased their arboreal prey consumption from 55% to 81% of their diet. Arboreal species are also a major component of the powerful owl diet and this prey shift by sooty owls has increased dietary overlap between these two species. Predation by foxes (Vulpes vulpes), and other feral species, is likely to have reduced the amount of terrestrial prey available to sooty owls since European settlement. Investigation of sooty owl diet changes may offer a unique monitoring system for evaluating the ability of fox control strategies to influence increases in critical weight range mammals.

Key words: sooty owl; powerful owl; diet shift; competition; fox control
Introduction

Since European settlement in Australia, many non-volant mammals within the critical weight range of 35g to 5500g have suffered major declines in abundance and distribution, while some have become extinct (Burbidge and McKenzie 1989; Dickman et al. 1993; Short and Smith 1994). The exact reasons for these declines are issues of dispute, with attributing factors appearing to include clearing and alteration of habitat, disease, altered fire regimes and the introduction of feral mammals that both compete with and consume native mammals (Burbidge and McKenzie 1989; Dickman et al. 1993; Wilson and Friend 1999).

Although it is difficult to prove the direct historic effect of predation on critical weight range mammals by feral species, there seems to be sufficient evidence for the decline of some mammal species with the introduction of the fox (*Vulpes vulpes*) and cat (*Felis catus*), in addition to the effects previously mentioned (Dickman et al. 1993; May and Norton 1996; Smith and Quinn 1996; Wilson and Friend 1999). What is certain is that, in forested systems, there continues to be high levels of predation on native mammals, particularly by foxes (e.g. Triggs *et al.* 1984; Wallis and Brunner 1987; Brown and Triggs 1990; Lunney *et al.* 1990).

Although foxes are recognized as a major threatening process on small mammal communities in Australia, their impact on other species within the ecosystem is virtually unknown. Introduced predators such as foxes have severely depleted, and are continuing to deplete, a terrestrial prey base that was once available to, and relied upon, by native predators such as Tytonidae owls. In heavily forested areas where introduced species such as European rabbits (*Oryctolagus cuniculus*) and black rats (*Rattus rattus*)
are low in abundance, the effects of a depleted terrestrial food source on native predators are virtually unknown.

One such predator is the sooty owl (*Tyto tenebricosa*) which is a large forest owl occurring in rainforest and wet eucalypt forests in south-eastern Australia (Blakers *et al.* 1984). It is a top order carnivore consuming large numbers of both arboreal and terrestrial mammal species (e.g. Hollands 1991; Lundie-Jenkins 1993; Debus 1994; Kavanagh 2002). The sooty owl often roosts in caves, where regurgitated prey remains can accumulate over thousands of years (Hollands 1991; Morris *et al.* 1997). These accumulations of prey remains provide the opportunity to assess the dietary change of the sooty owl since European settlement, by comparing prey items contained in cave roosts to prey items found in current regurgitated pellets. This not only provides us with information about dietary change in a top order predator, but also about the terrestrial mammals that once occurred in the area and their possible abundance.

A sympatric owl species, the powerful owl (*Ninox strenua*) is also a top order carnivore, however, this species has a diet consisting almost exclusively of medium-sized arboreal, marsupial prey (e.g. Cooke *et al.* 1997; Kavanagh 2002; Kavanagh 2004). Although the powerful owl does not roost in caves it has the potential to become a main competitor of the sooty owl if the sooty owl undergoes a dietary shift away from terrestrial mammals to a diet consisting more of arboreal species.

The overall aim of this study is to assess the sooty owls current diet in East Gippsland, Victoria. With this dietary information two further aims can be assessed: i) to compare the sooty owls current diet to their prehistoric diet (pre European settlement), and historic diet (post European settlement) from cave roosts in the Mitchell River National Park, and ii) to compare the sooty owls current diet to that of a sympatric owl species, the powerful owl where both species occur in the same habitat.
Materials and Methods

Study sites

This study focuses on 11 different sites that contain sooty owl populations within the Mitchell River National Park, the Nicholson River catchment and Lake Tyers Forest Park, in East Gippsland, Victoria (Figure 1). Sooty owl pellets were collected from nine territories within these sites. Powerful owl pellets were also collected from six territories within these sites. Prehistoric and historic diets were determined by analysing bone remains from two cave sites within the Mitchell River National Park. All study sites are located within communities of Warm Temperate Rainforest, Gallery Rainforest and Dry Rainforest, located in ephemeral streams. As rainforest takes centuries to form (Peel 1999), it is likely to have been a similar vegetation type for several hundred years, particularly given the size of many of the rainforest trees in the area (Melick and Ashton 1991).

(insert figure 1 here)

Cave deposits

Sooty owls currently occupy both caves where bone deposits were collected and were identified as the predator responsible for these bone deposits. The deposits were different to characteristic prey assemblages attributed to barn owls (Tyto alba) and masked owls (Tyto novaehollandiae) which are two species also known to roost in caves (Baird 1996). Barn Owls generally consume small terrestrial mammals less than 200 grams (Baird 1996) whereas these deposits contain larger mammals with body weights over 1000 grams. The prey body weight does fall within the range of the masked owl, however, during our study the cave deposits were all located in rainforest, a preferred habitat of sooty owls (Blakers et al. 1984).
Prehistoric diet

Mammalian prey species in the prehistoric diet of the sooty owl from the Mitchell River National Park were determined by analysis of a core sample excavation of bone material from the floor of a cave roost. This cave is still used by a sooty owl, which has been observed on numerous occasions. The core sample was approximately 20cm in diameter and 20cm deep, from a bone deposit 450cm in length, 850cm wide and up to 25cm in depth (Figure 2a). As it was a small sample, percentages of each species were not determined nor were they allocated to a stratified layer. The prey remains were sieved to remove the bones from the soil with all visible cranial material being used for identification, including mandibles, maxilla and teeth.

Historic diet

All visible mandibles were removed and identified from the surface of a bone deposit within a cave roost now rarely used by sooty owls in the Mitchell River National Park (Figure 2b). This deposit is referred to as their historic diet, as it represents a time post European settlement. The surface of two deposits within the cave have been analysed and one is 150cm in length, 125cm wide and approximately 10cm deep (Figure 2c), the other deposit is 110cm in length, 95cm wide and approximately 6-7cm deep. This deposit is 4 km south from the bone deposit where the prehistoric diet was determined. The minimum number of individuals present was determined by counting the number of left or right mandibles, with the most numerous side representing the number of individuals.

(Pellet collection)

Pellet collection

Current owl diets were determined by analysis of freshly regurgitated pellets collected beneath roosting sites of both sooty owls and powerful owls. Pellet collection dates
varied between sites, with sooty owl pellets initially being collected from the Mitchell River National Park in summer 2002/2003, with collections continuing every three to six months until September 2004. Collections from the Lake Tyres Forest Park occurred fortnightly from March until September 2004. When the owl was absent from the roost at the time of collection, the owl species could be determined by analysing the type or position of the roost, the colour and shape of the pellets, the degree of bone fracture within the pellets, the colour of the whitewash and occasionally the presence of feathers. Sooty owl pellets are generally tightly packed and dark in colour, usually containing unbroken bones. Powerful owl pellets (although dark/grey) can be lighter in colour often with broken bones of larger prey, and not as tightly packed (Hollands 1991; Kavanagh 1997). Sooty owl faeces are generally whiter than powerful owl (Kavanagh 1997), but with age, faeces can change colour, particularly after rain, so it was often inappropriate to determine the species on whitewash alone.

The sooty owls current diet was investigated in areas without fox control, and all sites were located at least 4 km from any area considered to have a fox control program in place. Sooty owl pellets were collected from nine sites, and powerful owl pellets were collected from six sites (Figure 1). All sites ranged from the Mitchell River National Park (37°41’S, 147°22’E) in the west, to Nowa Nowa (37°43’S, 148°05’E) in the east. Poisoned baits are laid periodically at the Mitchell River National Park, although it appears that populations of foxes are still relatively high (Glenn McLeod pers. comm.) and is therefore not regarded as having an effective predator control program for this study.

*Prey identification*

Individual pellets were collected separately and placed into labelled envelopes, with location, roost number, date and owl species being recorded. Each pellet was examined as an individual sampling unit. To identify pellet content, each pellet was soaked
individually in hot water until the pellet became soggy and bones began to separate from
the hair with ease. Water was removed by pouring through a sieve and the remains were
placed on a tray to manually remove bones from the hair for identification.
Distinguishable bone material was used for identification and determining the number of
individuals present. Bone material was compared to reference collections from
Melbourne Museum and CSIRO, as well as photographs from Wakefield (1960a, 1960b,
see 1967), Triggs (2001), and drawings from Green (1983). Some pellets contained
insufficient or damaged bone for identification and therefore identification was
undertaken using hair analysis. Hair analysis involved either making whole mounts or
cross-sections of the hair in order to examine the medulla structure and the shape of the
cross-section. These results were then compared with descriptions of hair in Brunner
and Coman (1974).

Statistical analyses
To assess compositional differences between the diets of the two owl species, a
similarity among species matrix was developed using a Bray-Curtis index based on the
percentage of each prey species detected in the diet of each species. Gross differences
between the diet of the species were compared by using ANOSIM (analysis of similarity).
The SIMPER (similarity percentage) procedure was used to identify those prey species
contributing most to the similarity within the two owl species, and the dissimilarity
between groups. Both the ANOSIM and SIMPER procedures were conducted using the
PRIMER software package (Clarke and Warwick 1994). Multi-dimensional scaling was
used to generate an ordination of the similarity of diet (Bray-Curtis Similarity) among the
two owl species.
Results

Sooty owl prehistoric and historic diet

The small core sample from the bone deposit in the Mitchell River National Park, representing the prehistoric diet, contained 20 species of small mammal, of which eight species were arboreal and 12 were terrestrial (Table 1). The more recent historic diet examination of the surface of cave deposits revealed a total of 129 prey items. Of these, six species were arboreal mammals and 11 species were terrestrial mammals. Overall, 55% of the diet consisted of arboreal mammals (Table 1).

Terrestrial prey constituted a significant proportion of the sooty owls historic diet representing 45% of prey items (Table 1). The two most abundant terrestrial species detected in the historic diet were the bush rat (*Rattus fuscipes*) and the southern brown bandicoot (*Isoodon obesulus*), representing 12% and 11% of the total terrestrial diet respectively. The eastern quoll (*Dasyurus viverrinus*) represented 7% of the total terrestrial diet and the remaining eight species comprised less than 4% of the overall total (Table 1). Interestingly, several of the species detected in the prehistoric and historic diet are now extinct or extinct from the area (e.g. white-footed rabbit rat (*Conilurus albipes*), eastern quoll and Hastings river mouse (*Pseudomys oralis*)).

(Insert Table 1 here)

Sooty owl current diet

A total of 972 individual prey items were detected in the 771 regurgitated pellets collected and analysed from areas without an effective fox control program. Of these prey items, 853 were detected in pellets collected from the Mitchell River National Park and 119 were detected in pellets collected within the Lake Tyers Forest Park. Seven different mammalian species were consumed in total, three arboreal species, three native terrestrial species and one introduced species (Table 2). When compared to the
historic diet a significant shift has occurred with 81% of the diet now derived from arboreal mammals as apposed to 55% in the historic diet (Tables 1 and 2). Arboreal prey species were detected in the pellets in larger quantities than terrestrial prey in eight of the nine sites investigated. At least four different mammalian species were consumed at each site with the sugar glider (*Petaurus breviceps*) and greater glider (*Petauroides volans*) representing the two most abundant species detected in the pellets at all sites (Table 2). An average of 2 ± 0.7 (mean ± 1SD) native terrestrial species were consumed at each site with the bush rat representing the most abundant terrestrial mammal detected in the pellets (Table 2). A total of three native terrestrial mammal species were detected in the sooty owls current diet, a reduction of eight species since European settlement (Tables 1 and 2). The second most common terrestrial species in the historic diet, the southern brown bandicoot, was not detected in the current diet. This shift towards mainly arboreal prey may be driving sooty owls into a competitive situation with powerful owls in East Gippsland.

**Sooty owl and powerful owl dietary comparison**

A total of 272 prey items were detected in the 253 powerful owl pellets collected during this study. Powerful owl pellets were collected from six different sites; one from the Mitchell River National Park, one from the Nicholson River catchment and four from the Lake Tyers Forest Park. A total of five mammalian species were detected in the pellets (Table 2). Of the mammalian prey consumed, all were arboreal species, with the greater glider, common ringtail possum (*Pseudocheirus peregrinus*) and sugar glider being the most abundant species detected in the pellets, representing 37%, 25% and 20% of the total diet respectively (Table 2).

(Insert Table 2 here)
Sooty owls were recorded in all six sites where powerful owl pellets were collected during this study. Based on Bray-Curtis similarity indices, there was a significant difference in the diet between sooty owls and powerful owls (ANOSIM), with two of the 999 random permutations exceeding the global R statistic (0.481, p<0.01) (Figure 3). The three main arboreal mammalian species detected in the sooty owl pellets were, however, also the main species detected in the powerful owl pellets. These three species, the sugar glider, greater glider and common ringtail possum represented over 81% of prey items detected in both owl species diet (Tables 2). Although both species consume the same three prey species, they do so in different quantities. Sooty owls consume more sugar gliders and terrestrial prey than powerful owls, which only consume arboreal prey and birds, preferring larger prey such as greater gliders and common ringtail possums (Table 3). The greatest degree of overlap occurred in consumption of greater gliders and sugar gliders whereas birds and terrestrial prey contributed to the dissimilarity between prey (Table 3).

Discussion

Arboreal prey dominated the current sooty owl diet in both the Mitchell River National Park and Lake Tyers Forest Park, to a degree not previously recorded in other dietary studies (e.g. Hollands 1991; Holmes 1994; Kavanagh 1997). This high level of arboreal prey consumption appears to be a relatively recent occurrence as prior to European settlement large numbers of terrestrial prey were consumed. Thirteen species of terrestrial mammal were once consumed in the Mitchell River National Park, with eleven of these occurring on the surface of one bone deposit, indicating the vast array of terrestrial prey available to and consumed by sooty owls until soon after European
settlement. Of these eleven species, the white-footed rabbit rat is now extinct, the
eastern quoll is extinct on mainland Australia, four species have not been recorded in
the area, and only five species have been recorded in the immediate area of the Mitchell
River National Park (Menkhorst 1995). Of these five species, only three are currently
detected in pellets, and the other two are most likely in low abundances. The southern
brown bandicoot and long-nosed potoroo (Potorous tridactylus) occur in the Lake Tyers
Forest Park, but have not been recorded in the Mitchell River National Park. There has,
therefore, been a major reduction of terrestrial prey species available to sooty owls since
European settlement, with eight of the eleven species currently unavailable as prey.
A similar array of species was also consumed by sooty owls prior to European
settlement from Marble Arch (Hall 1977 see Hollands 1991), Jenolan (Morris et al. 1997),
and Buchan where the attributing Tyto owl species is unknown (Wakefield 1960a;
1960b; 1967; 1972), indicating the large number of terrestrial prey available to sooty
owls prior to European settlement across their distribution.
Prey remains found in sooty owl cave roosts (including Buchan) indicate that the
Conilurini tribe of rodents was one of the most consumed prey groups prior to European
settlement. This group, however, has suffered the greatest decline of any terrestrial
mammal group in Australia since European settlement (Smith and Quinn 1996) and are
virtually non-existent in the current sooty owl diet (Smith 1984; Loyn et al. 1986;
Native terrestrial species less affected by European settlement, including the bush rat
and Antechinus species, appear not to be consumed significantly more by sooty owls
than they were historically. Introduced species including European rabbits and black rats
occur in low abundances in undisturbed forested areas (Menkhorst 1995) and are
therefore rarely consumed by sooty owls; when they do feature in the diet, it is in close
proximity to human settlement and relatively disturbed environments (Lundie-Jenkins
In most forested areas, there has been a reduction of terrestrial prey biomass that has not been supplemented by a dominant native species, or by introduced prey species. So without an alternative terrestrial food source in many forested areas, sooty owls have shifted their diet to consume more arboreal prey, rather than exploring alternative habitats where terrestrial species, such as introduced species are more abundant. Unlike the masked owl, which is more of a habitat generalist capable of occurring in areas where large numbers of introduced terrestrial prey are available, the sooty owl is a habitat specialist (Mooney 1993; Kavanagh 1997; 2002). Arboreal prey species are still in high abundance in most forested areas, and have been less affected since European settlement than many terrestrial species, and are therefore heavily consumed by sooty owls in areas where terrestrial prey are in lower abundance.

Where sooty owls currently consume large numbers of arboreal prey, they are possibly competing with a large sympatric owl species, the powerful owl, which almost exclusively consumes arboreal prey (e.g. Tilley 1982; Pavey 1994; Wallis et al. 1998; Cooke et al. 2002; Kavanagh 2002). The powerful owls distribution overlaps the entire range of the sooty owls (Blakers et al. 1984; Barrett et al. 2003), and they are known to often co-exist in the same habitat type (Hyem 1979; McNabb 1996; Kavanagh 1997; 2002). This study has shown that powerful owls still consume large numbers of arboreal prey in the same habitat where sooty owls occur. This high level of dietary overlap is unusual and probably did not evolve this way, instead increasing due to the reduction in terrestrial prey available for the sooty owl since European settlement.

Usually sympatric owl species differ in habitat selection if hunting aspects are similar, or they occur in the same habitat and consume different prey, resulting in low levels of interspecific competition (Lack 1946; Lundberg 1980; Hayward and Garton 1988; Kavanagh 2002). This shift towards a competitive system between sooty owls and powerful owls may have serious ecological consequences. Reduced reproductive output
could occur, as seen in competing tawny owls (*Strix aluco*) and long-eared owls (*Asio otus*) (Nilsson 1984), potentially affecting the population size. Increased predatory pressure on arboreal mammals may reduce their abundance and result in both powerful owls and sooty owls seeking to extend their home range size. Ultimately this may lead to a reduced density of both powerful owls and sooty owls in East Gippsland, increasing the risk to both species in the long term.

As the sooty owl is a generalist predator, potentially consuming all arboreal and terrestrial prey species available to them under 1500g, it is likely that their diet is an indicator to the current health of small mammal communities in an area. As it appears that they consume the most abundant mammal species available to them, sooty owls could offer an ideal model for monitoring post fox-baiting responses by terrestrial mammals. It would be expected that if significant changes occur in the availability of critical weight range mammals (the goal of fox baiting) these species will also start to appear more frequently in the sooty owl diet. Sooty owl populations may also exhibit a marked numerical response to an increase in the available terrestrial prey base.

**Acknowledgements**

We thank Andy Murray for information and advice on fox baiting strategies in the study area. Bill Peel and John Burns are thanked for advice on rainforest locations and Ken Aplin is thanked for his assistance with historical bone identification. Julie and Bob Hollingsworth are also thanked for providing knowledge on the Nicholson River powerful owls and the Goldsmith family for giving permission to access their property. Roger, Carolyn and Adam Bilney, Rob Grant, Fiona Hogan, Peter Kambouris and David Hollands are thanked for support in the field and the advice they so willingly provided. This research was undertaken by permit numbers 10002313 and 10002809 from the Department of Sustainability and Environment.
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Green, R. H. (1983). ‘An illustrated key to the skulls of the mammals in Tasmania.’ (Queen Victoria Museum and Art Gallery: Launceston.)


Lundberg, A. (1980). Why are the ural owl (Strix uralensis) and the tawny owl (S. aluco) parapatric in Scandinavia? Ornis Scandinavica 11, 116-120.


Table 1. Prehistoric and historic diet of sooty owls from the Mitchell River National Park

Numbers are in percentages, with (P) representing the presence of a species. Common names follow that of Strahan (1995). Historic diet is derived from 129 prey items.

<table>
<thead>
<tr>
<th>Prey species</th>
<th>Prehistoric</th>
<th>Historic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arboreal Mammals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>common ringtail possum</td>
<td>P</td>
<td>34</td>
</tr>
<tr>
<td>greater glider</td>
<td>P</td>
<td>10</td>
</tr>
<tr>
<td>sugar glider</td>
<td>P</td>
<td>8</td>
</tr>
<tr>
<td>eastern pygmy possum</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>yellow-bellied glider</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>leadbeater’s possum</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>feathertail glider</td>
<td>P</td>
<td>-</td>
</tr>
<tr>
<td><em>Trichosurus</em> sp.</td>
<td>P</td>
<td>-</td>
</tr>
<tr>
<td>Total Arboreal Species</td>
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<td>6</td>
</tr>
<tr>
<td><strong>Total Percentage Arboreal</strong></td>
<td></td>
<td>55</td>
</tr>
<tr>
<td><strong>Terrestrial Mammals</strong></td>
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<td></td>
</tr>
<tr>
<td>bush rat</td>
<td>P</td>
<td>12</td>
</tr>
<tr>
<td>southern brown bandicoot</td>
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<td>11</td>
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<td>eastern quoll</td>
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<tr>
<td>broad-toothed rat</td>
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<tr>
<td>long-nosed potoroo</td>
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<td>3</td>
</tr>
<tr>
<td>long-nosed bandicoot</td>
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<td>3</td>
</tr>
<tr>
<td>Hastings river mouse</td>
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</tr>
<tr>
<td>agile antechinus</td>
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</tr>
<tr>
<td>dusky antechinus</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>swamp rat</td>
<td>-</td>
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</tr>
<tr>
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</tr>
<tr>
<td>smoky mouse</td>
<td>P</td>
<td>-</td>
</tr>
<tr>
<td>brush-tailed phascogale</td>
<td>P</td>
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<tr>
<td>Total Terrestrial Species</td>
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</tr>
<tr>
<td><strong>Total Percentage Terrestrial</strong></td>
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## Table 2. Sooty owl and powerful owl diet within Mitchell River National Park and the Lake Tyers Forest Park
*sd = 1 standard deviation*

<table>
<thead>
<tr>
<th>Prey species</th>
<th>Sooty Owl (972 prey items)</th>
<th>Powerful Owl (272 prey items)</th>
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<td>Prey items</td>
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<td><strong>Arboreal mammals</strong></td>
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<td></td>
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<tr>
<td>sugar glider</td>
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<td>9</td>
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<tr>
<td>greater glider</td>
<td>210</td>
<td>8</td>
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<tr>
<td>common ringtail possum</td>
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<tr>
<td>yellow-bellied glider</td>
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<td>1</td>
</tr>
<tr>
<td>common brushtail possum</td>
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<td>1</td>
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<td><strong>Total Arboreal</strong></td>
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<tr>
<td><strong>Terrestrial Mammals</strong></td>
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<tr>
<td>agile antechinus</td>
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<tr>
<td>dusky antechinus</td>
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<td>2</td>
</tr>
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<td>European rabbit</td>
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<tr>
<td><strong>Total terrestrial</strong></td>
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<td><strong>Birds</strong></td>
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<td>5</td>
</tr>
<tr>
<td><strong>Insects</strong></td>
<td>8</td>
<td>2</td>
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Table 3. Percentage contribution of species to similarities between the diet of sooty owls and powerful owls, and to dissimilarities between sooty owls and powerful owls based on Bray-Curtis indices (SIMPER). Values are only provided for those prey species contributing to 90% of the similarity and dissimilarity of the owls diet.

<table>
<thead>
<tr>
<th>Prey species</th>
<th>Similarity (% contribution)</th>
<th>Dissimilarity (% contribution)</th>
<th>Mean composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sooty Owl</td>
<td>Powerful Owl</td>
<td>Sooty Owl</td>
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<tr>
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<td>55.31</td>
<td>21.90</td>
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<td>greater glider</td>
<td>21.75</td>
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<td>bush rat</td>
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<tr>
<td>birds</td>
<td>-</td>
<td>10.88</td>
<td>14.38</td>
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Figure Headings

Figure 1. Locations of sooty owl and powerful owl pellet collection sites, in East Gippsland

Figure 2. Cave roosts of sooty owls where prehistoric and historic diets were analysed.
a) the prehistoric diet cave, with the square indicating the excavation site, b) the historic diet cave, arrow pointing to cave entrance, c) part of the bone deposit in the historic diet cave, after the mandibles were removed.

Figure 3. Multi-dimensional scaling ordination of owl diets in East Gippsland, based on Bray-Curtis similarity measures of dietary composition.
▲ = Sooty Owls; ■ = Powerful Owls. (Stress = 0.11).